Horst Stopp, Peter Strangfeld (eds.)

FLOATING ARCHITECTURE 5

Construction on and near water

Institute for Floating Buildings at the Brandenburg University
of Technology Cottbus-Senftenberg (BTU)

LIT

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Floating Architecture 5

Schwimmende Architektur –
Bauen am und auf dem Wasser

Floating Architecture –
Constructions on and near water

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Opening remarks

Ladies and Gentlemen, dear floating home builders

Droughts and devastating forest fires, as well as heavy rainfall events and even flash floods inundating entire neighborhoods in many cities around the world, are each dramatic consequences of human-induced climate change. There are two ways to respond to this: Enormous efforts must be made to significantly reduce emissions of greenhouse gases such as CO_2 or methane. We even have a duty to do this with a view to the living conditions of young and future generations - as the first senate of the Federal Constitutional Court clearly demonstrated to us all in its decision of March 24, 2021. However, even if correspondingly effective measures to save greenhouse gases are taken with appropriate consequence from now on, we will no longer be able to prevent a further rise in temperatures and a progression of climate change. Therefore, enormous efforts must be made at the same time to implement climate adaptation measures. In this context, the settlement of water areas also comes into focus. The importance of such plans has been strongly expressed not least in the context of the 2nd World Congress "Paving the Waves" in October 2020 in Rotterdam. Three articles from Institute for Floating Buildings (IfSB) selected in the review process demonstrate the capabilities of the BTU's Department of Building Physics and Building Technology in this field.
All the more pleasing is the continuity in which floating architecture is dealt with at our faculty. The topic is of great importance; because it allows us to point out perspectives for younger and future generations, whose future opportunities for development are seriously endangered if action continues to be hesitant. The BTU thus also becomes an ambassador for life perspectives. Moreover, the theme of floating buildings fits in well with our region, which is the site of Europe's largest man-made chain of lakes, the development of which has not yet been completed. In the future, the opencast lake "Cottbuser Ostsee" will be located directly in front of the BTU's gates. With a planned size of 19 km², it will be larger than any other lake in the state of Brandenburg. These developments would be well supported by the establishment of a national centre of knowledge and technology in the field of floating architecture in Lusatia. The visit of the deputy ambassador of the Socialist Republic of Vietnam also testifies the growing worldwide interest in our expertise.
The upcoming complex of questions can be solved in an interdisciplinary cooperation of the departments united at our faculty concerning design, planning material development, construction, supply and disposal as well as legal, social, safety, ecological and economic aspects.
For this reason, the faculty supports the research of the IfSB with its own funds. Floating structures are in line with our faculty development goals. I wish the 5th conference "Floating Buildings - Building at and on the Water" of the IfSB and the 3rd volume of Floating Architecture all the necessary success!

Prof. Dr.-Ing. Bernhard Weyrauch,
Dean of Faculty 6

Editorial

The foresight with which the LIT publishing house in Berlin and its management levels not only took up the topic of floating and amphibous architecture, but also promoted it professionally, is amazing. The colonization of water surfaces as a result of climate and social change is increasingly becoming a globally topical task.
A special thank you should therefore first and foremost be given to those responsible at the publishing house; in today's fast-paced world, it is often forgotten how much commitment and steadfastness good work results require. For all questions and problems that have arisen in this long-term series of titles, the editors and speakers always found an open ear and advice from the management of the publishing house. Based on comments from the readership, the articles are each preceded by a short German summary.
Floating Architecture 5 essentially contains the contributions from the 7th Floating Buildings Conference, which, as usual, was able to take place again in the rooms of the IBA study house in Großräschen, supported by the proven management of Ms. Wolf and her staff, In this book you als will find papers from the 4th International Conference on Amphibious and Floating Architecture ICAADE 2023 at the BTU Cottbus-Senftenberg. And the range of topics as well as the circle of speakers is fortunately expanding more and more. This time, for the first time, mobility on the water will be addressed directly, which will play a decisive role during life on the water in the future growing floating settlements in the event of an accident or fire or medical emergencies.
Unfortunately, there is no contribution to amphibious architecture. There is a need to catch up here. The gap is in blatant contradiction to the requirements of European directives in relation to flood protection near rivers. So-called retention areas on the headwater of rivers are intended to protect settlements on their lower reaches from flooding. This leads to resistance from neighboring communities on the upper reaches, since these areas have to be reserved for years without structural use in case of an emergency. A larger, constant economic use could be achieved with amphibious architecture integrated into the existing infrastructure without having to evacuate their residents in the event of a flood. The above remarks may be understood as a call to present smart ideas on this subject at the 8th Conference on Floating Structures. It will be take place in November 2026 again among the well-known objectives for building on and near water.

The publishers
Cottbus, May 2025

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BTU Cottbus-Senftenberg

Juliane Jentsch

Rechtliche Voraussetzungen an das Bauen in Überschwemmungsgebieten

Juliane Jentsch

Der Hochwasserschutz dient der Abwehr von Gefahren für Leben, Gesundheit und Eigentum und erfährt durch Hochwasserkatastrophen, wie im Sommer 2021 wo die Bundesländer Rheinland-Pfalz und Nordrhein-Westfalen am stärksten betroffen waren, hohe Aufmerksamkeit. Maßnahmen für den Hochwasserschutz dienen auch dem Umweltschutz. Wenn Hochwasserereignisse mit deren Folgen nicht durch Risikomanagementmaßnahmen beherrscht werden können, führen sie zu massiven Umweltschäden und die Gewässerqualität kann durch unkontrollierten Schadstoffeintrag beeinträchtigt werden. Die Bauleitplanung ist ein wesentliches Instrument um hochwassersicheres Bauen zu gewährleisten und sicherzustellen, dass hochwassergefährdete Flächen von Bebauung freigehalten werden, damit Gefahren für den Menschen, sein Eigentum und die Umwelt gar nicht erst entstehen können. Hochwasserschutzrechtliche Fragestellungen spielen bzgl. schwimmender Architektur vor allem dort eine Rolle, wo diese in Überschwemmungsgebieten und in weiteren Risikogebieten nach § 78b WHG errichtet werden sollen. Zentrale Vorschrift für die Frage der hochwasserschutzrechtlichen Zulässigkeit ist § 78 WHG . Diese Vorschrift regelt, dass in festgesetzten Überschwemmungsgebieten die Ausweisung neuer Baugebiete im Außenbereich in Bauleitplänen oder in sonstigen Satzungen nach dem Baugesetzbuch untersagt ist (§ 78 I WHG).

Legal requirements for building in floodplains

Juliane Jentsch

Flood protection serves to avert dangers to life, health and property and receives a great deal of attention due to flood disasters, such as in the summer of 2021 where the federal states of Rhineland-Palatinate and North Rhine-Westphalia were the worst affected.[1] Flood protection measures also serve to protect the environment. If flood events and their consequences cannot be controlled by risk management measures, they lead to massive environmental damage and water quality can be impaired by the uncontrolled discharge of pollutants. Urban land-use planning is an essential instrument for ensuring flood-proof construction and ensuring that flood-prone areas are kept free of development so that dangers to people, their property and the environment cannot arise in the first place.[2] Flood protection issues play a role with regard to floating architecture, particularly where these are to be erected in flood plains and other risk areas in accordance with § 78b WHG.[3] The central provision for the question of flood protection law permissibility is § 78 WHG.[4] This provision stipulates that the designation of new construction areas in the outdoor area in designated flood zones is prohibited in urban land-use plans or in other statutes in accordance with the Federal Building Code (§ 78 I WHG).[5]

[1] *Götze/Müller-Wiesenhaken*, EurUP 2021, S. 396.
[2] *Köck*, ZUR 2015, S. 515.
[3] *Albrecht* in Schink/Fellenberg, GK-WHG, § 78b Rn. 1 ff.
[4] The current version of the provision was introduced by the Act on the Further Improvement of Flood Protection and the Simplification of Flood Protection Procedures (Hochwasserschutzgesetz II) v. 30.06.2017 BGBl. I S. 2193 (Nr. 44) erfahren.
[5] *Queitsch*, Wasserrecht, 2020, S. 103, Rn. 225.

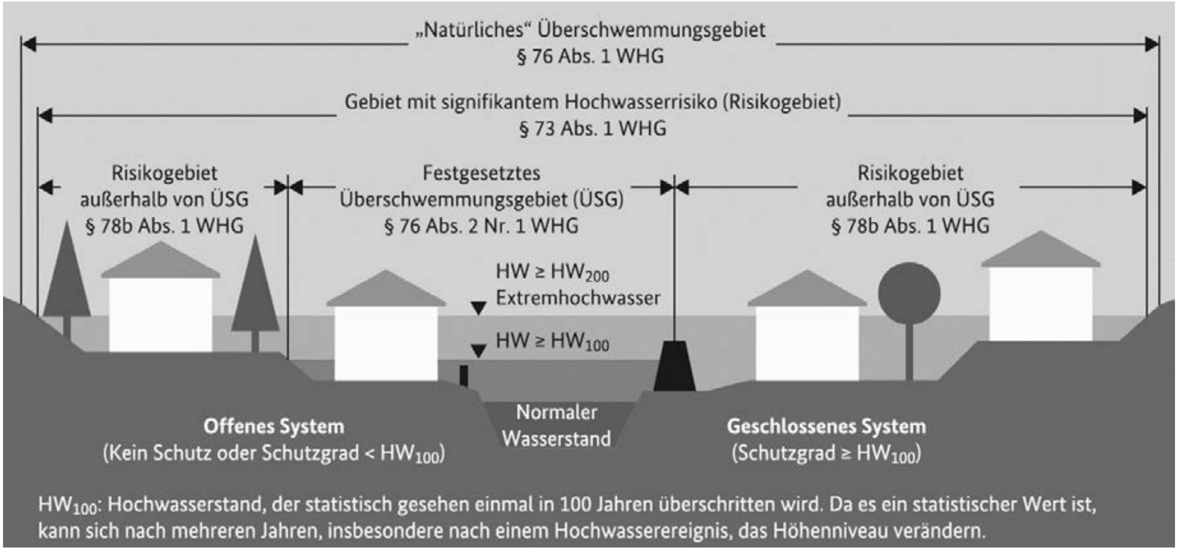

Abb. 1: Floodplains according to §§ 76 ff. WHG.[6]

In urban land-use planning, the question arises as to what constitutes a "new construction area" within the meaning of the WHG.

In its judgement [7] of 3 June 2014, the Federal Administrative Court ruled that *78 I 1 No. 1 WHG only covers areas in designated floodplains that are to be developed for the first time. Mere re-planning, such as changing the type of area of an existing building area, is not covered by this. In this case, the concerns of flood protection must be taken into account in the context of the land-use planning assessment (§ 1 VI Nos. 1 and 12, VII, § 2 III BauGB) as well as the deviation decisions required for project approval under flood protection law (§ 78 I 1 No. 2, III WHG). [...] According to this judgement, only a planning ban applied to "new construction areas", i.e. areas in designated floodplains that were to be developed for the first time. With the version valid since 5 January 2018, the designation of new building areas in designated flood zones is prohibited* [8] In accordance with § 78 II WHG, the competent authority may authorise the designation of new construction areas as an exception if the following cumulative conditions are met [9], erfüllt sind:

- no other possibilities for settlement development exist or can be created (§ 78 I 1 Nr. 1 WHG),
- the newly designated area is directly adjacent to an existing building area (§ 78 I 1 Nr. 2 WHG),
- no danger to life or health or significant damage to property is to be expected (§ 78 I 1 Nr. 3 WHG),

[6] Figure modified from*Einführung – Hochwasserschutzfibel des Bundesministeriums des Innern, für Bau und Heimat*, 9. Aufl., 2022, S. 21, https://www.fib-bund.de/Inhalt/Themen/Hochwasser/2022-02_Hochwasserschutzfibel_9.Auflage.pdf (letzter Abruf: 25.10.2022).
[7] BVerwG Urt. v. 3.6.2014 – 4 CN 6/12 (OVG Koblenz) in KommJur 2014, S. 432 ff.
[8] *Queitsch*, Wasserrecht, 2020, S. 104, Rn. 226.
[9] *Czychowski/Reinhardt*, WHG, 11. Aufl. 2014, § 78, Rn. 27; *Queitsch*, Wasserrecht, 2020, S. 104, Rn. 227.

- the flood discharge and the water level are not adversely affected (§ 78 I 1 Nr. 4 WHG),
- flood retention is not impaired and the loss of lost retention space is compensated for in terms of scope, function and time (§ 78 I 1 Nr. 5 WHG),
- the existing flood protection is not impaired (§ 78 I 1 Nr. 6 WHG),
- no adverse effects on upstream and downstream riparians are to be expected (§ 78 I 1 Nr. 7 WHG),
- the concerns of flood prevention are taken into account (§ 78 I 1 Nr. 8 WHG) und
- the construction projects are built in such a way that no structural damage is to be expected during the design flood in accordance with § 76 II 1 WHG, on which the determination of the floodplain is based (§ 78 I 1 Nr. 9 WHG).

These requirements are easier to fulfil by designating building areas with floating architecture than with conventional fixed buildings. § 78 II 2 WHG enshrines third-party protection (the impact on the neighbourhood must be taken into account), as the provisions of the WHG serve the public interest or the common good. This gives a certain group of people the right to subject exceptional decisions under § 78 II WHG to judicial review, even if they may lead to a deterioration in flood protection on their property.[10]

According to § 78 IV WHG there is a prohibition under planning law. According to this, the construction and extension of building structures is prohibited in designated flood zones in accordance with §§ 30, 33, 34 und 35 BauGB although this may be waived under the conditions of § 78 V WHG.[11] § 78 V 1 No. 1 d WHG could be relevant for the construction of floating architectur. According to § 78 V 1 WHG, the competent authority may authorise the construction or extension of structures if the project:

- does not or only insignificantly impair flood retention and the loss of lost retention space is compensated for in terms of scope, function and time,
- the water level and discharge during floods are not adversely affected,
- the existing flood protection is not impaired and
- is implemented in a flood-adapted manner

or the adverse effects can be compensated for by ancillary provisions. The requirements of § 78 V 1 WHG must be fulfilled cumulatively. Only in the case of projects that do not require a building permit does the competent lower water authority decide on the permits. The situation is different for projects requiring planning permission. Here, the building supervisory authority not only checks the permissibility according to the provisions of building law, but also other public law regulations, insofar as these are relevant to the project (see § 63 and 64 BbgBO).

[10] *Queitsch*, Wasserrecht, 2020, S. 104, Rn. 227.
[11] *Schink* in Schink/Fellenberg, GK-WHG, § 78 Rn. 71, vgl. auch *Faßbender*, ZUR 2015, S. 529.

This means that water law regulations are also taken into account in the planning permission procedure.

According to § 78 V 1 WHG, the competent authority "may" authorise the construction or extension of a structure in individual cases in deviation from § 78 IV 1 WHG. Accordingly, the authority has discretionary powers. However, for reasons of property protection, the authority has little room for reasons for refusal if all authorisation requirements are met.[12]

The construction project must be flood-adapted. This corresponds to the planning-related requirements of § 78 II No. 9 WHG. Flood-adapted construction[13] includes the following measures, for example:

- Construction of buildings on stilts or on a planned embankment,
- Construction of the upper edge of the slab above HQ100, no residential use of the ground floor,
- Construction of an evacuation deck,
- Ensuring the structural integrity of the building through sufficient building load or wall/floor dimensioning to prevent damage caused by uplift forces,
- Anchoring the building base to prevent the building from floating,
- Use of water-resistant materials,
- Construction of the lower foundation edge of the building 1 m lower than the expected erosion base; planning of a concrete wall in front to prevent damage caused by undermining and subsidence in erosion-prone soils,
- "Black" and "white tank" or internal sealing,
- Scheduled flooding of rooms that are not sensitive to water,
- Living rooms, bedrooms and escape rooms must be above the HQ-100 water level line
- Building services must be adapted to the flood level (e.g. by means of an electrical fuse, installation of heating systems, electrics, etc. on the upper floors),
- Exclusion of hazards from water-polluting substances (e.g. oil heating, protection of the oil tank with all connections and openings so that no water can penetrate from outside)

Furthermore § 101 BbgWG must be observed. According to this, installations in flood areas must be constructed and operated in such a way that there is no risk of contamination from flood water run-off. Installations for public water supply, wastewater disposal and other structures must be secured against uplift. The member of the state

[12] Ministry of Agriculture, Environment and Climate Protection (MLUK) of the State of Brandenburg, Hochwasserschutz und Bauplanungsrecht, 2020, S. 63 ff.
[13] Vgl. Ministerium für Landwirtschaft, Umwelt und Klimaschutz (MLUK) des Landes Brandenburg, Hochwasserschutz und Bauplanungsrecht, 2020, S. 57 ff., https://mluk.brandenburg.de/sixcms/media.php/9/Arbeitshilfe-Hochwasserschutz-Bauplanungsrecht.pdf (letzter Abruf: 11.10.2022).

government responsible for water management is authorised to determine further measures and issue regulations by statutory order insofar as this is necessary in individual flood areas in accordance with § 78 V WHG. The measures are aimed at avoiding flood hazards and minimising flood damage.[14]

Furthermore, in accordance with § 78 VI WHG, it is possible to authorise the construction or extension of structures when determining flood zones in accordance with § 76 II WHG if the requirements of § 78 VI 1 WHG are met. For example, the structures must comply with the requirements of the development plan that has been drawn up in accordance with the provisions of § 78 II WHG, or the structures must be designed in such a way that compliance with the requirements of § 78 V 1 No. 1 WHG is guaranteed.[15]

Binding requirements for planning and construction in risk areas were created with § 78b WHG.[16] For the risk areas outside of floodplains newly formulated in § 78b WHG, the legislator does not generally prohibit construction, but does stipulate that the protection of life and health and the avoidance of significant damage to property in particular must be taken into account when designating new construction areas in outdoor areas and when drawing up, amending or supplementing urban land-use plans for areas to be assessed in accordance with § 30 I and II or § 34 BauGB (§ 78b I 2 No. 1 WHG). When weighing up these legal interests, consideration could certainly be given to them by means of a determination in favour of floating (or floatable) architecture if this cannot be ruled out for reasons of proportionality.[17] The manifestation of the principle of proportionality can be found directly in § 78b I 2 No. 1 WHG and is regulated to the effect that the location of the property and the extent of the potential damage must be given appropriate consideration. With this regulation, the legislator wanted to ensure that the required measures depend on the possible water level during a flood event.[18]

§ 78b I 2 No. 2 WHG also stipulates that outside the areas covered by No. 1, structures may only be erected or significantly extended in a construction method adapted to the respective flood risk in accordance with the generally recognised rules of technology[19] if such a construction method is technically feasible given the type and function of the structure. In this case, the building supervisory authority will have to involve the lower water authority as part of the building permit procedure and, if necessary, issue ancillary provisions that determine the content.[20] This requirement for flood-adapted

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[14] Vgl. Ministeriums für Landwirtschaft, Umwelt und Klimaschutz (MLUK) des Landes Brandenburg, Hochwasserschutz und Bauplanungsrecht, 2020, S. 59.
[15] *Queitsch*, Wasserrecht, 2020, S. 106, Rn. 231; *Schink* in Schink/Fellenberg, GK-WHG, § 78 Rn. 92.
[16] Vgl. Europäische Hochwasser-RL (2006/60/EG).
[17] *Albrecht* in Schink/Fellenberg, GK-WHG, § 78b Rn. 14 ff.
[18] *Götze/Müller-Wiesenhaken*, EurUP 2021, S. 403.
[19] *Albrecht* in Schink/Fellenberg, GK-WHG, § 78b Rn. 19; vgl. hierzu: *Götze/Müller-Wiesenhaken*, EurUP 2021, S. 402, Eine Bauweise nach den allgemeinen Regeln der Technik könnten die sog. DWA-Merkblätter, https://de.dwa.de/de/ (letzter Abruf: 25.10.2022) und die sog. Hochwasserschutzfibel, Kapitel 8 „Bauvorsorge“ (Fn. a.a.O.) vorgeben.
[20] Vgl. *Götze/Müller-Wiesenhaken*, EurUP 2021, S. 403.

construction could also be realised with floating or floatable architecture. Here, too, the principle of proportionality must be taken into account, as is made clear in the second half-sentence by the wording that the location of the affected property and the extent of the potential damage must also be given appropriate consideration in the requirements for the construction method.[21]

In every risk and flood zone, potential damage must be prevented by planning and constructing buildings in a flood-adapted manner. In designated flood zones, the construction and extension of buildings is generally prohibited. If an exemption is granted, the building structures must be designed to be flood-adapted.

[21] Vgl. Gesetzesentwurf zum Hochwasserschutzgesetz II (Drucks. 18/10879), S. 29 f., https://dserver.bundestag.de/btd/18/108/1810879.pdf (letzter Abruf: 24.10.2022).

Simulative investigations of the geometric shape for the stability of a pontoon

Eduard Voelker

BTU Cottbus-Senftenberg

Simulative Untersuchungen der geometrischen Form zur Stabilität eines Pontons

Die Stabilität von Schwimmkörpern gehört zu den wichtigsten Aspekten des Bauens auf dem Wasser. Die angreifenden Kräfte wie Wind und Wellen bringen den Körper in Schwingung. Dabei muss die Bewegung von schwimmenden Bauten gegenüber einer zufälligen Frequenz der Wellen stabil sein. Dies ist nicht nur für die aufrechte Lage des Gebäudes notwendig, sondern auch für das Wohlbefinden der Nutzer oder Bewohner schwimmender Häuser. Die Veränderungen in der Beschleunigung führen zu Irritationen im Gleichgewichtsorgan, wodurch eine Seekrankheit als Folge der Reaktion des menschlichen Körpers auf die Bewegung hervorgerufen wird [1]. Mithilfe von Untersuchungen zu dem Bewegungsverhalten von Schwimmkörpern können Maßnahmen zur Verringerung des Aufschaukelns und damit einer Transformation des Erregungsspektrums zu höheren Frequenzen vorgeschlagen werden. Neu zu bewerten sind die Möglichkeiten der numerischen Untersuchung. Dabei werden die geometrischen und Modell-Randbedingungen variiert und es wird anhand von Parametern deren Einfluss auf das Bewegungsverhalten ausgewertet.

Simulative investigations of the geometric shape for the stability of a pontoon

Eduard Voelker

Abstract

The stability of floating bodies is one of the most important aspects of building on water. External forces such as wind and waves can cause these structures to vibrate, and as a result, their movement must remain stable even against the random frequencies of waves. This is not only necessary for keeping the building upright, but also for the well-being of its occupants. Changes in acceleration can irritate the organ of balance and result in seasickness due to the human body's reaction to the motion. By studying the movement behavior of floating bodies, measures can be proposed to reduce rocking and transform the excitation spectrum to higher frequencies. The possibilities of numerical investigation must be re-evaluated.

Based on the study on optimizing the shape of a floating body [1], simulative investigations into movement behavior were carried out using the ANSYS Aqwa software. The different geometric forms were examined for their movement behavior and compared with each other.

Arts of Waves

Water waves arise when external forces of various kinds cause the surface water to vibrate. In physics, waves are different in longitudinal (oscillating in the same direction) and transverse (oscillations are perpendicular to the direction of propagation) waves [2]. In addition, the water particles move in different patterns depending on the depth. In the deep-water area, its movement runs on radial circular paths. Near the shore, the movement of ellipses flattens out to the horizontal movement. As a result, the energy transport changes from an orbital path to a mass transport as a horizontal movement [3].

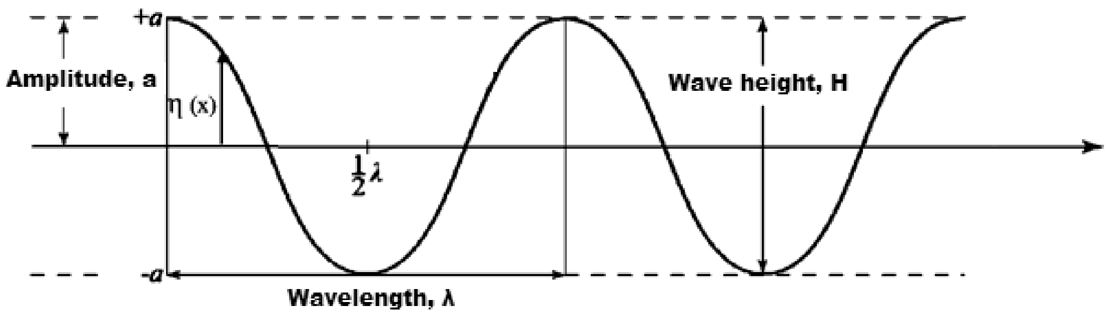

Fig. 1: Drawing of a linear wave. Source: "Hofmann Uni Konstanz -Lake Constance"

Amplitude **a**	Distance between zero line and wave crest ½ wave height
Wave height **H**	Vertical distance from wave crest to wave trough
Wavelength **λ**	Horizontal distance between two wave crests at a given time
Wave period **T**	The time interval measured at a fixed location between two wave crests
Wave frequency **f**	Number of wave crests passing a fixed location per second
Depth **h**	Water depth from the sea level

Linear Wave Theory

The linear wave theory assumes that waves propagate linearly in deep waters and that the wave height remains constant so that the water particles move on orbital paths. The linearized equations of motion are used to describe these waves, and the Bernoulli equation is simplified using the linear wave theory, especially at low wave heights ($H/\lambda < 1/50$), where the nonlinear term is neglected [2].

$$\zeta = -\frac{1}{g}\frac{\partial \Phi}{\partial t} \qquad (1)$$

Where Φ represents the velocity potential. Using the LAPLACE equation and considering theoretical assumptions for simplification with defined boundary conditions, the water level deflection ζ can be calculated with the following formula:

$$\zeta = a * \cos(k * x - \omega * t + \varphi) \qquad (2)$$

If the phase angle φ and the time duration t are neglected (<<1), then with the wave-number $k = 2\pi x/\lambda$ and the angular frequency $\omega = 2\pi/T$, the two-dimensional wave profile η(x) also known as Airy wave follows.

$$\eta_{(x)} = a * \cos\left(\frac{2\pi x}{\lambda} - \frac{2\pi}{T}\right) \qquad (3)$$

This makes it easy to show the wave profile. An example of the wave profile at Lake Geierswalde is shown based on a wave survey [4].

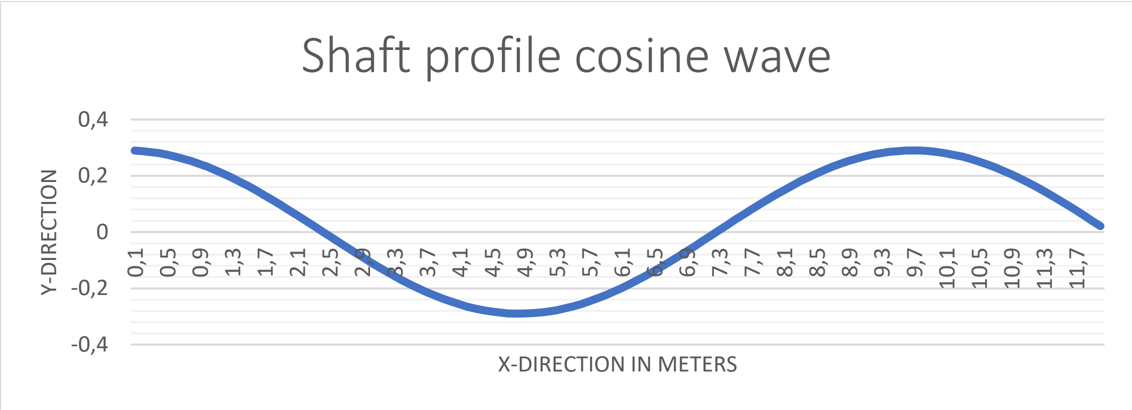

Fig. 2: Example of a linear wave from a wave report

Nonlinear Wave Theory

When the ratio of wave height **H** to wavelength **λ** is greater than 1/50, waves behave nonlinearly. The slope affects the wave profile, causing the wave to change into a horizontal motion with mass transport. There are different approaches to describing this phenomenon. The Navier-Stokes wave theory is commonly used in water depths that are medium to high, especially in the design of coastal and offshore structures to determine wave kinematics (i.e., free surface height and current velocities) [3]. However, the applicability of this theory is limited to small amplitude waves. Stock's wave theory, on the other hand, yields unrealistic values at higher terms, even in shallow water [5]. Therefore, the Cnoidal wave theory is used to describe waves in shallow water. Approximate solutions for nonlinear wave motions must meet stability criteria. Compared to the linear theory, the consideration of second-order perturbation terms brings only insignificant changes [6]. Energy transfer between individual partial waves only begins with the addition of third-order perturbation terms. The investigations described in the following sections are limited to the second-order Stokes waves, which are described by an equation.

$$\eta_{(x)} = \mathrm{a} * \cos(\frac{2\pi x}{\lambda} - \frac{2\pi}{T}) + \frac{\pi H}{8} * \left[\frac{H}{\lambda}\right] * \frac{\cosh(kh)[2+\sinh(2kh)]}{[\sinh(kh)]^3} * \cos[2(\frac{2\pi x}{\lambda} - \frac{2\pi}{T})] \quad (4)$$

Wave superposition - sea state

A natural irregular wave can typically be understood as a superposition of wave components with sinusoidal or cosinusoidal oscillations originating from different sources. A swell is therefore composed of several elementary waves from varying directions, amplitudes, and wavelengths that are superimposed. These wave components originate from physical processes, such as energy transfer from various sources. The mathematical model for this describes the temporal and spatial expansion of the swell based on the linear wave theory with the assumption of spectral oscillations being suspended. Waves with the same velocity can be superimposed using the superposition principle [7], according to the general wave equation.

$$f(x,n) = \sum_{j=1}^{n} a_j * cos(k_j * x - \omega_j) \quad (5)$$

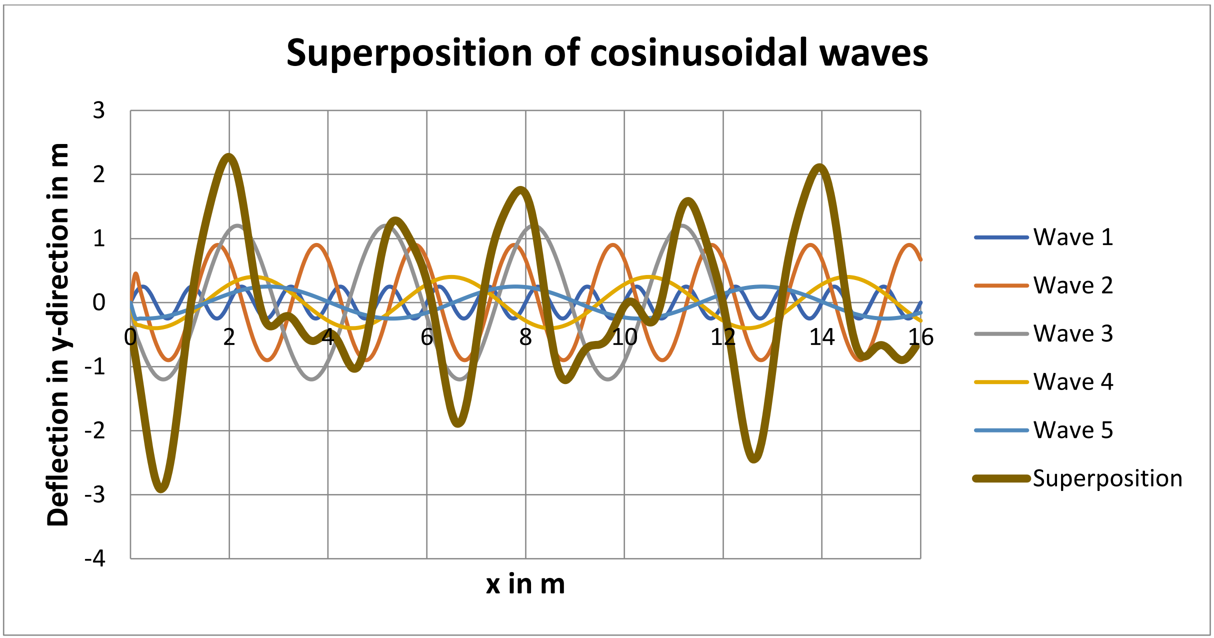

Fig. 3: Example of superposition of 5 cosinusoidal waves

Numerical investigations of the motion behavior of floating structures

For the specific numerical investigation, we can use two different software packages that utilize distinct approaches. The ANSYS AQWA software package is well-suited for determining motion behavior due to its efficient analysis capabilities, which save time and hardware resources. Additionally, the software provides solutions for calculating forces on various fastening options of pontoons. On the other hand, a detailed analysis of the interaction between fluid and solid can be achieved with sufficient accuracy using the ANSYS FLUENT software package, which utilizes the finite volume method (FVM) for approximating hyperbolic conservation equations [8]. The disadvantage is the duration of the simulation. Since every single node has to be calculated, an investigation of detailed floats requires several days or even weeks. Therefore, the software package AQWA is particularly suitable for a comparison of variants. Different geometries can be examined relatively quickly. The following table shows the available parameters for the investigation.

Table 1: Parameters that are investigated with the help of the software packages

Kinematic parameters	Dynamic variables
-Shift of the center of gravity -Angle of inclination -Horizontal and vertical deflection	-Deformation -Stresses -Tensions and compressive forces
Regular Waves	Irregular Waves
• Airy Wellen (linear) $\eta(x,t) = a \cos(-\omega t + kx)$ • Second-order Stokes $\eta(x,t) = a \cos(-\omega t + kx) + 0.5\, k A^2 \cos 2(-\omega t + kx)$	• JONSWAP spectrum • Gaussian • User defined waves • Long or short waves

Investigation variants of shapes

Several studies, such as "Optimal shape design of a floating body for minimal water wave forces,"[1] have already attempted to adapt the shape of a floating body to minimize the surface area attacked by water waves. This can prevent rocking under certain wave frequencies and reduce the forces acting on the mooring. Based on these findings, further investigations into the optimal geometry were undertaken using additional approaches such as the mathematical representation of specific waves and numerical calculation methods in collaboration with M.Sc. Yaraslau Sliavin and M.Sc. Thaer Basett, utilizing the analysis software Ansys Aqwa. For this purpose, detailed characteristics were given to the waves occurring in the region. This investigation allows us to obtain practical and realistic results. Thus, various parameters for a comprehensive evaluation of the proposed shape are to be determined and reference values are to be derived that exert an influence on the rocking up as well as the upward and downward motion. The exemplary geometrical shapes differ in a round and square shape, weight, and stabilization elements that change the metacentric height. They are used to gain initial experience with the proposed investigation methodology. Thus, the decisive factor for a significant comparison of variants is the same initial situation for the shaft parameters. In particular, the metacentric height (GM), the inclination angle (Roll), and the upward and downward motion (Global Z) are important for the evaluation of the stability.

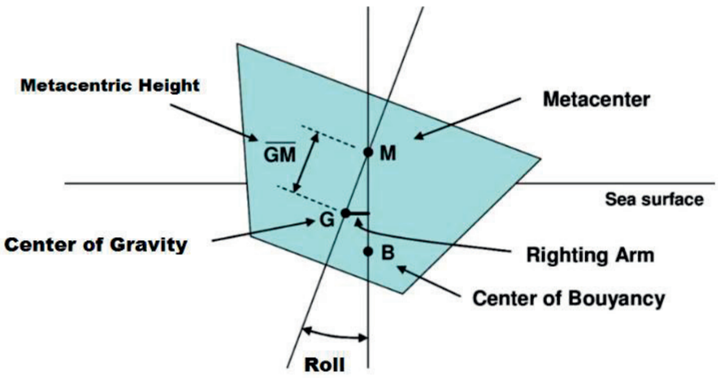

Fig. 4: Evaluation parameters for the movement behavior of floating structures. Source: Armin Walter Doerry

Boundary conditions of the wave

Environment Constants	
Water Depth	10 m
Hydrodynamic Diffraction	
Required Wave Input	
Wave Range	-180° to 180°
Interval	45°
Number of Intermediate Directions	7
Details of Analysis Settings	
Computation Type	Time Response Analysis
Time Response Specific Options	
Analysis Type	Regular Wave Response
Wave Type	Stokes 2nd Order Wave Theory
Direction	0.0°
Amplitude	0.5 m
Period	2.118 s
Time Step	0.01 s
Duration	50 s
Number of Steps	5001

Geometry 01 – Trident shape

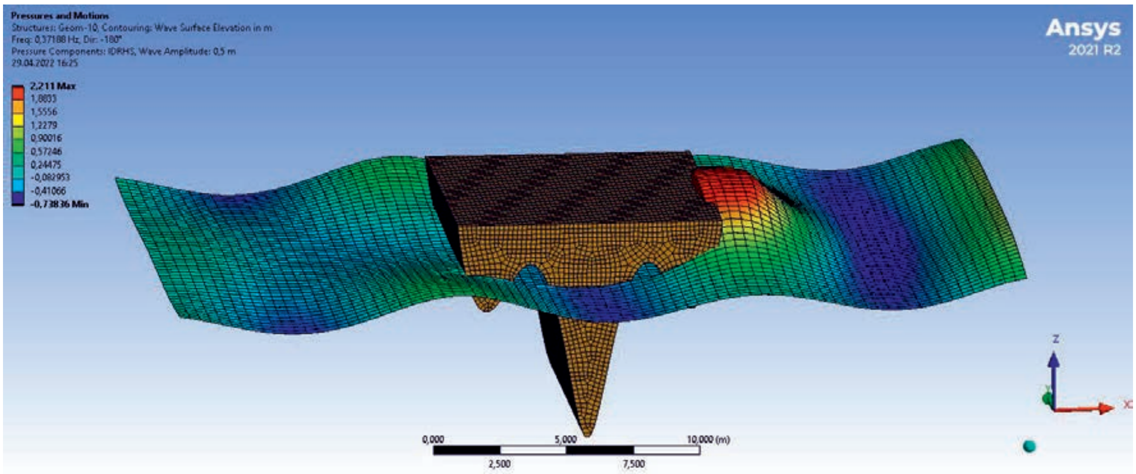

Fig. 5: 3D view of a trident shape with wave loading

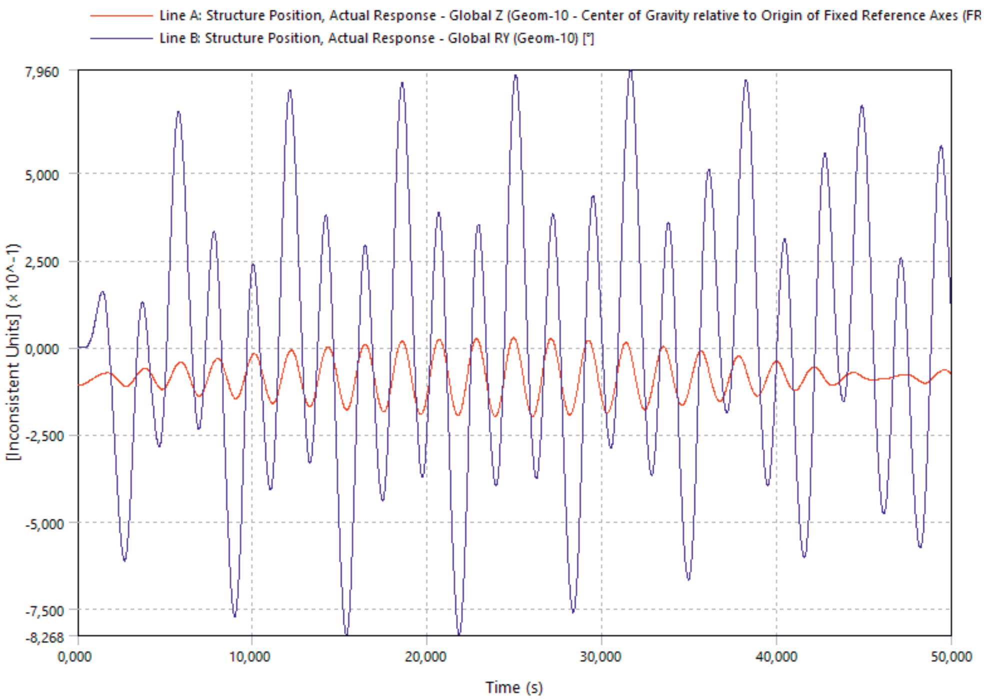

Fig. 6: Representation of the inclination and the stroke movement of the trident shape geometry

Geometry 2 – Circular geometry with a pointed cone

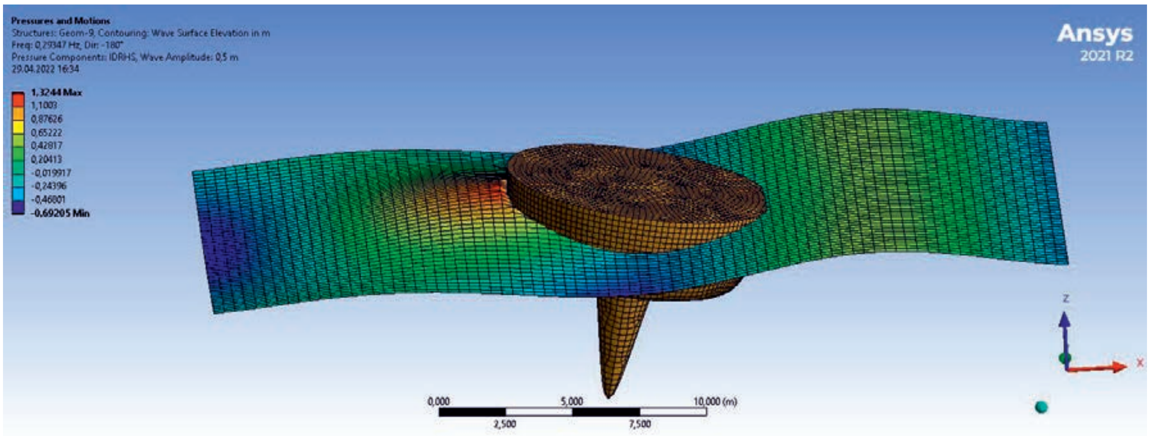

Fig. 7: 3D view of a circular geometry with wave loading

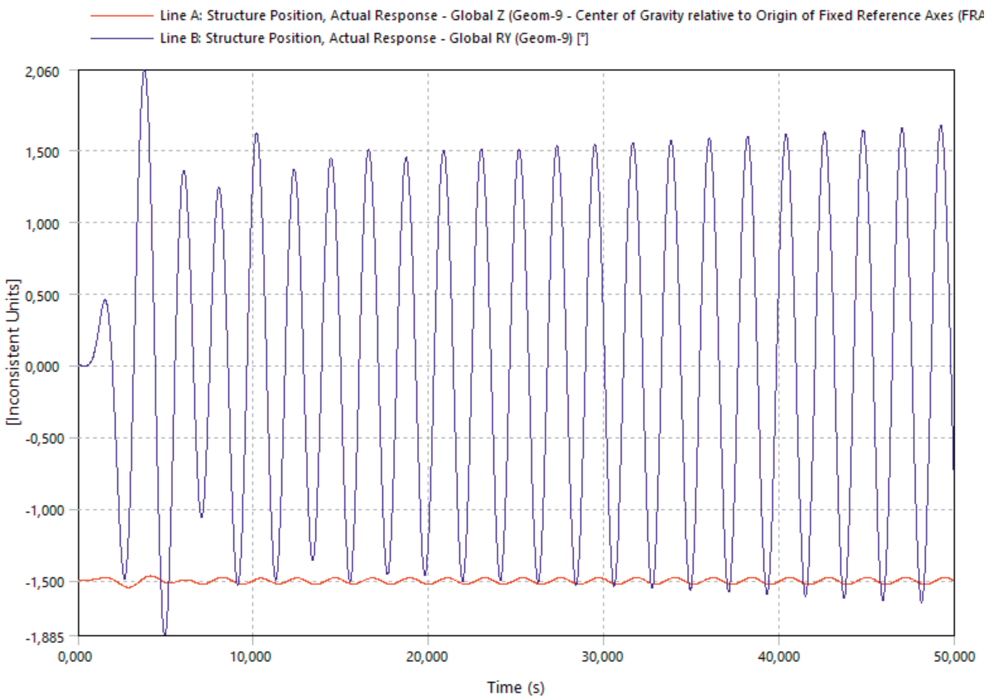

Fig. 8: Representation of the inclination and the stroke movement of the circular geometry with a pointed cone

Geometry 03 – Circular geometry with a blunt cone

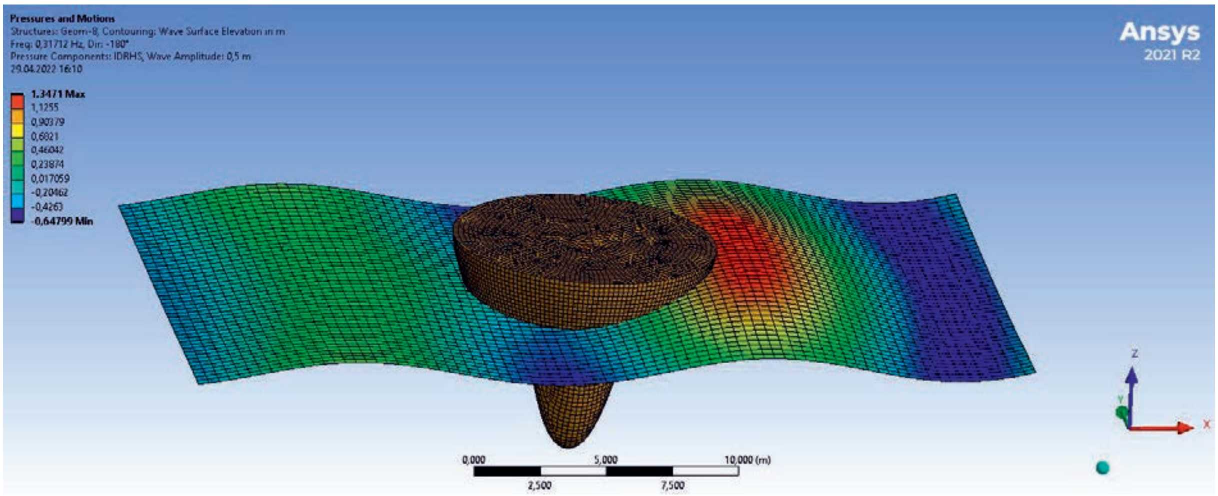

Fig. 9: 3D view of a circular geometry with a blunt cone and under wave load

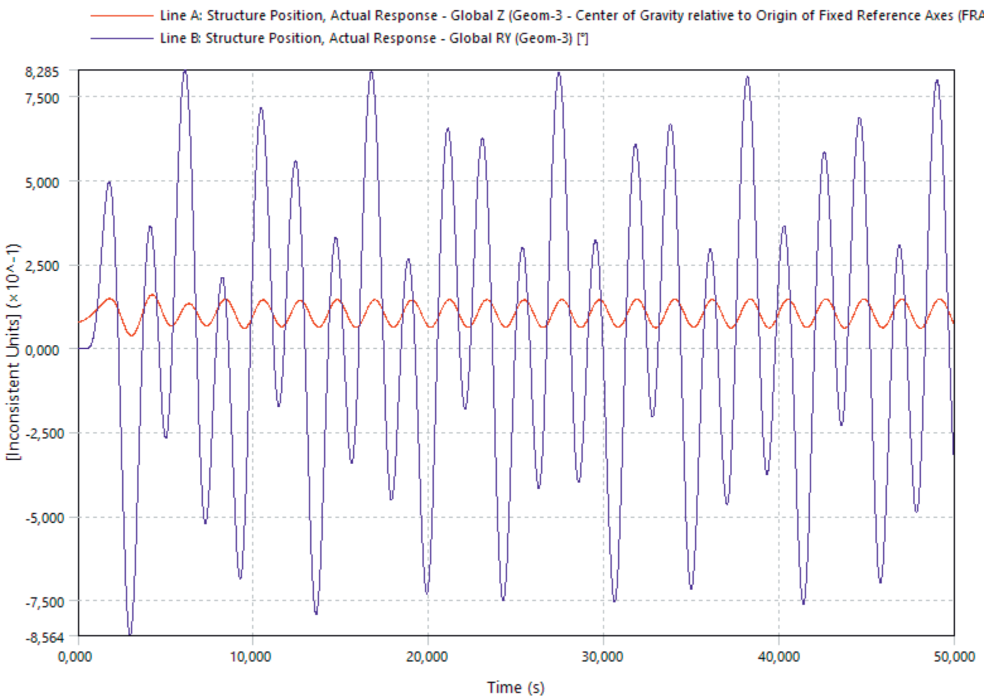

Fig. 10: Representation of the inclination and the stroke movement of the circular geometry with a blunt cone

Geometry 04 – Cuboid with a pyramid tip

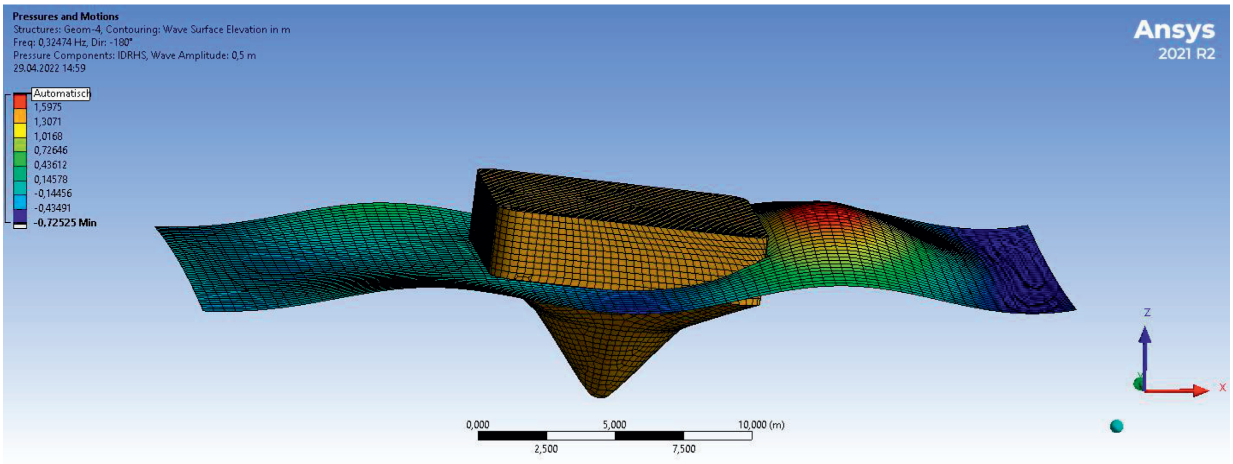

Fig. 11: 3D view of a cuboid with a pyramid tip under wave load

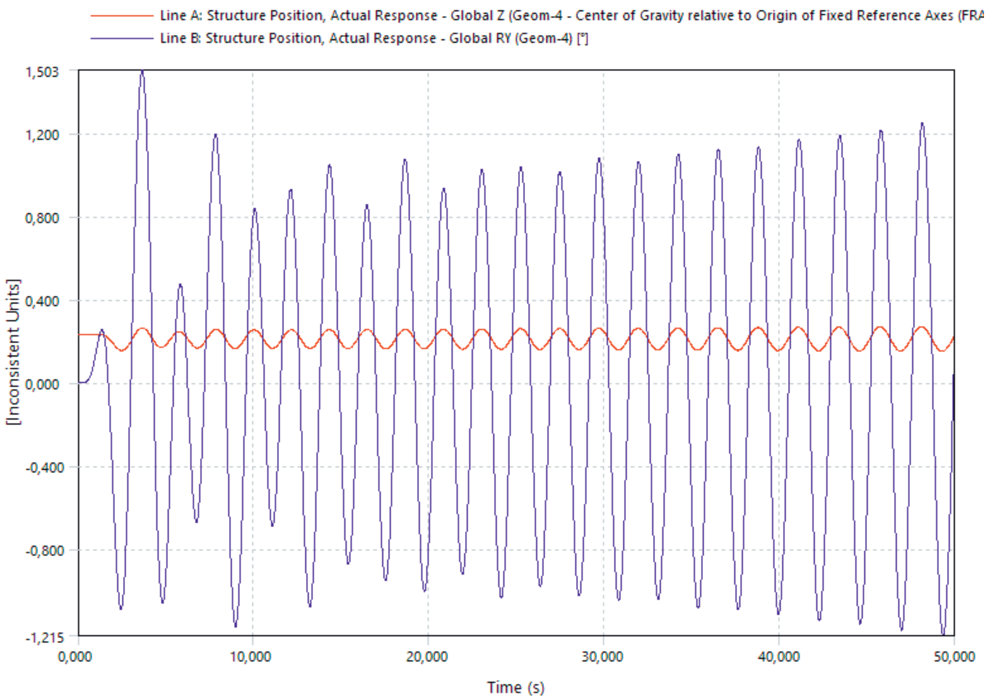

Fig. 12: Representation of the inclination and the stroke movement of the cuboid with a pyramid tip geometry

Geometry 05 – Thimble shape

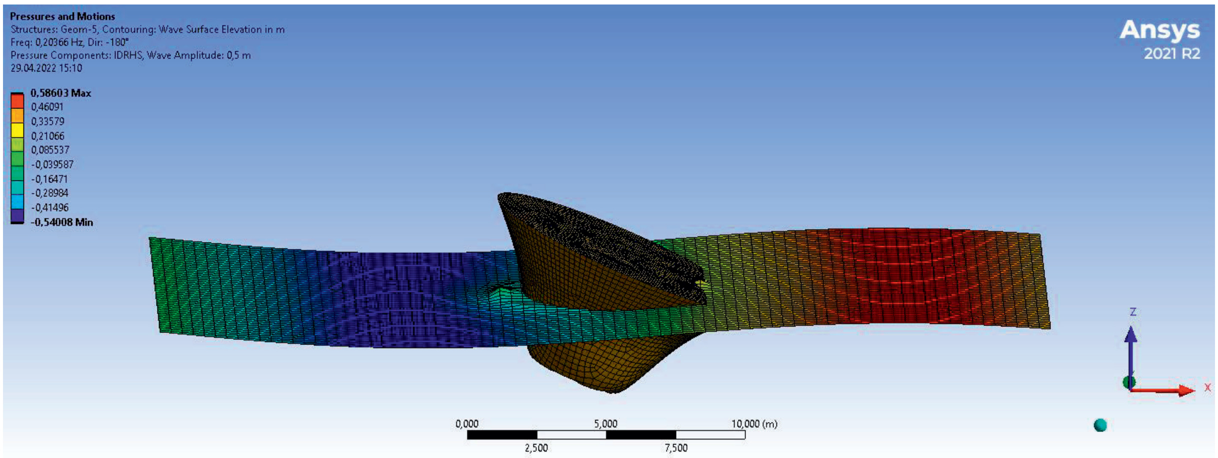

Fig. 13: 3D view of a cuboid with a thimble shape under wave load

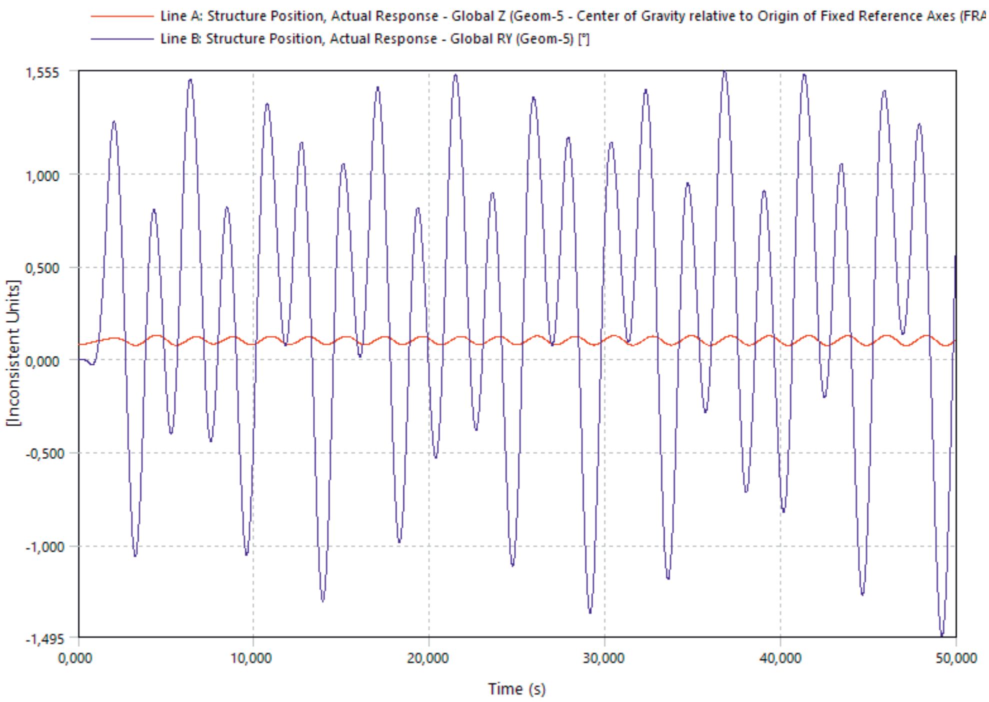

Fig. 14: Representation of the inclination and the stroke movement of the thimble shape geometry

Geometry 06 – Circular geometry with flat cone

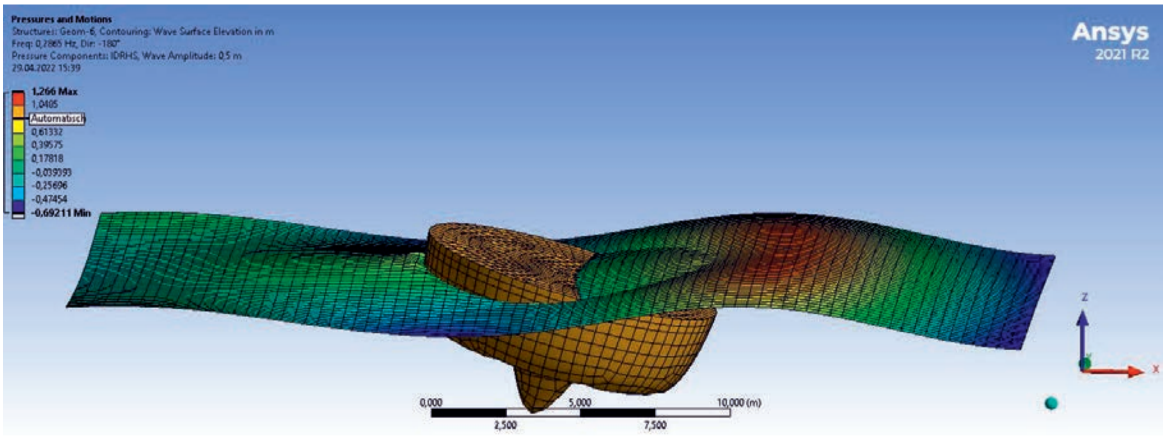

Fig. 15: 3D view of a cuboid with a Circular geometry with flat cone under wave load

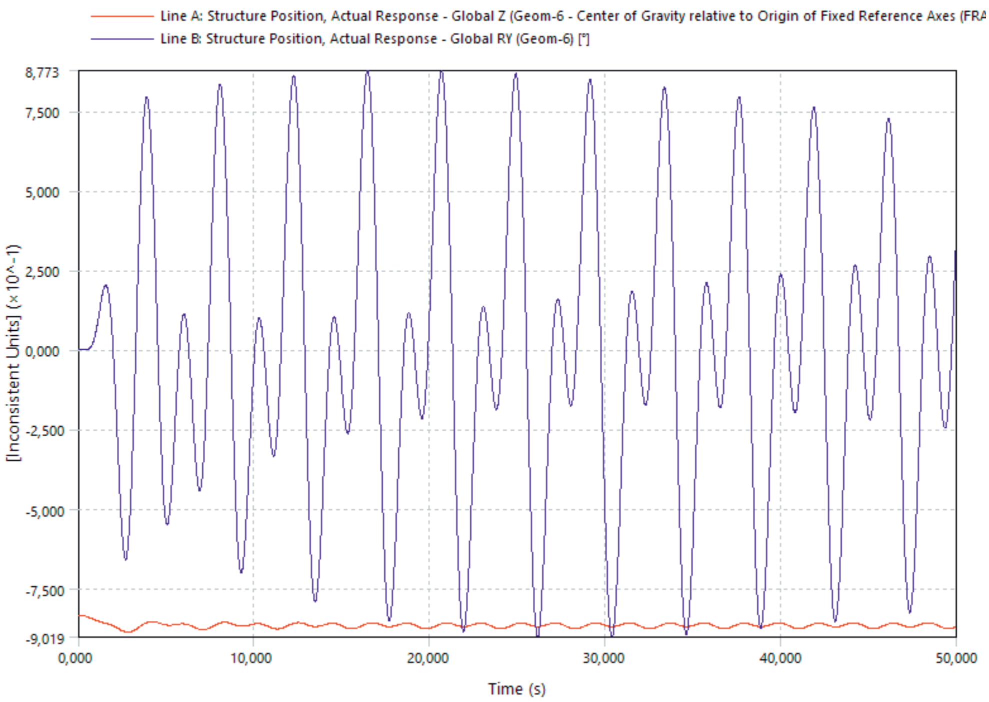

Fig. 16: Representation of the inclination and the circular geometry with flat cone

Summary of results

Table 1: Comparison of the stability parameters of new pontoon variants

Parameter		*Geom. 1-R*	*Geom. 2-C*	*Geom. 3-C*	*Geom. 4-C*	*Geom. 5-R*	*Geom. 6-C*
Negative increase	min. Z	-0.197	-1.547	0.037	0.150	0.073	-0.886
Positiv increase	max. Z	0.028	-1.467	0.1592	0.269	0.130	-0.83
Increase	**Delta Z**	**0.225**	**0.08**	**0.122**	**0.118**	**0.057**	**0.056**
Negative heel angle	min. °	-0.826	-1.884	-0.856	-1.215	-1.495	-0.901
Positive heel angle	max.°	0.795	2.06	0.828	1.5029	1.554	0.877
Total angle	°	**1.622**	**3.944**	**1.684**	**2.717**	**3.049**	**1.778**
Righting arm (CoG to CoB)	a	1.75	-0.46	1.475	1.335	1.185	0.265
Metacentric Heights	GM	2.28	4.63	1.359	4.171	0.866	2.823
CoB to Metacentre	M-Sa	4.03	4.16	2.834	5.507	2.051	3.088
Center of Gravity Z	G/Sk	-0.108	-1.5	0.079	0.231	0.079	-0.833
Center of Buoyancy (CoB)	B/Sa	-1.859	-1.03	-1.39	-1.01	-1.1	-1.09
Weight	t	131.17	99.77	100.35	148.88	62.32	153.99
Position	GM>0	stable	stable	stable	stable	stable	stable

Comparing the different variants highlights the influence of pontoon shape on its motion behavior. All geometric models met the stability criterion, hm > 0. The Metacenter is above the body's center of gravity. Geometry 1, 2, and 6 exhibited the lowest inclination, while geometry 2 and 5 had a large inclination but a very small stroke. Only geometry 6 demonstrated both properties, making it the best variant.

Conclusion

The comparison of variants shows the influence of geometry on the movement behavior of pontoons. Based on the results, however, no significant dependence of the parameters on each other can be determined. For example, geometries 5 and 6 move almost identically in the vertical plane with more than double the weight difference. The angle of inclination of the geometries, on the other hand, differs significantly. The situation is different for geometries 2 and 3 with the same weight. Here, no correlation can be determined concerning the weight. In addition, no clear proof can be provided that a circular shape should be better than a square shape. This statement is particularly important for practice, where cuboid pontoons are usually used. The results in connection with the metacentric height (GM) prove to be even more astonishing. According to these geometries, there is no difference between high and low metacentric heights concerning the resulting slope. However, the inner cavity on the bottom of the geometry seems to have a positive influence on the motion criteria. The results are not conclusive and only point in the direction of further possibilities of parameter studies with variable shapes. Displacement from the weight in the material layers of the pontoon with different bulk densities can additionally influence the motion behavior. Theoretically, optimal pontoon shapes can be determined depending on the need or requirement. The production of such complex geometries can certainly be realized with the wax formwork [9].

Keywords Behavior movement · Floating structures · Numerical simulation · Parametric modelling

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Financing and valuation of floating homes in Austria (part 2)

N.N.

Finanzierungs und Bewertung von schwimmenden Häusern in Österreich (Teil2)

Ausgehend von großen Schwierigkeiten, schwimmende Häuser in Deutschland mittels Fremdkapital von Banken zu finanzieren, beleuchtet der nachfolgende Fachbeitrag die Finanzierungsmöglichkeiten schwimmender Häuser in Österreich und sucht nach Lösungsansätzen für Deutschland.

Die zentrale Fragestellung lautet:

Kann die Finanzierungs- und Bewertungspraxis von Kreditinstituten in Deutschland für schwimmende Häuser mittels der Finanzierungs- und Bewertungspraxis von schwimmenden Häusern in Österreich erleichtert werden?

Die Grundlage hierzu bildet der Fachbeitrag in der Floating Architecture 4[72], in dem die Grundlagen des Wesens schwimmender Häuser und der Finanzierung und Bewertung von unbeweglichen und beweglichen Gegenständen i.S.d. österreichischen Liegenschaftsbewertungsgesetzes (LBG) aufgeführt werden. Ebenfalls wird in dem Fachbeitrag die Projektentwicklung Waterside Living in Linz in Bezug auf die Finanzier- und Bewertungsmöglichkeiten der in Linz befindlichen schwimmenden Häuser untersucht.

Der nachfolgende Fachbeitrag setzt die Analyse von Projektentwicklungen von Bauwerken auf dem Wasser mit dem im Wiener Neudorf (Niederösterreich) gelegenen LISI-Haus fort und schließt mit einem Fazit und Ausblick für die Finanzier- und Bewertungsmöglichkeiten von schwimmenden Häusern in Deutschland.

[72] Siehe o.V (2023): Financing and valuation of floating homes in Austria, in: Stopp, Horst / Strangfeld, Peter (Hrsg.): Floating Architecture 4. Construction on and near water, Berlin, Zürich 2023, S. 55-78.

Financing and valuation of floating homes in Austria (part 2)

N.N.

I Introduction

Based on the great difficulties in financing schimmende Häuser (floating homes) in Germany using loans from banks, the following article examines the financing options for schwimmende Häuser (floating homes) in Austria and looks for solutions for Germany.

The central question is:

Can the financing and valuation practices of credit institutions in Germany for schwimmende Häuser (floating homes) be facilitated by means of the financing and valuation practices of schwimmende Gebäude (floating homes) in Austria?

The basis for this is the technical article in Floating Architecture 4, which sets out the basics of the nature of schwimmende Häuser (floating homes) and the financing and valuation of immovable and movable property within the meaning of the Austrian Property Valuation Act (LBG). The article also examines the Waterside Living project development in Linz with regard to the financing and valuation options for the schwimmende Häuser (floating homes) located in Linz.

The following article continues the analysis of project developments of buildings on the water with the LISI-Haus located in Wiener Neudorf (Lower Austria) and concludes with a summary and outlook for the financing and valuation possibilities of schwimmende Häuser (floating homes) in Germany.

Notes

Note 1: In order to enable a better reading flow of the specialist article the associated primary sources, which have a very long character length, are not written down in the respective footnotes. The corresponding source references for the respective footnotes (short reference) as well as the bibliography (full reference) are available on request from the Institute for Floating Structures of the Faculty of Architecture-Civil Engineering-Urban Planning of the Brandenburg Technical University.

Note 2: The term “sH” is an abbreviation for “schwimmendes Haus”/”floating home”. You can find its definition in the brochure “Floating Architecture Vol. 4”.

II Examination of a second project development with regard to its financeability and assessability as valuation objects according to the LBG (Blaue Lagune)

The project “Blaue Lagune (Blue Lagoon)” serves as second project development to be analysed according to financing and valuation of floating homes in Austria.

1 Overview

Tab.1 Basic data project development Blaue Lagune

Source: Own representation, Data material: cf. Verwaltungs GmbH & Co. KG (ed.) (2022b).; cf. Fertighauszentrum "Blaue Lagune" Verwaltungs GmbH & Co. KG (ed.) (2016).

Location	- Construction and exhibition centre “Blaue Lagune“ - Wiener Neudorf, Federal State: Lower Austria
Number of objects	- 1 object called “LISI-Haus“ / Type of accommodation - Prize of the competition “Solar Decathlon (California, USA)” / most innovative and efficient solar house in 2013 - E.g. research and practice project of TU Wien
Year of constuction	Ca. 2013
Living space	Ca. 59 m^2
Floating body	- Five-part floating body made of wood - According to photos (at least) connected to the mainland above the water surface via damped and backlash-free cylinders
Structure	Modular wood construction
Supply and waste disposal	- All energy via photovoltaic system on the roof - Hot/cold water for room air conditioning via two-air heat pumps - Shower with integrated heat exchanger - Fresh water supply and waste water disposal: presumably via connections with mainland
Energy efficience	- Plus-energy house - Ecological insulation using Isocell and wood fibre insulation materials
Engine	No self-drive
Use	Current utilisation unknown

Fig.1 Site plan

Source: Fertighauszentrum "Blaue Lagune" Verwaltungs GmbH & Co. KG (ed.) (2022a).

Fig.2 LISI-Haus - exterior view

Source: Fertighauszentrum "Blaue Lagune" Verwaltungs GmbH & Co. KG (ed.) (2022b).

In the author's opinion, the LISI-Haus, which is part of the Blaue Lagune project development, can be described as a “floating home” in accordance with DIN SPEC 80003. If it is designed for living, then it would fall into the sub-category sH as defined by the author, in which the heating is self-sufficient using an air heat pump and a photovoltaic system.

Owner water parcel with pond and LISI-Haus (parcel 583/5)	Erich Benischek, Founder and Managing Director Blaue Lagune
Deposit number parcel parcel 583/5	2002 (Cadastral municipality Wiener Neudorf)
Parcels belonging to deposit number 2002 =1 Land registry body	583/6 and 583/5
owner of the LISI-Haus	Erich Benischek, Founder and Managing Director Blaue Lagune

Tab.2 Ownership structure and cadastre

Source: Own representation, data basis: cf. Fertighauszentrum "Blaue Lagune" Verwaltungs GmbH & Co. KG (ed.) (2022b); Lower Austria / Bundesamt für Eich- und Vermessungswesen (BEV) (ed.) (2022b).

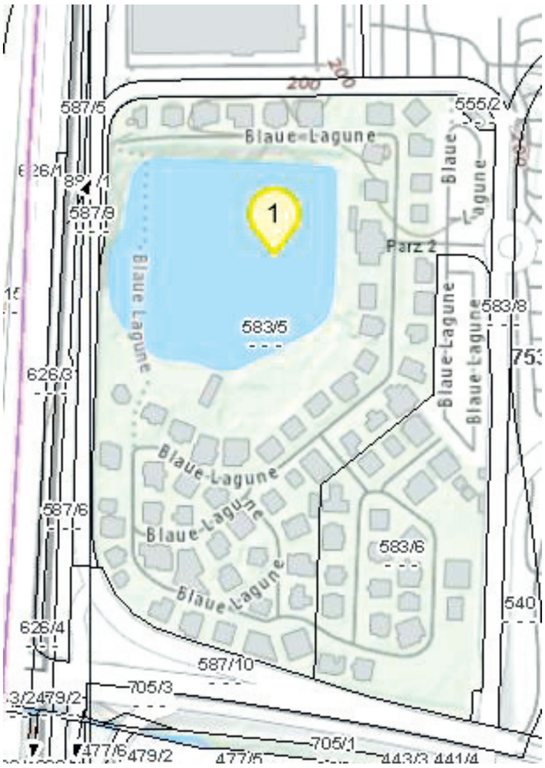


Fig.3 Real estate map and site plan Blaue Lagune

Source: Lower Autria / Bundesamt für Eich- und Vermessungswesen (BEV) (ed.) (2022a).

2 Relevant public law approvals for the LISI-Haus

According to the expert report from 2013, the LISI-Haus functions as a publicly effective exhibition house and as a prototype and model for other sustainable/ecologically built houses.[73] This information was confirmed or supplemented by the Marktgemeinde Wiener Neudorf, Bau-, Umwelt- und Verkehrsamt (see below).[74]

According to telephone consultation with the Marktgemeinde Wiener Neudorf, Bau-, Umwelt- und Verkehrsamt (abbreviation: Marktgemeinde Wiener Neudorf), the LISI-Haus is approved as an exhibition building under building regulations. A permit under building regulations for the LISI-Haus for residential use was not permitted due to its proximity to the highway and its location in or around the business park designated in the development plan.

The author gathered from the telephone conversation that the Marktgemeinde Wiener Neudorf always considers the granting of a building permit to be fundamentally necessary for the construction of a building on the water that is designed like the LISI-Haus.

[73] Cf. RegionalMedien Oberösterreich GmbH (ed.) / Müller, Kerstin (2013).
[74] Cf. telephone consultation with Marktgemeinde Wiener Neudorf, Bau-, Umwelt- und Verkehrsamt on 05.08.2022.

Based on current knowledge of the Marktgemeinde Wiener Neudorf the fact is that residential use is fundamentally not permitted under building law for a building located on an area designated as a body of water under spatial planning law in the province of Upper Austria. It may be necessary to reorganise the spatial planning law for the designation of a water area with permitted residential use, for which the province of Lower Austria is responsible. For a final statement on the realisation of a residential use of the LISI-Haus, the Marktgemeinde Wiener Neudorf would do more detailed research.[75]

3 Classification of the LISI-Haus as immovable objects and movable property with real estate economic connection

The following section examines the extent to which the LISI-Haus can constitute real estate or a movable objects with real estate economic reference within the meaning of the LBG. Various tests are carried out by the author.

The author's conclusions and comments are marked in italics. The Englisch translation of German /Austrian verbatim quotes are usually written under the German/Austrian verbatim quote or sections.

Meaning of the symbols used for evaluation:

✓ : Criterion is fulfilled / - : Criterion is not fulfilled / ? : unclear situation

3.1 Checking the LISI-Haus as Zugehör (accessory)

<u>Testing: A Liegenschaft (land) incl. accessory is given</u>

The author uses Bienert's (2014) definition of “Liegenschaft” (land)[76]:

„Bei einem Grundstück im Sinne einer Grundbucheinlage spricht man auch von einer Liegenschaft.“[77]

“A plot of land in the sense of a land register entry is also referred to as a property.”

In the author's opinion, the Liegenschaft (land) required for accessory is basically available, as the pond is located on the parcel 583/5 to which deposit number 2002 belongs and for which a land registry body therefore exists.

<u>Testing the LISI-Haus as Zugehör (Gebäude) (accessory (building))</u>

1) Definition “Gebäude (building)” within the meaning of § section 297 ABGB literally

? „und bey Gebäuden.

- […] Eben so gehören zu den unbeweglichen Sachen diejenigen,
- **welche auf Grund und Boden in der Absicht aufgeführt werden**,
- daß **sie stets darauf bleiben sollen […]“**

- [...] In the same way, immovable property includes those,
- which are placed on land with the intention
- that they should always remain thereon [...]”

[75] Cf. telephone consultation with Marktgemeinde Wiener Neudorf, Bau-, Umwelt- und Verkehrsamt on 05.08.2022.
[76] Cf. Bienert (2014), p. 61.
[77] Bienert (2014), p. 61.

a) Definition„Gebäude“ (building) referred to sH according to the meaning of MEINGAST (2018) taking into account the general interpretation of the law

Gebäude (buildings) are

? „[…] nur grundfeste *unklar, bzw. nicht erfüllt*
? für die Dauer bestimmte Bauwerke.“[78]

? “[...] only fundamentally unclear, or not fulfilled
? structures intended for permanent use.”

Foundation means[79] ,
? that the structure is built on the ground: *unclear or not fulfilled here*
The LISI house lies in the water and presumably has no physical points of contact with the ground beneath it.
? and must be firmly connected to it.

The LISI-Haus is not firmly connected to the ground under the float. The LISI-Haus may be connected horizontally to the mainland by the cylinders attached to the LISI-Haus. Whether the ground over which it was built (water) and that to which it is connected (land) can be described as the same (areas are at least both part of one parcel) is unclear to the author with reference to the Austrian case law currently known to the author.

- Anchoring to the ground is not necessary

b) Case law of the Administrative Court in Austria[80]

- Case law in tax law
- Assessment according to the public opinion

„[…] dass nach der Verkehrsauffassung unter einem Gebäude jedes Bauwerk zu verstehen ist,

✓ das durch räumliche Umfriedung Menschen und Sachen Schutz gegen äußere Einflüsse gewährt: *wird aus baurechtlicher Genehmigung als Ausstellungshaus und Forschungsobjekt geschlussfolgert*
✓ den Eintritt von Menschen gestattet: *erfüllt s.o.*

? mit dem Boden fest verbunden: *unklar bis nicht erfüllt,*

Siehe oben, wenn „mit dem Boden fest verbunden“ das gleiche gemeint ist wie „grundfest“

✓ und von einiger Beständigkeit ist: *das LISI-Haus besteht seit 2013 (Baujahr)*

[78] Cf. Mader in Kletecka/Schauer, ABGB-ON[1.02] § section 435 rounding figure 2 (status: February 2014, rdb.at), quoted from Meingast (2018), p. 58.
[79] Cf. Helmich in Kletečka/Schauer, ABGB-ON[1.04] § section 297 (status: 1.7.2018, rdb.at), quoted from Meingast (2018), p. 58 ff.
[80] VwGH 21.09.2006, 2006/15/0156; quoted from Meingast (2018), p. 58 f.

“[...] that, according to the public perception, a building is to be understood as any structure,

- ✓ which provides protection for people and property against external influences by means of a spatial enclosure: *is inferred from approval under building law as an exhibition building and research object*
- ✓ allows people to enter: *fulfilled see above*

? firmly connected to the ground: *unclear to not fulfilled,*
See above, if “firmly connected to the ground” means the same as “solid”

- ✓ and of some permanence: *the LISI-house has existed since 2013 (year of construction)*

The criteria for the existence of land can be regarded as given in the case of the project development LISI-Haus; the situation is different when it is examined whether the house can be regarded as an accessory belonging to the property, examined on the basis of the definition of a building. **In the author's opinion, it is not clear whether the LISI-Haus can constitute an accessory belonging to the land within the meaning of the ABGB.**

3.2 Testing the LISI-Haus as Wohnungseigentum (condominium ownership)

The analysis is based on the Federal Act on Condominium Ownership (Wohnungseigentumsgesetz 2002 - WEG 2002) and the explanations of MEINGAST 2018 with regard to “schwimmende Gebäude” (floating buildings).

<u>Definition „Wohnungseigentum“ (condominium ownership) within the meaning of § section 2 para. 1 WEG</u>

(1) Wohnungseigentum ist das dem Miteigentümer einer Liegenschaft oder einer Eigentümerpartnerschaft eingeräumte dingliche Recht, ein Wohnungseigentumsobjekt ausschließlich zu nutzen und allein darüber zu verfügen. Vorläufiges Wohnungseigentum ist das nach den Regelungen im 10. Abschnitt beschränkte Wohnungseigentum, das unter den dort umschriebenen Voraussetzungen vom Alleineigentümer einer Liegenschaft begründet werden kann.

(1) Condominium ownership is the right in rem granted to the co-owner of a property or a partnership of owners to exclusively use and dispose of a condominium property. Provisional condominium ownership is limited condominium ownership in accordance with the provisions of § section 10, which can be established by the sole owner of a property under the conditions described therein.

1) Testing: A „Liegenschaft“ (land) as basis is given (see above)

<u>Definition of “Wohnung” (apartment) according to § section 2 para. 2 WEG / testing: existence of “Wohnung” (an apartment) or “sonstige selbstständige Räumlichkeit“ (other independent premises) refered to the LISI-Haus</u>

„(2) Wohnungseigentumsobjekte sind Wohnungen, sonstige selbständige Räumlichkeiten und Abstellplätze für Kraftfahrzeuge (wohnungseigentumstaugliche Objekte), an denen Wohnungseigentum begründet wurde.

Eine Wohnung ist ein baulich abgeschlossener, nach der Verkehrsauffassung selbständiger Teil eines Gebäudes, der nach seiner Art und Größe geeignet ist, der Befriedigung eines individuellen Wohnbedürfnisses von Menschen zu dienen**.**

Eine sonstige selbständige Räumlichkeit ist ein baulich abgeschlossener, nach der Verkehrsauffassung selbständiger Teil eines Gebäudes, dem nach seiner Art und Größe eine erhebliche wirtschaftliche Bedeutung zukommt, wie etwa ein selbständiger Geschäftsraum oder eine Garage.

Ein Abstellplatz für ein Kraftfahrzeug ist eine - etwa durch Bodenmarkierung - deutlich abgegrenzte Bodenfläche, die ausschließlich zum Abstellen eines Kraftfahrzeugs gewidmet und dazu nach ihrer Größe, Lage und Beschaffenheit geeignet ist; eine Stellfläche etwa aus Metall, die zu einer technischen Vorrichtung zur Platz sparenden Unterbringung von Kraftfahrzeugen gehört, ist einer Bodenfläche gleichzuhalten.“

“(2) Condominiums are apartments, other independent premises and parking spaces for motor vehicles (objects suitable for condominium ownership) in which condominium ownership has been established.

An *apartment* is a structurally self-contained, independent part of a building that is suitable in terms of its type and size for satisfying the individual living needs of people.

Other independent premises are a structurally self-contained part of a building which, according to public opinion, is independent and which, due to its type and size, is of considerable economic importance, such as an independent business premises or a garage.

A parking space for a motor vehicle is a clearly demarcated floor area - for example by means of floor markings - which is dedicated exclusively to the parking of a motor vehicle and is suitable for this purpose in terms of its size, location and nature; a parking area made of metal, for example, which is part of a technical device for the space-saving storage of motor vehicles, is to be considered equivalent to a floor area.”

2) Testing: the LISI-Haus as Wohnung (apartment)

“An Wohnung (apartment) is a

- ✓ structurally self-contained: *presumably fulfilled: Building permit as an exhibition building*
- ? an independent part of a building according to the public perception:

  It is unclear whether the LISI-Haus constitutes a building or part of a building (see above), if so, then at least one other structure on plot 583/5 would have to constitute a condominium in order to constitute a condominium ownership
- \- which, according to its type and size, is suitable for satisfying the individual housing needs of people.” (§ Section 2 para. 2 WEG):

The LISI-Haus has at least one room, a bathroom and basic development facilities (bathroom, fresh water, sewage disposal and heating facilities) for living, but according to the building regulations, the house is not permitted for living, which in the author's opinion should be the prerequisite for being allowed to establish and also build the condominium.

Conclusion: the LISI-Haus cannot be Wohnung (apartment)

3) Testing: the LISI-Haus as sonstige selbstständige Räumlichkeit (other independent premises)

Eine sonstige selbständige Räumlichkeit (*another independent space) is*

- ✓ a structurally self-contained*: presumably fulfilled:*

  The LISI-Haus has planning permission as an exhibition building

- ? according to the public perception, an independent part of a building*: unclear see above*

- *?* which is of considerable economic importance due to its type and size, such as an independent business premises or a garage.

  It is unclear whether an exhibition building can be of significant economic importance.

In the author's opinion, the LISI-Haus cannot constitute Wohnungseigentum (condominium ownership) for residential purposes (apartment) within the meaning of the WEG. It is possible, although rather unlikely, that the LISI-Haus may constitute Wohnungseigentum (condominium ownership) as sonstige selbstständige Räumlichkeit (other independent premises).

3.3 Testing: the LISI-Haus as Bauwerk (building) belonging to the Baurecht (building right)[81]

§ 1 Abs. 1 Baurechtsgesetz (BauRG)
„Ein Grundstück kann mit dem dinglichen, veräußerlichen und vererblichen Rechte, auf oder unter der Bodenfläche ein Bauwerk zu haben, belastet werden (Baurecht).“
§ Section 1 para. 1 of the Building Rights Act (BauRG)
“A plot of land may be encumbered with the real, alienable and heritable right to have a building on or under the ground surface (building right).”

In the author's opinion, it is unlikely that the owner of the land on which the pond and the LISI-Haus are located will establish a Baurecht (building right) for himself to build the LISI-Haus, as he is the owner of the property and it is public knowledge that he is also the owner of the LISI-Haus. The author rejects any further examination.

The existence of Baurecht (building right) in relation to the LISI-Haus seems improbable or non-existent.

[81] Incl. Bauwerkswohnungseigentum (building ownership) according to § section 6a BauRG

3.4 Testing: the LISI-Haus as Bauwerk (building) belonging to the Superädifikat

§ 435 ABGB (Superädifikat)

„Dasselbe gilt auch für die Übertragung des Eigentums an Bauwerken, **die auf fremdem Grund** in der Absicht aufgeführt sind, daß **sie nicht stets darauf bleiben sollen**, soferne sie nicht Zugehör eines Baurechtes sind."

§ Section 435 ABGB (Superädifikat)

'The same shall also apply to the transfer of ownership of buildings which are erected on third-party land with the intention that they should not always remain there, unless they are part of a building right.'

According to the wording of the law (§ Section 435 ABGB), a Superädifikat is characterised by the fact that the buildings in question are erected on third-party land, which is not the case here. **The owner of plot 583/5 is also the owner of the LISI-Haus, which is why, in the author's opinion, the LISI-Haus cannot constitute a Bauwerk (building) belonging to the Superädifikat from this aspect alone; no further examination is required.**

3.5 Conclusion

In the author's opinion, it is not legally clear whether the LISI-Haus can constitute an accessory (building) belonging to the land within the meaning of the Austrian Civil Code (ABGB) or Wohnungseigentum (condomimium ownership) (sonstige selbstständige Räumlichkeit/other independent premises).

The existence of a Baurecht (building right) in relation to the LISI-Haus appears to be unlikely or non-existent in the opinion of the author.

In the author's opinion, the LISI-Haus cannot constitute an Wohnung (apartment) within the meaning of the WEG or a Bauwerk (building) belonging to the Superädifikat.

4 State housing subsidy for the LISI-Haus

In the following section is analysed whether the LISI-Haus can be financed by a state housing subsidy.

4.1 Fundamentals of state housing subsidy in Lower Austria

The Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) and the Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019) form the basis for the promotion of residential properties in the state of Lower Austria.

In addition to personal requirements (citizenship, net income, see §§ sections 3, 7), the Lower Austrian Housing Promotion Act 2005 stipulates that building-related requirements in particular must be met and public law provisions must be observed or licences must be presented. Individual essential basic requirements for the utilisation of a state housing subsidy in Lower Austria are presented below.

4.1.1 Essential building-related eligibility requirements according to NÖ WFG 2005

Summarised these elements are subsidized by the NÖ WFG 2005: Eigenheime (Owner-occupied homes), Eigentumswohnungen (condominium ownerships), Wohnungen (apartments), Wohnheime (residential homes), Einrichtungen, die der

Gesundheitsversorgung dienen (healthcare facilities), Geschäftsräume (business premises) und Dienstnehmerwohnungen (employee housing).

Basic definitions and essential characteristics of the above terms are listed in §§ sections 1, 11 and 33 of the Lower Austrian Housing Subsidy Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019).

§ Section 3 para. 1 of the Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) and § section 1 of the Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019) clearly state that, with the exception of Wohnungseigentum (condominium ownerships) and Einrichtungen, die der Gesundheitsversorgung dienen (facilities used for healthcare), every eligible residential property requires a building permit for housing in whole or in part or must be presented when submitting an application.

4.1.2 Eligible legale entities

According to § section 12 of the Lower Austrian Housing Subsidy Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019), only those who are either leaseholders, owners in the form of Wohnungseigentum (condominium ownership), full ownership or co-ownership or authorised builders of the property (Bauberechtigter) on which the subsidised property is located or is being built are eligible to apply. **This means that Liegenschaften (land) and their Zugehör (Gebäude) (accessory (building)), Wohnungseigentum (condominium ownership), Bauwerke (buildings) based on a Baurecht (building right) and a Superädifikat are eligible if they are constructed on the basis of a lease agreement.**

With regard to the lease agreement in § section 12 para. 3 of the Lower Austrian Housing Subsidy Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019), it is explicitly stated that the *lease agreement must have a duration of at least 27 ½ years* and that the lease agreement must be submitted to the funding institution.
For the application, an *extract from the land* register must be submitted to the funding institution in accordance with § section 25 para. 7 Lower Austrian Housing Subsidy Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019), which shows the (co-)ownership or the right to build (based on the Baurecht (building right)) on the underlying property on which the building is being erected or is located,

In the case of a tenant, according to further research by the author, the property owner must also sign the application, thereby additionally consenting to the encumbrance of the property in the first rank (see § section 25 para.7 in conjunction with § section 15 para. 1 of the Lower Austrian Housing Subsidy Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019)).

4.2 Examination of state housing subsidies according to NÖ WFG 2005 and NÖ Wohnungsförderungsrichtlinien 2019 for the LISI-Haus

4.2.1 Examination of the LISI-Haus as an eligible legal entity

According to Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) and the Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019), the legal entities for subsidies are as discribed above are Liegenschaft (land) or a Zugehör (accessory) belonging to the Liegenschaft (land), Wohnungseigentum (condominium ownership), Bauwerke (buildings) belonging to a Baurecht (building right) and a Superädifikat, if these are (additionally) established by means of a lease agreement and the lease agreement has a duration of at least 27.5 years.

As described above, in the opinion of the author, the LISI-Haus cannot be an apartment within the meaning of the WEG (owner-occupied apartment) and cannot be a Bauwerk (building) belonging to the Superädifikat; these two entities for the state housing subsidy in relation to the LISI-Haus are ruled out.

Even if this does not seem to be clearly legally clarified, it is possible to classify the LISI-Haus as an Zugehör (accessory) belonging to the Liegenschaft (land) within the meaning of the Austrian Civil Code (ABGB) and thus to be fundamentally eligible for subsidies in accordance with the Lower Austrian Housing Promotion Act 2005 / Lower Austrian Housing Promotion Guidelines 2019.

Another possibility, even if this is considered unlikely in the author's opinion with regard to the LISI-Haus, is that the LISI-Haus is a Bauwerk (building) belonging to a Baurecht (building right) or is a Wohnungseigentum (condominium ownership) as sonstige selbstständige Räumlichkeit (other independent premises) according to the WEG (not residential) and can basically be subsidized according to the state housing subsidy guidelines in Lower Austria.

To summarize, the legal entities that may exist in the house, namely Zugehör (Gebäude) ((accessory (building)), Bauwerk (building) belonging to a Baurecht (building right) and Wohnungseigentum (condominium ownership) as sonstige selbstständige Räumlichkeit (other independent premises) according to the WEG (not residential) can basically be considered eligible legal entities under the Lower Austrian housing subsidy regulations.

4.2.2 Examination of necessary subsidized objects and approvals of the LISI-Haus for housing subsidies

§ Section 3 para. 1 of the Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) and § section 1 of the Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderungsrichtlinien 2019) clearly state that, with the exception of the Eigentumswohnungen (condominium ownerships), Einrichtungen, die der Gesundheitsversorgung dienen (healthcare facilities) and Geschäftsräume (business premises), every eligible property requires a building permit for housing in whole or in part or must present such a permit when submitting an application.

The LISI-Haus has a building permit as an exhibition building and no building permit for residential use. It is therefore not eligible for funding under the Lower Austrian Housing Promotion Act (NÖ WFG 2005) as an owner-occupied home, apartment, residential home or employee accommodation, irrespective of other supplementary checks such as a necessary legal entity within the meaning of the Austrian Civil Code (ABGB).

In principle, the LISI-Haus would still be eligible as Eigentumswohnungen (condominium ownerships) as well as Einrichtungen, die der Gesundheitsversorgung dienen (healthcare facilities) and Geschäftsräume (business premises). However, in the author's opinion, the latter two do not constitute the LISI-Haus as an exhibition building and, in addition, the applicant would have to be the municipality or a building association recognized under the Austrian Non-Profit Housing Act (Wohnungsgemeinnützigkeitsgesetz, WGG), which is the owner of the LISI-Haus, presumably not even as a shareholder. In the author's opinion, the LISI-Haus cannot be a Wohnungseigentum (condominium ownership) according to the WEG, which means that this possible funding option under the the Lower Austrian Housing Promotion Act (NÖ WFG 2005) does not apply to the LISI-Haus either.

In summary, the LISI-Haus cannot be classified as an eligible property under the Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) / Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderrichtlinien 2019), as it does not have the necessary building permit for residential use or is not a Geschäftsraum (business premises), Einrichtung, die der Gesundheitsversorgung dienen (facility for social purposes) or a Eigentumswohnung (condominium). From the author´s point of view, the same applies to properties built in the same way as the LISI-Haus or for sH with residential use on this or fundamentally different water areas in Wiener Neudorf and possibly also throughout Lower Austria, as a mandatory building permit for residential use is not granted according to the current state of knowledge.

Due to the object of the study – a schwimmendes Gebäude for living (schwimmendes Haus (floating building for residential use (floating home)) - no further detailed examination of the possible promotion as a Einrichtungen, die der Gesundheitsversorgung dienen (healthcare facilities) and Geschäftsräume (business premises) is carried out.

4.3 Conclusion

To summarize, the legal entities that may exist in the LISI-Haus, Zugehör (accessory), the Bauwerk (building) belonging to the Baurecht (building right) and Wohnungseigentum as sonstige selbstständige Räumlichkeit (kein Wohnen) (condominium ownership as other independent premises (not residential)) can basically be regarded as eligible legal entities under the Lower Austrian housing subsidy regulations.

However, upon closer examination and attempted classification of the LISI-Haus as an eligible property, it cannot be classified as an eligible property under the Lower Austrian Housing Promotion Act 2005 (NÖ WFG 2005) / Lower Austrian Housing Promotion Guidelines 2019 (NÖ Wohnungsförderrichtlinien 2019), as it does not have the necessary building permit for residential use or is not a Geschäftsraum (business premises), Einrichtung, die der Gesundheitsversorgung dient (facility for social purposes) or Eigentumswohnung (condominium ownership). In the author's opinion, the same applies to objects built in the same way as the LISI-Haus or schwimmende Häuser (floating homes) for living on this or basically on other water areas in Wiener Neudorf, possibly also in the whole of Lower Austria, as a mandatory building permit for schwimmende Häuser (floating homes) for living is not granted according to the current state of knowledge.

Accordingly, state housing subsidies for schwimmende Häuser (floating homes) under the Lower Austrian Housing Promotion Act 2005 (NÖ WGF 2005) do not appear to be possible in the Marktgemeinde Wiener Neudorf and possibly the whole of Lower Austria.

III Conclusion of analysed project developments

The main conclusions of the project developments analysed are as follows:

1) **Different authorisation situations for sH in Austria**

- In some cases, a sH requires a building permit; the author is not currently aware of any building permits for sH in Austria
- In some cases, sH 'only' require a licence under water and shipping law and do not receive a building permit

2) **Legal uncertainty regarding the categorisation of an sH as an object of valuation under the LBG**

- Irrespective of the ownership structure between water area and sH, there appears to be legal uncertainty regarding the categorisation of a sH as a legal entity within the meaning of the LBG
- With the exception of the Wohnungseigentum for housing (condomium ownership for housing), all of the LBG valuation objects considered appear to be fundamentally realisable in the case of sH

3) **State housing subsidy currently not realisable**

- SH can represent a fundamentally eligible legal entity in terms of the housing subsidy laws of the federal states in Austria
- State housing subsidies are currently not considered realisable by the author in the province of Upper Austria as well as in the Marktgemeinde Wiener Neudorf and possibly in the whole of Lower Austria due to the impossibility of obtaining building permits for housing

IV Conclusion and outlook

1 Conclusion

- The author does not recommend further research into possible financing and valuation models for sH in Austria as a solution for sH in Germany
- The lack of a legal and standardised definition of sH in Austria and the lack of specialist literature make it difficult to conduct an efficient and well-founded analysis
- Fundamental legal uncertainty and planned reorganisation of buildings on third-party land represent a risk for the value of the valuation object in the area of Superädifikate and Baurechte (building right) that is difficult to calculate
  - Legal uncertainty exists for all valuation objects in accordance with the LBG for sH or
  - Valuation objects within the meaning of the LBG for sH are not realisable
- At present, the author has no knowledge of existing or standardised valuation and financing concepts for sH as a valuation object according to the LBG or other valuation procedures used by banks in Austria

2 Outlook

- The Swiss market may offer good valuation and financing conditions or concepts for sH, where the legal entities 'buildings on third-party land' are already favourably organised according to Kogler/Mayrhofer 2021

- If applicable, the specialist literature on the valuation of buildings on floating sand in Austria contains information on the valuation and financing of sH, which the author came across during her research

V References

In order to enable a better reading flow of the specialist article, the associated primary sources, which have a very long character length, are not written down in the respective footnotes. The corresponding source references for the respective footnotes (short reference) as well as the bibliography (full reference) are available on request from the Institute for Floating Structures of the Faculty of Architecture-Civil Engineering-Urban Planning of the Brandenburg Technical University.

Site selection for floating houses at opencast mine embankments

Thomas Kramer

Stadtverwaltung Cottbus

Standortwahl für schwimmende Häuser an Tagebauböschungen

Zunächst werden die allgemeinen Kriterien aus der Raumplanung dargestellt:

- EU-Ziel
- Bundesebene (Raumordnungsgesetz)
- Länderebene (Landesentwicklungsplan, zum Teil Regionalpläne)
- kommunale Ebene (Bauleitplanung nach Baugesetzbuch)

Dabei ist die Berücksichtigungspflicht übergeordneter Planungen von großer Bedeutung. Es sind die Belastungen für künftige Generationen zu hinterfragen, also eine Nachhaltigkeitsprüfung ist anzustreben. Die Verwirklichung der Raumordnungsziele geschehen über förmlich Verwaltungsverfahren des Bauplanungsrechts.

Am Beispiel des bereits beendeten Tagebaus Cottbus-Nord und der entstehenden Bergbaufolgelandschaft mit dem Cottbuser Ostsee am unmittelbaren Stadtrand von Cottbus/Chóśebuz wird aufgezeigt, wie Raumordnungsgrundsätze bereits im ersten Masterplan vor 20 Jahren zur großräumigen, interkommunalen Entwicklung der neuen Nutzungen an den Seeufern durch Anordnung der Projektgebiete Berücksichtigung finden. Maßgeblich wird die vorhandene überörtliche Verkehrsinfrastruktur zur Erreichung der neuen Projektgebiete betrachtet, da Besucherströme aus dem Umland und anderen Regionen erwartet werden.
Vorgängerprojekte zu schwimmenden Häusern aus der brandenburgisch-sächsischen Seenland-Region werden zum Vergleich herangezogen, um Fehler zu vermeiden und auf den Umgang mit der Verankerung von Stegen an der steilen Tagebauböschung zu reagieren. Der Abraumförderbrückenschnitt bei ca. 30° hat einen ufernahen Höhenversatz von 25-35 m. In Archiven dokumentierte historische Abbaufolgen in den Tagebauen (digital bei www.lmbv.de) geben hierzu Aufschluss an welcher Stelle die technologisch bedingten sogenannten Randschläuche verlaufen.

Zum Tagebau Cottbus-Nord und dem Masterplan Cottbuser Ostsee wurde 2016 eine Potenzialstudie für touristische Entwicklungen in Cottbus/Chóśebuz und der Gemeinde Teichland für die 17 Projektgebiete angefertigt [ProjectM & TOPOS Berlin]. Vertiefend zum Standort Lakoma wurde 2018 eine städtebauliche Studie für das Ferienwohnen an Land und auf dem Wasser bearbeitet [Architekturbüro Nagler &Dieck, Cottbus].

Am Mikrostandort Lakoma im Ortsteil Willmersdorf der kreisfreien Stadt Cottbus/Chóśebuz werden Standortfaktoren aufgezeigt, die eine gute Eignung für die Funktion „Ferienwohnen“ am und auf dem Wasser belegen. Der Standort liegt direkt an der Bundesstraße und hat teilweise durch das für den Bergbau umgesiedelte Dorf noch Rest von technischer Infrastruktur (Strom, Wasser) vorhanden.
Die städtebauliche Studie zeigt eine Stufenplan, da möglicherweise nicht der gesamte Bereich sofort neu bebaut werden kann (Eigentumsverhältnisse, Neuordnung von Wegen, Baurecht, Baugenehmigungen auf dem Wasser).

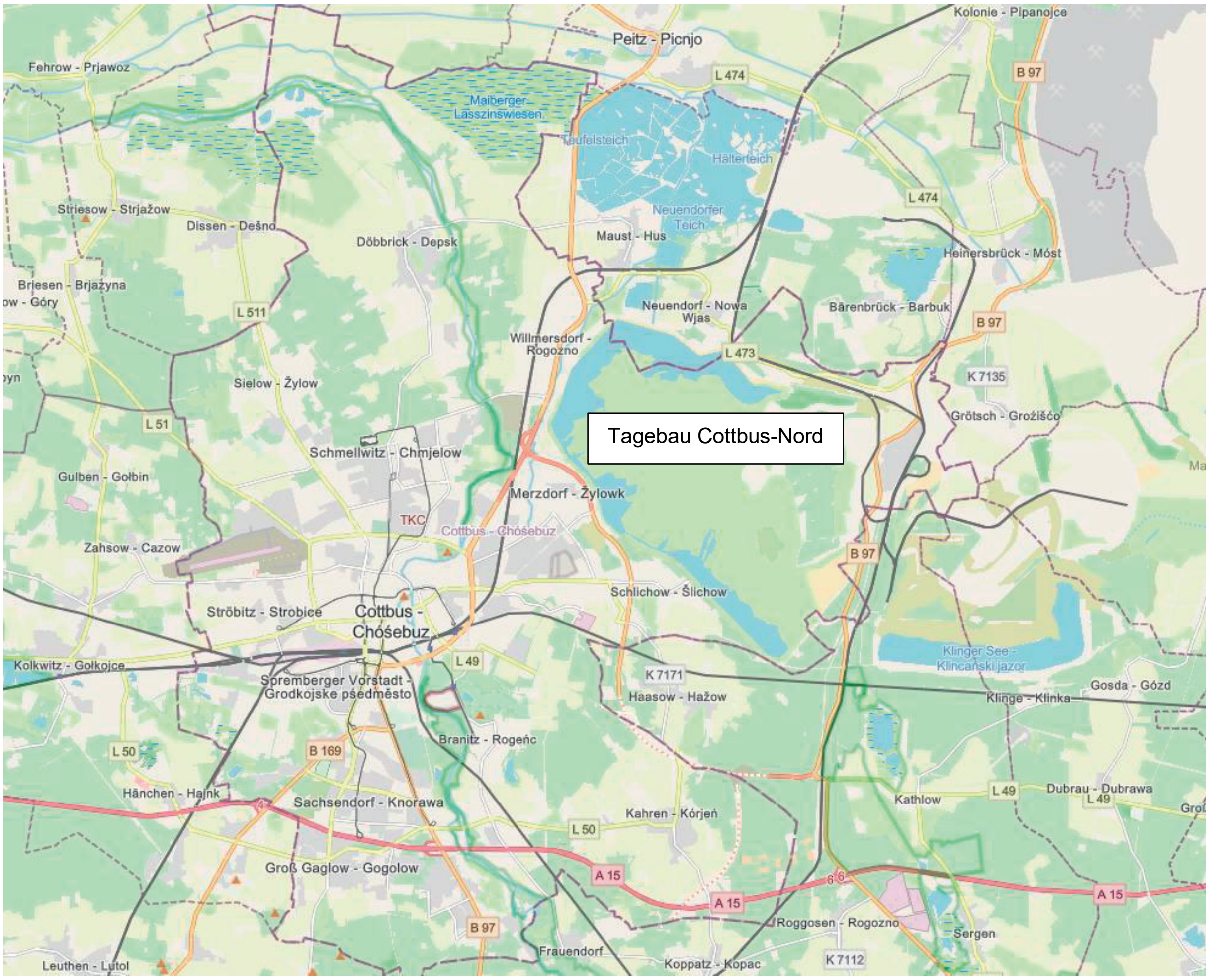


Fig. 1: Landkartenausschnitt Cottbus mit östlicher Umgebung [www.lmbv.de]

Site selection for floating houses at opencast mine embankments

Thomas Kramer

Firstly, the general criteria from spatial planning are presented:
- EU target
- Federal level (Spatial Planning Act)
- State level (state development plan, partly regional plans)
- Municipal level (urban land-use planning in accordance with the Building Code)

The obligation to take higher-level planning into account is of great importance. The impact on future generations must be scrutinized, i.e. a sustainability assessment must be carried out. Spatial planning objectives are realised via formal administrative procedures under building planning law.

From a European perspective, spatial disparities must be prevented. The use of funds and the subsequent costs should be carefully weighed up. The principles and objectives of spatial planning are defined in the Federal Spatial Planning Act and in the spatial planning programme (in some cases also transnational concepts, for example in the case of lake/inland port planning). The state development plan contains the objectives and principles of the respective federal state regarding settlement areas, open space, transport, etc.. The German Building Code allows local authorities to plan the specific utilisation of the entire territory and partial planning for individual areas with stipulations on local building law. Existing uses as well as areas with protected status and areas for replacement/compensation are taken into account. The type and extent of utilisation and public development are specified in the development plans.

In the central place system of regional planning, the supply function and the environmentally relevant public service function are structured together with the supra-local development principle in the area, which is particularly important for rural areas. The development plan establishes the specific building rights with conclusive stipulations within the scope of validity of the planning perimeter. As a rule, long-term follow-up costs are not included in the consideration of suggestions and concerns from the mandatory public participation (public agencies and citizens) in the development plan preparation process, even if the issue is sometimes discussed in local politics. Nevertheless, it is important to scrutinise the burden on future generations. Municipal planning is often only focussed on the short-term results of settlement and infrastructure development opportunities. Many plans are determined by the timing of election periods, but have long-term effects on the taxpayer. Demographic change in rural areas must be taken into account in the planning process (fewer and fewer people are paying for the maintenance of infrastructure in settlement areas (roads/paths including lighting sections; supply and disposal systems)). A sustainability assessment should be endeavoured. The economic, environmental and social aspects should be included. Today, individual assessments of sectoral factors/indicators (e.g. as part of environmental impact assessments for planning projects) are already mandatory and should be subsumed into an overall assessment result.

The spatial planning objectives are realised in the course of spatial planning procedures due to the spatial significance of planning projects:

- Settlements (e.g. holiday villages, hotel complexes, large leisure facilities)
- Commercial economy
- Transport (e.g. federal roads, railways, waterways, etc.)
- Energy supply (e.g. power stations, high-voltage power lines, gas pipelines, wind farms with 3 or more wind turbines, etc.)
- Waste disposal (landfills, waste incineration plants, underground storage facilities, etc.)

The administrative procedures are always project-related (the project developer is the applicant to the regional planning authority of the federal state); the procedures also include an examination of alternatives and require a large-scale assessment of the overall project (to be examined across sections if sub-projects exist); Examination of the 'zero variant' (insurmountable concerns in the assessment require the abandonment of the planned project). The Federal Spatial Planning Act requires the state development/regional plan authorities to support cooperation between municipalities to strengthen sub-regional developments.
Forms:

- Spatial planning development concepts
- Networks, regional forums
- Spatial observation (provide results to regional and inter-municipal bodies and specialised plan bodies; consultancy services for such bodies)

Reference to the principles of spatial planning:

- Inclusion of existing regional development concepts (e.g. „regional development concept Cottbus-Guben-Forst/L.")
- Municipal cooperation within a planning region and across regions (special-purpose associations)
- Cross-border cooperation between cities and regions (e.g. Euroregion Spree-Neiße-Bober e.V.)

An international urban and landscape planning ideas competition in 2000/01 led to the development of the inter-municipal 'Cottbus Baltic Sea Masterplan' by the winning group of offices, which was first adopted by the municipal committees of the city of Cottbus/Chóśebuz and the municipalities of Teichland, Neuhausen/Spree and Wiesengrund in 2006. Lake Klingen in the immediate neighbourhood was also considered in part. In terms of spatial planning factors, the transport connections of a planning project are often of great importance in urban location assessments.
Cottbuser Ostsee is surrounded by two federal highways and a state road.
The B 168 in the west and the bypass in the south-west pass very close to a number of project areas. To the north, the L 473 forms a link between the two federal roads 97 and 168.

In Lakoma, floating houses in combination with land-based holiday homes are to be proposed as a bundling in a project area on the site of the former village of Lakoma, but no new establishment of permanent housing.

Since then, updates have been drawn up in 2013, 2016 and 2021 and again adopted as a joint guideline for the neighbouring residents of Cottbus Baltic Sea.
The 2015/16 potential analysis had a significant influence on changes to the content/functions of the project areas around the lake.

Fig. 1: masterplan, Cottbus Baltic Sea [City of Cottbus, 2006]

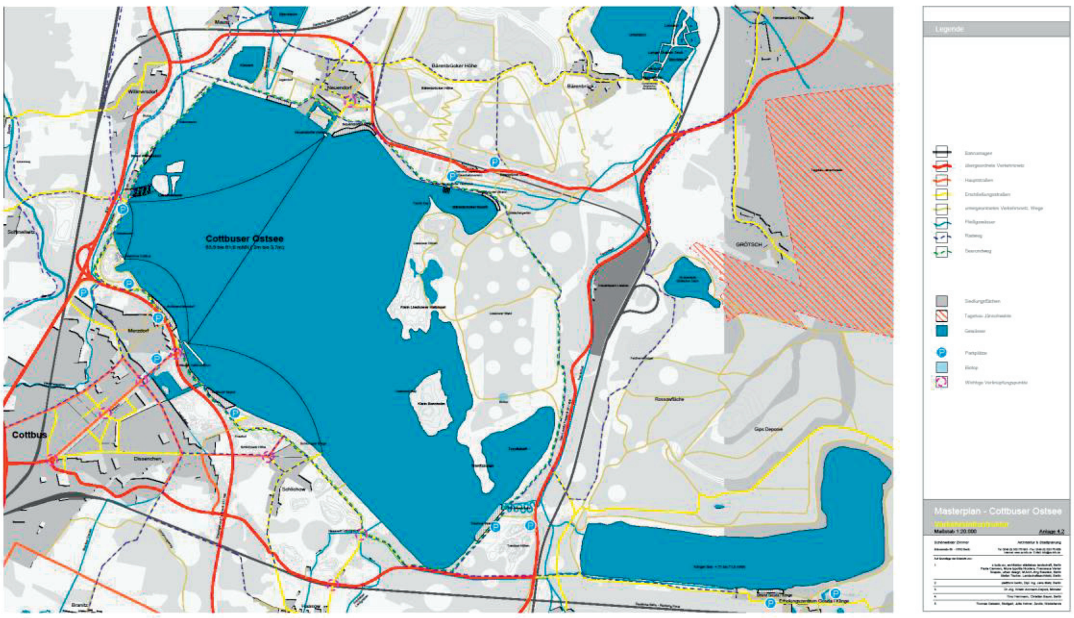


Fig. 2: masterplan, Cottbus Baltic Sea [City of Cottbus, 2006]

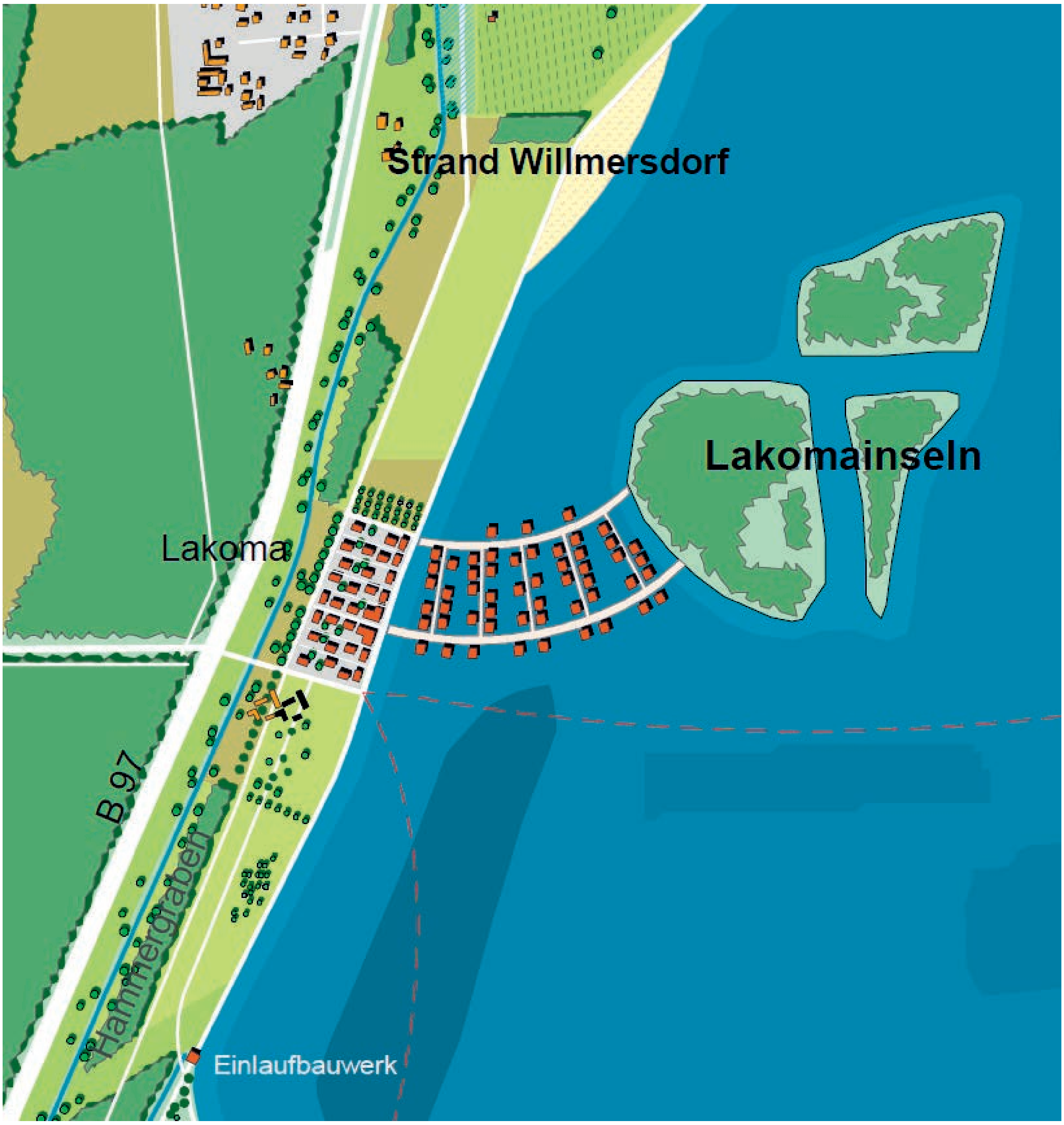


Fig. 3: Section of the masterplan, Cottbus Baltic Sea [City of Cottbus, 2006]

The islands shown here were not created from a mining point of view (effort required to consolidate the island banks before flooding began). These islands near Lakoma are then no longer shown in the updates of the masterplan.

In the 3rd update 2021, the illustrations have been reduced to pictograms for functions and locations of possible structures.

One reason for this is the uncertainty that has arisen as to how larger anchorages for a passenger ship jetty and future floating structures can be installed later on the steeply sloping embankment of fine sand. (Many things can be built - but the costs!!!)

The municipal objective is that the investments (jetties and floating structures) should come from private investors.

Fig. 4: Section of the 3rd update masterplan, Cottbus Baltic Sea [City of Cottbus, 2021]

In the Lusatian Lakeland on both sides of the Brandenburg-Saxony border, there are already floating houses on several lakes. Inter-municipal utilisation concepts have been drawn up for some of the post-mining waters.

Based on the historical mining sequence from the 1950s to the mid-1970s in the former Koschen open-cast mine, the technologically induced edge hoses can be categorised directly at the 'grown' site near Geierswalde - you can see an artificial embankment shape that resembles the shape of a natural lake bed. The overburden conveyor bridge cut, which is usually at approx. 30°, with a height offset to the berm of approx. 25-35 m poses a challenge for the anchoring. A notable point is the consideration of wave heights from different wind directions. A few years ago, the 5 houses in Geierswalde suffered considerable storm damage after having been anchored there for many years.

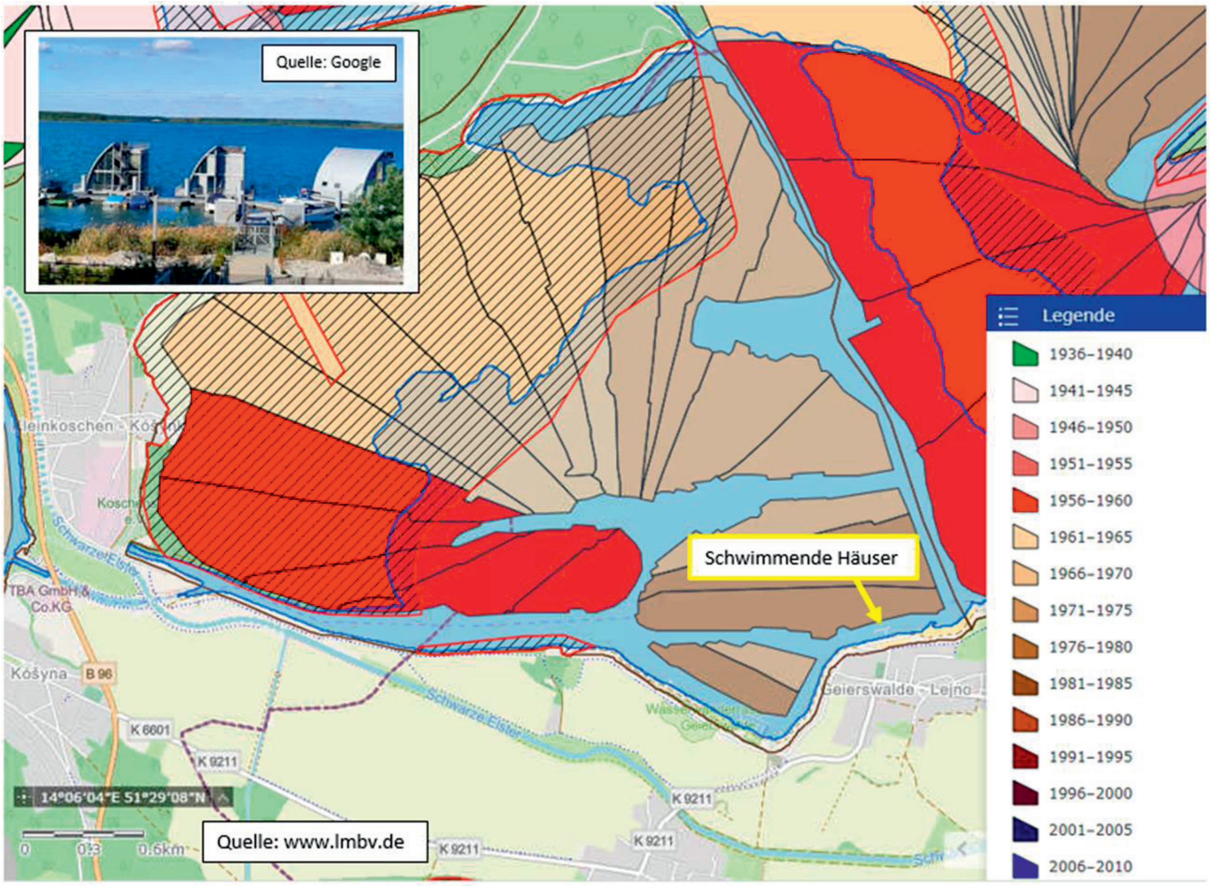


Fig. 5: Section of the www.lmbv.de/service/geoportal/ [LMBV, 2024]

The micro-local situation in Lakoma is as follows:

- Remaining village (2 farmsteads) of Lakoma (devastated until 1988) on the
- B 168 between Cottbus-Sandow and Cottbus-Willmersdorf
- today belongs to the district of Willmersdorf (only one uninhabited farmstead)

Fig. 5: Section of the https://intragis.svc.cottbus.de/ [City of Cottbus, 2024]

In the devastated area, there are still remnants of the former road network and media development (electricity, drinking water) for further development in post-mining use - e.g. for regional tourism and local recreation offers such as holiday homes in the immediate vicinity of the town centre. Supra-regional streams of visitors can easily reach their destination via the B 168. There are connections to the regional bus network to Cottbus and Peitz. The new use can be developed on land on a strip 90 to 110 metres wide between Hammergaben-(new course) and the lakeshore.

The diagram shows the section through the slope structure at the edge of the opencast mine near Lakoma (intake structure). The upper slope flattening with a gradient of 1:15 for the shaft outlet from the height of +59.8 m NHN bends downwards into the approx. 35-degree inclination of the dredged slope with a height offset of approx. 20 m to the berm, which was a working level for the travelling conveyor bridge. 75 m to 100 m from the shoreline, the water is around 17 m deep (mean water at +62.5 m NHN). The consequences for the anchoring construction of jetties and floating houses on the lakeshore are to be developed.

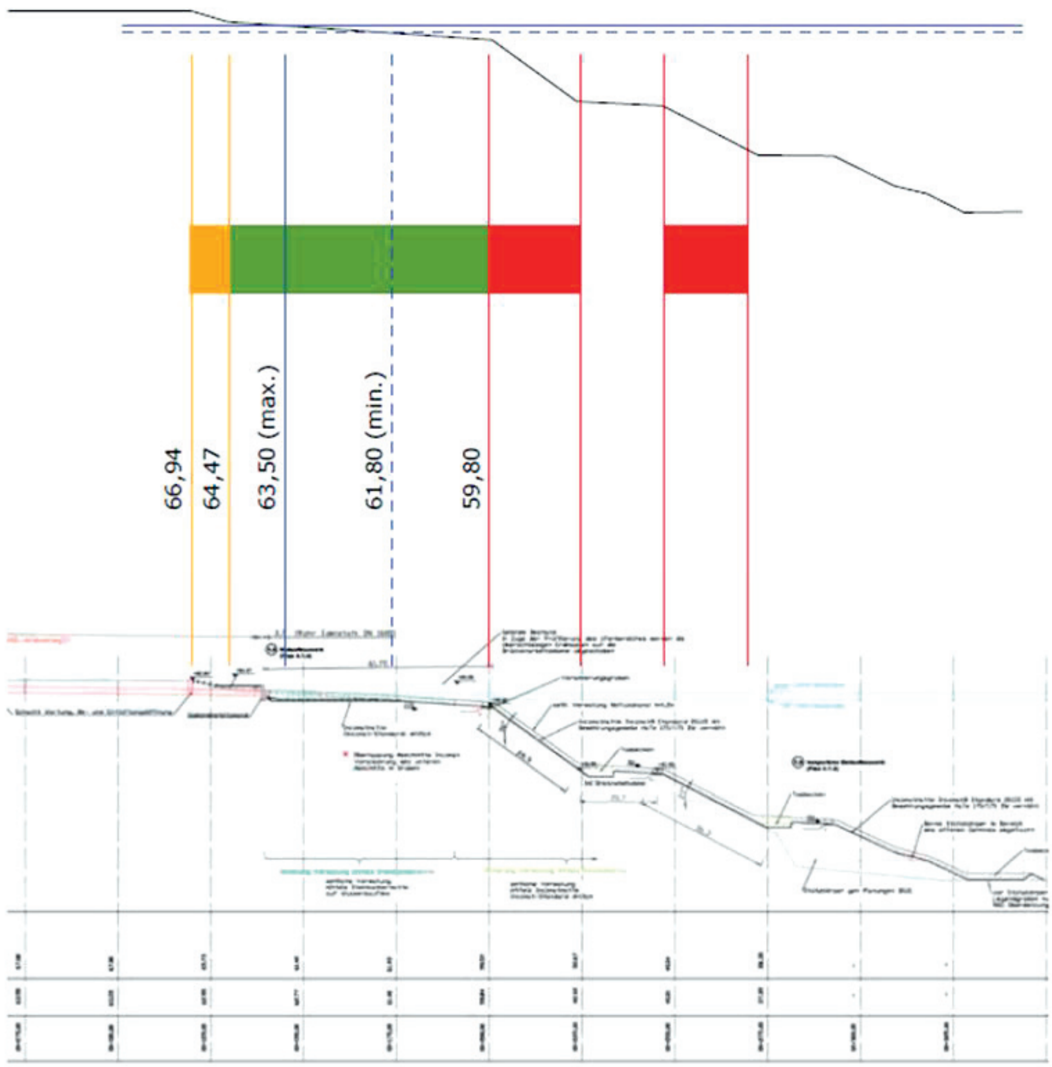


Fig. 6: Section of the Lakoma urban planning study [Architectural office Nagler and Dieck, 2018]

The 2018 urban planning study proposes developing the site in several phases. The last remaining farmstead of the former village is to be taken into account. Another fixed point should be the preservation of the large lime tree on the former village square. The buildings for holiday homes could structure the area in different types. A lakeside path forms the framework for the jetty, where the individual floating houses are placed. The area should have a central car park in the south near the Lakoma weir and the inlet structure so that streams of visitors/different interested parties can park together and the holiday home area remains calm.

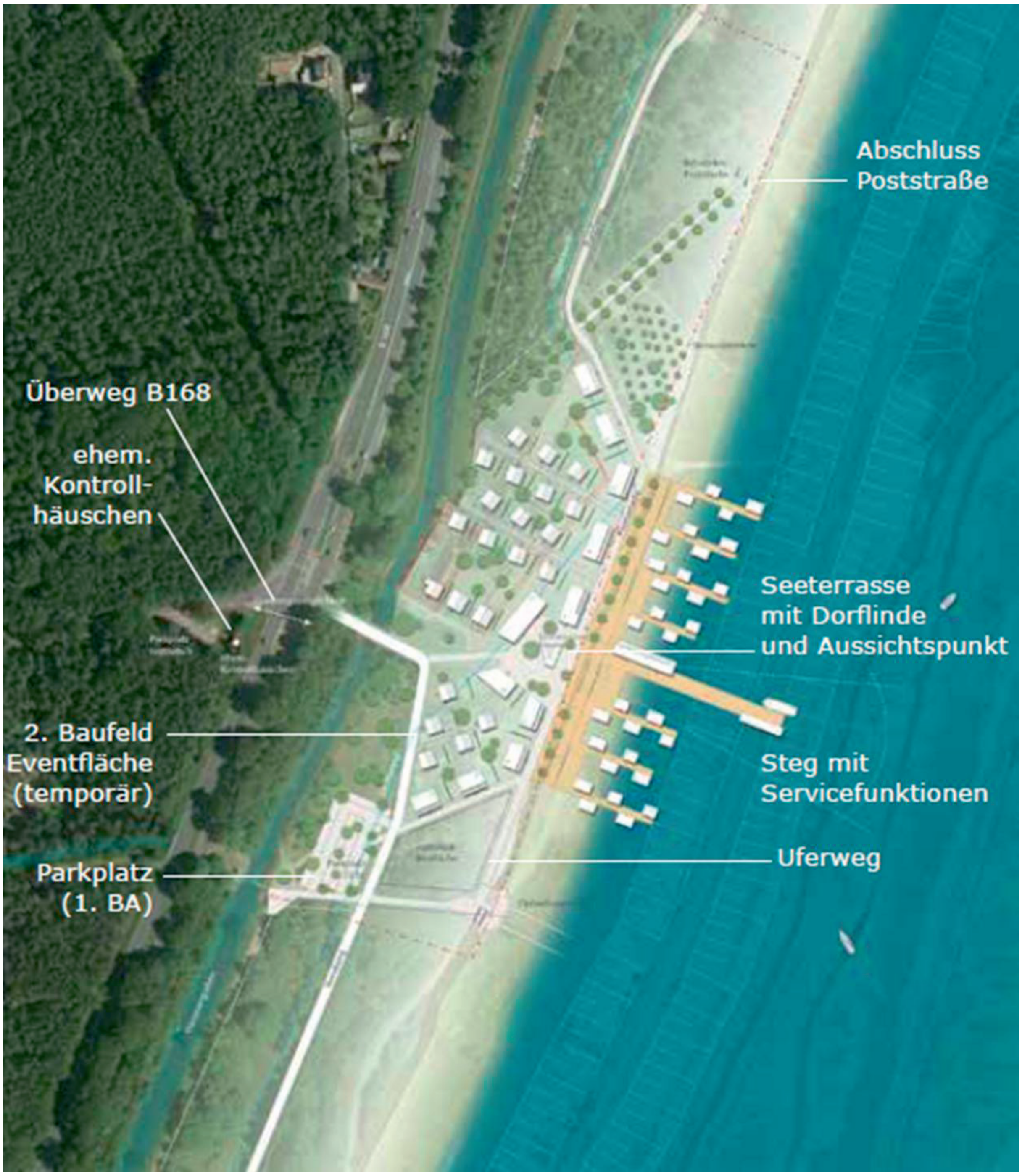


Fig. 7: Section of the Lakoma urban planning study [Architectural office Nagler and Dieck, 2018]

International conference on amphibious and floating structures (ICAADE 2023)

Institut für Schwimmende Bauten e.V.

Prof. Dr.-Ing. Frank Höfler

Internationale Konferenz zu amphibischen und schwimmenden Bauten

Mehr als 30 Experten aus aller Welt konnten vom 8. bis 11. Oktober 2023 an der Brandenburgischen Technischen Universität Cottbus-Senftenberg (BTU) im Rahmen der „4th International Conference of Amphibious and Floating Architecture, Design and Engineering - ICAADE 2023“ über ihre Arbeit berichten und diskutieren.

Den Einstieg in die Vortrags-Sessions bildeten an beiden Tagen Keynote-Speeches namhafter Fachkollegen aus England, Neuseeland, den Niederlanden und Deutschland. Abgerundet wurde die Veranstaltung durch Social Events und durch eine Poster Präsentation, um in lockerer Runde Gespräche zu führen und Kontakte zu vertiefen. In einem speziellen Veranstaltungsteil (GAPS Panel) wurde eine Diskussion zu den rechtlichen Randbedingungen zum Bauen im und am Wasser geführt.

Den Abschluss bildete eine Fachexkursion in das Lausitzer Seenland mit Besichtigung mehrerer schwimmender Bauten.

Gastgeber waren das Institut für Schwimmende Bauten (IfSB) sowie der Verein IfSB e.V., die Organisation und Leitung übernahm Prof. Dr.-Ing. Frank Höfler vom Fachgebiet Mobilitätsplanung der BTU Cottbus-Senftenberg.

Amphibische und schwimmende Architektur beziehen sich auf eine alternative Strategie zum Schutz vor Überschwemmungen, die es einem ansonsten gewöhnlichen Bauwerk ermöglicht, auf der Oberfläche des steigenden Hochwassers zu schwimmen, anstatt der Überschwemmung zum Opfer zu fallen. Ein amphibisches Fundament hält die Verbindung des Gebäudes mit dem Boden aufrecht, indem es unter normalen Umständen fest auf der Erde ruht, ermöglicht es dem Gebäude jedoch, bei Überschwemmungen so hoch wie nötig zu schwimmen. Es handelt sich um eine Hochwasserschutzstrategie, die mit den natürlichen Überschwemmungszyklen einer überschwemmungsgefährdeten Region zusammenarbeitet, anstatt zu versuchen, diese zu behindern. Die schwimmende Architektur umfasst einzelne Gebäude und größere Siedlungen an Ufern und Seen, die ständig auf der Wasseroberfläche schwimmen.

Amphibisches Design und schwimmende Architektur umfassen auch die Konzepte der Flächennutzungsplanung, der Standortwahl, Fragen der Widerstandsfähigkeit von Gemeinschaften, wie die Stellung von Gebäuden in Systemen mit mehreren Verteidigungslinien, und politische Überlegungen. Amphibische und schwimmende Konstruktionen befassen sich mit Fragen der Infrastruktur, mechanischer Systeme und Versorgungseinrichtungen, Systemkomponenten und Auswahlkriterien sowie mit Fragen der Kodifizierung und Zertifizierung.

International conference on amphibious and floating structures (ICAADE 2023)

Institut für Schwimmende Bauten e.V.

Prof. Dr.-Ing. Frank Höfler

What Is Amphibious and Floating Architecture?

Amphibious and floating architecture refers to an alternative flood mitigation strategy that allows an otherwise ordinary structure to float on the surface of rising floodwater rather than succumb to inundation.

An amphibious foundation retains the building’s connection to the ground by resting firmly on the earth under usual circumstances, yet it allows the building to float as high as necessary when flooding occurs. It is a flood mitigation strategy that works in synchrony with a flood prone region's natural cycles of flooding, rather than attempting to obstruct them. Amphibious construction may also refer to one of several *hybrid* conditions. One such is where the weight of a structure is partially supported by both land and water simultaneously. Another situation is where a mechanical system as jacks or hydraulic pumps are used to elevate the structure temporarily. "Wetproofing" is another hybrid strategy, whereby residents occupy the first floor during dry seasons and move to an upper floor during periods of flooding.

Floating architecture includes individual buildings and larger settlements on shores and lakes that are permanently floating on the water surface. Taking into account the resulting conditions related to the thermodynamic and mechanical properties of the existing water environment (use of alternative energies for cooling and heating, changeable location and position in relation to the water environment), there are many opportunities and risks to be considered for the future (influences from exposure to sunlight or neighborhood, and hazards related to water and ice attack, corrosion, and pollution). Another topic are questions about sustainable mobility, supply and disposal as well as about rescue services in case of accidents and fires.

Amphibious design and floating architecture also includes the concepts of land use planning, site selection, community resilience issues such as the place of buildings in multiple-lines-of-defense systems, and policy considerations. Amphibious and floating structures engineering addresses infrastructure, mechanical systems and utilities issues, system components and selection criteria, and codification and certification concerns.

The Buoyant Foundation Project

The Buoyant Foundation Project (BFP) is a non-profit based at the University of Waterloo that focuses on amphibious architecture, which allows otherwise-ordinary structures to float on the surface of rising floodwater. Whether working on homes or civic buildings, the BFP aims to safeguard heritage and promote social justice with low-cost, visually unobtrusive retrofits. The BFP was founded by Dr. Elizabeth English in Louisiana, USA, in 2006 to support the recovery of post-Katrina New Orleans' traditional cultures by providing a strategy for the safe and sustainable restoration of historic housing. She proposed that the city's traditional elevated wooden shotgun houses could be retrofitted with amphibious foundations to prevent flood damage, acting as an alternative to permanent static elevation that diminishes a neighborhood's character. Since then, the BFP's mission has broadened to apply to numerous other floodsensitive locations worldwide. The team recently completed four amphibious retrofits in Vietnam's Mekong Delta using locally familiar carpentry skills, construction techniques, and building materials. They are currently developing prototypes in Ontario with the goal of exploring buoyant foundation retrofits as a potential climate change adaptation strategy for Canadian communities. The BFP co-initiated the first International Conference on Amphibious Architecture, Design, and Engineering (ICAADE) to convene the world's leading experts in amphibious approaches. The BFP has been proud to be an ongoing partner as the momentum builds around this growing innovative field of investigation.

The 2023 Conference

More than 30 experts from all over the world were able to report on and discuss their work at the Brandenburg University of Technology Cottbus-Senftenberg (BTU) from 8 to 11 October 2023 as part of the "4th International Conference of Amphibious and Floating Architecture, Design and Engineering - ICAADE 2023". The conference was hosted by the Institute for Floating Structures (IfSB) and the association IfSB e.V., and organised and led by Prof. Dr.-Ing. Frank Höfler from the Department of Mobility Planning at BTU Cottbus-Senftenberg.

Fig.1: The participants of the conference (Source: IfSB e.V./Michalczack)

The conference motto is „settling safely on and beside water“. Thus the conference is intended to bring together practitioners, researchers, authorities, students, NGO’s, communities and investors in the exchange of knowledge and practice on amphibious and floating issues. The aim is to overcome the land-water-dichotomy by providing space and time for discussions on the various paths of practice, experience and knowledge. A pier for science to policy, to practice, and vice versa will offer opportunities to include business, health, finance, design, insurance, politics, research and engineering. In the procedural amphibious space and for floating architecture, it is crucial to integrate natural, technological and human interactions for a more sustainable stewardship. With shifting perspectives, the ICAADE conference reflects on shifting boundaries and water-levels.

Keynote speeches by renowned experts from England, New Zealand, the Netherlands and Germany kicked off the lecture sessions on both days. The event was rounded off with social events and a poster presentation, which provided an opportunity for informal discussions and networking. In a special GAPS panel of the event (Global Amphibious Policy Symposium), a discussion was held on the legal framework conditions for building in and around water.

Despite the growing global concern for floods, certain effective flood risk reduction approaches remain unimplemented due to significant policy barriers. One such approach is amphibious construction, which enables ordinary structures to float temporarily during flooding. Unfortunately, it is not yet a mainstream flood risk reduction method due to regulatory, insurance industry, and codification barriers. While a growing body of research and several built projects have showcased the significant potential of amphibious architecture to reduce flood damage to buildings, the lack of government policies and insurance industry guidelines hampers its effectiveness as a flood damage reduction technology. Flood management and insurance practices continually evolve to adapt to changing circumstances. However, the pace and direction of these changes vary significantly between countries. Flood risk and damage are addressed differently worldwide, resulting in diverse range of insurance and compensation systems to handle losses.

Fig.2: Floating homes on the Lake Geierswalde (Source: IfSB e.V./Michalczack)

To address these challenges, the Global Amphibious Policy Symposium will bring together key stakeholders, including leaders in amphibious architecture research and implementation, academics specializing in flood damage reduction research, and insurance industry experts. This collaborative platform will foster discussions to develop innovative strategies and solutions for overcoming the major obstacles to the global implementation of amphibious construction. Building upon existing international collaboration, the symposium will also discuss the future of ICAADE and GAPS. Given the growing concern for flood damage, we have a unique opportunity as leaders to navigate beyond the roadblocks and make progress toward the widespread implementation of these innovative technologies and approaches. At ICAADE 2023, hosted in Germany, the focus will be on addressing governments' lack of recognition of the technology, the absence of codes and standards, and the insufficient insurance schemes that rely heavily on legal and policy regulations. These constraints pose significant obstacles to the development and adoption of amphibious construction. By actively engaging with experts and stakeholders during the symposium, we can collectively work towards overcoming these challenges and unlocking the full potential of amphibious architecture and engineering in flood risk reduction.

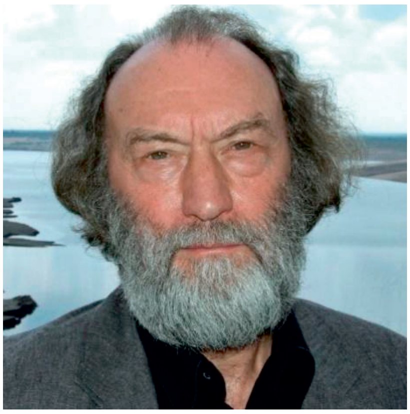
The event was concluded by a technical excursion to the Lusatian Lakeland with visits to several floating structures.

Fig.3: AUTARTEC House on Lake Bergheide (Source: IfSB e.V./Michalczack)

Ein Nachruf

Institut für Schwimmende Bauten e.V.

Zum Tode von Prof. Dr. Rolf Kuhn



(Quelle: picture alliance / dpa / Peter Jähnel)

Für uns unerwartet ist Professor Rolf Kuhn am 19.06.2024 verstorben. Mit ihm verliert die Lausitz eine prägende Persönlichkeit, die mit ihren Ideen und Plänen, ihrer Beharrlichkeit und Verbindlichkeit nachhaltige Zeichen im ehemaligen Kohlerevier hinterlassen hat. Mit ihm verliert auch das Institut für Schwimmende Bauten e.V. einen wertvollen Partner, der als Gründungsmitglied stetige Impulse in die Arbeit des Vereins eingebracht hat und eine unschätzbare Bereicherung für Forschung und Lehre sowie unsere Veranstaltungen darstellte.

Auch nach dem Auslaufen der IBA Fürst-Pückler-Land ist Rolf Kuhn der Lausitz treu geblieben. In vielen Projekten, Workshops und Veranstaltungen gab es eine Vielzahl von Verknüpfungen in unsere Arbeit hinein. Wir durften ihn auf seinem Weg fortwährend begleiten und wahrhaben, wie seine Ideen langsam immer realer wurden, indem sich unwirtliche Orte wandelten zu einer lebenswerten Region. Von 2012 bis 2014 war Rolf Kuhn als Gastprofessor am Fachgebiet Regionalplanung der BTU Cottbus-Senftenberg und auch dort ein geschätzter Kollege.

Mit dem IBA-Studierhaus in Großräschen hat Rolf Kuhn das Ziel verfolgt, einen Rahmen für das Studium der vergangenen IBA-Arbeit zu bilden und deren Weiterentwicklung durch neue Ideen und Projekte zu fördern. Studierende und Lehrende waren immer wieder mit Kolloquien und Workshops zu Gast in dieser inspirierenden Umgebung.

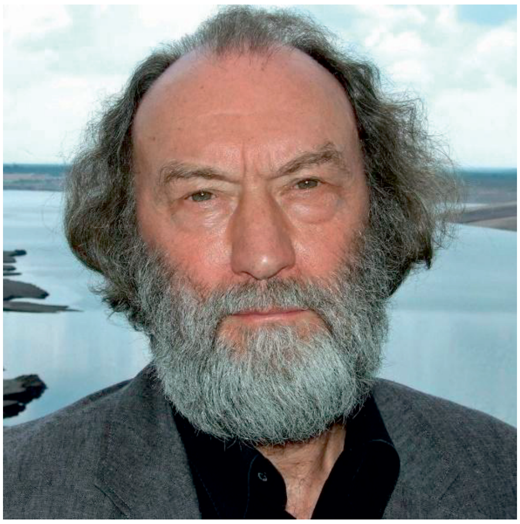
Nicht zuletzt wurde dort auch das Institut für Schwimmende Bauten gegründet und damit der Staffelstab für ein Herzensprojekt der IBA an die ehemalige Fakultät für Bauen und damit an uns durch Rolf Kuhn weitergereicht.

Wir alle haben hier einen umtriebigen, engagierten Kollegen und einen wundervollen Menschen verloren, ohne den in dieser Region vieles nicht möglich geworden wäre. Der Verlust schmerzt und wird eine Lücke hinterlassen. Die Erinnerung bleibt bestehen, und seine Ideen sollen auch in unserem Institut und Verein weiterleben und in die Zukunft getragen werden.

An obituary

Institute for Floating Structures e.V.

On the death of Prof Dr Rolf Kuhn



(Source: picture alliance / dpa / Peter Jähnel)

Unexpectedly for us, Professor Rolf Kuhn passed away on June, 19th. 2024. With his passing, Lusatia has lost a formative personality whose ideas and plans, perseverance and commitment left a lasting mark on the former coal-mining region. The Institute of Floating Structures has also lost a valuable partner in him, who, as a founding member, brought constant impetus to the work of the organisation and was an invaluable asset to research and teaching as well as our events.

Even after the IBA Fürst-Pückler-Land came to an end, Rolf Kuhn remained loyal to Lusatia. In many projects, workshops and events, there were numerous links to our work. We were able to accompany him on his journey and see how his ideas slowly became more and more real, transforming inhospitable places into a region worth living in. From 2012 to 2014, Rolf Kuhn was a visiting professor in the Department of Regional Planning at BTU Cottbus-Senftenberg, where he was also a valued colleague.

With the IBA Study Centre in Großräschen, Rolf Kuhn has pursued the goal of creating a framework for studying past IBA work and promoting its further development through new ideas and projects. Students and teachers have repeatedly been guests at colloquia and workshops in this inspiring environment.

Last but not least, the Institute for Floating Structures was also founded there, passing the baton for a project close to the IBA's heart to the former Faculty of Building and thus to us through Rolf Kuhn.

We have all lost an energetic, committed colleague and a wonderful person, without whom many things would not have been possible in this region. The loss is painful and will leave a gap. The memory remains, and his ideas should live on in our institute and association and be carried into the future.

Rise with the challenge: realizing floating projects with a positive impact

Arch. Barbara Dal Bo Zanon, Blue21, the Netherlands

Sich der Herausforderung stellen: schwimmende Projekte mit positiver Wirkung verwirklichen

Auf dem Weg ins 21. Jahrhundert nimmt die Urbanisierung weiter zu. Schätzungen zufolge werden bis 2050 68 % der Weltbevölkerung in Städten leben, und drei Viertel der Infrastruktur, die bis 2050 in den Städten vorhanden sein wird, muss erst noch gebaut werden. Ein großer Teil dieses Städtewachstums findet in Küsten- und Deltagebieten statt. Diese beispiellose Ausdehnung der Städte bringt erhebliche gesellschaftliche und ökologische Herausforderungen mit sich. Viele dieser Regionen sind besonders anfällig für Überschwemmungen, die durch die Auswirkungen des Klimawandels noch verschärft werden.

Um den Anforderungen der wachsenden Wirtschaft und Bevölkerung in Küstenregionen gerecht zu werden, wurde in großem Umfang Landgewinnung betrieben. Seit der Wende zum 21. Jahrhundert wurde der Erdoberfläche eine Fläche von 253.000 ha künstlich hinzugefügt. Es wird vorausgesagt, dass die neu gewonnenen Gebiete bis zum Jahr 2100 durch einen extremen Anstieg des Meeresspiegels gefährdet sein werden. Hinzu kommt, dass die Auffüllung von Feuchtgebieten und flachen Meeren zur Schaffung von neuem Land die lokalen Lebensräume und Ökosysteme erheblich verändert hat. In Anbetracht der Tatsache, dass es sich bei vielen Küstengebieten um Hotspots der biologischen Vielfalt handelt, besteht ein zusätzlicher Druck, Lösungen zu finden, die sowohl umweltfreundlich als auch klimaangepasst sind.

Durch den Einsatz innovativer Konzepte und Technologien haben schwimmende Entwicklungen das Potenzial, Lösungen für die Herausforderungen zu bieten, mit denen Küstenstädte im 21. Jahrhundert konfrontiert sind. Doch ebenso wie Entwicklungen an Land sich den aktuellen globalen Umweltproblemen stellen müssen, müssen auch schwimmende Projekte ihre Auswirkungen auf den Planeten berücksichtigen. Je größer und umfangreicher diese schwimmenden Strukturen werden, desto wichtiger wird es, ihre Auswirkungen auf die Umwelt zu verstehen und zu mindern. Durch proaktive Maßnahmen und innovative Lösungen können wir sicherstellen, dass schwimmende Entwicklungen einen positiven Beitrag zu den Umweltzielen leisten und eine widerstandsfähigere Zukunft fördern.

Rise with the challenge: realizing floating projects with a positive impact

Arch. Barbara Dal Bo Zanon, Blue21, the Netherlands

Introduction

As we move further into the 21st century, urbanization continues to expand. It is estimated that by 2050, 68% of the global population will live in cities[1] and three-quarters of the infrastructure that will exist in cities by 2050 has yet to be built.[2] A significant portion of this urban growth occurs in coastal and delta areas. This unprecedented urban expansion poses significant societal and environmental challenges. Many of these regions are especially prone to flooding, which is exacerbated by the effects of climate change.

To meet the demands of growing economies and populations in coastal environments, land reclamation has been extensively used. Since the turn of the 21st century, an area of 253,000 ha has been artificially added to the Earth's surface.[3] It is predicted that newly reclaimed areas will be vulnerable to extreme sea level rise by 2100. On top of these challenges, filling in wetlands and shallow seas to create new land has extensively altered local habitats and ecosystems. Considering that many coastal areas are biodiversity hotspots[4], there is added pressure to find solutions that are both environmentally friendly and climate adaptive.

Floating Development: A Viable Solution

In recent years, floating technology has been proposed as a potential solution to reduce land shortage in vulnerable coastal and delta areas. The main advantage of floating structures is that they are buoyant and are not affected by sea level rise. They can provide safe and comfortable space without displacing existing land-based communities. Secondly, compared to land reclamation, floating structures minimize the disruption to marine and coastal ecosystems, and often create new habitats for mussels and fish. The large amounts of sand which are needed for land reclamation are not required

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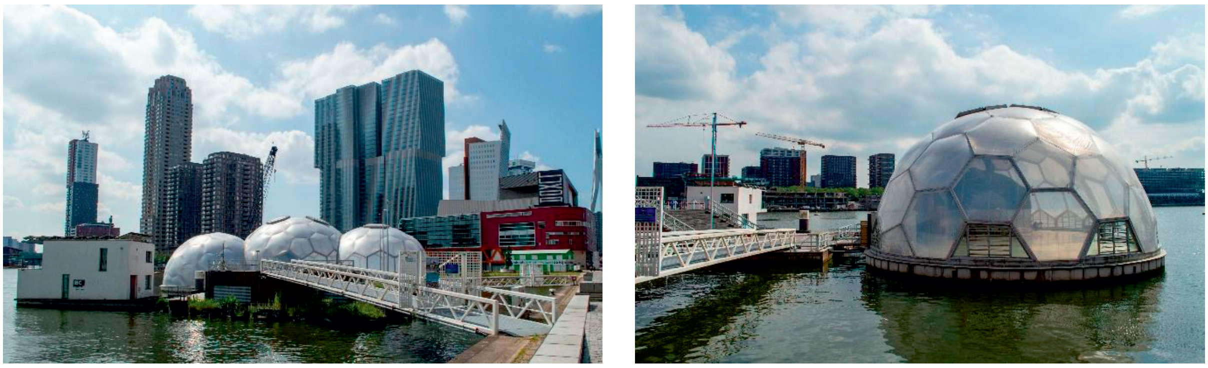
[1] https://unhabitat.org/wcr/
[2] https://news.un.org/en/story/2021/10/1101992
[3] Sengupta, D., Choi, Y. R., Tian, B., Brown, S., Meadows, M., Hackney, C. R., et al. (2023). Mapping 21st century global coastal land reclamation. Earth's Future, 11, e2022EF002927. https://doi.org/10.1029/2022EF002927
[4] Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GA, Kent J. *Biodiversity hotspots for conservation priorities*. Nature. 2000 Feb 24;403(6772):853-8. doi: 10.1038/35002501. PMID: 10706275.

to build floating structures. Considering the global scarcity of sand, and the socio-environmental impacts of sand extraction,[5] it can be argued that land reclamation will soon reach its limits, and floating technologies will become more widely adopted.

Meanwhile, increasing receptivity from organizations such as the UN and IPCC is contributing to the acceptance of floating technologies as a viable solution for sustainable development. In 2019 the 1st ever high-level roundtable discussion on floating cities was held at the UN-HQ (USA). In 2022 a new IPCC report titled *Climate Change 2022: Impacts, Adaptation and Vulnerability* mentioned floating urban development as an adaptation opportunity. In this report, several examples of “transformative adaptations in urban areas” were mentioned, including the Floating Pavilion in Rotterdam (Figure 1). Whereas numerous examples of floating projects exist, showcasing a variety of shapes



and functions, the main challenge is to move beyond their application as ‘experiments’ and to upscale them to a significant scale.

Figure 1: Floating Pavilion by Blue21 (Author’s pictures)

How can floating technologies support sustainable development?

Scaling up floating technologies is needed to be able to implement them at a larger scale. However, in this endeavor it is imperative to pay attention to environmental considerations. As we strive to scale up floating technologies, we must ensure that our actions are aligned with the urgent need to address climate change and other environmental challenges. Neglecting the environmental impact of floating development could undermine our efforts and potentially exacerbate the very issues we seek to resolve. Therefore, integrating environmental considerations into the planning and implementation of floating technologies is essential to ensure a sustainable and effective approach to addressing our global challenges.

Traditional approaches, which primarily focus on avoiding, minimizing, remediating, and offsetting environmental impacts, may fall short in addressing the scale of today's environmental challenges. It is becoming increasingly evident that to safeguard ecological integrity, a paradigm shift is imperative—one that integrates humans as integral

[5] https://www.scientificamerican.com/article/sand-mafias-are-plundering-the-earth/

components of ecosystems rather than entities separate from them.[6] Embracing a holistic and systemic perspective is pivotal, emphasizing regenerative sustainability[7] as the cornerstone of our environmental endeavors.

Regenerative sustainability embodies a proactive approach that goes beyond sustainability by actively restoring and enhancing ecosystems' health and resilience. It involves cultivating practices that not only minimize harm but also promote regeneration and thriving. This entails embracing innovative solutions that mimic natural processes, fostering biodiversity and communities that are deeply rooted in ecological principles.

Transitioning from Sustainability to Regeneration in the context of floating development entails a multifaceted approach, that promotes innovations in design, engineering and governance:

- **Closing resource loops**, which involves a series of actions aimed at achieving ecological balance and resilience.
- The introduction of **innovative Environmental Impact Assessment (EIA) frameworks**. Rather than simply mitigating harm, these frameworks guide floating projects toward enhancing water quality and fostering habitats. By adopting dynamic monitoring equipment, continuous oversight is ensured, enabling prompt responses to any unforeseen impacts and facilitating adaptive management strategies. An example of such framework was developed by Blue21 for a project in French Polynesia.[8]
- The **reevaluation of building permits**. Moving away from permanent permits towards conditional ones based on environmental impacts fosters accountability and incentivizes sustainable practices. This approach ensures that development aligns with ecological regeneration goals, promoting a harmonious coexistence between human activities and natural systems.[9]

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[6] du Plessis C. (2012) Towards a regenerative paradigm for the built environment. Build. Res. Inf. 40:7–22

[7] Mang P., Reed B. (2012) Designing from place: A regenerative framework and methodology. Build. Res. Inf. 40:23–38

[8] Czapiewska, K.M., Roeffen, B., Dal Bo Zanon, B., et al (2017) Environmental Assessment Framework for Floating Development

[9] De Graaf – van Dinther, R.E. (2018) The oceans as solution space for human and ecological progress - 7 key factors. Linkedin. Available at: https://www.linkedin.com/pulse/oceans-solution-space-human-ecological-progress-7-rutger/

By prioritizing these actions, floating development can transition from a focus on sustainability to a commitment to regeneration, contributing to the restoration and resilience of aquatic ecosystems while meeting human needs in a sustainable manner. While sustainability considerations have been applied to construction on land, there is still significant potential to push these efforts further, fostering greater ecological balance and resilience across all environments.

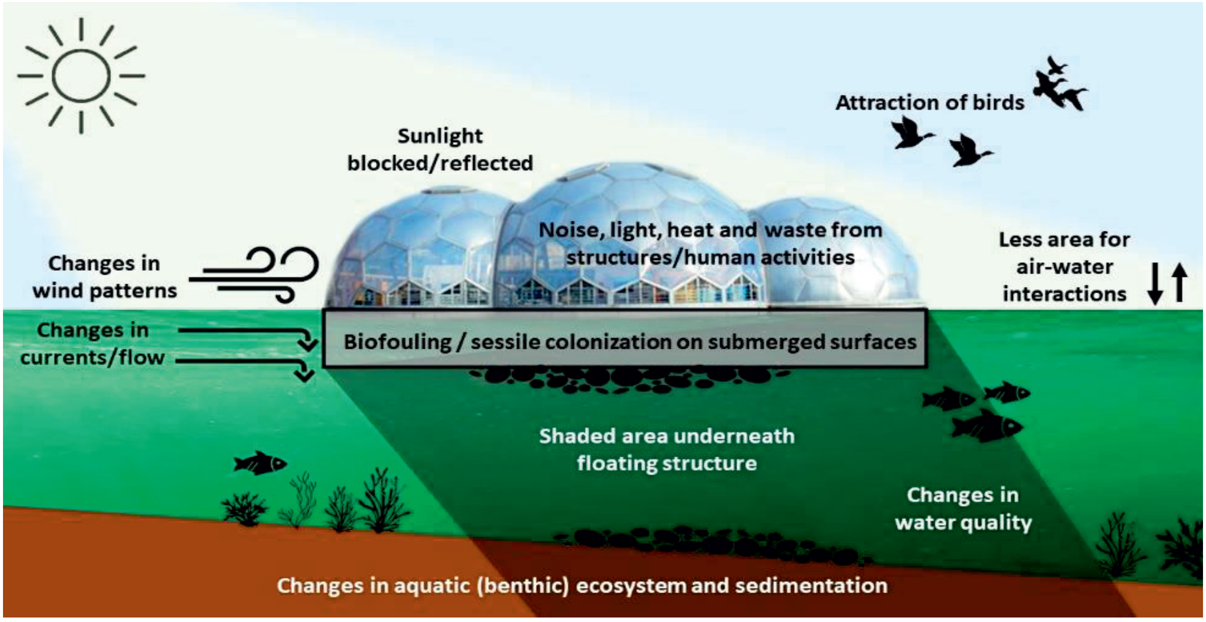

Figure 2: An Overview of possible effects of floating development on the environment (Source: Indymo)

Upscaling of floating concepts: the Floating Future project

It is evident that expanding floating development brings forth a spectrum of interconnected challenges, encompassing technical, environmental, and societal dimensions. In the Netherlands these integrated scientific challenges will be studied within the National Research Initiative "Floating Future"[10]. Floating Future aims to develop climate-proof solutions for space limitations in the Dutch Delta. The research has been awarded 5.3 M€ grant for 5 years by the Dutch Science Council (NWO). This interdisciplinary project involves 5 universities, 3 research institutes, and over 30 societal partners.

Within Floating Future, four research domains will be addressed: Governance, Technology, Ecology and Action Research. Governance's focus lies in investigating the societal acceptance for large-scale floating concepts, crafting legal frameworks, and formulating sustainable business models. Technology's efforts are directed towards reducing mooring and connector loads, particularly in motion, while determining optimal design approaches for Very Large Floating Structures (VLFS) amidst shallow waters and nonlinear waves. This involves the development of comprehensive knowledge, methodologies, and tools to support technological advancements. The domain of Ecology devises strategies to minimize adverse impacts on ecosystems, while maximizing

[10] https://floating-future.nl/

opportunities for their restoration and the services they provide. Additionally, environmentally friendly aquaculture practices are investigated. Lastly, Action Research focuses on translating knowledge into tangible outcomes. Through interdisciplinary collaboration, the aim is to effect meaningful change in practice. This involves applying the developed scientific insights in real-world case studies, ensuring practical relevance and impact.

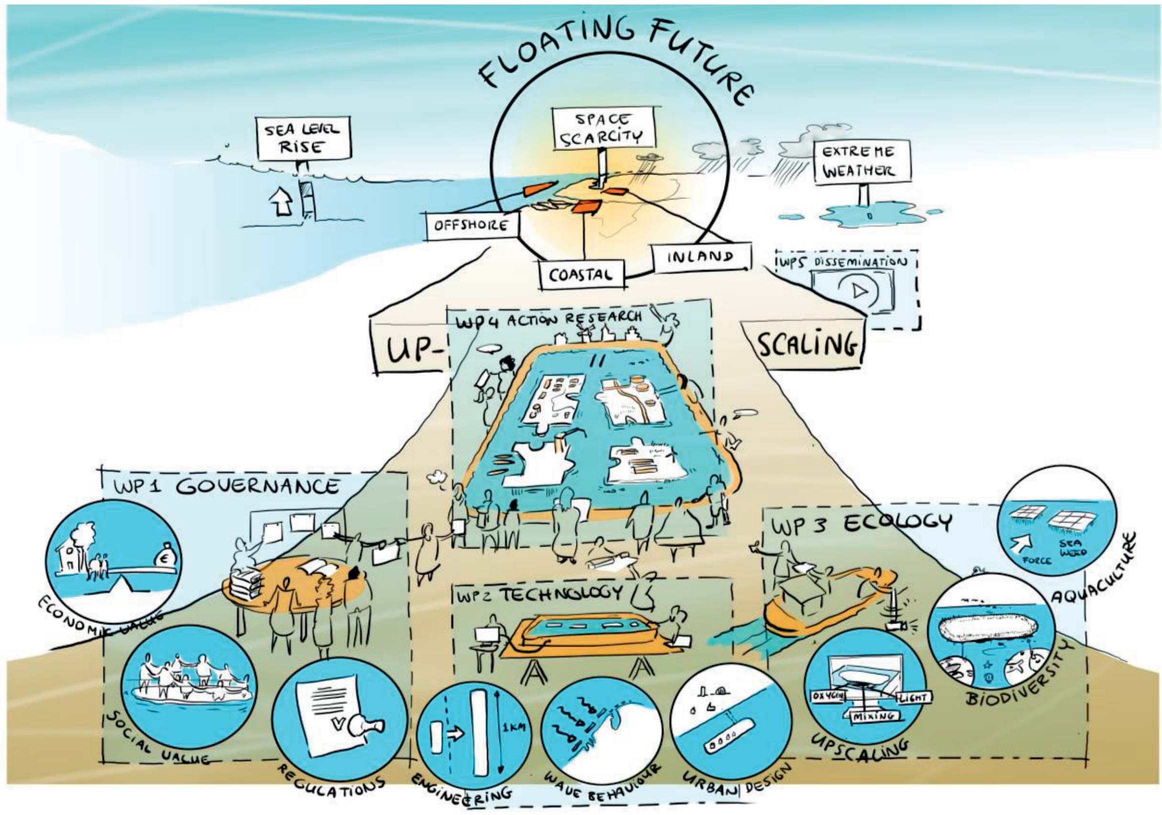

Figure 3: The research framework within Floating Future (Source: Floating Future)

Conclusions

By leveraging innovative approaches and technologies, floating developments have the potential to offer solutions to challenges that coastal cities are dealing with in the 21st century. However, just as developments on land must confront ongoing global environmental challenges, floating projects also need to consider their impact on the planet. As these floating structures expand in size and scope, it becomes even more crucial to comprehend and mitigate their effects on the environment. Through proactive measures and innovative solutions, we can ensure that floating developments can contribute positively to environmental goals, fostering a more resilient future.

BEYOND A SHELTER: Resilient Post-Disaster Architecture

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Über einen Schutz hinaus: Widerstandsfähige Architektur nach Katastrophen

In den letzten Jahren hat die Häufigkeit und Schwere von Naturkatastrophen, insbesondere von solchen, die mit Wasser zu tun haben, wie z. B. Überschwemmungen, weltweit alarmierend zugenommen. Die Auswirkungen dieser wasserbedingten Katastrophen auf Menschenleben und Wirtschaft sind aufgrund der Folgen der Klimakrise ein dringendes Problem. Von 2001 bis 2018 waren fast 80 % aller Naturkatastrophen mit Wasser verbunden, was in den letzten zwei Jahrzehnten zu mehr als 166.000 Todesfällen durch Überschwemmungen und Dürren führte und mehr als drei Milliarden Menschen auf der ganzen Welt betraf, wie die UNESCO in ihrem Bericht 2020 zusammenfasste. In demselben Bericht der Vereinten Nationen heißt es außerdem, dass diese Ereignisse einen geschätzten finanziellen Schaden von fast 700 Milliarden US-Dollar verursacht haben.

In dieser Studie werden hybride Schutzbauten als praktikable Lösung für überschwemmungsgefährdete Gebiete vorgestellt, die innovatives Design mit den Grundsätzen der Widerstandsfähigkeit und Nachhaltigkeit verbinden. Diese schwimmfähigen oder amphibischen Unterstände bieten eine dauerhafte und anpassungsfähige Alternative zu herkömmlichen Zelten. Durch die Verwendung umweltfreundlicher Materialien und eines kreislaufwirtschaftlichen Ansatzes stärken die Unterkünfte die Widerstandsfähigkeit der Gemeinschaft und fördern eine effiziente Ressourcennutzung. Die gemeinschaftsorientierte Gestaltung unterstützt die sozialen Strukturen und beschleunigt den Wiederaufbau, indem sie das Gefühl des Zusammenhalts unter den Bewohnern stärkt. Dieser Ansatz gewährleistet eine robuste, langfristige Antwort auf die zunehmenden Herausforderungen des Klimawandels.

BEYOND A SHELTER: Resilient Post-Disaster Architecture

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Introduction

In recent years, the world has witnessed an alarming increase in the frequency and severity of natural disasters, particularly those related to water, such as floods. The effects of these water-related disasters on both human lives and the economy are a pressing concern due to the impacts of the climate crisis. From 2001 to 2018, nearly 80% of all-natural disasters were linked to water, resulting in over 166,000 deaths from floods and droughts in the past two decades, impacting over three billion people around the world, as the UNESCO summarized in their 2020 report (UNESCO, 2020). Additionally, in this same United Nations report, it was stated that these events resulted in an estimated monetary damage of nearly US$700 billion (UNESCO, 2020).

Resilient architecture aims to design and construct buildings and structures that can withstand and adapt to adverse conditions, including post-disaster scenarios (Watson & Adams, 2011). It focuses on creating spaces that can endure and recover quickly from the impacts of natural disasters, providing shelter, safety, and stability for affected communities. Despite resilient architecture options, the current reality is that in the aftermath of disasters, affected populations often find themselves living in temporary tents for extended periods from six months to 3 years (Bashawria, Garritya, & Moodley, 2014). These temporary shelters, while providing initial relief, often lack the necessary infrastructure and amenities for long-term habitation. They are characterized by weaknesses, insecurity, discomfort, and a lack of privacy and dignity (Charlesworth, 2014). Likewise, these temporary tents are usually arranged in a grid-like pattern, lacking a sense of community and hierarchy (Charlesworth, 2014).

As can be seen below in Figure 1, there are several overlapping shelter definitions and types, with different terminologies used, based on the proposal from the International Federation of Red Cross and Red Crescent Societies (IFRC) (International Federation of Red Cross and Red Crescent Societies, 2013). For the present work, it is important to highlight that on one hand, transitional and progressive shelters offer a step towards permanent housing by providing improved living conditions and amenities for a limited period. And on the other hand, core shelters aim to establish a more permanent and sustainable solution by considering long-term needs, cultural context, and community integration (Rohwerder, 2016; Malayao, 2020).

Given the increasing urgency to mitigate the risks and impacts of water-related disasters, which are becoming more frequent and severe, the need for such solutions is more critical than ever. Within this context, the concept of post-disaster Hybrid Shelters (amphibious and floating) has emerged as a promising solution. These shelters address numerous challenges, including sustainability, assembly difficulties, transportation, reuse, and adaptation, making them a comprehensive response to the demands of resilient post-disaster housing.

Another important consideration is the circular economy, which seeks to minimize waste and enhance the sustainable use of resources through strategic design (United Nations, 2023). This approach necessitates careful selection of materials, as well as consideration of adaptability, floating capabilities, and other technical specifications during the design process.

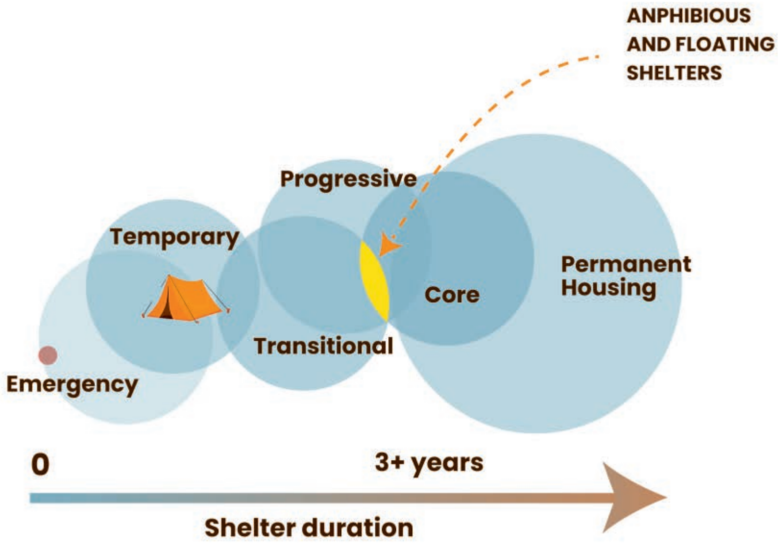

Figure 1. Shelter terminologies adapted from IFCR Post-disaster shelter: Ten designs 2013

Pakistan is among the top ten countries directly affected by global warming, mainly expressed by extreme floods (Shehzad, 2023), suffering massive floods in recent years. Moreover, as summarized by Lama and Tatu (Lama & Tatu, 2022), around 33 million people were affected by the catastrophic floods caused due to the monsoon rains, resulting in over 1700 deaths in 2022. This devastating scenario provided a critical case study inspiring the current design proposal.

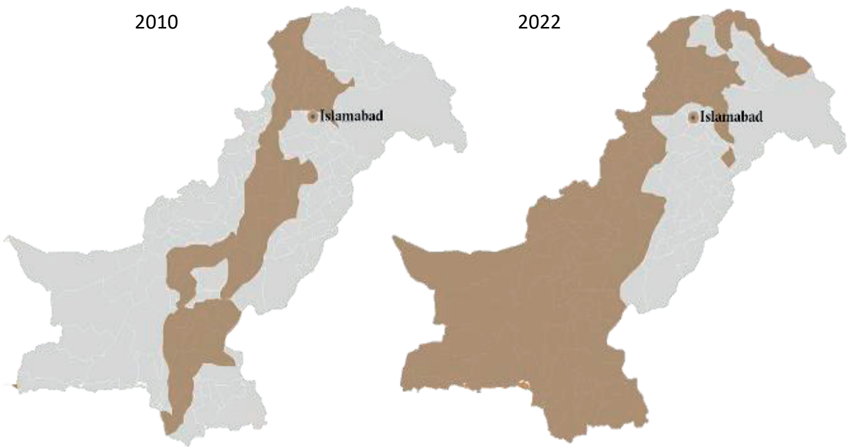

Figure 2. Pakistan Major Floods: brown colour represents flooded affected area. National Disaster Management Authority, 2022

The human costs and consequences of just the 2022 main flood in Pakistan are of great consideration. It was estimated that one-third of the country's landmass was underwater (Figure 2), which lead to_more than 2,28 million houses affected, 897 014 houses destroyed, 1,39 million houses damaged, 24 000 schools damaged, 7,6 million people displaced, and other complications for the country (Bhutta, Bhutta, Raza, & Sheikh, 2022; National Disaster Management Authority, 2022). Also, the implications in psychological impairments after the flood disaster in Pakistan headed to a higher rate of depression, suicidal thoughts, menstrual irregularities, and other complications (Sawangchaia, Razab, Khalidb, Fatima, & Mushtaque, 2023).

These issues highlight the urgent need to develop post-disaster shelters that effectively address the housing needs of flood-affected communities. To tackle the challenges of shelter design, this paper aims to develop resilient architectural solutions that extend beyond temporary tents, offering options that bridge the gap between transitional and core shelter models.

Concept

The shelter provides an innovative and sustainable response to the increasing effects of climate change, particularly floods, in vulnerable regions like Pakistan, one of the most severely impacted countries. Designed to function as either permanent floating structures or adaptable amphibious units (Figure 3), these hybrid shelters allow residents to remain close to their communities and minimize recovery time after floods offering enduring support to frequently impacted communities.

Figure 3. Shelters floating on the water

Constructed from eco-friendly materials and employing a circular economy model, the shelters can be locally produced and distributed post-disaster, with options to either upgrade with local resources towards longer term use or repurpose and recycle as needed (see figure 4). This strategy not only reduces waste and increases efficiency but also enhances community resilience, combining advanced design and sustainable practices for a robust response to climate threats.

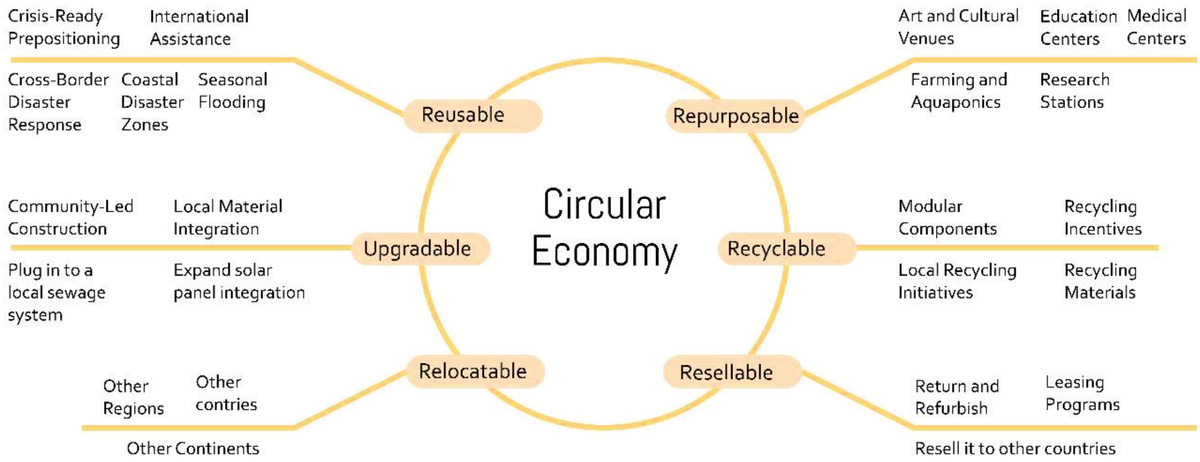

Figure 4. Circular economy model for the floating and amphibious shelters.

Design principles

The shelter design incorporates several key features to address the challenges of flooding and provide a resilient and sustainable solution. These features include:

The shelter consists of two primary components: the hull, which enables the structure to float, and the main structure situated above the water level. All the modular components and foldable furniture are designed to fit within regular truck transportation capacity, allowing easy shipping and deployment.

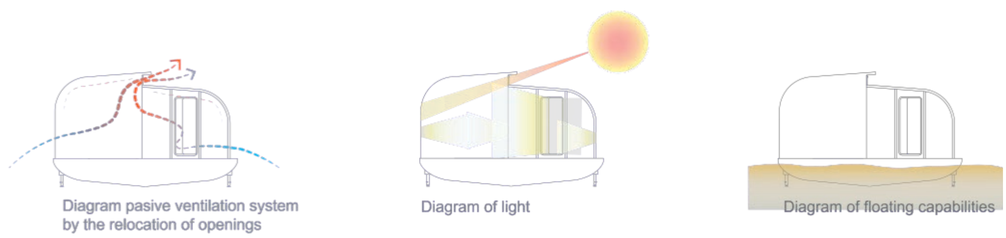

Figure 5. Diagrams of the interaction of water, air, and light with the shelter.

Ventilation and Natural light: The shelter features passive ventilation through adjustable and relocatable lower-placed openings and window panels, allowing users to control airflow and maintain optimal ventilation regardless of the shelter's orientation. Its curved design further enhances air circulation, preventing hot air buildup and ensuring efficient air exchange without the need for mechanical intervention. Additionally, the strategic placement of the upper and lower windows maximizes the entry of natural light while reducing direct sunlight during the peak heat of the day, as shown in Figure

5, effectively preventing overheating. Additionally, a solar panel on the roof powers two interior lamps, providing artificial lighting at night.

Privacy and Security: The shelter includes a lockable door and windows that enhance external security, while its L-shaped design provides internal privacy for its occupants (see Figure 6). This configuration also creates a protected outdoor area, which can serve as a safe refuge for animals.

Size and Flexibility: With 36 sqm of space, the shelter can accommodate up to 6 people and can be expanded or attached to other units to accommodate larger families, see Figure 6 and 7.

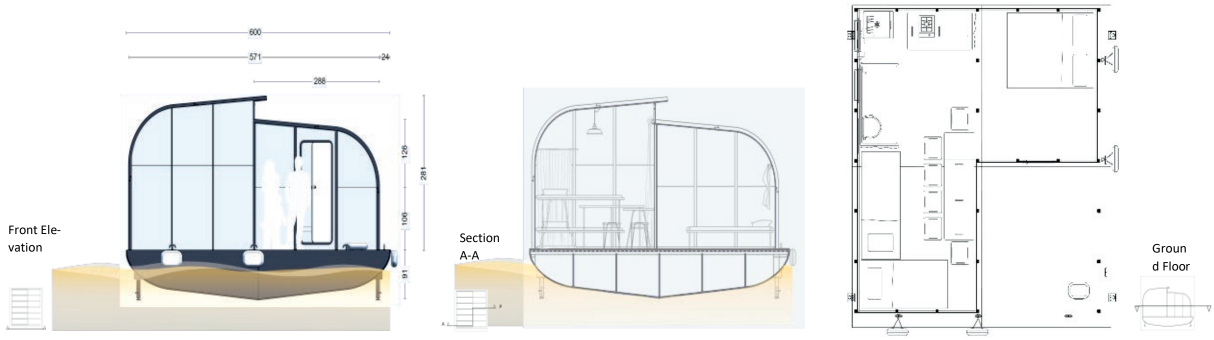

Figure 6. Elevation, section and plan view of the shelter

Materiality: The shelters are constructed using recycled plastic lumber for the roof, wall panels, and flooring, along with an ecologically optimized fiber-reinforced polymer composite for the hull, promoting sustainability. For more permanent or transitional use, the shelters are designed to be upgradeable with local materials such as bamboo and adobe. The structural framework, including skeleton-like beams, is engineered to support these additional materials, enhancing the strength and thermal performance of the structure.

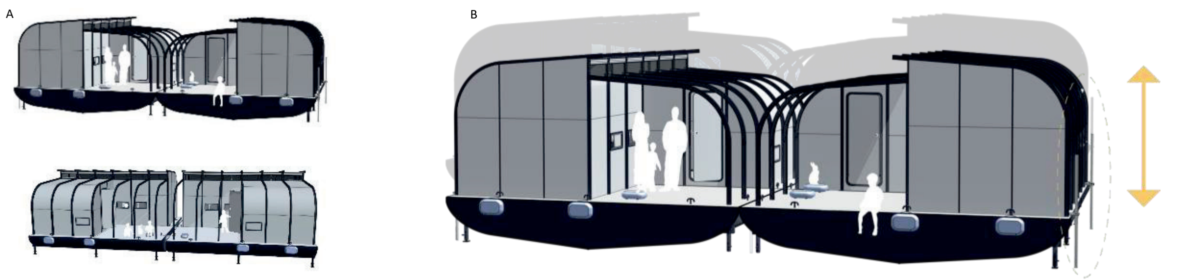

Figure7. Shelter arrangements for large families (A). Vertical movement of the shelter when used as amphibious option, fixed to the ground by its lateral guide poles (B).

Amphibious Design: The hybrid shelter has a hull for floating on water and adjustable legs for stability on uneven terrain. Steel poles anchor it to the ground, allowing it to rise and fall with flood levels while preventing lateral displacement, as shown in Figure 7.

Figure 8 shows the interior of the shelter is equipped with modular, foldable, and light-weight furniture, providing a modest yet functional space for families with essential amenities.

Figure 8. Interior of the shelter and bi-family shelter arrangement in a flooded area.

Mobility and Deployment: The shelter is designed for easy towing, allowing it to be quickly deployed to communities affected by flooding or where homes have been destroyed. This provides essential temporary housing during periods of high water, ensuring swift and effective relief.

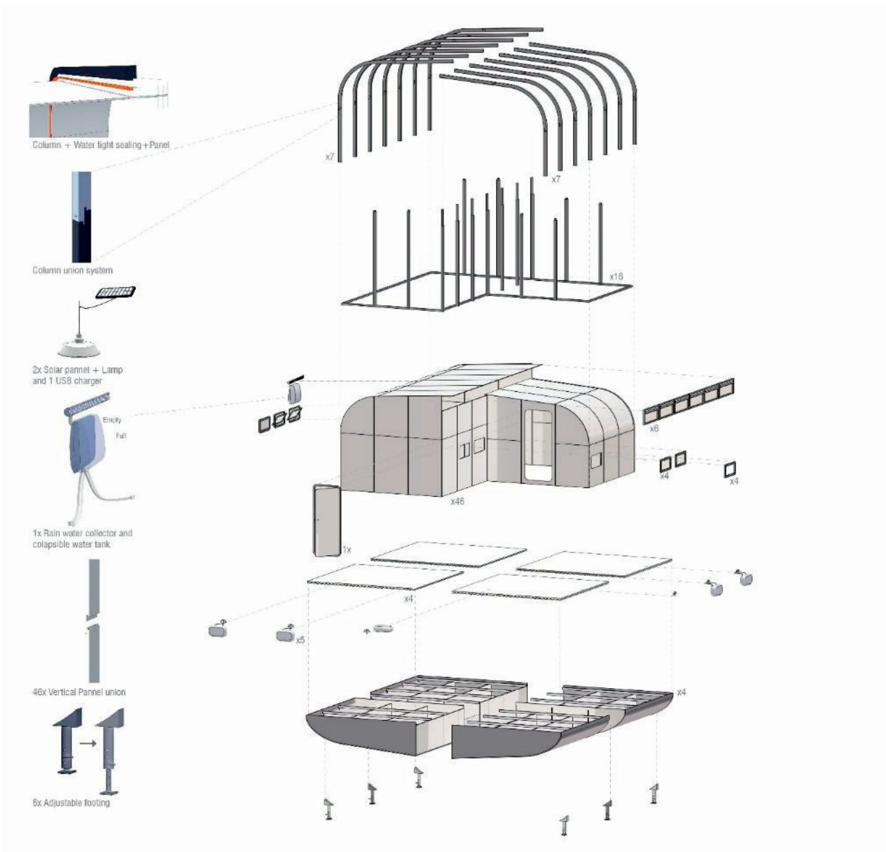

Figure 9. Exploded axonometric view.

The following image (Figure 9) displays the design components and characteristics of the shelter through an exploded axonometric view, illustrating how each part is assembled and functions within the overall structure.

Finally, displaced communities can benefit from an innovative amphibious shelter city layout designed to foster a sense of community and support. This design enhances existing social structures by creating physical spaces that encourage social interaction, promote mutual aid, and ensure secure recovery. By breaking away from the conventional, rigid grid-like arrangements of traditional tents, it offers a superior transitional shelter option. This community-oriented approach not only accelerates recovery but also strengthens resilience and cohesion among residents.

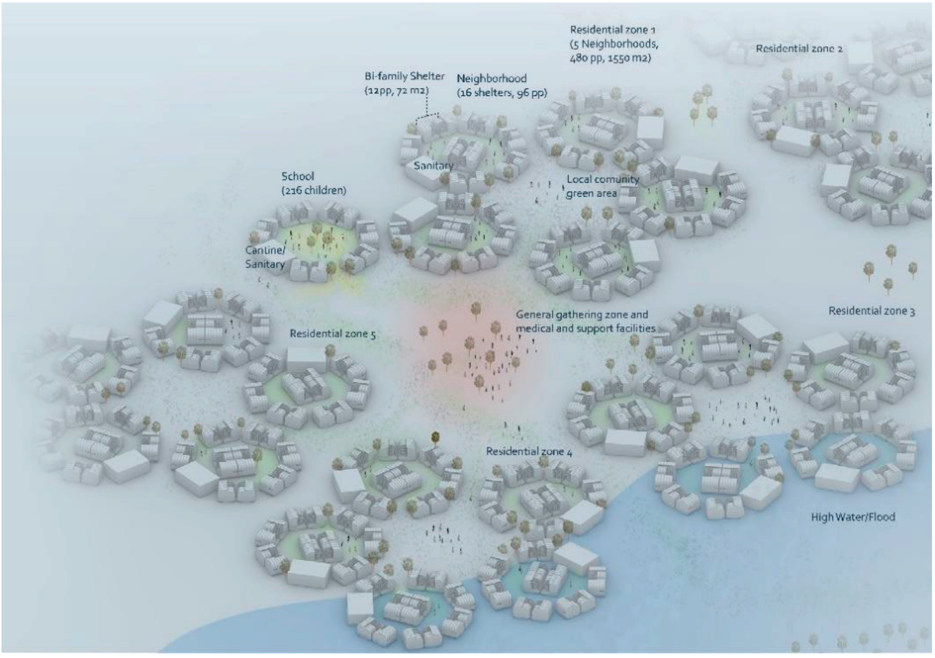

Figure 10. Proposal for a new amphibious shelter city layout.

Conclusions

This study presents hybrid shelters as a viable solution for flood-prone areas, combining innovative design with principles of resilience and sustainability. These shelters, capable of floating or functioning as amphibious units, offer a durable and adaptable alternative to traditional temporary tents. By integrating eco-friendly materials and a circular economy approach, the shelters enhance community resilience and promote efficient resource use. The community-oriented layout further supports social structures and accelerates recovery, fostering a sense of cohesion among residents. This approach ensures a robust, long-term response to the increasing challenges posed by climate change.

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Proposal for Floating Cabins in French River

Undergraduate Architecture Student Work

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Vorschlag für schwimmende Hütten im French River
Arbeit eines Architekturstudenten im Grundstudium

Bei diesem Projekt handelt es sich um einen neuen Entwurf für den Ersatz einer bestehenden Jagd- und Fischerhütte auf einer Lichtung, die die Bear's Den Bay mit dem French River in Ontario, Kanada, verbindet (Abb. 1). Der French River ist ein Mündungsflusssystem, das den Lake Nipissing über die Georgian Bay mit dem System der Großen Seen verbindet. Historisch gesehen war er ein wichtiger Durchgangsweg für indigene Völker wie die Anishinaabe und frühe französische Siedler, die den Fluss als komplexes Handelsnetz nutzten. Heute ist er Teil des French River Provincial Park, einer beliebten Kanu- und Campingroute mit privaten, abgelegenen Hütten auf dem felsigen Land. Durch den Klimawandel werden die Wasserstände in der Region immer unberechenbarer, und ein höherer Wasserstand kann zu Überschwemmungen für Gebäude in Ufernähe führen.

Zusammenfassend lässt sich sagen, dass das Projekt für das schwimmende Hausboot des Canadian Shield Watershed Conservation Institute einen Entwurf für eine neuartige schwimmende Hütte im French River Provincial Park bietet. Das Hausboot ist ein Prototyp für eine schwimmende Hütte, der sich an der Schiffsbauweise und der schwimmenden Architektur orientiert. Diese saisonalen Hausboote, die vor Ort abgebaut und gelagert werden, bieten eine alternative Grundstruktur für eine abgelegene Gemeinde, in der der Klimawandel zu immer unvorhersehbareren und schädlicheren Überschwemmungen führt. Der Entwurf für das Hausboot ist zwar spekulativ, schlägt aber ein effizientes Verfahren für den saisonalen Auf- und Abbau vor.

Nicht alle relevanten Aspekte des vorgeschlagenen Standorts des Hausboots in der Bear's Den Bay sind verfügbar. Als Gezeitenkanal wird das Flusssystem von saisonalen Gezeitenbewegungen beeinflusst. Weitere Untersuchungen zum saisonalen Tidenhub würden Aufschluss über die Eignung dieses Standorts für die saisonal schwimmenden Hausboote geben.

Proposal for Floating Cabins in French River

Undergraduate Architecture Student Work

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Introduction

This project is a new design to replace an existing game fishing and hunting lodge on a clearing of land that connects the Bear's Den Bay to the French River, Ontario, Canada (Fig. 1). The French River is an estuary river system connecting Lake Nipissing into the Great Lakes system via the Georgian Bay. Historically, it has been a key passageway for Indigenous peoples such as the Anishinaabe and early French settlers who used the river as a complex trading network.

Today, it is a part of the French River Provincial Park, a popular recreational canoeing and camping route, with private remote cottages on the rocky land. Climate change has made water levels increasingly unpredictable in the region [1], and higher water levels can lead to flooding for buildings near the shore.

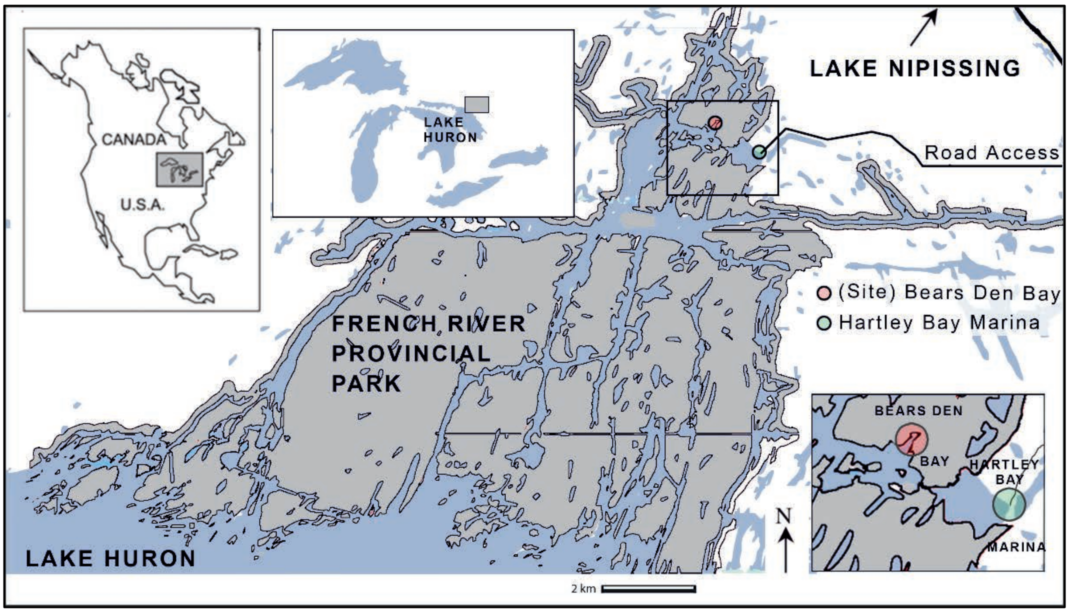
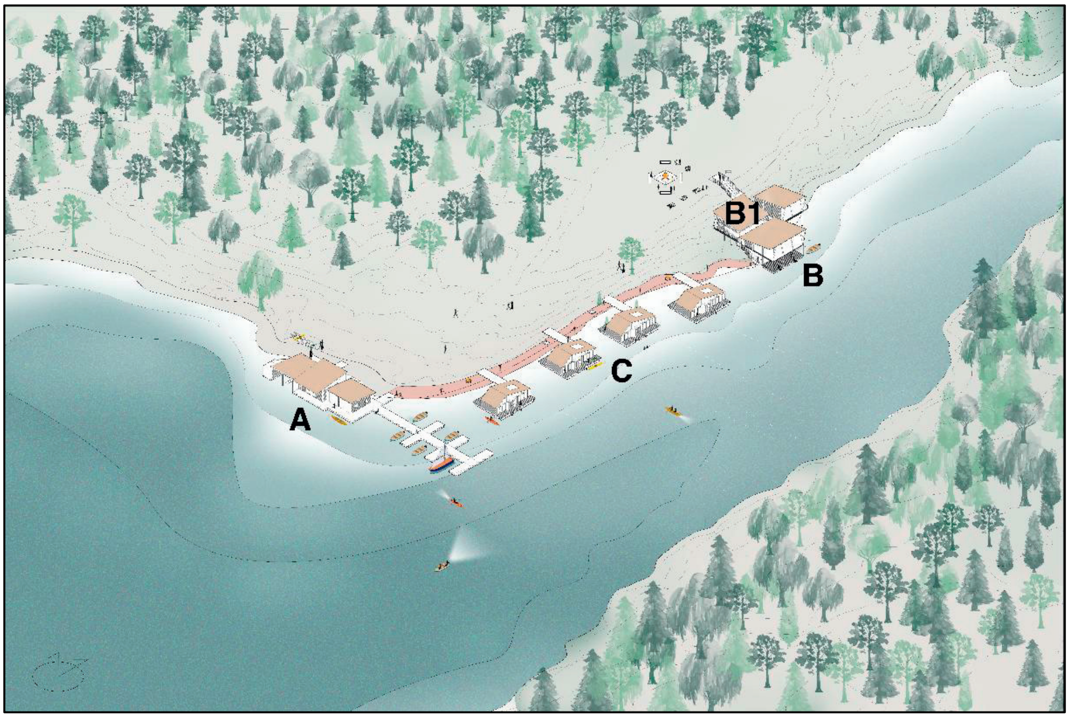


Figure 1: Site in the French River Provincial Park (Modified map, Note: Adapted from map [2])

The design[1] is a proposed masterplan for the Canadian Shield Watershed Conservation Institute that investigates how buildings relate to the water within a remote context. The project allows for short-term accommodation on land and on water for thirty people who are either students or researchers. To reflect this, the project consists of three building types (Fig. 2), which have three distinct foundation systems. It includes a

[1] This project is a student design proposal and therefore speculative.

research institute, which is a waterside building (A). According to Piątek, a waterside building is “a building located in direct proximity, partly or entirely in a water basin, and erected on a waterproof foundations [sic]“ [3]. There are three permanent buildings supported on “stilts” into the glaciated rock at the other end of the site (B). Their program includes dining, group activities, and the wintertime storage of the dismantled houseboats (B1). Between the two permanent structures, four seasonal floating



houseboats are fully supported on the water and are linked to the shore by four removable bridges connecting the houseboats to the land (C).

Figure 2: Site Isometric

This paper investigates the design of the houseboat,[2] each of the four floating cabins for up to six people each [3]. This is a novel design for the French River compared to the existing remote cottages that are built on land. For existing cabins in the French River Provincial Park, floating docks allow for boating access to owners' rocky sites. Instead, this design floats the houseboats entirely on the water. The houseboats are supported by a preliminary and speculative lateral restraint system made of mooring and elastic systems.

The houseboats are designed to be prefabricated and lightweight, as the nearest road access is two kilometres away at the Hartley Bay Marina. The components of the house and floating foundation are boated onto the site for assembly. Each houseboat contains two bedrooms, a common area with a kitchenette, and front and rear decking access to the shore and water, respectively. The houseboats operate seasonally in the warmer months between May and October to avoid the below freezing temperatures

[2] See Piątek for a comprehensive definition of architectural types found on the water [3].

found in the colder months. In the winter, the cabin and floating foundation system are removed from the water and stored on land in the permanent stilt-supported building (B1 in Figure 2).

Methodology

The main design objective of the houseboat project is to create a floating foundation that supports a cabin on the water. The orientation of the houseboat uses the project north as opposed to the actual north (Fig. 3). The design of the floating foundation is inspired by that of the NRC Pavilion constructed by the Buoyant Foundation Project (BFP) [4]. It is important to create a preliminary design of the buoyancy needed by considering the houseboat's weight. The weight of the houseboat will also determine how easily it can be removed for the winter season.

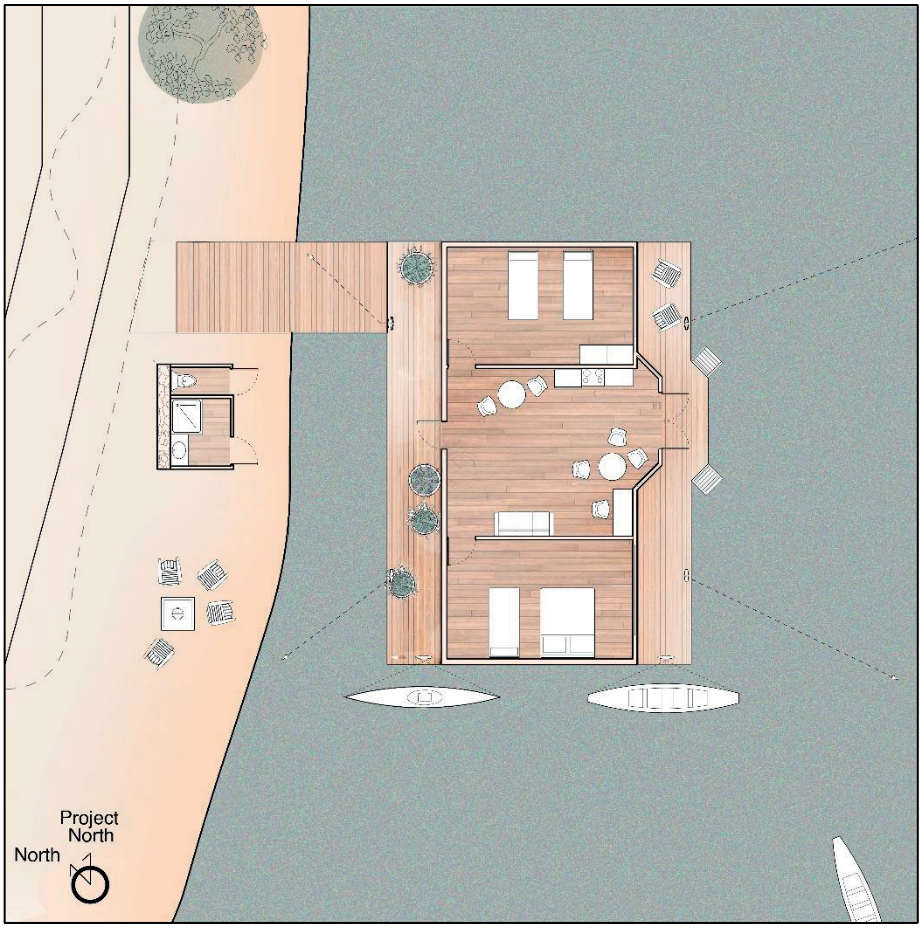


Figure 3: Houseboat floorplan (Note: The toilet and shower are on shore, in proximity to each houseboat. The side decks can accommodate smaller vessels. Defined project north to actual north)

This design uses the British Columbia Float Home Standard freeboard definition, developed in response to growing interest in floating homes. This standard defines freeboard as "the vertical distance from the waterline to the top of the floatation device or the lowest opening into the floatation device” [5]. In contrast, the US Federal Emergency Management Agency (FEMA) guidelines prioritize the freeboard calculation for the protection of structures in coastal areas. Their definition of the design “should incorporate freeboard above the required elevation of the lowest floor or bottom of the lowest horizontal member” [6], meaning the underside of the structure supporting the lowest floor.

The floating foundation needs a lateral restraint system that resists movement because of the wind and water currents. Therefore, two systems derived from naval architecture and shallow water docks are proposed in this paper. The lateral restraint system will be disconnected from the floating foundation for the winter.

Houseboat Design

Design of the Floating Foundation: The design of the floating foundation uses dock floats, (referred to as buoyancy elements in this paper) which are supported by wooden frames (Fig. 4). For buoyant foundations, “the buoyancy elements ... displace water to cause a building to float above the water’s surface” [7]. In the same way, the foam-filled dock floats provide uplift to keep the houseboat above the water's surface. The project’s floating foundation frame design borrows from certain details of the BFP’s project for the National Research Council of Canada (NRC) Floating Pavilion [8]. The wood framing system consists of 38x90mm^2 standard dimensional lumber, commonly referred to as a 2x4.

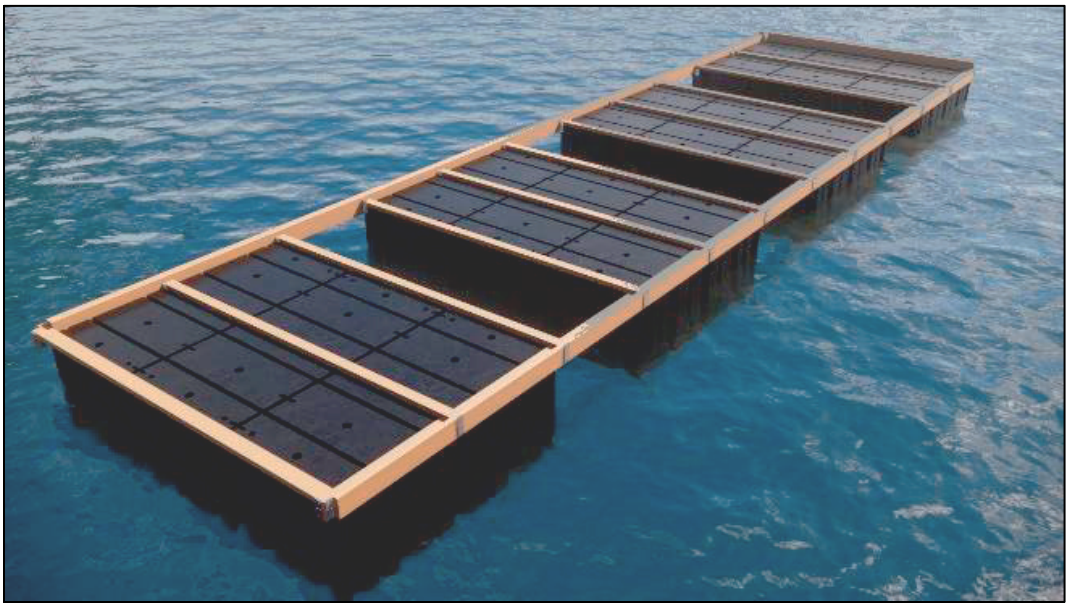


Figure 4: Rendering of a section of the floating foundation (Note: An outer wood-framed array before the decking and cabin structure have been installed)

The floating foundation consists of three wood-framed arrays (Fig. 5). It is calculated that at least twenty-two dock floats would provide adequate buoyancy (see Appendix

C). This results in the use of twenty-four buoyancy elements, each nominally measuring 48” x 96” x 36” (1.22m x 2.44m x 0.91m) [9]. The two outer frames consist of four compartments of three dock floats each. The middle frame is left empty in this design but could fit an additional eight of these buoyancy elements if required. In the nominal NS dimension, the platform has a length of 13.4m. Each wooden frame is divided into eleven sections spaced at 1.18m, which accommodates the size of the selected dock floats.

The houseboat is intended for seasonal assembly along the shore and for storage in a permanent building on the land before the water freezes each winter (see Figure 6 for procedure). The three wooden frames are connected to one another with mechanical metal fasteners to form the floating foundation, and the cabin structure is then built on the foundation deck.

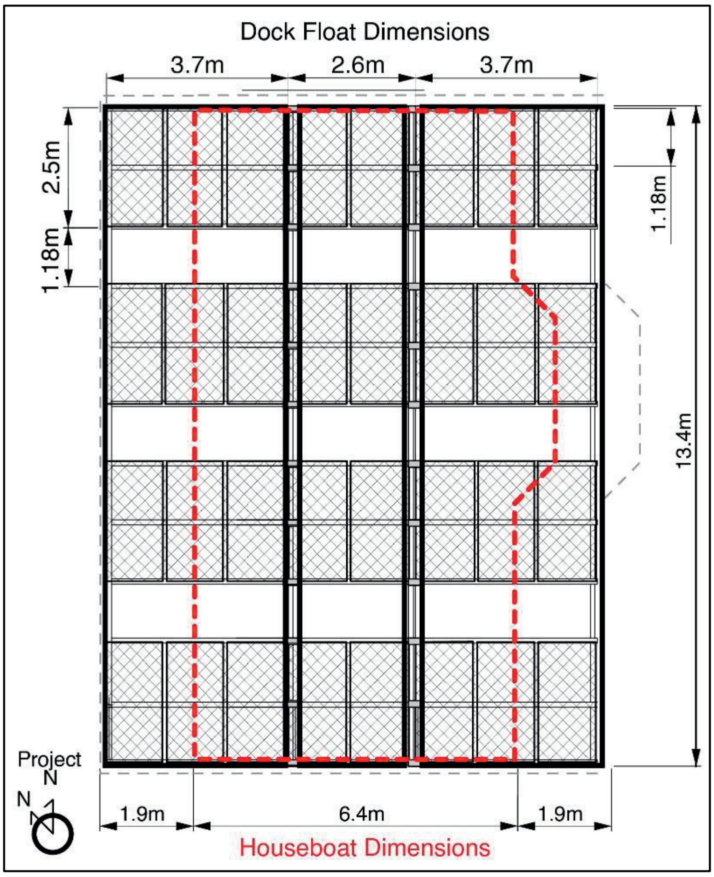


Figure 5: Floating foundation framing plan (Note: Framing plan draws from NRC Floating Pavilion preliminary construction drawings, courtesy of the Buoyant Foundation Project [8])

A removable bridge provides passage from the houseboat to the shore. Prior to snowfall, the unoccupied cabin structure is disassembled, and removed via the bridge to the shore. Then, the bridge, and the components of the cabin and floating platform are stored in a permanent building on the land (Fig. 6A). After the cabin and detachable bridge are removed, the lateral system is disabled, and then the three wood-framed arrays are detached from one another to be put ashore. The dock floats and frames are separated from one another, and divided into manageable sections that can be easily transported to the same permanent building for winter storage (Fig. 6B).

Load Determinations: Understanding the forces acting on the floating houseboat is crucial in maintaining safety and stability while floating. Dead loads, such as the static weight of structural elements, are permanent forces created by the action of gravity, and counteracted by the net uplift from the buoyancy elements. Live loads are dynamic and changing forces. Vertical live loads may include the occupants, the furniture, and the snow.

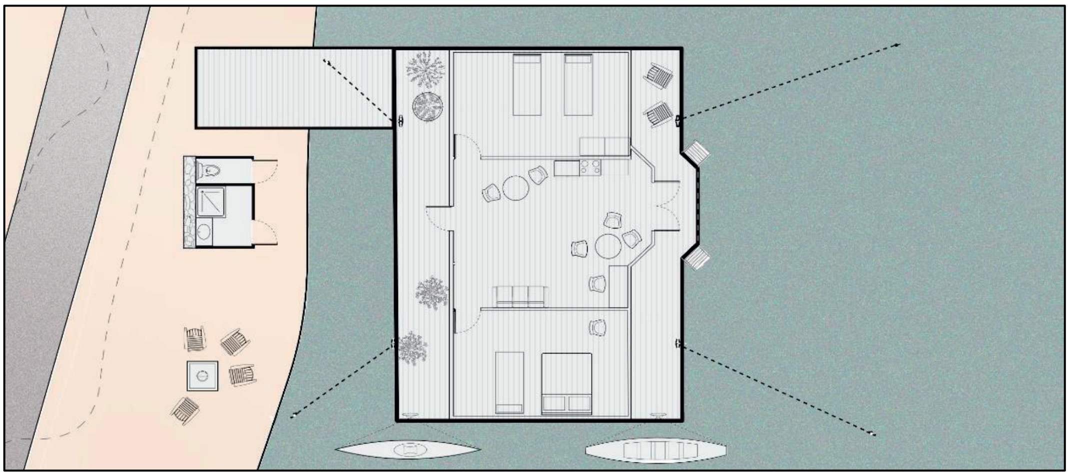


Figure 6A: Diagram showing houseboat components

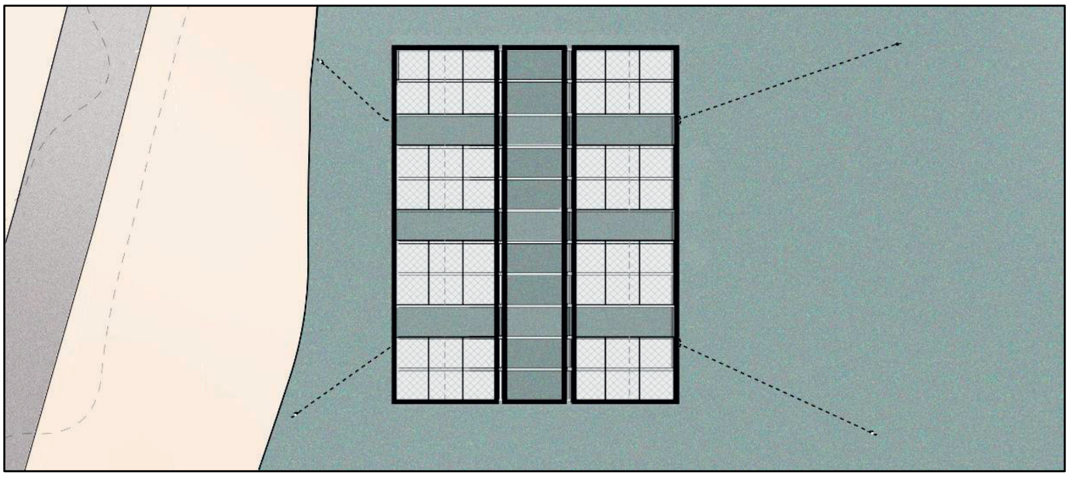


Figure 6B: Diagram showing the floating foundation in the water

However, given that the seasonal structure is unoccupied well before the cold weather arrives and subsequently dismantled and stored on the land, in this case the snow load has been excluded from the live load calculation (see Table 3 in Appendix B). This is justified because, even if there were an early snowfall before the houseboat has been dismantled, no human occupancy live load would be present. The dock floats supporting the houseboat should therefore have adequate buoyancy (see Appendix C).

Determining the preliminary buoyant capacity of the floating foundation requires comparing the vertical forces acting on it with the dock float's uplift capability. Each manufactured dock float of the size selected, marketed with a nominal volume of 96 cubic ft. (2718 L) and nominally measuring 48" × 96" × 36" (1.22 m × 2.44 m × 0.91 m) [9], consists of a watertight polyethylene casing providing buoyancy that is filled with expanded polystyrene (EPS) foam.[3] However, the buoyant capacity of the manufactured dock float does not correspond to the nominal volume alone, so the buoyancy rating is used in this calculation. The buoyant capacity of each dock float is its gross uplift minus its own weight, giving the net uplift. Therefore, the manufacturer provides the net buoyant capacity that is used to find the number of elements required to support the houseboat and the floating foundation framing system (see Appendix C).

The weights of each component of the entire cabin structure and floating foundation are calculated to find the total weight that the dock floats need to support. The Ontario Building Code (OBC) "strength and stability" guide (Table 4.1.3.2.) has been specified for its structural and legal relevance, as the project is located in Ontario and the BC Float Home Guide does not specifically address load cases. The design of a lightweight houseboat assembly is used to determine a preliminary dead load (see Fig. 10 in Appendix B). The volume of each component of the houseboat and floating foundation framing is multiplied by its material density to determine an individual weight for each element or set of identical elements (see Table 2 in Appendix B). These weights are added together to calculate a total dead load in kilonewtons. The vertical live load is calculated from the houseboat's residential occupancy as specified in the OBC (see Table 3 in Appendix B) [10]. A factored load of 1.25 x Dead Load and 1.5 x Live Load (OBC Case Two from Table 4.1.3.2.A) [10] is divided by the net uplift of a single dock float to determine the minimum number of dock floats required. These calculations show that a minimum of 22 dock floats is required; thus, 24 floats are fitted into two wooden frames, one on each side of the dock, with twelve floats each (Fig. 5). This arrangement provides sufficient buoyancy for the houseboat.

The forces from water, the wind, and waves acting on the floating foundations are also considered live loads. These lateral loads act horizontally on the floating foundation and structure, causing potential movement of the houseboat. The speculative lateral system that counteracts these forces is explained in the next section.

Lateral Restraint System: The floating foundation supports the houseboat's mass and loads, providing stability on the water. The lateral restraint system consists of both the mooring system and the elastic system that work together to resist excessive lateral movement of the floating foundation. The project's lateral system is a speculative adaptation of drag anchor systems described in Construction of Marine and Offshore Structures [11], and vertical elastic anchoring systems for docks [12].

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[3] The EPS foam maintains the buoyancy even if the casing is damaged and starts to leak.

As such, all of the details have not been resolved. Calculations for the lateral mooring and elastic systems are beyond the scope of this speculative design. The mooring system consists of four cables, one near each corner of the floating foundation, that are attached to drag anchors. In naval architecture, multiple drag anchors connect a vessel to the seabed, a critical part of resisting the wind, waves, and current [11]. The elastic system consists of four pairs of crossed cables in plan along edges of the floating foundation frame (see Fig. 8). They are attached to the wooden frames at the top and to block anchors that are sitting on the river bed.

This system allows the houseboat to move up and down while restricting horizontal movement. Together, these systems make the lateral restraint system, combining the strategies of naval architecture and floating dock technology. _To retrieve the lateral system, the drag anchors are removed,[4] and the elastic anchors are disconnected.[5] The houseboats are situated along the shoreline in shallow water with a minimum and maximum annual water level variation between 1.5m – 4.25m,[6] [13]. As both types of systems need to work in these conditions, modifications to the sources of the lateral system allow for an initial design (Figs. 7 – 9).

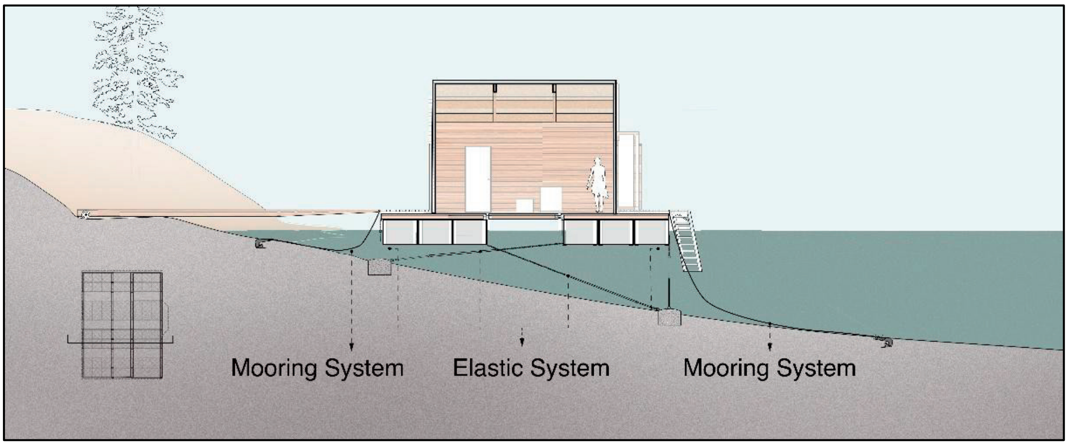
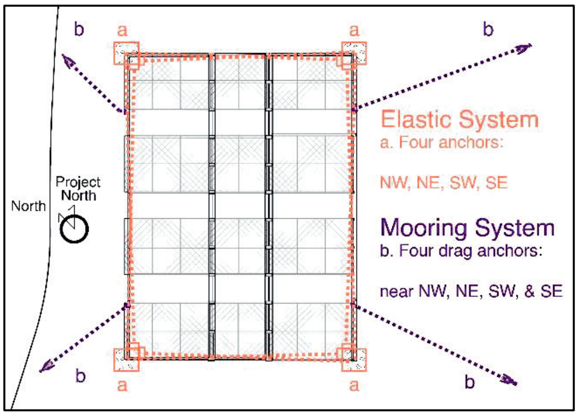


Figure 7: Section of the houseboat's components and lateral system

[4] A small boat simultaneously pulls the cable connected to the anchor up and in the direction opposite to the anchor's resistance. Once it is dislodged, the boat pulls up the anchor and brings it to the shore.

[5] The elastic anchoring system's elastics are loosened, then disconnected from the block anchor, and then attached to small buoys during the winter season.

[6] Range based on the overall minimum and maximum water level data recorded between 2019 and 2024 from the Hartley Bay Marina hydrometric station [13].



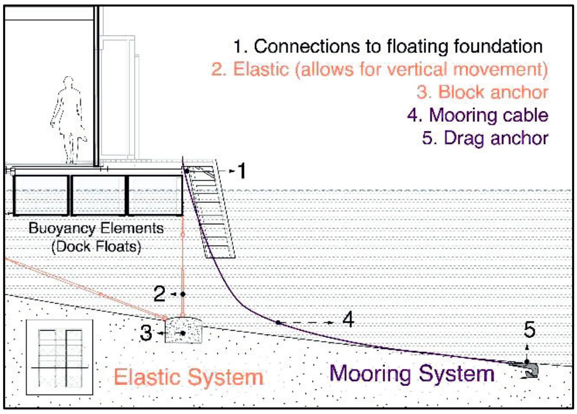


Figure 8 (left): Mooring and elastic system elastic layout plan

Figure 9 (right): Mooring and elastic system detail section

Design conclusions

In conclusion, the project for the Canadian Shield Watershed Conservation Institute's floating houseboat offers a design for a novel floating cabin in the French River Provincial Park. The houseboat design is a prototype for a floating cabin that is inspired by naval and floating architecture design practices. These seasonal houseboats that are removed and stored on site offer an alternative foundational structure for a remote community where climate change is causing the flooding to be increasingly unpredictable and more damaging. While speculative, the houseboat design proposes an efficient seasonal assembly and removal process.

Not all pertinent aspects of the proposed site of the houseboat on Bear's Den Bay are available. As a tidal channel, the riverine system is influenced by seasonal tidal movements. Further research into the water's seasonal tidal variation would provide insight into the appropriateness of this site for the seasonal floating houseboats.

Credits

The drawings and maps are created by the author unless otherwise noted.

Any errors or omissions in this paper are solely the responsibility of the author and should not be attributed to those who have advised on or provided support.

This paper is authored by Iain Mattan Jin, an architecture student at the University of Waterloo, and a research assistant with the Buoyant Foundation Project. I wish to thank Professor Elizabeth English sincerely for advising this research paper, from its inception as a design project, to its adaptation as a research poster presented at the International Conference on Amphibious and Floating Architecture, Design, and Engineering (ICAADE) 2023—an innovative conference of research and design in this field[7]—and finally, to this research paper. I would also like to thank Kim Chan, Derek Shin, and Erin Kim for their editing, review, and support.

The Buoyant Foundation Project (BFP) is a research organization founded by Professor Elizabeth English that conducts research on and development of amphibious architecture projects. The BFP aims to improve policies, practices and building codes, to allow for the implementation of amphibious projects internationally. The BFP was originally founded in 2006 in response to the flood damage and trauma caused by the collapse of the New Orleans levee system after Hurricane Katrina, but has since expanded to work in flood-sensitive areas around the world. In recent years, the BFP completed a series of projects introducing this technology to flood-prone communities situated in the Mekong Delta in Vietnam, with the support of the Z Zurich Foundation and the Global Resilience Partnership Water Window Challenge [14]. Canadian support for projects for First Nations communities has been provided by the National Research Council of Canada (NRC) and the New Frontiers for Research Funding – Exploration (NFRF-E) program.

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Developing Mega Artificial Shelter

Wei Lin, Yinghui Tian, Mark J. Cassidy

University of Melbourne

Entwicklung eines künstlichen Mega-Schutzes

Um Offshore-Aquakulturen oder große Infrastrukturen zu entwickeln, ohne dass ein großer Wellenschlag zu befürchten ist, wird in dieser Studie eine neuartige technische Lösung für den Bau von künstlichen Mega-Schutzbauten auf dem Kontinentalschelf in einer Wassertiefe von 20 bis 40 m vorgestellt und das dahinter stehende Konzept erläutert. Der vorgeschlagene Ansatz beinhaltet die Verwendung von großen Stahlbetonzylindern und vorgefertigten Wellenbrechereinheiten, um einen geschlossenen Bereich zu schaffen, der sicheren Binnenseen oder Buchten ähnelt.

Die Entwurfsphilosophie, die Konstruktionsmethoden und die innovativen strukturellen Formen der Mega-Shelter werden diskutiert. Darüber hinaus wird die Bedeutung systematischer physikalischer Modellversuche zur Validierung der Leistung und Wirksamkeit der vorgeschlagenen Lösung hervorgehoben. Diese Tests liefern wesentliche Validierungsdaten und Erkenntnisse für die technische Anwendung. Drei Fallbeispiele, nämlich die Vorstudie zur Durchführbarkeit der Mega-Aquakultur in Yangjiang, die technische Untersuchung des schwimmenden Flughafens in Sanya und der Plan "Blue Tianjin", werden als mögliche künftige Anwendungen vorgestellt.

Diese Studie bietet eine umfassende Untersuchung der Aspekte von Design, Konstruktion und Validierung von künstlichen Mega-Sheltern und zeigt deren Potenzial als transformative Lösung für die Schaffung sicherer und nachhaltiger Umgebungen auf dem Kontinentalschelf auf.

Developing Mega Artificial Shelter

Wei Lin, Yinghui Tian, Mark J. Cassidy

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ABSTRACT: To develop offshore aquaculture or large infrastructure without large wave impact concern, this study introduces a novel technical solution for constructing mega artificial shelters on continental shelf in water depth ranging from 20 to 40 m, as well as the thinking behind. The proposed approach involves the use of concrete-steel big cylinders and prefabricated wave breaking units, so as to create an enclosed area that resemble safe inland lakes or bay areas. The design philosophy, construction methods, and innovative structural forms of the mega shelters are discussed. Furthermore, the importance of systematic physical model tests for validating the performance and effectiveness of the proposed solution is emphasised. These tests provide essential validation data and insights for engineering application. Three case examples namly Yangjiang mega aquaculture pre-feasibility study, Sanya floating airport engineering research, "Blue Tianjin" plan as potential future applications are reported. This study offers a comprehensive exploration of the design, construction, and validation aspects of mega artificial shelters, showcasing their potential as a transformative solution for creating secure and sustainable environments on the continental shelf.

1. Introduction

Continental shelves cover approximately 32.1 million km^2, accounting for 8.1% of the ocean surface (Harries et al. 2014). These areas are increasingly playing an important role to address the growing demand for aquaculture food production. As Costello et al. (2020) predicted, meeting future food requirements will necessitate an increase of 21-44 million tons of edible meat by 2050 to sustain a population of 9.8 billion, which amounts to a seafood consumption rise from the current 17% to 36~74%. There are only two ways to obtain sea meat, capturing and farming. Capturing is no longer sustainable. The Food and Agriculture Organisation (FAO 2022) recognised the significant growth in seafood consumption and highlighted the potential of aquaculture to meet the needs of the expanding population.

However, most aquaculture farmings nowadays are built near shores in naturally sheltered or semi-sheltered region, which led to overcrowded farming, environmental concern, and low quality production due to poor water exchange, according to authors' interviews to China fish farming enterprenuers and experts. Therefore, in order to increase aquaculture farming volume and improve quality, deeper regions need to be explored. Because the medium (10~50m) relief shelf covers the greatest area (14.4 million km^2) than that of the low (<10 m) relief shelf as per Harris et al. (2014) and Schaaf (1996) estimates that in depths 20 to 40 m the region area is 4.1 million km^2 containing ~123455.1 km^3 seawater.

One of the main challenges for going further offshore preventing acquculture development is the exposure to open seas. However, deeper areas are subject to more severe sea loadings, with exposure ranging from sheltered (<10 m depth) to partly exposed (10-50 m depth and >90°) and exposed (>50 m and >180°) as defined by as Locatelli (2013). In relatively unexposed regions, low-tech High-Density Polyethylene (HDPE) collar farming is prevalent due to its cost-effectivenss. Conversely, other concepts, such as rigid or semi-rigid steel structures, are more susceptible to wave-load-induced-fatigue and corrosion issues, making them significantly more expensive (Fredheim and Langanm 2009). Furthermore, aquaculture faces substantial challenges in typhoon regions such as the south China sea, where wave height and period can reach 13.6 m and 15.1 s, and current velocities reach 2.05 m/s, respectively (DNV-E301 2018). Fig.1a illustrates a HDPE collar deformed during recent years typhoon Chaba, resulting in significant loss of fish yield. Fig.1b illustrates typhoon Doksuri killed fish inside the steel structured fish farm cage. While submersible farms have been employed to mitigate sea loadings, they introduce complexities in terms of net-changing and feeding and require diver intervention. To scale up China's offshore aquaculture amount, Lin (2022) proposed a new offshore aquaculture mode and one sub-system is a safe-wave-breaking system as illustrated in Fig. 2.

This study aims to provide a solution for constructing mega-shelter infrastructure at depth of 20~40 m, creating a calm sea environment suitable for aquaculture.

(a) Fish net deformed in typhoon process (02 July 2022), causing significant yield loss

(b) Fish cage situation in typhoon process (27 July 2023) causing fish death

Fig. 1. Recent cases of significant yield loss during typhoon processes

Fig. 2 Aquaculture inside the shelter wall basic concept (after Lin 2022)

2. Basic concept

The construction of a permanent wall in open sea to form a shelter is introduced in this study. The wall effectively eliminates most incoming waves while allowing for daily tidal current exchange. In the context of aquaculture, when an incident wave of return period 50 years with a height of 15 m, passes through the wall, its height is reduced to less than 3 m, resulting in a more than 80% reduction. This reduction mitigates the risks of fish escaping or overcrowding due to net damage or deformation. Additionally, both the openings in the wall and the master plane design of the wall can facilitate water exchange, reducing environmental impacts and enhancing fish meat quality, elaborated later.

For the master plane shape of the shelter wall, assuming a flat seabed, circle or square shapes are preferable, as they maximise the enclosed area per wall length, compared to oval, rectangle or other shapes.

Regarding the scale of the mega shelter, taking the circular layout of diameter 3, 4, 5 km as an example, firstly, equations in Fig. 2 shows that the cost-effectiveness of a shelter wall is linearly proportional to its plane diameter; the enclosed area per the length of wall increases from 750 to 1250 m^2/m. Secondly, as the shelter area expands, wind-generated wave inside the shelter becomes significant. For example, MTPRC (2013)'s wind-generated-wave empirical equation shows that as diameter increases the wind blowing distance increases provided sufficient long blowing time and so the wave-significant height H_s and wave significant period T_s increase from 2.2 to 2.6m and 4.2 to 4.7s respectively. And thirdly, there are other limitations related to construction duration and timing as we will see.

In Fig. 2, the plane layout has a diameter of 4000 m and a wall length of ~12 000 m, which shelters an area of $1.257 \times 10^7 m^2$. With an average water depth of 30 m, the wall encapsulates a water volume of $3.770 \times 10^8\ m^3$. Assuming the actual production amount of 5 kg/m^3, the farm can yield ~1.885 million tons per year. By constructing $44/1.885 \approx 24$ shelters, the projected demand for edible meat by 2050 could be met, given that other technological challenges in aquaculture are adequately addressed.

3. Mega shelter

3.1 Big cylinders

The construction of the wall involves the use of big cylinders, a proven technique employed in projects such as the Kisarazu Shi artificial island in Japan, as well as the Hong Kong-Zhuhai-Macao Bridge links and Shen Zhong links for the time in China (Nikkei Construction 1997; Lin et al. 2020). The utilisation of big cylinders offers several advantages:

- Big cylinders are prefabricated on land and installed as a single unit, resulting in significantly reduced marine works compared to caisson constructions or suction caisson (Fig.3b).
- The backfill material is formed into a cylindrical shape (Fig.3e), which not only conserves materials to a minimum but also reduce ground surcharge load in comparison to revetment (Fig.3d); the latter has a berm and slope configuration and thus is much wider and generates more weight.
- The load on big cylinders is conveyed through the backfill. Further, the cylinder's gravity generates lateral soil pressure, leading to pretension in cylinder shell. This structural feature prevents buckling of the thin-walled structure , as shown in Fig.3e. In contrast, piles (Fig.3a) and sheet-pile walls (Fig.3c) convey load through using structural bending.

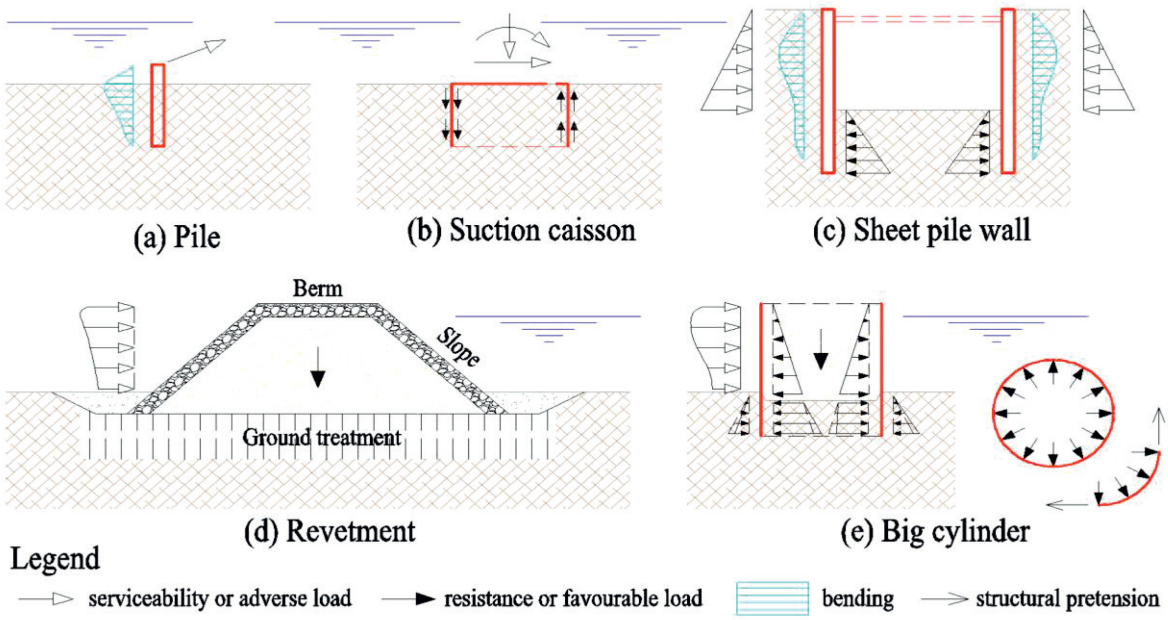


Fig.3 Big cylinder characteristics versus others

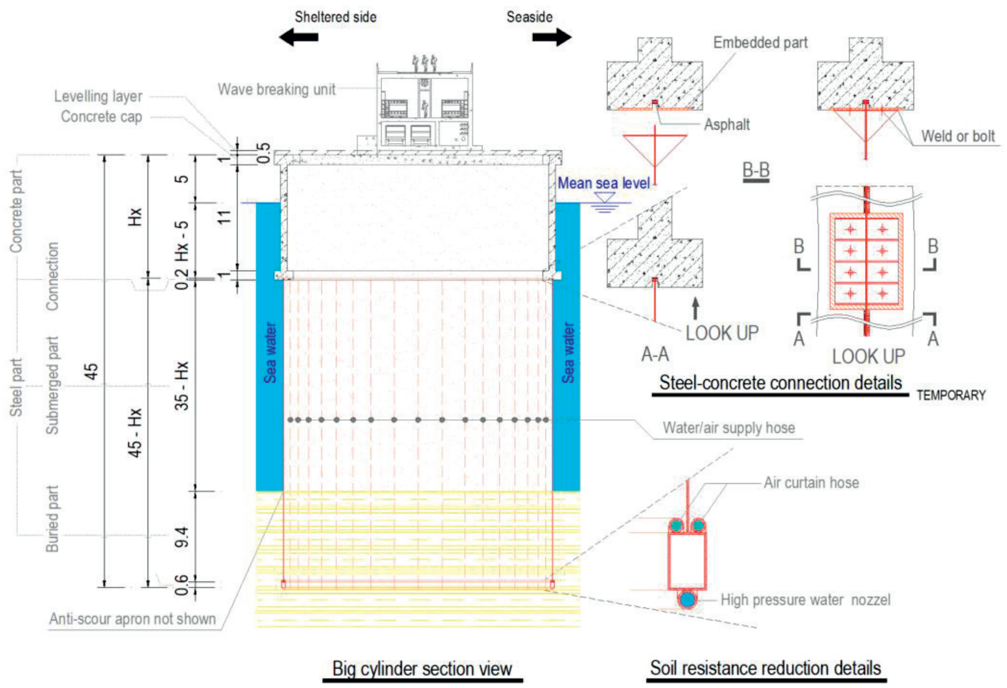
It is important to note that "big" emphasizes effectiveness:

- As the diameter increases, the volume the cylinder grows faster than the surface. A larger diameter yields higher capacity and a higher percentage of backfill utilisation.

- A bigger diameter reduces the number of installation times, thereby mitigating marine work risks and time. Installation can even avoid tphoon period as discussed later.
- Larger offshore geotechnical structures generally have less design and analysis complexity compared to smaller ones, as noted by Randolph and Gourvenec (2011)

However, the as-built big cylinders are designed for temporary construction and typically buried inside artificial islands, serving little to no function during the service period. In this study, the big cylinder must stand alone, withstand extreme sea loads, and remain functional for 70~100 years.

Therefore, instead of employing a steel shell as previously done, steel-concrete composite structure is designed. A typical design is depicted in Fig. 4a, featuring a diameter of 28 m, with a 10 m root embedded into the ground and a 5 m rise above the sea surface. Therefore its total height amounts to 10 + 30 + 5 = 45 m.



(a) details including temporary installation facilities

(b) high-pressure water jet (in testing) (c) air curtain (in testing)

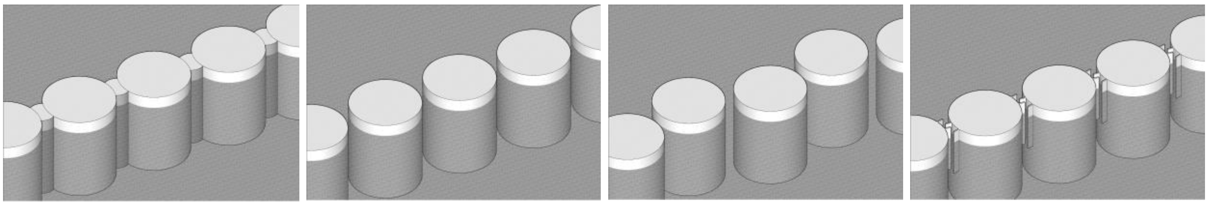
Fig. 4 Big cylinders conceptual design

The gaps between the big cylinders can range from 2 to 6 m, taking into account water exchange and accommodating offshore installation tolerances. Granular material dredged seabed sediments, or construction waste can be used as backfill. The backfill material creates lateral soil pressure to the inner surface of the shells, preventing them against from buckling. The upper part consists of reinforce-concrete, while the lower part comprises steel shells. The wall thickness of the steel section is ~4 cm: 1 cm accounts for corrosion allowance (combined with heavy painting and sacrificial anode) and 3 cm serves as the basic structure. The utilisation of this novel composite structure offers the following advantages

- The elevation of the concrete tube covers the tidal fluctuation region as described by DNV (2018), ranging from +5 m to –4 m. This reduces long-term concerns about corrosion and maintenance.
- The composite structure exhibits higher stiffness than thin-walled steel, making it more suitable for sea installation, particularly in adverse conditions with long-period swell waves. The depth ratio between the concrete and steel sections can be adjustable, allowing for customisable total weight. Lifting operations, controlling the weight is essential to avoid the use of very large (and expensive) floating crane on one hand, one the other, weight is advantageous in terms of balancing soil resistance and guiding inserting direction.

3.2 Options in-between the cylinders

The wall, constructed using big cylinders aims to block waves while enabling the passage of tidal-induced current; four different layouts of it were considered. In Fig.5a, auxiliary cells are inserted between the big cylinders (Lin et al. 2020), providing complete wave isolation but hindering. This layout has high environmental impact and the tide level inside and outside of the shelter will be different. To maintain the seawater quality and adjust the water level within the shelter, large pumps would need to be installed at multiple locations. While the power for the pumps could be supplied by 100% clean energy from wind turbines on some big cylinders, the water exchange system would still require monitoring and control, making malfunction and human errors are unavoidable. In Fig.5b, the auxiliary cells are removed, physical model indicates that the wave height reduction percentage for 28 m cylinders with 4 m gaps is around 40~60% in wave flume. In Fig.5c, the big cylinders are arranged in an zigzag offset pattern. Numerical results suggest that the wave reduction effect in this layout is similar to that in Fig.5b. However, this layout increases the cost substantially as the number of big cylinder numbers increase. Fig.5d presents a layout where the so-called ‘arms’ (vertical plates prefabricated by the same material and at the same time of the mainbody of the big cylinder) are set. Physical model tests shows that this layout can reduce wave height by 70%~90% while allowing the passage of low-speed current. To conclude, Fig.5d can be applied for the wall that exposed to the most severe waves while Fig.5b for the wall that exposed to the less severe waves.



(a) cylinders with auxiliary cells | (b) cylinders with gaps | (c) cylinders with plane rotation offset | (d) cylinders with vertical arms

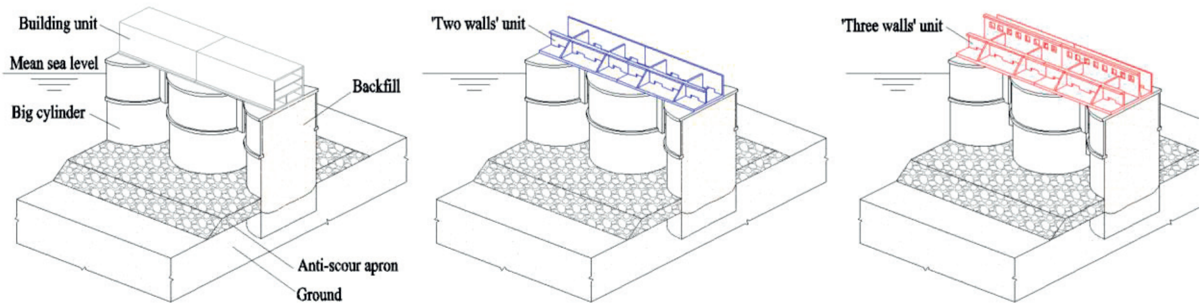
Fig.5 Comparison of different cylinders layouts

3.3 Wave breaker units

To prevent wave overtoppings and to provide arthitectural space, wave breaker units are prefabricated and placed on the top of the big cylinders, as shown in Fig.6a. These box-type units serve multiple purposes, including office spaces, monitor rooms, living areas, restaurants, bars and cafés. However, it should be noted that these box-type units resembling vertical walls, are not particularly effective in reducing overtopping in times of extreme waves. This limitation is demonstrated in Fig.6b, where a physical model incorporating a box unit, did by China Construction Communications Company (CCCC) in Tianjin Research Institute for Water Transport Engineering (TIWTE)'s lab, equivalent to a 22 m building in the prototype, still experienced significant overtopping. As a result, additional configurations are developed as shown in Fig.7.

(a) Construction concept render drawing (b) Wave flume testing

Fig. 6 Building unit early studies



(a) Shelter wall with building unit (b) Shelter wall with "two-walls" unit (c) shelter wall with "three-walls" unit

Fig. 7 Different optioins of wave breaking units on top of cylinders

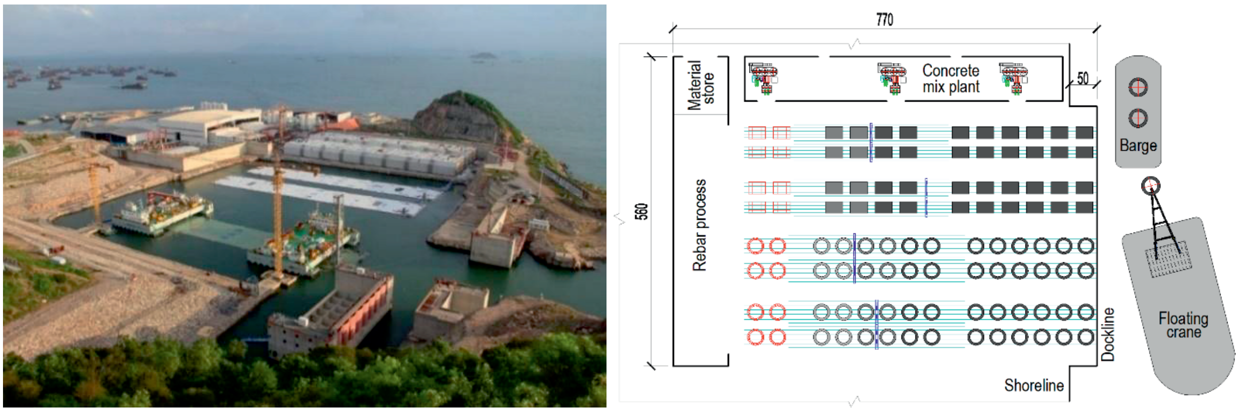
The 'two walls' and 'three walls' units featured in Fig.7 incorporate water tanks specially designed to capture water temporarily during wave events. These units prevent overtopping, also reduce wave reflection and sea loadings; the water stored within these tanks exerts transient vertical loadings on top of the big cylinders, improving the geotechnical stability of the big cylinder. This innovative approach aims to enhance the overall performance and resilience of the structure.

3.4 Construction

Both the steel and concrete parts of big cylinders are prefabricated in factories, transported to the site, and then assembled and installed as a unified structure using large capacity floating crane. After installation, backfilling into the cylinder will be carried on immediately to secure its stability, accompanied by anti-scour protection around the cylinder’s foot. After settlement of big cylinder stablised, the wave breaking units are prefabricated and placed on top of big cylinders (Fig. 6a) using the same construction method as the big cylinders.

To facilitate the smooth installation of big cylinders, soil resistance reduction systems that combine high pressure water jet and air curtains are being developed as shown in Fig.4b-c. These systems are particularly crucial for rapid construction in regions where typhoon occurs frequently. The initial installation phase can commence during non-typhoon periods, aiming to establish a complete or partially formed shelter. Previous experience indicates that a single floating crane, supported by accompanying vessels, can install three big cylinders per day, as reported by Lin et al. (2022). Assuming an average centroid distance of 33.3 m between cylinders, a 100 m wall composed of three big cylinders and three top structures can be completed within a day, while a 12 km wall resembling Fig. 2 would require approximately 120 days equaling four months, making a possible construction schedule that can fully avoid the typhoon season.

It is important to address the prefabrication progress as it could govern the schedule rather than the installation. To reduce land occupation, the production flowline technique should be implemented, drawing inspiration from established infrastructure projects. Examples include the ~4 km Øresund Tunnel (Busby & Marshall, 2000), the 6 km HZMB Link immersed tunnel (Lin et al., 2022) as shown in Fig.8a, and the ongoing Fehmarn Belt immersed tunnel project, anticipated to span ~18 km (Femern A/S, 2023). To build the ~ 12 km shelter wall, eight production flowlines shown in Fig.8b are adequate. The factory requires finding a shore area of ~500m and ~770m. Four production flowlines for big cylinder units and the other four for the wave breaking units, each lines are capable of producing one unit per day and hence the whole factory can produce maximum 4 cylinders and 4 wave breaking units per day, matching the pace of the installation.



(a) HZMB link immersed tunnel factory (b) factory conceptual layout for mega shelter

Fig.8 factory and flowlines as-build project and concept

4 Test validations

4.1 Drivabiliaty test

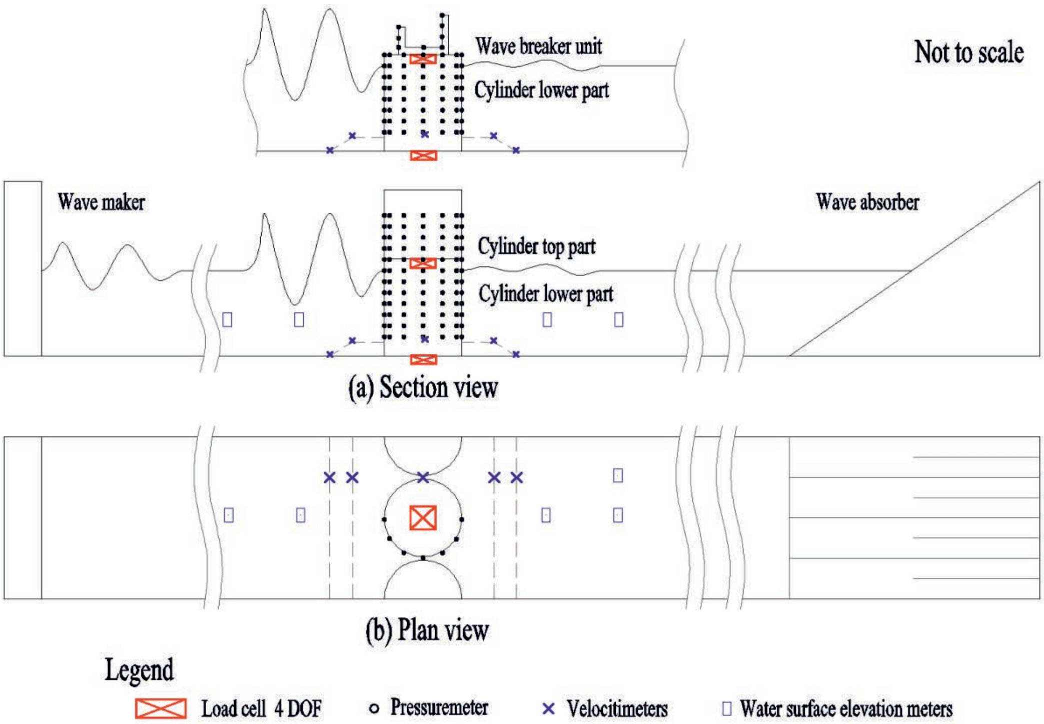
To validate the cylinder static drivability with soil reduction measures, large scaled tests have been carried out in CCCC Guangdong-Hong Kong-Macao Greater Bay Research Institute’s Qingdao experiment base as shown in Fig.9. To simulate offshore condition, several pits were pre-excavated and then backfiilled with soil layer of clay or sand of different kind of 5 m in depth. A ~40 tonnage I-shaped steel beam was manufactured to simulate part of the big cylinder’s steel part. The concrete part is simulated as weight on top of the I-shaped beam. During the test, the total lifting load, and water and air hose pressure were recorded continuously. Before and after test the in-situ standard penetration test and the cone penetration test were conducted to better understand the soil properties.

(a) before (b) after

Fig.9 Cylinder wall static driving test

4.2 Wave elimination effect and wave loading flume test

Flume model tests have been conducted to investigate the total force and moment acting on individual big cylinders, as well as the reduction in wave height after the wave passes through the wall. These tests aim to study the influence of various parameters such as the diameter of the big cylinders, arm configurations, clearance between arms, and top unit configurations. As illustrated in Fig. 10, water surface elevation meters are placed at specific locations before and after the wall to measure time series of the the water surface elevation, including standing waves and transmitted waves. Load cells are installed at the bottom of one big cylinder and its top structure to capture the time series of forces and moments induced by waves or currents. Velocitimeters are placed at the apron surface and gap between the cylinders to aid in the design erosion-resistant apron. It is anticipated that the velocities near the gap will be high due to the local slot effect.



(a) Test design

(b) Typical test photos by Nanjin Hydraulic Research Institude Lab

Fig. 10 Flume test design and implementation

Fig.11 provides an overview of the different models designed for the physical model testing. Fig.11a-b features a vertical wall model and a rectangle column model, with the results of the former serving as a basis for comparison with theoretical calculations.

The results of the latter can be compared to those of the big cylinder model. Fig.11c illustrates the big cylinder models with diameters of $24\lambda_i^{-1}$, $28\lambda_i^{-1}$, $32\lambda_i^{-1}$ m and gaps of $2\lambda_i^{-1}$, $4\lambda_i^{-1}$, $6\lambda_i^{-1}$ m, where λ_i is the scaling ratio and the lower index i is due to the fixed width of the flume tank which is approximately 1m of the used wave flume, the scaling ratio must be adjusted to accommodate the diameter and gapwidth of the prototype and the model. Fig.11d presents various arms layouts, including two arm pairs on one big cylinder with clearance of $3\lambda_i^{-1}$, $2\lambda_i^{-1}$, $1\lambda_i^{-1}$ m and one arm pair with clearance of $2\lambda_i^{-1}$ and $1\lambda_i^{-1}$ m.

The arms have the the same height as the big cylinder and do not have a bottom opening. Fig.11e shows arms of varying depth and bottom openings, ranging from $5\lambda_i^{-1}$, $10\lambda_i^{-1}$, to $15\lambda_i^{-1}$ m. In Fig.11f, top unit models are replaced by wave breaker units model for comparative analysis. Fig.11g represents the apron model with small stones.

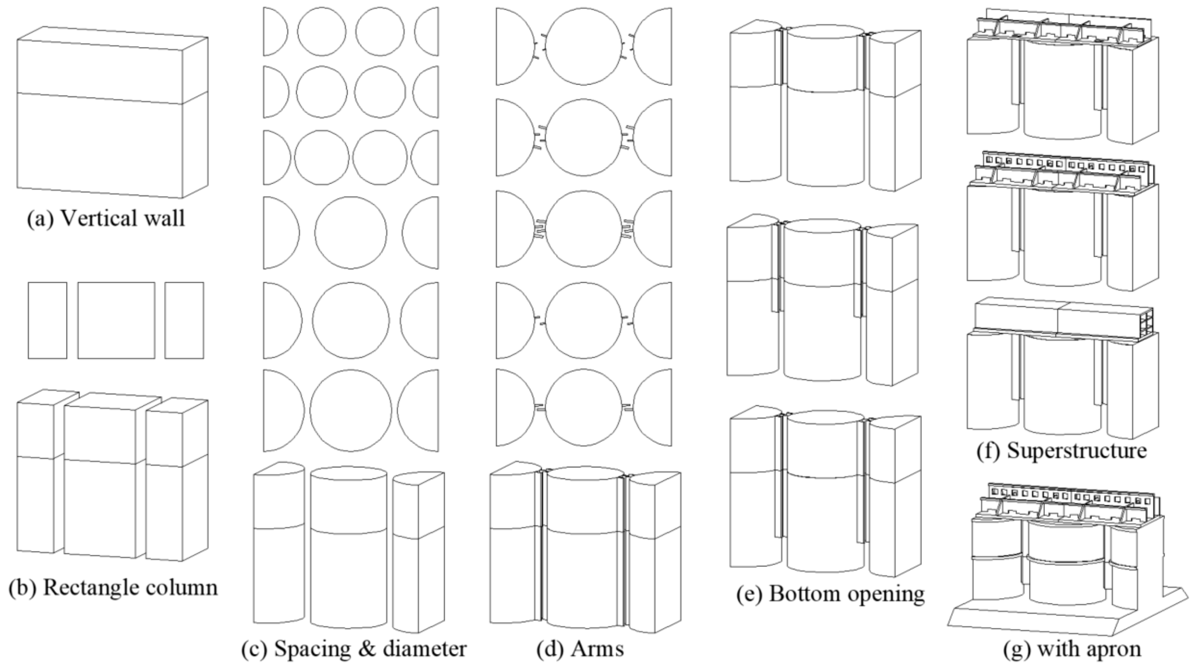


Fig. 11 Models in the wave flume

To cover a wide range of sea states representing the continental shelf environment and for probabilistic analysis, different water depth ($d = 20\lambda_i^{-1}, 30\lambda_i^{-1}, 40\lambda_i^{-1} m$) and sinusoidal waves with various height ($H = 6\lambda_i^{-1}, 8\lambda_i^{-1}, 10\lambda_i^{-1}, 12\lambda_i^{-1}, 14\lambda_i^{-1}, 16\lambda_i^{-1}\ m$) and periods ($T = 6\lambda_i^{-0.5}, 8\lambda_i^{-0.5}, 10\lambda_i^{-0.5}, 12\lambda_i^{-0.5}, 14\lambda_i^{-0.5}, 16\lambda_i^{-0.5}\ s$) are designed for the test. Certain combinations of wave parameters may be restricted due to wave breaking limit ($HL^{-1} > 1/16$) or wave making constraints ($H/d > 0.4$) by the laboratory limitations.

4.3 Stability and failure mechanism for survivability

Fig. 12 provides an overview of the centrifuge model test plan, which aims to observe the failure mechansim of big cylinders considering various variables, including soil layers, diameters, root depth, and backfill materials. Each testing batch involves four models placed in one soil sample strong box. A static pushover lateral loading at the target height will be applied to represent the maximum wave load and moment in the prototype.

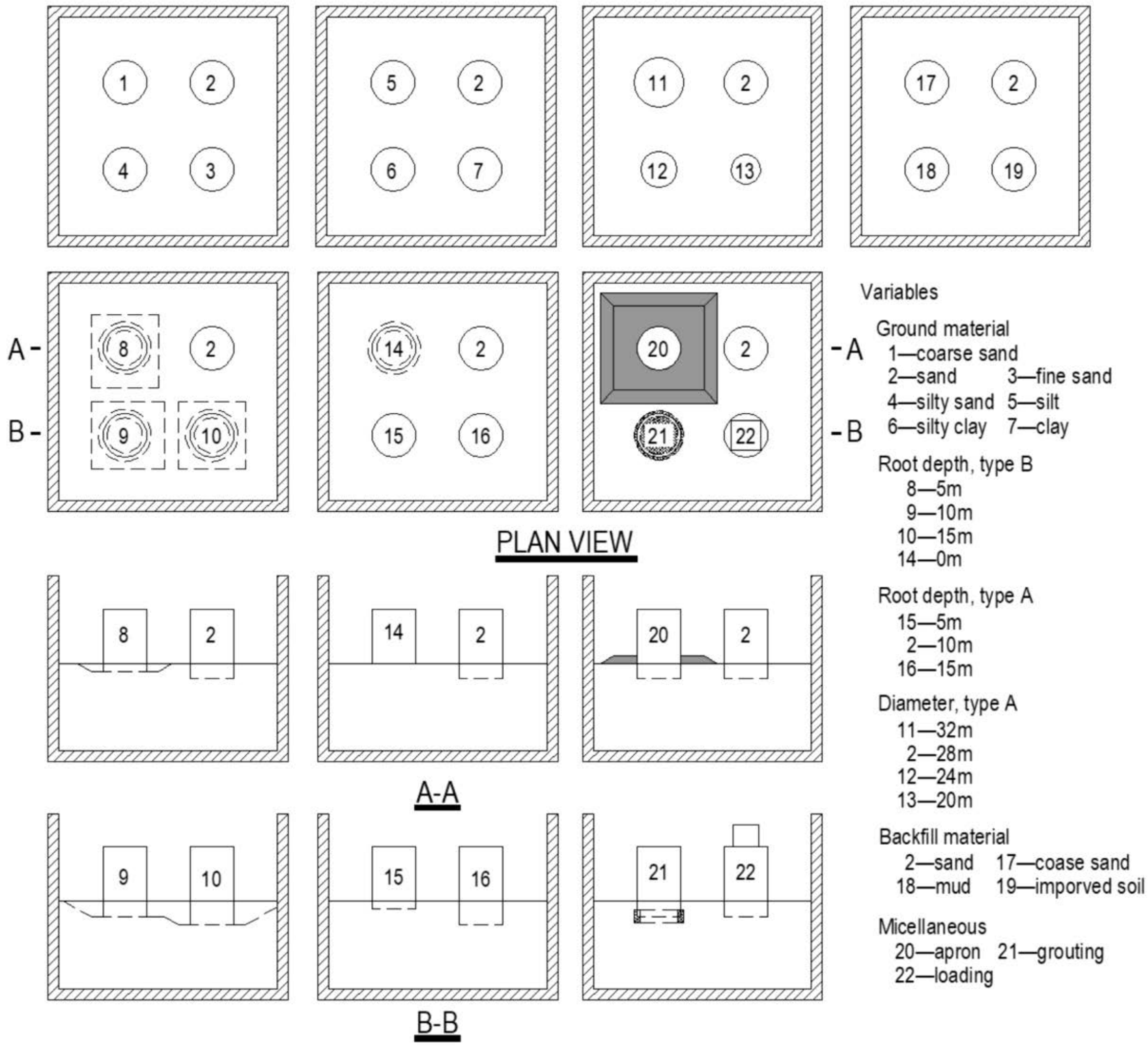


Fig. 12 Centrifuge test description in batches of the soil box

5 Application examples

5.1 Yangjiang mega-scale aquaculture farm

In this section, we will show several case examples based on the above described mega shelter engineering research outcrops.

Yangjiang mega-scale aquaculture farm project has completed its pre-feasiblility study by the time of writing this paper. Located approximately 20 km south of the Nanpeng Archipelago with a natural water depth of ~30m, this site is ~30km in a straight line from Hailing Island and about 40km in a direct line from Dongping Town in Yangdong

District. The permanent shelter structure is designed for 100 return period wind, wave, and current. The maximum 10-minute average wind velocity at 10 m high above mean sea level from various directions can reach up to 46.5 m/s. The maximum wave height of one-percent reaches 14.7m with a period of 13 s, and its primary direction is from the east to east-southeast. The maximum vertical averaged current velocity is 1.25 m/s. As seen, this site features very large wave but relatively low current and hence the master plane were further optimised.

The design criteria for the masterplane of this shelter of the aquaculture farm are: 1) to provide sufficient oxygen for the farmed fish, increase the exchange of aquaculture water between the interior and exterior of the shelter as much as possible; 2) the significant wave height in the sheltered region should be less equal to 3 m, considering the balance between the water exchange and wave elimination, as well as the aquaculture safety; 3) taking into account the fish net safety and its mooring system cost-effectiveness, the current velocity in the sheltered region should be 0.4 to 0.6 m/s.

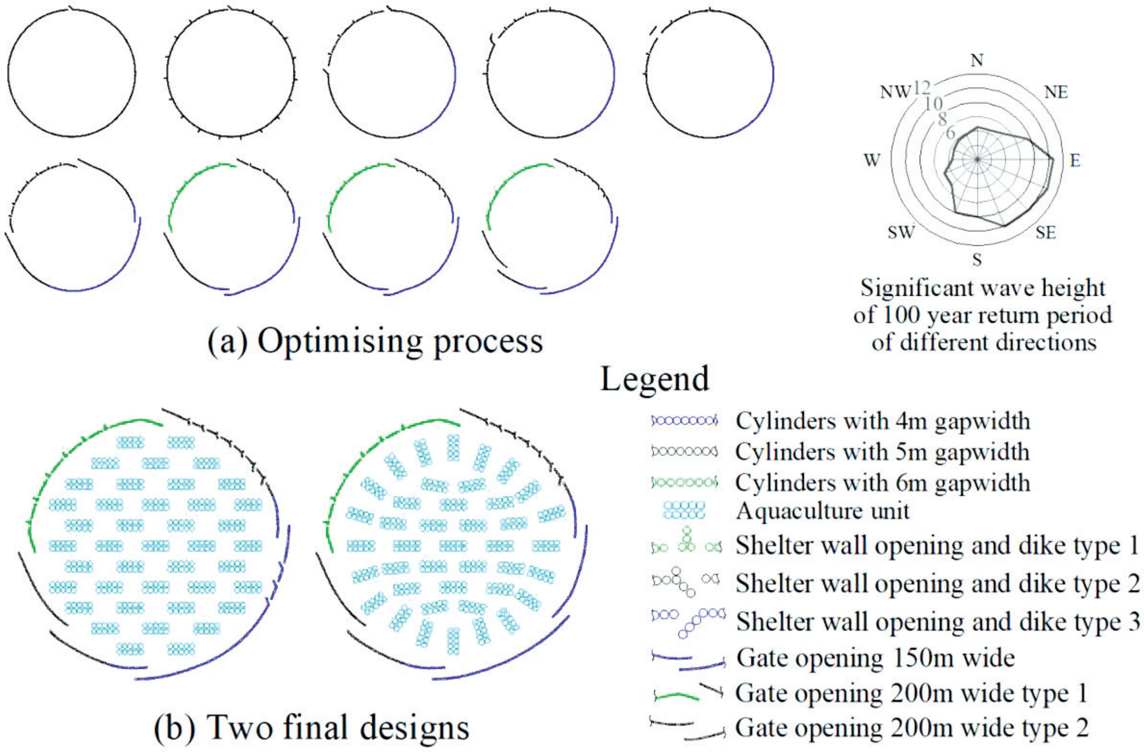


Fig.13 Design materplane of shelter structure (wave breaking units not shown)

Fig 13a shows the optimisation of masterplane to attract more current into the shelter region with openings and flow guiding layout. Totally there are 422 cylinders used to form this layout. This masterplane had been sent to various research institutes for studying: wind-induced wave and current increase in the sheltered region, marine ecological environmental impact, and aquaculture cultivation capacity, in which NHRI's numerical study (2023) shows that significant wave height in 50 return period waves are generally below 3 m and the water exchange volume is 10.24 ~ 10.94 billion m³ in winter and 11.69 ~ 14.61 billion m³ in summer, inferring that the freshwater are three times exchanged per day.

The aquaculture units, occupying ~10% of the sheltered waterbody, each unit has 10 HDPE fish nets of 80m diameter, are preliminarily set out on the two final masterplanes.

5.2 Sanya floating airport conceptual design and feasibility study

History of floating airport can trace back to the Sea Station patent by Armstrong (1932), preliminary design by Istvan Varga et al. (1969) for a four runway airport of ~4km^2, US Mobile Offshore Base (MOB 1992) concept, and Japan's floating runway platform (TRAM 2001), the stage two tests of which has a large scale of 1000, 60m in length and width.

In Sanya a new airport is needed for the increasing passenger demand. The original design was to build the airport of 80~100 million passengers per annual in an artificial island by the convention reclaimed method. The artificial island site was selected in 20 m waterdepth and 5km away from the shore of Haikou Sanya Tianyahaijiao, a very famous place of interest for tourist. However, the work has been stopped due to lacks of enough backfilling materials. In this background, the floating airport option was proposed and studied since 2021 lead by CCCC to replace the convention reclamation artificial island design.

Fig.14a showcases the on-going floating airport project. The new location is selected 10km away from the shore. The shelter wall is being developed to protect the floating island on which the airports will be built. The floating island, covering an area of 14 km^2, serves as a cost-competitive solution compared to convention reclamations as it eliminates 0.4~0.5 billion m^3 backfillings.

Various studies are being carried out such as floating airport architecture concept design and dead-and-live-load estimations for the design of floating island (Fig.14 show one of the solution by NACO), impact study of the newly built floating airport to the tidal hydrodynamics and beach erosion and siltation, marine ecological environment assesement including impact study to the coral reef and the endangered white dolphine, lightweight high-performance concrete development, social benefits and economic value study, etc. Main conclusions are that by shifting the airport location from 20 to 30 m of waterdepth and from 5 to 10km away of the shoreline, the natural shoreline is much less impacted and the sand beach as a tourist attraction will not disappear. Fig.14b shows one render from the perspective of tourists to evaluate the aesthetic appeal of the project.

(a) ariel view

(b) tourists view for project aesthetical evaluation

Fig. 14 Floating airport using mega shelter solution (rendered by CCCC/NACO)

5.3 “Blue Tianjin” plan

A more ambitious plan is proposed as shown in Fig.15. In the inner Bohai bay area, a mega shelter can be built. Beind the wall new campus of university, marine research facilities can be built on floating island. Furthermore, floating dock, oil storage facilities, Liquid Natural Gas import terminal, as well as offshore floating photovoltaics can be safely built and operated with the mega-shelter. These facilities are also connected by a ~15 km floating bridges and a ~15 km undersea tunnel back to the Tianjin city. By shifting the port offshore will make a blue shore of Tianjin city.

Fig. 15 “Blue Tianjin” plan

6 Final remarks

This study elaborates on building a mega-shelter wall to protect aquaculture or other very large offshore structures from hazardous sea loadings. To yield the largest region per wall length, the design master plan for the shelter should be a circle or square shape. Big cylinders using novel concrete-steel configurations can help build a permanent shelter. As a new structure, systematic physical model tests are essential to check the sea loadings, geotechnical capacities, effectiveness of wave reductions, and tidal flow exchangeability.

We hope this study can help promote sustainable use and smooth development for the continental shelf in water depths 20~40 m. And the mega shelter helps build safe sea farming that can create the majority of edible meat for the growing population. As Peter (2002) predicted, "fish farming may change us from hunters and gatherers on the seas into 'marine pastoralists'—just as a similar innovation some ten thousand years ago changed our ancestors from hunters and gatherers on the land into agriculturists and pastoralists".

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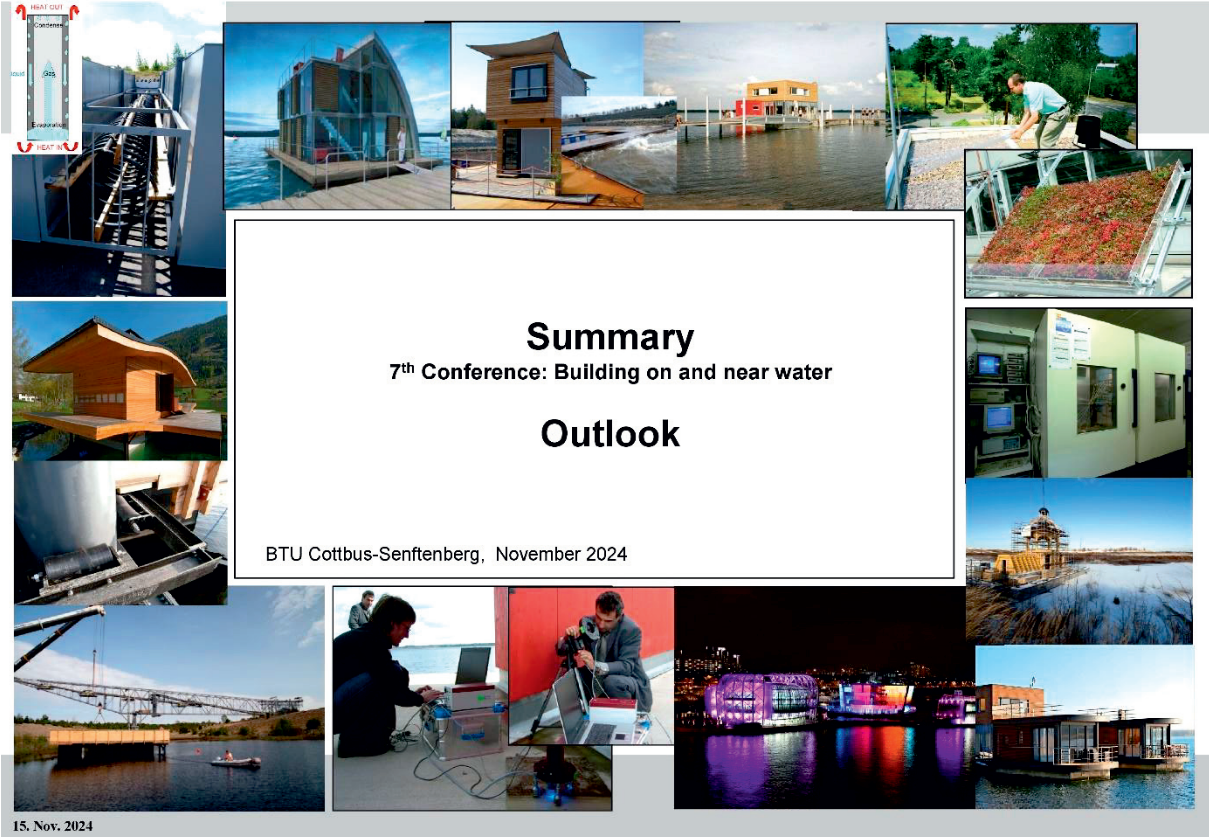
Summary and Outlook

Horst Stopp

BTU Cottbus-Senftenberg



Contributions to the conference according to the flyer

ANMELDUNG bis 10. November 2024

begrenzte Teilnehmerzahl zum Tagungstermin

Unkostenbeitrag: 60 € / ermäßigt 20 €

inkl. Konferenzmaterialien einschl. Pausenversorgung, Mittagstisch, Teilnahmezertifikat

TAGUNGSORT

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7. TAGUNG
SCHWIMMENDE BAUTEN
BAUEN AM UND AUF DEM WASSER

IBA Studierhaus, Seestraße 84-86, 01983 Großräschen
15. November 2024

ANLIEGEN DER TAGUNG

- Darstellen der allgemeinen und aktuellen Situation bzgl. Schwimmender und aufschwimmender Architektur
- Vermitteln technischer und naturwissenschaftlicher Kenntnisse und Forschungsergebnisse
- Erläutern und diskutieren regionaler und nationaler Zusammenhänge und Gegebenheiten
- Zusammenführen von Fachleuten sowie Investoren und Austausch von Erfahrungen
- Bilden und Unterstützen von Interessengemeinschaften
- Förderung der Strukturentwicklung und Schaffung von Arbeitsplätzen in der Lausitz
- Ausbau der wissenschaftlichen Basis schwimmender Architektur und ihre regionale Umsetzung sowie persönliche Kontaktaufnahme

SITUATION

Die Besiedlung von Wasserflächen schreitet voran. Aufgrund lokaler Starkregenereignisse und globaler Anstiege der Meeresspiegel werden schwimmende Bauten zu einem dauerhaft anstehenden Thema. Neben den Entwicklungen in den NL wird 2024/25 in Busan in Südkorea die erste schwimmnde Stadt eröffnet und die Malediven werben mit der größten schwimmenden Stadt in den nächsten Jahren.
Die 4. internationale Konferenz ICAADE für Schwimmende und Aufschwimmende Architektur mit Teilnehmern aus 15 Ländern an der BTU Cottbus-Senftenberg hat vom 9. - 11.10.2023 den Umfang des Themenspektrums beeindruckend demonstriert.
Ein DFG-Antrag mit der spezifischen Thematik zur Verwertung des Pontonraumes befindet sich in der Antragsphase. Entgegen dem internationalen Trend und objektiv mit dem Lausitzer Seenland vorhandenen Ressourcen hinsichtlich des zukünftigen Lebens auf dem Wasser und den damit verbundenen Exportchancen für die Region können regio-nal verantwortliche Ebenen keine Chancen für die Lausitz erkennen. Der Strategiebeauftragte der WRL lehnt die Entgegennahme einer Projektskizze für den Aufbau eines Zentrums für Schwimmende Architektur ab. Der Beauftragte des MP Brandenburgs und die Ministerin des MWFK verweisen auf die Hochschulautonomie.
Und die BTU Cottbus-Senftenberg beklagt die dünne Personaldecke. So ist auf Vorschlag der Verantwortlichen von Kommunen und der LMBV sowie des ehemaligen Leiters der IBA Fürst-Pückler-Land der Verein IfSB e.V. gegründet worden, um die Thematik zu befördern. Unterstützer sind jederzeit herzlich willkommen.

PROGRAMM

9.00 Uhr	**Einstimmung** Malkunst: Katja Wolf / Fotografie: Detlef Attila Hecht
	Begrüßung Prof. Dr. Bernhard Weyrauch, BTU Cottbus-Senftenberg, Dekan der Fakultät 6
	Einführung/ Moderation Dr.-Ing. P. Strangfeld, Leiter des Institutes für Schwimmende Bauten
9.30 Uhr	**Nachruf für Prof. Dr. sc. phil. Rolf Kuhn** Frank Höfler, BTU Cottbus-Senftenberg, Fakultät 6
10.00 Uhr	**Rechtliche Voraussetzungen an das Bauen in Überschwemmungsgebieten** Juliane Jentsch, BTU Cottbus-Senftenberg, Fakultät 5
10.30 Uhr	Kaffeepause
11.00 Uhr	**Das Bewältigen der Wohnungsbaukrise in San Francisco mittels Schwimmender Architektur** Carolina Jiménez
11.30 Uhr	**AquaBus – Flexibles amphibisches Angebot zur Erschließung schwimmender Siedlungen** Frank Höfler, BTU Cottbus-Senftenberg, Fakultät 6
12.00 Uhr	Mittagspause im Haus Vier
13.15 Uhr	**Einsatz von wasserbaulichen Modellen zur Untersuchung von Wellen in Seen** Konrad Thürmer, BTU Cottbus-Senftenberg, Fakultät 2
13.45 Uhr	**Standortwahl für schwimmende Häuser an Tagebauböschungen** Thomas Kramer, Stadtverwaltungtadtentwicklung Stadt Cottbus, Bereich Stadt-entwicklung
14.15 Uhr	Kaffeepause
14.45 Uhr	**Simulative Untersuchungen der Gestalt eines Pontons zum Stabilitätsverhalten** Yaraslau Silavin [?], BTU Cottbus-Senftenberg, Fakultät 3
15.15 Uhr	**Multifunktionale aufschwimmende Hybrid-Plattform für die Besiedlung des Wassers** Eduard Völker, BTU Cottbus-Senftenberg, Fakultät 6
15.45 Uhr	**Zusammenfassung und Ausblick** Horst Stopp, BTU Cottbus-Senftenberg, Fakultät 6

Regional situation

Lusatian lake district + **BTU C-S** = > ?

Including Cottbus Baltic Sea

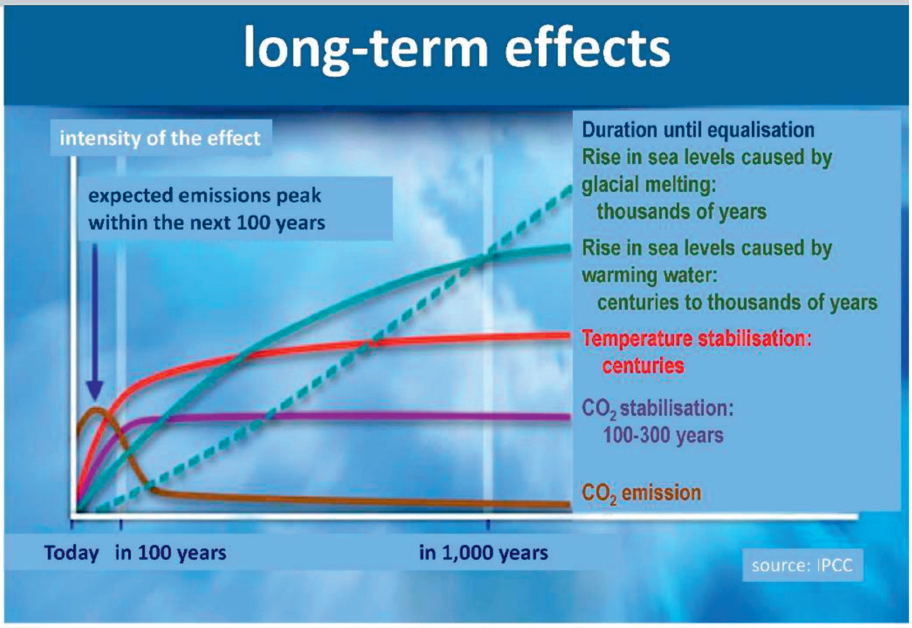
all disciplines

Experimental field for Floating Architecture

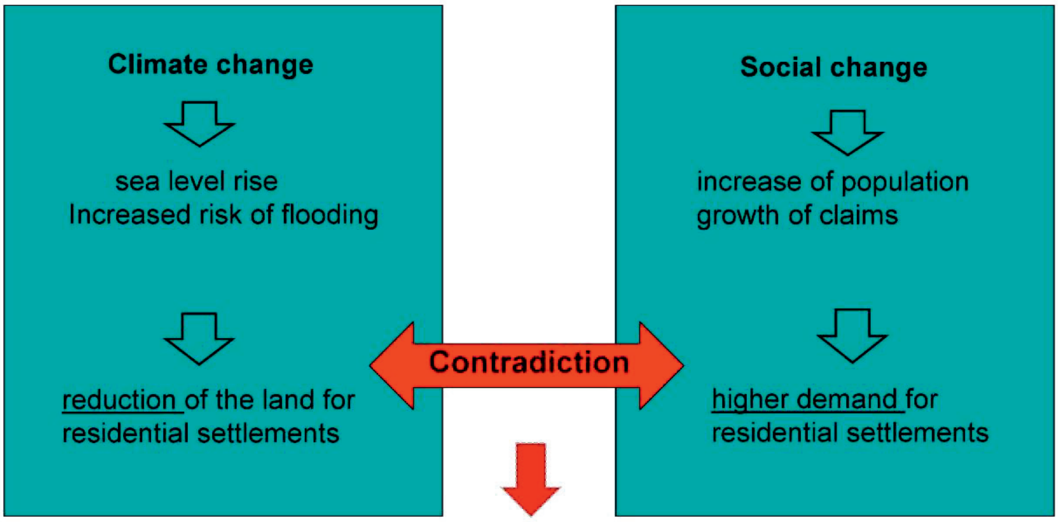
Global situation

Independent of subjective influences: accelerated climate change and its consequences

→ **Highly sustainable effects !**

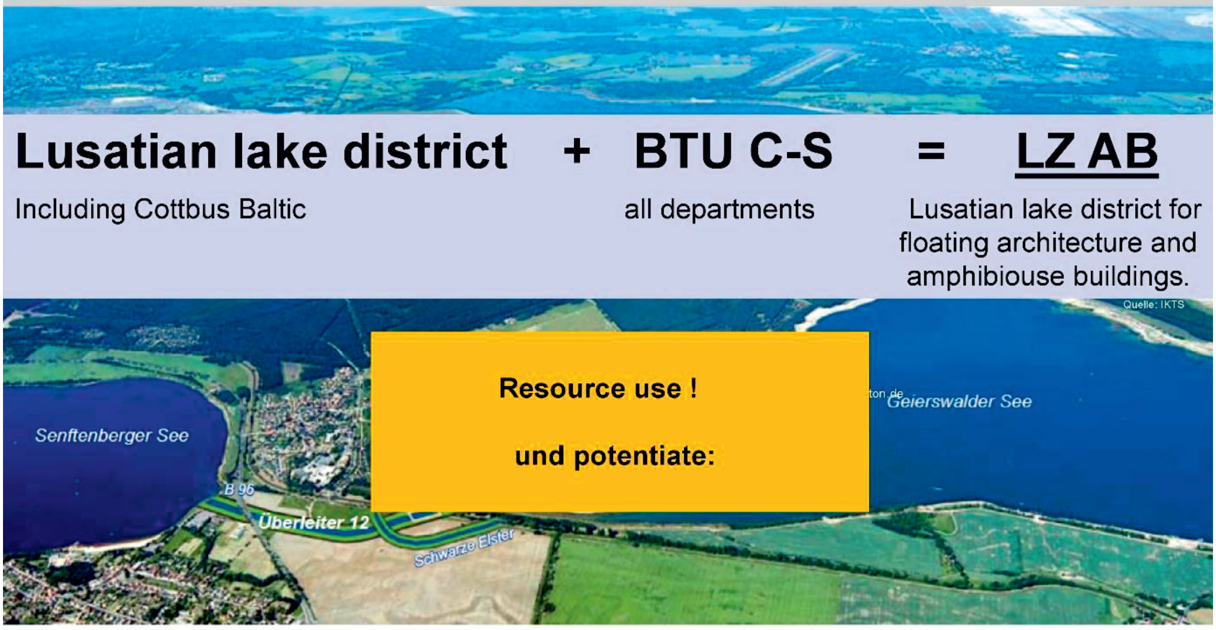


Conclusions



Solution: Floating and amphibious architecture

Outlook



Objectives and structure of the LZAB

Objectives

- Supporting the current change and transforming an economy, dominated by lignite, into a „green" region

- Utilizing the created open-cast mining lakes with their diverse characteristics regarding water chemistry, shoreline profille and wind effects

- Founding future-proof companies

- Development of globally adapted floating architecture and amphibiouse buildings

Structure

Locations: IBA – Terraces and Lusatian Science Park with branches at some lakes near Bergheide, Geierswalde and Partwitz

Expanding the range of topics

Pontoon rooms : Use as technical rooms
Use as storage facilities
Use as high-quality recreational areas
Aquaponics culture

Pontoon shell : Use as heat exchangers for heating and cooling
Use as traffic areas
- Access roads
- Parking areas
- Play and sports areas
- Runways

Water surfaces as
special areas : Floating settlements
PV lakes and wind farms
Nature conservation areas (e.g., flightless young birds)

Use of the mobility of the ground

- Benefit from changing the position of floating objects

  - Orienting surfaces towards solar radiation
  - Positive or negative influences from neighboring areas
  - Changing diving depth (tsunami protection)

- Taking advantage of the opportunity to relocate
  - Fulfilling individual preferences and needs
  - Avoiding future adversities
  - Flexibility regarding urban planning

- Use of damped energy from the vibrating total mass of floating houses
  - Conversion of vibration energy into stored compressed ai
  r- Underwater pressure tanks: advantageous dimensioning

Goodby ! 2026

In the spirit of Rolf + Tamara Kuhn
and their fellow campaigners:

for the

preservation of creation
and its sustainable use

everyone in their assigned place

in the interest of all
+
our children and grandchildren as well as their planet Earth

Schwimmende Architektur – Bauen am und auf dem Wasser Bauten /
Floating Architecture – Constructions on and near water
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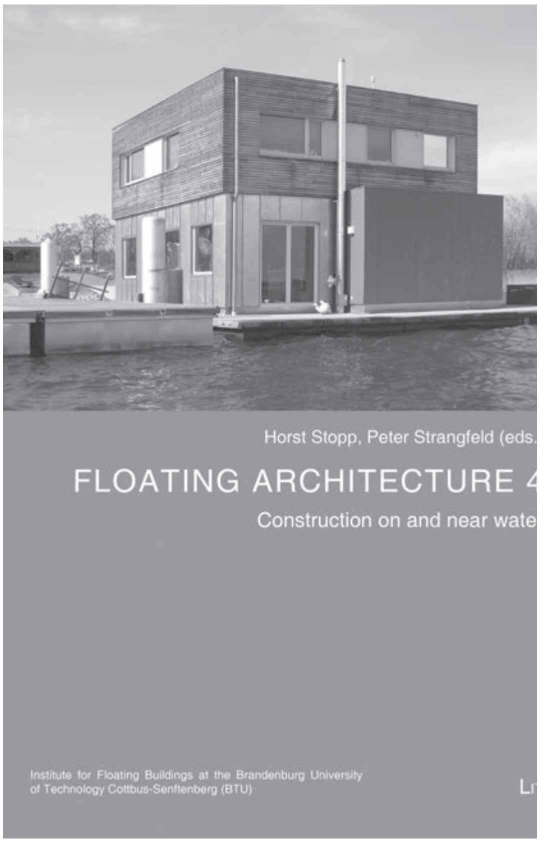

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Floating architecture is not only an issue for luxurious tourism but with the climatic change the building of floating structures becomes relevant for many areas in the world. In regions with rising sea levels, frequent flooding, or thawing permafrost, floating structures can be a solution to adapt existing settlement areas to these new conditions.

The self-sufficient energy and supply systems required for floating settlements can also be used in rural areas with a lot of migration.

The collection presents papers of conferences organized by the Faculty of Architecture and Urban Planning at Brandenburg University of Technology Cottbus-Senftenberg (BTU).

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