Horst Stopp, Peter Strangfeld (eds.)

FLOATING ARCHITECTURE

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

Schwimmende Architektur –
Bauen am und auf dem Wasser

Floating Architecture –
Building at the and on the Water

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List of authors (alphabetical)

Busse, Ralph-Peter, Dipl.-Ing.
BUSSE Innovative Systeme GmbH, Leipzig
Ralf-Peter.Busse@busse-gmbh.de

Fischer, Gert,
BTU Cottbus-Senftenberg, FG Funkbasierende und optische Kommunikationssysteme
Gerd.Fischer@b-tu.de

Gebauer, Gert, Prof. Dr.rer.nat.
BTU Cottbus-Senftenberg, FG Baustoffe, Bauchemie, Betontechnologie
gert.gebauer@b-tu.de

Höfler, Frank, Prof. Dr. Ing.
BTU Cottbus-Senftenberg, FG Mobilitätsplanung
Frank.Hoefler@b-tu.de

Junker, Sabine, Prof. Dr.-Ing
Beuth Hochschule für Technik Berlin, FB IV Architektur und Gebäudetechnik
Lehrgebiet Entwerfen, Innenraumplanung und Visualisierung
suju@beuth-hochschule.de

Kramer, Thomas, Dipl.-Ing.
Stadtverwaltung Cottbus, Fachbereich Stadtentwicklung
Thomas.Kramer@cottbus.de

Opperskalski, Stephan
BTU Cottbus-Senftenberg, FG Funkbasierende und optische Kommunikationssysteme
Stephan.Opperskalski@b-tu.de

Potthoff, Ulrich, Dr.-Ing.
Fraunhofer-Institut für Verkehrs- und Infrastruktursysteme IVI, Dresden
Ulrich.Potthoff@ivi.fraunhofer.de

Remus, Ricardo, M. Sc.
Bauhaus Universität Weimar, F. A. Finger-Institut für Baustoffkunde,
ricardo.remus@uni-weimar.de

Schlamkow, Christian, Dipl.-Ing.
Universität Rostock, Fachgebiet Geotechnik und Küstenwasserbau
Christian.schlamkow@uni-rostock.de

Schmidt,Wolfgang, Dr. –Ing.
BTU Cottbus-Senftenberg, FG Bauphysik und Gebäudetechnik
wolfgang.schmidt@b-tu.de

Scobel, Ekkehard, Dipl.-Chemiker
HTW Dresden, Fak. Elektrotechnik
Zentrum für angewandte Forschung und Technologie ZAFT e.V.
scobel@htw-dresden.de

Stopp, Horst, Prof. Dr. sc. techn.und Ing.habil.
BTU Cottbus-Senftenberg, FG Bauphysik und Gebäudetechnik
horst.stopp@b-tu.de

Strangfeld, Peter, Dr.-Ing.
BTU Cottbus-Senftenberg, FG Bauphysik und Gebäudetechnik
peter.strangfeld@b-tu.de

ThuTrang Nguyen, Doctoral
BTU Cottbus-Senftenberg, Fak. 6 Architektur, Bauingenieurwesen und Stadtplanung
thutrangnguyen101@gmail.com

Völker, Eduard, M.Eng.
BTU Cottbus-Senftenberg, FG Bauphysik und Gebäudetechnik
Eduard.Voelker@b-tu.de

Vukorep, Ilja, Prof. Dipl.-Ing. Arch.
BTU Cottbus-Senftenberg, FG Computergestütztes Entwerfen
ilja.vukorep@b-tu.de

Weidhase, Frieder, Prof. Dr. rer. nat.
BTU Cottbus-Senftenberg, FG Funkbasierende und optische Kommunikationssysteme
Frieder.Weidhase@B-TU.De

Winzer, Reinhard, Dr. Ing.
Dyckerhoff GmbH, Wiesbaden
reinhard.winzer@dyckerhoff.com

Opening remarks

For many years, the Faculty of Architecture and Urban Planning at Brandenburg University of Technology Cottbus-Senftenberg (BTU) has carried out research on the topic of “Floating Structures”.
At first glance, one might wonder how BTU, located in Prussia, an area nicknamed the “box of sand,” deals with this topic. It all started with the local problem of abandoned open cast mines and the resulting abandoned mine pits. Within the context of the International Building Exhibition „IBA Fürst Pückler-Land“, the idea was created to revitalise the post-mining landscape by flooding the mine pits in order to transform the whole area into a lake district called „Lausitzer Seenland“. Since made-up shore areas cannot be used for construction activities, the idea arose to build floating structures for tourism purposes on the lake.
Since this project was started, it has resulted in the research of a lot of questions about construction and urban planning by faculty members at BTU. At scientific conferences on this topic, it was quickly found out that not only luxurious tourism is a central issue but with the climatic change the building of floating structures also 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.
In Lusatia, with the flooded open cast mines, BTU has a real-world laboratory that is perfectly suited for applied research into “Floating Structures”.
This topic is a research priority of the Faculty within the complex of studies on „Building for Climate” and „Energy Efficiency and Sustainability“ studied by BTU. In recent years, a network comprising regions in Europe and Asia dealing with similar research tasks was established.
In-depth research at BTU and an expansion of the existing network in Lusatia are the aims of research development in our faculty.

Professor Dipl.-Ing. Markus Otto,
Dean of Faculty 6

Editorial

The publishers are receiving more and more inquiries about the topic “Floating Architecture”, particularly about technical details, water chemistry, as well as ice and wave problems. Since there is a lack of technical literature on this topic, most students working on projects or theses related to this topic send their inquiries. A time of general and quick changes results in a large number of daily publications. Therefore it is difficult to understand why there is a lack of literature about floating structures. One has to consider that sea levels will continue to rise and consequently a larger number of people will have to live on the surface of the sea.

Obviously, some expert knowledge is required which needs a longer period of time to be gained through scientific advancements and experience.

The publishers, who have been dealing with the topic of floating houses for some years, are grateful to the authors for their agreement to allow the publication of their papers on floating architecture. These papers were mainly prepared for two conferences on floating architecture held in the study centre of the IBA building, Großräschen.

Therefore, the reader should know that, along with the usual papers, only a selection of self-explaining transparencies is shown in order to meet the printing requirements.

The included list of both the authors and their addresses makes it easy for interested people to send any inquiries to them.

A short introduction as well as an outlook at the end of each paper is meant to draw attention to current events in order to be able to promptly identify opportunities and risks connected with living on the water.

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1 Introduction

Situation

The popularity of floating structures is on the rise. This applies to regions and communities as well as touristic uses. Rotterdam with its floating pavilion and Seoul with a floating entertainment centre, which can house more than 6,000 visitors, stand for municipal acceptance and self-representation of the administration and citizens. To promote tourism in South-East Asia, a centuries-old tradition of living on the water has been revived. Lower Lusatia in the east of Germany – a post-mining landscape with an exemplary structural change- showcases the largest artificially created lake scenery in Europe. In this region, floating houses with a variety of functions attract tourists. Through the construction of these structures, scientific progress has created the potential for job creation for the post-coal era. In the areas where coal is still being extracted and first areas were recultivated or marinas for floating houses have been made, a unique global scientific centre supported by university institutions is going to be established in the future.

Not only do revitalisation and the creation of tourist attractions form the background for interest in this topic, but so do rising sea levels caused by recent climatic change.

More than just the infrastructure of shores is endangered. River basins are severely threatened by river backwater and reduced outflow gradients during flooding. On the basis of flood management guidelines set up by the EU administration, floating structures could improve the efficiency of future retention areas.

Along with the transformation of abandoned industrial sites into tourist destinations, another advantage of floating architecture is its potential as a promising German export good.

The Lusatian Lake District created with the support of the International Building Exhibition ”Fürst-Pückler Land“, LMBV, (Lusatian and Central German Mining Administration Company) and BTU Cottbus-Senftenberg is a unique and eminent landmark of the state of Brandenburg.

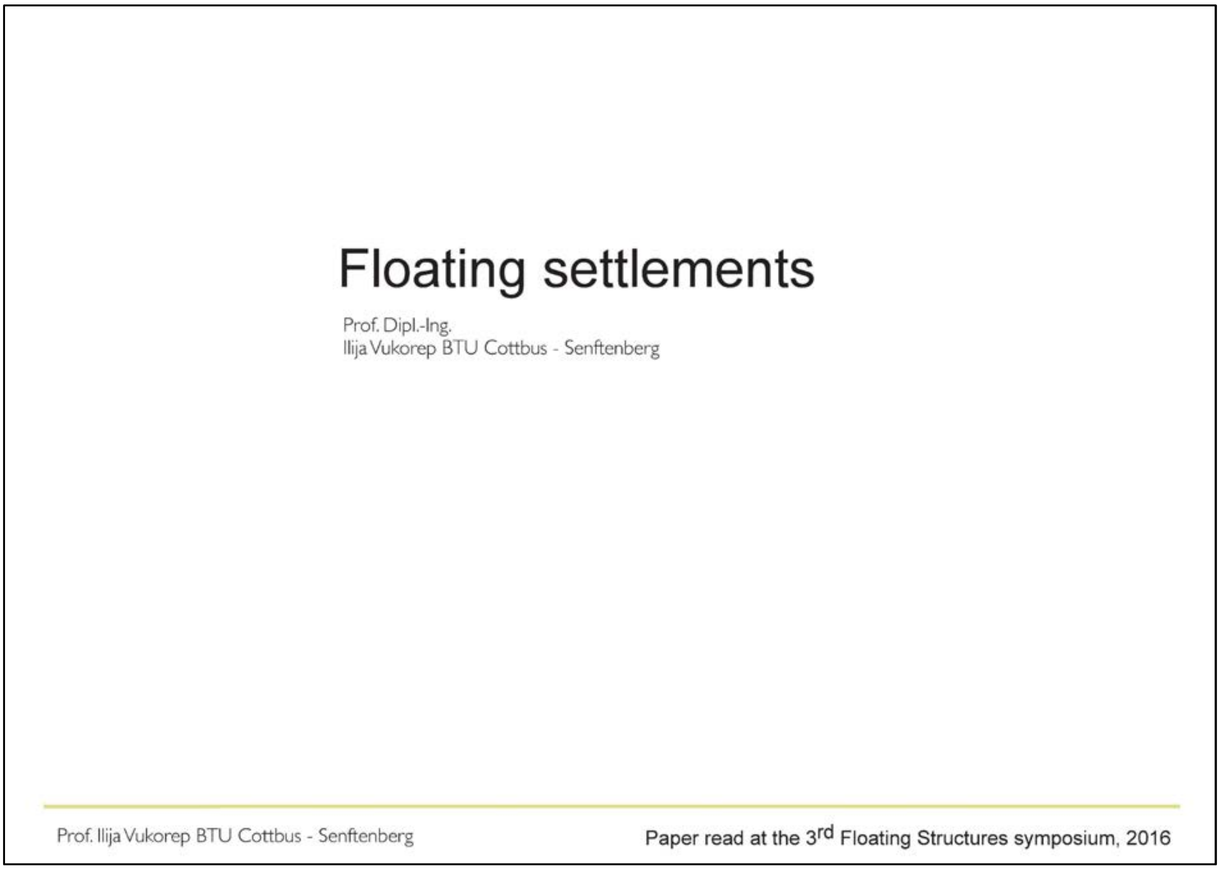
The concern

The concern of floating architecture and thus the aim of the Institute for Floating Structures (IfSB) of Brandenburg University of Technology Cottbus-Senftenberg results from the existing situation. The latest IPCC report predicts an accelerated rise in sea levels that is a serious threat to developed coastal regions and flood plains.

Construction on the water as a possible solution to this problem requires complex approaches. However, it also includes risks regarding material stresses, environmental pollution and social safety. On the other hand, it also offers opportunities in terms of the mobility of structures and the utilisation of alternative energy sources.

The self-sufficiency, the supply with electric energy, heat energy, freshwater, and the discharge of waste water and waste form the basis of future floating settlement structures. This fact has to be taken into consideration in order to be able to successfully compete in the world market and to avoid economic damage in the long run.

The selected papers were read and discussed by experts at the last two “Floating Architecture-Construction near and on Water” symposia, held in 2014 and 2016 at the study centre of the IBA, Großräschen.



Floating Structures – A Catalyst for Innovative Construction

Water is life – life on earth is inseparably tied to water. When viewing the development of civilisations, we can see that their advancement was connected with the innovative use of water (Romans – aqueducts, Mesopotamians and Egyptians - utilisation of rivers, East-Asian Civilisations – rice terraces).

Throughout history, human development has taken place in coastal regions. By looking at the habitation of floating islands by ancient people such as the Uros in Peru and Bolivia and the ancient swamp settlers in Iraq, we can realize important characteristics for future development: ecologically-related connections and a high degree of self-sufficiency. From these cases, we can also conclude that floating structures are more effective when they take the form of connected housing systems rather than single settlement structures.

With new materials, innovative energy generation, and computer-generated methods of production, we are able to cope with climate challenges. In the future, we will not see water as a threat but as new living space with inexhaustible potential. Developments in the Netherlands and South-East Asia show us that floating structures can have functions outside of the realm of tourism. Rising sea levels and the growing world population result in alternative forms of living and settling with a high technological degree of innovation connected with knowledge gained from traditional settlements on water.

Floating settlements

Pats and places of the mankind
Typologies
Uros Lake / Peru
Swamp settlement
Floating settlements in Asia
Postwar planning
Metabolism
Buckminster Fuller
First floating settlements in Europe

Floating Settlements

Itsukushima

Pile Buildings

Floating Settlements

Uros Lake Peru

Floating Settlements

Swamp Settlement, Marsh Arabs / Irak / Iran

Floating Settlements

Floating Settlements in Asia, Ko Panyi / Thailand

Floating Settlements

Bangkok / Thailand

Floating Settlements

Postwar Planning, Manila / Philippinen

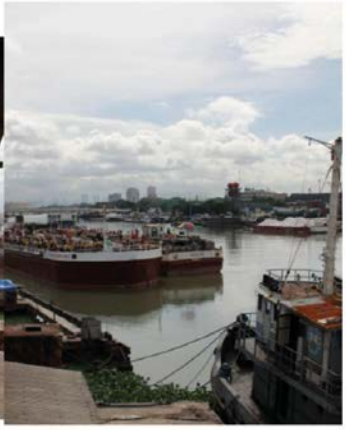


Fig.4.4 Pasig River looking North.
Source: Altea, G.

Metabolism, Manila / Philippinen

Fig.5.15 Dwelling unit with two additions.
Source: Altea, G.

Fig.5.12 Baseco community with new shelters.
Source: Altea, G.

Manila / Philippinen

Fig.5.6 Structural Study Model

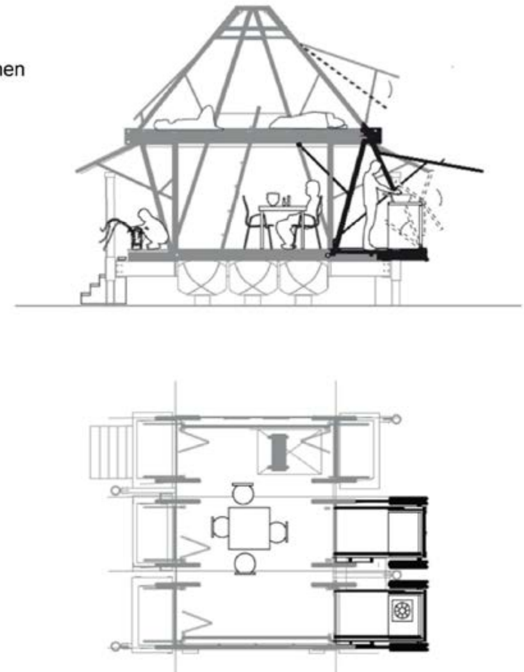


Fig.5.16 Ground floor plan and section of dwelling unit with two additions.
Source: Altes, G.

Inle See / Myanmar

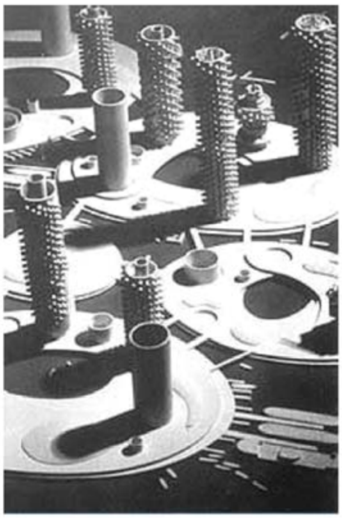
Cho Chau Doc / Mekong Delta / Vietnam

Floating Settlements

Cho Chau Doc / Mekong Delta / Vietnam

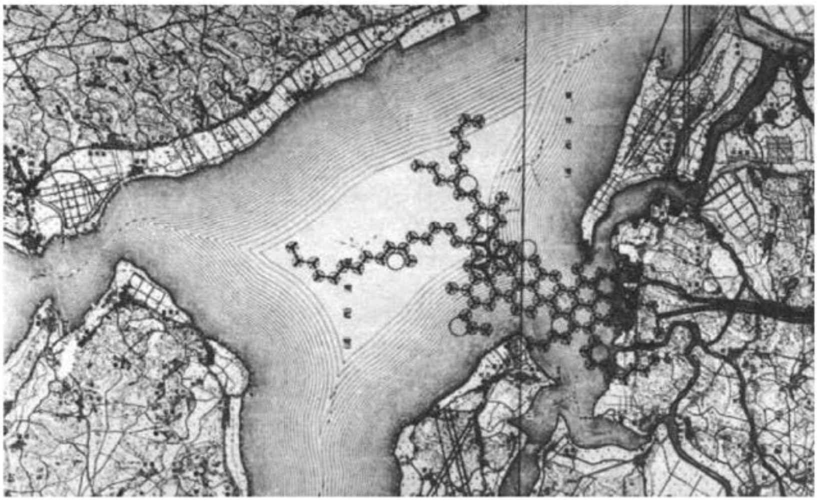
Floating Settlements

Kiyonori Kikutake / Unabara / 1960



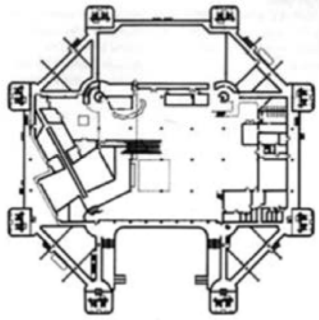
Floating Settlements

Kurokawa / Tokyo Bay Masterplan / 1960



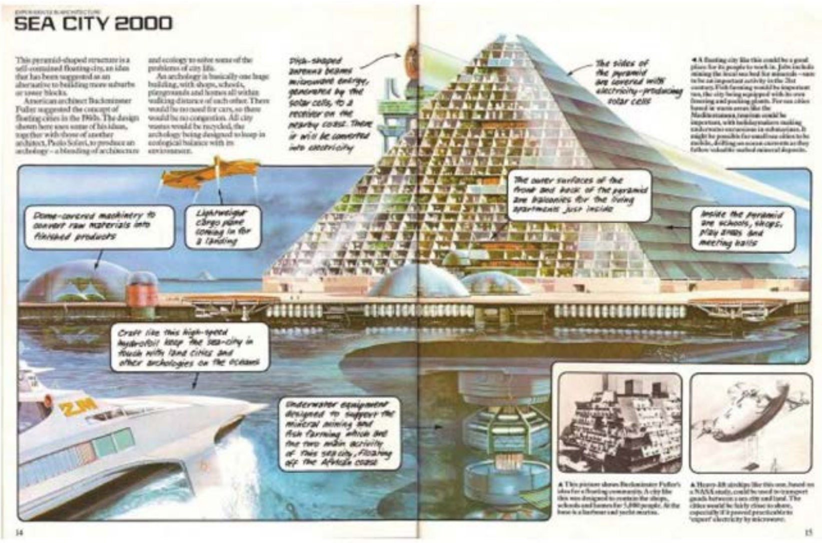
Floating Settlements

Pile Buildings, Kiyonori Kikutake / Aquapolis / EXPO / Okinawa 1975

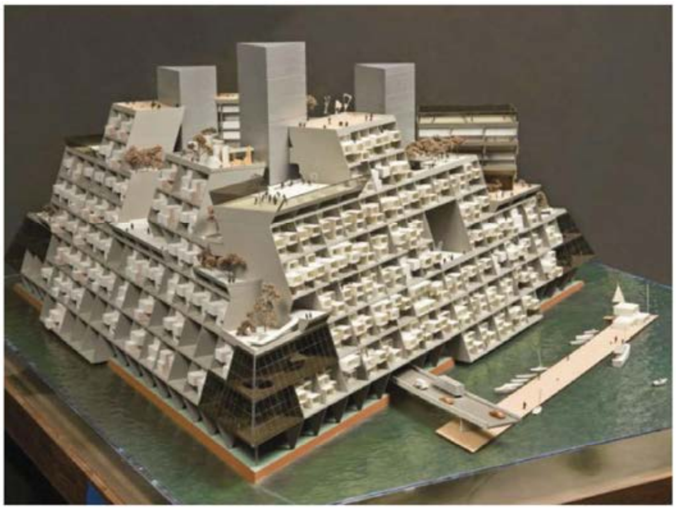


- 18m above water / 15 m deep
- Total area 10.000 sm
- Stabilizing with a pump system
- semi-automatic operation

Buckminster Fuller / Triton City / 1968



Buckminster Fuller / Triton City / 1968



Floating Settlements

Floating Settlements in Netherlands

Floating Settlements

Architectural Approaches to A Sustainable Community with Floating Housing Units Adapting to Climate Change and Sea Level Rise in Vietnam

Nguyen Thi Thu Trang, Supervisor Prof. Ilija Vukorep

Abstract — Climate change and sea level rise is one of the greatest challenges facing human beings in the 21st century. Because of sea level rise, several low-lying coastal areas around the globe are at risk of being completely submerged, disappearing under water. Particularly in Viet Nam, the rise in sea level is predicted to result in more frequent and even permanently inundated coastal plains. As a result, land reserving fund of coastal cities is going to be narrowed in near future, while construction ground is becoming increasingly limited due to a rapid growth in population. Faced with this reality, the solutions are being discussed not only in tradition view such as accommodation is raised or moved to higher areas, or "living with the water", but also forwards to "living on the water". Therefore, the concept of a sustainable floating community with floating houses based on the precious value of long term historical tradition of water dwellings in Viet Nam would be a sustainable solution for adaptation of climate change and sea level rise in the coastal areas. The sustainable floating community is comprised of sustainability in four components: architecture, environment, socio-economic and living quality. This research paper is focused on sustainability in architectural component of floating community. Through detailed architectural analysis of current floating houses and floating communities in Viet Nam, this research not only accumulates precious values of traditional architecture that need to be preserved and developed in the proposed concept, but also illustrates its weaknesses that need to address for optimal design of the future sustainable floating communities. Based on these studies the research would provide guidelines with appropriate architectural solutions for the concept of sustainable floating community with floating housing units that are adapted to climate change and sea level rise in Viet Nam.

I. INTRODUCTION

The coastline of Vietnam is more than 3,260km long and stretches from north to south with two fertile deltas of Red river and Mekong river that discharge into the sea. The river system and the sea do not only provide water for rice cultivation and fishing grounds for inhabitants, but also become the habitat of many Vietnamese generations. It was observed that early in the twentieth century, Vietnam had many 'floating villages' which included groups of fishers or boatmen [1]. Figures for these groups were not provided. Other sources indicate that the number of floating villages was not high. At the beginning of the 19th century, there were 70 floating units in 12 old towns in the provinces of the Red River Delta and along the coast, from Quang Ninh Province to Ha Tinh Province [2]. In the 1930s, there were about 90 floating hamlets or villages located in rivers, and about 21 ones along the coast in the region from the Vietnamese/ Chinese border to the Tien Yen area [3]. In contrast, in the Central Region of Thanh Hoa to Binh Thuan provinces, where the rivers are short and the land is mountainous, freshwater bodies cannot sustain fisheries big enough to support 'floating villages'. Therefore, such communities are concentrated in estuaries and lagoons. Since 1955 the number of 'floating villages' has decreased, mainly as a result of the reorganization of rural management, irrigation development, the destruction of riverine resources, and water pollution. Consequently, the Vietnamese government erased some floating villages and many families either switched to living on land or changed occupations entirely. As a result, nowadays the number of floating houses and floating villages has been decreasing rapidly in Vietnam. By contrast, in recent years, floating houses are an emerging household trend for many coastal communities all over the world. The majority of researchers have appreciated that the floating house is an effective solution which helps coastal areas adapt to climate change and sea level rise.

Therefore, the aim of research is not only preserving floating houses - a unique accommodation type of traditional architecture in Vietnam, but also developing the concept of sustainable floating communities with floating housing units that help coastal communities withstand dramatic changes in climate and sea level as well as ensure a stable and permanent living for water dwellers. Most of the water dwellers are poor and low-income people who have been farmers. Therefore, floating villages emerged from farming villages. Floating communities and floating houses reflect traditional Vietnamese rural architecture. Based on traditional architecture, water dwellers modified and developed structures, materials and space of the house in order to adapt to the natural environment on the water, and to be suited to local culture. Through centuries, water dwellers accumulated valuable experience for designing floating houses with a view to the environment, the climate and the local culture. Based on analysing both the strengths of traditional architecture and the weaknesses of the current state of floating houses and floating villages in Vietnam, this paper provides solutions which are going to be architectural guidelines for a proposed concept of sustainable floating communities with floating housing units. From that, lessons are drawn in 4 categories: site planning, building design, using energy and sanitation.

II. Overview of Natural Conditions and Cultural Setting

A. Natural Conditions

Vietnam embraces around 3,260 km of coastline from Mong Cai in the north to Ha Tien in the south. Vietnam covers a relatively complicated terrain: countless mountains, criss-crossed rivers, stretching and meandering coastlines. Between the regions, the relationship between mountains and plains on the mainland differs. The coastal zones are divided into 3 regions; south, central and north with 28 coastal provinces.

Located in a tropical monsoon climate region, Vietnam is influenced by natural calamities, such as typhoons, monsoons, storm surges, sea level rises and El-Nino phenomena. Scientific research, currently being undertaken in Vietnam, indicates that significant impacts due to sea level rise may already occur. Vietnam generally has a hot and humid tropical monsoon climate. The territory of Vietnam has a long S- shape and is entirely located in the tropical belt, stretching from 8°30′N and 23°22′N which causes a high solar radiation all the year round, and the sun mainly moves in the southern sky. The northern coastal zone has a humid subtropical climate, with four seasons and with short cold winters. The temperature rarely falls below 5°C and occasionally it reaches 40°C. Rainfall and rain intensity are quite intensive. Therefore, cold wind protection in winter is a specific requirement. The central coast has a tropical climate with monsoons. In summer, hot dry monsoon brings in extremely hot temperatures, whereas the northern area is still affected by the cold wind in winter. Rainfall and rain intensity are quite large, and typhoons frequently strike this area from June to December. Due to extreme weather with massive flooding and typhoons, there are very few floating houses and floating villages in the central coastal zone. Preventing overheating and providing typhoon resistance are most crucial in this area. With its much hotter temperatures, the southern region of Vietnam has only two main seasons: a dry season and a rainy season. Genial climate with average temperature around 22°C to 27°C and storms are less common, as well as a criss- crossed river systems. There are a number of floating villages located in the southern coastal zone. There are different architectural solutions to each region that respond to a specific climate and natural environment.

B. Cultural, Social and Economic Setting

Fishing activities in the coastal areas of the north and south never were of major importance. Further, the northerners were unfamiliar with seafood. Therefore, many spices were used while cooking to mask the taste of marine fish and make them resemble freshwater species. Southerners started fishing much later than the northerners. In addition, since the south of Vietnam is rich in freshwater fish, southerners never traditionally caught marine species [4]. They did not live from fishing in natural resources, but were also breeding fish in cages under or beside of their floating houses. Fishers moved from mobile living on the boat to a permanent living in floating houses used for both living and working. The situation is different in the Central Region, where agricultural land is poor and scarce, and the swift-flowing rivers do not have much fish. There, in contrast to the northern and southern parts of the country, marine currents bring large fish stocks into nearshore waters. Therefore, migrants from the northern provinces of Vietnam who settled in the coastal area of the Central Region became marine fishers, and a new culture and way of life gradually emerged. Therefore, floating houses and floating villages are more often built in the northern and southern coastal zones than in the central ones.

III. MAIN RESULTS

A. Sight Planning

1. Planning

Asia is historically renowned for its local original principles of floating houses with a floating community which is called floating village (Fig 1). The village community has been the basic administrative unit. in Vietnam for a long time. The floating village is a group of fishers and their families who permanently live on their fishing boats or their floating houses. There is a lack of both dwelling houses on land and farmland which forces the fishers and their families to live on rivers or in estuaries or coastal lagoons. Floating villages respect family and professional relationships. In a water-based hamlet, people with the same family name always use the same fishing gear and gather together to form a hamlet, a traditional, small and self-managed community [4]. Some five or more family floating houses are always moored together and linked together by footbridges. Residents greatly respect neighbourhood relationships, because they live in a natural environment that combines both abundant resources and numerous challenges. The struggle for survival has increased the need for mutual assistance among lagoon fishing community members [5]. All the rivers and waterways are more characteristic for their local floating markets even if more conventional markets halls or market streets offer essential sales and shopping venues for the people who live on the water [6], (Fig. 2).

Fig. 1 (a) Floating village, Ha Long Bay, Vietnam, (b) Planning of a floating village.

Fig. 2 Floating market, Cai Rang, Can Tho, Vietnam

The floating houses are divided into 2 types; one is used for living and another one for both living and working with cages built under or beside the floating houses for breeding fish. There are two types of compound housing in a floating village:

- Individual houses.
- Cluster of houses.

Individual households are autonomous as regards spatial, technical and architectural decisions of building design and construction in accordance with preference, income and technical upgrade of water dwellers. The autonomy seems to enhance creativity and flexibility of water dwellers in establishing abundant structural solutions adapting to the environment and climate change.

Besides the strength as characteristics of a traditional community, floating villages also have obvious drawbacks. One of the problems facing many of floating villages is lack of urban planning and public buildings that are very important for the activities of a community such as kindergartens, schools, culture houses, playing grounds for children etc. In addition, floating villages also lack parking space for boats for individual houses and public places. People could park their boat at any empty space on the water surface without a being restricted by lines. As a result, in the areas where plenty of floating houses are located, the boat traffic is hindered leading to a congestion of boat traffic and the flow of water.

Lessons:

- Planning of floating villages has to be in accordance with local planning.
- Developing concepts for floating communities - floating villages including family floating houses, educational and recreational facilities such as schools, clinics, markets and public buildings etc.
- According to the economic conditions, habits and purposes of owners, designers will develop two types of compound floating housing. Along the waterway routes and river banks, *lines of detached floating houses* are built for water dwellers who have good economic conditions and desire a private living (Fig. 3). The ownership of a floating housing unit imparts a feeling of responsibility for maintenance of the house facilities. These houses will be linked together as well as (sai bỏ) linked with boat parking and transportation on land by floating bridges located behind the houses. Lines of housing compounds will be appropriate and effective to be built in narrow rivers and on nearby the river banks. On the other hand, *groups of attached floating houses* for water dwellers who live with families or with people of different professional relationships (Fig. 4). Some houses are separated or linked with each other. The group of houses provides an open space not only for social, craft, and cultural activities, but also for children playing. It is not only suitable for a traditional community but also makes a balance of a stable associated foundation for houses that struggle against and adapt to climate change such as storms, floods, sea level rise etc. Moreover, water dwellers would share responsibility and budge for maintenance of their facilities, such as sewage systems, water supply. It would be helpful for water dwellers to reduce the cost of the houses. The group of floating houses would be the basic unit of a floating community. Living in a group of attached floating houses, the autonomy of water dwellings would not be unambiguous. Their dependence would be reduced in the shared spaces with shared facilities. Therefore, households would have to make a clear distinction between the shared parts and individual parts, and raise their public awareness, respect and responsibility for both the individual parts and the shared parts.

Fig. 3 Line of detached floating houses, Ha Long Bay, Vietnam

Fig. 4 (a) Group of attached floating houses, Ha Long Bay, Vietnam,

Fig. 4(b) Vision for a cluster of four floating houses, NLÉ's proposed 'Lagos Water Communities Project', Nigeria.

2. Building Site and Landscape

Orienting the houses is extremely vital when water dwellers start setting up a plan of a floating house. Living on the water is extremely affected by nature, wind and water waves. Therefore, floating houses and floating villages are often located in territories which are less influenced by strong winds, which have a slow water flow that is convenient for transportation. These territories also have a low salinity, the landscape and the quality of water resource are more suitable for living and breeding fish such as in the mouths of rivers, lagoons, bays which are located by the sea and protected from strong wind and tsunamis by mountains. Moreover, according to traditional experience, the south is the best direction for constructing a house. The main block frequently faces south to welcome the cool wind. In north and central coastal zones, the south direction prevents the house from solar radiation from the east and west and cold wind from the north in winter.

In rural traditional houses, gardens and plants take a role as climatic mitigation, sources of daily green vegetables, seasonal fruits, construction timber and landscaping. Although, living on the water without land, water dwellers still keep planting trees in pots, flower vases located around their houses. These plants do not only provide a beautiful landscape for floating houses but also can take in as much cool air as possible and sunlight heat in winter as well as fence off cold wind and limit heat losses. The gardens which exist in rural traditional architecture inspire ideas of vertical garden that could be used as climate screen to prevent solar radiation, cold wind and rain, as well as floating gardens using hydroponic systems that could be built in proposed concepts of floating houses and floating villages. Vertical garden and floating gardens would provide green vegetables for the house owners around the year (Fig. 5 and 6).

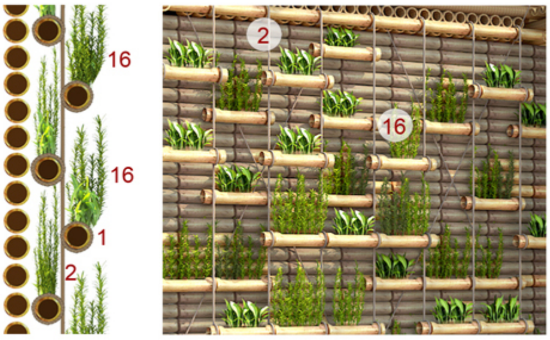


Fig.5 Vertical garden as a climate screen, designed by H&P architects, Vietnam.

Fig. 6 Floating gardens, Inle lake, Myanmar.

B. Building Designs

1. Organization of Space

Space organisation of floating houses based on rural traditional architecture is established. The front garden, patio, main block, and back garden form the typical design chain of most rural houses in Vietnam (Fig. 7). Maintaining the characteristic of traditional architecture, fundamental spaces of floating houses also include potted plants instead of front gardens, shared patios, and main blocks. This setting creates a good microclimate for the house and convenience in daily life. The potted flowers located in front of the houses as well as the shaded patio or porch which is a transitional buffer space between the interior and exterior of the floating houses prevent flying rainwater and direct solar radiation. Floating houses also can take in plenty of cool air and sunshine, while being protected from cold wind. Furthermore, a large shaded patio seems to be an open space used for relaxing, social activities, craft or business such as cafés, tailor shops, barber shops, etc.

The main block is usually divided into two parts. The main part includes a living room possible to be used for business, crafts, Buddha prayer niche, bedrooms. The secondary part includes a kitchen, sheds, toilet, storage space and working places (Fig. 8(a)). The whole block is not in a compact form. It is either a consecutive connection or a combination of various separate facilities including side blocks which are built for breeding fish, cattle sheds etc. The blocks are linked by narrow footbridges or terraces (Fig. 8(b)). In fish farm villages, except for the private main house and the guesthouse, there are fish cages below the houses. Inside the floating houses, beside common furniture, there are also prominent features such as simple power supply, antennas, generators, ventilators etc. [6].

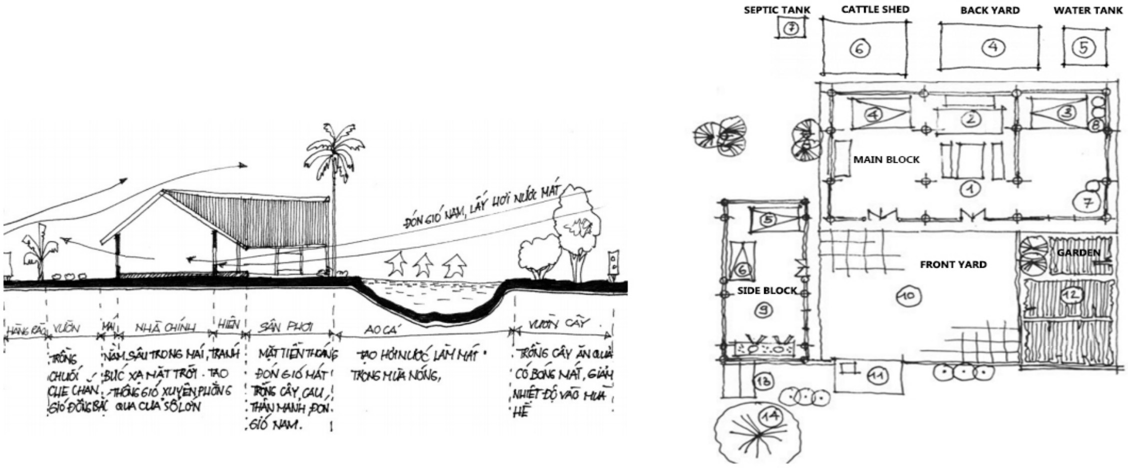
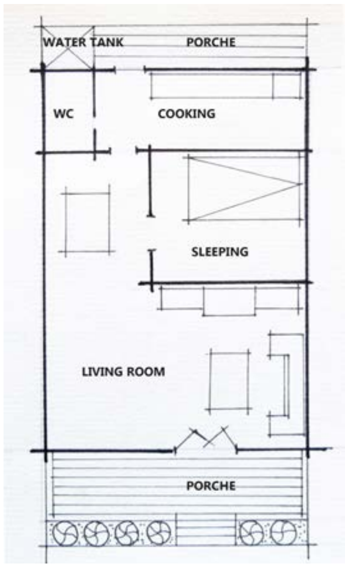


Fig. 7 Space organization of rural traditional houses [7]



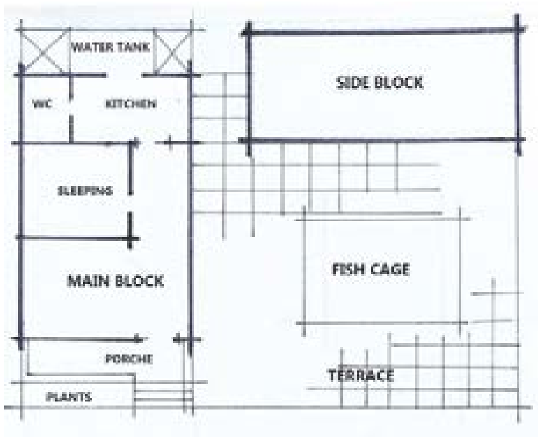


Fig. 8 Space organization of floating houses. Individual floating house, Individual floating house combines with fish cage

2. Structure and Joining System

In floating villages, there are two types of houses: stilt houses and floating houses. Others are designed as small boats which reside permanently on the water. The floating houses of the village are of various sizes and types depending on the owner's economic conditions and their purposes. Some of the floating houses are built on a platform which is made of empty oil drums or pontoon-like materials, whereas others are designed like rafts and simply float on the water [6].

The floating houses which are simple timber post and beam structures, are built predominantly from lightweight bamboo, mangrove, and wood. The flooring is made of timber planks or plywood sheets. The roof structure is mostly bamboo-leaf thatching, although corrugated sheet metal applications are often used as a substitute. Exterior and interior non-load bearing partitions are filled in with bamboo or light timber materials [8].

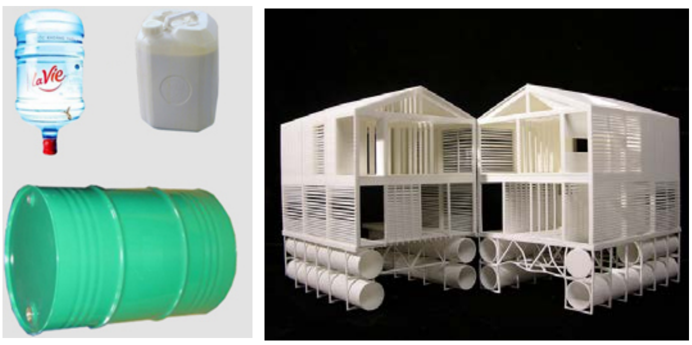
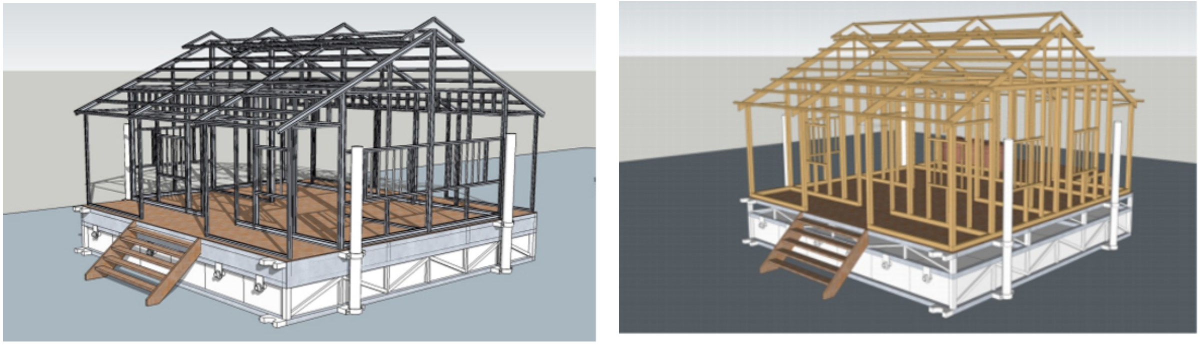


Fig. 9 Floating structure using recycled barrels, drums, etc.



b)
Fig. 10 Proposed structures of floating houses, student research project, HCM University 2010. (a) steel post and beam structure of floating house, (b) timber post and beam structure of floating house.

Lessons:
- The technology of floating structures depends on owner's economic conditions. For poor communities, water dwellers can use pontoons or recycled drums, barrels such as empty oil drums, steel drums or airtight plastic cylinder etc. to build floating platforms. Moreover, people can use wood frames or steel frames to fix drums together (Fig. 9). It would make floating platforms more stable and durable. For wealthier communities, designers can use innovative floating materials such as polystyrene EPS and concrete.
- Using timber or steel post and beam structures or other innovative structures that are light-weighted, flexible and easy to assemble and construct (Fig. 10)

3. Material Usage

Materials used in floating houses are simple and delicate. Due to the economic status, water dwellers select locally available materials which are light-weighted and adaptive to climate conditions for setting up low-cost floating houses. Most of the materials used in floating houses come from natural sources and are highly environmentally friendly. The floating houses, simple timber post and beam structures, as mentioned above, are built predominantly from light-weighted bamboo, mangrove, and wood. The climate screens on the facades, gables and roofs are typically made of steel sheets, tin, wood, bamboo, reeds, palm fronds etc.

In addition, water dwellers also select recycled materials to build their houses. As mentioned above, some of the floating houses are built on a platform which is made of empty oil drums or pontoon-like materials, whereas others are designed like rafts and simply float on the water. Using recycled materials is an effective solution to reduce the cost of houses with the aim to provide affordable floating houses in accordance with the economic status of water dwellers in Vietnam.

Lessons
- Using light-weighted materials such as wood, bamboo, steel, polystyrene EPS etc.
- Using local materials and eco- friendly environmental materials.
- Using recycled materials.

4. Unique Features

Lessons on improving the microclimate environment: Design for natural ventilation and minimum insulation standards.
- The facades of the floating houses are often designed to allow air and gusts of wind to pass through the material, which typically includes variants of wickerwork, latticework and reed weaves, in order to make the houses as pleasant as possible in day and night time. (such as doors, screens or windows etc.) [6], (Fig. 11).
- Water dwellers maximise the area of windows (e.g. louvres) which should be shaded from sun and protected from rain. Windows are designed in the way to be able to catch the breeze and to be left open in wet conditions, such as louvres or using awning to shade windows as well as provide rain protection. Large entry doors can be opened and expanded under the hot weather conditions.

- Sloping roofs on two sides with steep slopes provide a rapid drainage of rain water. Roofing materials utilise natural resources such as wood, bamboo, reeds, palm fronds etc. which are light-weighted and have a high foam thickness needed for effective insulation and ventilation. Moreover, roof ventilation draws the heat out [9]. The roof structure is mostly bamboo-leaf thatching, although nowadays corrugated sheet metal applications are often used as a substitute (Fig. 12).
- The organisation of architecture spaces is flexible and open to increase ventilation and reduce the level of humidity (Fig. 13).
- The shaded patio or porch which is a transitional buffer space between the interior and exterior of the floating houses protects from flying rainwater and direct solar radiation. Floating houses can also take in plenty of cool air and sunshine, while being protected from cold winds.

Fig. 11 The façade of floating houses are made of wickerwork, latticework, and reed weaves

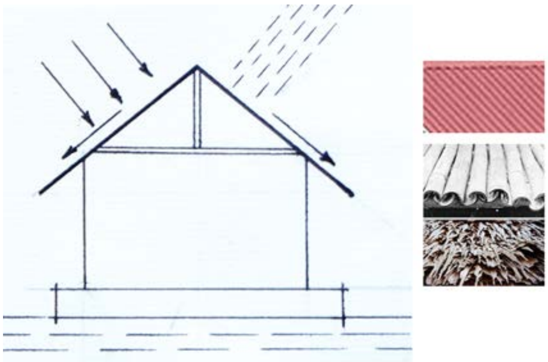


Fig.12 Sloping roof structure of floating houses

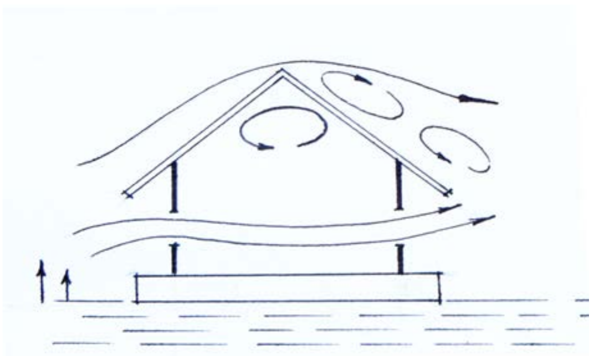


Fig.13 Ventilation of floating houses

C. Energy Usage

Lessons from the advantageous use of the rain water

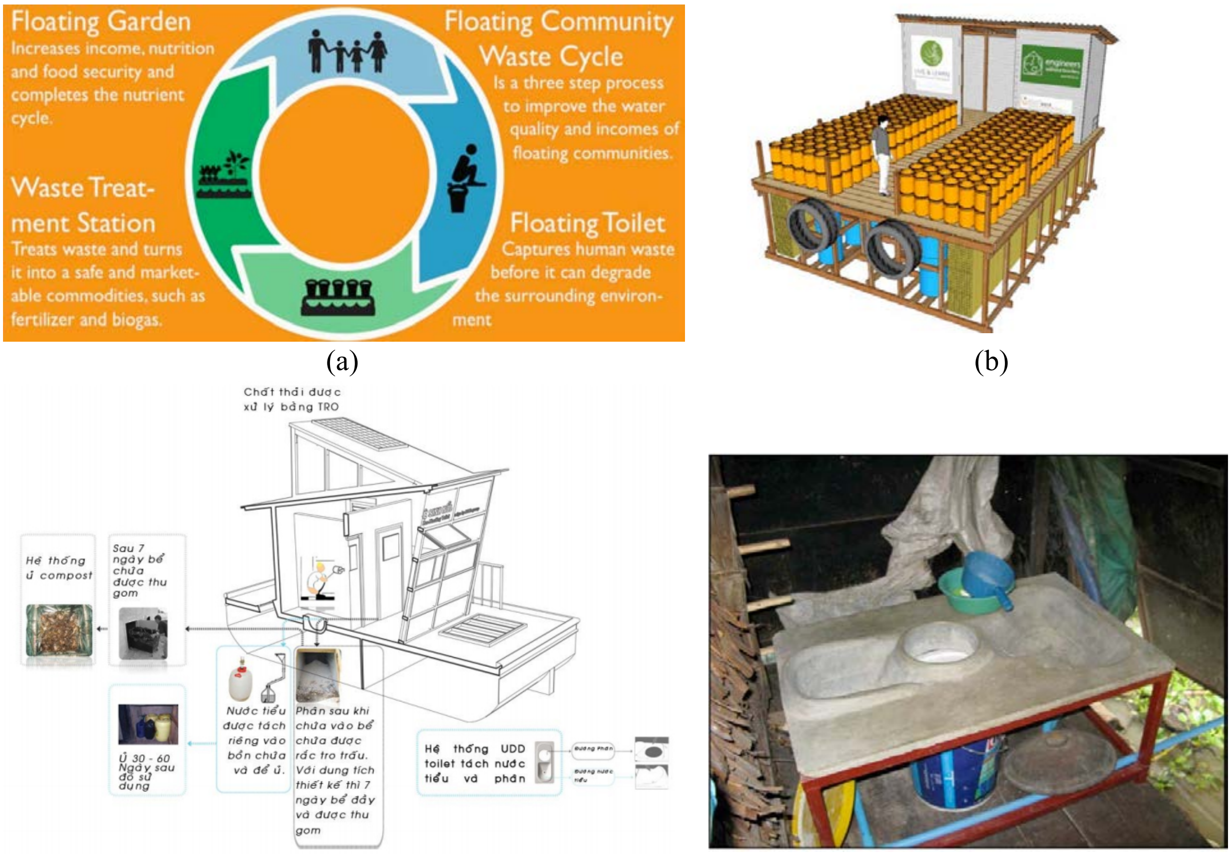
The natural water source inside a rural traditional house often allows an effective and sustainable use. Apart from the open well system, rainwater is also collected and kept in domestic tanks for use in daily life. However, few domestic water tanks on the floating houses are not enough to provide rainwater for water dwellers. Therefore, they have to buy on land fresh water bottles for drinking and cooking. In the proposed concept of floating houses, designers will consider appropriate locations and capacities of domestic tanks. In addition, designers could offer an idea of converting salt water into drinking water. It is possible to get a feasible solution which provides a huge capacity of freshwater for daily life use.

Lessons from taking advantage of the sunlight

Water dwellers use the sunlight not only for drying clothes but also for drying sea food, storage or business. Moreover, designers could offer an idea for floating houses that are equipped with solar panels to provide electricity.

D. Sanitation

Sanitation Almost all people living on the water use water from the river to wash their clothes, clean food and for cooking. There are not any sewage system and septic tanks for toilets. Everything goes directly into the river. Especially in the floating markets which attract a lot of tourists and business, there are no any public floating toilets. Domestic and business wastes which enter the river and float on the water surface lead to water and air pollution. The smell and bacteria in the sewage create health hazards for the water dwellers. Therefore, in order to build sustainable floating houses and floating communities, designers should offer solutions and technologies for floating community waste management which is culturally appropriate, reliable, economically efficient and environmentally viable for the future, in particular toilets for floating family housing as well as floating community toilets and floating community waste management stations (Fig. 14).



(a) (b)

(c) (d)

Fig.14 (a) Idea of floating community waste management cycle (Michael Brown 2010), (b) Design of floating community waste management station (Michael Brown), (c) A floating toilet prototype under trial in Phat Sanday in March 2010 (Michael Brown), (d) Community floating toilet project in Cai Rang floating market (Vu Linh Tran 2010)

IV. Conclusion

Floating houses are an unusual type of accommodation which is built on the water. Due to transportation difficulties and extreme impacts on climate and the environment, the floating houses lack facilities that provide a standard quality of living for water dwellers, such as water supply, electric and sanitary installations etc. Therefore, in order to develop a concept of sustainable communities with floating housing units, designers should propose solutions to solve the drawbacks of floating villages as well as preserve and develop precious values of traditional architecture which have to be adapted to climate, cultural and socio-economic conditions. In analysing the four components of architecture of floating houses in Vietnam, the research paper accumulates various helpful lessons for the design of floating houses and floating communities such as lesson on microclimate, lesson about garden and plants, lesson on local and friendly environmental materials, and lesson on how to use natural resources etc. Based on these lessons, the research paper develops and establishes design recommendations to approach a concept of a sustainable floating community with eco-friendly floating houses.

Recommendations for sustainability:

A.Sight Planning

1. Planning

- Planning of floating villages has to be in accordance with local planning.

- Developing concepts of floating communities - floating villages include family floating houses, educational and recreational facilities such as school, clinics, markets, public buildings. According to economic condition, habits and purposes of the owners, the designers will develop two types of compound floating housing: Line of detached floating houses; Group of attached floating houses (Table 1).

2. Building Site and Landscape

Lessons about plants and gardens.

- Floating houses and floating villages are often located in territories which are less influenced by strong winds, have a slow water flow, and which are convenient for transportation. These territories are also characterised by a low salinity. The landscape and the quality of the water resources are perfect for living and breeding fish such as in the mouth of rivers, lagoons, bays located by the sea and protected from strong wind and tsunamis by mountains.
- The main block frequently faces south to welcome the cool prevailing wind. The southern direction also prevents the house from solar radiation from the east and west and a cold wind from the north in winter in the north and central coastal zones.
- Developing floating garden concepts.

B. Building Design

Lessons for improving the microclimate environment.

1. Organization of Space

- The organisation of architectural spaces should be flexible and open to increase ventilation, and to reduce the level of humidity.
- The design would be based on local architecture, according to cultural, social-economic conditions.

2. Structure and Joining System

- The technology of floating structures would correspond to the owner's economic condition. For poor communities, to reduce the cost of houses, floating platforms can be built with recycled floating materials such as oil drums, barrels etc. For wealthier people, designers can use innovative floating structure such as EPS, concrete etc.
- Using timber or steel post and beam structures or other innovative structures which are light-weighted, flexible and easy to construct.

3. Materials

- Using local materials and eco- friendly environmental materials
- Using recycled materials.
- Using light-weighted materials.

4. Architectural Features

- Architectural elements should be designed for natural ventilation, minimum insulation standards and adapted to tropical climate (patio, porch, door, window, roof etc.). Moreover, the form of floating houses should ensure their stable position on the water.

C. Energy Usage

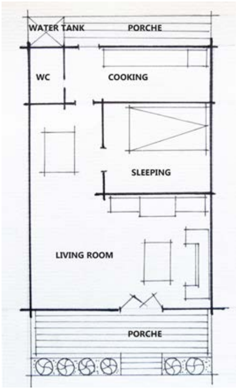
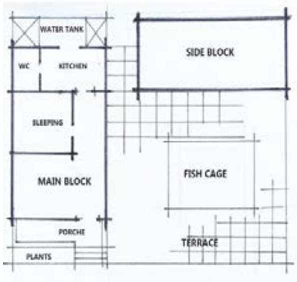
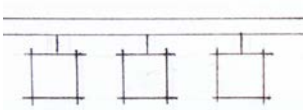
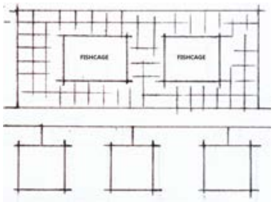
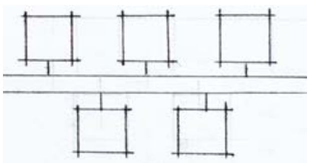
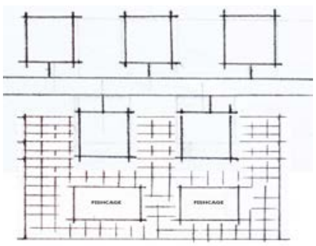
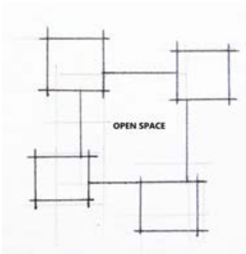
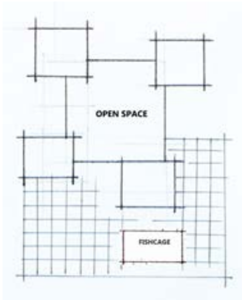
Lesson about natural resources such as rainwater, sunlight etc.

- Developing a concept of self-sufficient floating houses using natural resources such as rainwater, sunlight and renewable energies such as solar panels, wind turbines.

D. Sanitation

- Development of sewage systems and septic tanks.
- Development of floating toilet concepts.
- Development of floating community waste management cycles.

TABLE I
PROPOSED ARRANGEMENT OF FLOATING HOUSES IN THE FLOATING VILLAGES
Drawing by author

Arrangement of floating houses	
For living	Combination of living and working
Individual houses	Individual houses with fish cages
	
Housing cluster	Housing cluster
Cluster configuration	Cluster configuration
1.Straight line layout	1.Straight line layout
	
2. Axis layout	2. Axis layout
	
3.Compact layout	3.Compact layout
	

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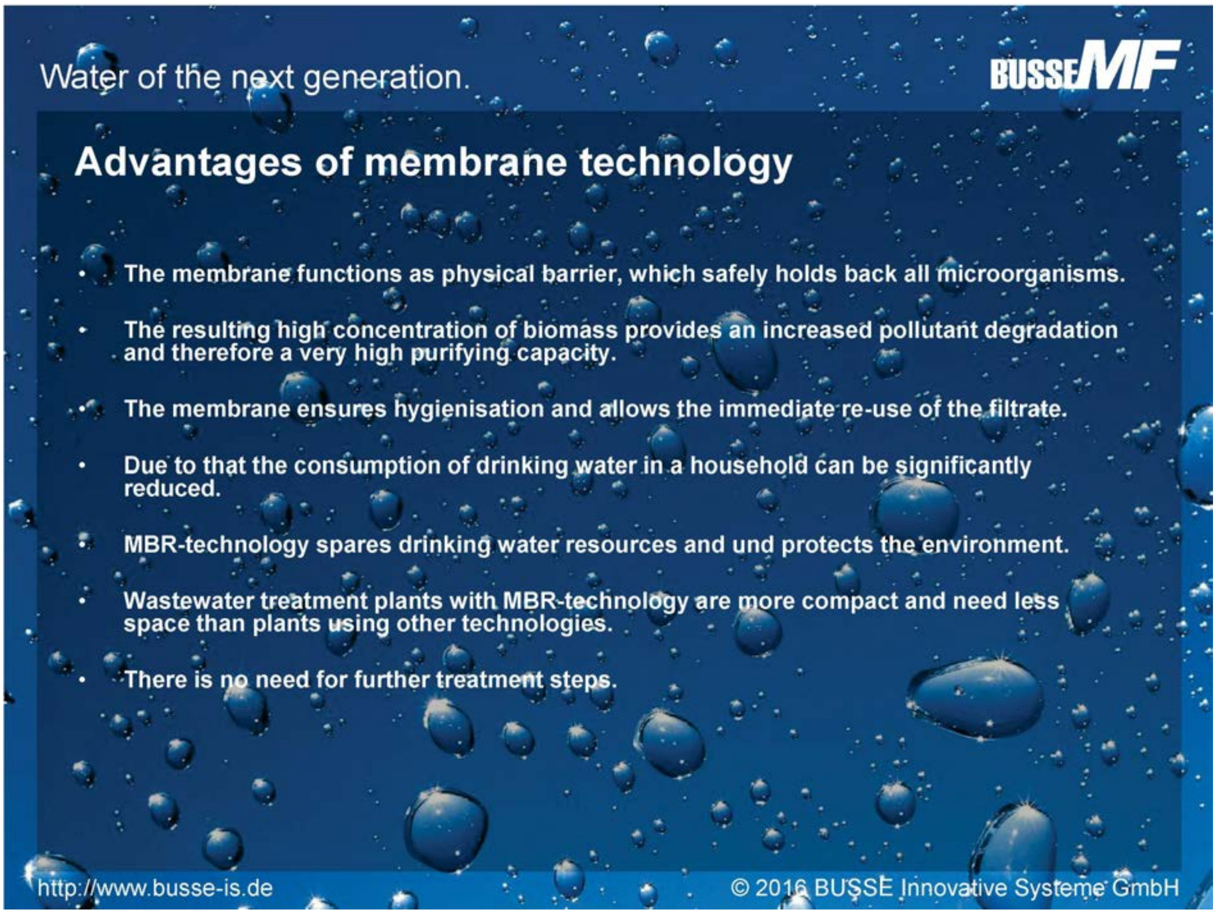
Floating wastewater treatment with membrane technology

Dipl.-Ing. Ralph-Peter Busse,
Busse Innovative Systeme GmbH,
Leipzig

Paper read at the 3rd Floating Structures symposium 2016


Water of the next generation.
BUSSE MF
Advantages of membrane technology
The membrane functions as physical barrier, which safely holds back all microorganisms.
The resulting high concentration of biomass provides an increased pollutant degradation and therefore a very high purifying capacity.
The membrane ensures hygienisation and allows the immediate re-use of the filtrate.
Due to that the consumption of drinking water in a household can be significantly reduced.
MBR-technology spares drinking water resources and und protects the environment.
Wastewater treatment plants with MBR-technology are more compact and need less space than plants using other technologies.
There is no need for further treatment steps.
http://www.busse-is.de
© 2016 BUSSE Innovative Systeme GmbH


Water of the next generation.
BUSSE MF
Special application for floating homes, houseboats, ferries etc.
The different types of the BUSSE-MF are being adapted to the individual hull (see following references).
http://www.busse-is.de
© 2016 BUSSE Innovative Systeme GmbH


Water of the next generation.
BUSSE MF
From an empty steel structure to a livable houseboat with wastewater treatment system BUSSE-MF
BUSSE-MF type MF-S04
IBS 2014
Direct discharge to the surrounding water
http://www.busse-is.de
© 2016 BUSSE Innovative Systeme GmbH


Water of the next generation.
BUSSE MF
Luxury on small space and hightech-wastewater treatment on smallest space.
BUSSE-MF type MF-S04
IBS 2014
Direct discharge to the surrounding water
http://www.busse-is.de
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Summary

Bio-membrane-filtration is the only technology for wastewater treatment that should be called state of the art by now.

The purified wastewater is being defined in its quality by the microfiltration pore size of < 0,4 µm.

A high sludge age (> 100 d) enables a minor production of waste activated sludge and at once a high process stability with constant quality of the filtrate (purified wastewater).

Thus the re-use of the filtrate as service water and therefore effluent free manufacture is possible.

Unproblematic discharge of the filtrate even in sensitive areas.
Extensive reduction of BSB_5 (99%), CSB (97%) and nitrogen (87%).

FIB

Bauhaus-Universität Weimar

Durability of concrete exposed to acid mine lakes

Remus, R., Gebauer, G., Winzer, R

Tagung Schwimmende Bauten, 28.11.14, Großräschen

FIB

Bauhaus-Universität Weimar

Content

F.A. Finger-Institute for Building Material Science Ricardo Remus (M.Sc) 3

1. Acid Mine Drainage

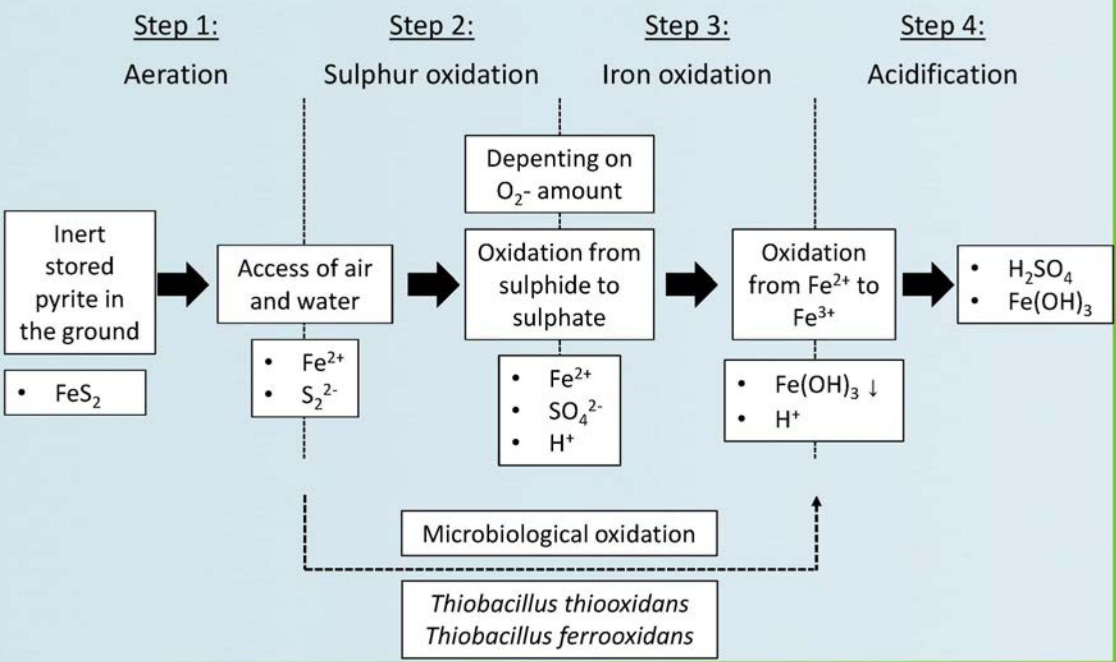
Acid Mine Drainage describes acidic lakes and waters with high concentrations of minerals.

- Source of the acidification is the chemical and microbiological oxidation of reduced sulphur spezies

Figure: Coal mine in Nochten and Power plant in Boxberg

Bauhaus-Universität Weimar

1. Acid Mine Drainage



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1. Acid Mine Drainage

The consequences of the acidification:

- Extreme lowered pH- Values (< 3,0)
- Increased concentrations of concrete damaging ions
- Increased iron concentrations

Figure: Bärwalder Lake and Power Plant Boxberg

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Chemical attack of concrete

The chemical attack of concrete can be divided in 2 fields:

- Chemical attack from internal sources
- Chemical attack from outside sources
  - Expanding attack
  - Concrete corrosion

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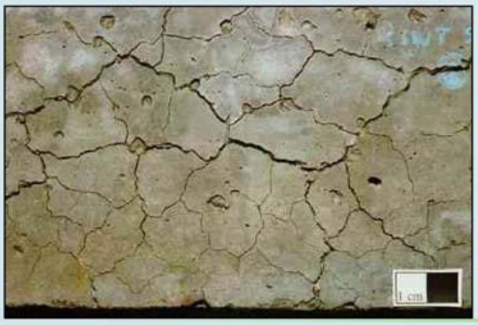
Chemical attack of concrete

Expanding Attack

- Parts of the cement clinker reacting with attacking salt solutions
- Reaction products with increased volumes up to 800%
- Pressure due to cristallisation destroys the structure



Concrete corrosion

- Readly soluble cement phases leaches out
- Lower pH-value leads to further instabilization of other cement phases
- Gradual solution of the concrete structure

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Chemical attack of concrete

Determination of the environment according to DIN EN 206-1 in 3 exposure classes:

	XA 1	XA 2	XA 3
SO_4^{2-}	200 – 600 mg/l	600 – 3000 mg/l	3000 – 6000 mg/l
pH- value	6,5 – 5,5	5,5 - 4,5	4,5 – 4,0
CO_2 (free)	15 – 40 mg/l	40 – 100 mg/l	> 100 mg/l
NH_4^+	15 – 30 mg/l	30 – 60 mg/l	60 – 100 mg/l
Mg^{2+}	300 – 1000 mg/l	1000 – 3000 mg/l	> 3000 mg/l

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CHEMICAL ATTACK OF CONCRETE

Determination of the environment according to DIN EN 206-1 in 3 exposure classes:

	XA 3	Partwitzer See	Geierswalder See
SO_4^{2-}	3000 – 6000 mg/l	1100 mg/l	350 mg/l
pH- Wert	4,5 – 4,0	2,7 – 3,0	(4,5 – 5,0) 6,8
CO_2 (frei)	> 100 mg/l		
NH_4^+	60 – 100 mg/l		
Mg^{2+}	> 3000 mg/l	35 mg/l	15 mg/l

Test environments (lakes)

CHEMICAL ATTACK OF CONCRETE

In Partwitzer See a **combined acid and sulphate attack** will take place due to the superposition of low pH and high sulphate.

- Intensification of the single machanisms
- Increased corrosion for weak concretes
- Superposition with further ions possible (Mg^{2+})

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PROJECT: CONCRETE IN ACID MINE LAKES

For assessing the concrete durability over 1500 samples are stored in acid mine lakes for 2 years.

Which includes:

- Development and production of the different concretes
- Identification of the environment
- Determination of the degradation
- Assessment of the concrete due to their durability

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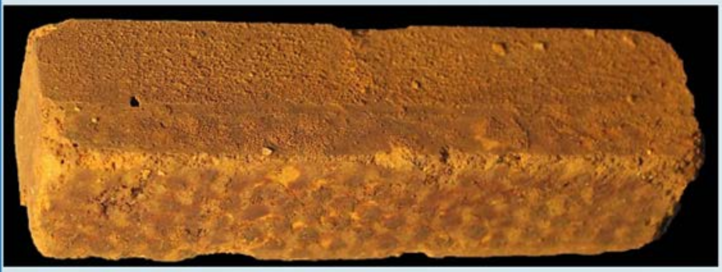
PROJECT: CONCRETE IN ACID MINE LAKES

24 months storage in Partwitzer See:

- CEM III/ A 320 kg/m³
- w/c-value = 0,50
- No additives



- CEM I- SR0 320 kg/m³
- w/c-value = 0,50
- No additives

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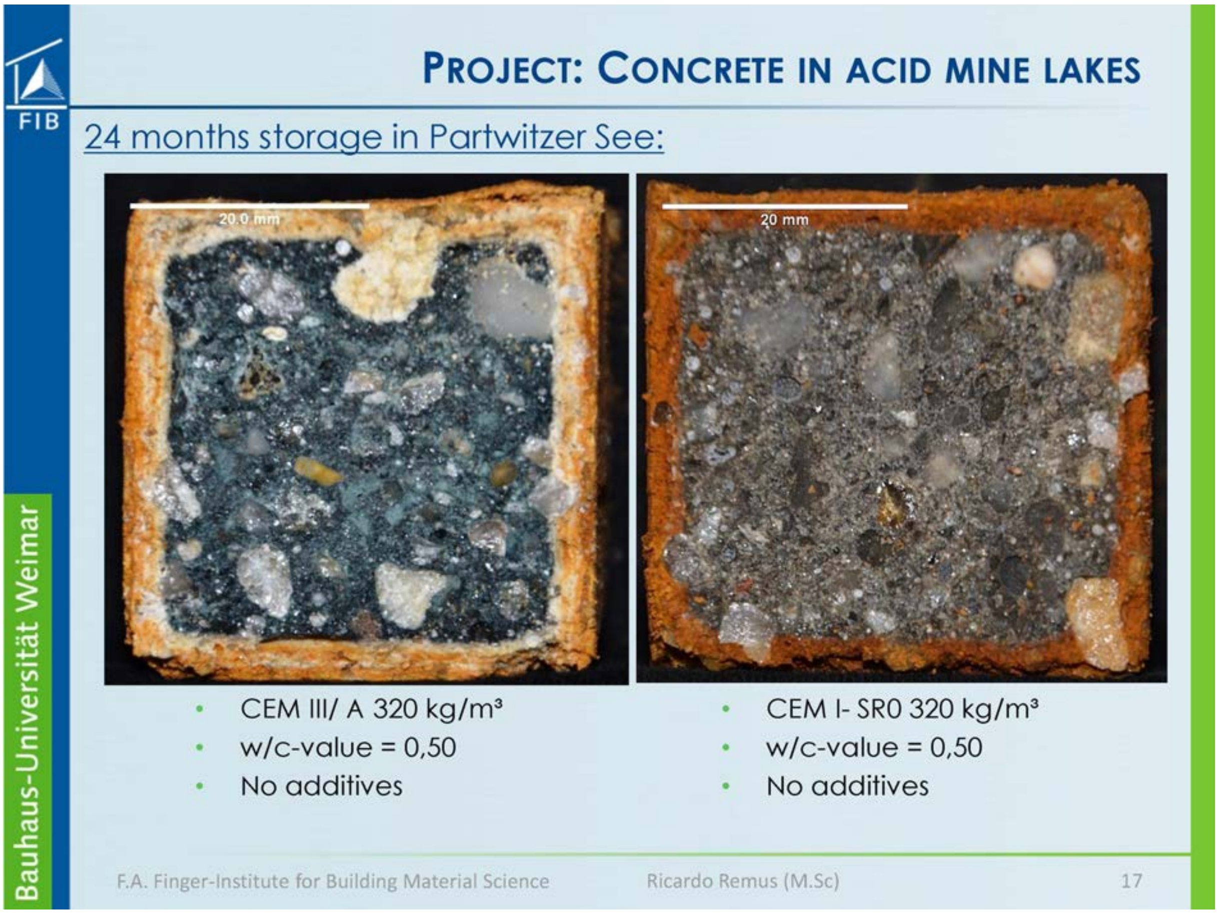
FIB
PROJECT: CONCRETE IN ACID MINE LAKES
24 months storage in Partwitzer See:
20.0 mm
20 mm
• CEM III/ A 320 kg/m³
• w/c-value = 0,50
• No additives
• CEM I- SR0 320 kg/m³
• w/c-value = 0,50
• No additives
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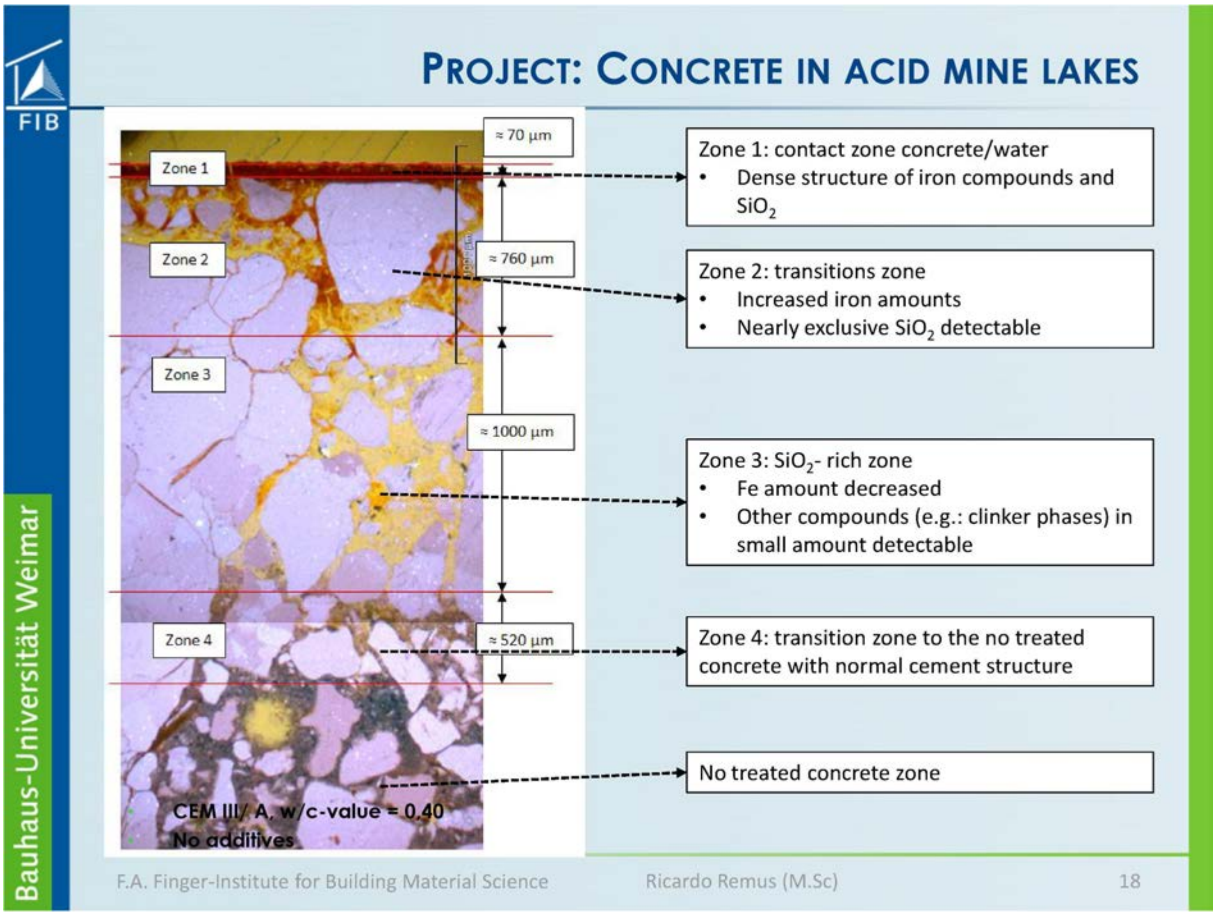
FIB
PROJECT: CONCRETE IN ACID MINE LAKES
Zone 1
Zone 2
Zone 3
Zone 4
≈ 70 µm
≈ 760 µm
≈ 1000 µm
≈ 520 µm
Zone 1: contact zone concrete/water
• Dense structure of iron compounds and SiO_2
Zone 2: transitions zone
• Increased iron amounts
• Nearly exclusive SiO_2 detectable
Zone 3: SiO_2- rich zone
• Fe amount decreased
• Other compounds (e.g.: clinker phases) in small amount detectable
Zone 4: transition zone to the no treated concrete with normal cement structure
No treated concrete zone
CEM III/ A, w/c-value = 0,40
No additives
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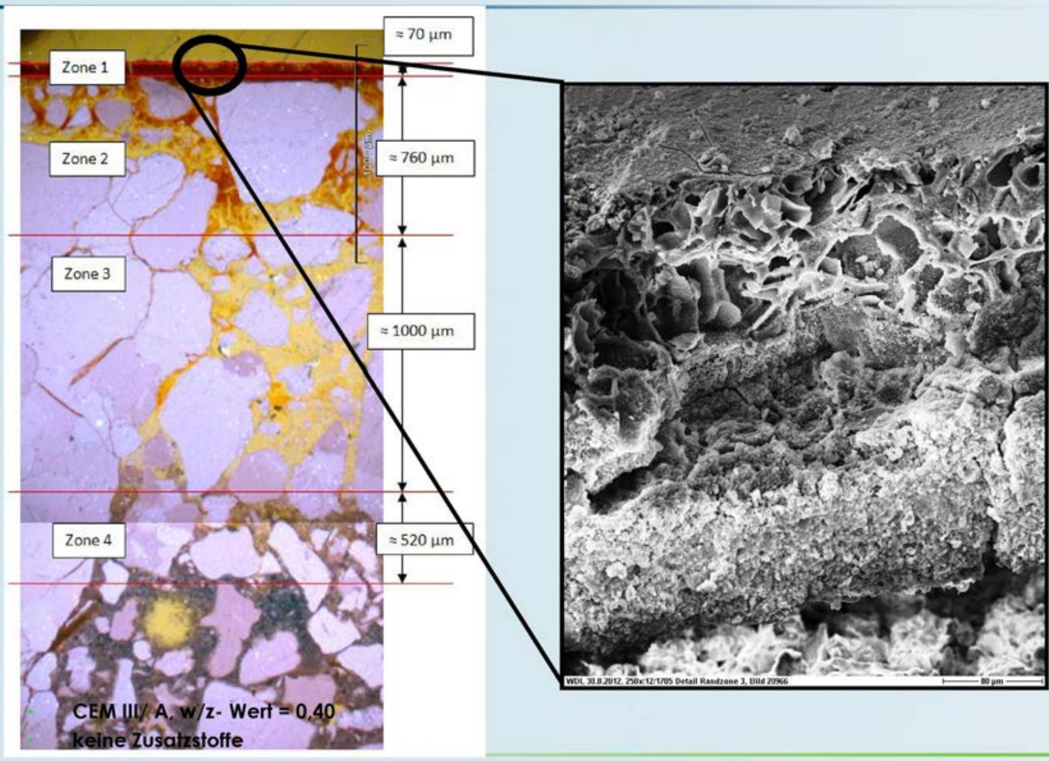
PROJECT: CONCRETE IN ACID MINE LAKES



WAYS OF PROTECTION

Extract from the DIN 1045-2:

„For chemical attack of exposure class XA3 or stonger, protection is necessary – like protection layers or covers -, if no expert propose another solution.“

FIB

Ways of protection

Common ways <u>without</u> layers/ covers are:
(building-authority approval necessary)

Extended concrete layer

descriptive concrete composition:
- Maximum w/c-value
- Minimum cement amount
- Minimum compressive strength

Addition to structural concrete:
- Static not acting concrete layer
- Ensures usability over the expected lifetime

Performance-based composition

- Accelerated test methods should present lifetime exposure
- Durability is calculated for a single concrete composition

Acceleration by 2 mechanisms:
- Intensify the attack
- Weakening the concrete

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Ways of protection

Common ways <u>with</u> layers/ covers are :

Coatings

Organic:
- Expoxy resin
- Polyurethane resin

Inorganic:
- Cement-containing coatings (PCC)
- cement-free coating (water glass, silicate mortar,...)

Covers

Organic:
- PEHD, PVC, PP, GFK

Inorganic:
- Ceramics

Metal:
- Stainless steel, Aluminium

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Outlook

Building development in acid mine environments is not only a problem of the Lausitz. It is also of national and international importance.

Therefor:

- Further investigations of the durability of concrete and covering systems
- Education of designer and constructor for the complex mechanisms

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Any questions?

Thanks for your kind attention!

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Functionally Optimised Concrete Elements for Floating Structures

Prof. Dr. Gert Gebauer • FG Baustoffe, Bauchemie, Betontechnologie • Fakultät 6

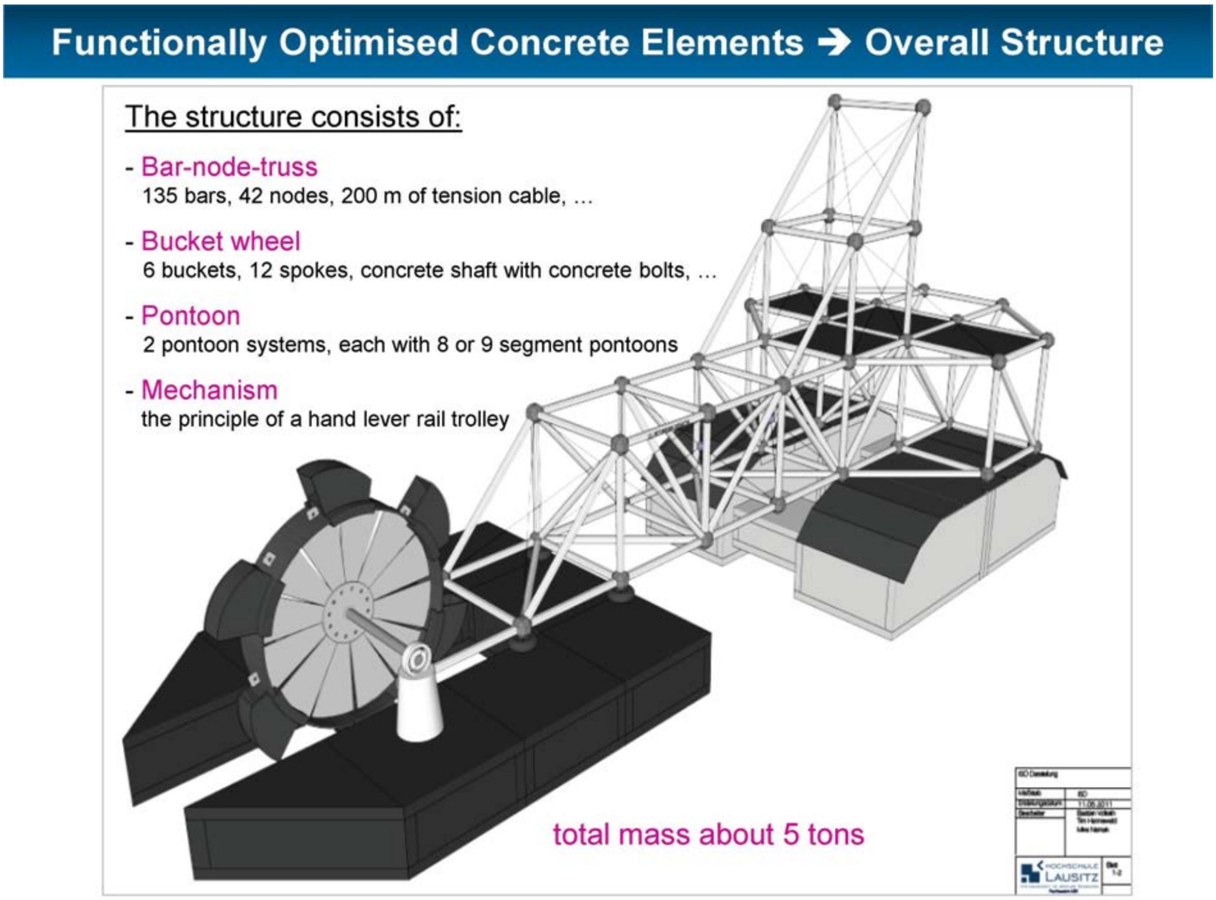
In the student project "concrete canoe regatta", a floating structure consisting of functionally optimised concrete elements was built by applying innovative detailed solutions. The concrete canoe regatta is a combination of concrete and boat building technologies and a sports competition.

About 1,000 students from more than 40 universities of applied sciences and universities from countries like Germany, the Netherlands, Austria, Switzerland and Belgium compete either in the "competition class" (canoe) or "open class" (motto: made of concrete and able to swim).

The important criteria for evaluation in the "open class" are originality, construction, concrete technology, design, equipment as well as presentation. Taking these criteria into account, the students of BTU Cottbus-Senftenberg have designed a technically interesting and elaborate structure.

It is the analogous reproduction of a bucket wheel excavator with a length of 13 m, a width of about 4 m, and a height of about 6 m with a mass of about 5 tons. The truss-like structure consists of 135 hollow concrete bars and 42 concrete nodes tied together by tension cables.

At the front of the structure, there is a bucket wheel with a diameter of 2.50 m completely made of concrete including bolts, nuts and ball bearings. At the rear, there is a mechanism functioning on the principle of a hand lever rail trolley. The whole structure rests on two large pontoon systems that consist of concrete tanks with a wall thickness of only 1 cm. The rear pontoon system was designed in such a way that the existing cavities can be" flooded" with water. Thus an optimal sinking depth and floating stability of the whole structure can be adjusted directly on site.



In order to meet both the high water-proof requirement of the pontoons and impact, bending and compressive stresses the different structural elements are subjected to, special high performance concretes were developed that are reinforced with glass fibre fabric as well as glass-fibre modified plastic bars.

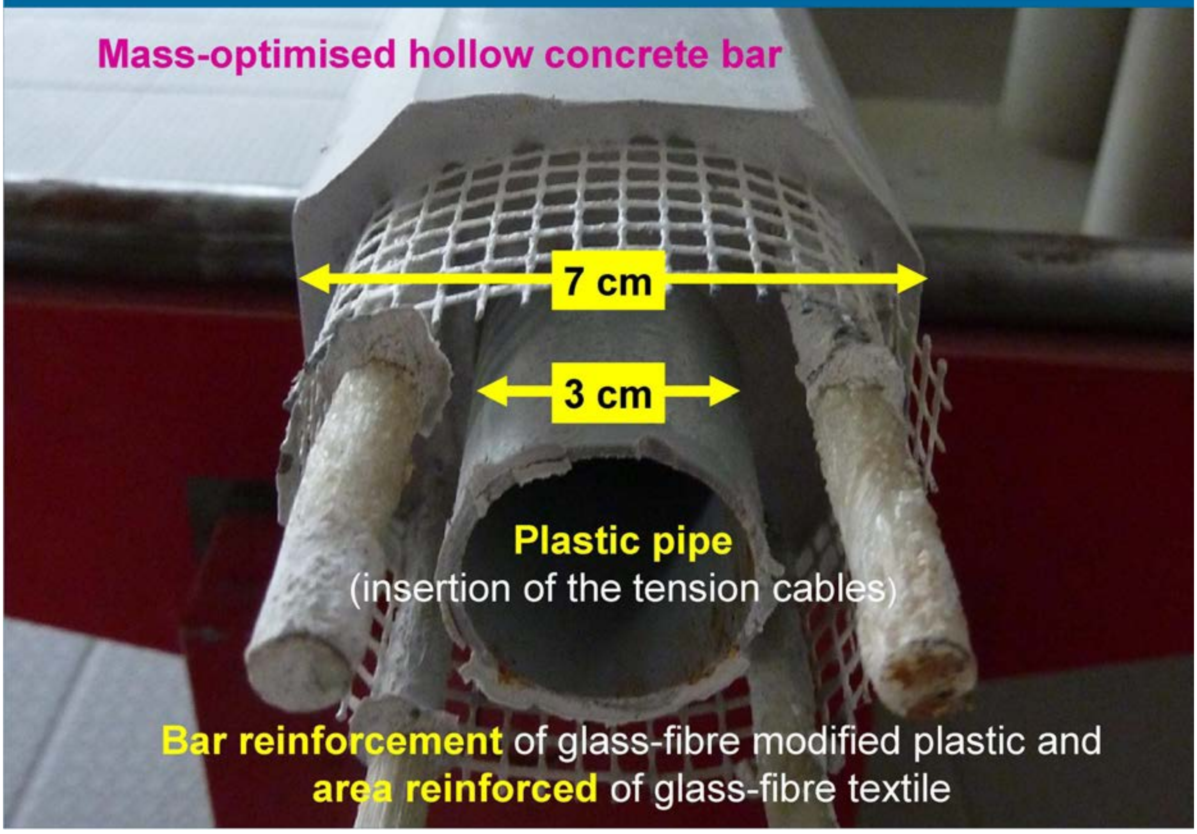
In total, among other things, more than 2 tons of cement, 400 m² of textile area reinforcement as well as about 1,000 m of high-quality, corrosion resistant reinforcement consisting of glass-fibre modified plastic were needed for construction. With respect to design and technical abilities, material and technical implementation, the variety of different individual components, formwork requirements, and time expenditures, the structure was seen as a great engineering challenge and awarded with the first prize by the organiser (German Cement – and Concrete Industry).

Functionally Optimised Concrete Elements → Concrete Bars

The concrete bars are hollow bars with an octagonal cross-section. The cross-section of bar is 70 mm. In total, 91 short bars (L = 1,15 m; mass = 10,1 kg) and 44 long bars (L = 1,70 m; mass = 14,9 kg) are needed for the structure. In order to be able to produce such a large number of bars, a formwork system in form of „battery moulds“ was built.

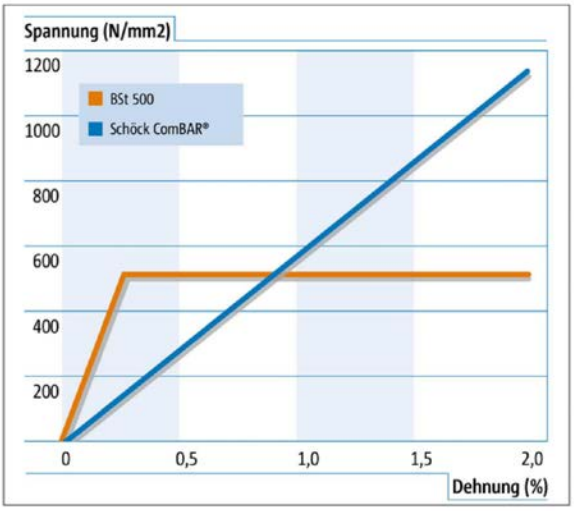
The reinforced for hollow concrete bars was implemented with 4 reinforcing bars (diameter = 6 mm) made of glass-fibre modified plastics and a cage made of glass-fibre textile. The cages were arranged around the 4 reinforcing bars.

Functionally Optimised Concrete Elements → Concrete Bars



Functionally Optimised Concrete Elements → Reinforcement

Materialeigenschaften gerader Stäbe	Betonstahl DIN EN ISO 15630 DIN 488	Schöck ComBAR® gemäß EC 2
charakteristische Streckgrenze f_{yk} (N/mm²)	500	≥ 1000
Bemessungswert der Streckgrenze f_{yd} (N/mm²)	435	≥ 445
Zug-E-Modul E (N/mm²)	200.000	60.000
Bemessungswert der Verbundspannung f_{bd} (Normalbeton) (N/mm²)	gemäß DIN 1045-1	bis C40/50 wie BSt > C40/50 f_{bd} = 3,7
Betondeckung c_{nom} (mm)	gemäß DIN 1045-1	d_s + 10
spezifischer Widerstand (μΩcm)	$1\text{-}2 \times 10^{-5}$	$> 10^{12}$



Parameters – comparison concrete steel and GFP reinforcement

Functionally Optimised Concrete Elements → Reinforcement

Glass-fibre textiles

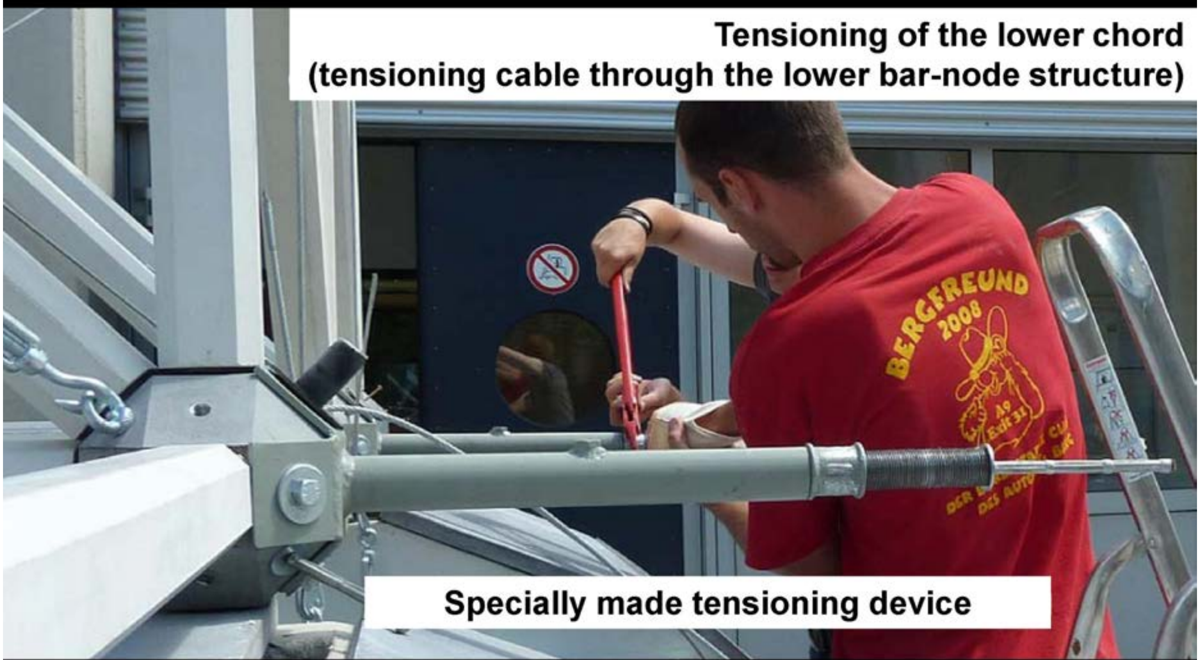
Textile fabric	Textile lining
Weight per unit area > 150 g/m²	Weight per unit area = 198 g/m²
Mash width = 4 x 4 mm	Mash width = 12 x 12 mm
Tex - warp = 2 x 136	Filaments/bundle of fibres = 3.200
Tex - weft = 300	Tex - roving = 1.200
Thread density - warp = 24/10 cm	Tensile filament strength = 3.500 N/mm²
Thread density - weft = 22/10 cm	Breaking strain = 2,4 %

Functionally Optimised Concrete Elements ➔ Tensioning Technology

The conception of tensioning looks like this:

- Tensioning across the space diagonales of the cubically arranged bars (material tensioning steel cable diameter = 5 mm; permissible tensile load = 17,7 kN)
- Tensioning across the whole bar structure in longitudinal direction (bottom chord of truss) (material tensioning steel cable diameter = 8 mm; permissible tensile load = 33,0 kN)

Functionally Optimised Concrete Elements ➔ Tensioning Technology



Functionally Optimised Concrete Elements → Concrete Pontoons

Both floating body systems consist of 9 (front) „segment pontoons“ and 8 (rear) „segment pontoons“, that are concrete tanks. The pontoons were produced using water impermeable concrete. The wall thickness of the pontoons is about 1 cm. Different layers of glass fibre textile reinforcement were built in to secure the bending stress.

Functionally Optimised Concrete Elements for Floating Structures

An overview of a few figures:

- 42 items concrete nodes
- 135 items hollow concrete bars (91 short und 44 long bars) = about 180 m
- 270 items concrete plugs
- 12 items concrete spokes
- 6 items ring segments (bucket wheel)
- 24 items adjustment elements (bucket)
- 12 items arch elements (bucket)
- 12 items side elements (bucket)
- 32 items lightweight concrete plate elements

and other concrete components (rosette, shaft, bolts, nuts, ball bearings, …)

- 750 items striker (for nodes)
- 300 items self-punched rubber discs
- 10 m³ extruded foam polystyrene
- 15 dm³ sealant and adhesive (50 cartridges, 300 ml each)
- 2 t cement and special binding material
- 200 m polyethylen pipes as inside formwork for the bars
- 200 m tensioning cable (additionally turnbuckles and other accessories)
- 400 m² glass-fibre textiles
- 1,5 km glass-fibre reinforcing bars

and other products (special grain sizes, admixtures, formwork material, …).

Research approaches regarding sensor technology and data communication for floating structures

Weidhase, F.; Fischer, G.; Opperskalski, St.
BTU Cottbus – Senftenberg
Fak. 3: Maschinenbau, Elektro- und Energiesysteme

Paper read at the 2ndFloating Structures symposium 2014

1. The beginning

Due to the cessation of lignite mining Lusatia is rich in lakes. Floating structures can contribute to the development of these areas for cultural and industrial purposes. Research into water wave parameters and constructive measures to attenuate the wave effects on the floating structures play a decisive role in this development.
With the beginning of the Autartec project (see Fig. 1) the opportunity arose to prioritize the research of wave parameters in the inland lakes of Lusatia. In earlier studies there were sporadic measurement sets of wave heights in relation to simultaneous wind parameters. Unfortunately, high operational costs amounting to € 2000 annually meant that measurements could not be continually conducted.
After considering the aspect of extensive autarky and modern approaches of the "smart home", the concept of floating houses was elaborated on in cooperation with two departments from the Fraunhofer-Gesellschaft as well as 13 regional partners. First components are already working. Implementation of this approach is in full progress at Lake Bergheide.
In 2012 first contact was established, and with the help of the Chair for Optical and Radio-based Communication the search for an affordable long-term solution for continuous measurements using new sensor technology and data communication began.

However, the suggestions, which were presented on the occasion of the 2nd Floating Structures conference on 28 November 2014 in Großräschen, ended in a fiasco, see Fig. 2.
Therefore a new concept, now in the third generation, was required. This paper aims at presenting different implementation methods and their advantages and disadvantages.

Fig. 1 The Autartec House (http://www.autartec.com)

Fig. 2: Buoy with destroyed electronic equipment drifting after dislodgement

The storm “Niklas” brought with it blasts of up to 192 km per hour, which dislodged this buoy. When the buoy drifted and scraped along rocks near the shore, the electronic equipment and cable ducts were destroyed. As a consequence, water flowed into the interior part of the buoy and its electronic equipment became inoperative.

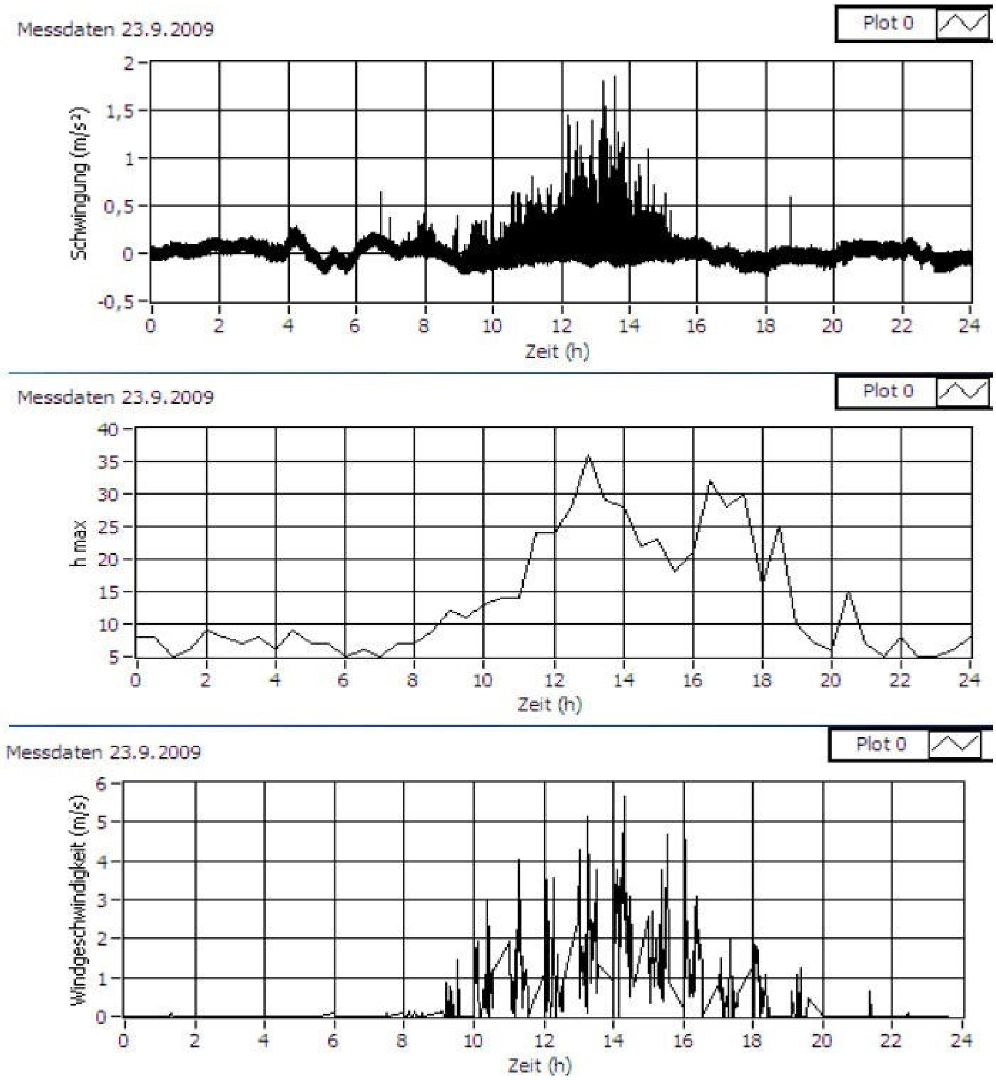


Fig. 3: Example of rudimentary data sets

2. New conception of the approach

2.1. Principle

The main reason for using a new concept was the reduction of operational costs. At the same time it was also necessary to explore whether newer approaches could offer qualitative improvements. This includes the improvement of online access to current and archived data. With the new concept for the approach the chance to perform research regarding the optimum solution should be used. The latest advancements in sensor technology were investigated.

Positive experiences in technical literature had to be included in the consideration, see [5], [6].

2.2. Classic electricity supply using primary cells

The most effective method to reduce operational costs is to substitute the single-use primary cells. A set of primary cells costs approximately €2000 and has a supply capacity of about a year.

Fig. 4: Electricity supply for the aquatic observation buoy, Datawell DWR-G

Table 1: Battery set variants for the aquatic observation buoy, Datawell DWR-G

Type	RC16R	RC20B	RC25GB
Rechargeable:	Rechargeable	Non-rechargeable	Non-rechargeable
Magnetic:	Non magnetic	Non Magnetic	Magnetic
Colour:	Red	Black	Green
Nominal voltage:	1.5 V	1.5 V	1.5 V
Nominal capacity:	160 Wh	200 Wh	250 Wh
Weight	1.37 kg	1.45 kg	1.48 kg

In the available buoy (Fig. 16) 32 primary cells of the type alkaline manganese dioxide-zinc from the company Datacell were used. This set has 8,000 Wh of electrical energy.

2.3. Classic solution using batteries

When using batteries (i.e. secondary cells) it should be borne in mind that they will be used in the open and thus should be operational in temperatures of up to -30 °C. Due to this requirement, lithium iron phosphate ($LiFePO_4$) or lithium-titanate-oxide ($Li_4Ti_5O_{12}$) are to be primarily considered. However, developments in the field of lithium-ion batteries take place so rapidly that in the future other variants should also be considered.
Today lithium-NMC-cells seem to be a promising option, which, among others, Ford, Honda, Toyota and BMW have opted for. NMC stands for nickel, manganese and cobalt oxide. This type of battery is characterised by a high energy density with good temperature behaviour properties and is explicitly recommended for boats.

2.4. Energy-harvesting using photovoltaics

The term "energy harvesting" refers to the "harvesting" of energy from the surrounding area. This would provide a method for maintenance-free operation of the observation buoys. The most famous and obvious method is using photovoltaics. Fig. 5 shows two variants of implementation. The disadvantages here are the possibility of ice formation in the winter and cloud cover in the summer. Extended periods of little sunshine restrict the power supply.

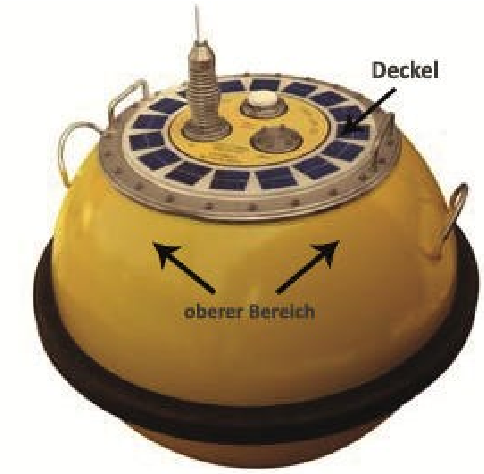


Fig. 5: Design options for buoys using photovoltaics as a power source

Left: Datawell horizontal, right: buoy near Warnemünde

2.5. Alternative types of energy harvesting

Due to the above-mentioned problems with photovoltaics, for the problem of icing we took another type of energy harvesting into consideration. Energy cannot be harvested from wave movement in winter since inland lakes are generally frozen over and thus there is no movement. A better option is using the Seebeck effect, i.e. using Peltier elements for power generation and not for cooling. Although the < 15% efficiency it provides is not particularly high, we believe the Seebeck effect can be extremely useful for providing energy. An important factor here is that there are temperature differences around the buoy year-round (air temperature, surface temperature of the water, ice surface, water below the ice surface). Here the temperature difference between the ice layer and the unfrozen water underneath could be used.
Using heat pipes for heat transfer is essential for utilising the Seebeck effect for energy harvesting, because otherwise a sufficiently high heat flow cannot be generated.
A temperature difference of a few degrees is sufficient for the generation of electrical energy. However, this is only sufficient to supply electronic equipment that uses low levels of electricity.

3. Radio standards for buoy communication

3.1. Radio standards of inland navigation

The Datawell-DWR-G buoy uses high-frequency data communication between 27 MHz and 40 MHz. In order to exclude interference from other buoys, an individual frequency is assigned to each buoy. Though it is possible to transmit signals over a distance of 50 km a transmission range of only 5 km is used in order to avoid licensing fees. This frequency usage must follow the rules of inland navigation radio and requires a single frequency assignment.

A new method for data communication is possible because of the Federal Network Agency, which has released usage of the so-called ISM bands free of cost. ISM stands for "*I*ndustrial *S*cientific and *M*edical", and relates to high-frequency applications in industry, science and medicine. A newly released frequency band of 169.400 MHz to 169.475 MHz is planned for the remote collection of measured values. This ISM frequency band is suitable for the data transmission of buoy measurements. One advantage of this system is that the permissible transmission power of 500 mW promises ERP with a transmission range of up to 25 km with relatively low transmission power. It should also be mentioned that the distance specification is considered as "line of sight", but this should be given for data communication above water.

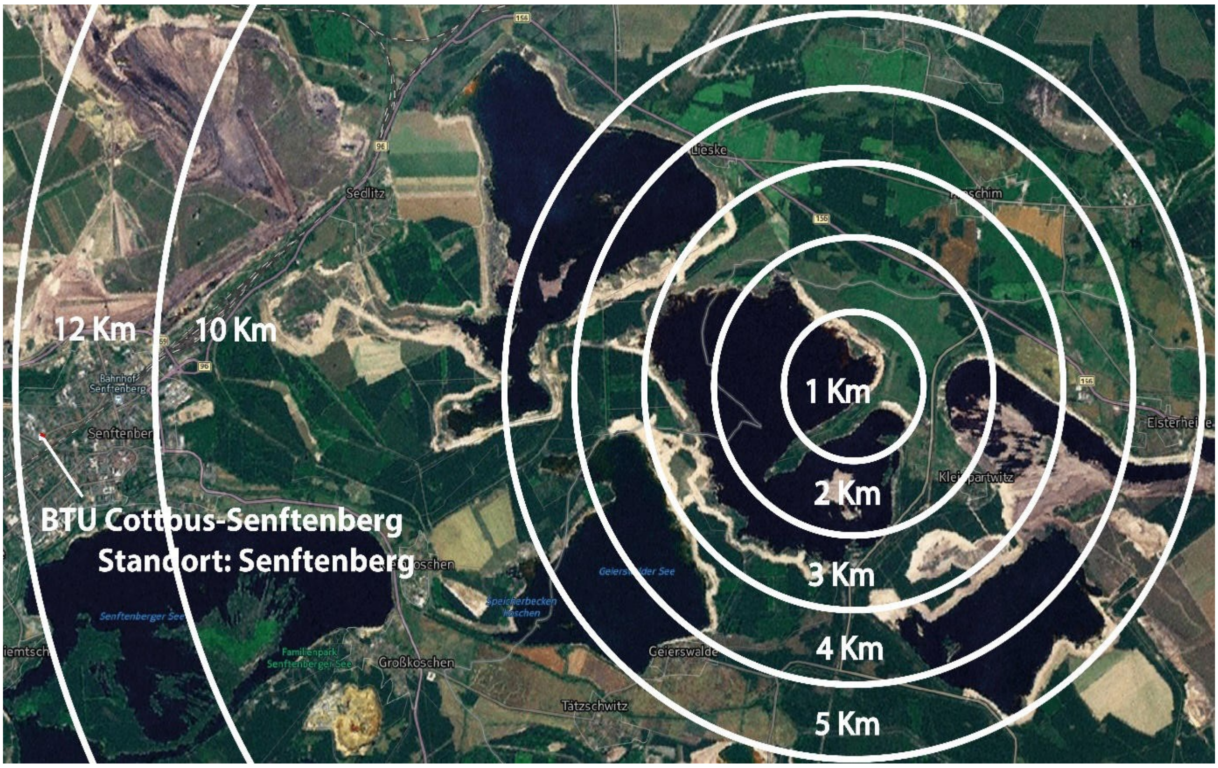


Fig. 6: Distance between Cottbus and Lake Partwitzer See

3.2. ISM-short-distance radio

The Federal Network Agency released various frequency bands for free use for applications in industry, science, and medicine. These ISM bands facilitate short-distance radio. The following approximation calculation shows the expected radio range under the best conditions best. The difference between maximum transmission power (P_{TX}) and minimum required received power (P_{RX}) considering antenna gain is called the system budget.

When using ISM short-distance radio, a distance of only 100 m with an unobstructed line-of-sight is usually planned. The lower the frequency band the lower the free space attenuation of the air path D_{Luft}. For this reason, in Germany, the lowest ISM band of 169 MHz with $D_{Luft} \approx$ 10 dB/km is of special importance. In addition, it is strongly recommended to plan path losses of $P_{Reserve}$ = 20 dB for unpredictable obstructions of the radio signal (fading, people passing through etc.). Despite all calculations visual obstructions and fog can cause restrictions so that only the experimental determination of the range can capture the actual relationships of reflections and attenuations as well as the form or obstruction of the Fresnel zone. For the radio module ME70-169 the following applies assuming an isotropic emitter as antenna at the sender (G_{TX}) and the receiver (G_{RX}):

P_{Budget} [dBm] = P_{TX} [dBm] -P_{RX} [dBm] + G_{TX} [dB] + G_{RX} [dB] - $P_{Reserve}$

P_{Budget} [dBm] = 30 dBm - (-120 dBm) + 0 dB + 0 dB - 20 dB

P_{Budget} [dBm] = 130 dB $L = P_{Budget} / D_{Luft}$ L ≈ 130 dB / (10 dB/ km) = 10 km

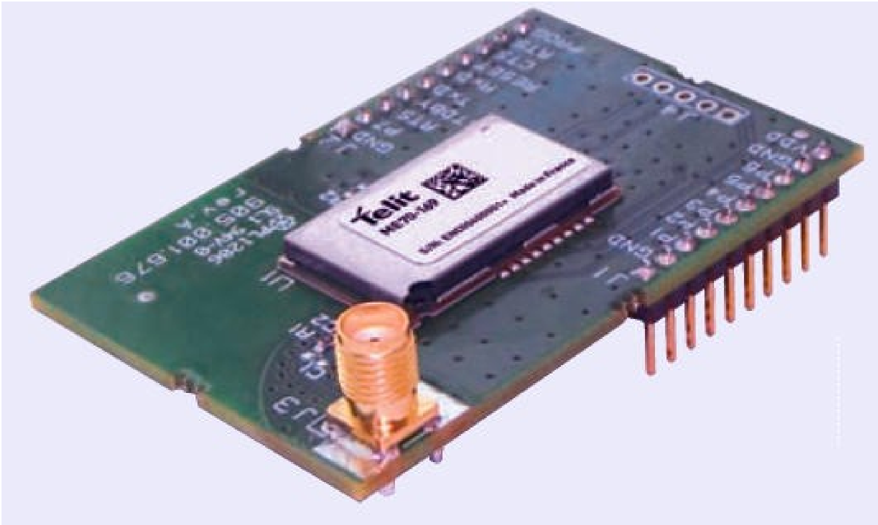


Fig. 7: Radio module from the Telit Typ ME70-169 company

This estimate shows that ISM short-distance radio does not guarantee a sufficient direct data link with the BTU Cottbus site. In any case, implementation by means of relay stations or internet connection will have to be planned.

3.3. Data communication by mobile means

Due to attenuation losses occurring in short-distance radio it may be useful to focus on mobile communication. There are different levels of communication speed. For simple data transfer (weather, wave height) the "Global System for Mobile Communication (GSM)" with its basic function of 14.6 kbit/s may be sufficient. As soon as basic tasks of remote control are included, GPRS (General Pocket Radio Service) or the extended GSM standard EDGE (Enhanced Data Rates for GSM) are required. If in addition to this there is a desire to transmit weather images, UMTS (Universal Mobile Telecommunications System) or even faster methods are needed (see Fig. 9). The prerequisite for using mobile communication is having a good service provider. Fig. 8 shows the supply conditions using the provider Vodafone, which has good coverage in this area, as an example.

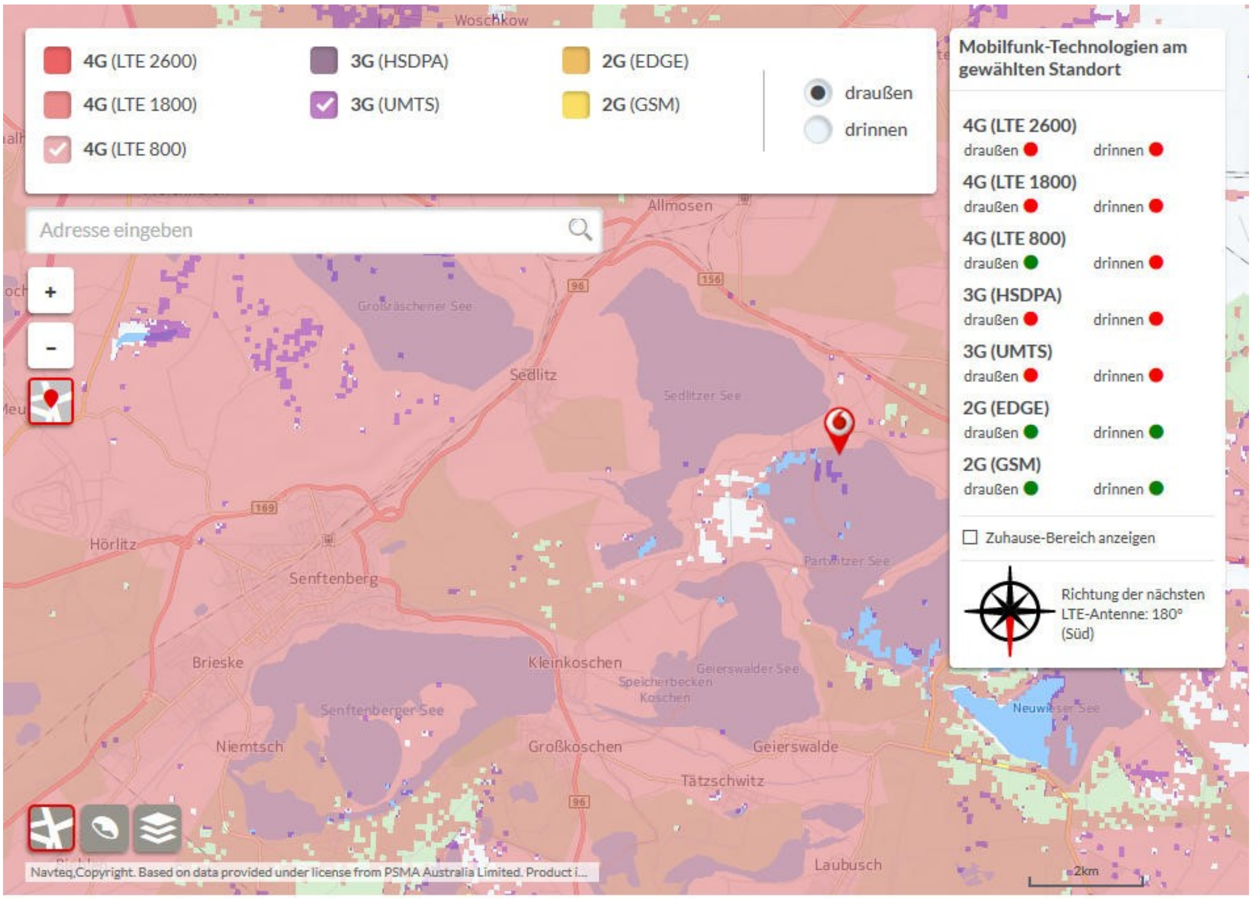


Fig. 8: Vodafone in the area of the Lausatian lakes (as of 22 December 2016)

The white spots in Fig. 8 indicate where the supply conditions can be considered borderline. The same can be said for Telekom. On the basis of these facts it can be concluded that no general guarantee for the availability of connection to a mobile network at the Lusatian lakes can be given.

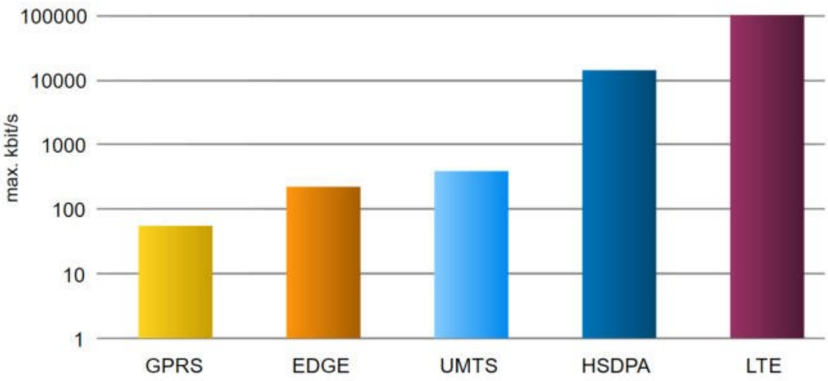


Fig. 9: Bit rates for different mobile radio standards

3.4. Infrastructure of data communication

It is self-evident that data communication and the components included are equipped according to the latest technologies in the Internet of Things. This is the only way the investment reserve required can be guaranteed.

4. Sensor technology and mathematics for the calculation of the wave height

4.1. Reference to GPS-Systems

The four biggest satellite navigation systems worldwide are GPS (Global Positioning System) a product of the USA, GLONASS (Globalnaja nawigazionnaja sputnikowaja sistema) a product of Russia, Compass a product of China, and Galileo a product of the EU/ESA. The complete system comprising 30 satellites will presumably not be finished before 2020. By using dual-frequency receivers a position accuracy of 4 m will be achieved.

Receivers that receive data from several satellite navigation systems provide more exact position determination due to higher coverage. Additional advantages are the protection against failure or manipulation of individual systems.

With the inclusion of different navigation satellite systems (e.g. GPS and Glonass) and multiple satellites as well as corrections it is currently possible to make accurate measurements at the scale of a centimetre in a vertical direction. In Germany correction data is provided by reference services, usually related to the reference system ETRS89/WGS84. By using this information, vertical accuracies of within 3 cm are estimated for Brandenburg.

However, position determination via satellite cannot be utilised when wave parameters (especially amplitude) are to be determined in real time with several measuring points in the waveform. This statement becomes comprehensible if one bears in mind that under these conditions only 10 ms are available for every measuring point and thus a large number of random errors are to be expected.

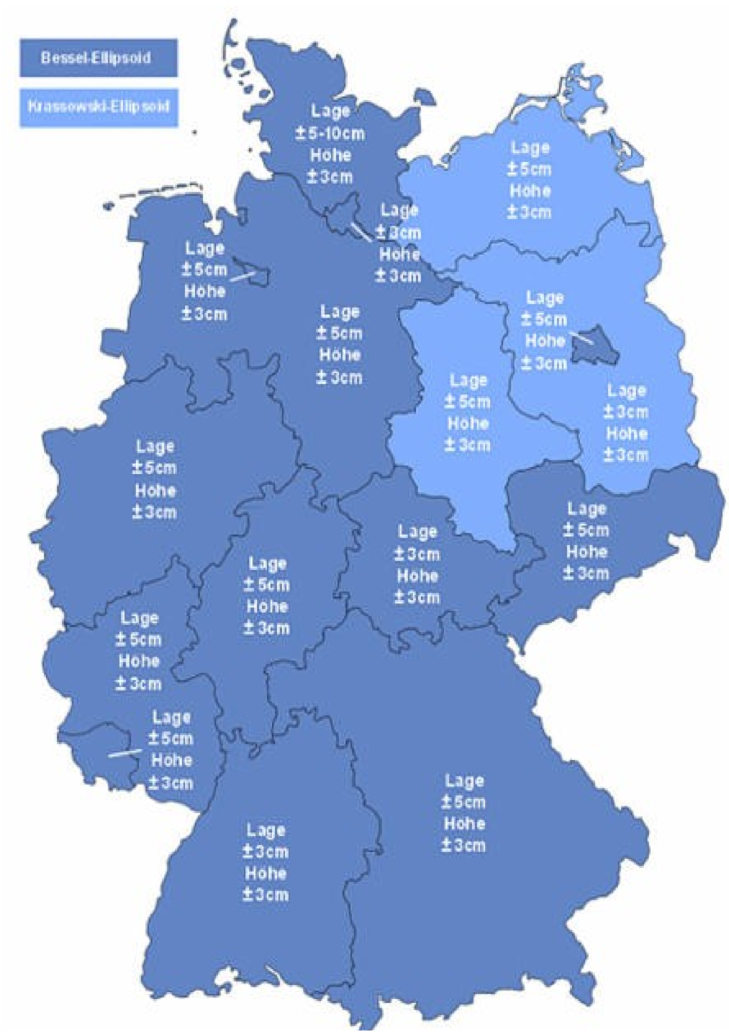


Fig. 10: Transformation accuracies in the individual Federal States

In March 2016, the company u-blox launched the smallest GNSS-RTK high-precision module with measurements of 12.2 mm x 16 mm x 2.4 mm (Real Time Kinematic Typ NEO-M8P). It works using the satellite-based navigation systems of GPS and GLONASS. The rover with theNEO-M8P-0 from u-blox receives correction data from the basic receiver NEO-M8P-2 via its communication link which uses the RTCM protocol (Radio Technical Commission for

Maritime Services) and makes position determination with an accuracy of centimetres possible.
The RTK algorithms have already been integrated into the module. Compared to the state of the art, electricity consumption was reduced to a fifth. Up to 18 measurements can be generated per second.

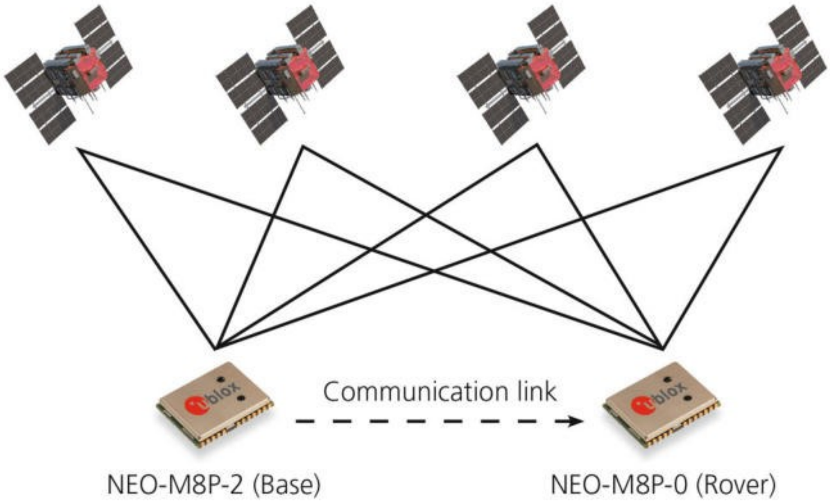


Fig. 11: Real Time Kinematic using GPS and GLONASS

4.2. <u>Satellite-based measurement and acceleration sensors</u>

A promising approach to overcome system-dependent limits of satellite-based measurements is to connect GPS and inertial sensor technology. Temporally high-resolution acceleration and angular velocity sensors deliver short-term stable information on the position of the arrangement being measured. In this case, GPS positioning has a supporting function because the results of inertial sensor technology alone randomly drift with time in all directions of the 2D space.
In principle, low-g acceleration sensors can be used alone, i.e. without satellite support. Then one has to take into account that in inland lakes lift is generally by an order of magnitude smaller than in oceans. In addition, for floating structures, which are often positioned near the shore, harmonic waves in the wave movement can be observed to a greater extent. This is of great importance insofar as interferences of various wave fronts can lead to superpositioning:

"As soon as waves in inland lakes reach shallow depths, the wave movement is significantly disturbed by the lake bottom. Under these shallow water conditions the waves at the surface become shorter and steeper; the frequency of wave breakers increases. If a group of waves approaches the shore above slowly rising ground, due to the low phase velocity in shallow water their crests are gradually positioned almost parallel to the depth contours; the distance from crest to crest becomes smaller, there is a shoaling effect for individual waves and the waves tend to break. Even long flat swells can develop into very high breakers with destructive power". [7]

When using low-g acceleration sensors the wave lift is calculated by double integration over the time. The corresponding numerics has to achieve a cumulation of da/dt values with calibration and elimination of the influence of gravity, which can be handled for today's microprocessors in life mode. With accelerations of 10^{-2} m/s^2 and frequencies in the range of 0.025 to 0.035 Hz random measuring errors smaller than one millimetre are to be expected. In this case, the random drifts can be mathematically eliminated assuming a relatively constant water level and unchanged position (achieved by anchoring the buoy).
But the buoy with its mass and buoyancy represents a spring-mass system. Such a system has an upper limit frequency. In this case this means that the buoy cannot make rapid vertical movements beyond its natural frequency. This brings up the question of the utilisation of free-floating buoys in inland lakes, since in inland lakes shorter wave periods of up to 0.33 s are typical. Consequently, lighter free-floating buoys or other measuring principles are required.

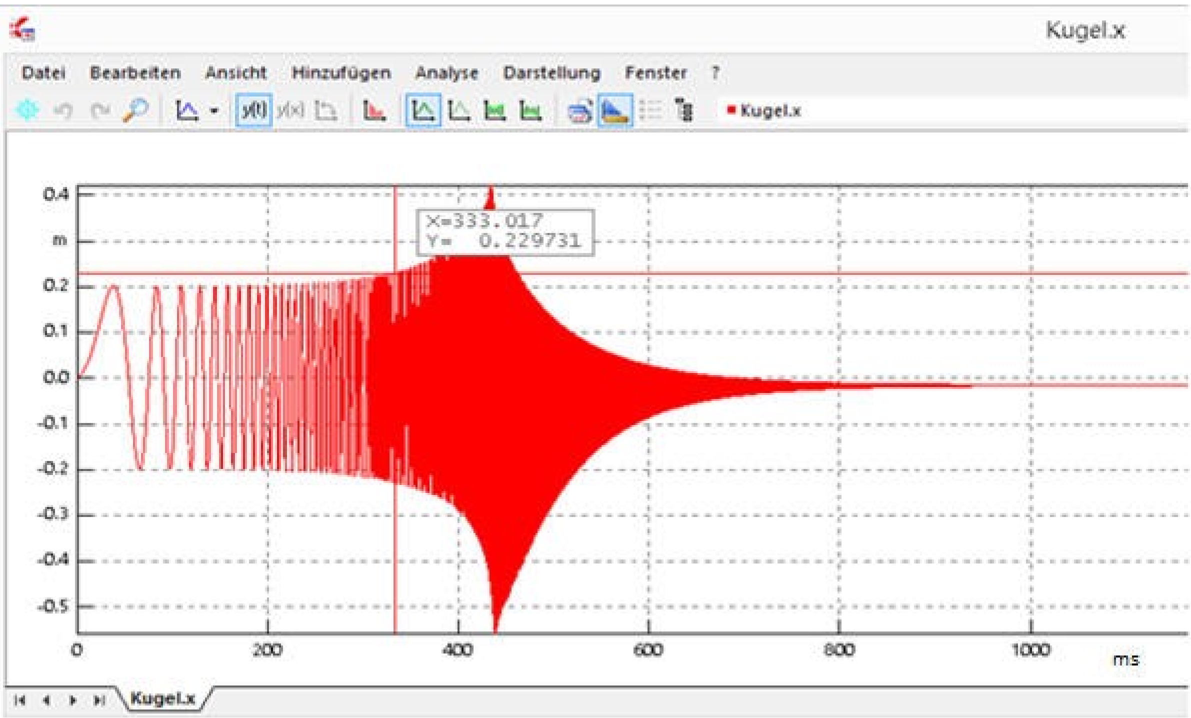


Fig. 12: Measuring problems caused by self-resonance with periods smaller than 333ms

4.3. <u>Utilisation of differential pressure sensors for measuring wave height</u>

A method to measure low wave heights, which has yet to be exploited, is using differential pressure sensors. The measuring would determine the differential pressure between the ambient air at water level and the pressure of the water column of an inert buoy, which cannot follow wave lift. By doing so, the advantage is compensated for.

The following parameters show the potential of this approach:

- < 1 mm zero point repeatability
- 16 bit resolution, i.e. differences of 1 mm in the water column can be recorded.
- up to 200 measuring values per second

However, such sensors must be protected against direct contact with water.

Fig. 14: Differential pressure sensor from the company SENSIRION

5. State of work

In order to solve the problem, techniques of SRD radio, UMTS communication, online web visualisation, GPS position determination and sensor technology, (temperature, brightness, wind and acceleration) as well as energy harvesting were integrated. During development a functioning prototype was set up and anchored in Lake Partwitzer See. In order to prove functional capability endurance tests were conducted. Unfortunately, the accumulator cells failed twice, so the device requires further improvement.

Furthermore, the data transfer system was upgraded in order to allow for direct transmission to the internet via UMTS. It is now possible to view the measurement results in real-time anywhere in the world.
Close to the shore, a weather station was installed on a floating house. Wind direction, wind speed, air pressure, rainfall, and temperature can be recorded online (live broadcast).

Fig. 15: Measurement of wind and wave parameters at Lake Partwitzer See 23

The weather station positioned on the embankment of Lake Partwitzer See is operated parallel to the other weather station on the floating house. (see Fig. 16).

In this way the influence of the microclimate and spatial distribution can be recorded. The weather station according to Fig. 16 has been upgraded with technology from the Internet of Things so that its data can be presented on the Internet in real time. The DEMO access is always open to interested parties.

Fig. 16: Datawell buoy with new electronic equipment in its compartment at Lake Partwitzer See

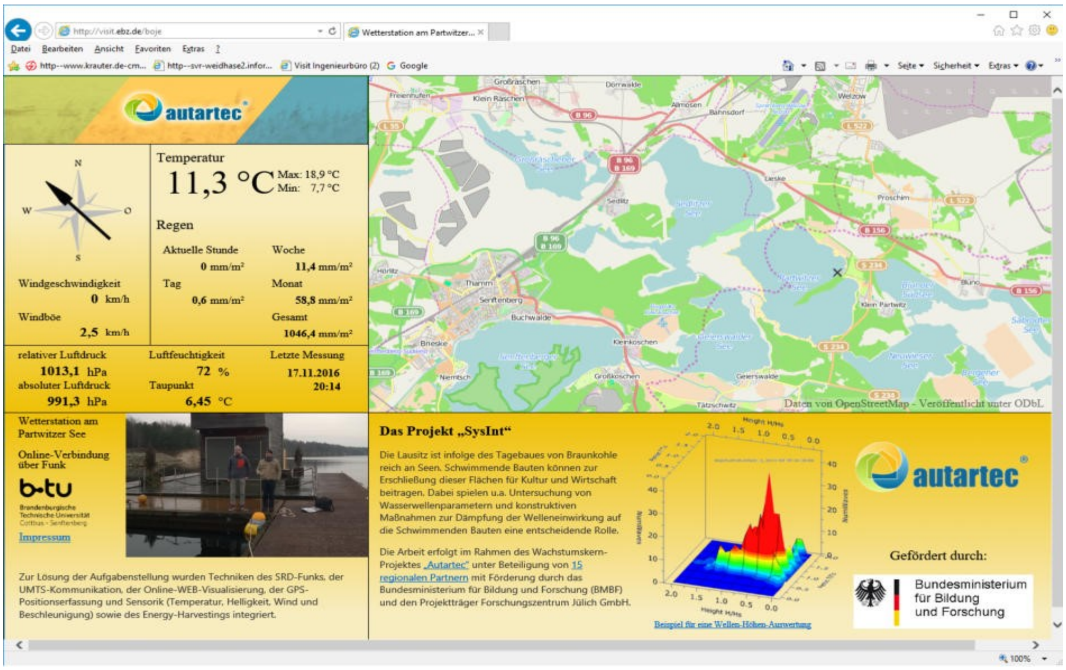


Fig. 17: Website showing weather and wave heights at Lake Partwitzer See

6. Suggestions for further research

- It is suggested to consistently pursue the approach of using energy harvesting and to successively improve the measuring system for the duration of project Autartec and to strive for permanent utilisation around the clock.
- New sensor principles (e.g. differential pressure) are to be tested regarding their practicability.
- For the improvement of the reliability of the measurement results the construction of special lightweight inland lake buoys would be useful.
- The authors are of the opinion that several buoys should be used if the influence of wind speed and wind direction is to be investigated.

7. Sources

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[2] Die Arbeit erfolgt im Rahmen des Wachstumskern-Projektes „autartec (03WKCH02H)“ unter Beteiligung von 15 regionalen Partnern mit Förderung durch das Bundesministeriums für Bildung und Forschung (BMBF) und den Projektträger Forschungszentrum Jülich GmbH.
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8. Acknowledgement

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28.11.2014

Swell Measurement in Coastal Engineering

Christian Schlamkow
Christian Kaehler

Universität Rostock
Lehrstuhl für Geotechnik und Küstenwasserbau
Justus-von-Liebig-Weg 6, LAGII
18059 Rostock

Paper read at the 2nd floating structure symposium, 2014

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Water waves

Water waves are surface waves at the interface between water and air. The spreading of the waves results in a transport of energy. Water waves do not transport masses of water but kinetic energy.

Development

- tidal movement
- ships
- wind
- operation of locks and weirs
- landslides
- earthquakes, seaquakes

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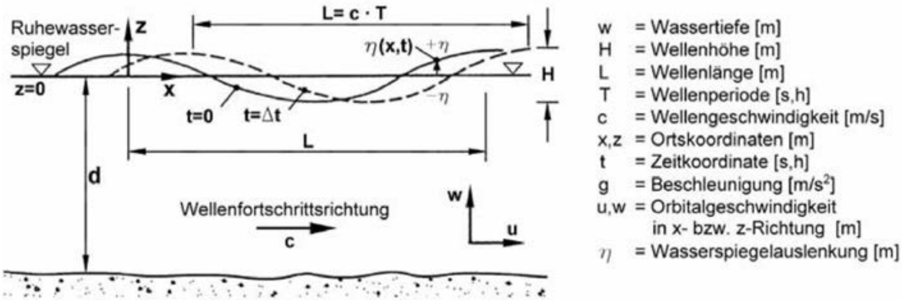
Water waves

parameters on waves



For the calculation of water waves parameters exists many theories of waves. The easy to calculate linear wave theory is sufficient for most of the tasks in coastal engineering.

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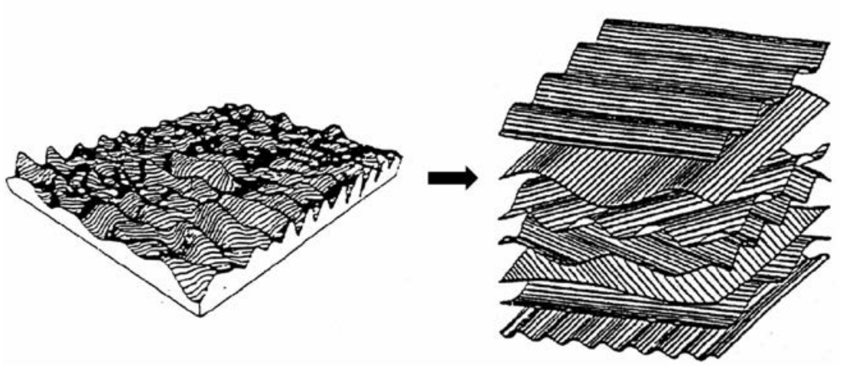
Swell

The swell is defined as an overlapping of waves of different heights, periods and directions. The swell comprises both swells caused by wind and the movement of the sea. It is influenced by the strength, direction, duration of the wind and water depth.



Overlapping of waves of different height, periods and directions

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Swell measurement

In relation to

- the duration of the measurement
- the requirements regarding accuracy
- the operation area
- according to the size of the area and the financial budget, a variety of measuring procedures to monitor swell is available

Assortment of procedures

- Measurement by buoys
- Pressure measurement
- Pressure measurement including current measurement
- Radar
- Ultrasound
- Image analysis
- Mechanical procedures
- Corrugated wire (resistance/capacities

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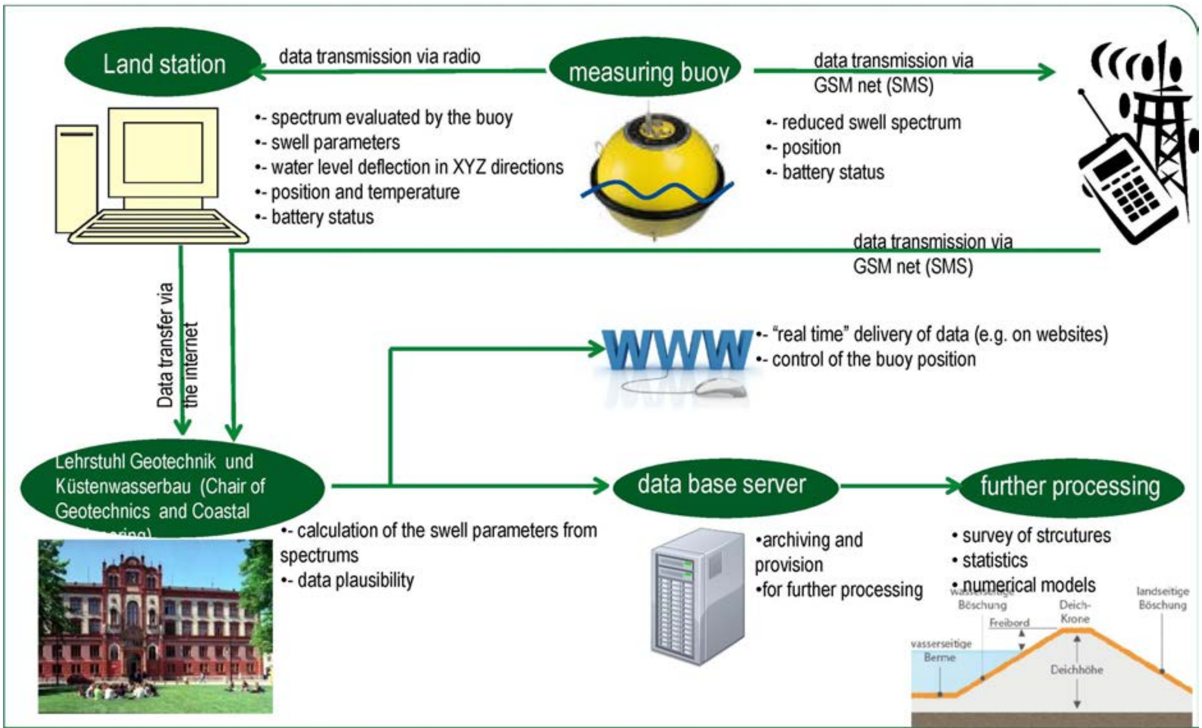
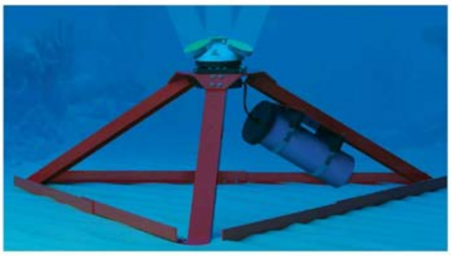
Swell measurement as a complex procedure



Swell Measurement

Acoustic Wave And Current Profiler (AWAC)



source: nortek-as.com

- Nortek Company (Norway)
- Measuring principle: acoustic
- Measurement of
  - wave height (-15 m to 15m)
  - wave period (1-50 seconds)
  - wave direction
  - flow velocity
- Accuracy: ~1 cm, 0.1°, 0.5 cm/s
- Maximum water depth: 35 m
- Data transfer via cable and modems (acoustic, radio and IP) possible

Swell Measurement

Monitoring of the wave height via ultrasound measurement in the lab

source: Erik Jasmand

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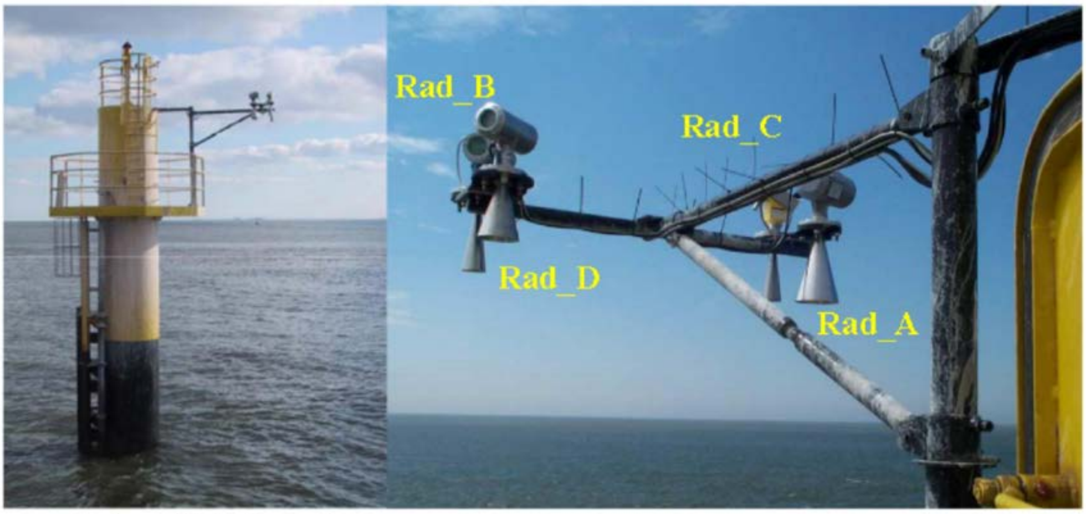
Swell Measurement

Monitoring of the wave height via radar (Borkum, Southern Beach)



source: Bundesanstalt für Gewässerkunde

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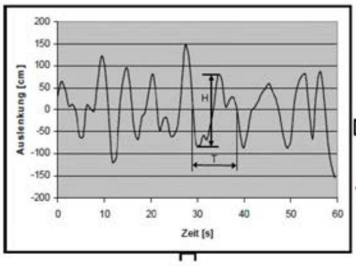
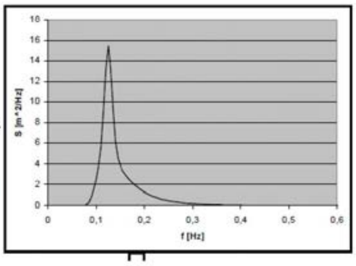
Swell

evaluation of swell

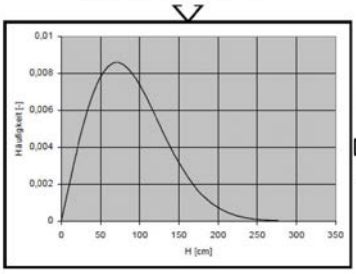


Fourier Trans-formation



Statistical analyses

parameterisation



Parame-trisierung

Time series	Spectral parameters
$H_{1/3}$	H_{m0}
$H_{1/10}$	T_{02}
H_{max}	Θ_M
T_m	T_p
$T_{H1/3}$	Ψ
...	...

"Floating Architecture on Acidic Bodies of Water- a Challenge with Regard to Corrosion Protection "

Dipl.–Chem. Ekkehard Scobel

ZAFT Dresden an der Hochschule für Technik und Wirtschaft Dresden

paper read at the 3th Floating Structures Symposium, 2016

Dipl.-Chem. Ekkehard Scobel 3. Tagung SCHWIMMENDE ARCHITEKTUR 25. November 2016 1

The problem of a constantly growing world population and the threat of a worldwide rise in sea levels due to climate change requires new comprehensive solutions. Floating architecture could be an answer to these problems.

The construction of floating architecture on artificial lakes created through rehabilitation and recultivation of open-cast lignite mines results in new requirements for corrosion protection. The lakes created by flooding of empty open-cast mines are sometimes extremely acidic and have pH – values between 2 and 4. These values are the cause of both geogene impurifications of the overburden with iron sulphide as a consequence of the pyrite weathering in the overburden dumps and the leaching of the weathering products. Besides the limitation of biological diversity in the lakes, special and specific concepts for corrosion protection will be required.

In the process of rehabilitating the Lusatian lakescape that is in the so called "stadium nascendi", 20 artificial lakes are being created and transformed into holiday and leisure centres in the region. On the other hand, with the establishment of a diversified new economic structure, they provide one of the bases for the newly developing economic region. With the Lusatian Lake District, a holiday region is being transformed from a lignite mining region to one of the largest human-made lakescapes in Europe. For sure, the planned habitation on these lakes is a unique selling point. For its implementation, special concepts have already been developed, the results of which can have a far-reaching influence and their amplification can be nationally promoted.

exposure of objects in Lusatian Lakes

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ZAFT

- **Corrosion in the water orrosion**
  pH value, temperature, oxygen content, ion concentration (particularly sulphate), zones:
  - underwater zone
  - zone of fluctuating water levels
  - splash water zone

- **Corrosion above water**
  humidity of air, temperature, oxygen content

- **Mechanical stress**
  Ice, sand, wave movement, wind

- **UV stress**
  e.g., depletion of aromatic ether bridges with epoxy coatings

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Mechanical stress in the Lusitian lakes

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Ice loads on lake Partwitz, winter 2011

Corrosion on non-standard coated edge - lake Partwitz

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Corrosion and fine art

Concrete corrosion caused by acidic bodies of water

Corrorsion of reinforcing bars

Cause of Corrosion

(Energy intake)
Smelting

Iron oxide ⇄ **Iron**

Corrosion

Magnetit (*Magneteisenstein*, Fe_3O_4)
Hämatit (*Roteisenstein*, Fe_2O_3)
Pyrrhotin (*Magnetkies*, FeS)
Pyrit (*Eisenkies*, FeS_2)
Siderit (*Eisenspat*, $FeCO_3$)
Limonit (*Brauneisenstein*, $Fe_2O_3 \cdot n\ H_2O$)

thermodynamically more stable

percentage by mass of the Earth's crust: 4,7%
crystal structure :
α-Eisen: kubisch raumzentriert
γ-Eisen: kubisch flächenzentriert
density : 7,874 g/cm3
melting point : 1538 °C

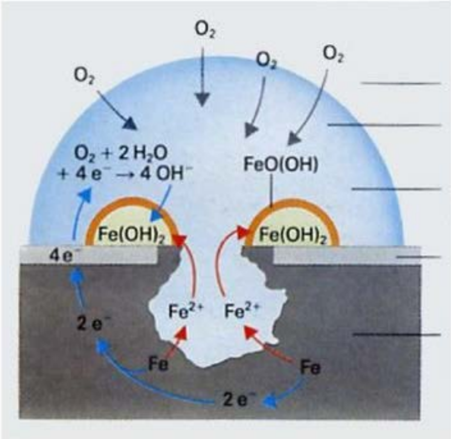
thermodynamically unstable

red. Form	oxid. Form		E_0 in V
Li	Li^+	+ e^-	- 3,04
K	K^+	+ e^-	- 2,92
Ca	Ca^{2+}	+ $2e^-$	- 2,87
Na	Na^+	+ e^-	- 2,71
Ce	Ce^{3+}	+ $3e^-$	- 2,48
Mg	Mg^{2+}	+ $2e^-$	- 2,37
Al	Al^{3+}	+ $3e^-$	- 1,66
Ti	Ti^{2+}	+ $2e^-$	- 1,53
Mn	Mn^{2+}	+ $2e^-$	- 1,18
Zn	Zn^{2+}	+ $2e^-$	- 0,76
Cr	Cr^{3+}	+ $3e^-$	- 0,74
Fe	Fe^{2+}	+ $2e^-$	- 0,44
Cd	Cd^{2+}	+ $2e^-$	- 0,40
Co	Co^{3+}	+ $3e^-$	- 0,28
Ni	Ni^{2+}	+ $2e^-$	- 0,25
Sn	Sn^{2+}	+ $2e^-$	- 0,13
Pb	Pb^{2+}	+ $2e^-$	- 0,12
H_2	**$2H^+$**	**+ $2e^-$**	**0,00**
Cu	Cu^{2+}	+ $2e^-$	+0,34
Ag	Ag^+	+ e^-	+0,80
Hg	Hg^{2+}	+ $2e^-$	+0,85
Pt	Pt^{2+}	+ $2e^-$	+1,20
Au	Au^{3+}	+ $3e^-$	+1,50

z u n e h m e n d U n e d e l ==> ---- Edel <===

electromotive series

Oxygen – corrosion



source: Wikipedia

sulphate cluster

$SO_2 + ½\,O_2 \rightarrow H_2SO_4$ Elektrolyt

$Fe^{2+} + H_2SO_4 + ½\,O_2 \rightarrow FeSO_4 + H_2O$

$2FeSO_4 + ½\,O_2 + 3H_2O \rightarrow$ **2FeO(OH)** $+ 2H_2SO_4$

chloride cluster

$NaCl \rightarrow Na^+ + Cl^-$ Elektrolyt

$Fe^{2+} + 2Cl^- + H_2O \rightarrow (Fe(OH)^+ + Cl^-) + (H^+ + Cl^-)$

$4Fe(OH)^+Cl^- + O_2 + 2H_2O \rightarrow$ **4FeO(OH)** $+ 4HCl$

Keep away from corrosion

- keep water away
  damp proof course
  hot-dip galvanising, enamelling
- keep oxygen away
  hot-dip galvanising
  enamelling
- chemical corrosion protection
  anodisation, burnishing
  use of active pigments (zinc chromate, read lead)
- prevention of corrosive elements
  organic polymer layers
  take note: diffusional vulnerability for individual non-charged molecules (water, oxygen and positively charged ions)
  take note: impermeable for large negatively charged anions
  (tightness of the coating and its thickness (barrier principle)
- corroding sacrificial anodes (e.g. zinc)
  corroding sacrificial anodes (e.g. zinc)
  an artificial direct-current source

Liquid Paint/Wet Lacquer

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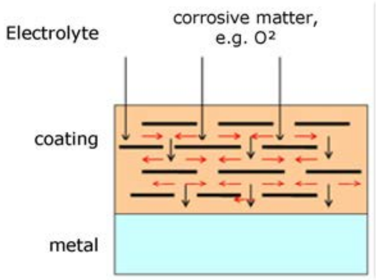
Structure of a liquid paint coat

- Primer :
  - barrier effect
  - active corrosion protection (saponification, conversion coating)
- Top coat
  - sealing
  - gloss
  - visual appearance



longer diffusion times through binding materials or pigments/dyes

→ System balanced, prevention of "internal stress"

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Standards for Corrosion Protection, Guidelines, Technical Guidelines

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- **DIN 55928? outdated, in 1998 superseded by ...**
- **DIN EN ISO 12944 (1998) coating materials, corrosion protection of steel structures by coating systems**
- **Norsok- M 501 (für Nordeuropa) (for Northern Europe) (revision 5 June 2004 or subsequent revisions)**
- **DIN EN ISO 20340, coating materials, performance requirements regarding coating systems for offshore structures**
- **BAW guidelines for testing coating systems for corrosion protection in hydraulic steelwork (RPB), 2011**
- **DB TL 918.300e.g. sheet 87 German Railways**
- **ZTV/TL/TP-KOR Additional technical contractual conditions and guidelines for engineering structures (ZTV-ING), Part 4 steel construction, composite steel construction**
- **DIN 28051 (1997) chemical apparatus engineering, coating and lining with organic materials**
- **Fire protection regulation ...**

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Protection Period

- definition: expected service life of a coating system up to the first partial renewal

- Zeitspannen:

short	*2 bis 5 years*	*low (L)*	*bis zu 7 years*
medium	*5 bis 15 years*	*medium (M)*	*7 bis 15 years*
long	*> 15 years*	high (H)	> 15 bis 25 *years*
		very high (VH)	mehr als 25 *years*

when choosing coatings/coating systems, planning parameters have to take periods of time into account

- The protection period (technical term) is not a warranty period (legal term). Generally, the warranty period is shorter than the protective period. There are no regulations to connect these terms.

Corrosivity Categories

for atmospheric environmental conditions, mass loss per unit area after one year of exposure

corrosivity category	mass loss per unit area/loss of thickness			
	unalloyed steel		zinc	
	mass loss [g/m2]	loss of thickness[μm]	mass loss [g/m2]	loss of thickness[μm]
C1 unimportant	≤ 10	≤ 1,3	≤ 0,7	≤ 0,1
C2 low	> 200 ... 400	1,3 ... 25	> 0,7 ... 5	> 0,1 ... 0,7
C3 medium	> 200 ... 400	> 25 ... 50	> 5 ... 15	> 0,7 ... 2,1
C4 strong	> 400 ... 650	> 50 ... 80	> 15 ... 30	> 2,1 ... 4,2
C5 I very strong (industry)	> 650 ... 1.500	> 80 ... 200	> 30 ... 60	> 4,2 ... 8,4
C5 M very strong (sea)	> 650 ... 1.500	> 80 ... 200	> 30 ... 60	> 4,2 ... 8,4

Corrosivity Categories

for water and soil:

IM 1	freshwater	structures in rivers
IM 2	sea or brackish water	port areas with steel structures, such as lock gates, barrages, piers, offshore structures
IM 3	soil	tanks in the soil, steel sheet pilings, steel pipes
IM 4	extreme	especially for offshore applications

→ Corrosion protection in acidic bodies of water is not regulated by any standards

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fabrication of edges suitable for minimal coating application

	Preparation level		
	P1	P2	P3
	Sufficient preparation	good preparation	very good preparation
rolled edges	no preparation	no preparation	the edges must be rounded with a minimum radius of 2 mm
edges made by punching, cutting or sawing	no part of the edge must be sharp,the edges must befree of burr	the edges must be fairly smooth	the edges must be rounded with a minimum radius of 2 mm
thermally cut edges	the surface must be free of slag and loose scale	no part of the edge must have an irregular profile	the cut surface must be reworked and the edges must be rounded with a minimum radius of 2 mm

x→

DIN EN ISO 8501-3: Preparation of steel surfaces before application of coating materials

$$KG = \frac{DFT_K}{DFT_F}$$

KG: = degree of burr coverage
DFT_k = dry layer thickness at the edges
DFT_k = dry layer thickness on the surface

DIN EN ISO 12944-3

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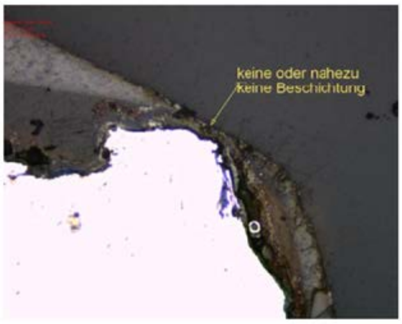
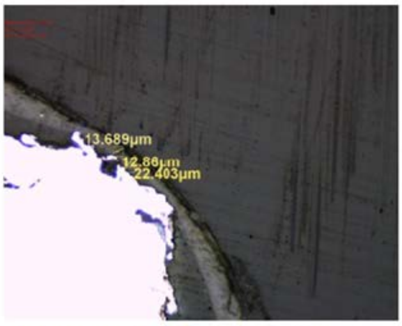
Coated Edges in Practice

grinding check at ZAFT





non-rounded and uncoated edges – minimal application DFTk (mostly below 20µm)
edges → extremely endangered by corrosion

benchmarks with high corrosive stresses :

edge radius R > 2 mm (unworked edge R = 0)
threefold smoothing of the edges (parameter x with I = 3) (grinding)

formation of acidic bodies of water in the Lusatian lake district

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Sources of water inlet for the Lusatian lakes:

- water from Spree river
- water from Schwarze Elster river
- rising groundwater
- leaching of dumps

overburden dump, Jänschwalde, Lusatia

source: Wikipedia

geogene impurities with iron sulphides (FeS²), minerals, pyrite and marcasites

Acidification by :

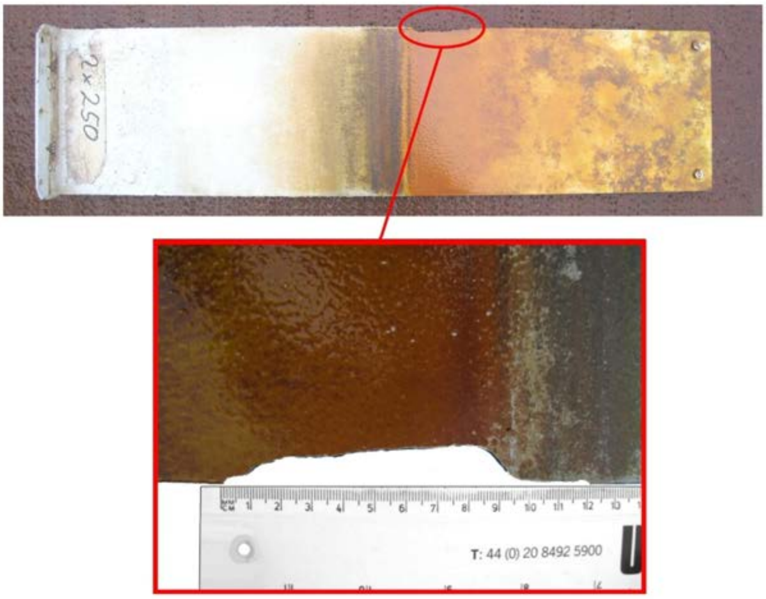
- Leaching of dumps
- pyrite weathering caused by the air flow in the dump (oxidation)
- strong microbial catalysing (about the 100-fold)

$$2\,FeS_2 + 7\,O_2 + 2\,H_2O \rightarrow 2\,Fe^{2+} + 4\,SO_4^{2-} + 4\,H^+$$

$$2\,Fe_2+ + 0{,}5\,O_2 + 4\,H_2O \rightarrow 2\,Fe(OH)_3\ (\downarrow) + 4\,H^+$$

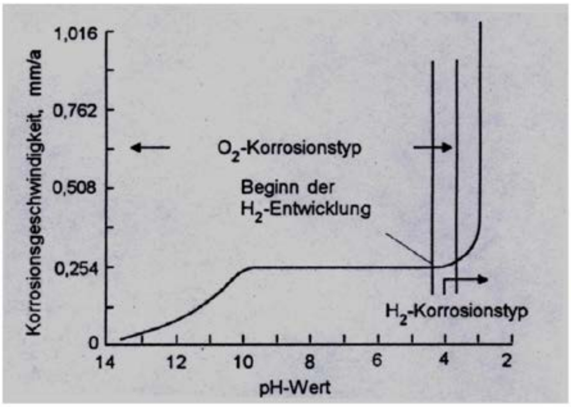
strong increase in acidity by subsequent hydrolysis and precipitation of iron (III) compounds

aggressiveness of acidic lake water



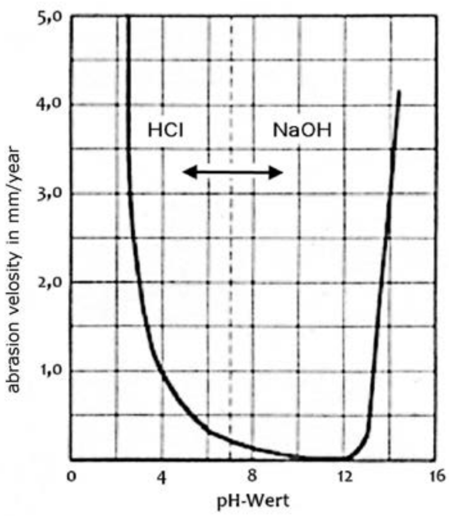
Pitting corrosion at 2-K thick-coat epoxy system at a practically uncoated edge after 138 weeks of instalment in Lake Partwitz

aggressiveness of acidic lake water



velocity of corrosion type of corrosion start of H² formation

source: Akademie Verlag 1970



abrasion velosity zinc abrasion dependent on the pH-value

Mitteilung IKS Dresden, 2010

concrete subjected to aggressiveness of acidic lake water

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analysis	attack intensity		
	weak attack	strong attack	very strong attack
pH-value	6,5…5,5	5,5…4,5	unter 4,5
lime-dissolving carbonic acid (CO_2) mg/l	15…40	40…100	über 100
ammonium ($NH4^+$) mg/l	15…30	30…60	über 60
magnesium (Mg^{2+}) mg/l	300…1000	1000…3000	über 3000
sulphate (SO_4^{2-}) mg/l	200…600	600…3000	über 3000

boundary values for the evaluation of naturally composed bodies of water attacking concrete (according to DIN 4030)

$$3\ CaO \cdot 2SiO_2 \cdot 3\ H_2O\ +\ 6\ H^+ \rightarrow 3\ Ca^{2+} + 2\ SiO_2 + 6\ H_2O$$

slightly soluble easily soluble

Conclusion

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Conclusion

- problems of corrosion can usually be solved, even in an aggressive environment
- compliance with normative specifications required
- professional workmanship required
- selection and testing of suitable materials and coating systems
- adaptation to existing technologies

Numerical Simulation and Evaluation of the Movement Behaviour of Floating Structures

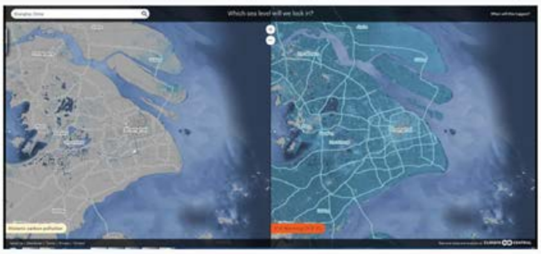
Brandenburgische Technische Universität
Cottbus-Senftenberg

Dr.-Ing. Wolfgang Schmidt
M.Eng. Eduard Völker

paper read at the 3rd floating structure symposium 2016

Intension to Build on Water

- Global consideration such as lack of settlement areas resulting from population growth and an increasing quality of life as well as a rise in sea levels



Climate Central

Carbon emissions causing 4 degrees Celsius of warming (7.2 degrees Fahrenheit) — a business-as-usual scenario — could lock in enough eventual sea level rise to submerge land currently home to 470 to 760 million people globally. Carbon cuts resulting in the proposed international target of 2 °C warming (3.6 °F) would reduce the rise locked in so that it would threaten areas now occupied by as few as 130 million people. This contrast is one expression of what is at stake in the December 2015 global climate talks in Paris.

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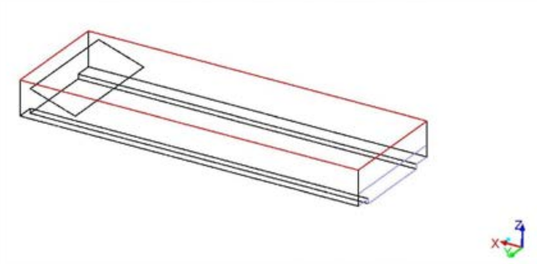
2

Wide hydro-engineering flow canal

for testing floating structures and heat exchangers under stresses caused by water waves

-Wave Canal-

Numerical Simulation



Constructed Wave Canal

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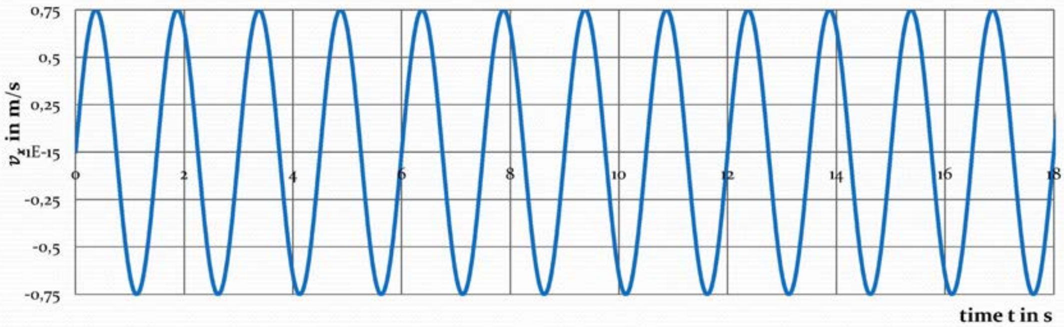
Wave Generator

Generation of a piston flow

Inlet opening : $v_x = v_0 \cdot \sin(\omega t) \quad mit\ \omega = \frac{2\pi}{T}$

Example I: v_0= 0,75 m/s   period duration : T=1,5 s

Wave generator: velocity vx in the inlet opening



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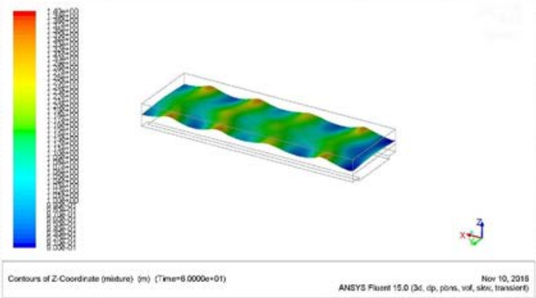
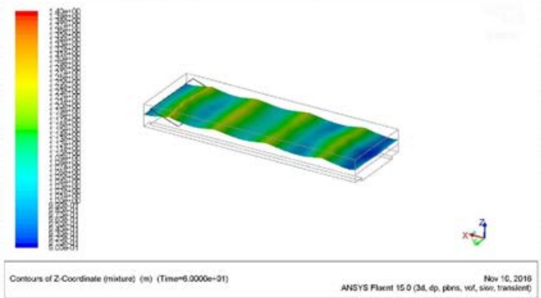
Comparison: Free wave surface

Wave canal without absorber



Wave canal with absorber



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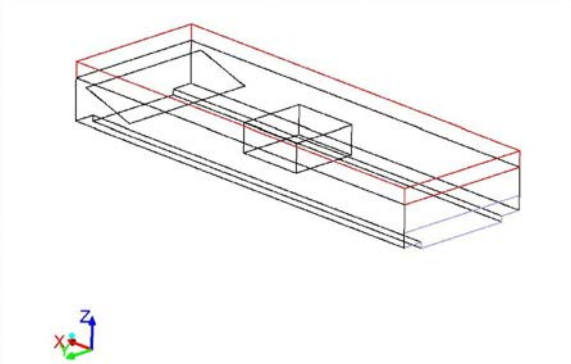
5

Wave canal with closed floating body

Water level in the wave canal: 1.1 m

Floating body (pontoon)
Dimensions: 2,4 m x 2,4 m x 1,0 m
Mass: 2880 kg

wave generator
v_0= 0,75 m/s
T=1,5 s



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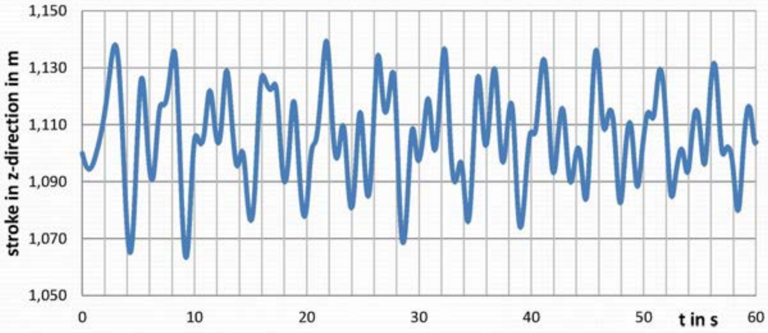
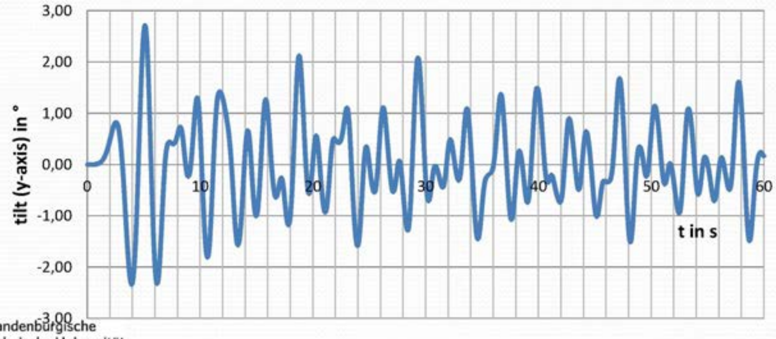
6

Pontoon movement because of waves



Pontoon movement because of waves



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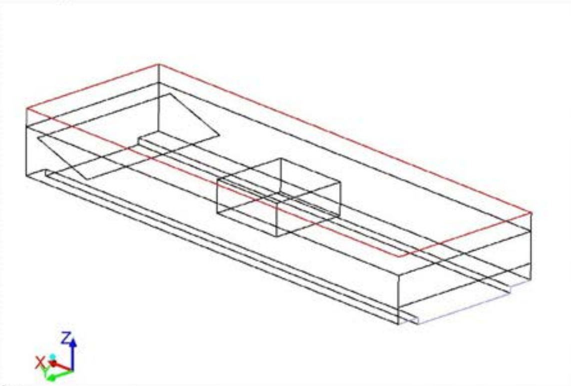
7

Wave canal with floating body with an opening on its underside

water level in canal: 1,4 m
water level in floating body : 0.9m

floating body (pontoon)
dimensions: 2,4 m x 2,4 m x 1,0 m
mass: 2880 kg

wave generator
v_0= 1,25 m/s
T=1,25 s



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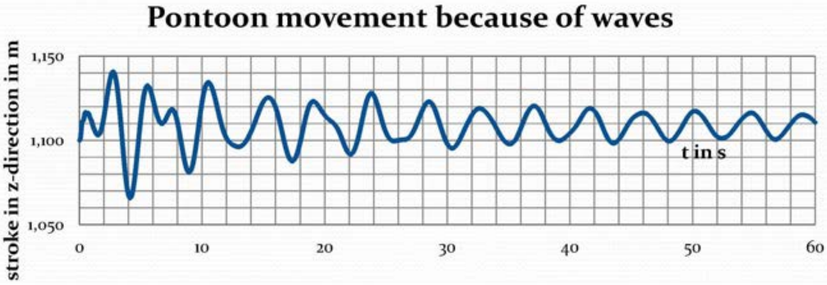
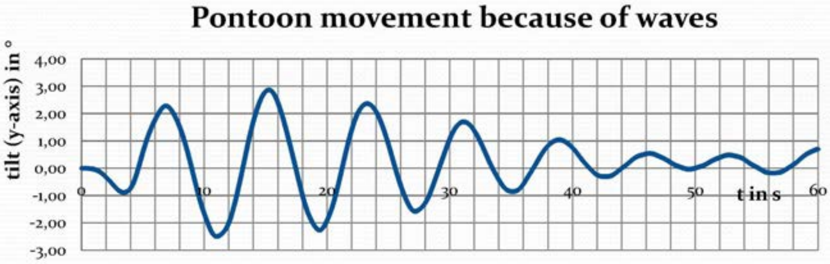
8



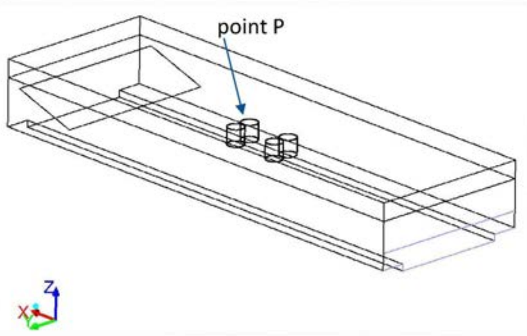


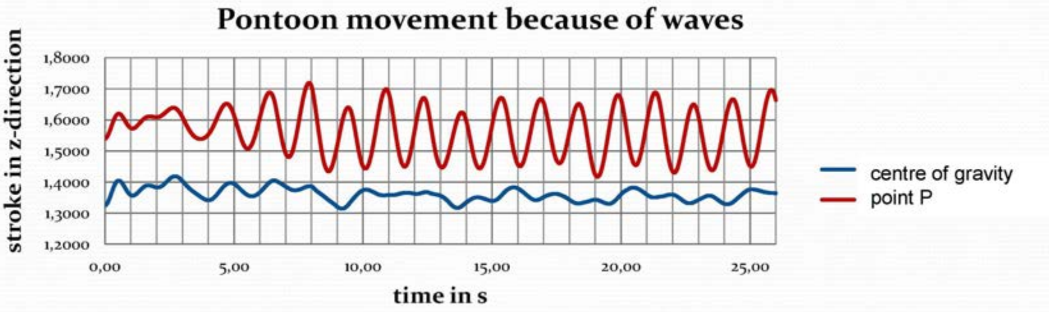
Wave canal with floating body with an opening on its underside

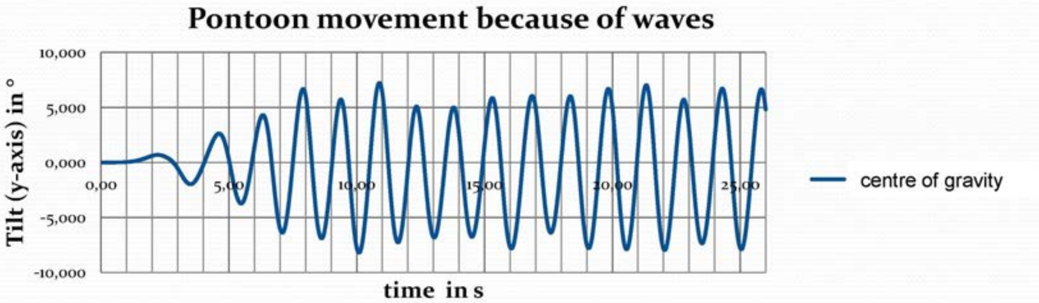
water level in the canal: 1,2 m

floating body (4 pipes: h_R= 0.51 m, D_R= 0,5 m, s_R=0,015m)
dimensions: 2,04 m x 1 m x 0,51 m
masse 72 kg
!frame not showed!

wave generator
v_0= 0,75 m/s
T=1,5 s







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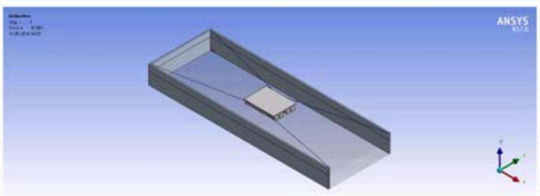
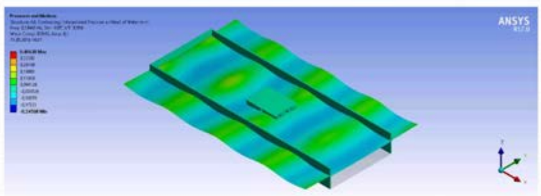
11

Simulation of the movement behaviour of a pipe pontoon in the wave canal. The pontoon is fixed with 4 elastic cables

<u>Airy-waves:</u> period = 1,68 s frequency= 0,6 Hz wave level= 0,2 m wave length:= 4 m





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12

Use of the Energy Potential of Floating Structures

Final report on the joint FKZ project: FKZ: 03ET1018B/C
Coordination FG Bauphysik/ Gebäudetechnik, BTU Cottbus-Senftenberg

I short description
II detailed description
Report sheets German/English
Hannover technical information libary

Brandenburgische Technische Universität Cottbus - Senftenberg

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Stopp / Strangfeld: Großräschen 25. November 2016

II Detailed Description

edited by :

Architekturbüro Hülsmann & Thieme
Architekt Dipl.-Ing. F. Hülsmann
Architekt Dipl.-Ing. C. Thieme

Fraunhofer-Institut Solare Energiesysteme ISE
Dr. P. Engelmann

GS Baugesellschaft
Dipl.-Ing. S. Giebler M.A.

Hochschule Ansbach
M. Henninger, B.Eng.
Prof. Dr. phil. nat. W. Schlüter
Schneiderer, M.Eng.

Ingenieurbüro F. Batke
Dipl.-Ing.(FH) F. Batke M. Eng.

Metallbau Wilde GmbH
Thomas Wilde, Metallbaumstr.

BTU Cottbus-Senftenberg (Koord.)
Dipl.-Ing.(FH)F. Hansel
Prof. Dr.-Ing. habil. P. Häupl
Malakhova M. Eng.
Dr.-Ing. P. Strangfeld
Dr.-Ing. W. Schmidt
Prof. Dr.sc.techn. H. Stopp
Dipl.-Ing.(FH)T. Toepel
E. Völker M. Eng.

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Selected chapters of the "detailed description"

1 introduction

2 use of alternative energies in floating structures

3 integration of the pontoons with rooms for equipment, storage and dwelling into the utilisation structure of floating buildings

4 energy supply of floating buildings

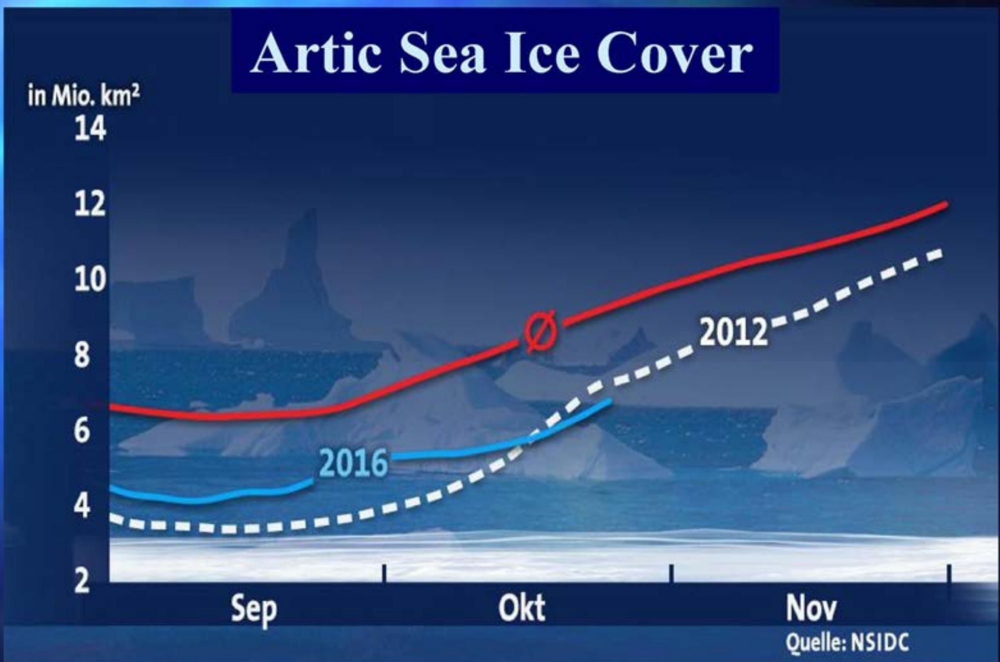
5 architecural design of technical solutions

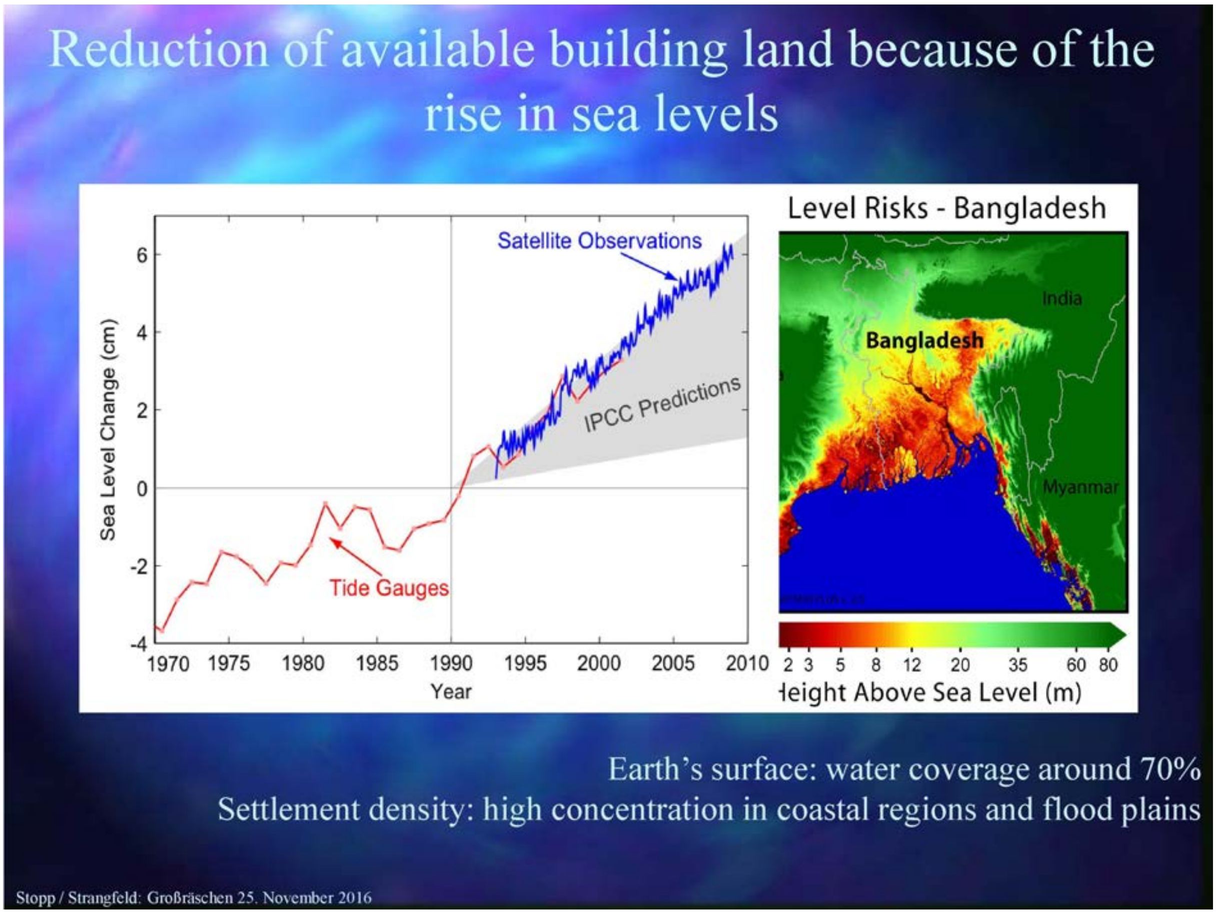
6 efficiency of floating houses

7 guidelines for planning technical equipment for the supply and disposal of floating houses

Referring to 1: Introduction

Reduction of the ice masses at the poles and rise in sea levels due to rise of the mean temperature in the lower atmosphere




Reduction of available building land because of the rise in sea levels
Satellite Observations
IPCC Predictions
Tide Gauges
Sea Level Change (cm)
Year
Level Risks - Bangladesh
India
Bangladesh
Myanmar
Height Above Sea Level (m)
Earth's surface: water coverage around 70%
Settlement density: high concentration in coastal regions and flood plains
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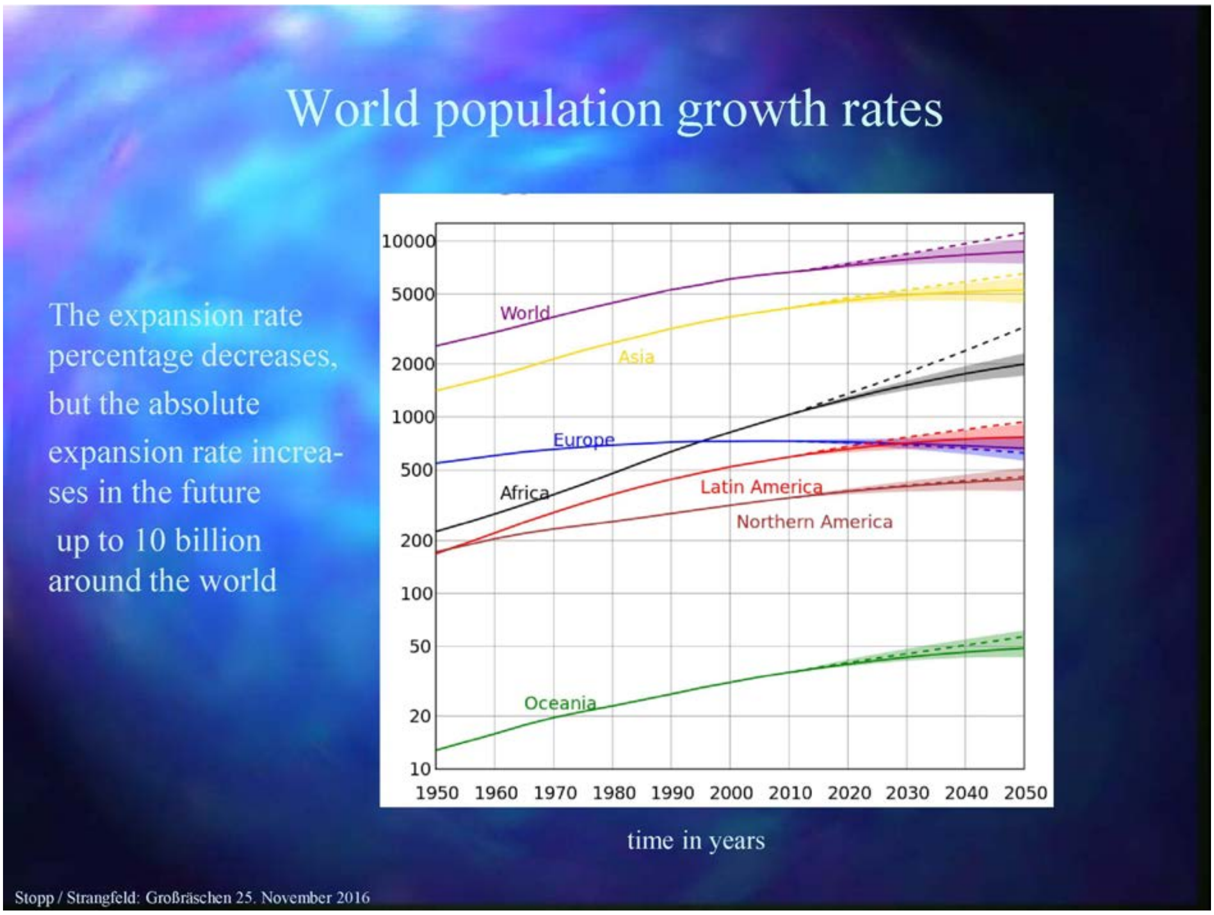
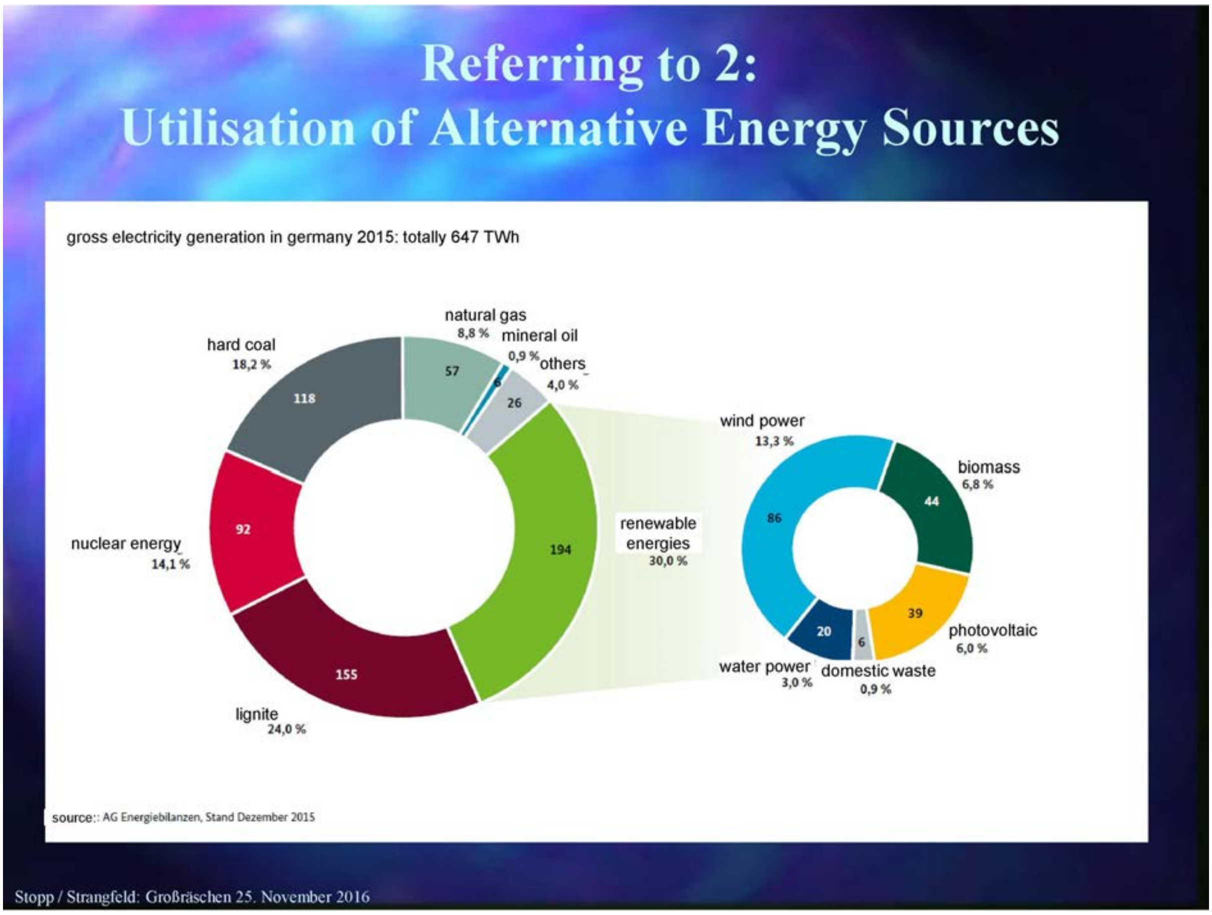

World population growth rates
The expansion rate percentage decreases, but the absolute expansion rate increases in the future
up to 10 billion around the world
World
Asia
Europe
Africa
Latin America
Northern America
Oceania
time in years
Stopp / Strangfeld: Großräschen 25. November 2016


Referring to 2:
Utilisation of Alternative Energy Sources
gross electricity generation in germany 2015: totally 647 TWh
natural gas
8,8 %
mineral oil
0,9 %
others
4,0 %
hard coal
18,2 %
nuclear energy
14,1 %
lignite
24,0 %
renewable
energies
30,0 %
57
6
26
118
92
155
194
wind power
13,3 %
biomass
6,8 %
photovoltaic
6,0 %
water power
3,0 %
domestic waste
0,9 %
86
44
39
6
20
source:: AG Energiebilanzen, Stand Dezember 2015
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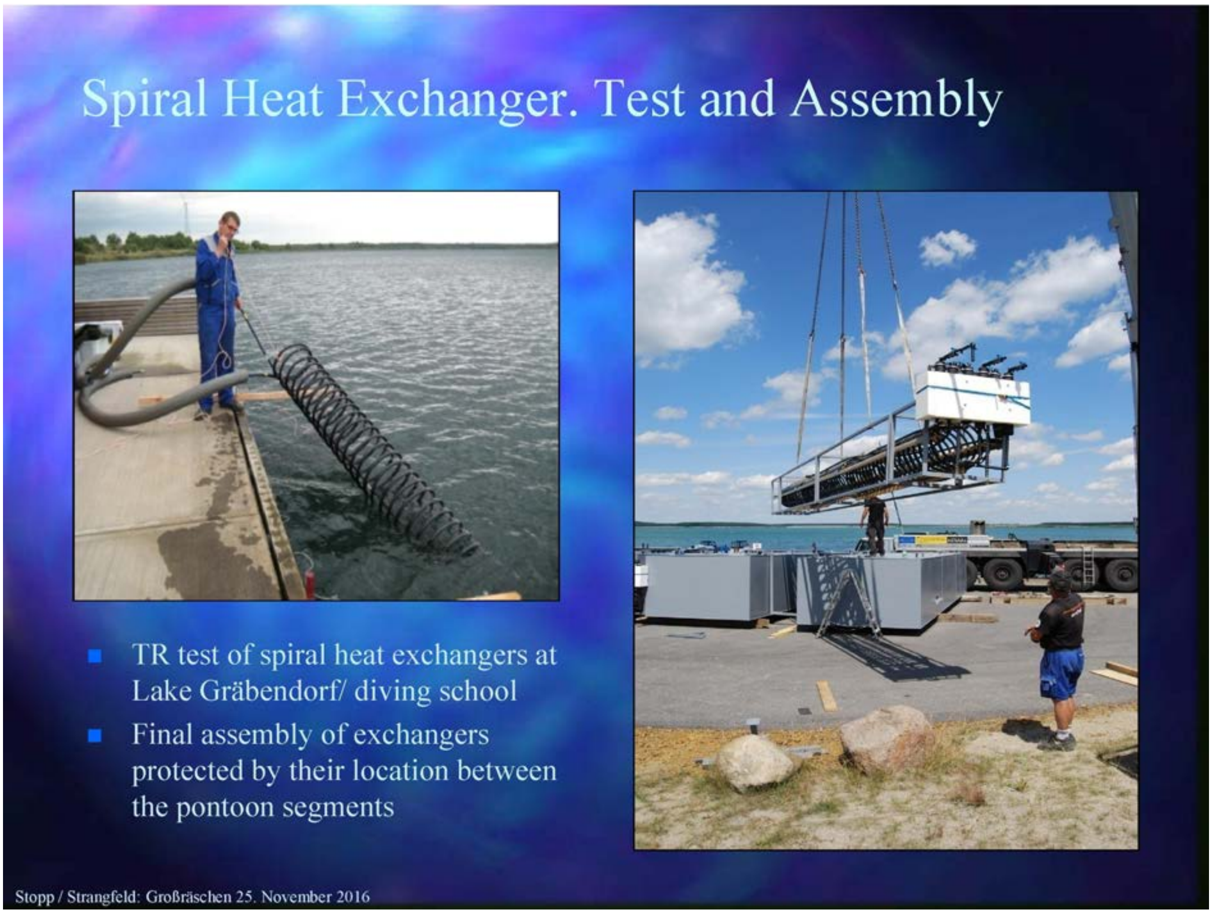
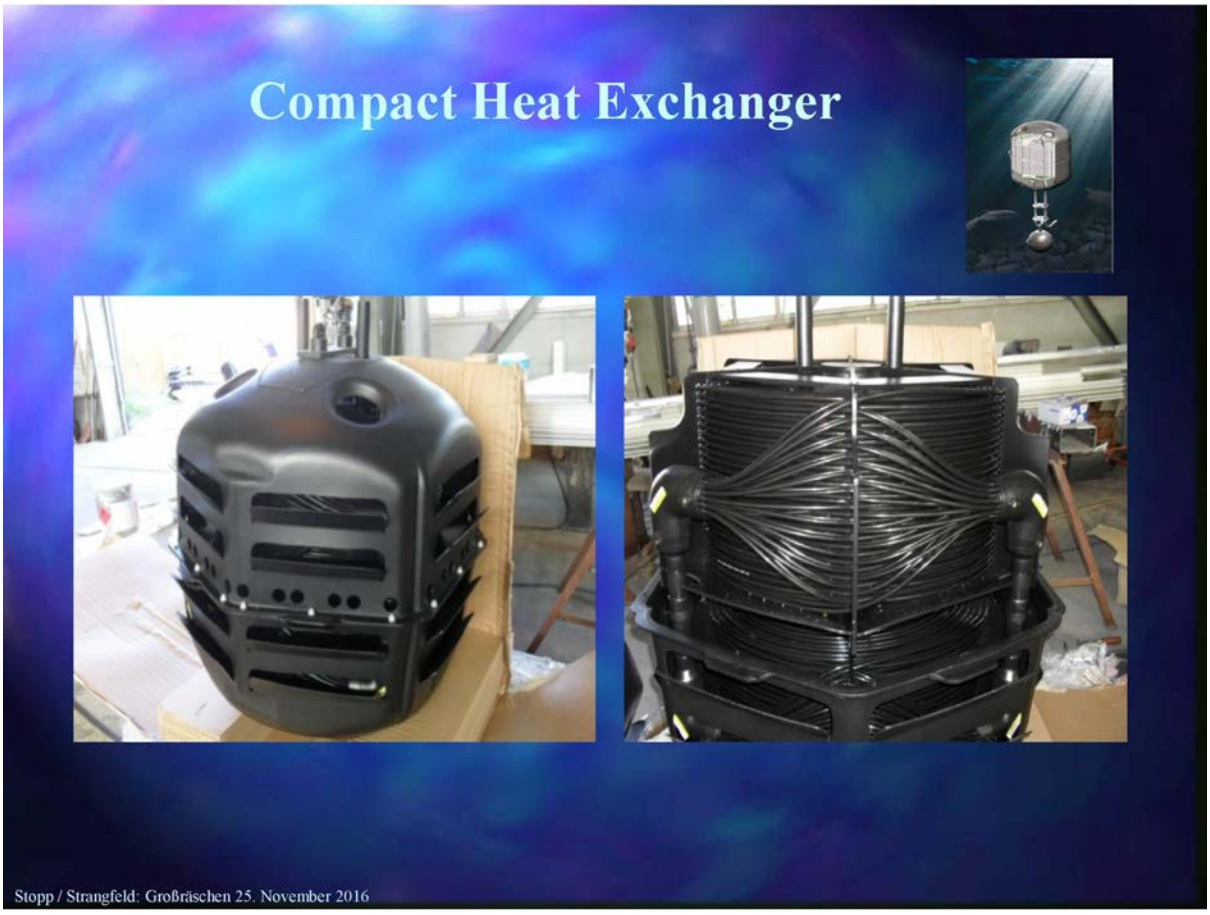
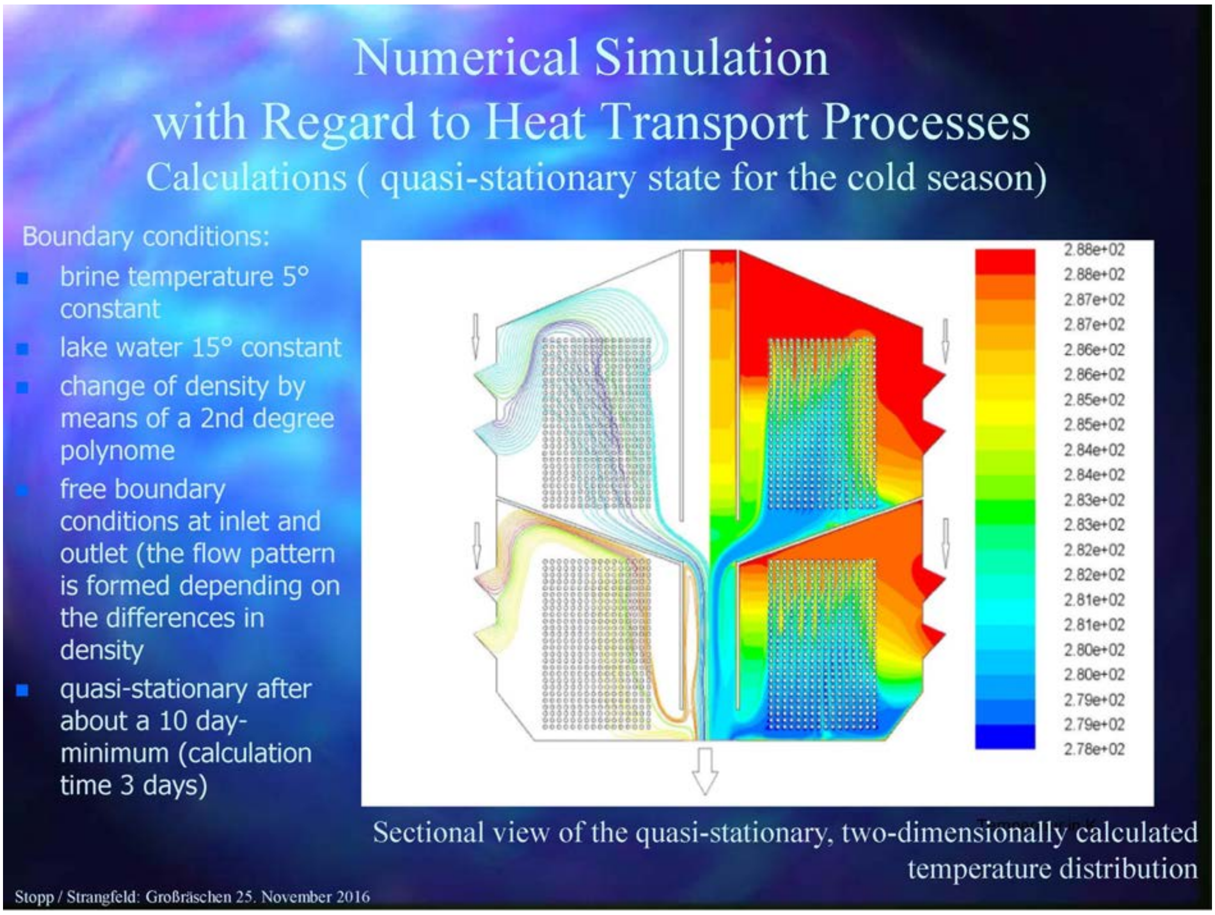

Spiral Heat Exchanger. Test and Assembly
TR test of spiral heat exchangers at Lake Gräbendorf/ diving school
Final assembly of exchangers protected by their location between the pontoon segments
Stopp / Strangfeld: Großräschen 25. November 2016


Compact Heat Exchanger
Stopp / Strangfeld: Großräschen 25. November 2016


Numerical Simulation
with Regard to Heat Transport Processes
Calculations (quasi-stationary state for the cold season)
Boundary conditions:
brine temperature 5° constant
lake water 15° constant
change of density by means of a 2nd degree polynome
free boundary conditions at inlet and outlet (the flow pattern is formed depending on the differences in density
quasi-stationary after about a 10 day-minimum (calculation time 3 days)
2.88e+02
2.88e+02
2.87e+02
2.87e+02
2.86e+02
2.86e+02
2.85e+02
2.85e+02
2.84e+02
2.84e+02
2.83e+02
2.83e+02
2.82e+02
2.82e+02
2.81e+02
2.81e+02
2.80e+02
2.80e+02
2.79e+02
2.79e+02
2.78e+02
Sectional view of the quasi-stationary, two-dimensionally calculated temperature distribution
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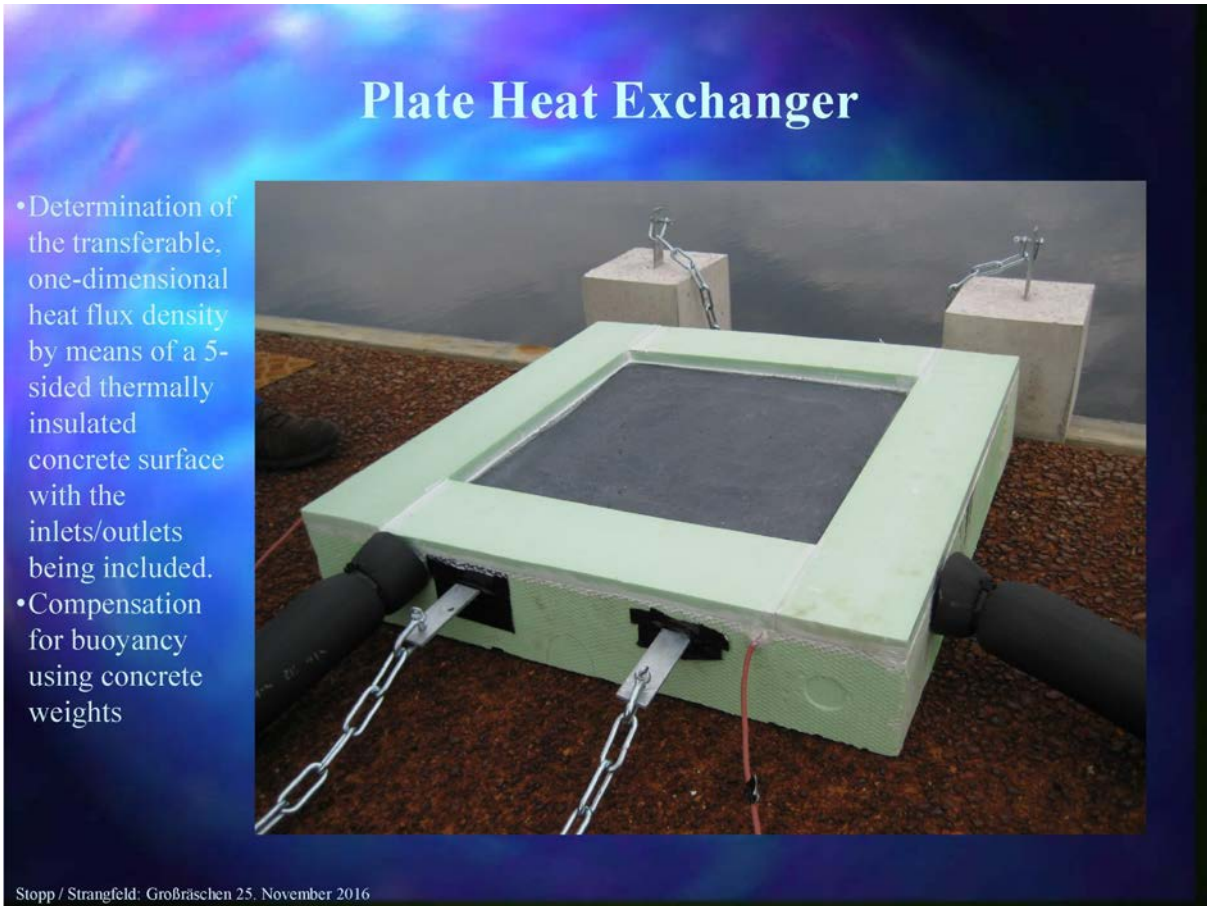
Plate Heat Exchanger
•Determination of the transferable, one-dimensional heat flux density by means of a 5-sided thermally insulated concrete surface with the inlets/outlets being included.
•Compensation for buoyancy using concrete weights
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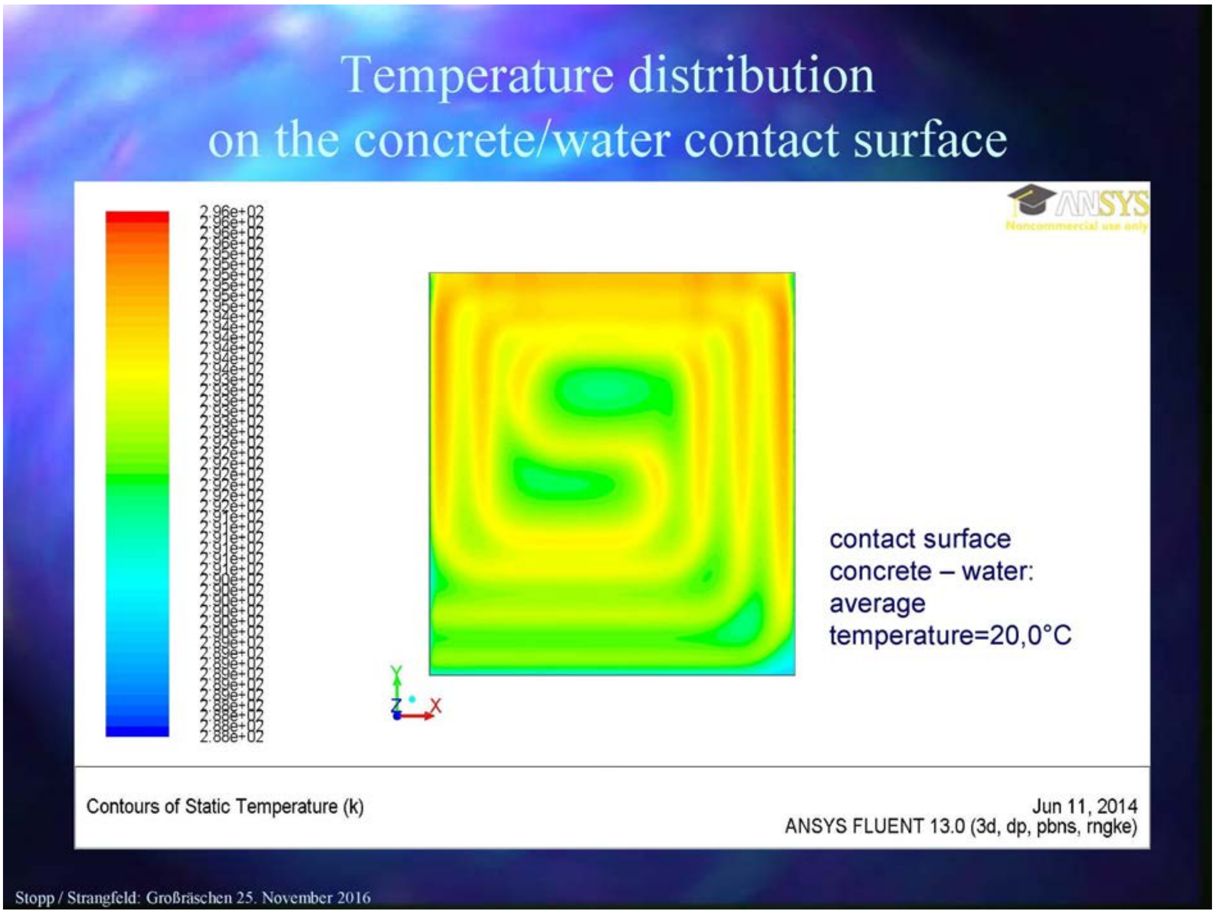
Temperature distribution on the concrete/water contact surface
2.96e+02
2.88e+02
ANSYS
contact surface concrete – water: average temperature=20,0°C
Contours of Static Temperature (k)
Jun 11, 2014
ANSYS FLUENT 13.0 (3d, dp, pbns, rngke)
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Interim Results

1. In connection with the consequences of climate change, the demographic development, the development of resources and human needs as well as economic and ethical reasons, care and provision of basic requirements allow for a comprehensive dealing with the complex of topics, " Floating Structures for Living".
2. With a view to floating structures, heat exchangers still offer enough possibilities for innovation and optimisation of energetic parameters.
3.
4.

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Referring to 4:
Energetic supply of Floating Structures

Floating research station on a gravel pit lake located on the Lower Rhine

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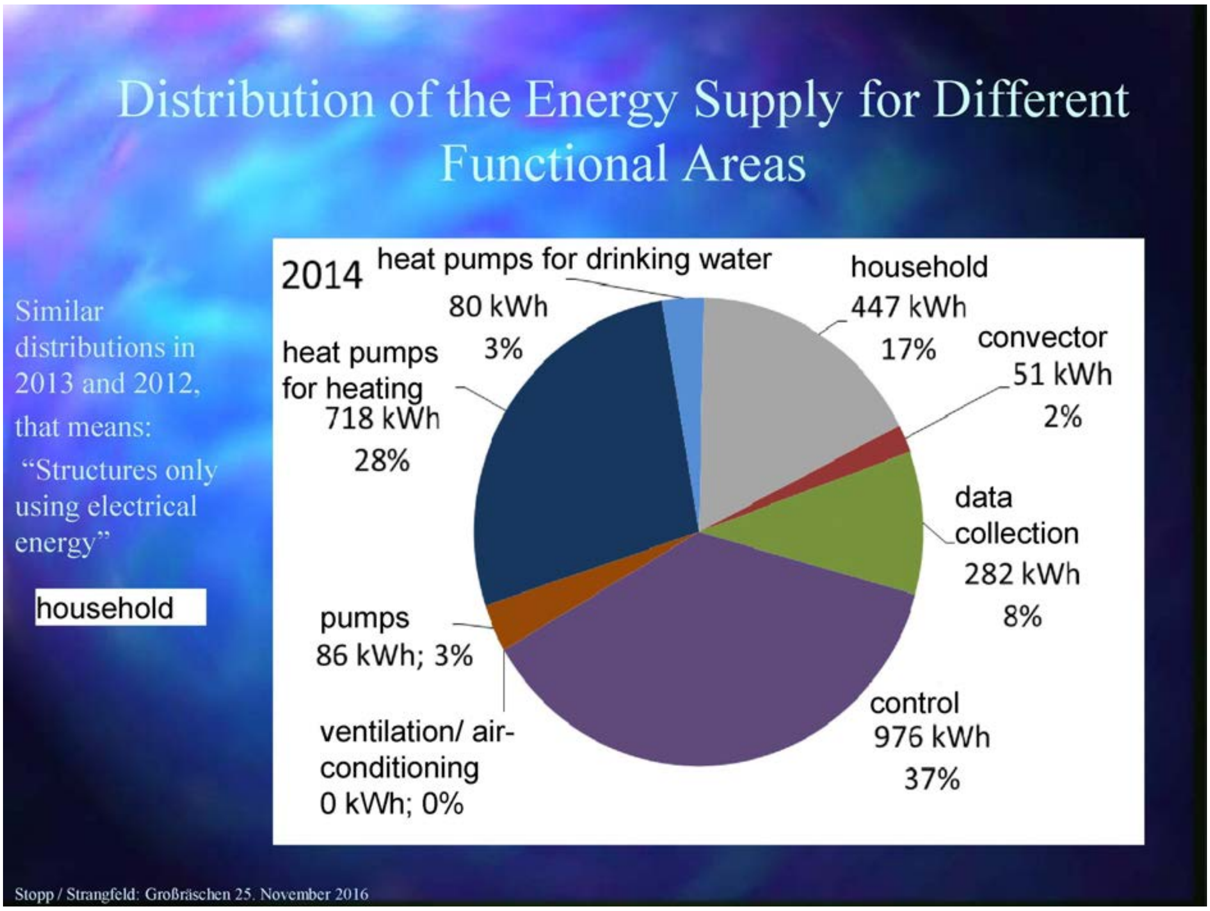

Distribution of the Energy Supply for Different Functional Areas
Similar distributions in 2013 and 2012, that means:
"Structures only using electrical energy"
household
2014
heat pumps for drinking water 80 kWh 3%
household 447 kWh 17%
convector 51 kWh 2%
heat pumps for heating 718 kWh 28%
data collection 282 kWh 8%
pumps 86 kWh; 3%
ventilation/ air-conditioning 0 kWh; 0%
control 976 kWh 37%
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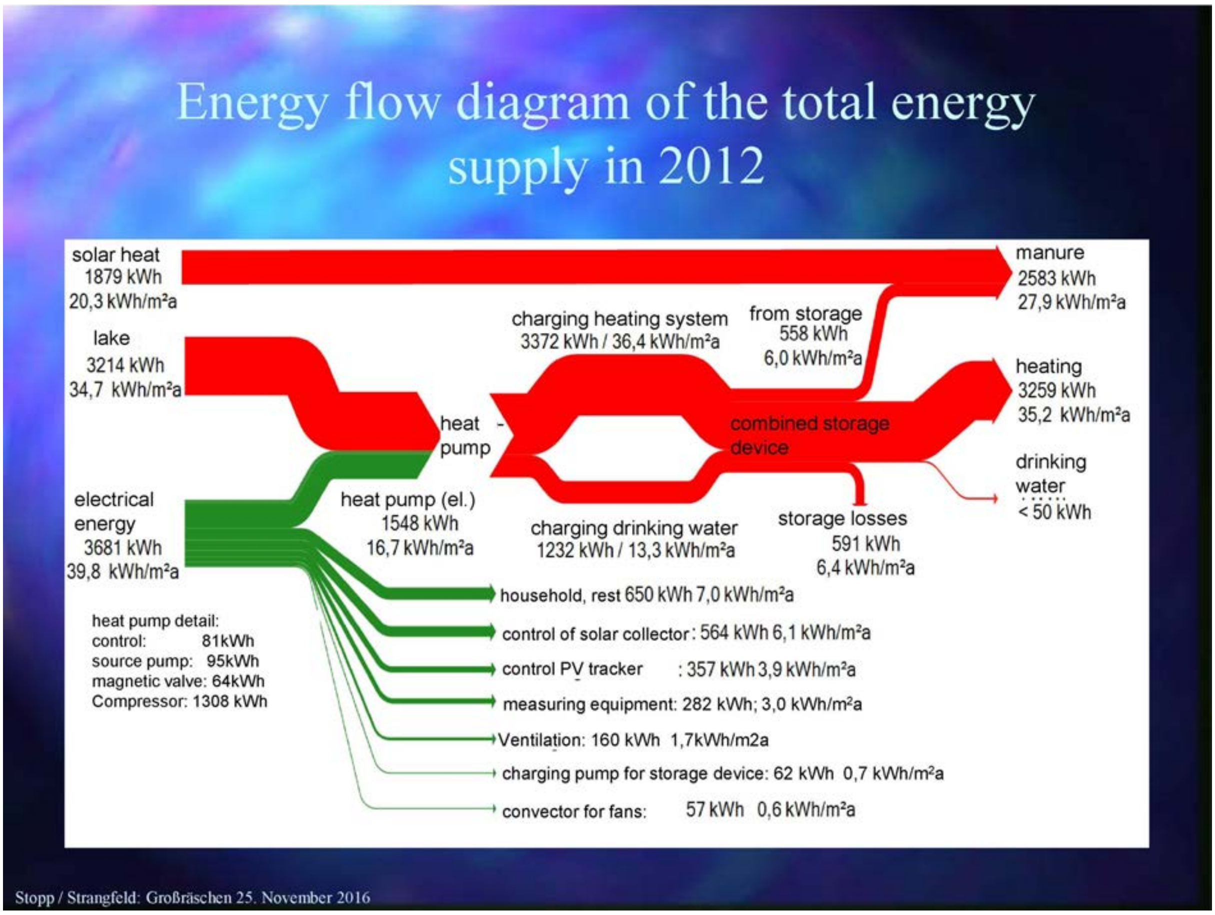

Energy flow diagram of the total energy supply in 2012
solar heat 1879 kWh 20,3 kWh/m²a
manure 2583 kWh 27,9 kWh/m²a
lake 3214 kWh 34,7 kWh/m²a
charging heating system 3372 kWh / 36,4 kWh/m²a
from storage 558 kWh 6,0 kWh/m²a
heating 3259 kWh 35,2 kWh/m²a
heat pump
combined storage device
drinking water < 50 kWh
electrical energy 3681 kWh 39,8 kWh/m²a
heat pump (el.) 1548 kWh 16,7 kWh/m²a
charging drinking water 1232 kWh / 13,3 kWh/m²a
storage losses 591 kWh 6,4 kWh/m²a
household, rest 650 kWh 7,0 kWh/m²a
control of solar collector: 564 kWh 6,1 kWh/m²a
control PV tracker : 357 kWh 3,9 kWh/m²a
measuring equipment: 282 kWh; 3,0 kWh/m²a
Ventilation: 160 kWh 1,7kWh/m2a
charging pump for storage device: 62 kWh 0,7 kWh/m²a
convector for fans: 57 kWh 0,6 kWh/m²a
heat pump detail:
control: 81kWh
source pump: 95kWh
magnetic valve: 64kWh
Compressor: 1308 kWh
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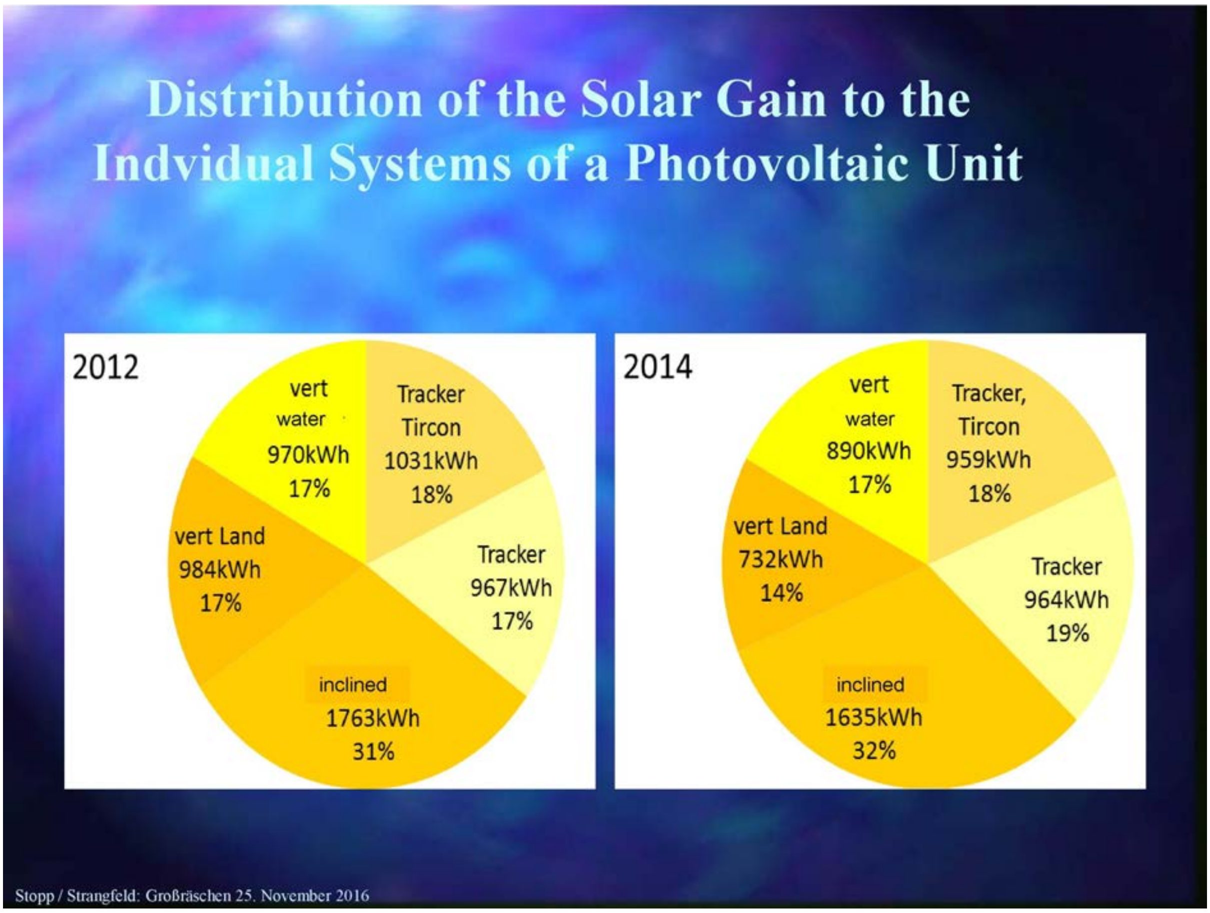
Distribution of the Solar Gain to the Indvidual Systems of a Photovoltaic Unit
2012
vert water 970kWh 17%
Tracker Tircon 1031kWh 18%
Tracker 967kWh 17%
inclined 1763kWh 31%
vert Land 984kWh 17%
2014
vert water 890kWh 17%
Tracker, Tircon 959kWh 18%
Tracker 964kWh 19%
inclined 1635kWh 32%
vert Land 732kWh 14%
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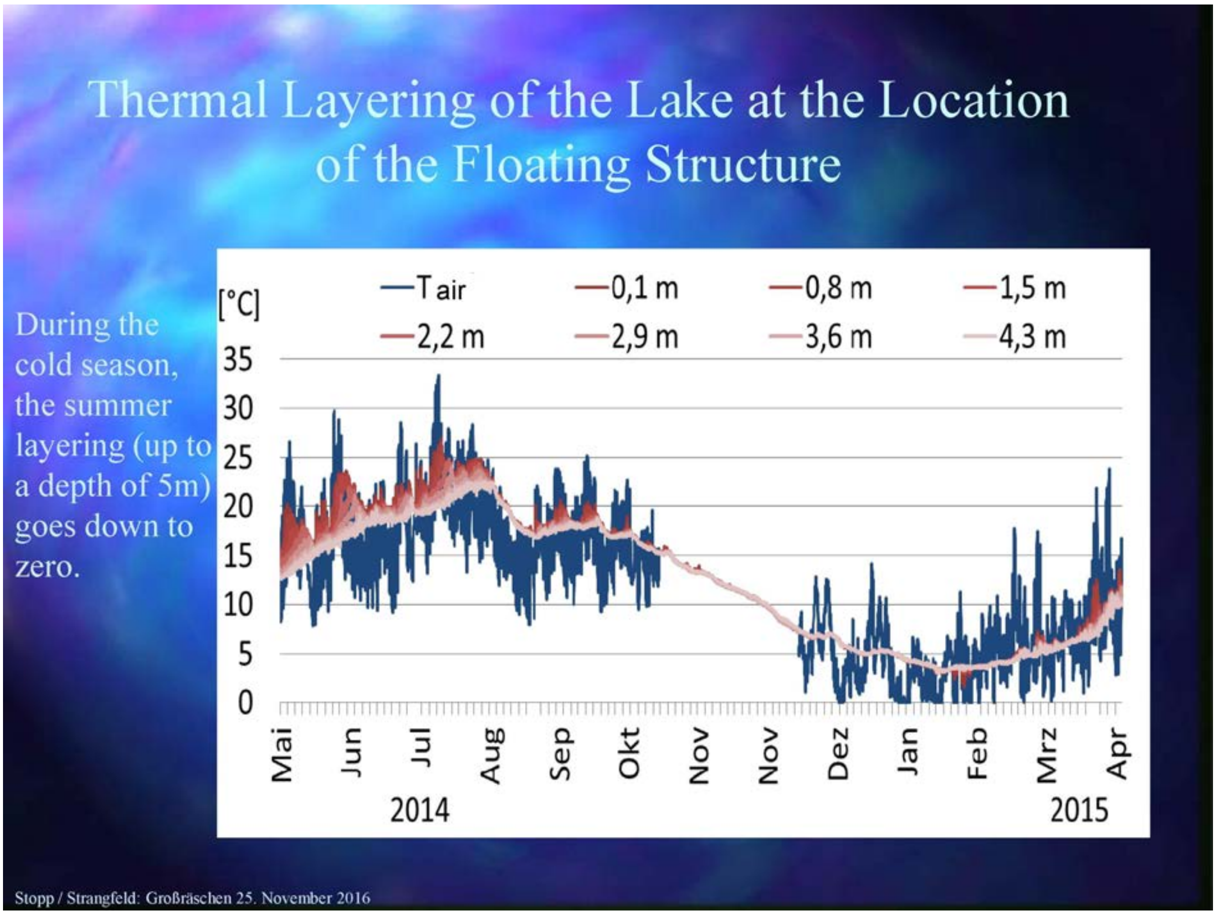
Thermal Layering of the Lake at the Location of the Floating Structure
During the cold season, the summer layering (up to a depth of 5m) goes down to zero.
[°C]
T air
0,1 m
0,8 m
1,5 m
2,2 m
2,9 m
3,6 m
4,3 m
35
30
25
20
15
10
5
0
Mai
Jun
Jul
Aug
Sep
Okt
Nov
Nov
Dez
Jan
Feb
Mrz
Apr
2014
2015
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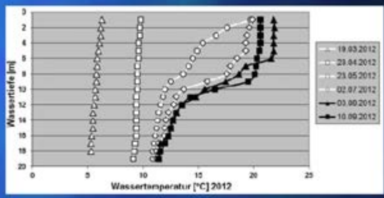
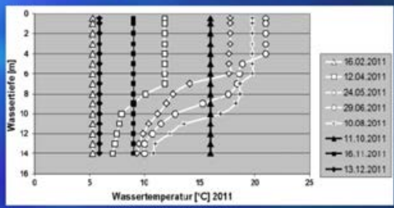
Measurments of Thermal Layering in Different Seasons of the Year in other Bodies of Water

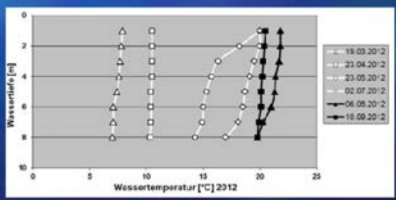
- Upper Rhine: "Reeser Meer" south, lake near Rees (above)



- Lake Lohrwardt (middle)



- Reeser Meer" north, (below)



Results

1. In connection with the consequences of climate chance, the demographic development, the development of resources and human needs as well as economic and ethic reasons, care and provision of basic requirements allow for a comprehensive dealing with the complex of topics, " Floating Structures for Living".
2. With a view to floating structures, heat exchangers still offer enough possibilities for innovation and optimisation of energetic parameters.
3. In considering changing boundary conditions, a large variety of alternative energy sources can be used and successfully implemented in the planning and establishment of floating settlements.
4. The implementation of the energetic potential of floating buildings is the determining factor for the scientific advance in the creation of production capacities in the fields of floating architecture

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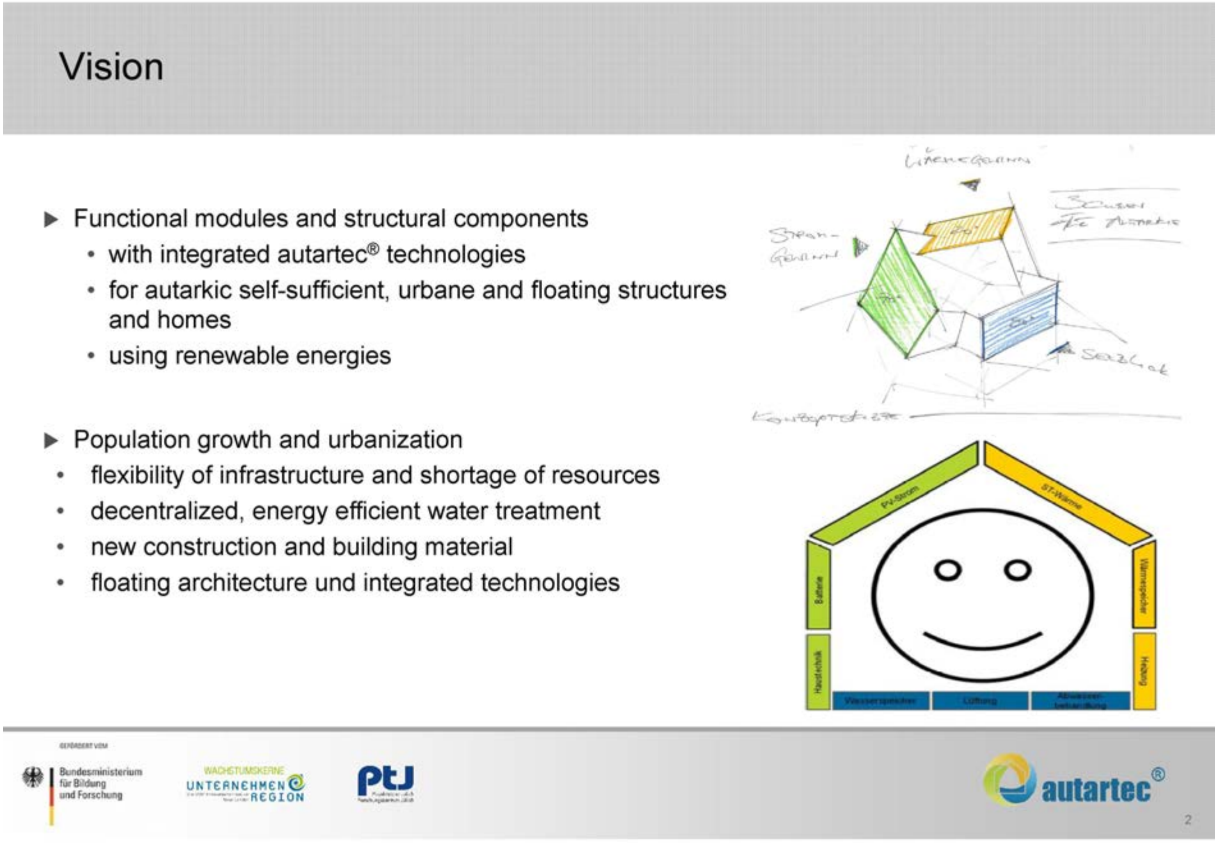
autartec® “FreiLichtHaus” – A new landmark of floating architecture

Premium quality systems, which provide self generated power and heat for modern buildings, are already available in a wide variety on the global market of environmental technologies.

One the other hand, water treatment technologies for self-sufficient drinking and service water supply are designed to solve problems of waste water treatment locally.

Closing the loop of regenerative water cycles in urban areas as well as in floating homes while simultaneously practicing a self-sufficient energy supply, the development objectives of the autartec® “FreiLichtHaus” project regarding power, heat and water are pursued as goals even worldwide.

A consortium of small and medium-sized enterprises, consulting engineers, scientific institutions as well as future operators will develop technologies for solar power and heat generation, decentralized electric and heat storage, microfiltration and disinfection. A distinctive conceptual feature is to integrate such technologies into the building shell. As a result, valuable space in such technologically equipped buildings is saved, but even more: it promises synergies in building physics.



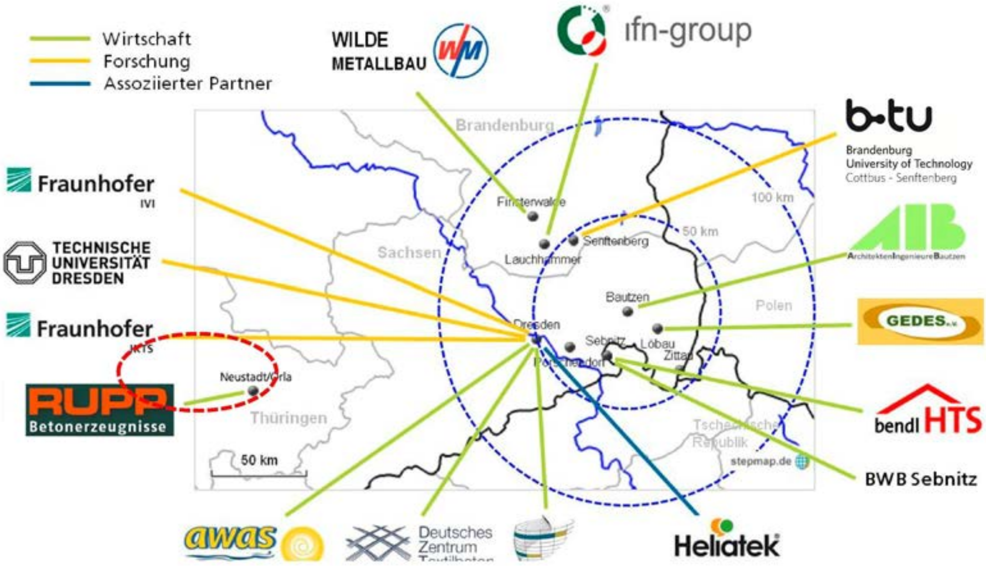
With the background knowledge of a rapidly growing market of energetic components and indoor air conditioning, all autartec® partners are united by an entrepreneurial vision: Providing a construction kit for almost self-sufficient – autarkic - buildings by developing structurally integrated autartec® technology components and closely bring them to the market. The development goal can be achieved by several different configurations of wall shells, from conventional construction materials, structure support, lightweight design or up to ultra thin carbon concrete wall elements containing electric storage capacity.

Due to the currently ongoing changes in energy supply new business and market opportunities emerge in all fields of building and construction industry, reconstruction and building equipment.

Architectural freedom as well as a strong demand for at least semiautarkic energy and water supply are characteristic of the sector of floating architecture and onshore settlement.

The lighthouse project autartec® “FreiLichtHaus” is a demonstrative example of feasibility and integration of water and energy autartec® components, while having an instructive public demonstration with great architectural appeal.

Structure and business partners



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3

Products and Services

- Carbon concrete parts
- Battery storage, new cell technologies
- Photovoltaics, organic photovoltaics
- Power electronics, inverter
- Climatisation, heat, phase change materials
- Zeolith-based heat storage
- Waste water treatment
- Passive house standard, “PlusEnergyHouse”
- Self-sufficient autarkic buildings
- Floating homes

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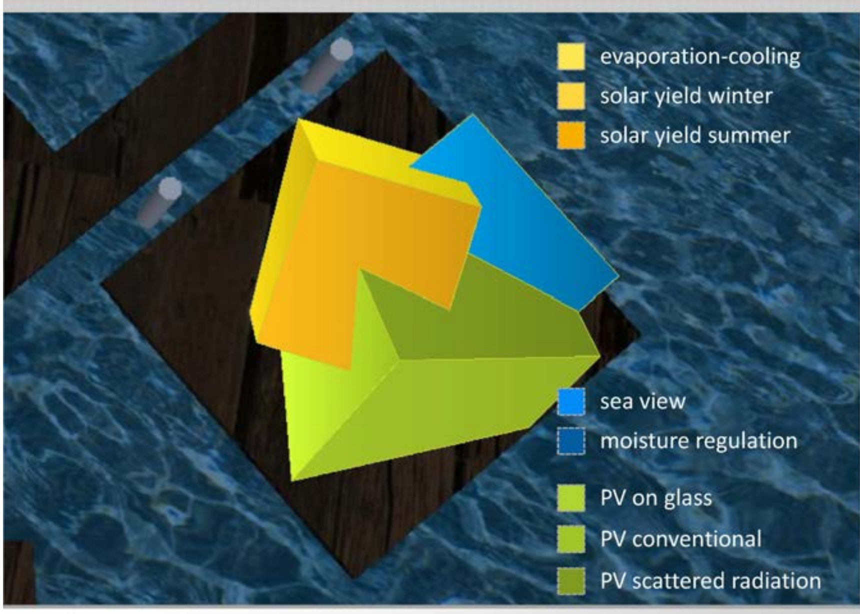
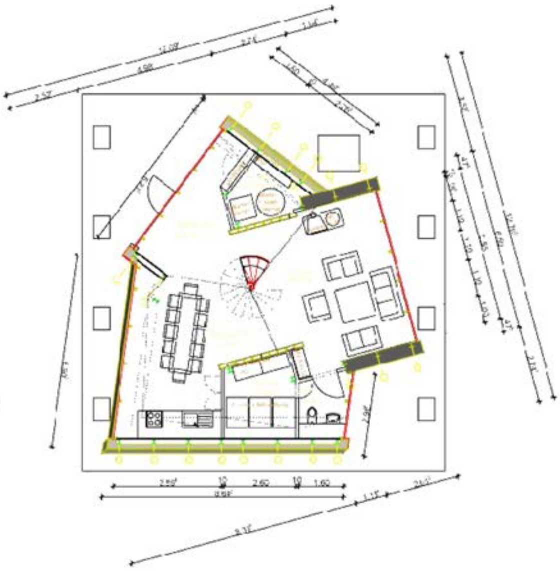
4

Architectural Concept

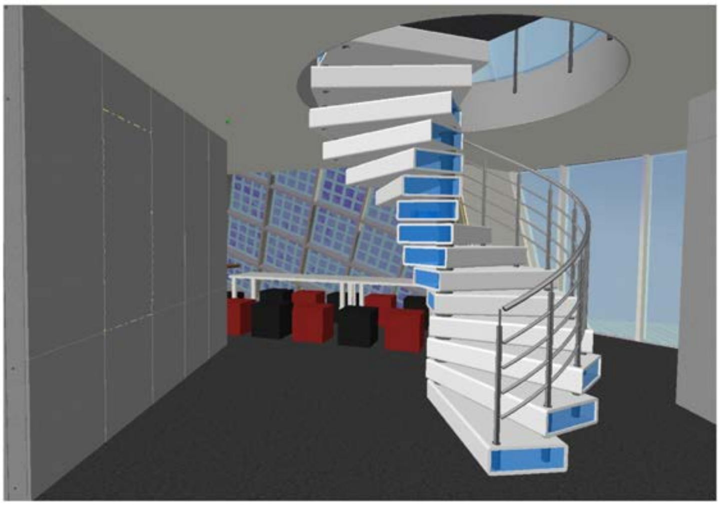


- Done:
  - building concept
  - structural analysis
  - certification EnEV
  - fire safety
  - building permit
  - layout of functional components
- Next steps
  - construction
  - operation
  - roadmap catalog for functional integrated components

Position of technological components in the building



Position of technological components in the building



- Example stair case realized in carbon concrete
  - building integration
  - space for additional functionality
  - electric battery storage

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WACHSTUMSKERNE UNTERNEHMEN REGION

PtJ

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7

Location Bergheider See, Germany

- Infrastructure planning
  - groundbreaking
  - invest volume 4,2 Mio. Euro
- Planned pedestrian bridge
- Highly recognized in media and local politics
- Driver for infrastructure, tourism and business development of the region

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WACHSTUMSKERNE UNTERNEHMEN REGION

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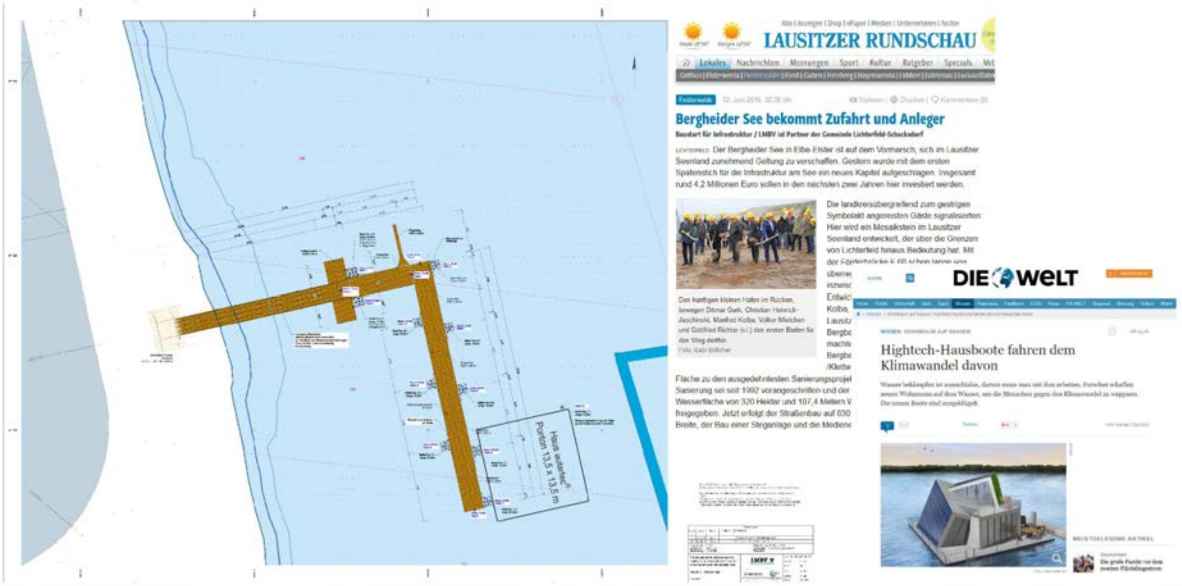
Pedestrian Bridge Bergheider See, Germany



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WACHSTUMSKERNE UNTERNEHMEN REGION

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9

Summary

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung

WACHSTUMSKERNE UNTERNEHMEN REGION
Die BMBF-Innovationsinitiative Neue Länder

PtJ
Projektträger Jülich
Forschungszentrum Jülich

STADT COTTBUS
CHÓŚEBUZ

Potential Analysis – Lake Ostsee

Project M and TOPOS Berlin commissioned by the City of Cottbus, 2016

Dipl.-Ing. Thomas Kramer
Stadtverwaltung Cottbus

3rd Floating Structures Symposium, 2016

STADT COTTBUS
CHÓŚEBUZ

Potential Analysis

A successful development of Lake Ostsee requires a feasible vision with clear aims as well as sufficient flexibility

- We cannot look into the future. However, we can try to design it in accordance with our imaginations. On the one hand, the development process also is a balancing act between precise planning, and, on the other hand, sufficient flexibility. With a view to attractions and infrastructure, the potential analysis defines a load-bearing framework with central focal points that also offer enough space to allow a flexible reaction towards potential problems and insecurities.
- It is not the aim to achieve any general developments, but a specific demanding and sustainable one.
- Ideas about the future look of the "Lake Ostsee" house. Before the locations, "rooms", have to be "furnished", it should be clear how the house as a whole will look and who will live in it.
- This is a major prerequisite for a self-determined and controlled development of the lake.
- A guiding principle for the lake provides an indispensable basis for a successful development of the lake.

2

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CHÓŠEBUZ

Potential Analysis

- "The worm has to be tasty for the fish and not for the fisherman". The consequent orientation as to target and user groups is a decisive factor for success. For further development, the definition of the core target groups is of priority, that means:
  - knowledge about the target groups needed to be addressed
  - knowledge about the requirements these groups have
  - serious assessment, whether or to what an extent they might be implemented (potentials)
  - not all target groups can be served in the same way. The requirements of the core target groups are of priority
- The strategy "everything from all for everybody" cannot be successful. Priorities must be set that give the lake an outside profile that makes it competitive and provides the basis for further development.
- As regards financing, the setting of priorities is of importance, both for investment and maintenance.
- Limited funds have to be concentrated on priorities that will have the highest success and effects.
- Honest assessment of the potential considering specific local conditions/suitabilities, market conditions and competition
- Everybody involved determines the course of development, defines the aims "destinations" and knows what to do in order to achieve these goals.

3

STADT COTTBUS
CHÓŠEBUZ

Potential Analysis

Realistic assessment of the initial situation

- Due to the existence of a lot of bodies of water in the Brandenburg State, no-one awaits the creation of Cottbus "Ostsee".
- The lake does not have any unique features resulting in a high demand. The superlative "Brandenburg's largest lake" has not yet caused any demand.
- As regards tourist activities on water, it even has disadvantages in competitiveness with nearby competitiors Lausitzer Seenland (Lusatian Lake District) and the lakes Schwielochsee and Dahme-Spree See
- the structure of the lake and large parts of its surroundings , particu (touristic), are not very attractive
- few properties are owned by the neighbouring communities
- future property ownership at the lake is still unclear
- declining income from commercial taxation limits the financial scope

widely attractive and unique features can only be achieved by the existing tourism infrastructure and/or artificial attractions or a broadly attractive service profile

4

STADT COTTBUS
CHÓŚEBUZ

Potenzialanalyse

Realistic assessement of the initial situation

- high primary market potential provides a very good basis for year-round offers relating to leisure, the infrastructure and attractions at the lake
- high day-traveller potential from the secondary market, most of all from the Spreewald tourists
- the size of the lake and its expansion allow a broad and, to a certain degree, competing use spectrum
- high attraction potential of the city of Cottbus
- an attractive surrounding landscape at the north side of the lake
- good possibilities for landscaping, since there are not any contaminated si... ew conservation areas that are located at the east bank
- an outstanding bicycle path network with connections to five long-distance bicycle tracks

Good basic prerequisites for the development as a lake for leisure and recreation

5

STADT COTTBUS
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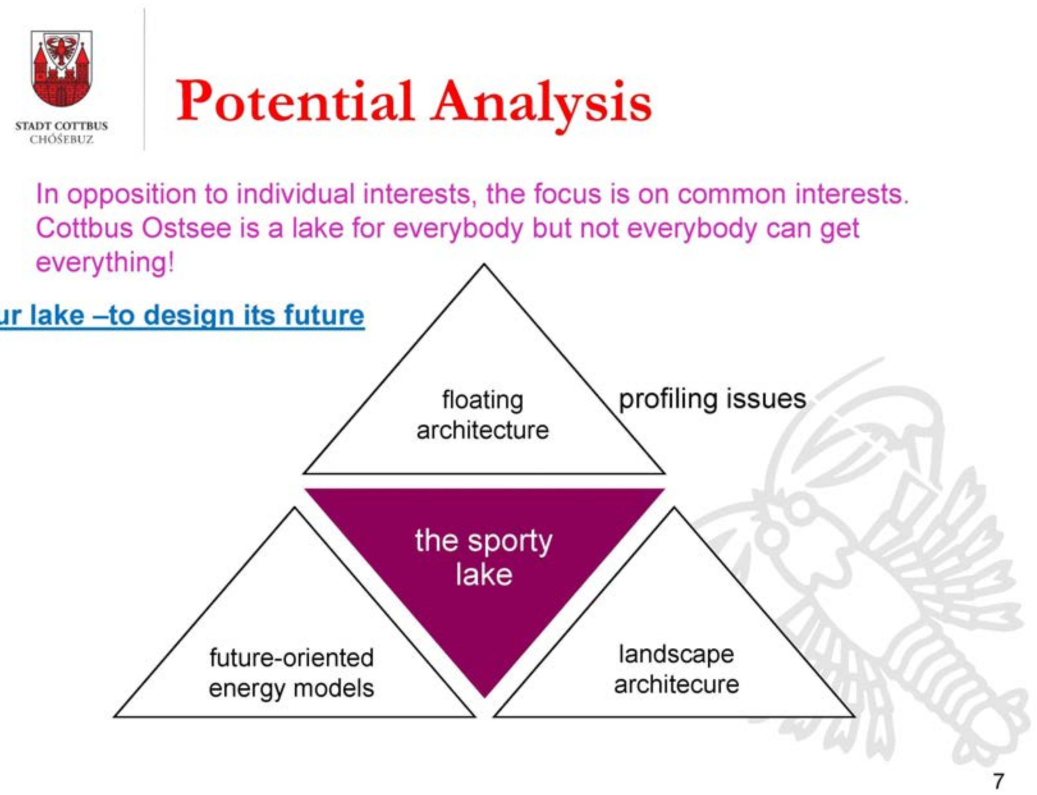
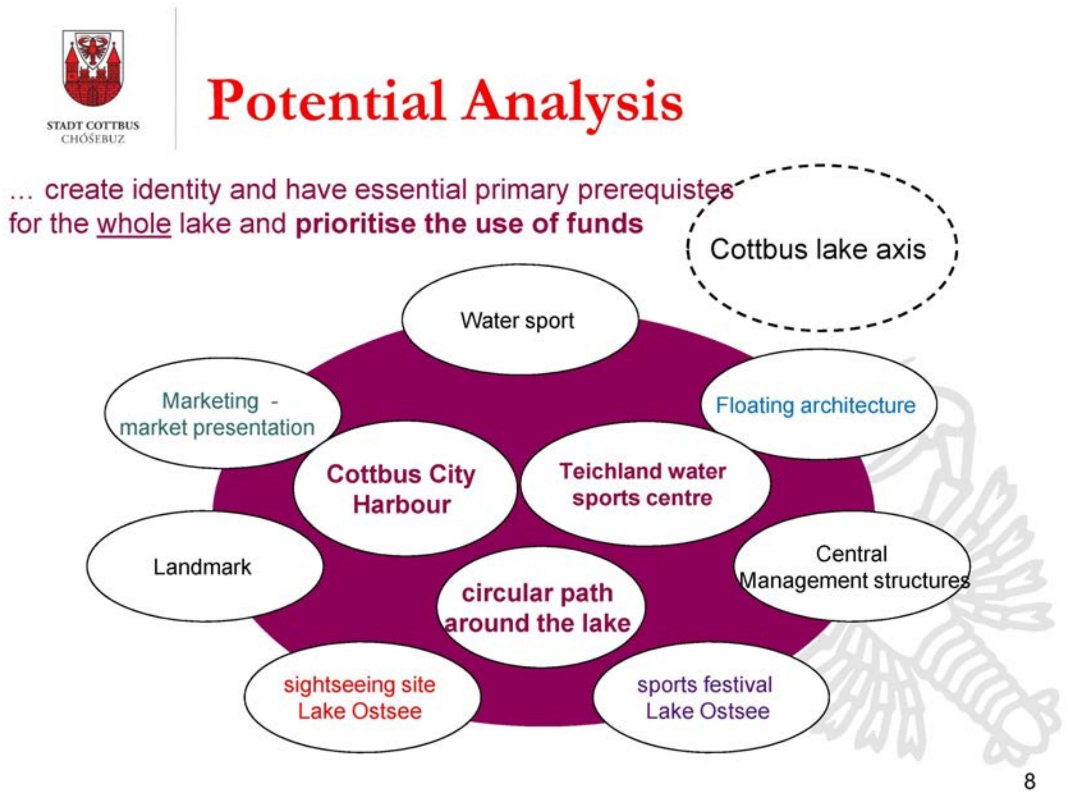
Potenzialanalyse

Finally giving up a few “old thoughts”. Correction of some former assumptions and reassessments.

- **1.** No water connection between Lake Ostsee and Klinge Lake as well as no whitewater course (even in the long run). **2.** No open-air theatre/ lake stage
- The importance of the circular path has to be more highly assessed. The circual path has a key function for the development of the lake playing the roles of a generator of frequencies and impulses that become the impetus for private engagement
- A “Green Belt” (nature as a priority) between Bärenbrück Bay and Lake Klinge or the southern tip of Cottbus Ostsee is also sensible for tourism. Its use only involves nature-compatible activities, such as cycling and hiking. **3.** No Daytona Beach, Florida.
- The previous plans for marinas were too optimistic. **4.** The further planning of the town harbour foresees the accommodation of 200 boats at maximum.
- The lake needs two harbours, a Cottbus town harbour and a water sports centre – Teichland Harbour with its own profile. **5.** No other harbours at the lake.
- Tourist potential primarily includes holidaying by the water and not on the water. Bathing/swimming as the the driving development force are of central importance for one-day visitors.

6


STADT COTTBUS
CHÓŚEBUZ
Potential Analysis
In opposition to individual interests, the focus is on common interests. Cottbus Ostsee is a lake for everybody but not everybody can get everything!
Our lake –to design its future
floating architecture
profiling issues
the sporty lake
future-oriented energy models
landscape architecure
7


STADT COTTBUS
CHÓŚEBUZ
Potential Analysis
… create identity and have essential primary prerequistes for the whole lake and prioritise the use of funds
Cottbus lake axis
Water sport
Marketing - market presentation
Floating architecture
Cottbus City Harbour
Teichland water sports centre
Landmark
Central Management structures
circular path around the lake
sightseeing site Lake Ostsee
sports festival Lake Ostsee
8

STADT COTTBUS
CHÓŚEBUZ

Potential Analysis

Aims for the development of water sports on the lake

- accessibility to the lake for water sportsmen with or without boats
- access to the water for sport boats and passenger ships for communities bordering the lake
- avoidance of conflicts between the different user groups and nature protection interests

Topics of priority

- infrastructure for sport boats (main location Teichland because of land availability)
- kite and windsurfing (close to Wilmersdorf Bärenbrück Bay)
- passenger ship traffic with five docks possible

Infrastructure elements

- **harbour for sport boats**, full service-offers for all user groups (bundling function)
- **public berth for sport boats in Cottbus City Harbour** along with club jetties, only for one-day visitors (no regular users, no service features – since offers are for one-day visitors –also can be combined with the docks of the passenger ships
- **docks for passenger ships**
- **individual docks**, only in connection with holiday resorts and restaurants

9

STADT COTTBUS
CHÓŚEBUZ

Potential Analysis

Construction of floating architecture at the location Cottbus city harbour, Lakoma and See-Mitte (navigation mark/landmark) and possibly at other locations

- buildings, leisure centres but also landscaped islands
- coordination meetings with BTU about possible cooperation
- establishment of a project group (competence group) with the administration unit, the city and BTU as members
- regular consideration of Cottbus Ostsee at the symposiums organised by BTU and held every second year
- preparation of proposals in student competititons for "Future Windows of Cottbus" at the city harbour
- and "Floating Islands" in Lakoma, preferably beginning in 2017

10

Potential Analysis

Development of a "navigation mark" in a central location

Consideration:

- floating architecture
- innovative energy model
- special design –high aesthetics
- good visibility from all banks (even in darkness)
- high strength (breaking waves, ice)

Implementation

- a desired joint project driven by the local economy under the guidance of IHK (Chambers of Commerce)
- implementation of an open idea competition in cooperation with the local population, schools etc. Follow-up exhibition in 2017 (info box exhibition)
- implementation competition in 2018

11

Potential Analysis

Advisory board for floating architecture, energy, sport, landscape architecture ↔ **members neighbouring communities**

booster club Cottbuser Ostsee i.G. ↔ **association management lake manager**

Management

Maintenance of instructure and amenities (harbours, circular path, beaches etc.) focal point from 2025 onwards

Location development

planning and development of the location as well as project development focal point until 2025

Marketing

communication/presentation of the lake focal point until 2025 internal marketing

12

Urban perspectives at the Cottbus Ostsee by floating architecture

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Institut für schwimmende Bauten

THOUGHTS ON A FLOATING HOUSING SCHEME

b-tu
Brandenburgische Technische Universität Cottbus - Senftenberg
Prof. Dr.-Ing. F. Höfler

By 2025, the largest water surface in the Lusatian Lake District will be created with the Cottbus Ostsee. In order to assess future use, a potential analysis is already under way, which in particular sees day tourism as an important target group. In a master plan, locations for swimming buildings are also named as holiday apartments. However, the region's tourist attractiveness must also be seen relating to existing offers nearby the lakes in the immediate surroundings. This leads to the consideration that floating buildings on the Cottbus Ostsee cannot constitute a special offer if (in case) a realization is economically meaningful at all. The relatively expensive construction of floating holiday houses is viewed critically, as sufficient areas are available for holiday house settlements on the shore side of the country. The low water depth also allows simple and cost-effective pile foundations, if housing is aimed at the water.
The Cottbus Ostsee needs a special perceptible profile in order to set itself apart from the competitors in the surrounding area. This can only be achieved through innovative and unique planning. Therefore, a project is presented, which provides for a floating city on the Cottbus Ostsee. The modular structure allows a wide range of uses as a holiday, hotel, meeting or an event facility. A "cruise" on the lake can be realized by means of several landing stages on the lake shore, which makes it possible to experience various attractions on the country side successively.
The concept includes the linking and arrangement of different usage modules (housing, stay, conference /event /gastronomy) as well as the required technology modules (drive/energy, supply/disposal, development). The floating settlement will move at low speed autonomously across the water surface.

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Summary

- Cottbus Ostsee
- The world has not seen yet …
- Thoughts on implementation

Prof. Hoefler - Nov. 25th, 2016 3RD. CONFERENCE ON FLOATING BUILDINGS 2

"Demand effective and supraregional distinctive features can only be achieved through the resulting offer respectively artificial attractions."
Potential Analysis Cottbus Ostsee (July 2016)

Facts
- 1.900 ha water surface
- Largest lake in Brandenburg
- Typical water depth 2,50 – 3,70 m
- Use from 2025 onwards

Potentials
- City of Cottbus
- Day tourism
- Countryside

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Cottbus Ostsee

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The Cottbus Ostsee needs to set apart from other lakes in Brandenburg and Saxony to be perceived as an attractive destination.

The tourism potential on water is currently seen in sportive and active forms of use.

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„The *new bath* of the city is the Cottbus Ostsee. This is big and especially attractive enough for holidaymakers."
Potential Analysis Cottbus Ostsee (July 2016)

Profiles
- Floating architecture
- Future energy
- Landscape architecture

Use of potentials with an above-average supply structure
- Sports and leisure time
- Communication and visitors
- Culture and nature

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Cottbus Ostsee

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- Only the size of the Lake is not sufficient as an special offer.
- The lake needs a special profile, which can be perceived from the outside.
- Competitors are located in the vicinity of the Cottbus Ostsee.

⬇

Innovative and unique planning is required.

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The world has not seen yet

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„Key and key projects create identity and have initial effect for the whole Lake.“
Potential Analysis Cottbus Ostsee (July 2016)

Innovative character

- Development of new offers
- Identification with the lake
- Extending the existing standards
- Future orientation

Creation of a "trademark" as an identity bearer and a hallmark for the entire lake environment.

Sites for floating buildings are already part of the current master plan

↓

Floating buildings are, however, not a special attraction in the Lusatian Lake District

↓

Floating buildings are expensive and leave only a limited demand as a pure holiday home.

↓

Opportunity for consistent further development

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„ We want to collect all the ideas, even the crazy ones, and look at what can possibly be realized in future years.“
Lord Mayor Holger Kelch (July 2016)

Innovative character

- Mooring around the lake
- Nomads in the "water desert“
- Floating housing scheme
- Adventure and cruise

Usages

- Holiday homes
- Hotel and conference facilities
- Catering trade and leisure activities

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The world has not seen yet

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Project „Floating City“

- Holiday housing area as an innovative attraction for tourism,
- Hotel complex with meeting rooms as a highlight and hallmark,
- Gastronomy and entertainment as a magnet for tourism.

Floating settlement in modular design with various usages and the possibility to cruise on the lake. Several docking points are available on the shore and ensure the accessibility of local attractions.

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„There may be in the future even cities that are constantly on the move. Follow the ocean currents and drift back and forth between the continents. In this way, the man would again become who he had been at the beginning of its history: the nomads“
Stadtgeschichten

Modules
- Holiday home
- Restaurant, Hotel, Conference
- Supply and disposal
- Access and development

Energy
- Photovoltaics
- Heat pump
- Biogas

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Thoughts on implementation

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Modular concept: project "floating city"
- Coupling and ranking of the modules as needed
- Drive and power through fuel cells
- Energetically self-sufficient settlement

The island moves autonomously between docking stations with very low speeds (ca. 0,05 m/sec)

The stay at the lakeside allows the 'experience' of all offers to the Cottbus Ostsee.

The settlement island is perceptible from different places and forms a hallmark on the lake.

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Modules
Utilisation

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Thoughts on Implementation

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Module Holiday Home
Living, bathing in part-public areas (rental, not for permanent residential use)

Hotel-, Conference-, Cateringmodules
Holiday and Conference Hotel with lounges and conference rooms, as well as public dining areas

Open-Spaces-Modules
Designed semi-public and public areas, preferably with connections to hotel and catering modules

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Modules

Function



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Thoughts on Implementation

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Supply-Modules
Water and waste water supply and treatment, waste disposal (separation, bio-waste) fire-fighting water supply

Energy-Modules
Photovoltaic, biogas, heat pump hydrogen generation (PV modules)

Drive-Modules
Drive and control units (fuel cells and electric motors, navigation, autonomous control systems)

Access-Modules
Public paths and access ways, linkage, communication and networking

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Laws

Planning

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Thoughts on Implementation

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The Federal building code (BauGB) obliged the communities to make plans, to ensure an orderly urban development and a social-friendly land use corresponding to the well-being of the general public.

As soon as and to the extent necessary for urban development and regulation, development plans are to be derived for limited areas within the municipalities from the guidelines for the land use plan.

- Which municipality is responsible?
- How mobile construction is to be classified?
- Is there a land use planning for water surfaces?

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Laws

Implementation

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Thoughts on Implementation

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Construction projects on the water differ from "normal" projects on the ground not with regard to their use and design, but for example by means of specific safety relevant features such as climatic influences (storm, ice and flood), flow velocity and flow behavior of the water or due to special requirements of the locations.

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14

Laws

Adaptation

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Thoughts on Implementation

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Houses on the water are to be viewed as building structures according to country specific building regulations (LBauO), if they are connected to the bank or to the water body (by piles or by anchoring) and if the function of fixed houses is fulfilled.

Standards are to be interpreted in any particular case for meaning and purpose on "Floating structures" and to apply (for example: stability proof is equivalent to the buoyancy).

- Are "Floating cities" to classify as a "Ship"?
- Which measures of land use planning should be applied?
- Are 'terrestrial' regulations (noise, energy, fire) valid?

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15

Laws

Type and Dimension

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Type of structural use (e.g. special area for sport, leisure, recreation and tourism). Systems that allow a user friendly and economical operation of the "floating houses" are allowed. These include places (carports, shelters) for cars, boat traps and/or garbage containers, equipment for supply and disposal, storage facilities for equipment and accessories (tool shed) as well as fencing. There are technical measures to take in order to prevent the penetration of pollutants in the ground or in the water.

Dimension of construction use Definition of the base number (GRZ, max GRZ 0.8), the number of full storeys and the height of the building (from top water level) and others.

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Laws

Regulations

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Thoughts on Implementation

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- Building Code (BauGB)
- Regulation on the structural use of land (Ordinance)
- Regulation on the development of plans and the presentation of the plan contents (PlanzV)
- Specific building regulations, E.g. building regulations of Saxony-Anhalt (BauO LSA)
- Regulations on Spatial Planning (ROG)
- Regulations of Country Planning (LPlG)
- Law on the State development plan, for example Saxony-Anhalt (LEP-LSA)
- Regional development plan for the planning region
- Law on nature protection and landscape conservation (BNatSchG)
- Land conservation law, E.g. of Saxony-Anhalt (NatSchG LSA)
- Law to the regulation of the water budget (water resources Act - WHG)
- Country water resources Act, E.g. of Saxony-Anhalt (WG LSA)
- Regulation of the State Administration Office to the determination of the flood areas
- Act for the protection against adverse environmental impacts (BImSchG)
- Act for the protection against harmful soil changes (BBodSchG)
- Conservation and heritage law
- Law on environmental impact assessment (EIA)

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Thank you for your attention

Contact us:

MOVE-US
Mobility planning and traffic development
Urban Development
Prof. Dr.-Ing. Frank Höfler
BTU Cottbus-Senftenberg

b-tu
Brandenburgische
Technische Universität
Cottbus - Senftenberg

3rd Floating structure symposium

Pontoon Houses for Inner-City Water Areas

Examples from Berlin

Prof. Dr.-Ing. Susanne Junker
FB IV Architektur und Gebäudetechnik
Lehrgebiet Entwerfen, Innenraumplanung und Visualisierung

BEUTH HOCHSCHULE FÜR TECHNIK BERLIN
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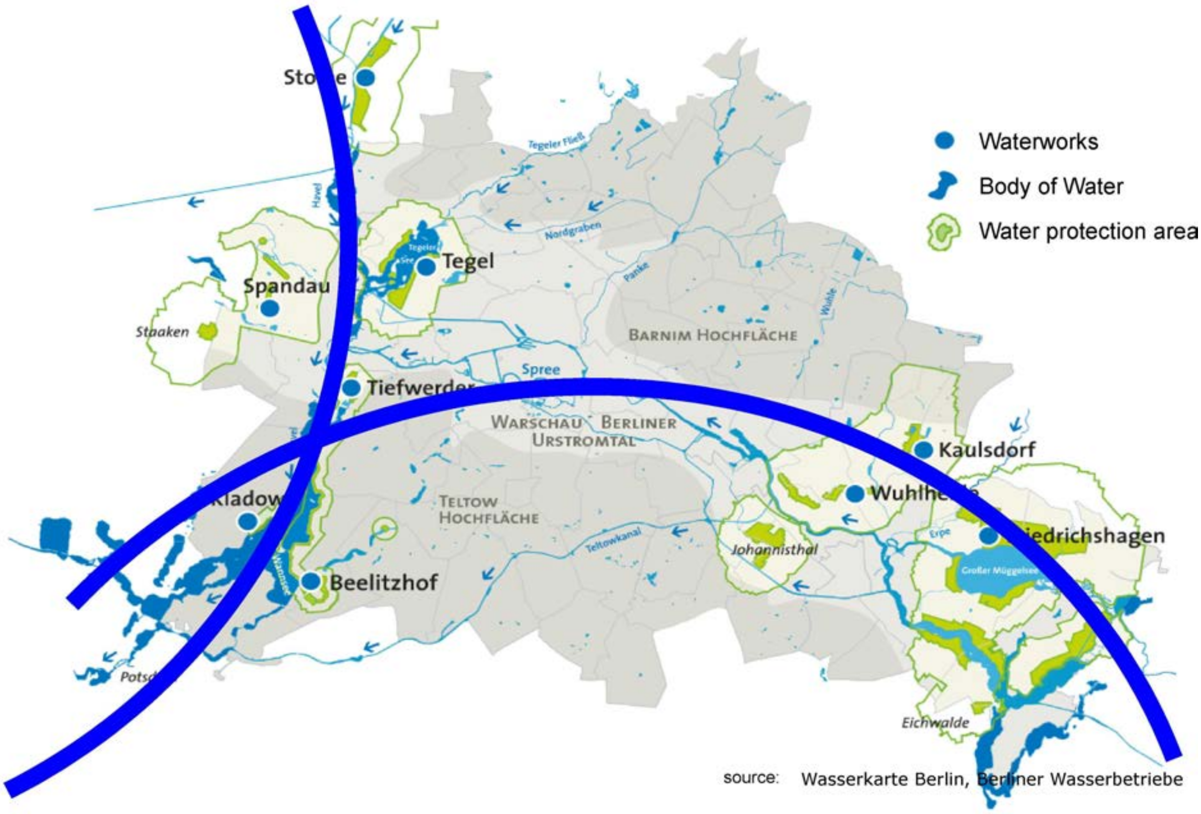
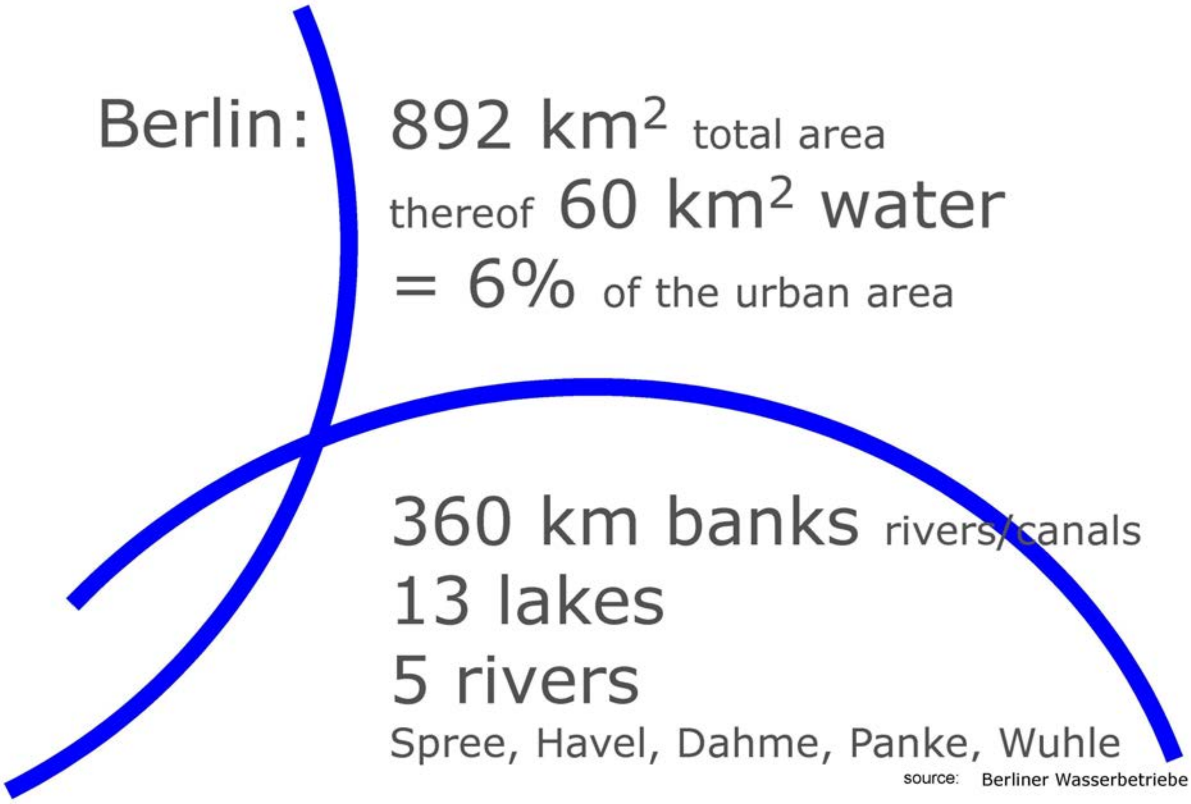


source: Wasserkarte Berlin, Berliner Wasserbetriebe

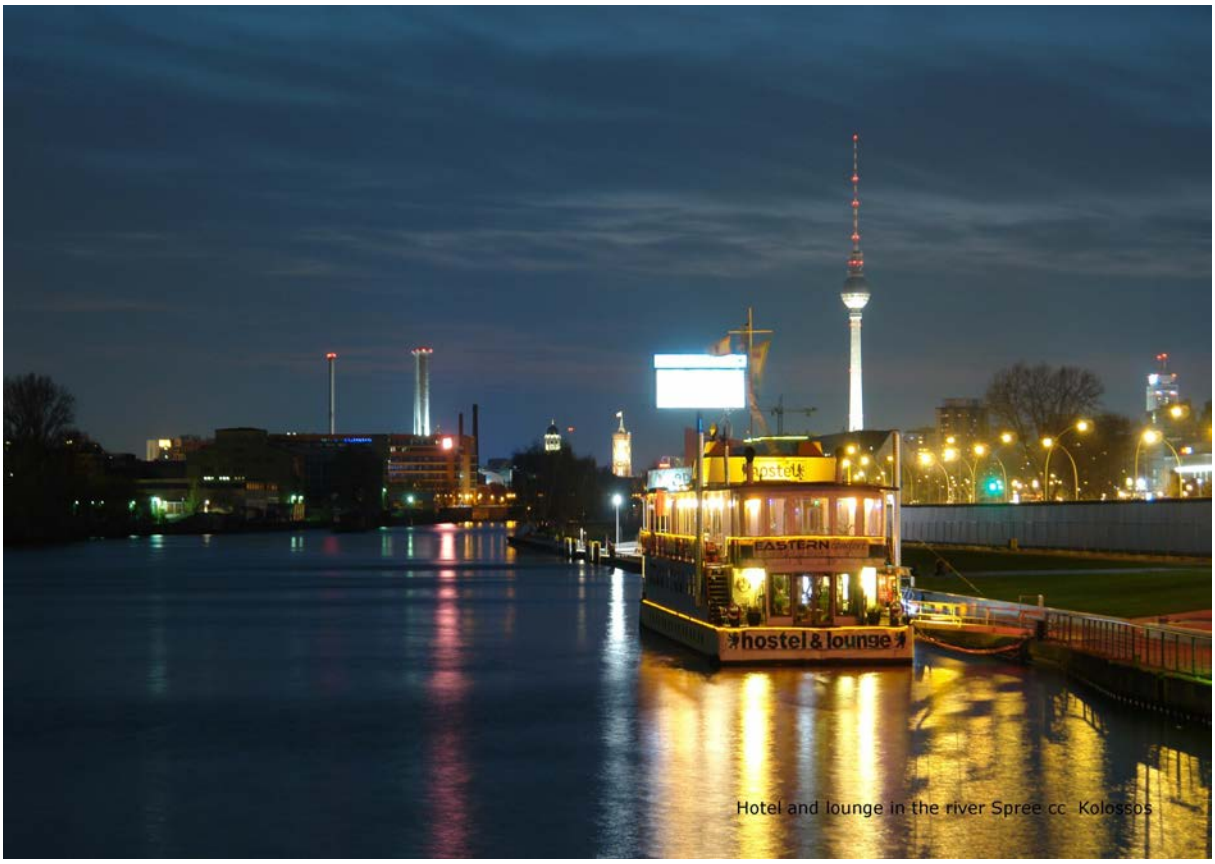


Brücken der Hochbahn über den Landwehrkanal um 1900, historische Postkarte

Wasserkorso Stralauer Fischzug 1897,
Historical press photo

House boats on the Landwehrkanal / Tiergarten, cc Sir James


Swimming caravan castle "Lummerland" in der Rummelsburger Bucht, © Susanne Junker

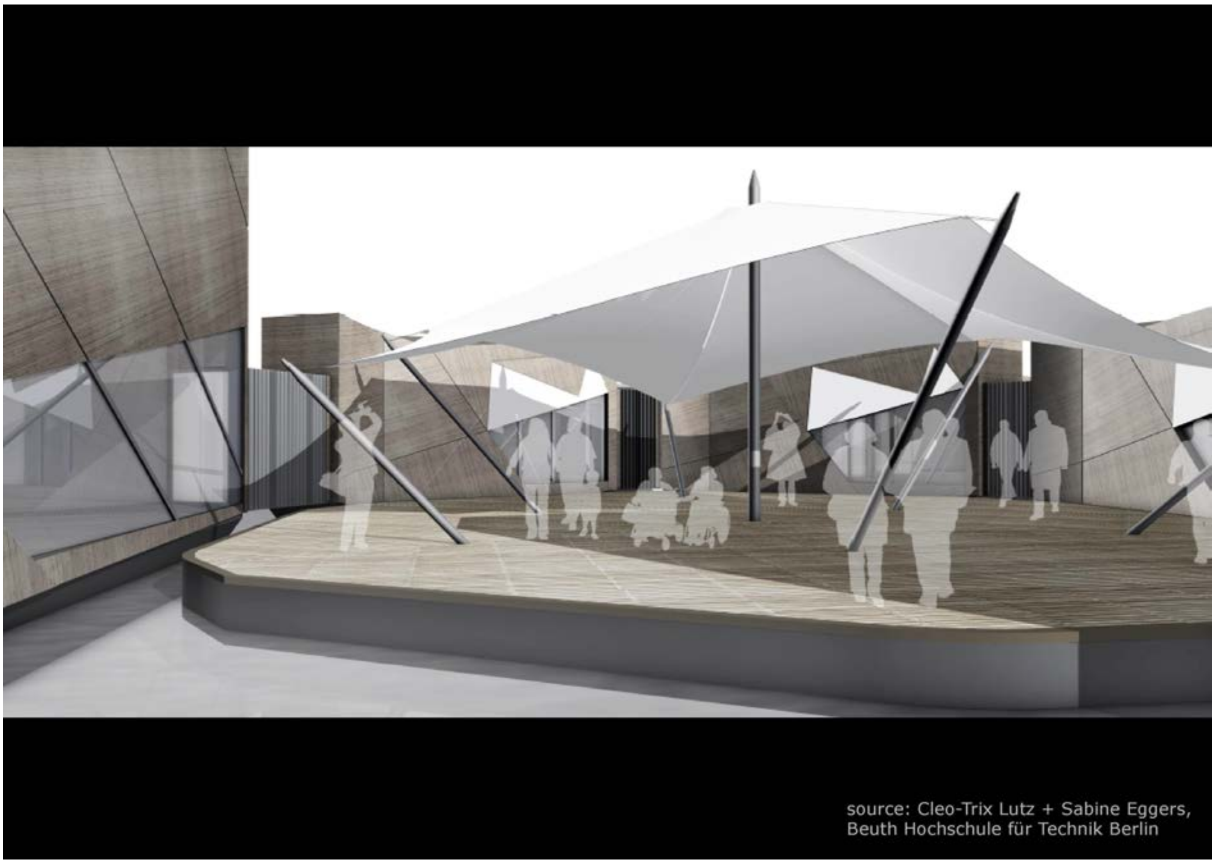


Hotel and lounge in the river Spree cc Kolossos


bathing ship in the river Spree Maxim K.


from the bathing ship will be the winter bathing ship
cc Susanne Junker (o.l.), © Thomas Freiwald (o.r., u.)


cc Georg Slickers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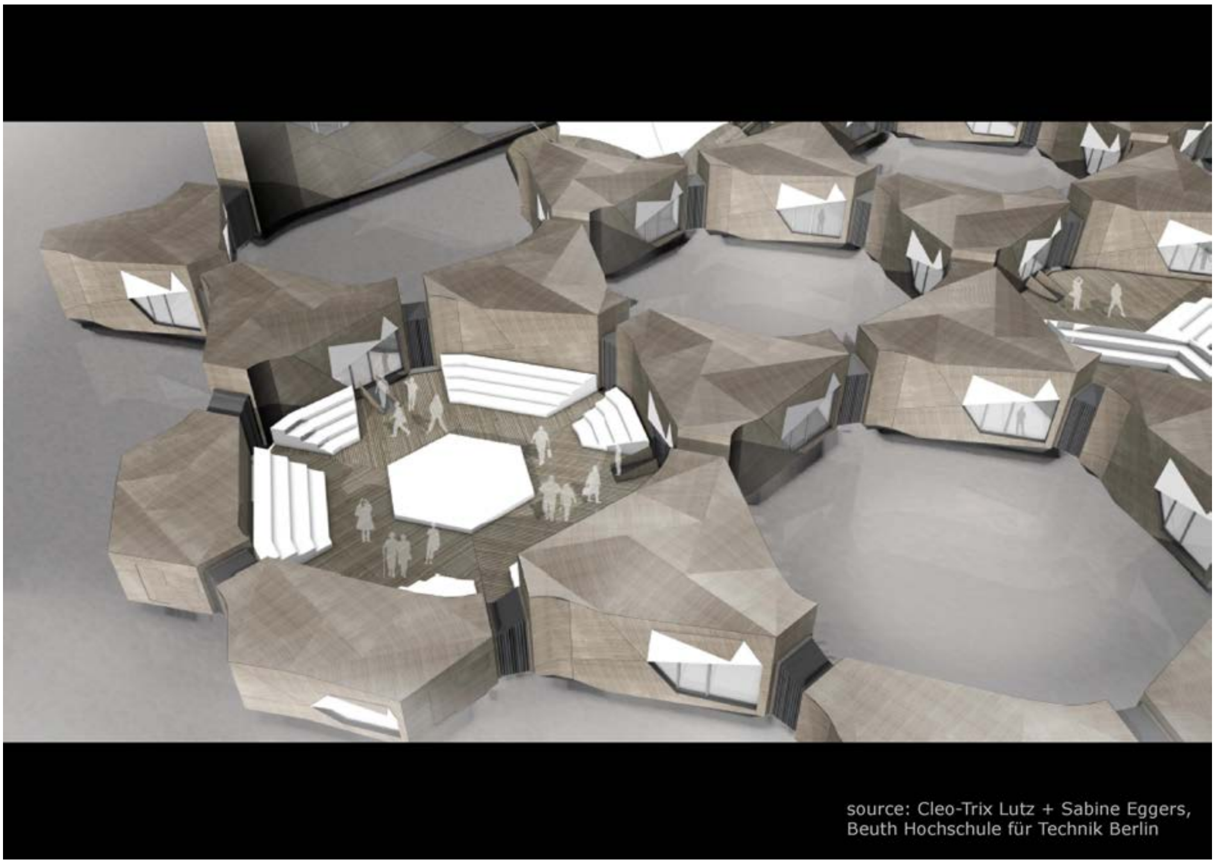

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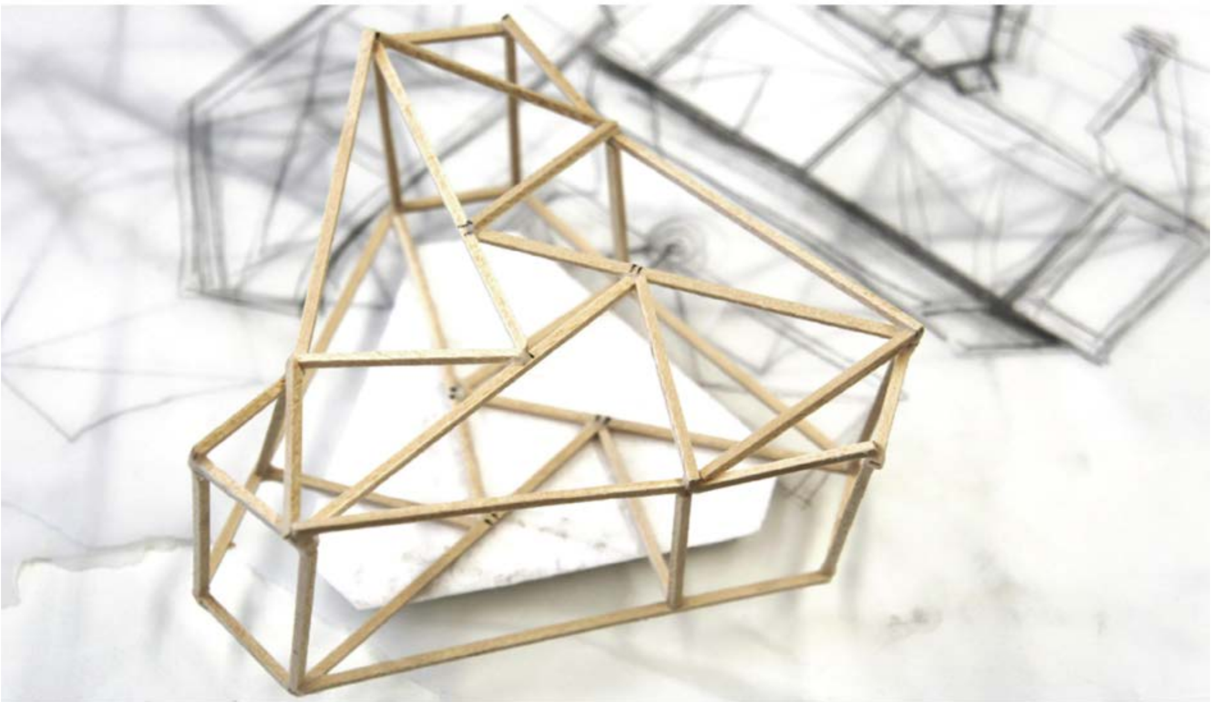

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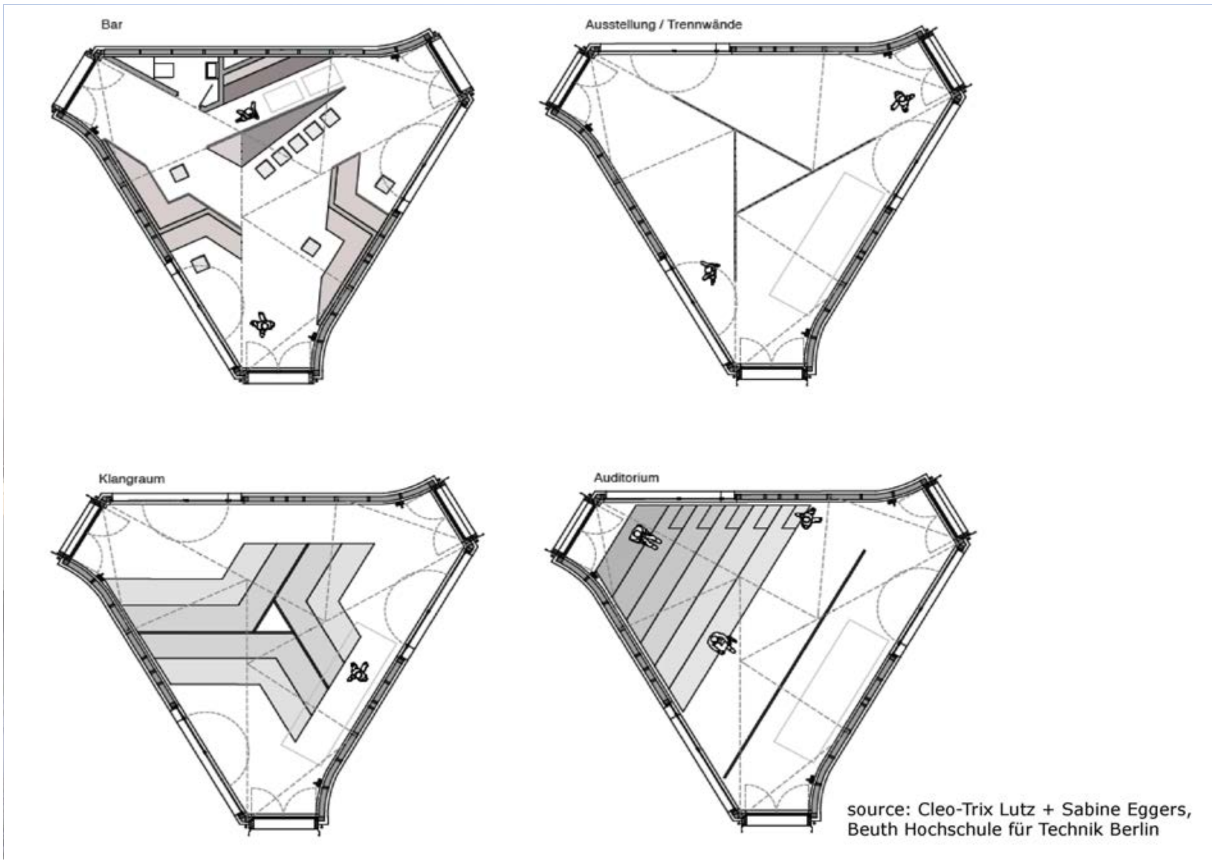
Bar
Ausstellung / Trennwände
Klangraum
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moleculART
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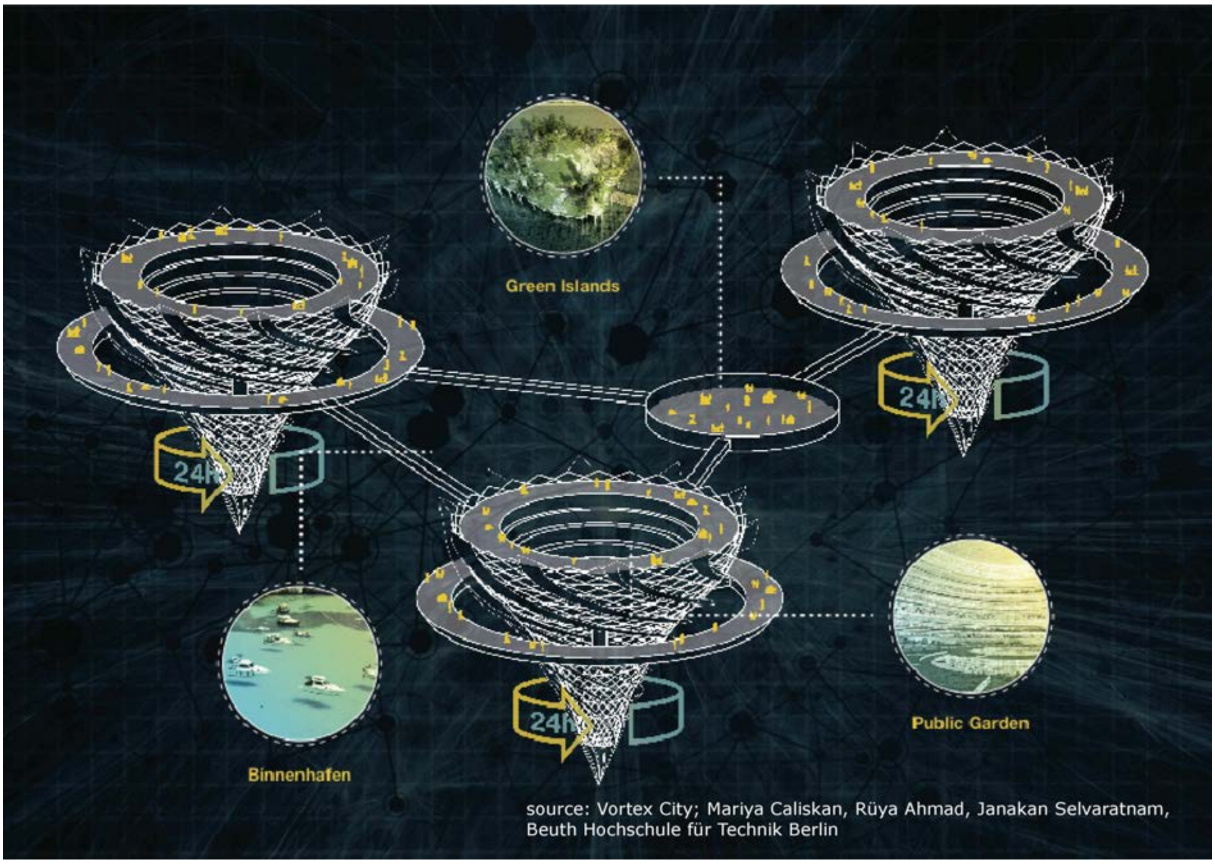
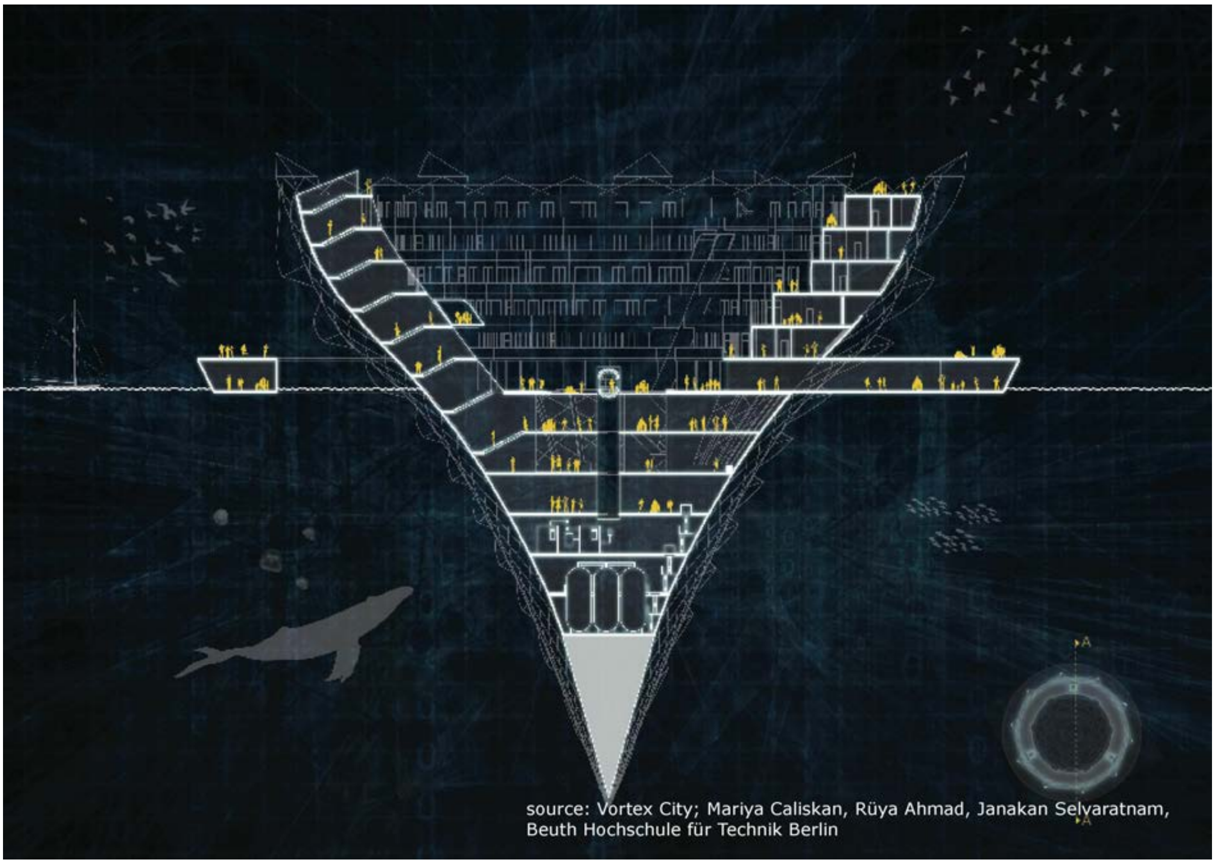

Green Islands
24h
24h
24h
Binnenhafen
Public Garden
source: Vortex City; Mariya Caliskan, Rüya Ahmad, Janakan Selvaratnam,
Beuth Hochschule für Technik Berlin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source: Vortex City; Mariya Caliskan, Rüya Ahmad, Janakan Selvaratnam,
Beuth Hochschule für Technik Berlin


Prof. Dr.-Ing. Susanne Junker
FB IV Architektur und Gebäudetechnik
Lehrgebiet Entwerfen, Innenraumplanung und Visualisierung
BEUTH HOCHSCHULE FÜR TECHNIK BERLIN
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16 Outlook

In these selections from symposia proceedings, very heterogeneous papers on floating architecture were deliberately chosen to demonstrate the complexity of the topic. Both opportunities and risks are studied here within and can be summarised in this economic and socio-political future directive:

Nothing against the water, but with the water, i.e., construction near and on water!

Worldwide population growth, expanding deserts, rising sea levels, as well as worsening climate change are considerably reducing the available building space in many regions of the world. Even if the global community's K2 aims are met, which seems unlikely at this time, there will still be long-term effects due to a phase displacement between causes and chains of effects (Fig.1).

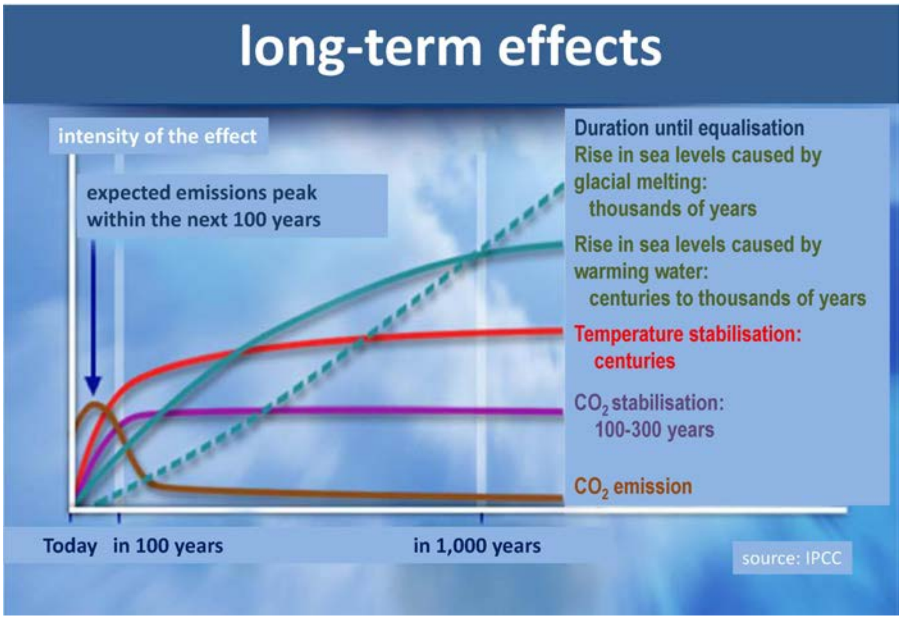

Fig. 1
Time difference between emission of CO_2 and its effects according to IPCC (Intergovernmental Panel on Climate Change)

The 5th IPCC-report is very clear about this. Regardless of the causes of climate change, all serious scientists, politicians, and governmental bodies must prepare to cope with its effects. Even if the rise in the average global temperature in the lower atmosphere is limited to the K2 aim, a further rise in sea levels will take place due to a century-long phase displacement between the rise in temperature and its chain of effects. This will, of course, threaten existing settlement areas and their infrastructures. The demand for land suitable for construction purposes is still increasing because of global population growth and increasing demand for homes and recreational space, especially the threshold and developing countries. In Germany, a country with a shrinking population, the additional and daily used areas still require 30-60ha. These accelerating social and environmental changes necessitate a movement towards human settlement on water. The effects of rising sea levels are exacerbated by the backflow of rivers into lowlands. Additionally, global climate change brings with it the problems of intensified rainfall and subsequent flooding. European guidelines for protecting against and managing flood damage require the creation of retention areas for interim water retention. The efficiency of these areas is improved by the addition of temporary floating structures the use of which is supported by the region and the people living upstream.
Enormous financial means are required to finance the acquisition of materials and labour for dyke, lock, gate, and other aquatic structure construction and maintenance projects.

Floating structures that adapt to the prevailing water level are superior to structures built on solid ground below sea level and houses on stilts, the construction of which is becoming popular in coastal regions.
Floating structures do not simply have planning advantages in their adaptability to unknown future climate conditions. They also possess advantages in terms of mobility, access, and their response to flooding.
Sufficient building space for future generations is available on the coasts of the world's oceans and inland water bodies. Therefore, offshore structures with higher requirements for human settlement are a second choice.
Similar to classical structures of different design with or without basement, single or multi storey in lightweight and heavy construction, floating structures will also demonstrate their manifold uses.
When constructing floating structures a pontoon as useable area of high quality (need not be used in every case. If desired, a well-made pontoon can offer spectacular views of the underwater world. Besides capillary-active insulating materials, condensation free and partially transparent wall and floor surfaces as well as energy efficient pontoons made of steel, plastic, water impermeable concrete and dense concrete with undamaged interior insulation, floating structures require hydrothermally active interior surfaces to achieve optimal climate control. Having this knowledge puts one ahead of the competition. It is obvious today that high requirements on the room climate for pontoon rooms in use can also be met with today's air conditioning technology.
However, the designer's aim should be to achieve satisfactory results with the use of both commonly available building materials and those with improved properties. In the design of floating architecture and its technical and sustainable implementation, cultural and regional preferences have to be considered. Private floating gardens commonly found in South-East Asia can be installed as additional open spaces on floating water containers that store solar heat. This can be done in the same way as with seaweed beds and blooming water flowers used as food or for home decoration (Fig. 2).
Aquaponics is implemented to create a sustainable closed loop economy.

Fig. 2

A fisherman standing on one leg in front of the floating gardens on Lake Inle, Myanmar.

All current structural designs need to be assessed for suitability for floating structures. In this context, with a view to the increasing worldwide demand for energy and food as well as their availability for existing settlements, the energy political aims are in the focus. These aims require a precise utilisation of water as a free and accessible resource in the form of alternative energy. Besides the relatively high specific and absolute water capacity, the freely available temperature gradient between the surrounding water reservoir and the prevailing outside air can also be utilised. The latter allows for the use of the heat pipe principle. To figure out to what extent this principle thermal electricity, in the form of thermal batteries, represent technically applicable potentials, is the task of future studies. This needs to be done in order to implement the upcoming 2019 requirements of the European Buildings Directive for zero-energy houses.

In addition to the utilisation and preservation of traditional alternative energy sources, hydrogen technology and fuel cells remain relevant possibilities for future energy solutions. In connection with waste water treatment, the supply with freshwater has to be dealt with. Current technology offering a decentralised, environmentally-friendly, and energy efficient treatment system for sea and waste water is promising for the development of self-sufficient floating systems.

For floating structures, building materials such as steel, timber, and concrete will become more and more important. Due to varying water quality, as found in mining lakes and abandoned industrial waters, concrete will have to play a larger role as a building material. Composite concrete used for both pontoons and their superstructures still offers a lot of possibilities. This is particularly relevant to the use of pontoons as permanent living space for people. Timber in its natural and processed forms still has potential for construction on water. Its properties and sustainability make it a valuable building material.

As regards the safety of floating structures, issues regarding fire protection have to be taken into account. Under all weather conditions, the floating access paths have to be slip-resistant and perform well in their function as emergency exits. In the cold season, it cannot be guaranteed that ice surrounding floating structures is load-bearing. Therefore, it does not provide a suitable emergency exit. There is also no guarantee that a boat would be available for evacuation under emergency conditions caused by drift ice and high waves. The social component of living on water in single objects for tourism and larger settlements for alternative living has not been studied comprehensively. In connection with sensitive surroundings, targeted studies are required.

In the Lusatian Lake District, there has already been a differentiated user profile. The district comprises different types of floating houses, for example, a diving school and a holiday house for sailors. “Wohnhafen Scado”, a marina combined with a residential complex on the mainland, will be built. In addition, there is the well-performing Senftenberg harbour facility, twelve connecting canals between the central lakes of the Lusatian Lake District and “Großräschen Süd”, a town harbour that is still under construction.

The launching of a so-called open-air house on Lake Bergheide in 2017 will stimulate further interest in the development and continuation of architectural advancement in Lusatia.

From a large number of possible topics, the following ones should be dealt with in the future:

- unified recommendations (if necessary national/European standards) for floating housing and public buildings on the basis of existing structural and water relevant specifications, including the preparation of safety regulations for objects functioning all year round.

- economically reasonable and user-friendly structural solutions for floating structures regarding a low-time change of place and position.

- comprehensive use of water as an energy resource in close vicinity to floating structures, storage of energy, and the decreased use of high-quality energy. This also includes tested solutions for protection from ice encroachment and year-round temperature control of the structural shell through the use of alternative energy sources.

- damping the vibration behaviour of floating bodies, particularly of steel pontoons and other lightweight pontoon structures.

- validated prediction of former mining lakes swells on the basis of available techniques and measured data on wind and wind/wave parameters.

- optimisation of heat exchangers as regards their design, dimensioning and positioning when used in stagnant and moving water.

- design and structural solutions to achieve optically perfect views of the surrounding aquatic world from the used pontoon rooms of the floating structures.

- overall concept for the supply and discharge of floating houses in using new membrane-cascade systems, including an overall energy balance in comparison with different energy carriers depending on the number of objects and the existing and future infrastructures.

- proof of an improvement of the lake quality if purified water is led into.

- feasibility study for energy self-sufficient floating structures on the basis of solar, wind, and wave energy production as well as fuel cell technology.

- development of pontoons with usable living space taking safety into account. (installation of robust humidity sensors, warning systems, and smoke detectors).

- material studies for the development and use of composite concrete as mass building material for reasonable superstructures and pontoons independent of the water quality.

- year-round accessible weather-independent access paths to floating structures regarding view, vibrations and safe walking without the use of both "chemicals" and high-quality energy.

- studies on the efficiency of floating houses in different economic and cultural regions in Central Europe and South-East Asia in comparison with structures built on the mainland as a basis for Germany's export policy.

- establishment of a functioning and active scientific centre in the Lusatian Lake District, involving local, experienced partners.

In their complexity, the results achieved thus far by competent authors allow for further development and expansion of this unique experimental field. This field also involves specific disciplines, BTU S-C, LBMV, the IBA study centre e.V. as well as the IBA terraces. In a research centre for floating architecture, there exists the unique opportunity to address problems with floating settlement structures in good time. The topics of research are choice of location, design, use of water as an energy source and material, structural, interior climate control, legal, economic, environmental, and political problems.