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Sustainable Architecture and Its Impact on the Formation of Floating Tourism Habitat Models in Tonekabon

Samaneh Hoseinpoorian[1,*], Soheil Sardashti[1]

[1] Department of Architecture, Ayandegan University, Mazandaran, Tonekabon; s_poorian@yahoo.com; Soheil_sardashti@yahoo.com.

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Abstract

Considering the increasing urban population, the limited availability of buildable land, and the intensification of environmental crises caused by climate change, the development of innovative living spaces, particularly in water-based environments, has emerged as a sustainable solution in contemporary architecture. The "Floating Habitat" project adopts an interdisciplinary approach to design a floating residential, cultural, and recreational complex that aims to meet human living needs while reducing environmental impacts and maximizing the use of renewable energy. Based on the principles of sustainable architecture, this project seeks to balance the natural and built environments. The use of solar, wind, and potentially wave energy systems plays a key role in meeting the complex's energy demands. In addition, the design of floating structures using lightweight, durable, and recyclable materials contributes to reducing carbon footprint and improving structural efficiency. In the residential section, flexible housing units with high adaptability are designed to respond to changing resident needs. The cultural section includes exhibition, educational, and social interaction spaces aimed at strengthening human connections and raising environmental awareness. The recreational area provides spaces for relaxation, water-based sports, and collective activities, offering a unique living experience on water. From an environmental perspective, the project incorporates smart water management systems, wastewater recycling, rainwater harvesting, and optimized energy consumption to create a semi-self-sufficient ecosystem. Furthermore, the floating structure design allows adaptability to changing water levels and provides resilience against risks associated with rising sea levels. Overall, the Floating Habitat project is not only an architectural response to land scarcity in coastal and urban areas but also a model for future sustainable development, where humans, nature, and technology coexist harmoniously.

Keywords: Floating habitat, Sustainable architecture, Renewable energy, Ecological design, Sustainable development, Tonekabon.

1 | Introduction

Beyond conventional forms of tourism and adventurous destinations, floating habitats offer a unique opportunity to experience life on one of the most extraordinary elements of the natural world, water, and its ecosystem. These habitats, as settlements established on the sea, create a connection between the water surface and subsurface layers, forming a hybrid space that integrates residential, recreational, and scientific functions [1].

Corresponding Author: s_poorian@yahoo.com

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The design and construction of such complexes, which simultaneously serve as buildings and vessels, are based on analyses of hydrodynamic forces and hydrostatic pressure. Structural stability, buoyancy control, and spatial organization under changing marine conditions are among the fundamental principles shaping these habitats. In these structures, the main body combines residential, recreational, and service functions, and through the use of natural light, renewable energy, and multi-layered design strategies, aims to create a sustainable and integrated experience within the marine environment [2].

Given the technical complexity, environmental sensitivity, tourism potential, and economic requirements of such developments, a comprehensive evaluation is essential. Accordingly, the following fundamental question arises: based on which technical, tourism-related, economic, and environmental criteria can a recreational–tourism–residential floating habitat be sustainably designed and subjected to feasibility assessment?

Despite possessing valuable natural resources, unique coastal landscapes, and significant tourism potential, Tonekabon County faces a significant shortage of modern, sustainable infrastructure to attract domestic and international tourists. The development of residential and recreational spaces in this region has become increasingly challenging due to limited coastal land availability, growing environmental pressures, and the rising demand for tourism facilities. Contemporary tourists seek distinctive experiences, access to pristine natural environments, high-quality services, and environmentally responsive structures; however, the existing facilities in Tonekabon do not adequately address these emerging needs.

In recent years, unregulated coastal construction, ecosystem degradation, and restrictive regulations on coastal land use have further constrained tourism development options in the region. These challenges highlight the urgent need for innovative, low-impact, and environmentally sustainable solutions [3].

The concept of a floating residential–recreational habitat presents a potential response to these issues. By transferring part of tourism-related activities to sustainable floating structures, pressure on coastal land can be reduced while providing new opportunities for residential, recreational, and tourist spaces with unique visual perspectives, direct access to aquatic environments, and an enhanced visitor experience [4]. Nevertheless, the absence of similar precedents in the region, along with technical and environmental considerations, the need for standardized design, safety provisions, and integrated service systems, necessitates a thorough investigation and a clearly defined problem framework. Accordingly, the main research question of this study is as follows:

How can a floating residential–recreational–tourism habitat be designed and implemented along the coasts of Tonekabon in a manner that is compatible with the region's climatic and environmental conditions, satisfies the growing demand for high-quality accommodation, offers an innovative tourism experience, and simultaneously reduces pressure on the coastal zone?

Climate transformations, including rising sea levels, coastal subsidence, and increasing pressure on coastal zones, have intensified the need to reconsider conventional approaches to the development of residential and marine tourism spaces. Under such conditions, floating habitats emerge as innovative, flexible, and environmentally compatible solutions that can provide residential and recreational facilities within aquatic environments without extensive coastal construction. Accordingly, a comprehensive scientific investigation of these structures from technical, tourism, economic, and environmental perspectives is an undeniable necessity [5].

Moreover, marine tourism has become one of the primary drivers of development in the global tourism industry in recent decades, prompting countries to seek sustainable, distinctive experiences to enhance the attractiveness of their destinations [6]. Floating habitats, with their potential to offer unique and highly competitive tourism experiences, can play a significant role in advancing the blue economy, extending tourists' length of stay, and generating sustainable employment opportunities. Academic research in this field facilitates feasibility assessment, the formulation of safety and environmental standards, optimized structural design, and the development of sustainable operational models. Therefore, beyond addressing technical and tourism-

related demands, the present study can contribute meaningfully to policymaking and strategic planning for the development of coastal zones and aquatic territories.

2 | Theoretical Framework

Based on the topics discussed, the key terms and concepts used in this research are defined as follows:

2.1 | Sustainability Principles

Following the Industrial Revolution and the increasing mechanization of human life, the neglect and overconsumption of natural resources intensified, posing significant threats to them. This situation led public awareness to embrace the concept of Sustainability as a means to preserve natural resources and to outline corresponding principles and strategies. Today, the term "sustainability" is widely used to describe a world in which human and natural systems can coexist and thrive in the long term [6].

2.2 | Sustainable Development

Development refers to continuous changes over centuries, particularly in economic, technological, and social aspects of human civilization, while Sustainability reflects a consistent and efficient process. This concept gained significant attention during the 1980s, following the introduction of the World Conservation Strategy by the International Union for Conservation of Nature (IUCN), with the overarching goal of achieving sustainable development through the management of vital resources [6].

Sustainable development is defined as a type of development in which the needs of the present generation are met without compromising the ability of future generations to meet their own needs [6]. This definition, provided by the World Commission on Environment and Development (WCED), emphasizes balancing environmental, social, and economic aspects of development. Sustainable development aims to prevent issues such as the depletion of natural resources, the destruction of ecosystems, global pollution, climate change, overpopulation, social injustice, and the decline in human quality of life.

The term sustainable development was first officially introduced in the WCED's Our Common Future (Brundtland Report) in 1987. This report presented a set of proposals and guiding principles for achieving sustainable development, particularly in developing countries, with a strong emphasis on environmental assessment and the careful use of natural resources [7].

2.3 | Goals of Sustainable Development

The primary goal of sustainable development is to meet basic human needs, improve and enhance the quality of life for all, conserve and better manage ecosystems, and ensure a safer and more prosperous future. However, it is important to recognize that implementing sustainable development models requires fundamental changes in national and international policies [8].

Internationally proposed strategies are largely strategic in nature, and without detailed guidelines and regulations at lower administrative levels, they cannot be effectively implemented. At the national level, the objective is to adapt these international strategies to the country's specific conditions and implement them accordingly. However, most discussions and solutions for sustainable development are addressed at the local scale [9]. At this level, the roles of local governance and citizen participation in decision-making and implementation are crucial factors for achieving effective and appropriate sustainable development [10].

2.4 | Sustainable Architecture

Since all human activities occur within architectural spaces, architecture plays a crucial role in providing a desirable quality of life sustainably. The application of sustainability concepts in architecture has led to the emergence of Sustainable Architecture, also referred to as Ecological Architecture, Green Architecture, or

Environmental Architecture, all conveying the same meaning: architecture compatible with the environment. The term "sustainable" literally refers to what is endurable and maintainable.

El Shihy and Ezquiaga state: "I build buildings that are tolerable in nature." In other words, sustainable architecture aims to construct buildings that are harmonious with nature, exert minimal harmful impact, preserve identity, and maintain continuity across historical layers, present, and future [10].

Sustainable architecture is based on the principle that humans take only what they need from the world. Sustainable buildings do not prescribe a universal formula for saving the environment; rather, they are created with this awareness. The ultimate goal of sustainable architecture is to find architectural solutions that ensure the well-being and coexistence of the communities they serve. The main objectives of sustainable architecture include:

I. Conservation and efficient use of resources.

II. Design based on the life cycle of buildings.

III. Design appropriate for human life and activity.

By examining these three stages, architects can develop a comprehensive understanding of architecture's environmental impact and make informed design decisions.

2.5 | Floating Residential, Cultural, and Recreational Complexes

Floating habitats utilize wave, wind, and solar energy. These structures can even produce their own food through agriculture, aquaculture, and hydroponic farming (soil-less cultivation). A small forest can be established on the upper level, alongside wind turbines, while residential areas are located on the lower levels, optimized for maximum natural light. A comprehensive understanding of climate change phenomena can only emerge by considering both mitigation and adaptation strategies. Architecture plays a crucial role in mitigating climate change by designing and constructing buildings that are environmentally sustainable throughout their life cycles, thereby reducing carbon dioxide emissions. Architecture that contributes to climate change mitigation emphasizes energy management, relying on renewable energy sources and materials that reduce energy consumption.

Golabchi et al. [11] in their article "Selecting an appropriate site for a tourism-residential complex in desert areas using the Analytic Hierarchy Process (AHP) method: case study of Khur and Biabanak county", investigate a practical model for selecting an optimal and systematic site for a tourism-residential complex in arid and desert regions. He states that proper site selection allows for maximum audience attraction, development, and economic benefits for the region and its people, while minimizing environmental and social impacts.

Khasm Afkan Nezam and Arbabi Sabzevari [12], in the article "explaining the role of sustainability components in the formation process of ecological tourism complexes (case study: Abbas Abad lake, Behshahr, Mazandaran)", examine the role of sustainability components in the formation of tourism complexes. He explains that one strategy recently emphasized globally is the development of tourism in underdeveloped areas with the potential for tourism growth. A significant part of global tourism is driven by a strong desire to benefit from nature, now known as ecotourism, aiming to design and build ecological tourism complexes that lead the region toward sustainable development.

Pourrouhani et al. [13], in the article "objectives, pillars, and requirements of rural tourism planning with emphasis on ecotourism: case study of Shiyadeh village, Babol county", state that rural tourism programs have four main components: attractions, requirements, education, and monitoring. Attractions include natural-ecological, socio-cultural, economic-activity, and spatial-physical types. Requirements involve developing infrastructure, providing access and transportation, organizing and linking attractions, offering recreational, cultural, and accommodation facilities, facilitating investment, and using local or environmentally friendly architectural patterns [14].

Hosseini et al. [15], in the article "Investigating the impact of ethnic tourism development on social and cultural issues", emphasize the significance of tourism development, noting that the 21st century is marked by global interdependence and convergence. While cultural convergence occurs, ethnic differences are preserved, influencing national, religious, racial, and ethnic tendencies. One major outcome is planning for human leisure, making tourism a significant driver of national income and international cultural exchange.

Zandieh and Godarzian [16], in "landscape approach as a factor for urban tourism success, " highlight that the landscape approach considers temporal-spatial, historical-civilizational, and objective-subjective dimensions of the city simultaneously, interpreting urban phenomena in relation to historical context and the natural environment.

Ghaemi et al. [17] in "Analysis of economic variables' effects on the number of international tourists to Iran with emphasis on economic growth and employment", demonstrate that a 1% increase in international tourists results in a 15% increase in economic growth and a 5% increase in employment.

Rahmani Fazli et al. [18] in "Analysis of factors influencing the commodification of tourism spaces: case study of rural areas in Mahmoudabad county", emphasize that weak taxation systems, inefficient banking, and insufficient government support for production have made the tourism environment fragile, leading to land-use changes, construction expansion, and landscape degradation.

Bagheri et al. [19], in "sociological consequences of tourism in Shiraz", note that positive sociological outcomes include improved employment and cultural activities, while negative outcomes include fraud and extortion.

3 | Literature Review

The European Union (EU), in its climate change policies, has emphasized not only the importance of urban scale but also the integration of climate change into its new urban agenda. Climate adaptation is identified as one of nine thematic areas in this agenda, aiming to "anticipate the negative impacts of climate change and take appropriate measures to prevent or minimize damages to cities". The focus in this context includes vulnerability assessment, climate resilience, and risk management (including the social dimension of climate adaptation strategies) [2].

In EU member states, climate adaptation is promoted through various means, including participation in urban networks and climate investment budgets (e.g., enhancing bioclimatic construction and open spaces). Cities and metropolitan areas implement climate policies differently, whether or not they have formal climate adaptation plans. Adaptation strategies vary between countries depending on the severity of climate change impacts, environmental awareness, overall vulnerability, and climate resilience. By 2013, only fifteen European countries had adopted a National Adaptation Strategy (NAS). The EU's adaptation strategy, initiated in 2013, has been designed to play a central role in guiding these efforts. While climate adaptation planning is closely linked to environmental and energy planning, it seeks to define its scope and content as a new planning domain. For instance, climate adaptation planning must go beyond energy-focused, project-based interventions, as energy planning occurs at two interconnected levels: building and open spaces (both public and private), affecting architectural and structural elements as well as renewable energy usage and energy efficiency. Often, climate interventions follow necessary funding regulations; a report on European urban adaptation strategies noted that despite significant EU support for city adaptation budgets, these funds are mostly project-based and expire upon project completion, creating a challenge for the implementation of strategies developed during the project [1], [2], [5].

Urban networks and partnerships across Europe play a significant role in climate-related planning and actions. Notable among these are two networks established by the European Commission: the "Adaptation Mayors" network, launched in 2014 in close collaboration with the Climate Adaptation Platform, and the "Covenant of Mayors," initiated in 2008 to mobilize local and regional authorities toward climate action. By 2015, these initiatives were integrated into the new "covenant of mayors for climate and energy." These tools support

cities in adopting climate adaptation planning and developing comprehensive, locally relevant strategies. Starting with the identification of the effects of climate change (extreme temperatures, water scarcity, flooding, sea-level rise, drought, storms, snow, and ice), these tools facilitate not only individual project interventions but also the planning, selection, and implementation of broader strategies [9].

In the Iranian context, Mortezaei et al. [20] highlighted in their article "typology of new residential fabrics for optimizing primary energy consumption" that rapid technological advancement and urban population growth make the development of residential complexes inevitable. Unregulated construction, morphological changes in urban fabrics, and a lack of adaptation to climatic conditions have increased buildings' energy demand.

Madahi and Abbasi [21], in their article "Analysis of thermal behavior of exterior building envelopes using traditional and modern construction materials and technologies for energy optimization," emphasize that urban energy consumption in Iran is primarily attributable to buildings, accounting for approximately 40% of total urban energy consumption. Gössling [5], in his study "Optimizing energy consumption in residential buildings in cold climates," notes that over one-third of the country's energy demand comes from the residential sector. Although energy optimization is not a novel global topic, its importance in Iran, especially in buildings, has only recently been recognized, with initial actions underway. Average energy consumption in Iranian buildings is about 310 kWh per square meter annually, approximately 2.5 times higher than in comparable European contexts.

Madahi and Abbasi [21] further argue that energy reduction can be achieved by arranging spaces on plans according to occupancy patterns and solar cycles, selecting climate-appropriate envelopes, sizing and properly positioning openings, and ultimately substituting renewable energy sources for non-renewable ones [5]. Zahri and Tahbaz [22], in their article "providing an optimal layout for residential villas in Rasht with a focus on solar and wind energy utilization", emphasize that appropriate building placement based on site conditions (climate and natural environment) is critical for achieving environmental and lifestyle benefits.

Additionally, Rasouli et al. [23], in "green architecture as a step toward sustainable architecture," note that green architecture stems from sustainable architecture and development, addressing contemporary human needs in response to the impacts of industrial and consumer society. Preserving natural resources, protecting against air and other environmental pollution, safeguarding the ozone layer, and promoting physical and mental health are fundamental aspects that highlight the growing necessity of sustainable architectural practices.

In the design of floating habitats, environmental conditions and climatic and hydrodynamic characteristics play a fundamental role in the stability, safety, and performance of the structure. Recent studies indicate that natural forces such as waves, wind, ocean currents, and water level are among the most influential factors affecting the behavior of floating structures and must be carefully analyzed during the design stages [5].

Research in the field of floating architecture and marine structures shows that rising sea levels due to climate change have increased the need to develop floating architecture that is resilient to flooding and wave forces. In this approach, sustainable design, based on adaptation to the natural environment and the use of renewable energy sources, is strongly emphasized [24].

Hydrodynamic studies also demonstrate that the behavior of floating structures is influenced by waves, wind, and marine currents, leading to complex oscillations. Therefore, accurate analysis of the structure–environment interaction is essential to ensure stability [6].

In studies related to the architectural design of floating structures in coastal areas, factors such as wave height, wind intensity, water depth, seabed conditions, and coastal characteristics are identified as key criteria for site selection and structural design. These factors directly affect the form, structural system, and performance of floating habitats [5].

Furthermore, studies indicate that, when designing floating structures in coastal regions such as the Caspian Sea shores, an integrated approach incorporating climatic, environmental, and engineering analyses must be adopted to ensure stable performance under changing environmental conditions.

Based on field studies and research in marine structure design, the most important factors influencing the design of floating habitats in climates such as Tonekabon include:

I. Intensity and direction of prevailing coastal winds.

II. Wave height and wave period.

III. Water level fluctuations and tidal changes.

IV. Water depth and seabed geotechnical conditions.

V. Humidity, precipitation, and Caspian climatic conditions.

VI. Requirements for stability, safety, and mooring systems.

Together, these factors determine the final form, structural system, and economic feasibility of floating habitats [6], [10], [25].

3.1|Case Studies of Floating Residential, Cultural, and Recreational Complexes

To gain a better understanding of the project topic, this research includes, in addition to theoretical discussions, an analysis of successful and unsuccessful implemented cases in the field.

Table 1. Comparative analysis of selected floating architecture and floating city projects, highlighting their locations, functions, key design features, strengths, and weaknesses.

No.	Project Name	Location	Function	Key Design Features	Strengths	Weaknesses
1	Floating pavilion	Netherlands	Cultural–exhibition	Lightweight structure, climate adaptation, ETFE dome	High climate sustainability	Limited residential function
2	Oceanix city	Conceptual (United Nations)	Urban–Mixed-use	Modular design, energy self-sufficiency	High flexibility	Not fully implemented
3	Floating seahorse villas	Dubai	Residential–tourism	Underwater spaces, luxury design	High tourist attraction	Very high construction cost
4	Makoko floating school	Nigeria	Educational	Simple, vernacular, flood-resistant structure	Low-cost and local	Limited durability
5	Ijburg floating houses	Amsterdam	Residential	Connected to urban infrastructure, modular	Proven performance and stability	High initial cost
6	The ark project	Russia	Shelter	Disaster-resilient design	High safety	Purely conceptual
7	Seasteading city	Polynesia	Urban	Functional independence	High innovation	Legal challenges
8	Floating park	Denmark	Recreational	Public space on water	Enhances urban quality	Limited scale
9	Lilypad	Conceptual	Environmental	Nature-inspired, self-sufficient	High Sustainability	Not implemented
10	Arctic bath hotel	Sweden	Tourism	Use of local materials	Harmony with nature	Climate-specific limitations

3.2|Comparative Analysis

A comparative review of these case studies indicates that successful floating habitats share the following common characteristics.

3.2.1 | Climate adaptation

Projects such as Floating Pavilion and Arctic Bath demonstrate that successful design depends on full adaptation to climatic conditions (temperature, humidity, wind). In contrast, luxury projects like Floating Seahorse pay less attention to this factor and tend to be more consumption-oriented.

3.2.2 | Sustainability and energy

Examples such as Oceanix City and Lilypad emphasize energy self-sufficiency (solar, wind, and water). Meanwhile, more traditional projects like Makoko rely primarily on indigenous and local solutions.

3.2.3 | Structural system type

Successful projects utilize:

I. Modular systems (Oceanix, IJburg).

II. Lightweight and flexible structures (Makoko).

These approaches allow for future expansion and adaptability.

3.2.4 | Connection to cultural and social context

Projects such as Likuliku Resort and Makoko show that using local architectural patterns enhances social acceptance and reduces construction costs.

3.2.5 | Economic challenges

The main weaknesses of most projects include:

I. High construction costs.

II. Dependence on advanced technologies.

(particularly in luxury or conceptual projects)

3.3 | Relation to Tonekabon Site (Localization Analysis)

Considering the coastal conditions and humid Caspian climate of Tonekabon, the findings of the case studies can be adapted as follows:

3.3.1 | Climate and environmental conditions

I. High humidity+heavy rainfall.

II. Suitable models: Arctic Bath and Makoko (both feature moisture-resistant materials and natural ventilation).

III. Caspian Sea waves (milder than ocean waves).

IV. The possibility of using lighter structures than those used in oceanic projects.

V. Possibility of using lighter structures compared to ocean-based projects.

3.3.2 | Structural system selection

The most suitable option for Tonekabon:

I. Modular floating systems (similar to IJburg and Oceanix).

II. Gradual development capability.

III. Reduced initial costs.

3.3.3 | Materials and vernacular architecture

Use of:

I. Moisture-resistant wood.

II. Forms inspired by northern Iranian architecture, similar to Likuliku and Makoko.

3.3.4 | Suitable functional program

Based on the studies:

I. Mixed-use development is recommended.

II. Tourism+residential+recreational.

3.3.5 | Sustainability and energy

Suitable strategies for Tonekabon:

I. Solar energy (adequate solar radiation).

II. Natural ventilation (coastal winds).

III. Rainwater harvesting.

IV. Similar to a floating pavilion.

3.3.6 | Challenges in Tonekabon

I. Lack of advanced marine infrastructure.

II. Legal issues (water ownership).

III. High initial investment costs.

3.3.7 | conclusion for thesis

Based on the comparative analysis, the proposed model for the Tonekabon site should include:

I. Modular and expandable design.

II. Use of local, moisture-resistant materials.

III. Integration of tourism–residential functions.

IV. Utilization of renewable energy sources.

V. Full adaptation to the Caspian climate.

4 | Findings

4.1 | Geographic Location and Study Area

The proposed site is located along the coastal strip of Tonekabon County, in the western part of Mazandaran Province, on the southern coast of the Caspian Sea. The area is bounded by the Alborz forested slopes to the south, the sandy beach and Caspian Sea waters to the north, and developed urban lands and tourism-related land uses to the east and west. This geographic position places the site at the intersection of three ecosystems: forest, beach, and sea, increasing the sensitivity and importance of environmental analyses. We should view the Tonekabon coastline as a "layered coastal system" rather than a simple linear shoreline. Based on climatic analysis, accessibility, water depth, and existing land uses, several potential and high-capacity locations can be identified within this area.

4.2 | Core Site Selection Analysis-Tonekabon Floating Habitat

Table 2. Analysis of the proposed coastal site in eastern Tonekabon for floating architecture development.

Category	Analysis	Conclusion
Main proposed area (core site)	Shahid Shiroudi Boulevard Coastal End-Eastern Tonekabon	Best candidate for project implementation
Land–sea accessibility	Direct urban boulevard access+potential for light pier development	Best "urban–sea interface."
Bathymetry and seabed conditions	Gentle slope, soft sediments, low engineering complexity	Lower structural risk
Existing tourism context	Presence of restaurants, accommodations, and recreational activities	Strengthens existing tourism network
Landscape value	Sea+forest+urban fabric integration	Unique triple ecological setting
Regional connectivity	Potential linkage with Ramsar–Tonekabon tourism corridor	Acts as a regional tourism node
Environmental management	Distance from sensitive forests+better pollution control	More sustainable and controllable site

4.3 | Lower Priority Areas

Table 3. Limitations and suitability of different coastal zones for the development of floating architecture.

Location	Limitation	Suitability
River mouth zones	Sedimentation, flooding risk, unstable seabed	Not recommended
Western pristine coastal areas	High ecological sensitivity	Environmentally restricted
Dense urban coastal zones	High pollution and human pressure	Low suitability

4.4 | Final Site Conclusion

Table 4. Final selected site and its justification for floating architecture development.

Final Selection	Reason
Shahid Shiroudi Boulevard, coastal end (eastern Tonekabon)	Urban–marine transition zone with the highest technical, environmental, and tourism compatibility

4.5 | Key Scientific Justification

Table 5. Evaluation of the selected site based on accessibility, marine stability, tourism potential, and regional connectivity.

Criteria	Status
Urban accessibility	✓ Strong
Marine stability	✓ Acceptable
Tourism potential	✓ High
Regional connectivity	✓ strong (Ramsar corridor)

5 | Conclusion

Based on the conducted site analysis of the Tonekabon coastline, it was determined that a "layered coastal system" approach enables the identification of locations with real potential for establishing floating habitats. Among the evaluated areas, the eastern coastal end of Shahid Shiroudi Boulevard was identified as the most suitable proposed site.

This selection is based on a combination of technical, environmental, and functional criteria, including simultaneous access to land and sea, favorable seabed conditions and water depth, proximity to existing tourism land uses, a unique ecological setting (the integration of forest, sea, and urban fabric), and the potential connection to the Ramsar–Tonekabon tourism corridor. In addition, this area offers greater control

over environmental impact management compared to other coastal zones. In contrast, areas such as river mouths, pristine western coastal zones, and densely urbanized coastal regions are not considered suitable options due to ecological, geotechnical, and human pressure constraints. Overall, the proposed site functions as an "urban–marine transition zone" and demonstrates the highest level of compatibility with the objectives of floating habitat design. From scientific, functional, and regional development perspectives, it represents an optimal location for further design development and feasibility studies of the project.

Authors' Contributions

The author carried out all aspects of the research and manuscript preparation. The author has read and approved the final version of the manuscript.

Data Availability

All data supporting the reported findings in this research paper are provided within the manuscript.

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The author confirms consent for the publication of this work

Ethics Approval and Consent to Participate

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