Evaluation of the influence of brown coal operation on the landscape shaping and the environment protection

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Abstract. The article concerns the assessment of the new landscape and spatial effects of brown coal mining areas transformation of in the region of the Lower Lusatia in eastern Germany, in the context of the region's changes taking place after Internationale Bauausstellung (IBA) Fürst-Pückler-Land 2000-2010. IBA Fürst-Pückler-Land functioned in 2000-2010 as the institution responsible for determining the direction of the transformation of Lower Lusatia. A region dominated by the brown coal mining industry, with a declining population and an unimaginably degraded landscape. The assessment, from the perspective of 20 years from the commenced process, raises research questions: in what part the assumed strategic goals were met, one of which was a development towards industrial heritage tourism and is the process initiated earlier perhaps still ongoing? The research method involved the use of planning tools such as: graphic interpretation of the resources of Geoportal.de and Google Earth Pro, analysis of data provided by: Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (LMBV) and research trips in the years 2006-2019. Conclusions from the research are formulated through the prism of the European Landscape Convention [1], in which the postulate of treating landscape as an integrated term, consisting not only of natural and cultural elements but also human, is important. This approach provides the basis for establishing the rightness of transformations of post-industrial landscapes in the "pro-tourist" directions ensuring the connectivity of all elements using initiatives in the field of "industrial heritage tourism". In situ studies have shown that the transformation process has not been completed and is still ongoing, and the assumed effects are still far from expected. Tourism of industrial heritage may be an interesting "combination" of industrial areas in the European service economy. However, given the scale of the impact of the energy industry and its importance for the development of the whole country, its impact on regional restructuring may be limited. At present, care for the environment and its repair are more important in the context of improving living conditions along with the implementation of the postulates of using alternative energy sources. And modern use of the industrial heritage for other economic activities than just tourism can be an important alternative for the development of the region.

1. Introduction
The landscape is a good found by man. However, as a result of his activity, it undergoes a transformation. From the natural landscape, it transforms into a cultural landscape - considered as a creation of the human economy. As a result of expansive human activity, the natural landscape shrinks more and more and over time it even disappears.
Landscape transformation is a permanent process that has always existed, from the beginning, and its transformations take place at different rates depending on the level of civilization development. The period of rapid industrialization in the 19th and 20th centuries, which greatly contributed to the degradation of the landscape, are particularly important in these processes.

The European Landscape Convention, signed in 2000, treats the landscape as an area whose nature is the result of the action and interaction of both natural and human factors [1]. Hence the article concerns the assessment of the new landscape and the spatial effects of the transformation of brown coal mining areas in the Lower Lusatian region in eastern Germany, in the context of ongoing region changes after the completion of the Internationale Bauausstellung Fürst-Pückler-Land 2000-2010 taking into account important aspects of significant protection environment and quality of life.

2. Innovative space transformations
The European Landscape Convention is the first concept of international law that treats the landscape as a whole. According to this convention, the landscape is: "an area whose nature is the result of the influence and interaction of natural and anthropogenic factors. The landscape is understood here not only as a passive object of social activities, but also as a basic component of the European cultural and natural heritage, affecting the local culture formation" [1].

This approach was important for the originators of the International Building Exhibitions in Germany, organized for over 100 years. Their assumptions and effects have often been considered as milestones in innovative repair and development activities. [2]

A common feature of the so-called exhibitions was innovation in architecture, urban planning and spatial planning as well as development strategies. Thus, subsequent editions broke the previously used patterns, spatial ranges and impact ranges. They show how the understanding of corrective action has changed, as well as the context and complexity of challenges, how they evolved from their beginnings until the establishment of IBA-SEE in 2000.1

The first post-war IBAs were based on earlier exhibitions: in Darmstadt (1901) and Stuttgart (1927), whose axes were architectural issues, although lined with current social problems, such as overcrowding, quality of life, and housing availability. Exhibition goals and formulas developed - from architectural and construction solutions (IBA Interbau Berlin 1957), through architectural and urban planning (IBA Berlin, 1977-1987) to urban planning on a regional scale (IBA Emscher Park, 1989-1999). The later ones concerned successively: landscape on a regional scale (IBA Fürst-Pückler-Land, 2000-2010), urban issues in the network of cities on a land scale (IBA Stadtumbau, 2002-2010), and on metropolitan issues (not) (IBA Hamburg Wilhelmsburg, 2006-2013). Each of them had a significant impact on the formation of theoretical concepts, as well as subsequent manifestos: the New Urban Planning Card of 1996 or the New Athens Charter of 1998, updated in 2003.

IBA 1957 (Berlin) was an example of a functional approach to urban renewal, defined in Germany as the revitalization’s foundations, i.e. urban planning and modernist, functional architecture. Hansa Viertel's new, modernist multi-family housing estate perfectly matched these ideas, as it was built on the post-war ruins of a nineteenth-century, intimate estate with a clear quarter structure.

1 Further exhibitions that can be a guide in the development of urban thought are: IBA Stadtumbau 2002-2010; IBA Hamburg 2006-2013; IBA Basel 2010-2020; IBA Heidelberg 2012-2022; IBA Thüringen 2012-2023; IBA Parkstadt 2013-2020; IBA Wien 2016-2022; IBA Stadtregion Stuttgart 2017-2027. Information on all IBA exhibitions is available at www.open-iba.de.
IBA 1977-1987 (Berlin) was one of the first examples of the revitalization of a downtown district with a quarter structure. It was characterized by the use of many so-called soft social and pro-environmental activities. It implemented postulates for rebuilding cities related to the classic revitalization model, complemented by bottom-up activities.

Elements characteristic of the classic revitalization model were visible in the approach to the renewal and protection of the existing urban fabric supplemented with solutions to social problems. Model’s rejection of imposing top-down decisions significantly influenced the content of the postulates included in the New Athens Charter a decade later. They concerned increasing the public participation in planning and decision-making processes, reorienting the mandatory planning system to a bottom-up process, and orienting this system to the needs of residents, expressed by themselves.

IBA 1989-1999 (Emscher Park) can be considered as a breakthrough in terms of a radical increase in the spatial scale and introduction of new planning instruments. The impetus for these actions was the systemic state failure in the need to solve the problems of degraded regions. Thus, the exhibition was a plan to restructure the entire agglomeration along the Emscher River (over 70 km long). This exhibition was an example of an innovative solution based on the formula of strategic planning and planning through projects. The renewal program was based on natural, ecological, social and cultural values. IBA Emscher Park was a program implemented in the spirit of sustainable development, development without growth. Achieving sustainable and balanced development as a priority also resounded in the postulates for sustainable and balanced development formulated in the New Athens Charter. The postulates of recreational areas and landscape zones outside the city, as well as the issue of green corridors, have already been formulated in this exhibition [3]. The completed Landscape Park has become a model implementation of these issues. It is worth emphasizing that the postulates of the New Athens Charter regarding access to and flow of information, as well as monitoring of planning processes treated as continuous processes, were consistent with the IBA Emscher Park formula.

IBA SEE 2000-2010 (Fürst-Pückler-Land) concerned the transformation of landscape degraded with opencast mining on an unprecedented scale. The knowledge and experience gained as a part of previous exhibitions were used. It was the first exhibition in the former GDR, whose main goal was to give the region a new vision of lasting and balanced development, what was a consistent continuation of the previous IBA exhibition and the records of the New Athens Charter.

The formula of the program, understood as a more than local spatial-functional and landscape structure (structure of nine thematic islands), as an idea was also already outlined in the New Athens Charter. Through its idea of the largest landscape construction site in Europe and visions of development associated with tourism development and landscaping, IBA-SEE has directly entered the demands of the New Charter regarding recreational areas, landscape zones and open areas [4].

This mentioned heritage and significant historical and cultural values, settlement structure, and socio-cultural relations were of significant importance for the IBA - Fürst-Pückler-Land. This meaning was rooted in the inseparability of the dimension of space from the man who constantly lives, experiences, describes it and organizes what he can notice. In this way, we touch spatial identity as the identification with elements and events arranged in space that shape the social group and its relations with the environment [5].

3. Relations of culture, history and region’s development

In the first half of the nineteenth century, the ideas of landscaping underwent a significant evolution. In some ways binding, arcadian, semantically saturated vision of the garden created by philosophers and poets was replaced with the vision of gardeners-artists, guided by aesthetic criteria and botanical passion. A landscape park from a park-landscape, a park-kingdom of nature quickly became
a sanctuary of art, not a mirror of nature, but an autonomous enclave of aesthetic and botanical values. The search for beauty and painting in parks was subordinated to aesthetic ideals [6].

Personifying nature perceived and created as a being that affects the emotions of the viewer by its character and the literary program of parks co-created by numerous buildings and sculptures were gradually replaced. Artistically idealized nature became an essential material, affecting the sphere of purely aesthetic feelings. On the basis of aesthetic theory, this process was initiated in the first half of the 18th century by statements that negated the sense and the possibility of imitating nature. In 1746, A. Batteux criticized garden art for avoiding any trace of human activity, which makes it impossible to create a work of art [7]. And according to I. Pindemonte (1792), a landscape garden cannot be a work of art, because a creator imitating nature is not able to achieve the ideal if he uses the matter he imitates. This statement led the author to the surprising praise of geometric gardens. The English gardener H. Repton (1752-1818) came to similar conclusions, doubting the sense and possibility of copying nature in the vicinity of the human residence. And it is the views and works of Repton that are very important in the context of German garden art of the 19th century, because it was under their influence that they created the precursors of new ideas in Germany - Prince Hermann von Pückler-Muskau and P. J. Lenné. Repton, guided by the principles of aesthetic nature, functionality and harmony, emphasized and propagated:

- aesthetic value of nature;
- connecting the park with the surroundings, i.e. aestheticization of the rural landscape in the spirit of a “decorative farm;
- the geometric and architectural way of shaping the home surroundings due to the aesthetic unity between the house and the garden, followed by the functionality of the garden, while criticizing the introduction of park meadows in close proximity to the building [6].

Prince Hermann von Pückler-Muskau had undisguised admiration for Repton's art, realizing his landscape and gardening visions primarily in his own estates in Muskau and Branitz in Lower Lusatia. He included his experience in the treatise "Notes on landscape gardening" from 1834. This publication, dealing with locating, composing and caring for parks, illustrating theory with the description and graphics of the Muskau foundation, took garden art to new tracks, disseminated the new philosophy of “landscape park” and aesthetics of “beautiful style”.

What he especially developed from the idea of Humphry Repton was:

- zoning the site, separating a flower garden (pleasureground, Blumenpark) and a park;
- emphasizing “artistry” in the vicinity of the residence and striving for naturalism in the park;
- respecting “locality”: adapting to the surrounding landscape of park plants and architecture, following a kind of “functionalism” by, among others rational, road connecting viewpoints, limiting buildings to facilities necessary for functional and aesthetic reasons;
- pursuit of momentum and multipurpose of park assumptions [8].

The legacy left behind, the significance for the development of landscaping art, the locality of the works of H. von Pückler-Muskau today leads to current conclusions: a landscape created by man has a utility value, grows out of respect for the laws of nature and the rules of art and is based on harmony between the natural and cultural environment. That is why they became the motto of the exhibition IBA Fürst-Pückler-Land, and the prince “reappeared” again as an advocate of important landscape changes. And the inhabitants of the area covered by the planning experiment had a chance to identify more with the initiated changes.
4. Lignite mining in Lower Lusatia - risk assessment

In Lower Lusatia, in the land of Pückler, the shallow brown coal beds began to be exploited as early as the second half of the 19th century, which resulted in the development of the energy and processing industries. The source of secondary landscape degradation has become huge heaps of overburden with different, often toxic composition, multi-kilometer depression funnels lowering the level of groundwater around excavations, acid rain and dozens of other damages. By 1989, the mines had absorbed almost 120 villages, of which more than 25,000 people were resettled [9]. Monstrous mining machines have become part of the landscape of many other towns, giving the impression of incredible view (figure 1). More than half of these villages were inhabited by Sorbian people. This gives the case an additional, highly conflicting aspect, having no equivalent in other areas.

![Figure 1. F60 metastatic and mining bridge in the background of the town of Lichterfeld-Schacksdorf](image)

After the reunification of Germany, it was estimated that as much as 5.6% of the total area of the Eastern Länder was in a state of complete post-industrial devastation [10]. The area requiring revitalization amounts to 7,180 km², while the number of inhabitants is about 700,000. In addition - the region does not have centers with a distinct and excellent tradition, strength of attraction and intellectual facilities. The state of the environment and the level of economy at which Lusatia had to begin its reconstruction in a sustainable direction were alarming. The economy of the socialist era has left behind hundreds of thousands of hectares of degraded post-mining areas along with infrastructure after industrial processing such as: coking plants, briquetting plants, combined heat and power plants, tar and phenolic landfills, including thousands of hectares of mine excavations and multi-story heaps creating lifeless moon-like landscapes.

From 1977 to 1989, as a result of the reduction of financial outlays for the reclamation of these areas, while increasing the growth rate of brown coal deposits, there was a serious violation of the basic elements of the environment. Degradations included:

- changes in the natural landscape - giant surface transformations of areas covered by opencast mining, carried out with the help of the largest metastatic bridges and dumpers in the world, left without reclamation together with a huge number of technologically outdated post-industrial equipment and buildings;
- destruction of soil structure and its biological values - poisoning, death or lack of soils on huge surfaces as a result of stacking huge overburden masses with a high content of sulfates and heavy metals, especially in the areas of toxic waste deposits (settling tanks, burial grounds, landfills, reservoirs etc.) [11];
- violation of the geological stability of soils - cracks and slides of excavations and heaps (figure 2), displacement and settlement of disturbed soil layers, rapid collapse and displacement of unstable, mixed overburden masses, including the formation of moving dunes, caused by runoff of rainwater and strong air turbulence in an endless deserted space;
- water relations disturbance of the natural groundwater table, on an area of about 120 thousand hectares, caused by a deficit of about 7.0 billion m³ of water [11];
• Increase in the level of acidity of ground and surface waters acidification (pH = 2.5 ÷ 3.0) during runoff from heaps and filtration through dumps and collection in excavations, formation of reservoirs deprived of any life [12];
• Air pollution - exceeding the permissible concentrations of dust and toxic volatile substances, dangerous to health and life, causing common respiratory diseases due to acid air [13].

Such a highly degraded environment requires radical action, far exceeding the budgetary capabilities of both Länder, which, in the author's opinion, is visible to this day.

5. Phases of landscape changes documentation
As in the art of gardening, when Le Nôtre mapped a park in Versailles, he knew how he would look, but did not see him in finished, full form. Similarly, in Lower Lusatia, in the restoration of the landscape, under the IBA Fürst-Pückler-Land program\(^2\), the creation of conditions was planned not to recreate nature, but to its natural succession. Before the mined excavations fill with water and revive nature, the landscape of destruction was treated as a special tourist attraction (figure 2,3), [14].

The assessment, from the perspective of 20 years from the commenced process, raises research questions: to what extent were the assumed strategic goals realized, one of which was a development towards industrial heritage tourism and is the process initiated earlier perhaps still ongoing? The direct research method was research trips in 2006-2019, documenting the process.

Figure 2. Großräschen, 2006. Cracks in the bottom of the excavation and heaps, subsidence of soil layers, rapid collapse due to runoff of rainwater

Based on in situ visits, although changes are visible (figure 3-10) are characterized by certain superficiality. This applies primarily to poor flora and, above all, fauna. Where there is contact with water even used for recreational purposes - there is no smell; flower meadows do not attract insects; no traces of small animals and gangue emerge between the clumps of grass. There are silence and order in the landscape

\(^2\) Description of activities under the IBA Fürst-Pückler-Land, and the concept of creating landscape islands, hence also called IBA-SEE, can be read in many scientific articles, as well as basic information can be found on the following websites: www.iba-see.de, www.open-iba.de and many others.
6. New conditions - new directions - discussion

The IB A Fürst-Pückler-Land as an institution no longer exists, but the process of landscape transformation and reconstruction of the natural environment that it initiated is still ongoing. Slowness sometimes planned, sometimes not - unpredictably can extend for decades (figure 5, 6, 7).

The inhabitants of Lower Lusatia, who lived on coal and benefited from the material well-being and cultural wealth associated with it, in effect paid a high price. At first glance, post-mining landscapes are making a depressing impression. However, in points, interesting, well-preserved biotopes can be found in various landscape forms. From the nature’s protection point of view, all dumps, sandy heaps or wild grasses fields are particularly valuable and worth preserving. Financial arguments also support
their protection. Comparison of various forms of landscape restoration for agriculture and forestry shows that the nature protection option is clearly more financially advantageous. This leads to the fact that during the healing of the landscape in Lower Lusatia, about 18% of the area of post-mining landscapes is to be transformed into nature reserves [4]. These include the “Grünhaus” natural paradise, under the care of the “Nationales Naturerbe” or the natural landscape of Heinz Sielmann in Wanninchen within the “Niederlausitzer Landrückten” with an area of 3 000 ha.

However, in the region, new circumstances and conditions have emerged, which make the process impossible to stop, but it can “go” on other tracks. The German economy needs energy, and the eastern Länder were, and as it turned out, are still the place where this energy is produced. Consequently, the conclusion is that at any time we experience the landscape and the state of the environment, it is in its transitional form. This form is sometimes predictable, sometimes planned and sometimes - unpredictably can extend for decades. On the one hand, the landscape and environment repair process are underway, but on the other, a new chapter in the history of the region has already begun. It results, for example, from the fact that due to the numerous post-mining landscapes it is obvious that the tradition of the “energy region” will continue. This tradition can be seen as a chance to use the potential of renewable energy production. Currently, tapping new, cost-effective land uses with renewable energy sources is ongoing, leading to the emergence of new energy landscapes.

The new challenge is to combine economic changes according to the regional pattern of innovative energy region with the process of landscape transformation, initiated by the IBA Fürst-Pückler-Land as a proposal to create a vision of new landscapes.

The innovative nature of the undertaking lies in the spatial combination of various forms of renewable energy obtained from wind, sun, water, biomass or geothermal energy and corresponding energy storage technologies, in connection with the formation of free space around these new energy sources. Energy landscapes are not only to have high spatial values, but also to influence the economic recovery of the region and the sustainable development of new cultural landscapes. Based on the transformations observations, it will be possible to determine whether it is possible to combine sustainable economic development with landscape design with high aesthetic values.

Such energy landscapes, in addition to modern and in the perspective of carbon dioxide-free power plants fired with brown coal have a double face and uses different potentials. In the case of wind energy, this potential is already exploited, or it is envisaged and located in regional plans. In addition, there are also good conditions for obtaining energy from biomass. Production of ecological solid fuel from biomass combined with its own source of biomass - energy plantation - can bring high profits and create prospects for new jobs in agriculture and forestry, and as a consequence gradually increase the quality of the natural environment. However, the transformation of the old landscape strongly influenced by traditional agriculture and forestry into an energy landscape in the current economic conditions is not easy. In addition, the question arises: to what extent, as 50 years ago, the development paradigm will not overshadow the quality of the environment? Is the conversion from post-mining landscape to “solar” one a step forward (figure 11, 12)?

The demand for renewable energy in the Federal Republic of Germany is constantly increasing. New landscape features such as energy plantations, wind farm propellers and solar collectors are changing the cultural landscape. New concepts provide for the creation of “energy gardens” with different sources of renewable energy, located in a landscape with high values [15]. Because each region has its own energy potential, there are different possibilities for shaping new energetic cultural landscapes. Is there not a dilemma in the energy projects implementation as those giving a chance for economic recovery region, and opening new perspectives for development and employment for people living in it in counterbalance with the quality of the environment?
Research using tools in the form of databases in geoportals indicates two parallel processes. On the one hand, the creation of the Lower Lusatia lake district is being carried out, eliminating the effects of lignite mining (figure 13, 14), and on the other hand, a comparable size of the surface is pledged with solar farms (figure 15, 16).

7. Conclusions
In the Fürst-Pückler-Land region, affected by the effects of industrial activities, EUR 46 million from public funds, state budget and EU funds, was invested in the landscape renewal and shaping a new quality of the natural environment. These funds were intended for IBA-SEE activities planned in 2000-2010.
In situ studies have shown that the transformation process has not been completed, and is still ongoing, and the assumed effects are still far from expected. Currently, care for the environment and its repair become more important, and in the context of improving living conditions - concepts for implementing the postulates of using alternative energy sources. At the same time, modern use of cultural and industrial heritage for other, contemporary economic activity than just for tourism can be an important alternative for the development of the region.

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