Title: Adapting Settlements to Climate Change: Transforming Former Industrial Areas Along Rivers in Germany into Resilient Mixed-Use Real Estate

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Climate change poses numerous threats in urban areas, such as heatwaves, reduced air quality, ecosystem disturbance, etc. For city areas located along rivers there is an increased risk of more frequent and intense flooding. Various riverside industrial zones in German cities were redeveloped into mixed-use areas in the post-industrial era. Therefore, this paper investigates the challenges faced by these new settlements, such as flood management, ecosystem protection, water pollution reduction, provision of public spaces, enhancement of urban aesthetics, and their connection to the real estate market on the local level. For research purposes, three projects from the German context are elaborated: Hamburg (HafenCity project), Heilbronn (Neckarbogen project), and Basel-Huningue-Weil am Rhein (3Land project). This qualitative research applies a case study approach to analyze historical documents, scientific literature, planning documents, and urban and architectural projects, thus identifying correlations among historical, spatial, social, and economic factors that influenced these redevelopments. To collect context-specific data, case study visits were conducted. Findings indicate that flood and social resilience are issues addressed in riverbank settlements through multifunctional public space design. Equal efforts are made in architectural innovation in the design of the buildings, which is highly important when adapting settlements to climate change effectively. A significant contribution is the improvement of connection of the redeveloped areas to the broader urban fabric of the respective cities. Furthermore, the newly redeveloped areas play an important role in improving the city's overall image while successfully integrating elements of its industrial heritage. Finally, this research develops valuable recommendations for policymakers, urban planners, and stakeholders involved in the development of real estate in riverside areas.

Keywords: climate change adaptation, flood risk management, riverbank settlements, urban resilience

Introduction

Waterfronts have historically evolved through several stages. This morphodynamical development of waterfronts is correlated with five historic periods of industrial development from 1801 to the introduction of the EU Water Framework Directive (EU-WFD). Each period exhibits a distinct influence on the watercourse, driven by human intervention. As a result of deindustrialization in recent decades, industrial zones, ports, and transportation routes have been relocated with brownfield sites being left behind. These areas are predominantly located in central city areas, and frequently, along rivers as remains of former ports. Brownfields near rivers are a result of economic restructuring as well (Hersh et al., 2012). Both architects and the real estate industry support transforming these former ports into promenades that can attract residential developments, offices, and cultural facilities (Schubert, 2010). Furthermore, transforming these areas along rivers could potentially help in adapting and mitigating climate change threats.

In the 1960s, brownfields were replaced with new facilities, which was a trend that first emerged in North America. By the early 1980s, large-scale mixed-use developments began to take place on these brownfields which were often characterized by weak planning. In the early 1990s, participative planning and design competitions became more common, often accompanied by events like the Olympics or flagship architectural projects, particularly in Europe. Finally, in the new millennium, projects were increasingly characterized by public-private partnerships and professional planning management. These kinds of redevelopments often served as city marketing strategies. Mixed-use developments and luxury housing became dominant on the riverfronts (Schubert, 2010).

The restructuring of waterfront brownfields is unique because of their proximity to existing infrastructures and their complexity in terms of land use, historical, economic, and other factors (Hersh et al., 2012). Revitalizing old port areas involves a complex web of stakeholders and interests as they present opportunities for sustainable development. Successful waterfront regeneration requires attention to creating a master plan that involves communities and developers from the earliest stages, public-private partnerships, collaboration between public authorities and private organizations and overseeing by an independent development agency (Wang, 2002). Riverfront redevelopments in brownfield areas in Europe and especially in Germany are leveraging the growing awareness of climate resilience, sustainability, and environmental responsibility to create projects that meet modern real estate demands while also addressing environmental challenges. Many riverside industrial zones in German cities were redeveloped into mixed-use areas, with residential use often being dominant (Wolf et al., 2021).

The objective of this paper is to analyze riverfront redevelopment projects in Germany, the challenges they face in the process of planning and implementation and the role of real estate in that process. The research examines three different case studies positioned in different contexts and with different objectives. However, all these projects share the common goal of implementing sustainable practices in shaping contemporary settlements by the river. The projects under study are still in progress: the HafenCity project in Hamburg, the Neckarbogen project in Heilbronn, and the 3Land project in the border area between the cities of Weil am Rhein in Germany, Basel in Switzerland, and Huningue in France. The paper will introduce each of the case studies, beginning with an exploration of the historical context that initiated these redevelopments, and the goals of each project. Furthermore, the important innovations in planning, design and governance will be analyzed. The paper will conclude by presenting key insights and recommendations drawn from the analysis.

Methodology

This research was done through a qualitative case study approach. The data on the specific projects was collected through a review of historical and planning documents, scientific literature, and documentation on the selected urban and architectural projects. Furthermore, site

visits were conducted with the goal of familiarizing oneself with the specific context that the projects are set in. Finaly, for two of the case studies semi-structured interviews were held with urban planners included in the plan development. The analysis of the gathered data identifies correlations between the specific objectives and processes in which these redevelopments are being conducted so final conclusions could be drawn.

Case studies of riverfront redevelopments

Neckarbogen, Heilbronn

Heilbronn was a key player in Württemberg's economic development in the last century and the analyzed area in Heilbronn holds a historically strategic position along the Neckar River. The area's spatial significance understandably came from its proximity to the river and railway lines. The Wilhelmskanal, which made the Neckar River navigable, was constructed in 1821 and a terminus station was established in 1848, which connected Heilbronn to Stuttgart by rail. The discovery of rock salt in the 1880s spurred the growth of the local chemical industry (Rösch, 2007). Over the years, the area saw the creation of harbors and the relocation of railways to accommodate growing traffic. Since 1935 the Neckar was blocked off by steep embankments and roads and was only visible as an element in the urban space in a few places in the area. Despite significant wartime damage and industrial use, the Wilhelmskanal and the former terminus station still remain in the area (Stadt Heilbronn, 2009). As transportation modes evolved and industries began to relocate or decline, the area along Neckar faced spatial challenges. Some of those challenges were the underutilization of the railway infrastructure and the port facilities. Therefore, this area was set to be repurposed into mixed-use developments with residential, commercial, and service-oriented activities.

Development plan

In 2009, an Urban Development Competition was held for the master plan of the area. The competition area covered approximately 100 hectares, and the task was to create a master plan that would serve as a guiding framework for the area’s development. The transformation was driven by the need to better integrate the Neckar River into the city's urban fabric. An important aspect was the reconnection of the east and west districts that had been historically separated by industrial infrastructure. Key objectives of the competition included the conception of an urban quarter with around 750 residential units, the development of mixed-use spaces that would combine living, working, culture, and leisure, and the development of riverbanks as open spaces. The master plan was expected to address several critical factors such as ensuring protection against emissions from adjacent industrial areas, integrating higher-level transport requirements, and creating sustainable infrastructure. The overall goal was to create a district that meets the needs of the current population and also serves as a model for future urban development, that integrates green spaces and sustainable practices into the urban landscape while revitalizing a historically industrial area (Dokumentation Modellquartier Neckarbogen, 2017). Steidle Architekten from Munich, in collaboration with t17 Landschaftsarchitekten, won the competition. The competition's results led to a framework plan that included a distinctive triangular settlement figure, green landscape strips, and bridges to connect different parts of the area. The plan integrated the garden city model and served as the basis for decisions related to the Federal Garden Show which was a project that was being parallelly developed in the same area. Several development plans are further derived from the Neckarbogen framework plan.

Figure 1: Neckarbogen district area in Heilbronn. Source: author, 2023

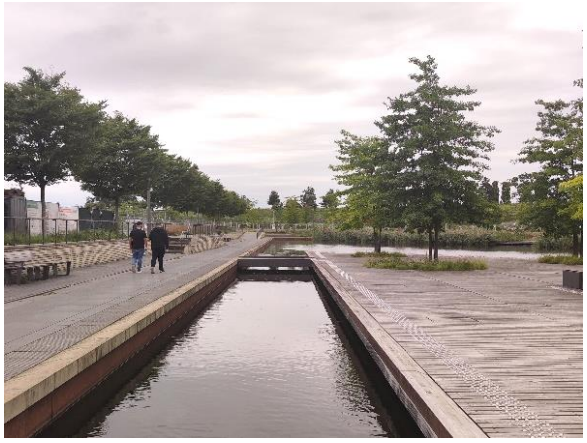

Figure 2: Neckarbogen public spaces. Source: author, 2023

BUGA 2019

The 2019 Federal Garden Show in Heilbronn, known as BUGA 2019, combined a garden exhibition with a city exhibition, transforming a 40-hectare area called Neckarbogen. In preparation for the show, an open space planning competition was held in 2011, based on the 2010 framework plan for Neckarbogen. The competition was won by sinai Gesellschaft von Landschaftsarchitekten mbH in collaboration with Machleidt GmbH. The project was set to revitalize the underused land, connect districts across the Neckar, and improve the city's image by integrating existing structures like the ABX Hall. The garden exhibition featured green spaces, horticultural art, and urban block development. The exhibition also included the construction of three blocks of mixed-use buildings up to nine floors, that would create a mix of urban living, shopping, and leisure opportunities, ultimately forming a the new Neckarbogen district in Heilbronn. The three construction sites were located between Stadtsee and Altneckar, bordered by the canal and Westrandstraße. The first construction phase of Neckarbogen was completed for the event, making the Neckarbogen an integral part of BUGA 2019. The new quarter was visible to visitors along with other important features like the city and leisure lake that would later become part of the district. The BUGA 2019 served as a catalyst for urban development in the area. It was a decisive instrument in driving the implementation process, linking to the theme of sustainability and acting as an ambassador for this idea. It provided a platform for stakeholders as users or exhibitors, by the realization of high-quality living spaces (Stadtplanung & Landschaftsarchitekten, 2015).

A model for integrated urban development and sustainability

In the wish to make the Neckarbogen a model neighborhood, there was a question on what Neckarbogen can serve as a model. To explore this, potential model aspects were divided into levels, such as: urban development (which includes integration, mix, diversity, layout, and strategy), open space (which includes community gardens, public spaces, street designs), architecture/typology (which includes rooftop terraces, cooperatives, sustainable construction), mobility (which includes car sharing, public transport, cycling, pedestrian traffic), and energy/sustainability (which includes water management, energy supply, energy-efficient buildings). These model aspects were further categorized into three types: Heilbronn New Standard 2019 (implementation of current standards in the district by the 2019 BUGA), Heilbronn Innovation (introduction of innovative projects by combining or evolving existing ideas) and Heilbronn Lighthouse (forward-thinking projects as experimental research). A matrix was developed to guide decisions on these aspects as the Neckarbogen develops.

One of the important aims of the Neckarbogen district is to create a diverse mix of functions, housing types, ownership models, and sponsorships, which would promote social sustainability. This urban mix includes diverse functions (combining living, working, leisure, and services within each area); variety in housing (offering different types of housing, such as perimeter blocks, row houses, and urban terraced houses); mixed ownership (including rental, ownership, and leasehold options); sponsorship diversity (involving investors, housing associations, cooperatives, and individual builders) (Dokumentation Modellquartier Neckarbogen, 2017). Finally, the framework aims to create a city of short distances, where living, working, and leisure is closely integrated. This means achieving inclusivity, as people with varying income levels can live near their workplaces and participate in the community.

Planning process, governance and stakeholder collaboration

The development of the Neckarbogen area has followed a clear, integrated planning process since the 2009 urban planning competition, including early and ongoing citizen participation. The 2010 framework plan was updated to refine existing plans, achieve a density that would allow for a critical mass to form in the district, and was closely aligned with the BUGA 2019 mission statement to maximize synergies between these complementary projects (Dokumentation Modellquartier Neckarbogen, 2017).

For the implementation of the plan a design manual was provided to ensure the design outcomes for the district. The Design Manual serves as a guide for future developments and ensures that the Neckarbogen becomes a unique and recognizable urban district. It provides guidelines for coordinating different construction projects. The manual is not rigid but serves as a flexible guide to create a unified and distinct identity for the area to achieve coherent overall picture. This gives all involved a clear direction for future developments (Dokumentation Modellquartier Neckarbogen, 2017). The Design Manual helps all involved in the planning process to coordinate between each other. The selection of developers for the properties is done through quality criteria and not through price. Furthermore, the allocation is made by parcel, so interested parties can apply for a maximum of two plots for a building with the same architect that are not directly adjacent to each other and at least one building cooperative/building group should be provided for each construction site. With the creation of building groups, the private builders collaborate to create properties. These projects, which include participatory planning and long-term self-use, often result in innovative and eco-friendly housing (Dokumentation Modellquartier Neckarbogen, 2017). The idea is to create a mixture of sponsorships (Pressestelle, n.d.).

Furthermore, a special building commission reviews all the projects. The building commission is a city-appointed group of urban planners, landscape planners, and architects, reviews construction projects based on the design manual, energy, mobility concepts, and the development plan. Finally, competitions where at least five architectural firms are participating are mandatory for key buildings and areas. The awarding authority is the plot owner or, in larger proceedings, the city of Heilbronn (Stadtplanung & Landschaftsarchitekten, 2015). This kind of planning and implementation contributes to a collaborative design context, where investors and builders are given the greatest possible scope for their individual needs.

HafenCity, Hamburg

Hamburg, Germany's second-largest city and, despite being 100 km from the North Sea, Hamburg's port is the third-largest seaport in Europe and remains one of the busiest in the world (Bruns-Berentelg et al., 2022). HafenCity is a district in Hamburg-Mitte, situated on Grasbrook Island along the Elbe River, where the former Port of Hamburg was located. The analyzed redevelopment area is situated south of the historical Speicherstadt district which served as a port warehouse, built between 1883 and 1927, and was added to the UNESCO World Heritage List in 2015. This warehouse complex, built on oak piles over demolished 16th-18th century

residential buildings, isolated the port from the city center. Following extensive damage during World War II, when about 70% of the warehouses were destroyed, and the rise of container shipping in 1956, the old port basins near the city became too small and shallow. As a result, the harbor quickly shifted to the south banks of the Elbe River (Prinzleve, 2023) and post-war, Hamburg's development had focused away from the Elbe (Gelfond, 2021). After World War II, many German cities prioritized urban reconstruction with separating industrial, office, retail, and residential areas. Hamburg created a 75 km^2 city center zone dedicated solely to harbor use (Bruns-Berentelg et al., 2022). During the third Industrial Revolution, HafenCity's significance as an industrial hub further declined. By the fourth Industrial Revolution, driven by cultural and creative industries, the area's industrial facilities were no longer in use (Bruns-Berentelg et al., 2022).

By the early 2000s, the port facilities had moved west to accommodate large vessels (Gelfond, 2021). Because of this, Hamburg undertook two major regeneration projects: HafenCity (initiated in 1997) and Wilhelmsburg Island by IBA-Hamburg (which begun in 2006). Both projects were a part of the Hamburg Spatial Vision 2020. The HafenCity project is Germany's largest urban reclamation initiative aimed at expanding downtown Hamburg by 40%. The area of the projects spans approximately 155 hectares, stretches from Speicherstadt to the Elbbrücken and transforms former port facilities into a mixed-use area (Petrow, 2011).

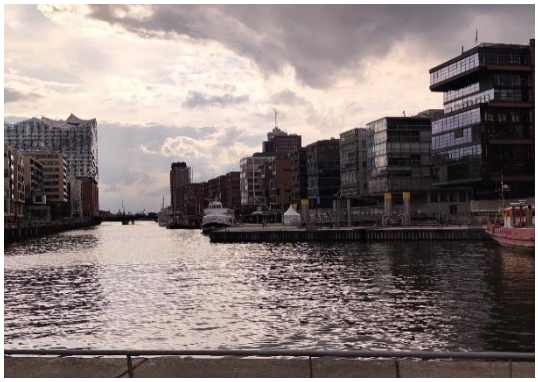

Figure 3*:* Mixed use district in HafenCity. Source: author, 2023

Figure 4: Mixed use district in HafenCity. Source: author, 2023

Development plan

The concept of HafenCity was initiated in the 1990s and unveiled in 1997. In the competition held in 1999 the "Hamburgplan" and Kees Christiaanse / ASTOC design was selected as winning. The plan aimed to turn the area of 157 hectares into a mixed-use urban area that preserves the historical and natural features of the context while adding socio-economic value to it (Gelfond, 2021). The Masterplan integrated residential, commercial, leisure, retail, and cultural facilities, and maximized land use with a high building density index of 2.5 to accommodate Hamburg's limited development space (Alpay, 2012). The initial Masterplan proposed in 2000 faced significant public criticism, as it was overly rational and failed to preserve elements of the site's industrial heritage. The Masterplan also outlined a phased development of HafenCity, which was set to move from west to east to ensure controlled construction across the area. A zoning plan for the first phase was established in 2000, and the first buildings were completed by 2004 (Schubert, n.d.). The project’s phased implementation also ensures connection with broader urban goals. This approach contrasts with the piecemeal redevelopment of other European port cities, as it also integrated HafenCity into a larger city-wide and regional strategy (Deubig, n.d.). HafenCity framework plan encouraged experimentation and adapted to emerging opportunities, such as nurturing creative hubs in historic warehouses. This approach exemplifies Hamburg’s shift from managerialism to entrepreneurialism in urban policy.

A model of sustainable and resilient urban development

There are five key points of sustainable development strategy for the HafenCity: reuse of the former industrial area and achieving high density; providing mixed use and sustainable land use in the redevelopment area; including sustainable mobility and implementing the concept of walkable city; achieving high efficiency and use of renewable energy and certification of buildings (Deubig, n.d.). Waterfronts have become key locations for city marketing, featuring iconic architectural projects. Similarly, HafenCity project features design by renowned architects such as Rem Koolhaas, Massimiliano Fuksas, and Herzog & de Meuron and also aims to showcase a blend of high-class housing, tourist attractions, and public events to build its image and integrate it into Hamburg's identity (Petrow, 2011).

HafenCity is located between the Norderelbe and the public flood protection line, placing it within the Elbe's flooding zone. Unlike other parts of the Elbe Estuary, which are protected by embankments and levees designed to withstand storm surges predicted for 2085, HafenCity requires unique flood protection solutions due to its geographical positioning and the nature of its development. The key flood protection measure in HafenCity involves elevating buildings on artificial mounds or plinths that reach 8 meters above mean sea level (msl) (Ge et al., 2014). This strategy allows for the integration of HafenCity with Hamburg's existing urban fabric by implementing innovative adaptive architecture. Finaly, this resilient building principle enables phased development from west to east and north to south.

HafenCity is designed as a "walkable city" where everything is easily accessible without a car, thanks to its mixed-use layout, a dense network of pedestrian streets, car lanes, and bus lines, the U4 subway line (operational since 2012) and an extensive quayside promenade. Parking is heavily restricted, and most parking spaces are hidden underground to integrate with flood protection measures. Finally, the HafenCity eco-label from 2007 was Germany's first to set high energy standards for all building types and requires annual performance verification. The district also features various tourist attractions distributed throughout its area (Bruns-Berentelg, 2014).

Planning process, governance and stakeholder collaboration

The HafenCity project reflects the complexities of urban development in port areas. Early in the planning process, dialogue and interdisciplinary collaboration were established to build consensus on the objectives of the plan (Alpay, 2012). The Hamburg Port Authority (HPA), not the Ministry for Urban Development and the Environment (BSU), oversees planning in the port, which complicates collaborations (Schubert, n.d.). By 2004, Corporation for Harbor and City Development was transformed into HafenCity Hamburg GmbH, a public company, which took over the development process (Bruns-Berentelg, 2014) and soon owned most of the land. The company uses its influence to ensure that investors adhered to the broader planning vision. This approach balances immediate land sale profits with long-term planning goals, incorporating mixed-income and mixed-use neighborhoods (Bruns-Berentelg et al., 2022). In this way public ownership in the area was maintained. Instead of charging the highest possible price for land, they require investors and developers to contribute to the overall planning goals of HafenCity, which in turn raises the value of new land plots.

A specific example of the original form of governance in HafenCity is the new Elbphilharmonie concert hall. The idea for a new iconic concert hall on Hamburg's redeveloped waterfront came from a local developer who had commissioned famous architects Herzog & de Meuron to design it. The planning and building process of the indicates a shift in the governance of iconic flagship projects at least in Germany and reveals new discourses and practices of a place-specific neoliberal governmentality. Uniquely, this project relied heavily on local civic commitment and patronage, as a new form of governance in urban development that blends public and private interests (Balke et al., 2018). Another aspect of the project that relies on private stakeholders is the flood preparation for privately owned buildings meaning that the

owners pay higher price for real estate in the area because the funds go in flood protection and maintenance of the buildings (Mees et al., 2014).

3Land, Weil am Rhein – Basel – Huningue

The municipalities of Basel, Weil am Rhein, and Huningue form a historical border triangle on the river Rhine. These areas have gradually become a continuous urban space through uncoordinated growth. Before 1840, the Rhine between Kembs and Breisach was a broad, branching floodplain. From 1842 to 1876, the river was narrowed into a deeper, more controlled bed and became less navigable until 1962 when the Rhine Lateral Canal was built. In that time Basel was known internationally as a "factory city" with a high number of workers, a trend that continued until the 1980s (Team LIN, 2015a). The Hafen-Stadt port in Kleinhüningen, Switzerland, evolved from a fishing village into a vital industrial and residential area. Originally it was the most important port in Switzerland, whose growth was spurred by key developments such as the construction of the St. Johan port in the early 1900s, the opening of the Maritime Station in 1926, and a second port basin in 1946. This expansion influenced the growth of the

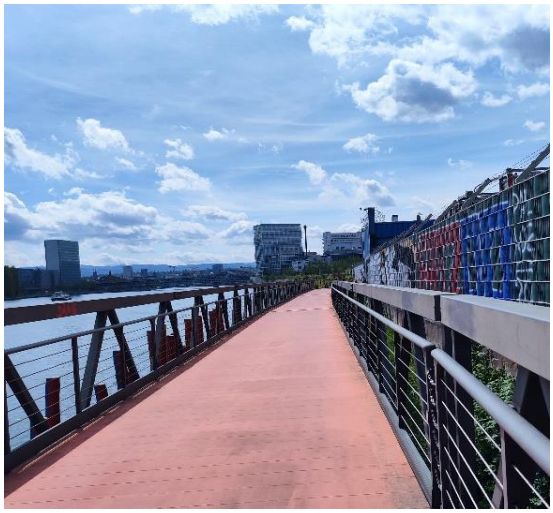

Figure 5: 3Land area in Basel.
Source: author, 2023

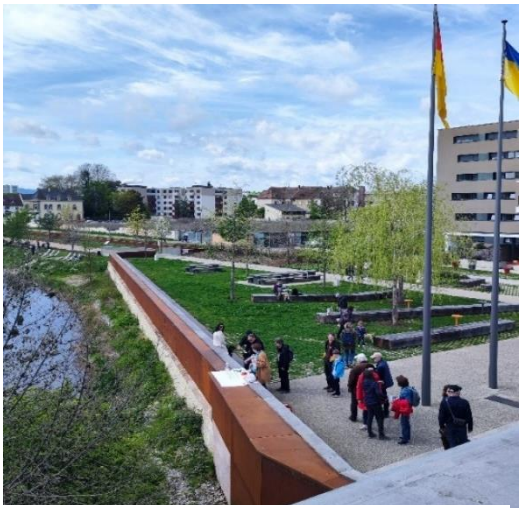

Figure 6: 3Land area in Huningue.
Source: author, 2023

pharmaceutical and chemical industries in the region. The early 2000s saw the beginning of a new transformation phase with the development of the Novartis Campus, which was later extended to connect with the Rhine (ENSURE - EuropeaN Sustainable Urbanisation through Port City REgeneration, 2019). A significant cross-border protest occurred in 1986 after a chemical spill polluted the Rhine. By 2000, the Rhine had become clean enough for swimming through Basel's city center. The national borders have shifted over the centuries and today they have significant marks on the urban landscape. Over time, the cities have expanded towards these borders, resulting in a complex mix of urban areas and a closely connected cross-border region (Team LIN, 2015a). Despite its well-developed infrastructure—proximity to the port, airport, railway stations, and main roads—the 3Land area has not fully realized its potential, with infrastructures often acting as barriers rather than connectors. The region had a fragmented urban space while people's access to the Rhine was limited, with residential areas often located behind industrial zones. Despite its urban and industrial nature, the 3Land area also includes ecologically valuable habitats and biotope networks that are crucial for maintaining local, regional, and supra-regional ecological networks (IBA Basel, 2020).

Before the project, the Rhine was mainly seen as a border, especially for Huningue and Weil am Rhein, while Basel viewed it as central to its identity. Basel's growth is limited by land availability, so it needs cooperation with nearby municipalities in a polycentric agglomeration. Furthermore, the development of the Swiss Rhine ports, including relocating the harbor station,

is a focal point of Basel's urban strategy (Team LIN, 2015c). Huningue, though not the initiator, sees the project as a significant opportunity for its own development (Team LIN, 2015c).

Today, efforts are underway to restore some of the Rhine's original floodplain to create sustainable habitats for endangered species. Rhine is now also viewed as a central figure in European cross-border identity, which offers opportunities for multifunctional, transnational urban development (Team LIN, 2015a). The cities of Basel, Huningue, and Weil am Rhein, along with the Saint-Louis Agglomération and the Conseil Général du Haut-Rhin, joined forces to develop this area into dense, sustainable urban districts. A 2012 planning agreement led to the creation of a joint development vision and spatial concept (IBA Basel, 2020). The 3Land project is situated in a 430-hectare cross-border area and aims to reconnect the cities with the Rhine, while providing green and open spaces, particularly in Friedlingen. The transformation of port and industrial areas in 3Land is freeing up space for new urban districts (Team LIN, 2015a). The idealized lifestyle—working in Switzerland, shopping in Germany, and living in France—is being reevaluated for sustainable development across the region (Team LIN, 2015c). The reintegration of the port with the city and EU funding were key catalysts for regional economic development and cultural exchange (Le Den et al., 2019). This development aims to maintain each city's distinct identity while merging them into a unified space with potential for 20,000 jobs and residents over the coming decades.

Development plan

The initial concept for the Rhine Island, was also known as "Rheinhattan," proposed by MVRDV and faced criticism for its perceived luxury focus which led to fears of displacing existing residents. Therefore, the newly proposed planning concept of the area aimed for a gradual and careful transformation rather than exclusivity. In November 2013, Team LIN was tasked with developing a spatial concept for 3Land. After consulting with politicians, planners, and experts from Germany, Switzerland, and France, they proposed the framework. The 3Land spatial concept is a preliminary framework, not a final master plan. The concept of the framework was refined based on feedback. In the process of citizen involvement, demands for diverse and flexible living arrangements were discovered, with 45% of respondents valuing a variety of housing types and 50% demanding flexible building designs. Many prefer renting over ownership and asked for affordable and cooperative housing (Team LIN, 2015b). The 3Land project aims for a mixed-use approach and envisions three cross-border hubs: Campus Labor (education and research functions, new industries), Urban Vis-à-vis (living and working functions), and Vis-à-vis across the Rhine (residential and leisure functions). Approximately 900,000 m^2 of space was set to be developed (Team LIN, 2015d).

The project implementation is divided into four phases, each addressing specific goals and timelines. The pre-project phase focuses on laying the groundwork with flexibility to adapt plans as needed, while coordinating land release, and implementing temporary uses in preparation for future development. Phase 1 (2015-2020) focuses on the area's visibility through temporary projects, improvement of accessibility with new bridges and public transport, and hosting trinational events. Phase 2 (2020-2025) intensifies urban redevelopment with the introduction of an express bus line, transformation of Huningue South, construction of a northern bridge, and residential projects in Weil am Rhein. Phase 3 (2025-2030) is planned for developing the previously started areas and improving public transport connections, including a direct link to EuroAirport, while further constructing bridges and advancing urban projects. The final, Phase 4 (2030-2035), focuses on completing urban development in Huningue South and Basel's southern port area, and exploring potential long-term projects with BASF and Novartis (Team LIN, 2015d).

A model for cross-border sustainable urban development

3Land seeks to achieve a unified riverfront experience that respects the varying cultural approaches to the Rhine in each country. Furthermore, 3Land will support a new educational

institution focused on language acquisition and international schooling in order to aid cross-border communication and education. The newly redeveloped area is set to provide flexible spaces for start-ups, small businesses, and innovative enterprises. This includes business incubators and adaptable office spaces, complementing traditional commercial areas. Leveraging the area's rich cultural backdrop and its unique border location, 3Land will accommodate both permanent cultural facilities and temporary events such as festivals and markets.

The 3Land area is designed for high flexibility, allowing further subdivision of plots as needed. Shore areas will be publicly accessible. Development will incorporate buffer zones between different uses and connect new and existing districts through open spaces and harmonized urban planning (Team LIN, 2015d). In the 3Land project, a catalog of criteria was implemented to guide private and non-profit investors, developers, and landowners across the three participating countries. This catalog, known as the "Trinational Criteria Catalog," aims to exceed current standards and awards the "Sustainable 3Land Durable" certificate to those who meet its rigorous requirements. The catalog has five overarching goals: creating green and open spaces by opening previously closed areas, enabling user-oriented and cooperative development, ensuring accessibility for all city residents, prioritizing walking, cycling, and public transport, and implementing environmentally friendly transformation processes. For instance, one key indicator under energy efficiency is the reduction of gray energy, which involves upgrading existing buildings with minimal intervention and designing new buildings for flexibility (Expertenhandbuch, n.d.).

Planning process, governance and stakeholder collaboration

In the context of 3Land, governance represents a pragmatic and adaptable approach to managing complex cross-border interactions among three countries. The project impacts a wide range of stakeholders, including architects, conservationists, neighborhood groups, and businesses. While traditional governance might seem inadequate, especially in regions with varied administrative systems and national traditions, governance in 3Land is viewed as a complement to existing structures. It employs direct interaction between citizens and decision-makers rather than relying solely on democratic representation (Team LIN, n.d.).

Out of the 430 hectares in 3 Land area, a significant portion is privately owned, particularly by Novartis, BASF, and other companies in the Huningue South zone. Public ownership is limited, mainly in France. Effective planning for the 3Land project requires strategic negotiations with the private landowners. The Port Company is a key partner, and as port areas transition to the Canton of Basel-Stadt, gradual land releases are anticipated. However, the planning process for 3Land remains complex and evolving (Team LIN, 2015a). The cities and local authorities of the Basel agglomeration have a long history of cross-border cooperation as shown by the establishment of the Trinational Eurodistrict Basel (TEB) (Team LIN, 2015a). Despite Switzerland's non-EU status, the TEB allows it to benefit from EU funding.

An open space and nature conservation concept was also developed for 3Land. While implementation is primarily managed at the municipal level, certain bi- and trinational projects will be jointly developed. It will guide future planning in each city, serving as an orientation and regulatory tool. The concept also outlines tasks for each city, categorized into short-term (until 2025), medium-term (until 2030), and long-term (from 2030) goals to inform future planning processes, such as Basel's Klybeck-Kleinhüningen district development plan and Weil am Rhein's Integrated Urban Development Concept (ISEK) (IBA Basel, 2020). Finaly, the 2012 "Strategy 2030 Trinational Basel Agglomeration" also presents a vision for a compact city-region that is complementary to the 3Land vision (Ohgai & Toda, 2013).

Discussion and conclusion

New settlements along rivers in Germany have faced multiple challenges in the process of development, like flood management, balancing public-private responsibilities, resolving land

ownership conflicts, preserving industrial heritage, addressing social and environmental justice issues, maintaining environmental ecology, integrating with the existing urban fabric, achieving critical mass, implementing sustainability practices, navigating urban policy complexities, designing effective public spaces, enabling citizen involvement, developing adaptive infrastructure, and ensuring economic viability. These challenges arise in the context of climate change, and urban growth that seek sustainable and resilient practices in city building. This paper presented three riverfront redevelopment cases: two in Germany and one in a border region between Germany, France, and Switzerland. All three case studies were envisioned as future models for urban development, each with a different focus. The HafenCity aimed to serve as a model for flood resilient and sustainable settlement; The 3Land focuses on improving connections and ecological status of the district and the river area and the Neckarbogen project focuses on improving social resilience while building sustainably. A key objective across all three projects was to improve the respective city's image, particularly given their prominent riverfront locations. This was achieved through strategies like building iconic architecture by renowned architects, preservation of industrial heritage, creation of high-quality public spaces, and the implementation of compact, sustainable, and innovative architectural solutions.

Comparing all three case studies helped identify some similar objectives and sustainable practices that were given a priority in each of the planning frameworks. Firstly, riverfront redevelopment projects should be part of a long-term integrated vision, like, for example, Hamburg's Spatial Vision 2020 or Basel's Vision 2030, which would effectively connect them with other individual projects. Various sustainable concepts were identified in the planning frameworks for these districts such as "cities of short distances," that would enable the residents to reach necessary function in their neighborhoods and which adds to social resilience of those neighborhoods. Furthermore, walking and cycling are prioritized modes of mobility. The plans also favor green interventions, and design of multifunctional spaces along the rivers that accommodate both social events and flood management.

The analyzed case studies demonstrated several innovative approaches in implementation processes and building processes that contributed to their success so far, and that can provide valuable conclusions and recommendations for stakeholders involved in similar processes. The planning and implementation processes, as shown, are highly complex. Each of the three case studies developed a flexible planning framework in the beginning, followed by either a design manual, or a design handbook, or eco-label certifications for buildings, that could help in behavioral change necessary for achieving long-term sustainability and that would give some restrictions to the existing flexible frameworks. The development process is typically phased so it can adapt to possible changes. Finaly, new governance models, public-private partnerships, and funding mechanisms proved crucial for project implementation. To familiarize the public with the projects and public events and exhibitions such as BUGA 2019 or IBA Basel were held.

Finally, real estate plays a key role in these redevelopments. One of the key objectives across all projects was achieving sufficient density to reach critical mass. However, while estate development brings economic benefits, it can also lead to gentrification by displacing lower-income residents. This is reflected in the higher price for properties in Hafencity as private real estate owners are also the ones providing crucial funding for flood management in privately owned buildings. On the other hand, the 3Land and Neckarbogen projects incorporate affordable housing to offset social resilience concerns.

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