ARE IBA/IBTA SUCCESSFUL INSTRUMENTS FOR REGENERATING MINING REGIONS SUSTAINABLY? (1155)

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Abstract. IBA *Internationale Bauausstellung* has been for more than a century an important instrument of structural change in the regions facing socio-economic and environmental concerns. With the onset of Information Technology being used as a successful tool for urban planning, IBA now has reinvented itself as IBTA *Internationale Bau und Technologieausstellung*. It can be said that IBA and IBTA are constantly striving to have a forward looking approach to global change in socio-economic, environmental and climatic systems.

The *IBA-Fürst-Pückler Land* was an attempt to reimagine the post industrial landscape of the open-cast lignite mining region in Lausitz or Lusatia which was completed in 2010. As part of the vision, several decommissioned and abandoned open-cast lignite mines were transformed into pit lakes, therefore becoming Europe's largest artificial lake district. Two decades later the *Rheinishce Revier* or the Rhenish Mining Area (RMA), also an important Lignite region in Germany, is undergoing a similar process of change with plans to fill up the open cast mines with underground and river water to fulfil the vision of a Lake for the community.

In the context of climate change, the observed declining ground water recharge potential and the unpredictable precipitation patterns in Germany, filling up of the open cast mines with water may not be the most optimal proposition when thinking for a sustainable future. The paper therefore seeks to highlight the limitation and challenges of the IBA/IBTA as a tool for regenerating mining regions and suggest measures and frameworks to address them.

Keywords: IBA, IBTA, Mining Regions, Lausitz and Rheinishce Revier.

1. Introduction

Germany used to be the largest lignite producer in the world since the beginning of industrial lignite mining and it has been responsible for shaping the landscape and lives of communities within the region. To date, opencast lignite mining has altered 179,490 hectares of countryside, leaving behind open pits and derelict industrial lands. Since

1924, 313 settlements have been lost to lignite mines within the country (Appunn, 2023).

Presently, due to the commitment under the Paris Agreement, Germany is aiming to reduce its dependency on coal and shift to more renewable sources of energy. One of the most contested aspects of the phase-out of brown coal is how it will affect the social and economic well-being of the people living in the mining regions. Hence the official name of the coal exit commission: “Commission on Growth, Structural Change and Employment”. The idea of *Strukturwandel* or Structural Change is a key idea in the transition of German economy and executing it in coal regions involves several challenges ((BMWi), 2019).

To help facilitated the economic transition in coal regions from various formal and informal planning instruments, the *Internationale Bauaustellung* (IBA) was suggested for the regions such as Ruhr which was the largest industrial hub in Europe during the Industrial Revolution. The IBA first carried out in 1901 is an innovative strategy for urban and regional development. Among all IBA’s, the IBA-Emscher Park (1988-1998) designed for the Ruhr region, was labeled as “A workshop for the Future of Industrial Regions”. Headed by Prof. Karl Ganser, IBA-Emscher Park was characterised by the establishment of new planning structures and a regional approach that went far beyond mere housing and urban living. For the first time in the history of the building exhibitions, landscape design and architecture came to the fore in particular to establish a regional identity (Land, 2010).

Apart from the mining region of Ruhr, the lignite basins in east Germany were regions that had intensively been mined using open-cast method. The considerable spatial expansion of mining wastelands in the early 1990s made it necessary to conduct a rehabilitation programme involving the reforestation of large areas and the flooding of residual pits to form a lake landscape that is still under development. The Lower Lusatian lignite region is today known for its lake system, which was promoted throughout the 2000s by the *IBA-Fürst-Pückler Land*.

A similar approach has been seen within the Rhenish Mining Area (RMA) with the onset of IBTA and the expected expo by 2032. The idea of the *Internationale Bau und Technologieausstellung* (IBTA) for the Rheinische Revier represents a further development on the narrative of *IBA-Fürst-Pückler Land.* The Rhenish district seeks important tasks and future questions around the topic of technology, the *IBTA-Rheinisches Zukunftsrevier* will develop and show selected, highly ambitious next-practice projects within the dynamic structural change process in the Rhenish district. The public discussion mainly focuses on the development of new recreation areas, including a vital blue and green infrastructure, consisting, among others, of woods, meadows, and lakes (Greiving et al., 2022) .

In recent years, structural change in coal regions has been accelerated by a new driver: climate change. Although, Germany does not appear in the EU commission's report, it has always been considered a water-rich country, until now. Climate change is making summers warmer and drier (UK, 2021). As a result, landscapes are withering, wetlands are drying out, and forests are burning. Rivers too fail as important habitats for aquatic life and as transport means for ships. And as the groundwater levels drop, there is mounting concern over the future (Hein, 2022). It is therefore of utmost importance that climate mitigation policies take a strong hold in the process of Structural Change.

The nature and extent of environmental disturbance associated with mining commonly entails completely new and challenging combinations of climate, lithology and landform (Doley & Audet, 2013). Mining operations in Lausitz and RMA have been practised through open cast mining method resulting in large open pits. Before and during the mining operation the ground water table is lowered by pumps, so that the seam can be mined easily. As a result of this operation, the aquifers and the river catchments around the mining region are disturbed from their natural behaviour. This influences the water quality and quantity of the region.

In Germany, recultivation of closed mines has been practiced and investigated since the second half of the 19th century. Over the years the conversation on re-cultivation strategies has advanced with new ecological and bio-engineering thinking. Pit lakes are often the suggested post mining landform for open pit mining and life on earth is linked with the availability and presence of water, therefore it should be in the forefront of climate change discussions. The idea of converting open cast mines into pit lakes may present risks in the mining region. Poorly planned pit lakes often present risks to the environment and human health and safety (Hinwood et al., 2012), such as slope instability, drowning, entrapment, falls hazards, and poor water quality (McCullough & Lund, 2006). Conversely if well planned, pit lakes manage to have a beneficial end use. Such end uses include ecological reserves, recreation areas, water supplies for irrigation or stock water, reservoirs for cooling water and energy production, and treatment facilities for contaminated mine water (McCullough et al., 2020).

In this paper, two main Lignite producing regions of Germany are compared, through the context of its mining and recultivation history, impact on hydrology, and the planning instrument of IBA. IBA-Fürst-Pückler Land initiated 30 years ago, and IBTA-Rheinisches Zukunftsrevier which is presently being organised have their own independent memorandums. The paper intends to highlight how IBA as an instrument can help facilitate not just economic transition of these regions, but also consider new drivers of change - climate change.

2. Case of Lusatia/IBA Lausitz

2.1 Location

The Lusatian mining region is primarily a rural area in the east of Germany beside the Polish border, and stretches across the federal states of Saxony and Brandenburg. Its largest city is Cottbus with 100,000 inhabitants. The other closest urban agglomerations are Dresden in the south, Leipzig on the west and Berlin on the north. The Lusatian lignite field extends across the south-east of the State of Brandenburg and the north-east of the State of Saxony (Schulz & Schwartzkopff, 2018).

2.2 Mining and Landscape Restoration History

While open-cast lignite mining had been important in Germany since the early twentieth century, it intensified considerably in the eastern part of the country, first under the Nazi regime and then after the Second World War in the GDR (Deshaies, 2020). As a state with virtually no energy resources other than lignite, the GDR significantly ramped up the extraction of this poor quality fuel, which exceeded 300 millions tonnes per year at the end of the 1980s. Between 1970 and 1990, the areas mined for lignite in Lower Lusatia almost doubled, from 37,578 to 70,578 ha, meaning that mining activities consumed more than 2,000 ha per year throughout the 1980s.

The Slavic word Lusatia roughly translates to “swampland”. This region of swampland has been mined for lignite since 1800s. And since Lignite is the youngest form of coal, it is found closer to the surface and in the region of Lusatia it was found sometimes on the surface. When technology was not so advanced, coal was extracted with simple techniques, because of which the mines were very small in scale. By 1924, the technology for carrying out open cast lignite mining was achieved by the construction of the world’s first overburden conveyor bridge at the “Agnes” pit in Plessa, State of Brandenburg increasing the scale of the pit mines. By 1989, the whole lignite basin was characterised by mineral wastelands due to the giant excavators. The region suffered due to the incessant mining activity, which was responsible for the devastation of vast tracts of land. Although the end of mining was supposed to bring rehabilitation, recultivation or reforestation to mining wastelands, the priority given to production and the lack of financial resources as of the 1980s was to be blamed.

Following reunification in 1990, lignite mining was privatised and reorganised. This resulted in most mines closing as a result of the sharp decline in mining volumes, which today equates to around 70 millions tonnes per year in the three remaining mines. By 1994, a very important decision to separate brownfield remediation activity from mining activity was made by the federal Government. The remediation of the mines was done in collaboration with actors at three institutional levels. The federal government took charge of the rehabilitation of mining wastelands through public companies brought together in 1994 to form LMBV (Lausitzer und Mitteldeutsche Bergbauverwaltungsgesellschaft mbH). Although dependent on the Ministry of Finance (BMF), it was able to act as a relatively independent player, integrating the complementary proposals of the Ministry of the Environment (BMU) and the Ministry of the Economy (BMWi). In 1994, however, the Ministry of the Environment wanted the remediation of operations to be done in connection with economic development and tourism, while the Ministry of the Economy saw it primarily as an objective of the country's new energy policy.

But the story recultivation measures in Lausitz starts long ago sometime in 1949. In terms of shaping of the post industrial landscape, the study "Balance Disturbances in Landscapes" (*Gleichgewichtsstörungen in der Landschaft*) by the landscape architect Reinhold Lingner at the Institute for Architecture of the German Academy of Sciences could be seen as the starting point. One year later, in 1950, this study was extended to the "Landscape investigation of the Lower Lusatia lignite mining district" (*Landschaftsuntersuchung des Niederlausitzer Braunkohlenreviers*). It was carried out on the basis of 15 plane survey sheets covering about 123,000 hectares.

The "Landscape investigation" marks a conceptual turning point in the field of recultivation as before it was understood that re cultivation is to be done in isolation. The study suggested to analyse the entire area. Based on that, complex reclamation and recultivation plans could be formulated and these plans were seen as the basis for a consistent post-mining landscape. At the same time, this study was a pilot project for the comprehensive research project "Landscape diagnosis of the GDR" (*Landschaftsdiagnose der DDR*) covering all East German states. Furthermore, the new planning methodology of surveying local farmers was applied. The results of this anaylsis are considered as follows: Due to the "capitalist predatory economy" (Reinhold Lingner), fundamental disturbances of the water balance, significant water pollution, agricultural yield losses and other negative effects had occurred. There was no complaint about the industrialized landscape itself – on the contrary, the postmining landscape was described as "often not without charm" (*häufig nicht ohne Reiz*). So due to the"generous replanning" (*grosszügige Neuplanung*), the social relevance of the post-mining landscape as a place of recovery was to be taken into account, a "special planning task" (*spezielle Planungsaufgabe*) to be carried out by landscape architects in close cooperation with city planners, geographers, water managers, spa specialists, architects and economists etc.

Later, Lingner's team deduced an "action program" (*Aktionsprogramm*) for the Lusatian mining district. However, this was not adequately supported by the Central Committee of the Socialist Unity Party of Germany (Sozialistische Einheitspartei Deutschlands). Only the demand for soil protection and the implementation of so-called “operative groups” (Operativgruppen) was included in a Central Committee decision of 1 June 1953. Already one month later, such an “operative group” was established for the Lower Lusatian mining district.

At the Humboldt University Berlin, the research project F 3-322 “Improvement of the recultivation of dumps by researching its conditions with the help of pot and field experiments and review of previous measures in Lower Lusatia” (Verbesserung der Rekultivierung von Abraumkippen durch Erforschung der Voraussetzungen hierfür mit Hilfe von Gefäß- und Freilandversuchen und .berprüfung bisheriger Maßnahmen in der Niederlausitz) started. This was led by the well-known landscape architect Georg Pniower. The overall objective of this project was the development of scientific planning principles for the recultivation and afforestation of heaps and dumps. The research results were to be made available to the participating institutions of mining, forestry, water management and land culture. Wilhelm Knabe was another scientist incharge of this research project, whose objective was to understand the cultural value of soils and how substantial anthropogenic intervention (in this case mining activity) was needed to form life on new land.

2.3 Impact on Hydrology

In the Spree and Schwarze Elster river catchments, located in the Lower Lusatian mining district, a strong influence on water quality and quantity becomes evident. It results from more than 100 years of excessive open-cast lignite mining. In the open-cast mines of the Lower Lusatian region the mean ratio of pumped water to extracted coal is more than six tons of water to one ton of coal. This encroachment on large static ground-water supplies, in particular as effected in accordance with the energy policy of the former German Democratic Republic, resulted in the formation of a large cone of depression extending over an area of more than 2100 km2 (Grünewald, 2001). This led to a deficit of more than 9 Gm3 in the water resources of Lower Lusatia. As a result of the discharge of sump waters into the public receiving watercourses the average run-off increased by more than 30%. The rapid decline of pumped groundwater due to the abrupt closure of most mines after the German reunification in 1990 caused problems of water quantity and quality. The extent of the problem threatens the whole river system in the mining area and, additionally, other users and uses located downstream (for instance the UNESCO biosphere reserve Spreewald, the region of the German capital Berlin) (Koch et al., 2005).

The Upper Spree region (South Brandenburg) receives an annual precipitation of about 550 mm. The intensive opencast lignite mining in this region resulted in a significant groundwater depression, reaching a deficit about 13 billion m3 in 1989 (Grünewald, 2001). In the past the low surface runoff and the seepage losses of the river system were more than compensated by the amount of groundwater pumped in the course of mining. Nowadays, the problem of water availability is aggravated by a rapid decrease of released groundwater from about 32 to 12m3/s, due to the abrupt closure of a great number of mines.

In addition, the cone of ground-water depression and the related effects of reduced surface runoff and infiltration can only be reduced during a time span of several decades. On the other hand, the water demand of traditional users, established by formerly stable and sufficient water yield due to mining, persists. Moreover, a great number of former mining pits has to be filled with surface water because the rising groundwater is characterised by pH-values down to 2.5 and low acid binding capacity (Grünewald et al., 1996, 1997, 1999, 2001). Therefore these acid mining lakes would be a threat for the connected river system and other areas located downstream. Other utilisations of these lakes, e.g., for recreation and tourism, would not be possible. A fast filling process with surface water can prevent the exfiltration of acid groundwater into the mining pits and can ensure the dilution of the acid water.

The economic consequences that accompanied the social change in Germany from the end of 1989 onwards also had significant effects on the brown coal mining industry. To an increasing degree importance is attached to questions pertaining to the effect of a decrease in output on the water resources economy. During the period up to the year 2000 the average run-off in the River Spree will decrease to about 50% of the initial water level in the period up to the year 1990. A considerable proportion of the future water supply will be provided by the 5 longterm opencast mines of LAUBAG (Lusatian Brown Coal Corporation). With the aid of the sets of ground-water models available at the LAUBAG and an extensive data base, specified targets and concepts as regards water supplies can be converted into reliable forecasts for the water resources economy, taking into account actual planning measures. In this connection interest in focussed primarily not only on ensuring a steady flow into the rivers Spree and Schwarze Elster in future, but, above all, on accelerating replenishment of the ground water and the residual lakes. It is clearly evident that a solution of the water resources problem in Lower Lusatia cannot be reached solely by means of a water resources policy for surface waters that is based on storage systems.

These changes have had a profound impact on European mining regions and towns, which had been shaped by these industries over decades if not centuries . The end of mineral exploitation often meant de-industrialisation, high unemployment and out-migration. Such regions often face a difficult environmental legacy stemming from mining and related industries in the form of persistent pollution of water, soil and air. Overall, such regions and their inhabitants face enormous challenges to their economic, social and environmental future. Owing to the lack of economic alternatives, the organisational, financial and conceptual resources of such regions are generally regarded as extremely sparse (Lintz & Wirth, 2009).

2.4 IBA instrument

The IBA-Fürst-Pückler Land is named after Hermann Ludwig Heinrich Fürst von Pückler-Muskau who was a Travel author and a Landscape Architect. He is well known for his contribution to the field of landscape architecture through projects such as his own family estate and other parks in Bad Muskau and Branitz done during the early 19th century.

Mining activity across the Lower Lusatia region for 150 years had transformed and changed the original landscape. By early 1990s 20 opencast mines were closed leaving behind wounded landscapes and abandoned industrial buildings. In 1999, the then prime minister of Brandenburg asked the IBA to give it a new face and an identity. Following the example of what had been achieved in the Ruhr basin in the 1990s with the support of the Brandenburg Land government, policy makers of the Lausitz-Spreewald region created an IBA (Internationale Bauausstellung) ; i.e. a company in charge of initiating, coordinating and promoting projects for the rehabilitation and enhancement of the heritage and landscapes developed in the region. The Government of Saxony only participated in the IBA for what concerned the area of Lausitzer Seenland.

From 2000 IBA got together the national government, the federal states of Brandenburg and Saxony, the local communities and administrative districts, employers, unions and civil society organisations to come together to implement 30 large and small scale projects for changing the structure and landscape of the region. With the support of joint subsidies of €7.3 million from the Federal Ministry for Economic Affairs and Energy, the Free State of Saxony and the federal state of Brandenburg, guiding principles were developed. In addition, there was considerable support of about 1.23 billion EUR for landscape restoration and engineering upto the year 2022 (Irimie, 2017).

Between 2000 and 2010, the IBA Fürst-Pückler-Land thus contributed to showcasing the changing landscape and a new image of the Lower Lausatian basin; the IBA logo, See (lake in German), playing on its English meaning. Thirty projects concentrated in nine areas, known as “landscape islands”, were initiated by the IBA.

The team headed by Rolf Kuhn based its work on the experiences of IBA Emscher Park, which also focused on a former industrial landscape, as well as on the Dessau-Wörlitz Gardens which were designed by the Bauhaus Dessau as an “industrial garden realm”. Together with representatives of the communities and the region, planners and students, the IBA see concept was developed in coordination with national and international experts and IBA projects were implemented throughout the entire Lower Lusatia region. Two of the projects spanned the German-Polish border (Land, 2010).

The IBA see stimulated these immense landscape and structural changes economically, ecologically and creatively: Industrial memorials were preserved and repurposed, urban renewal projects were promoted and the lunar landscapes of lignite mines were opened for tourism. This created the Lausitzer Seenland (Lusatian Lakeland), Europe's largest artificial landscape with 20 lakes. It has 14,000 hectares of water surface with navigable canals interconnecting the lakes, kilometres of cycle tracks as well as floating houses, unique city harbours and and distinctive buildings giving the region its identity.

Radically transformed by lignite mining, the landscapes of Lower Lusatia are acquiring a new identity. When mining operations cease in 2030, the region will have become a lake and woodland region with 50,000 ha of forest and more than 140 lakes covering 26,000 ha, i.e. a quarter of the former mining areas. These landscapes, which will be reminiscent of those inherited from the ice age in Mecklenburg-Vorpommern and Finland, will also be characterised by the omnipresence of renewable energy sources, especially wind power, which is still being developed.

3. Case of Rhenish Mining Area (RMA)/IBTA Rhenish

3.1 Location

The Rhenish Mining Area (RMA) is located in North Rhine-Westphalia (NRW) in Western Germany near to the border of Netherlands and Belgium. It is surrounded by the cities of Aachen, Mönchengladbach and Köln. The area is home to around 2.1 million people with a slight downward trend, as a population decrease of 2.1% is expected by 2030. However, the population outflow is much less severe than in Eastern German lignite areas.

3.2 Mining and Landscape Restoration History:

This important lignite deposit was created by a uniform lowering of the Lower Rhine Bay during the Miocene that lasted for several million years. The main seam is located in the middle area of the Lower Rhine Bay with a thickness of up to 100 m.

Lignite was first discovered in Lucherberg (near Inden) in the year 1819, with extraction beginning in1826. With the increasing demand for primary energy sources with high energy density during the beginning of industrialization as well as technical innovations regarding the mining of lignite, the extraction of lignite in the region began to be profitable and also because before that the hard coal of the Ruhr region was a formidable competitor. In 1892, the first lignite-fired power plant was commissioned making power plants an important part of the energy industry within the region. The lignite reserves here are of around 55 billion tonnes out of which some 35 billion are commercially recoverable.Mining on a large scale started in the sparsely populated south of the lignite region, the so called “Villerücken”. In this area only woodland was affected by mining activities. This situation changed in the 1960s and 1970s, when lignite-mining was shifted steadily northwards. The devastation of the landscape now affected densely populated areas and highly productive farmland. In these parts, the soils are among the best to be found in Germany so that the land is mostly used for farming (with an index of productivity of 90 from 100). Reclamation processes became much more complex. Now, not only forests, lakes and rivers had to be relocated but also farmland and villages with several thousands of inhabitants. In the 1950s and 1960s, the creation of extended opencast mines caused an increasing number of conflicts. For the first time, mining activities provoked noteworthy resistance among people, who took the loss of fertile farmland and their homes more seriously. In contrast to the decades before, only few families were dependent on a job in the mining industry and therefore only a few accepted the traditional way of mining lignite. They attached more importance to reclamation aims, and more and more people began to reject the mining policy and even the current energy policy. Supported by local politicians and citizens ’ action groups, they tried to fight against new opencast mines.

Since the beginning of lignite-mining in the Rhineland in the 19th century, there has been a considerable change in the approach to reclamation. Proper landscaping after the shut-down of the mines has always been the responsibility of the mine operator. The “Allgemeines Berggesetz für die preuischen Staaten” (general mining act for the Prussian states), published in 1865, contained only few statements on recultivation regulations. It was not until sixty years later that reclamation or “recultivation” was defifined in more detail in a mining police directive for the Rhenish lignite-mining region by the “Oberbergamt” (state mining authorities) in Bonn in 1929: “Overburden masses shall be deposited in mined-out opencast mines in such a way that as much land as possible is reclaimed so that it may then be given over to forestry and farming”. This development is the result not only of technological progress, but also of the changing characteristics of the lignite deposits. Until the middle of the 20th century it was possible to gain lignite close to the surface. Only small pits were necessary and they were scarcely recultivated.

Currently, three large-scale open-cast mines – Garzweiler, Hambach and Inden – are in use by RWE AG and produce between 90 and 95 million tonnes of lignite per year, amounting to between 53% and 57% of Germany’s annual lignite output. The Inden opencast mine, only minor changes in the running time and mining area are to be expected. The Hambach opencast mine, the shortening of the mining time by 15 years and the significant reduction of the mining area to preserve the Hambach forest results in a significant change in the old planning status. New plans taking into account the Coal Phase-out Act are not yet available to the LANUV.

The Rhenish coal-mining area can be roughly characterized by two different landscape types: the average mountain landscape in the southwest with high annual precipitation rates (800 mm/a), and the lowlands in the northeast with a mean precipitation of about 650 mm/a, including flat loess soil areas as well as Holocene zones adjacent to the Rhine River and its tributaries. While the lowlands in the northeast comprise “Jülicher Börde”, “Zülpicher Börde”, and all other landscapes north from the two mentioned landscapes, the average mountain landscapes are located south from “Jülicher Börde” and “Zülpicher Börde”. Because of the high fertility of the loess soils, the Börde landscapes, at least since Roman times, have been, to a high extent, used as arable land. The soil quality in the hilly average mountain landscape is much lower, leading to a higher degree of grassland and forests, with the consequence of more diversified habitats and a rich, attractive, and partly protected landscape, which can be used for recreational purposes, as well. And due to the high quality of soil in the region, there used to be a strong focus on agriculture and still is on the food sector.

3.3 Impact on Hydrology:

As of 2020, the mining company RWE Power in the Rhineland has pumped off 512 Mill m3 for mine dewatering. Beside water supply to the power plants and some water suppliers, 132 Mill m3 were used for recharging the aquifer. Especially in areas north of the Garzweiler open cast mine (Nordraum), groundwater conditions are significantly controlled by managed aquifer recharge, particularly to support groundwater-connected wetlands, even some decades after mining has ceased. At the peak, up to 1.3 billion m3/ year of groundwater was pumped for dewatering. At the same time, controlled groundwater rise is taking place in several areas as part of the rolling mining system. Due to the long mining history, measures for controlled groundwater rise will last until the 2080s/2090s. By then, the three future mining lakes will be the largest artificial lakes in Germany. They will cover a total area of approx. 7000 ha and will hold a water volume of approx. 6.8 billion m3. The future lake Hambach will be up to 360 m deep.

Original plans for this mining lake assumed a volume of 4.6 billion m3, which exceeds the volumes of all natural lakes in Germany, with the sole exception of the Lake Constance (Bodensee). Due to the planned earlier stop of lignite production in the Rhenish district in 2030, the plans for these lakes have to be reconsidered and there final dimensions are still subject to public discussions. The future lake levels should be balanced with the groundwater level and they will also be connected to rivers (Inde, Erft, Niers).

Future giant artificial lakes with wide stretched water surfaces and very great depths will be formed after closure of the still active Hambach, Garzweiler and Inden largescale open cast mines. Also running waters have been affected by mining processes. Between 1998 and 2005, a 4-km long and straight section of the Inde River has been relocated resulting in a 13-km long new river (New Inde River) around the Inden open cast mine due to the eastward extension of the lignite mining. The new artificial river section is still geomorphologically "naïve" and characterized by temporary, highly energetic morphodynamic processes resulting in strong erosion processes in the river bed and the surrounding area. Extreme precipitation and resulting extraordinary discharge on July 15th 2021 caused serious flooding and erosion in the Inden open cast mine. After heavy rainfall, bankfull discharge of the Inde River resulted in a spillover into the open cast mine. As the lignite mining is more than 200 m below the surface, rapid erosion of the old channel and fast backward erosion created a 540-m long gorge which was about 5 m deep. More than 500,000 m3 of material were eroded and subsequently accumulated in the open cast area. A similar event happened at the Erft River close to the settlement Erftstadt-Blessem flooding a 60 m deep gravel pit. In both areas, erosion and sediment transport occurred, showing the high risk and strong geomorphological processes in flooded open cast mining areas with large base-level changes on short distances. However, due to the spillover of water, the flood in the lower reaches of both open cast mines was reduced. In future, the open cast mine can store water and could be used as retention basins for flood protection.

3.4 IBTA instrument

The IBTA is still in its nascent stage but it primarily is based on two main operational pillars: a continuously progressing project development on site and a process-accompanying, stimulating, lively exhibition/exposé. The aim is ambitious and futuristic so that they meet international quality standards through:

(I) meet structural-spatial (B) and technological-linking systemic (T) innovations with each other as well as their high-profile exhibition (A) with a motivation of local people for active participation.

The implementation of the format IBTA in the Rhenish area requires an independent, central organizational unit as well as adequate human and financial resources. The establishment of an IBTA GmbH is recommended, as a subsidiary directly to the Future Agency Rheinisches Revier GmbH (ZRR GmbH). The task of the IBTA GmbH is to carry out the curatorial process of identification, qualification and continuous monitoring of IBTA projects. It is also responsible for the preparation and implementation of the exPOSITION, especially in the context of the three central exhibition years 2026, 2032 and 2038, as well as cooperation with third parties. The successful implementation of the IBTA is not only based on suitable management structures and innovation-promoting processes but it fundamentally requires the will of the decision-makers* inside the Rhenish Revier and the country North Rhine-Westphalia.

4. Discussion and Way-forward

The study of the re cultivation strategies in the Lausitz and Rhenish region show that the objectives and activities were simpler and have grown tremendously in terms of technological advancement. It is also understood that the socio-economic aspects of recultivated and rehabilitated areas are important concerns to be addressed in the planning procedures of post-mine regions. But so are the eco-climatic factors. With increasing complexities of open cast mines, regional aspects need to play an important role. The paper aimed at introducing a discussion on the intention of the future of IBA. As much as it is a innovative tool for uplifting regions, IBA struggles with some past challenges of keeping up with a vision. For eg. despite the economic success story of the Lausitz region, over decades it was called as a “water emergency area” (Wassernotstandsgebiet) due to demising aquifers and heavy pollution of surface water bodies. Although it is commonly understood that it is not possible to rebuild the same landscape that existed 100 years before mining, there is a constant discussion on which post-mining landscape/landform/landuse is most beneficial for a region going through an economic transition. As IBA is a unique instrument that engages on dealing with pressing issues with region specific challenges, the more important question therein is: Are they able to address the larger sustainable development goal. Since the structural changes in both the regions are not only caused by the phase-out of mining activities, but are also related to land-use and demographic changes and, as mentioned above, and influenced by climate and mobility changes. Following are some highlights and suggestions:

1. The project oriented strategy of IBA is practical, but it takes away from the regional issues that are prevalent in such large scale mining regions.

2. The attempt to match to the international standard should be valid in technological innovations, but the design solutions should be contextual to the region.

3. IBA-Lausitz although is globally is taken as a successful case for mine reclamation but due to the ongoing climatic challenges, it is failing to meet its vision. The suggestion here is to develop future direction of pit lakes through research themes which focus on understanding the following key areas (Schultze et al., 2022):

- Interactions between pit lakes and groundwater
- Defining the role of pit lakes within the hydrology and geochemistry of watersheds

- Assessing Ecotoxicology, Biomagnification and role of micro-organisms in containment removal
- Assessing the Value of Litoral and Riparian Zones
- Influence of Pit-Lakes on post mining ecosystems
- Predicting the effects of climate change on pit lakes through advancing pit lake models

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