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FLOATING BUILDINGS AS A RESIDENTIAL SOLUTION IN BELGRADE

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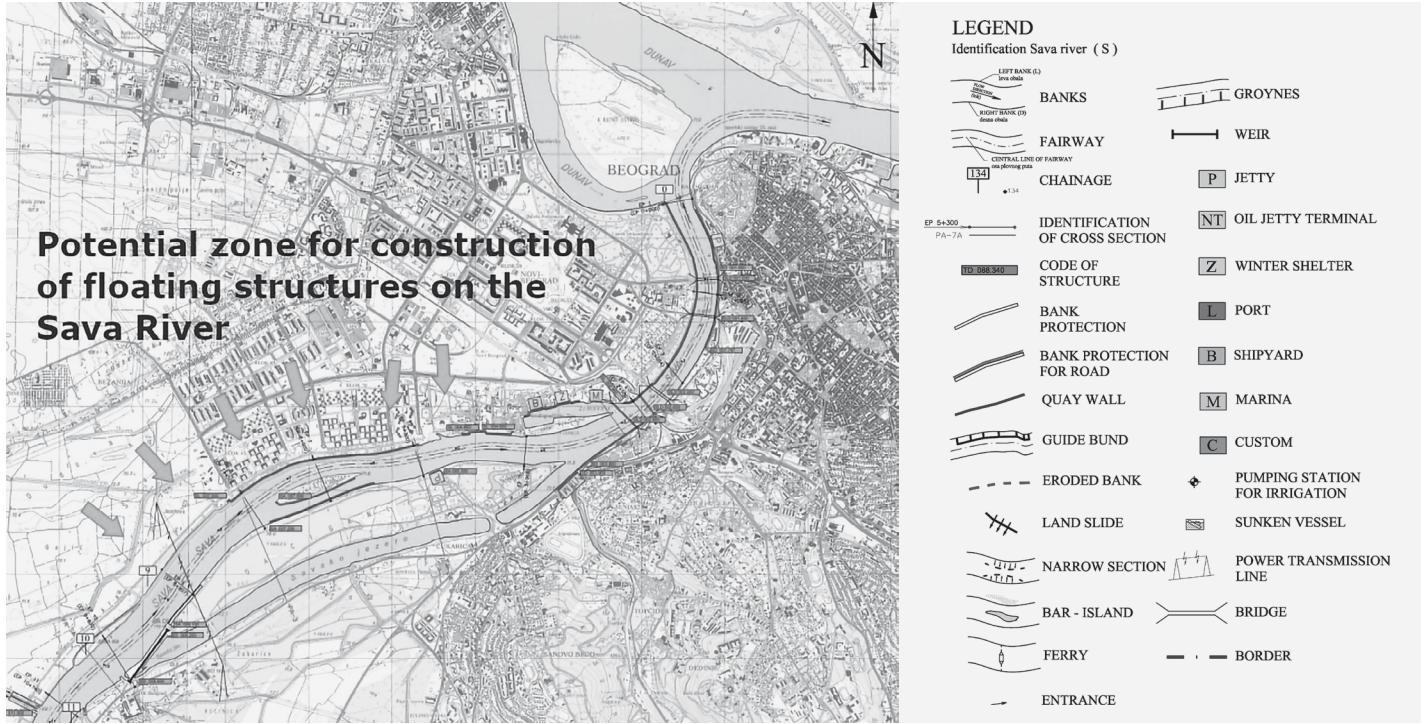



FIG. 1 POTENTIAL ZONES FOR THE IMPLEMENTATION OF MODULAR FLOATING HOUSING ALONG THE SAVA RIVER (KM 9.5-0.0) IN BELGRADE

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FLOATING BUILDINGS AS A RESIDENTIAL SOLUTION IN BELGRADE

BELGRADE SPATIAL PLANNING
CLIMATE RESILIENCE
FLOATING ARCHITECTURE
RIVERFRONT HOUSING
SUSTAINABLE URBAN DEVELOPMENT

This study is intended to provide a preliminary insight into the potential role of floating buildings in redefining residential development in Belgrade. Increasing urban density and land scarcity have encouraged the exploration of alternative housing models, among which floating structures have gained attention due to their adaptability and sustainability. Drawing upon previous research on urban riverfronts and floating typologies, this paper outlines the key environ-

mental, regulatory, and socio-economic dimensions relevant to Belgrade. In addition to theoretical analysis, the research includes a site visit to the Ijburg floating housing project in Amsterdam, complemented by a comparative overview of European case studies. The findings are expected to serve as a foundation for continued interdisciplinary research and strategic urban planning along Belgrade's waterfront.

INTRODUCTION

Rapid urbanisation and increasing housing pressures compel cities worldwide to reconsider spatial strategies and explore alternative models that address land scarcity and sustainability. Floating architecture has emerged as a viable, climate-resilient strategy, particularly suited to flood-prone and high-density urban contexts (Olthuis and Keuning, 2010: 22; Kim and Bae, 2020: 3; UN-Habitat, 2019). In Europe, floating typologies have taken diverse forms, reflecting socio-spatial, technical, and governance models. In the Netherlands, Waterbuurt-West – a consolidated neighbourhood within IJburg – and Schoonschip, a self-initiated project, serve as key precedents with varying levels of planning integration (Metabolic, 2019; Schoonschip, 2022). The IBA Waterhouses in Hamburg and Urban Rigger in Copenhagen illustrate modular, mobile typologies supported by institutional frameworks (BIG Architects, 2017; Koekoek, 2010). The amphibious housing cluster in Maasbommel demonstrates a hybrid approach, with homes that float during floods but rest on land in dry periods (Bertram, 2010: 56; Climate-ADAPT, 2020). Together, these five cases reveal the potential of floating settlements to deliver spatial efficiency, energy autonomy, and circular resource systems, while also exposing barriers such as regulatory ambiguity, infrastructural challenges, and maintenance complexity (Lago and Czapiewska, 2020: 97-99;

Jaroszynska and Wolanski, 2019; Kuryłek, 2016).

In Serbia, water-based living remains informal and marginal, often seasonal in nature, and lacking legal or infrastructural support (Vuksanović-Macura, 2017: 118; Planning and Construction Act, 2022). Riverfront development in Belgrade is largely shaped by private investment and excludes inclusive or sustainable strategies (Tilinger and Lalić, 2008: 42). Building on prior research into sustainable housing and waterfront regeneration (Maksimović, 2019; Maksimović and Krstić-Furundžić, 2020), this paper investigates the conditions under which floating housing could be adapted to the Sava riverfront. The aim is not to prescribe a universal model but to identify spatial, institutional, and technical enablers for context-sensitive implementation in Belgrade – an alternative paradigm of urban living in response to ecological and demographic pressures.¹

METHODOLOGICAL FRAMEWORK

This research adopts a qualitative multi-case study design to examine the applicability of floating residential architecture as a sustainable response to Belgrade's urban and hydrological challenges. It employs an analytical-synthetic and comparative method, widely used in architectural and urban planning research for analysing complex typologies and context-specific implementation. Case studies were identified through desk research and targeted digital searches using terms such as “floating housing”, “modular floating buildings”, “amphibious dwellings”, and “water-based urban development”. Sources included peer-reviewed articles, architectural monographs, technical documentation, and policy frameworks.

To validate secondary data, a site visit was conducted to Waterbuurt-West in Amsterdam, one of Europe's most integrated floating neighbourhoods (Metabolic, 2019). This enabled in-situ assessment of urban morphology, infrastructure, and typological organisation.

Given the need for climatic, institutional, and infrastructural comparability, the initial search was intentionally limited to European case studies. Non-European cases – although methodologically relevant at the global scale – were excluded due to substantial differences in regulatory regimes, hydromorphological conditions, and governance structures, which would reduce the analytical con-

¹ These studies were presented at the 6th and 7th International Academic Conferences Places and Technologies, held in Pécs and Belgrade respectively.

sistency and limit the transferability of lessons to Belgrade's context.

Five European case studies were selected: Waterbuurt-West, Schoonschip, IBA Waterhouses, Urban Rigger, and Maasbommel. Selection was guided by four criteria:

1. Typological relevance – replicable modular or collective housing rather than experimental or touristic units;
2. Institutional integration – formal inclusion in planning frameworks (BIG Architects, 2017; Schoonschip, 2022);
3. Constructed status – realised and operational beyond the prototype stage;
4. Multi-dimensional urban value – addressing at least two dimensions of environmental sustainability, infrastructural connectivity, or social inclusion (Lago and Czapiewska, 2020: 97-99; Jaroszynska and Wolanski, 2019; Kuryłek, 2016).

Micro-houseboats, individual cabins, and non-residential prototypes were excluded due to their limited urban relevance.

METHODOLOGY

Building on this framework, the study applies a comparative, qualitative multi-case analysis to evaluate the transferability of selected typologies to Belgrade's Sava riverfront. Three complementary methods were combined:

- Document analysis of planning records, architectural documentation, and policy reports (Urban Planning Institute of Belgrade, 2021; Planning and Construction Act, 2022);
- Literature review of peer-reviewed articles, technical studies, and regulatory frameworks;
- Empirical observation during a site visit to Waterbuurt-West, enabling spatial validation under real conditions.

Each case study was evaluated according to five analytical dimensions, selected for their relevance in assessing adaptive housing strategies for urban waterfront contexts:

- 1) Legal and regulatory framework (Planning and Construction Act, 2022);
- 2) Urban integration
- 3) Architectural and technical systems (Olthuis and Keuning, 2010: 22; BIG Architects, 2017);
- 4) Environmental performance (Bertram, 2010: 56; UN-Habitat, 2019; Climate-ADAPT, 2020);
- 5) Socioeconomic dimension (Schoonschip, 2022; Metabolic, 2019).

An evaluation matrix, based on the principles of Qualitative Comparative Analysis (QCA), ensured standardised comparison and the identification of recurring patterns. Cross-

validation with independent sources enhanced reliability and methodological robustness. This structure supports critical analysis of the technological, legislative, spatial, and social conditions required for implementing floating housing in Serbia.

SITE-SPECIFIC CONSIDERATIONS: THE SAVA RIVER AS A TARGET AREA

Building on the comparative evaluation of European case studies, this section narrows the focus to Belgrade and identifies the Sava River as a potential pilot site for floating housing (Fig. 1). It represents the first step in translating general lessons into site-specific conditions. The Sava offers favourable morphology, a moderate hydrological profile, and proximity to strategic urban zones. With an average discharge of about 1,560 m³/s and a width of 200-300 metres, several central segments are non-navigable, making the river technically more suitable than the faster and commercially busier Danube (Plovput, 2018-2022). Underutilised riverbanks – such as Ada Huja, the Lower Sava Amphitheatre, and downstream areas near the Belgrade Waterfront – present promising conditions for developing infrastructurally integrated and ecologically responsive floating neighbourhoods (Tilinger and Lalić, 2008: 42; Vuksanović-Macura, 2017: 118; Maksimović, 2019). However, Serbia's current planning framework creates significant barriers. The General Urban Plan of Belgrade 2041 acknowledges the importance of riverfront development but does not classify floating housing as a legal typology (Urban Planning Institute of Belgrade, 2021). Likewise, the Planning and Construction Act (2022) lacks explicit provisions for modular residential structures on water. Future implementation therefore depends on targeted legal amendments, the creation of new zoning categories, and the adoption of technical standards aligned with sustainable development goals and international best practices (UN-Habitat, 2019; UNEP et al., 2024).

In sum, the Sava River offers technically viable sites for pilot deployment, but regulatory reform is indispensable. These findings form the basis for the following chapter, which examines how European floating housing models can be adapted to Belgrade's institutional and ecological framework.

CASE STUDIES OF FLOATING BUILDINGS IN EUROPE

This chapter presents an analytically structured evaluation of five built examples of floating housing in Europe. Each case was selected based on the methodological crite-

TABLE I CASE STUDIES

Case	Name of Floating Building	Method of Investigation	Location	Year	No. of Units	Avg. Unit Size (m.)	Shared Spaces	Typology
1	“Waterbuurt-West (Ijburg)”	Site visit + Docs	Amsterdam, Netherlands	2017	75	100-180	Yes	Modular cluster housing
2	“Schoonschip”	Literature + project documentation	Amsterdam, Netherlands	2019	46	120-160	Yes	Co-housing, community-based
3	“IBA Waterhouses”	Literature + project documentation	Hamburg, Germany	2013	5	140-200	No	Luxury / pilot units
4	“Urban Rigger”	Literature + official website	Copenhagen, Denmark	2016	12	30-40	Limited	Student housing
5	“Maasbommel Amphibious Housing”	Literature + reports	Gelderland, Netherlands	2005	32	100-150	No	Amphibious single-family

TABLE II SYNTHETIC EVALUATION OF REPRESENTATIVE CASE STUDIES OF FLOATING ARCHITECTURE IN EUROPE BASED ON KEY INDICATORS

Case Study	Legal & Reg.	Urban Integration	Arch./Tech. Innovation	Environmental Approach	Socio-Economic Value	Replicability in Belgrade	Author's Note
“Waterbuurt-West (Ijburg)”	☑☑☑	☑☑☑	☑☑	☑☑	☑☑	☑☑☑	Strong precedent; modular typology aligns with Sava riverfront urban conditions.
“Schoonschip”	☑☑	☑☑	☑☑☑	☑☑☑	☑☑	☑	Ecological innovation inspiring, but regulatory model weak
“IBA Waterhouses”	☑☑	☑☑	☑☑☑	☑☑	☑	☑	High-tech pilot; not scalable or socially inclusive
“Urban Rigger”	☑	☑☑	☑☑☑	☑	☑☑	☑	Suitable for student housing; lacks legal and infrastructural integration.
“Maasbommel Amphibious Housing”	☑☑	☑☑	☑☑	☑☑	☑	☑☑	Amphibious model is relevant for flood-prone areas; low-tech and adaptable.

☑ – minimal level of development / indicator present; ☑☑ – moderate development / partially transferable; ☑☑☑ – high development level / directly transferable model

ria previously defined in the research, including typological diversity, integration into urban infrastructure, and relevance for potential adaptation to the riverine context of Belgrade. Rather than relying solely on descriptive narratives, the case studies are analysed through a comparative framework of seven key indicators (see Tables I-II). This analytical-synthetic method enables cross-case evaluation and the identification of shared challenges and opportunities.

- **Waterbuurt-West (Amsterdam, Netherlands)** – Fully integrated into Amsterdam’s zoning plans under the VINEX policy, Waterbuurt-West has legal recognition through cadastral registration and municipal building

regulations. The neighbourhood is connected to standard infrastructure networks (electricity, potable water, sewage, internet, and district heating), demonstrating the feasibility of integration into urban systems (Kurytek, 2016: 155). The modular housing units are built on concrete pontoons, standardised for scalability, though costs remain relatively high (Baker, 2015: 44-46). Environmental strategies include passive solar orientation and stormwater management, though renewable energy use is limited (Bertram, 2010: 56). Socio-economically, the project targeted middle-income groups through a public-private partnership, with limited inclusivity. Its replicability for Belgrade is high due to legal

FIG. 2 VIEW OF WATERBUURT-WEST FLOATING NEIGHBORHOOD, IJBURG, AMSTERDAM



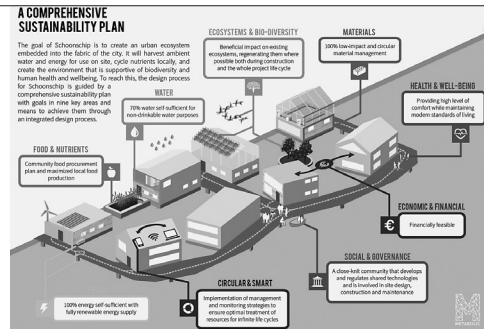


FIG. 3 CONCEPTUAL VISUALIZATION AND SUSTAINABILITY FRAMEWORK OF THE SCHOONSCHIP FLOATING NEIGHBOURHOOD, AMSTERDAM

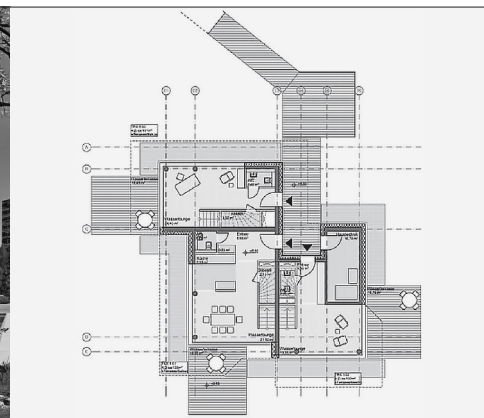
clarity and infrastructural integration but constrained by cost (Fig. 2).

- Schoonschip (Amsterdam, Netherlands)** – Developed through a cooperative model, Schoonschip demonstrates how bottom-up initiatives can achieve legal integration within Amsterdam’s planning framework (Schoonschip, 2022; Metabolic, 2019). It is fully connected to municipal infrastructure and features a collective smart grid enabling energy exchange. Architecturally diverse yet modular in pontoon design, Schoonschip stands out as the most environmentally advanced project, with solar panels, green roofs, and high insulation standards. Its cooperative structure promotes affordability for middle-income groups, though entry costs remain high (CityChangers, 2024). Replication potential exists, but it requires supportive legal and financial frameworks in Belgrade (Fig. 3).
- IBA Waterhouses (Hamburg, Germany)** – Realised within the Internationale Bauausstellung (IBA) Hamburg 2013, the Waterhouses illustrate how state-backed pilot projects can provide legal and infrastructural legitimacy. Architecturally, they are high-end cus-

tom units with advanced prefabrication, but positioned in the luxury housing segment – limiting inclusivity and scalability. Sustainability features include solar panels and green roofs, though performance monitoring remains fragmented. For Belgrade, the relevance lies more in the policy precedent of using public innovation zones than in replicating the luxury model itself (Fig. 4).

- Urban Rigger (Copenhagen, Denmark)** – Conceived by BIG Architects, Urban Rigger uses recycled shipping containers on floating concrete platforms. The project operates under temporary harbour leases, with fragmented infrastructure and off-grid systems (Danfoss, n.d.). It targets students through affordable rental models but lacks legal and infrastructural permanence. Replication potential exists in Belgrade for temporary housing in pilot zones, especially for young professionals or students (Fig. 5).
- Maasbommel Amphibious Housing (Gelderland, Netherlands)** – Developed in collaboration with Dura Vermeer and DeltaSync, this project introduced a legal exception to permit construction in a high flood-risk zone

FIG. 4 IBA WATERHOUSES IN HAMBURG - COMBINATION OF A PHOTOGRAPH OF THE COMPLETED UNITS AND A TECHNICAL FLOOR PLAN. THE PROJECT DEMONSTRATES THE POTENTIAL OF HIGH-QUALITY PREFABRICATION AND INTEGRATION WITH THE URBAN CONTEXT, ALTHOUGH POSITIONED WITHIN THE LUXURY HOUSING SEGMENT.



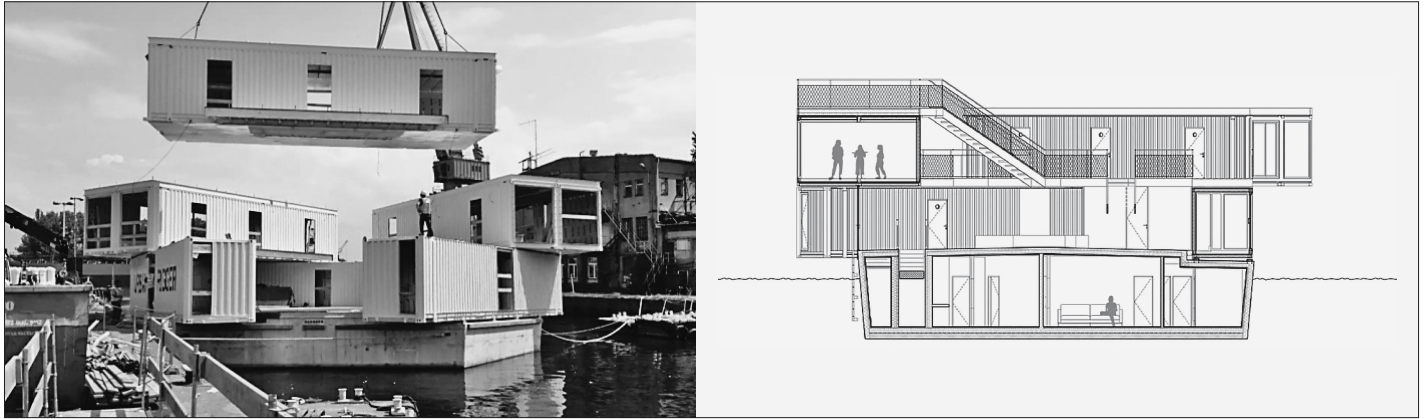


FIG. 5 URBAN RIGGER IN COPENHAGEN – PHOTOGRAPH OF MODULAR CONTAINER UNITS DURING ASSEMBLY AND AN ARCHITECTURAL SECTION DRAWING. THE PROJECT, DESIGNED BY BIG ARCHITECTS, DEMONSTRATES A SCALABLE AND MOBILE TYPOLOGY FOR STUDENT HOUSING ON WATER

(Climate-ADAPT, 2020; UrbanGreenBlueGrids, n.d.). The houses are amphibious – resting on the ground under normal conditions and floating during floods via concrete pontoons. Connected to conventional infrastructure, they adapt through flexible utility connections. While sold at market prices with limited inclusivity, they demonstrate a low-tech, scalable model highly relevant for Serbia's flood-prone riverbanks (Fig. 6).

Table II offers a critical comparison of five European case studies, highlighting strengths, limitations, and lessons most relevant for Belgrade's riverfront adaptation.

The cross-case analysis highlights two transferable lessons: the importance of regulatory adaptability and robust infrastructure integration. Waterbuurt-West offers the strongest urban precedent; Schoonschip illustrates participatory and ecological innovation; Maasbommel demonstrates flood resilience. IBA Waterhouses and Urban Rigger provide insights into policy experimentation and temporary housing, though with limited scalability. No single model fulfils all criteria; instead, a hybrid model – modular, inclusive, and

regulation-ready – offers the greatest potential for Belgrade's Sava riverfront.

ADAPTING FLOATING HOUSING MODELS TO BELGRADE: A COMPARATIVE PERSPECTIVE

This chapter examines how European floating housing models can be adapted to Belgrade's urban, institutional, and ecological conditions. Six analytical dimensions guide the analysis: legal frameworks, infrastructure, architectural typologies, environmental performance, social inclusivity, and replication potential. The aim is to identify enabling conditions and barriers for resilient, inclusive, and sustainable floating housing along the Sava River.

- **Institutional and Planning Framework** – European cases such as Waterbuurt-West, Schoonschip, and the IBA Waterhouses highlight the role of institutional backing. In Belgrade, the General Urban Plan 2041 notes riverfront development but omits floating typologies (Urban Planning Institute of Belgrade, 2021). No clear rules exist for mooring rights, cadastral registration, or insurance (Planning and Construction Act, 2022). To enable legal adoption, Serbia must introduce new classifi-

FIG. 6 AMPHIBIOUS HOUSING IN MAASBOMMEL, NETHERLANDS – RESIDENTIAL UNITS RESTING ON THE GROUND UNDER NORMAL CONDITIONS AND FLOATING DURING FLOODS VIA CONCRETE PONTOONS. THE PROJECT DEMONSTRATES A LOW-TECH YET SCALABLE MODEL FOR CLIMATE ADAPTATION IN FLOOD-PRONE AREAS.



cations, amend planning laws, and set technical standards for buoyancy and flood resilience. Without coordinated governance – e.g., JP Srbijavode, and the ministries of construction and environmental protection – floating housing risks remaining informal.

• **Urban Morphology and Site Conditions** –

The Sava's morphology offers spatial potential, with underutilised zones such as Ada Huja and inner bends downstream of the confluence. However, infrastructure is lacking, and speculative developments such as Belgrade Waterfront dominate riverfront planning (Tilinger and Lalić, 2008: 42; Vuksanović-Macura, 2017: 118). Lessons from IJburg demonstrate that floating neighbourhoods must be infrastructurally equal to land-based ones to avoid marginalisation.

• **Typological Relevance and Transferability**

– This subsection articulates the typological relevance of the selected European floating housing models and evaluates the degree to which their spatial, technical, environmental, and governance features can be meaningfully transferred to the Belgrade riverfront context.

– Waterbuurt-West demonstrates high typological relevance due to its large-scale modular pontoon system, fully integrated infrastructural grid, and clear internal spatial governance hierarchy, all of which align with the morphological and regulatory requirements of Belgrade's Sava riverfront (Calcagni, 2025).

– Schoonschip exhibits strong transferability because of its cooperative governance model, decentralised utilities, energy-positive design logic, and adaptable modular clusters, although its advanced ecological systems would require significant institutional adaptation within the Serbian regulatory context (BIG Architects, 2016).

– The IBA Waterhouses provide a valuable typological precedent through prefabricated hybrid structures supported by municipal innovation frameworks and embedded within long-term urban regeneration, demonstrating how state-enabled experimentation can legitimise new urban residential formats – an approach directly relevant for Belgrade.

– Urban Rigger illustrates a compact, replicable typology based on modular, stackable units suited to student and young-professional housing, suggesting high transferability for Belgrade's educational and innovation districts along the river (BIG Architects, 2016).

– The Maasbommel amphibious typology offers direct relevance for flood-exposed segments of the Sava basin, combining land-based stability with flood-responsive buoyancy, and therefore represents a particularly strong candidate for adaptive residential development in Belgrade (Climate-ADAPT, 2020).

TABLE III COMPARATIVE ENVIRONMENTAL LESSONS

Case Study	Ecological Measures	Lesson for Belgrade
Waterbuurt-West	Limited renewables, passive design	Upgrade sustainability benchmarks
Schoonschip	Floating wetlands, smart grid	Combine ecology and energy strategies
IBA Waterhouses	Buffer zones, rainwater harvesting	Use state-backed pilots for monitoring
Urban Rigger	Off-grid solar, recycled containers	Test temporary pilot housing solutions
Maasbommel	Amphibious lots, flood adaptation	Apply to flood-prone peripheries

• **Environmental and Public Value Considerations**

– Sustainability must extend beyond energy to encompass ecosystem health. While projects such as Schoonschip integrate floating wetlands and smart grids (Metabolic, 2019), Belgrade lacks ecological zoning and environmental monitoring. Riverbanks are largely privatised, limiting public access (Vujosevic and Petric, 2015). The UN-Water SDG 6.6.1 report underscores the need for biodiversity-sensitive indicators, yet Belgrade currently lacks baseline ecological data (UNEP and UN-Water, 2024). Table III provides a comparative overview of key environmental and infrastructural strategies applied across the selected European floating housing projects. It synthesises measures such as floating wetlands, decentralised energy systems, passive orientation, and adaptive buoyancy solutions, highlighting which ecological interventions are most relevant for Belgrade's hydromorphological conditions. By structuring these strategies side by side, the table enhances the analytical coherence of the chapter and clarifies which models offer the highest transferability to the Sava River context.

STRATEGIC DIRECTIONS FOR BELGRADE

The following strategic directions synthesise the institutional, spatial, infrastructural, and ecological priorities required to integrate floating and amphibious housing into Belgrade's planning framework.

1. Introduce new zoning categories for floating and amphibious housing (Planning and Construction Act, 2022).
2. Designate specific implementation zones (e.g., Ada Huja, inner Sava bends) with integrated utility provisions.
3. Include floating typologies in strategic documents such as the General Urban Plan 2041.
4. Treat water as a public good – develop participatory planning methods and prevent riverbank privatisation (UNEP, 2024; Vuksanović-Macura, 2017).
5. Pilot modular housing typologies (e.g., Urban Rigger) to test legal regulations, infrastructure performance, and community acceptance.

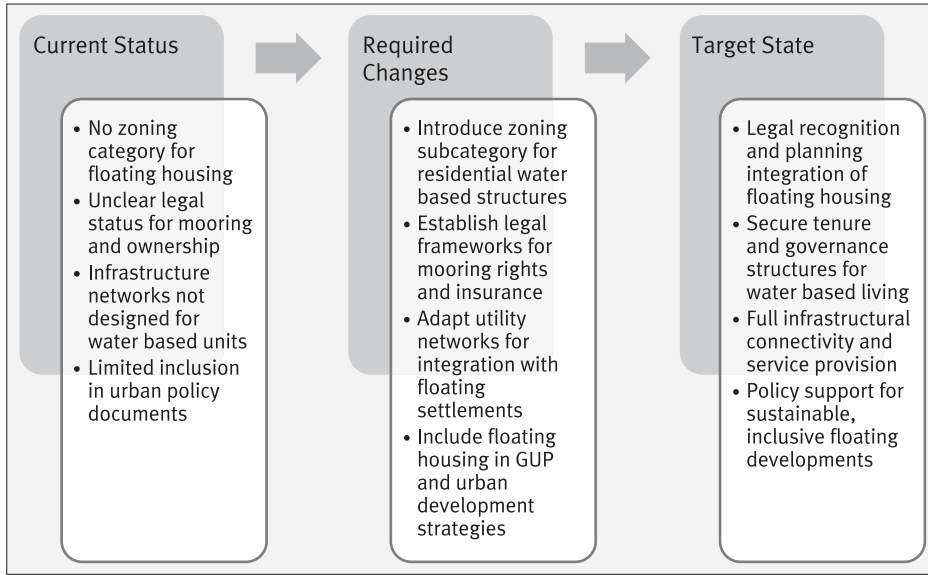


FIG. 7 INSTITUTIONAL PATHWAYS TOWARD LEGALIZING FLOATING HOUSING IN BELGRADE

The diagram on Fig. 7 synthesizes the institutional and regulatory transformations necessary to enable the full integration of floating housing into Belgrade’s urban framework. Moving from the current absence of zoning categories and legal ambiguity, to a state of legal recognition, infrastructural parity, and policy inclusion, requires a multi-level and cross-sectoral effort.

European precedents confirm that Belgrade cannot directly replicate but can selectively adapt floating housing models. Priority lies in legal innovation, intersectoral coordination, and ecosystem-based design. A hybrid ap-

proach – modular, inclusive, and regulation-ready – offers the greatest potential for integrating floating housing into Belgrade’s Sava riverfront.

CONTEXTUAL ADAPTATION: TOWARD FLOATING LIVING IN BELGRADE

Insights from European case studies demonstrate not only the technical feasibility of floating housing but also the institutional, ecological, and social mechanisms that support its implementation. For Belgrade, the value of these precedents lies less in direct replication than in their adaptive potential. This chapter therefore examines how lessons from Waterbuurt-West, Schoonschip, the IBA Waterhouses, Urban Rigger, and Maasbommel can be translated into Belgrade’s spatial and institutional context. The analysis is structured around four interrelated themes: institutional frameworks, environmental and civic dimensions, spatial integration zones, and strategic planning prerequisites. By embedding the analytical-synthetic framework developed in this research, the chapter moves from comparative evaluation to local application – assessing how floating housing could be planned, regulated, and socially embedded along the Sava River. The aim is to identify enabling conditions, expose regulatory gaps, and outline pathways through which floating housing might evolve from conceptual innovation into a legitimate urban typology in Belgrade.

Institutional Roadmap for Integration – Currently, Belgrade has no legal category for floating residences, and regulatory gaps exist across construction codes, utilities, insurance, and property rights (UN-Habitat, 2020). To move from institutional ambiguity toward systemic inclusion, a phased roadmap is required. Table IV outlines a phased institutional roadmap that illustrates how Belgrade could progress from the current legal vacuum toward full integration of floating housing. It identifies key governance milestones – from regulatory recognition and legal reform to infrastructure alignment and pilot implementation – thereby clarifying the administrative steps necessary to support long-term adoption.

This roadmap reflects a transition from fragmented governance toward a systemic urban policy framework – anchored in cross-sectoral collaboration, legal precision, and ecological responsibility – thereby enabling floating housing to evolve from conceptual innovation to legitimate urban typology.

Environmental and Civic Dimensions – Environmental responsibility is essential to the long-term viability of floating housing. In Bel-

TABLE IV INSTITUTIONAL ROADMAP FOR FLOATING HOUSING IN BELGRADE

Phase	Key Features	Lesson for Belgrade
a) Legal Vacuum	No codes, zoning, or legal definitions for water-based housing	Blocks planning and investment
b) Recognition	Expert debate and awareness raising	Initiate academic and civic dialogue
c) Legal Reform	Amend GUP, introduce subcategories, clarify cadastre	Establish legal certainty for housing on water
d) Infrastructure Alignment	Integration with utilities; compliance with EIA & SDG 6.6.1	Align with EU and UN environmental standards
e) Pilot Deployment	Modular units tested in controlled zones (Ada Huja, Blokovi)	Evaluate technical feasibility and public response
f) Urban Integration	Floating housing embedded in long-term plans; rivers as commons	Ensure inclusivity and ecological protection

TABLE V ENVIRONMENTAL AND CIVIC LESSONS FROM EUROPEAN PRECEDENTS

Case Study	Ecological Measures	Civic/Policy Implications
Waterbuurt-West	Passive orientation; stormwater management	Legal clarity; infrastructural integration
Schoonschip	Smart grid, floating; wetlands	Cooperative model; public access
IBA Waterhouses	Green roofs, rainwater harvesting	State-backed pilot; policy integration
Urban Rigger	Off-grid solar, recycled containers	Temporary/affordable student housing
Maasbommel	Amphibious resilience, flood response	Legal adaptation in risk zones

grade, such developments must address not only flood resilience and infrastructural integration but also the ecological and civic dimensions of water management. Reclaiming the river as a shared civic and ecological commons is crucial for ensuring spatial equity and sustainability. European precedents demonstrate that technologies such as floating wetlands, decentralised wastewater treatment, and adaptive energy systems are effective only when embedded within governance frameworks that guarantee public access, transparency, and long-term monitoring. In line with SDG Indicator 6.6.1 (Change in the extent of water-related ecosystems over time), floating housing should be preceded by environmental impact assessments (EIA) and monitored through biodiversity performance indicators (UNEP, 2024). Unlike Amsterdam or Hamburg, Belgrade lacks baseline ecological data – including macrophyte density, benthic invertebrates, and fish diversity – making it difficult to evaluate long-term consequences. Establishing systematic biodiversity monitoring and participatory environmental councils would enhance transparency, prevent riverbank privatisation, and secure rivers as public goods. Ecological safeguards and civic governance must therefore be treated not as optional add-ons but as structural prerequisites for sustainable floating housing. While the inclusion of a separate ecological indicator in the case study evaluation exceeds the scope of this research, the analytical-synthetic framework nonetheless integrates environmental concerns across institutional feasibility, socio-political inclusion, and infrastructural adaptability. Table V synthesises ecological and civic governance lessons from the five European case studies. By comparing environmental measures with their corresponding policy implications, the table identifies which governance mechanisms – such as biodiversity monitoring, public access safeguards, and state-enabled pilot zones – are most transferable to Belgrade’s riverfront development.

Spatial Potential and Integration Zones – Three priority zones along the Sava River emerge as suitable contexts for controlled pilot deployment of floating housing. The New Belgrade Blocks (70-72), with their wide river section and proximity to existing utilities, are well suited for student or affordable housing pilots. Ada Huja, an underused industrial zone prone to flooding, offers potential for mixed-use floating clusters with ecological buffer zones. Ćukarica Bay, with its semi-enclosed morphology and low current, provides favourable conditions for a recreational and residential floating settlement.

Prerequisite	Description	Relevance for Belgrade
• GUP Inclusion	• Formal recognition of floating/amphibious	• Establishes planning legitimacy
• Zoning Reform	• Legal status for residential water-based units within cadastral system	• Creates regulatory certainty
• Institutional Collaboration	• Coordination across planning, water, and environmental agencies	• Enables coherent governance
• Participatory Planning	• Mechanisms for civic benefit and transparent regulation	• Secures social inclusivity

Together, these locations illustrate how diverse hydromorphological and infrastructural contexts can support differentiated models of floating housing in Belgrade (Tilinger and Lalic, 2008: 42; Vuksanovic-Macura, 2017: 118; Urban Planning Institute of Belgrade, 2021).

Strategic Planning Prerequisites – For floating housing to move from concept to viable urban policy, four prerequisites must be addressed through planning and governance reforms (Fig. 8).

Reframing the River-City Interface – By treating the river not merely as a scenic backdrop but as a spatial and ecological platform, Belgrade has the potential to redefine its urban-river interface. Floating housing, if institutionally supported and ecologically embedded, could serve as a model for adaptive urbanism in Southeast Europe – bridging the divide between housing innovation, environmental resilience, and democratic governance.

CONCLUSIONS

This research has demonstrated that floating housing is more than an architectural experiment: it is a climate-adaptive, socially inclusive, and institutionally demanding typology with the potential to reshape Belgrade’s river-city interface. The study introduces an original analytical-synthetic framework that applies context-specific indicators to assess the legal, spatial, environmental, infrastructural, and socio-economic feasibility of floating settlements. By combining comparative case study analysis with field validation in Waterbuurt-West (Ijburg, Amsterdam), it expands the methodological toolbox for urban

FIG. 8 STRATEGIC PLANNING PREREQUISITES FOR BELGRADE

studies and architectural practice in post-socialist contexts.

Five European cases – Waterbuurt-West, Schoonschip, IBA Waterhouses, Urban Rigger, and Maasbommel – were evaluated not for direct replication but for their adaptive potential. The analysis confirms that modular and amphibious typologies offer pragmatic pathways for Belgrade, while cooperative models require legal and financial innovation. Key transferable lessons include the need for regulatory clarity, infrastructural parity with land-based housing, and the embedding of ecological safeguards.

The study reframes Belgrade's rivers not as residual territories but as vital commons capable of supporting resilience and public value. Floating housing thus becomes a test of democratic governance of urban waterscapes. Without legal reform and ecological integration, such projects risk reproducing privatisation and environmental degradation. With them, however, Belgrade could pioneer a new paradigm of inclusive and adaptive water-based urbanism in Southeast Europe.

Methodologically, the article advances research by integrating spatial mapping, hydrological assessment, and typological comparison into a multi-indicator framework, enabling side-by-side evaluation of projects and providing a transferable model for other river cities. Although it relies primarily on secondary data and a single field observation, it establishes a basis for future research through stakeholder interviews, participatory co-design, and scenario-based simulations.

For governance, the findings underscore the urgency of zoning reform, cadastral recognition of floating typologies, and intersectoral coordination. For design, they highlight modular prefabrication, phased pilot projects, and ecosystem-based strategies – such as floating wetlands and decentralised wastewater systems – that can enhance resilience and generate public benefit.

Ultimately, floating housing in Belgrade is not only a response to climate pressures and spatial scarcity but also an opportunity to redefine the city-river relationship. By embedding legal innovation, infrastructural integration, and participatory governance, Belgrade can establish itself as a regional reference point for adaptive river-based living aligned with global sustainability goals.

[Translated by Branka Kosuh]

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SOURCES OF ILLUSTRATIONS AND TABLES

- FIG. 1 Adapted by the author based on: Urban Planning Institute of Belgrade (2021), General Urban Plan 2041; and Ministry of Construction, Transport and Infrastructure (2021), Master Plan of Inland Waterway Transport – Serbia
- FIG. 2 Author's field visit and photographic documentation during site survey of floating buildings in Ijburg

FIG. 3 ArchDaily (2021) "Amsterdam's Floating Neighbourhood Schoonschip Offers a New Perspective on Circularity and Resiliency." Available at: <https://www.archdaily.com/964050/amsterdams-floating-neighbourhood-schoonschip-offers-a-new-perspective-on-circularity-and-resiliency>

FIG. 4 Schenk Fleischhaker Architekten, "IBA Waterhouses, Hamburg" (<https://www.schenk-fleischhaker.de/projects/iba-waterhouses/>)

FIG. 5 BIG Architects, "Urban Rigger Project" (<https://big.dk/projects/urban-rigger-3021>)

FIG. 6 UrbanGreenBlueGrids – "Amphibious Homes, Maasbommel, The Netherlands" (<https://urbangreenbluegrids.com/projects/amphibious-homes-maasbommel-the-netherlands/>)

FIG. 7 Author's elaboration based on Urban Planning Institute of Belgrade (2021), Planning and Construction Act (2022), UN-Habitat (2019), UNEP et al. (2024), IBA Hamburg (2013), Climate-ADAPT (2020)

FIG. 8 Author's synthesis based on Urban Planning Institute of Belgrade (2021), Planning and Construction Act (2022), Vuksanovic-Macura (2017), UN-Habitat (2019), UNEP (2024)

TABLE I Author's synthesis based on Baker (2015), Bertram (2010), Kurytek (2016), BIG Architects (2017), Danfoss (n.d.), Metabolic (2019), Schoonschip (2022), IBA Hamburg (2013), Climate-ADAPT (2020), UrbanGreenBlueGrids (n.d.).

TABLE II Author's synthesis based on project documentation, academic publications, and official websites (e.g., Urban Rigger, Maasbommel, Schoonschip, Waterbuurt-West, IBA Hamburg). Full references are provided in the Bibliography section.

TABLE III Author's synthesis based on Baker (2015), Kurytek (2016), Metabolic (2019), Schoonschip (2022), IBA Hamburg (2013), BIG Architects (2017), Danfoss (n.d.), Climate-ADAPT (2020), UrbanGreenBlueGrids (n.d.).

TABLE IV Author's synthesis based on Urban Planning Institute of Belgrade (2021), City of Belgrade (2021), Planning and Construction Act (2022), UN-Habitat (2019), UNEP (2024).

TABLE V Author's synthesis based on Metabolic (2019), Schoonschip (2022), IBA Hamburg (2013), Climate-ADAPT (2020), UNEP and UN-Water (2024), Kurytek (2016).

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