

ABOUT THE CONCEPT OF IMPROVING BORDER DEFENSE LINES BY MEANS OF LANDSCAPE ARCHITECTURE

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Abstract. The article presents the authors' scientific work on the improvement of border defense lines with the help of landscape architecture. The highlighted issues are extremely relevant for the entire European community, especially for the residents of Ukraine. The territories of the states bordering the aggressor country must be strongly fortified, have defensive positions, points, fortifications and fences. Publications related to the war, the protection of the population, and the arrangement of life under martial law appeared in Ukraine. But the question of inclusion of landscape architecture means in defensive fortification lines rarely occurs in practice. The authors use an environmental approach to address these issues. The authors monitored the environment and considered the natural framework. It includes pronounced natural components - forests, open spaces, hydrographic network, etc. The methods and concepts of landscape architecture are also used in this study. A brief history of the development of the fortification case is presented. Fortifications that were built in European states in the period between the two world wars are considered. The most famous of them are: the Siegfried Line (Germany), the Maginot Line (France), the Mannerheim Line (Finland), the Metaxas Line (Greece), the "dragon teeth" tank barrier in the Alpine Mountains ("Alpine Wall"). An analysis of the current situation in the Russian-Ukrainian war was made. When strengthening borders, it is important to build dual-purpose artificial objects, use objects of natural or natural-anthropogenic origin, in particular – means of landscape architecture. It was found that, first of all, communication routes should have a clear system of defensive engineering structures. They must be activated immediately after the start of armed aggression against the country. The conditions of the geographical environment have always had a significant impact on the character, methods of conducting hostilities and their organization. This is also essential for arming soldiers, clarifying the possibilities of using the types and kinds of armed forces. Therefore, the influence of natural factors in military activity is significant. Analysis and assessment of the situation on the ground is an important step in the development of a preliminary plan of combat tasks. Those means of landscape architecture that are useful in the development of defense affairs have been identified. Among them are the relief of the area and vegetation, their characteristics, options for their solution. A system of fortified areas equipped with long-term fortifications and fences along the state border should be Ukraine's nearest prospect. Areas of land of natural origin should become defensive fortifications during the period of active offensive actions of the enemy. In the southern and eastern regions of Ukraine, there are no natural barriers for enemy ground forces. Therefore, it is worth using agro-recreational and agro-production areas. It will be a significant addition to the main system of long-term fortification.
Keywords: fortification district, defensive line, dual purpose objects, means of landscape architecture

Introduction

Since ancient times, for all peoples, the protection of borders and the territory of their residence is an integral part of military affairs. In order to solve the problems of countering enemy attacks, they learned to prepare in advance – they strengthened borders and settlements, created artificial shelters and obstacles. This strengthened the defense capability of the army. In general, such artificial shelters and obstacles are divided into long-term and field. Long-term – are early fortifications of extremely important directions for the purpose of defense. At the same time, in the course of improving the types of offensive weapons, there was a need to reconstruct defensive objects of long-term fortification. There was even a need to dismantle them and build modern fortifications in their place.

The historical experience and events of the current aggression of the Russian Federation against Ukraine show that the country must have fortified lines. We mean having a system of fortified areas, defensive positions, nodes of resistance and strongholds, equipped with long-term fortifications and barriers. They should be built primarily along the state border to cover important directions. At the same time, the cost-effectiveness or environmental friendliness of such valuable structures is usually ignored. Therefore, in our opinion, other

approaches and means should be used to strengthen the country's borders. It can be about the construction of artificial objects of dual purpose and the involvement of natural or natural-anthropogenic objects, in particular, means of landscape architecture, for defense purposes.

Materials and Methods

The purpose of this publication is a brief analysis of the history of the fortification's development and the identification of ways to improve border defense lines by means of landscape architecture.

The authors of this article are specialists in the field of urbanism, planning organization of settlements, their recreational areas, landscape architecture and design. Considerable theoretical and practical experience in these issues and the situation in Ukraine pushed the authors to search for effective measures capable of strengthening the defense capability of the country and its military formations. The author's previous works concern a number of important landscape issues related to the formation of park areas [1], boulevards [2], courtyards of multi-story residential buildings [3; 4], historical park areas in the palace and park ensembles of Ukraine [5; 6] and the issue of landform architecture [7]. At the same time,

the author's experience in the formation of recreation systems in Ukraine is important in these matters [8; 9; 10], ecological and agroecological settlements [11]. Separately, some issues of the development of defensive urban planning should be highlighted [12]. Recently, a number of publications have appeared covering issues related to the war, the protection of the population, and the arrangement of life under martial law. Among them, scientific developments in this area are relevant, in particular, by such authors as Koval M. [13], Khandiy O., Karachevtseva M. [14]. Materials authored by teachers of military higher education institutions are valuable. They are based on the experience of tasks performed by the country's defense forces in the Russian-Ukrainian war, including personal experience [15; 16; 17]. These materials are presented in special educational manuals, access to which is limited to the general public.

In general, the issue of including the means of landscape architecture in the defensive lines of long-term fortification is not widely covered in literary sources and rarely occurs in practice. Therefore, these issues remain relevant not only for Ukraine, which is fighting for its right to its own independent life in European society. It is also timely for other countries, especially those that border the aggressor country.

In general, methodology as a teaching about the system of scientific principles, forms and methods of research activity has a four-level structure. There are philosophical principles, general scientific principles (which constitute the actual methodology), scientific principles of a specific scientific field, as well as a system of specific methods and techniques for solving special research tasks. This constitutes the methodology itself – a collection of research methods, together with techniques and various operations with actual material [18]

Among the existing trends in the development of the methodology for the analysis of urban planning objects, it is appropriate to focus on the environmental approach in this scientific study. It uses such concepts as environmental monitoring, natural framework, which includes pronounced natural components – forests, open spaces, hydrographic network, etc. In turn, the possible landscape character of the natural framework is determined at the level of local settlement systems. This is the composition of components, their potential, structure and degree of connection. In this case, the use of the geographical conceptual and terminological system should also be correct. In particular:

- location – the specific state of the distribution of certain phenomena on the territory;
- density – a degree of saturation of a certain territory with any objects;
- dispersion is a concept opposite to density, that is, it is the area of the territory that falls on each object of this class (average distance between objects, average radius of the territory that falls on a certain object);
- limit density - the maximum possible density of the phenomenon in a certain territory;
- the potential of the territory – the ratio between the actual density and the marginal density in changing conditions, and others.

The methods and concepts of landscape architecture are also used in this study.

A brief history of the fortification development

In general, the history of fortification can be divided into the following four periods [19]:

- 1st period – from ancient times to the appearance of fire artillery, that is, to the XIV century;
- 2nd period – from the XIV century before the

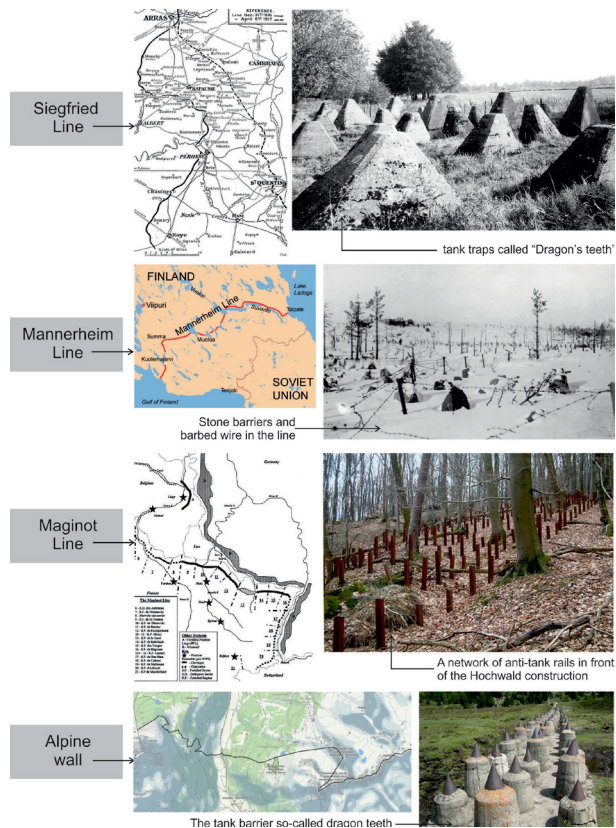


Fig. 1. Fortified fortification lines in European countries [from V. Shulyk scheme]. Photos are from open sources [21, 22, 23, 24]

introduction of rifled artillery, that is, until the middle of the 19th century;

- 3rd period – the middle of the 19th century – 1885, invention of high-explosive bombs;
- 4th period – the period of high-explosive bombs – to the present time.

In general, fortification is a military science of artificial shelters and obstacles that strengthen the location of the army during battle and are called fortification structures (from the French fortifier – to strengthen). It is believed that the theory of fortification was developed by Albrecht Dürer.

Fortification as a science of artificial shelters and barriers is divided into 3 groups: I – field, II – long-term, and III – temporary [20]. Among them, it is long-term fortification that considers shelters and obstacles that serve to strengthen the defense of particularly important military strategic points or directions of the country. Their meaning is usually established in advance before the war and is preserved for the entire duration of hostilities. This kind of fortification is interesting for us, and its filling can be enhanced by means of landscape architecture.

The gradual development of artillery and other military systems prompted the emergence of new options for long-term fortification. After the 20s of the 20th century, the idea of "Feste" was implemented. It no longer represents a reference point, but a reference area. It looked improved as follows: fortified lines, consisting of fortified areas, began to be used to prepare the territories of countries for fortification [20]. In the period between the two world wars, such fortifications were built in many countries of Europe and Asia. The most powerful of them are known under generalized names: the Siegfried Line (Germany), the Maginot Line (France), the Mannerheim Line (Finland), the Metaxas Line (Greece), the "dragon teeth" tank barrier in the Alpine Mountains ("Alpine Wall"), Fig. 1. A powerful fortified line was built in Manchuria



Fig. 2. Map of the main directions of movement of the Russian army on the territory of Ukraine (as of March 6, 2022) [from V. Shulyk scheme]

and on many Pacific islands by Japan after the occupation of a number of Southeast Asian countries. England, Argentina and other countries also built their fortified areas.

Fig. 1. Fortified fortification lines in European countries [from V. Shulyk scheme]. Photos are from open sources ([21, 22, 23, 24])

Taking into account the way in which such objects were created, the following can be stated:

- defensive objects of long-term fortification in the course of their formation required not only skill from the performers, but also long time and significant financial costs for construction. The economic efficiency of this issue was not usually the main one.
- with the change or improvement of the types of offensive weapons over a long period of time, the need arose for the reconstruction of defensive objects of long-term fortification or even their dismantling and the construction of modern fortifications in their place.

Analysis of the current situation in the russian-Ukrainian war

Having considered a current example – the invasion of the army of the Russian Federation on the territory of Ukraine, starting from February 24, 2022, it is possible to establish how the army of the aggressor country moves on the territory of another country, its certain directions. Consider, for example, the situation at 10:00 a.m. on March 6, the 11th day of the invasion (according to Yuriy Butusov) [25]. Here it can be seen that the directions of the enemy's movement mostly coincide with the directions of the existing communication routes with a hard surface (Fig. 2).

You can also quite clearly observe the directions of movement of the Russian army deep into Ukraine in the first days of the war based on data from the Center for Countering Disinformation at the National Security and Defense Council of Ukraine. The department explained that the Russian occupiers do not control the territories – instead, they temporarily control the roads and some settlements. The map presented by Nathan Ruser from ASPI Cyber Policy (Fig. 3) displays the most up-to-date and correct information - without manipulation of the territory [26]. This map should not necessarily be considered

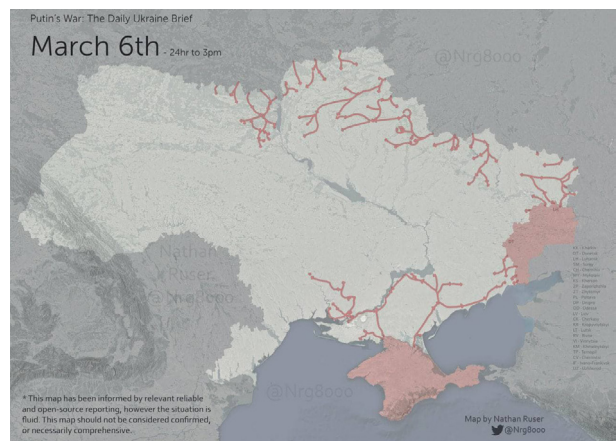


Fig. 3. Map by Nathan Ruser as of 03.06.2022 [from V. Shulyk scheme]

exhaustive. However, despite the above, it is clearly visible here that the Russian army is moving deep into the territory of Ukraine along the existing paved roads. They capture primarily the areas adjacent to highways. That is, it can be clearly indicated that the capture of the Ukrainian territory by the aggressor took place using the anthropogenic framework existing in the border regions of Ukraine. Its content and design features already have separate generalizations [8, 9, 10].

Such a framework includes international and state highways, railway lines, as well as paved roads of local importance, along with streets and roads of nearby cities and other settlements. Taking into account the existing experience of previous years, it can be indicated that the transformational processes during and after the resolution of the military conflict on the territory of Ukraine include the decentralization of power, changes in the sectoral structure, strategic management of the use of internal resources and their recovery, balanced development of all regions, international and state support for the recovery of the affected territories, application of self-development tools [14]. Strategic orientations and plans for the recovery of territories from military operations should change in general in the conditions of post-conflict transformation. As for the conditions for arranging the border, we can agree that in the best case, the border between Ukraine and Russia will be

like the border between North and South Korea, only more powerful and full of weapons. Exclusion strip, minefields, anti-tank ditches, surveillance cameras, patrolling drones, fortifications, targeted map [27].

Means of landscape architecture in the development of defense affairs

Taking into account the history of the development of architecture, starting from the time of Vitruvius (usefulness, reliability, beauty) to the present day, the requirements for architectural objects have changed in the direction of their increase. Today, their list can be defined as: beauty, convenience, reliability, environmental friendliness and economy. Such a list is not possibly the most comprehensive, but it allows a more balanced approach to making certain decisions in the field of construction in general, and in the construction of defense objects of long-term fortification in particular. From the point of view of the system approach, we know that any architectural system has its limits and exists in a certain "external" world. They are outside the set of elements of this system and influence it. Such influence is external factors: demographic, social, economic, spheres of production and consumption, scientific and technical, climatic, topological and others. They are perceived by the corresponding elements of the system, interpreted by the system into internal factors. Those, in turn, cause one or another reaction of the system or individual groups of its components (subsystems) [28]. That is, fortification objects are also influenced by various factors. And most importantly, they lack such criteria as economy and environmental friendliness. Therefore, in our opinion, other approaches and means should be used to strengthen our borders. It can be about the construction of artificial objects of dual purpose and the use of objects of natural or natural-anthropogenic origin, in particular, means of landscape architecture.

First of all, here it is possible to clearly single out the opinion that the communication routes should have a clear system of defensive engineering structures. They should be activated immediately after the start of armed aggression against our country. Such objects, and a sufficient list of them can be found [29], in our opinion, should be designed as dual purpose objects – both civil and military. At the specified time, it should be possible to quickly transform them into a defensive object by moving supporting or other structures or, finally, by blowing up supports or walls. Special specialists should work on this issue regarding the construction of dual purpose artificial objects within fortified areas. Such objects are not considered in this study.

Secondly, when assessing the role of natural factors in military activity, it should be assumed that the conditions of the geographical environment have always had a significant impact on the nature, methods of conducting hostilities, their organization, and armament, the possibility of using weapons, and the types and kinds of armed forces. The connection of natural conditions in military affairs has a historically variable character. Depending on the development of means and methods of armed struggle, the scale of wars, it acquires new features and trends. It is known that forest massifs and wetlands are impassable for ground military equipment. Such areas of land served and can continue to serve as excellent defensive fortifications during the period of active offensive actions of the enemy. The network of such territories has already been used today for defensive purposes and may be widely used in the future in the northern regions of Ukraine. An important step in the development of a preliminary plan for solving combat tasks is the analysis and assessment

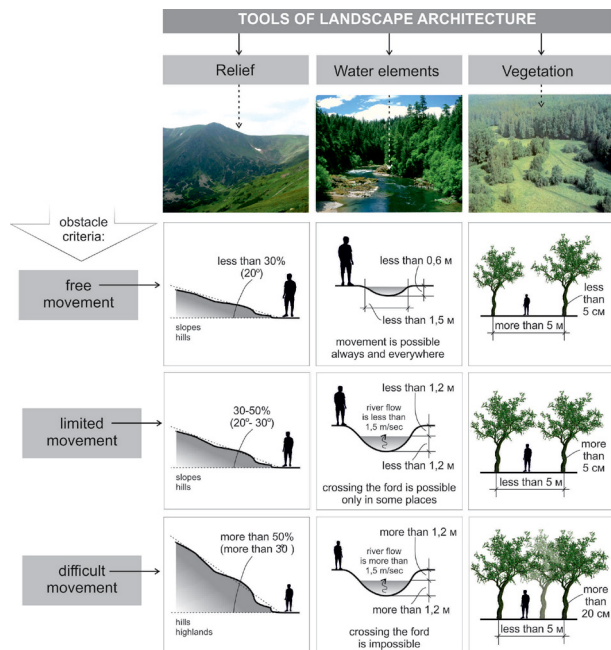


Fig. 4. The influence of landscape architecture tools on determining the criteria for obstacles to the movement of military formations [from L. Shevchenko scheme based on the materials of D. Okipnyak, O. Neshchadin, G. Kovalov]

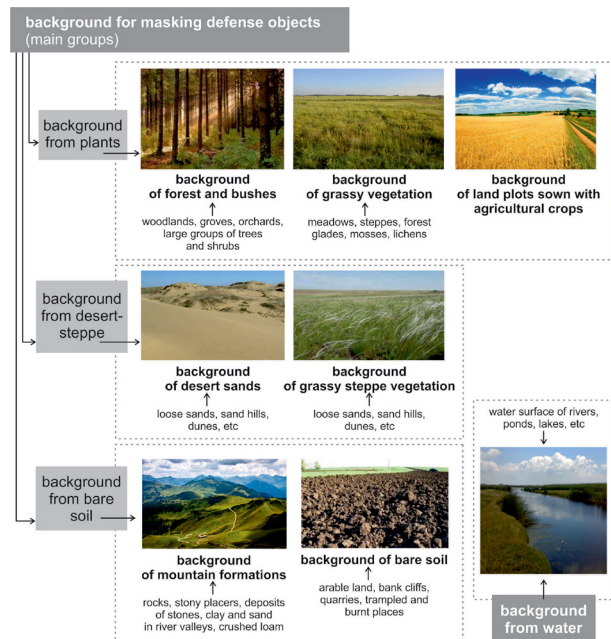


Fig. 5. The background texture of the terrain as the main carrier of visual structural and color characteristics for camouflage [from L. Shevchenko scheme based on the materials of A. Karshen, S. Tsybulya, O. Galushka]

of the situation on the terrain. Here we consider how the territory, terrain, as well as weather (climate) conditions can affect the performance of the task. The area is considered from the point of view of military aspects [15]:

- obstacles on the terrain;
- avenues of approach;
- key terrain areas;
- observation conditions;
- concealment and cover.

The analysis includes all elements of the environment of the given area, which significantly affect the performance of the task. A general picture of the surface of the area is being developed. It reveals the existing natural and artificial obstacles that can limit the army's performance of its assigned tasks, its movement and mobility (stop, redirect, impede movement). As a result of such an analysis, the terrain is

divided into three main types – passable (absolutely does not hinder the movement of armies), limited passable (slows down the pace of movement, complicates movement at the required pace), impassable (greatly hinders the advance of the army, therefore requires additional engineering actions) [15]. In military terms, natural obstacles include “rivers, forests, mountains, gorges, gaps, ravines, and ditches more than 3 meters wide, tree stumps and large rocks higher than 18 inches (45 cm), forests with trees 8 inches (20 cm) thick) and more with a distance between trees of less than 4 meters” [15]. Based on the received data, the military determined the criteria for obstacles that in one way or another affect the movement of army (Fig. 4).

This study makes it possible to reveal those qualities of the existing territory, its topography, which become important natural assistants in the creation of defensive structures. According to one of the concepts of the European Charter of Cities (1992), human activity takes place within the boundaries of an urban center based on the archaeological and topographical foundation. This is evidenced by the first such settlements on elevated terrain (cliffs, plateaus, heights, hills, mountains, rocks, etc.). This made it difficult for enemies to access them. Even better, such a solution “worked” in combination with water elements. Our ancestors used all possible means of landscape architecture (relief, water elements, and vegetation) to create a safe and protected environment for their life activities.

In the modern realities of life during war, one of the key terms of our daily existence is “quick” – quick response to a threat, quick strengthening of defenses, quick defense and self-defense. In such cases, the use of objects and elements of the existing environment is important and effective. Speaking in the language of the military, this is “adaptation of local objects” when there is not enough time for engineering work [16]. At the same time, “only those local objects that occupy a sufficient area, have a long length, or are located on the terrain in a significant number” [16] can be used in battle. That is, everything that maximally reflects the naturalness of the territory, its relief, the landscape as a whole, without arousing the suspicion of the enemy. This process is complicated by the diversity in the actions of the enemy camp. Currently, in the 21st century, a complex approach to obtaining intelligence data, the maximum use of various modern high-tech means for air, space and ground visual surveillance has become characteristic. In particular, the use of optical devices, optical-electronic, thermal, radio and radio engineering equipment, radar and sound devices for this purpose. Such an arsenal of intelligence tools testifies to the vulnerability of our army and its locations from different angles of the enemy's view. This encourages the maximum use of the terrain, its characteristics (both positive and negative), landscape means for protection, camouflage, deployment of our military in open terrain, as well as for disorientation and misinformation of the enemy. Currently, military specialists have confirmed the effectiveness of using landscape architecture tools as:

- obstacles to the movement of enemies;
- masking the movement routes and location of our army;
- imitation of the activities of our army to mislead the enemies;
- ground observation of enemy actions;
- locations of firing points, shelters for protection against enemy attacks [16].

The surrounding environment and characteristics of the terrain have a significant influence in the process of determining the organizational and engineering measures that must be carried out by the military in a particular place.

On the one hand, they act as a background for defense and military objects when they are camouflaged, and on the other hand, they are an object of the enemy observer's field of vision. Here, such characteristics of the area as color, texture, surface pattern are taken into account. The background has a different texture – from rough, typical of freshly excavated earth and rubble, and shaggy, like a grass or mossy surface, to smooth, showing sand and concrete. The mirror surface is demonstrated by polished metal, glass and the calm surface of water. The vast majority of characteristics are formed by the vegetation that prevails in a particular area, and climatic and seasonal characteristics. According to data [16] the following main groups of backgrounds are distinguished: vegetation, desert-steppe, and bare soil backgrounds (Fig. 5).

Among them, the group that forms the plant background is the most effective. It is dense vegetation in the form of combinations of trees and shrubs that create favorable conditions for camouflage from ground, air and space reconnaissance. Forests are the best natural camouflage. Their masking quality depends on the species composition, density of plantings, their height, structure (tiering), and the level of urbanization (the presence of roads, footpaths, or vice versa – overgrowth, brushwood, etc.). The color scheme of the background is dependent on both weather conditions and the season. After all, some plants change their leaf color in autumn and remain without it in winter. Therefore, the background formed by coniferous forests with evergreen plants, coniferous groves and shrubs that keep their leaves all year round is considered the most stable.

On the basis of military studies and real events, it was found out how one or another means of landscape architecture can be used for the above purposes.

Vegetation

High vegetation is used in the form of tree plantations, medium and low in the form of shrubs and crops of various herbs, respectively. Dense plantings like a dense forest with trees and shrubs can make it much more difficult for enemies to observe, take photos and video. Dense green plantings act as shielding elements. They make it possible to hide objects from enemy optical, electronic, and thermal reconnaissance means. Forests are also an effective countermeasure to enemy sound reconnaissance [16]. The process of masking with living vegetation involves the implementation of certain works. Among them is turfing of surfaces followed by sowing of herbs and planting of trees and shrubs. The most effective is the planting of plants that provide a significant masking volume – seedlings and cuttings. A number of factors influence the choice of plant material: time, available resources and forces, as well as the local climate, soils and vegetation of a specific area. Local species of trees and shrubs with a branched root system are chosen for such tasks. They are able to grow quickly, regenerate with sprouts, and form extensive thickets. Some methods of using plants are shown in Fig. 6.

Relief

The characteristics of the earth's surface are actively involved in arranging firing points with various firearms (machine guns, mortars). Notches, ditches, steep banks of ravines, their bottoms are most actively used on flat and sloping surfaces. When setting up the points, it is important to observe the visual characteristics of the terrain – not to violate the relief lines, its structure, color, not to unmask the appearance with freshly dug earth, especially from a slope open to enemies. The hilly terrain does not allow you to go deep. Therefore, fortification structures are recommended to be constructed

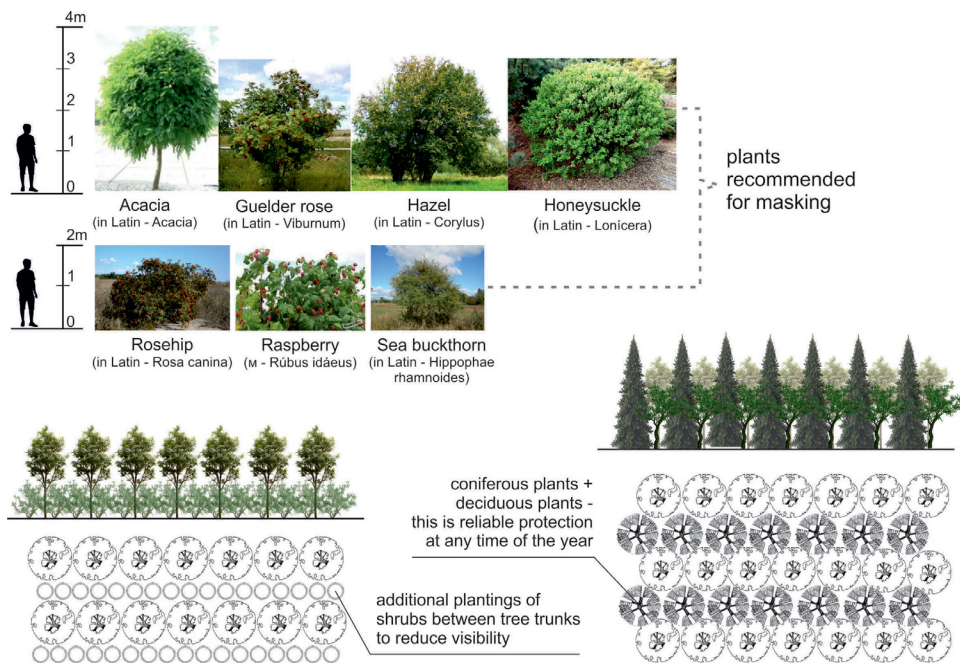


Fig. 6. Recommended plants and methods of their use for camouflage and barrier purposes [from L. Shevchenko scheme based on the materials of A. Karshen, S. Tsybulya, O. Galushka]

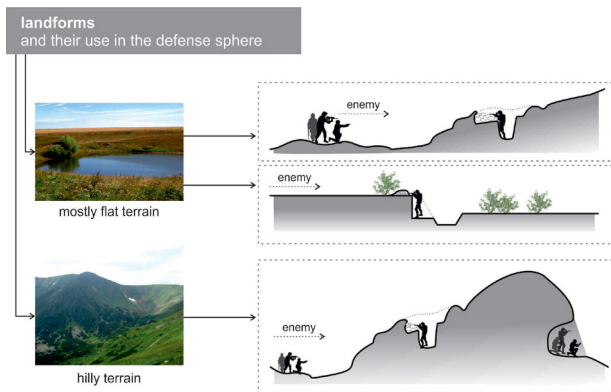


Fig. 7. Relief forms and methods of its use for camouflage and barrier purposes [from L. Shevchenko scheme based on the materials of A. Karshen, S. Tsybulya, O. Galushka]

of a semi-buried or bulk type using stones, soil, and earth bags [17]. But in this case, there is an opportunity to use caves, tunnels, other natural storages in such an area, to create stone rubble (Fig. 7).

Gabion structures are actively used in landscape architecture and design to strengthen slopes and shorelines of reservoirs. It is interesting that they found their application in the defense field as well – for the equipment of machine-gun installations, the arrangement of checkpoints, “fortification structures in the areas of hostilities, for the rapid construction of protective barriers along the perimeter of the military units location” [17]. Gabion constructions proved to be especially effective in extreme conditions – in the absence of sufficient time for the construction of fortifications without mechanizations’ means and limited material support [17]. They are quickly built, dismantled, and can be filled with materials at hand available in the relevant area, such as stone, soil, sand.

Water elements

Water elements in a calm state have a mirror surface. Such a surface is the most vulnerable to all types of enemy intelligence. In addition, water surfaces are landmarks during aerial reconnaissance of the enemy. Therefore, water can be considered mainly as a water obstacle for the enemy, which is difficult to overcome.

Conclusions

The history of the development of military science shows that defense objects of long-term fortification require a long time and significant financial costs for construction. Economic efficiency is usually not considered here. The expediency of such construction is determined by increasing the level of the country’s defense capability. With the beginning of the Russian-Ukrainian war in 2022, the aggressor invaded the territory of Ukraine in certain directions. That is, it can be clearly indicated that the capture of the Ukrainian territory by the aggressor took place using the anthropogenic framework existing in the border regions of the country.

In the future, Ukraine should have fortified lines - a system of fortified areas equipped with long-term fortifications and barriers. They should be built along the state border to cover important directions. Artificial objects of dual purpose and objects of natural or natural and anthropogenic origin should also be used. They significantly improve the efficiency and environmental performance of such buildings. Areas of land of natural origin (forests and swampy areas) should serve as defensive fortifications during the period of active offensive actions of the enemy. In the southern and eastern regions of the country, where there are no natural barriers for the enemy’s ground forces, agro-recreational and agro-production territories (rice plantations, plantations with fast-growing trees, etc.) should be used. It will be a significant addition to the main system of long-term fortification. This approach will allow to increase the indicators of economy and environmental friendliness in the general structure of defense facilities of Ukraine. In general, taking into account the specifics of these defense measures, decisions about the directions of deterring a potential aggressor, certain types of fortifications, their filling, should be made by specialists in the field of military strategy and tactics. The system of fortified areas, defensive positions, nodes of resistance and strongholds equipped with long-term fortifications and barriers should remain a basic element of the defense infrastructure. It should be erected along the state border of the country to cover its important directions.

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