

## MAN-MADE LANDFORMS IN LANDSCAPE DESIGN OF TERRITORIES AS A MEANS OF SOLVING ENVIRONMENTAL PROBLEMS

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### Abstract

The paper is devoted to the role of man-made landforms in landscape design as a means of solving a range of environmental problems. This paper gives a characteristic of man-made landforms. The use of artificial forms of relief as a means that allows evoking bright emotions in the viewer is actualized. Such objects as Mill Creek Canyon (USA), Heart of Reeds (Great Britain), Devil's Lake (USA), Buitenschot (Holland), Landform Ueda (England) and Crawick Multiverse (Scotland), created by famous artists and designers were considered in the course of the analysis. In their landscape organization man-made landforms play the leading role, the use of which has opened up the possibility of solving a number of environmental problems. As a result, it was established that the formation of compositions from earthen embankments allows overcoming problems of regulating water balance of territories, contributing to protection from excessive noise loads, as well as becoming a tool for rehabilitation of former industrial territories.

Keywords: **Composition; Ecology; Environment; Landscape design; Man-made landforms; Rehabilitation; Relief.**

### 1. INTRODUCTION

Over the past decades, the depletion of natural environment under the influence of man-made factors has become apparent. But the formation of this trend was laid even more than a century ago. Significant progress in technical, technological and scientific fields has led to an increase in population, improvement of its well-being and active exploitation of natural resources. As a result, there was an active settlement of vast territories, transformation of natural territories into cultivated lands, loss of forest and flood-

plain lands, excessive consumption of all resources, high dependence on fossil fuels, which as a result had a negative impact on the environment [1].

It is human activity that has the most active influence on ecosystems, subjecting all their components to changes in particular, including their topography [2]. Although human involvement in the evolution of relief has a long history, so, fundamental changes are observed in our time. With the deepening of industrial revolution, acceleration of urbanization process and constant socio-economic development, changes in the relief no longer occur solely under the action of

natural forces, but it turned out to be a process deeply marked by human activity [3].

The world is becoming increasingly industrialized and consequences of human activity for environment are becoming very obvious. Modern thinking, determining the development of environment is still characterized by an emphasis on efficiency and economy. But reality has witnessed the need for a shift towards the formation of environmental awareness in society [4]. Recognition of the fact that system-wide environmental services are important for future survival of humans has intensified shifts in the field of ecology [5]. Scientific literature notes the urgent need to continue the search for ways to form an effective balance between the use of natural resources by a human and environmental problems. It is extremely important to study landscapes that are in the process of degradation, as an integral part of systems that determine life support process of people and other living organisms [6]. One of the focuses of problems of landscape ecology, as an interdisciplinary science, is the study of the man's role in creation and influence on landscape models and processes. The function of an ecosystem depends on interaction of a model and a process. Therefore, landscape ecology is also based on the fact that spatial models affect ecological processes, which, in turn, affect spatial structures. Interaction of spatial pattern and process determines general orientation of landscape ecology [7]. After ecological crisis of the 1970s, environmental design became one of the means that could solve indicated problems. American architects, authors of famous monograph "Ecological Design" Sim Van der Ryn and Stuart Cowan identified five principles of environmental design, focused on solving numerous environmental problems. They are as follows:

- decisions grow out of place: more attention should be paid to the context of the place, its unique cultural and physical characteristics;
- environmental accounting: environmental and social factors, such as energy, water, materials and air quality inside and outside premises, are equally assessed along with financial side of the project;
- design with nature: design with consideration of nature, for example, taking into account movement of the sun in a building design;
- everyone can be a designer: design process must be an open process, interacting with all stakeholders;
- to make nature visible: in growing urban world, it is very important that children and adults can see and access natural systems and processes [8].

One of the starting points in modern approach to solve environmental problems was determined by the paradigm of multi-functionality of landscape areas. Such landscapes must perform a number of functions simultaneously:

- ecological (as an area for living);
- economic (as an area for production);
- socio-cultural (as an area for recreation and identification);
- historical (as an area for settlement and identity);
- aesthetic (as an area for experiences) [9].

Thus, based on the relevance of identified problems, the goal of this scientific paper is to study practical world experience of using man-made landforms to create a multifunctional landscape that solves a number of environmental problems.

## 2. RESULTS AND DISCUSSION

Today, landscape design that combines architecture, design and sculpture seeks to meet deep environmental, social, technological and artistic problems. According to John Beardsley, landscape design "... tends to do more than just to create places for safe, healthy, and enjoyable use; it has become a forum for the articulation and expression of individual and social attitude to nature" [10]. Modern landscape design also has direct links with art, since it works with the same materials in the same space and expresses themes that stir the modern art.

At the end of the 20<sup>th</sup> century English landscape architect Geoffrey Jellicoe wrote: "Having come to the conclusion that the landscape for modern civilization is not a luxury but a vital necessity, we understand that it is not enough if landscape is just pleasant to the eye. The task is much more difficult, it is necessary to express the «other unknown world» hidden in the depths of the subconscious. This result can be achieved by means of contemporary art, always operating with abstractions, using surrealistic methods or relying on unusual compositional solutions" [11].

The conceptual aim of modern landscape design is to identify individual visual space code. It is created through an unconventional, sometimes paradoxical combination of natural and artificial components of the landscape. Appeal to emotions and feelings of the viewer; desire to "tell" him/her something new is manifested in the use of certain symbols and associative content of environmental elements. Relief as an ecological and plastic base of landscape acts as the most stable component, making up its ecological and

plastic basis. In modern landscape art, relief has a special part [12]. Its leading role in formation of landscape is determined by many components, constancy in time and space, by its ability to model that is to fix in space the interrelation of various components of landscape. On a flat open area, even a relatively small, smooth elevation or dimple can greatly enliven its appearance. The diversity of such a landscape is created by differences in ratios of angles of slopes and changes in light and color. Such decisions can form key characteristics of the area (both natural and artificially created), causing a whole range of feelings – from tranquility to surprise and delight in the process of contemplating the landscape [13].

Relief, created with participation of man is anthropogenic. Recently, it is human activity that becomes a powerful force of shaping reliefs. Man drains and floods the territory, interferes with the life of the coast, creates mountains, pits, builds cities, changing the relief of the earth. In landscape design, relief and natural surroundings are the main components to achieve aesthetic expression of the object. Man-made reliefs are geomorphological units formed on the basis of natural reliefs. Man-made landforms are geomorphic units formed on the basis of natural landforms [14]. Man-made territories and reliefs are of great importance for regional planning and construction, transformation of urban and rural areas, development of tourism, etc. [15]. Such reliefs have ecological characteristics, have aesthetic value inherent in natural landscape, and are economically justified [16].

Relief is the basis of any landscape. Its character largely determines architectural and planning solution of the territory, its three-dimensional composition and emotional perception. In addition, nature of the relief – whether it is plain, flowing hills or steep slopes – significantly affects the uniqueness of the landscape. Artificial relief, as a technique, has been used in landscape design for a long time: retaining walls of various configurations, terraces, artificial hills formed an expressive image of the environment. Such constructions as Scythian burial mounds, earthen ramparts around Slavic settlements, and terraces on the mountain slopes of south east Asia, which served as a means of developing agriculture are widely known. Archaeologists have discovered figured hills in the form of animals in Peru created over 4000 years. In the Netherlands residents created manmade elevations 2000 years ago they were built for security purposes during periods of flooding. People started to talk about artificially created gardens and labyrinths in China in the 13<sup>th</sup> century, but landscape

art in this country existed long before that period. In the Renaissance era, specific points were artificially formed in gardens, from which the garden visitor could admire the opening perspective. This view was created by terracing, opening the panorama from upper platforms to lower ones. A significant contribution to the practice of forming an aesthetically expressive landscape was made by famous French landscape architect Andre Le Notre. Gardens in the Tuileries, the park of Vaux-le-Vicomte and the park building pearl – Versailles Park were the result of his creative genius. The creation of the latter was made possible by unlimited material, human and financial resources of King Louis XIV. In the process of its construction, an unprecedented transformation of the relief took place. It was the use of man-made landforms allowed to build a grandiose landscape ensemble in the marshland. An important role in the engineering and artistic design was assigned to a large channel. It was intended for boating and celebrations on the water. In addition, it was the canal that carried out important ameliorative functions, contributing to lowering the level of groundwater and draining the park. In the 19<sup>th</sup> century, man-made landforms were widely used in the practice of horticulture as a way to “improve” natural topography. Creation of artificial hills and mounds, grottoes and terraces acts as a powerful means of transforming the landscape. It allows you to avoid the monotony of the flat terrain and reveal the beauty of the landscape.

Traditionally, depending on the purpose of the work, man-made landforms are divided into several types:

- terracing of slopes;
- construction of dams and ramparts;
- creating slides, labyrinths and other game structures;
- construction of hills and slopes.

By forming various man-made landforms, there is the possibility of recreating (or imitating) relief forms that occur in nature; building of exaggerated new forms (pyramids, slides, ramparts, islands, hills, etc.); organization of functional forms of relief against noise, as well as installation of slides for descents, placing sculptures or arbors on them. In modern modeling of the earth's surface, it is necessary to highlight the direction associated with the aestheticization of relief – creation of new, often geometric forms of artificial relief, in which the participation of the artist, sculptor, and architect is expressed. Artificial forms of relief with their skillful use can perform various functions:

- emphasize features of existing relief;
- neutralize certain negative factors (presence of technical and ancillary facilities, etc.);
- to be an independent active compositional focus.

Landscapes solved with the help of man-made landforms organically fit into water objects, which are the most important components of nature. Water occupies a significant place in the formation of the park environment. It reduces the temperature of the air, increases its humidity and in general significantly affects the microclimate. The aesthetic value of water and its physical properties are also important. Very often, rivers, streams, ponds, canals, etc. are decisive in the formation of planning structure of a park or garden, its compositional axes, centers and nodes. Such structures as pools, waterfalls are often centers of compositions. Used pits are often used to organize water reservoirs. The shape of water reservoir is determined by the relief, and the contour of water mirror corresponds to horizontal pattern on which the water level is located. A special decorative advantage of inland waters is the reflection of landscape paintings in the water mirror. In turn, visual depth of space is enhanced by islands. In modern environmental design, man-made landforms are relevant and cost effective. First of all, they allow improving already existing natural relief, contributing to an increase in diversity of its forms and types both in urban environment and beyond its borders. But, what is especially important, such a technique makes it possible to restore and revive fully zones of disturbed territories. Such solutions make it possible to use urban spaces rationally, preserve and maintain positive ecological characteristics of urbanized landscapes. Traditionally, man-made landforms perform two main functions in the formation of landscape objects: protective and spatial-organizing. Complicated relief with elevation changes makes it possible to obtain combinations of solar and shady areas, and formation of a relief on a flat area visually increases its size. However, environmental challenges are at the forefront of the concept of sustainable development of modern society. Thus the process of forming an artificial relief of the earth becomes a real way to solve them. Technological development, population growth and rapid changes in cities, especially those that occurred after industrial revolution, disrupted ecological balance, as a result of which the process of rapid depletion of natural resources began. While continuing to increase gradually the need for areas for development, mankind intensified the process of land degradation, which significantly changed the

work of ecosystems [17]. Today, environmental design is an effective tool in the process of rehabilitation of such areas. It implies deep understanding of the structure, function, and relationships that exist in an ever-changing ecosystem, and as a means of landscaping, it uses man-made landforms. Positive impact of the relief is manifested in the formation of temperature and wind regimes, soil and hydrological conditions. And from the point of view of aesthetic evaluation, according to American architect and theorist Allen Stan, “[landform projects] gather in and orient the space of the landscape around them, not as simple sculptural solids, but as complex objects creating new relationships between the inside and the outside” [18].

Thus, the work of Austrian artist and Bauhaus master Herbert Bayer (H. Bayer) at Mill Creek Canyon in Kent (Washington, USA) marks a turning point in the integration of art, ecology and landscape architecture. The complex, built in 1982, as a dam to prevent storm rainwater runoff, consists of sculpted earth volumes, paths, ponds and lawns that function together as a rainwater storage facility, a public park and an object of landscape art. “A dam in the ordinary sense constitutes a radical interference with the natural configuration of the land. My intention was, therefore, to give the dams a natural appearance conforming to the landscape (surroundings) and to become integral parts of the landscape being created” [19].

Composition is a series of organized spaces, thanks to sculptural forms of earth mounds-cones, circles and lines integrated into the river delta. Circle and its derivatives are the main shaping elements in a design solution. Compositional axis of the landscape is formed by winding line of the river. Its outlines are due to regular circles adjacent to it, formed by an earthen hill and a pond with a ring-shaped earthen mound in the middle, a kind of earthen “ridge” with two mounds and protruding semicircular concrete disks. The principal feature of the composition is that the author operates with an ideal geometric shape – a circle, the meaning of which can be symbolically interpreted as eternity. Chosen design solution is characterized by the smoothness of outlines of earthen mounds with a grassy surface, using water surface, which complements expressiveness of serenity of artistic image of nature.

In turn, English land-art artist and designer Chris Drury solves ecological and artistic problems of territories, based on scientific research in the field of medicine. His object “Heart of Reeds” (2005) with an



**Figure 1.**  
Chris Drury. Heart of Reeds in Lewis (East Sussex, United Kingdom). Photo from <https://chrisdrury.co.uk/heart-of-reeds/> (published by permission)

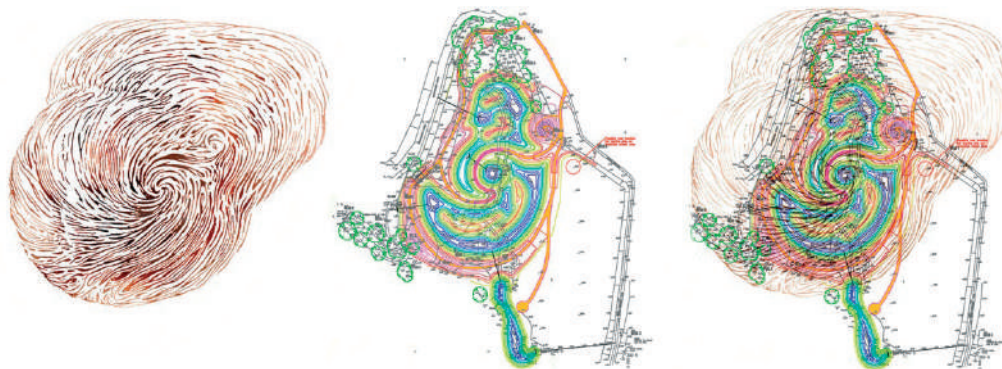
area of about 2.5 hectares is intended to restore wetlands of the Lewes Railway Land nature reserve in the center of Lewis (East Sussex, United Kingdom) [20] (Fig. 1). The territory on which the reserve was located more than 50 years ago was a railway sorting hub, and it turned into a wild forest with a river flowing through it after dismantling the railway line. As a prototype for the design of earth mounds, between which there is water, a model of blood flow in a human heart was taken, forming two spiral vortices. Such a choice of prototype, in the artist's opinion should symbolize relationship of a person with environment (Fig. 2). The concept stipulates that water levels can be adjusted using a sluice gate, and proposed idea allows two halves of the territory to be isolated from each other for separate flow of water. Constantly flowing water flows away from meadows into the pond. The author proposed two spiral paths for visitors of the park that allow ascending to the species points on embankments and the hill for a

holistic perception of spatial solution. "Heart of Reeds" has no specially defined boundaries and harmoniously fits into natural landscape. A forest that grows alongside from one side composes its location with composition.

With the help of a landscape design solution in 1990, the problem of Devil's Lake purification in North Dakota (USA) was solved. In the project, designer Viet Ngo used a simple water purification system based on a natural biological method of purification using aquatic plants of the genus *Lemna*. To do this, the author has created nine connected channels, tortuous shape of which resembles a snake-like ribbon, when passing through which phosphorus, nitrogen and other harmful substances are removed from the water [21].

Also, to overcome anthropogenic impact on the environment, a land park of Buitenschot was created; it was opened in October 2013 in Holland near Schiphol Airport. It was authored by H + N + S Landscape Architects together with the artist Paul De Kort. In terms of its layout, it represents a peculiar geometric structure consisting of 150 straight, sundered, three-meter elevations, with distinct edges and located in a certain rhythm [22]. The main functional task of building these hills was to create a barrier to the sound of taking off and landing planes. Necessary result was achieved due to the fact that ridges formed from earthen mounds are perpendicular to the sound wave, which is absorbed by formed structure. It is important to note that experiments of German physicist Ernst Florens Friedrich Chladni the "father of acoustics" served the source of the design idea.

In addition to its main function – the noise barrier, the park has become a place of rest, combining



**Figure 2.**  
Chris Drury. Heart of Reeds. CAD plan. Photo from <https://chrisdrury.co.uk/heart-of-reeds/> (published by permission)

scientific knowledge and modern art. In the planning solution, the composition has a diamond-shaped structure, so, a walk between hills is perceived as a journey through a maze. Paths between earthen pyramids serve as a walking and cycling site. In addition, the complex of the park area includes two thematic works of land art by Paul De Kort, which are focused on developing an understanding of physics of sound among visitors.

Identical utilitarian function of protection against the noise of a country road is carried out by the project “Landform Ueda” (1999–2002) in Edinburgh. It is carried out by Charles Jencks for the Gallery of Modern Art, which is part of the National Gallery of Scotland. The architect has created a new space by changing flat lawn with man-made landforms. The landscape composition combines a stepped mound in the form of an elongated crescent and a body of water. The embankment representing the stretched letter “S”, is steeply inclined towards the road, and on the opposite side, by gentle terraces, goes down to the water. This zone is offered as a resting place for visitors where they can sit and walk. Flowing lines of the composition begin from the hill and continue into the earthen mound passing through the lake. In the design of the author’s interpretations, rethinking of smooth outlines of natural formative materials is read (Fig. 3).



**Figure 3.**  
Charles Jencks. Northumberlandia (England)  
Photo from <https://www.northumberlandia.com/about/about-the-lady/>

Man-made landforms are also used in the process of restoring areas affected by industrial production. Man-made landforms as a leading method in landscape design became the basis for Charles Jencks’s work on the creation of Northumberlandia garden in the north of England (2005–2012). The work was commissioned by the British Coal Company during the expansion of the Scottish National Gallery of Modern Art (SNGMA). This project was created within the framework of transformation of industrial areas (not far from it there is a coal mine and a quarry where red clay is mined). The design solution made it possible to turn a large quarry into a landscape with an expressive composition of giant mounds and artificial lakes. The huge sculpture of lying goddess of the Earth, about 35 m high and about 400 m long, is a conceptual and compositional organizing element of the landscape (Fig. 4).



**Figure 4.**  
Charles Jencks. Landform Ueda in Edinburgh (Scotland).  
Photo from [https://en.wikipedia.org/wiki/Charles\\_Jencks](https://en.wikipedia.org/wiki/Charles_Jencks)

Its generalized volumetric forms created an original lively landscape with relief differences, terraced slopes and artificial crescent-shaped reservoirs. The whole composition is surrounded by footpaths, which distinguish it from the rest of the landscape space.

Another major project on land restoration in Scotland of Charles Jencks is Crawick Multiverse (2015), it doesn’t have any visible borders. It is located between Sanquhar, Dumfries and Galloway. It should be noted that themes of both of these works by Charles Jencks on the restoration of territories on which industrial production was previously located are focused on forming associations about ancient periods of people’s life among visitors. Landscape design of an area of 22 hectares was made of local materials and turned the former coal mine into a cul-

tural and recreational site. The author of the project positions it as a land-art project, which is based on cosmological themes. Each element of landscape composition symbolizes a certain part of the Universe and processes occurring in it. Compositions that resemble both comet collisions, a black hole in the center of the Andromeda galaxy and the Milky Way were created with the help of stones and man-made landforms. Boulders used in the project give the landscape a similarity to megalithic structures. The complex consists of a flat road, at the edges of which stone boulders are set in rows; two spiral mounds, two separate stone pillars with a viewing platform and an amphitheater that can accommodate up to 5 thousand people (Fig. 5). It is symbolic that the official opening of this park took place on the day of the summer solstice on June 21, 2015.



**Figure 5.** Charles Jencks. Crawick Multiverse. Landforms: Multiverse (foreground); Supercluster (centre); Milky Way and Andromeda Galaxy Mounds (Scotland). Photo from [https://en.wikipedia.org/wiki/Crawick\\_Multiverse#/media/](https://en.wikipedia.org/wiki/Crawick_Multiverse#/media/)

### 3. CONCLUSIONS

The analysis of modern design solutions of territories, in the organization of which man-made landforms techniques were used, confirmed the relevance of using this technique in the process of forming not only an aesthetically attractive landscape, but also as a means of solving a number of environmental problems. It has been established that artistic compositions from artificially created earthen embankments can successfully solve problems of regulating the water balance of territories, contribute to protection from excessive noise loads, and also become a tool for rehabilitation of former industrial territories. Modern project experience convincingly shows that man-made landforms is one of the leading techniques in solving urgent tasks of organizing landscape terri-

ories, within the framework of the concept of sustainable development. Its use allows you to create a comfortable environment of human stay, which meets not only the criteria of environmental friendliness, but also has expressive aesthetic qualities.

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