The Set of Contemporary Aquatic Architecture

Zbyszko Bujniewicz
Silesian University of Technology ul. Akademicka 2a, 44-100 Gliwice Poland
zbyszko.b@wp.pl

Abstract. The presented investigations prove that there exists a set of architecture connected with water. The investigations, which started about 10 years ago, state that it is possible to indicate the contemporary objects which have some common features creating the set of aquatic architecture. The relation between architecture and water has different aspects. The first is placing the object in the water as the environment, the second is when the water is the purpose of constructing the building (e.g., swimming pools), the next is to use the water as the decoration material or medium for energy flowing in the building and the last one is to find any intangible associations between water and architecture. It is described as the simple method to include the object to the set contemporary aquatic architecture basing on the determination of the function of water in the building. The utility water function is excluded from the set because it is part of another discipline as for example water treatment or sewage technology. On the base of several case study investigations, it is proved that the aquatic architecture is a significant part of the architecture. The approx. 12% of raised buildings can be attached to the set. The passed study confirmed that the architecture paying attention to the water is realised not only at the border of the land and water or in the water, it can also be found in the middle of dry land, in which case, it follows the intangible associations. The immaterial relation is based on personal experience and connotation to the cultural environment of human.

1. Introduction
The preliminary research passed in 2010 revealed that approximately 11-13% of architecture objects has relation with water. Then the investigation has been continued and in 2015, the set of contemporary aquatic architecture was described [1]. It was proved that the objects in the set have some individual features. The features and the simple scheme of the method of joining the object to the set are described. Nowadays the method is tested on the current investigations. The following researches based on the case study of 28 architectural objects in Austria, Germany and Switzerland confirmed the method.

The aim of the paper is to present the main features and the method of connecting object to the set, to present a definition, to show the current trends end to establish the development conditions of the aquatic architecture using the SWOT analysis.

2. The material and method of investigation
The preliminary researches have been passed on 1052 objects and it was established that approx. 12% of modern architecture is somehow connected to the water. The preliminary investigation was based on the Phaidon Atlas of Contemporary Investigation [2].
The main researches take 609 architectural objects. They allow to create the definition of contemporary aquatic architecture and establish the main features. It based on examples of realized, published or individual tested architecture.

The current investigation is based on 32 objects which were the aim of the science seminar under the title “Globalization in Contemporary Architecture”. The selection criteria were not clearly defined. However, there are several decisive ones to which they belonged: a significant person of the creator, the popularity of the object. From the point of view of the research topic, the selection of objects was random, therefore it will be possible to carry out some quantitative research

An expert research method was adopted at all stages of the research [3], the justification for the adoption of this method is the author's assessment as a properly qualified person. The method of work was based on the assessment of case studies [4]. As a summary, some calculation was made to describe the importance of the investigated problem. The possibilities of development of aquatic architecture were tested by the SWOT / TOWS method, which is suitable for solving the problems of empirical sciences. The SWOT Analysis – is one of the most commonly used heuristic analytical techniques and serves the purpose of information ordering. [5]

3. The features of aquatic architecture set

It must be paid attention that term “aquatic architecture” is different from “naval architecture” as the kind of technical science about ship constructing but some times met term “nautical architecture” is included to the set of aquatic architecture if concerns buildings with the form following the ship shapes.

The main issue was to select the objects where architecture has a connection with water. It is based on the description of designers or authors about the building or on personal studies. In the building description or the image, the relation with water was sought. The kind of relation is mentioned by several authors.

Niemczyk [6] shows how water appears as an artistic and symbolic form. This author most emphasizes its function as a symbol including symbolic cultural meanings, a metaphor for contact with nature. Boeminghaus S. [7] in "Wasser im Stadtbild. Brunen, Objekte, Anlagen "shows water as a material of particular importance in shaping the urban landscape. Wyllson A. [8] in "Aquatecture: Architecture and the Water” gives water as a spatial context, a visual effect, as an attraction. The influence of cultural references is also demonstrated. Water is also an environment of creation on an urban and architectural scale. Pancewicz A. [9] draws attention to technical-natural, spatial-functional and socio-cultural relations. In the relationship of the river and architectural space, she finds the issues of environmental protection, landscaping, energy, communication, regeneration, recreational spaces and prestige. Zumthor P. [10], Kuma K. [11] ”, Koolhaas R. [12], Ando T. [13], and Le Corbusier [14] postulate that water in contemporary architecture should be treated as a three-form material with specific functions in shaping space. Crafti S. [15] treats water as a symbol of luxury and spatial composition. Burchard C., Flesche F. [16] point to objects in the aquatic environment as a living space. Water deciding on aesthetics and spatial solutions. Januchta-Szostak A. [17] points to the advantages of sustainable planning and watery plastic compositions. He talks about the water body and surface. It particularly emphasizes the ecological functions of water in the city's spatial development. Nyka L. [21] sees water in buildings as a means of artistic expression, as a reference to the natural environment as well as a source of artistic effects. She also defines water as factors of shaping space as a result of the influence of physical and technical parameters, she also finds a confrontation of the built and aquatic
environment in cases of implementation on water or on the shore. Specifies the area of impact of the aquatic environment on architecture.

Based on the analysis of the views of various researchers, the following functions of water in contemporary architecture were determined: architectural materials, determining destiny, creative inspiration, environment. The definition composed on the researches can be stated as: Aquatic architecture is a collection of objects whose features are determined by its functional, technical, aesthetic and symbolic relationships with water as a material or the environment [1].

The features of the aquatic architecture are divided into the following functions [1]:

1. Environment
   a) water as a natural obstacle, constituting a technical challenge,
   b) location of the object on the land and water border,
   c) location of the object in the water space;

2. Determination of the purpose of the facilities:
   a) sports and recreation
   b) communication
   c) therapy
   d) research;

3. Architecture material:
   a) building material,
   b) decoration (plastic element),
   c) the factor shaping the environment and rooms climate;

4. Creative inspiration:
   a) formal appeals, including nautical appeals,
   b) cultural references,
   c) references to knowledge about water and the environment.

An architectural object is identified as water if at least one water function is found. A simple scheme for including the object in the water architecture collection is given below.

architecture + water function= aquatic architecture     (1)

4. The seeking for aquatic architecture.
In 2019 during the science seminar in Austria, Germany and Switzerland, the identification of aquatic elements in tested examples was made. The researches passed through: BMW Welt author: COOP HIMMELB(L)AU, Wolf D. Prix, Helmut Swiczinsky, Wolfdieter Dreibholz; Olimpic park Munchen author Benish architekten; Allianz Arena author: Jacques Herzog & Pierre de Meuron; Brandhorst Museum author: Matthias Sauerbruch, Louisa Hutton; Kunsthaus Bregenz, author: Peter Zumthor; Vorarlberg Museum author: Cukrowicz Nachbaur Architekte; Housing estate w St. Gallen author: Baumschlager Eberle; Helvetia, extension of head office author: Jacques Herzog & Pierre de Meuron; Szoła w Zurich Autor: Christian Kerez; Housing estate Zurich author: Annette Gigon, Mike Guyer Architekten; Housing estate Zurich Autor: Annette Gigon, Mike Guyer Architekten; Vitrahaus author: Jacques Herzog & Pierre de Meuron; Campus academic Luzern author: Durisch + Nolli Architetti; Migros market Luzern author: Diener und Diener; Expansion Muzeum Transportu author: Annette Gigon, Mike Guyer Architekten; KKL author: Jean Nouvel; Therme Vals author: Peter Zumthor; Ski jump Bergisel author: Zaha Hadid; Vitra Fire Station
Using the formula (1) the group of aquatic objects was found in investigated buildings, there were: Olimpia Park Monachium (Figure 1); Vorarlberg Museum, KKL in Luzern (Figure 2); Therme Vals. The following functions of water were found at the objects given above: determination of the purpose, architecture material, environment.

![Figure 1](image1.png)  
**Figure 1.** The water as the purpose of function of a swimming hall in Olimpia park in Munchen and Bregenz Vorarlberg Museum window in “view room” connecting the building to the water space

![Figure 2](image2.png)  
**Figure 2.** Internal pools as water decoration in KKL Luzern

It is well seen that the water is used to create an architectural space or context to architecture. It is used as material especially decoration or purpose defining medium. In 32 analysed objects, 4 aquatic objects were found, it is 14%.

5. Results
During the preliminary researches (Figure 3) it was calculated that 13 % of architectural objects have relations witch water, including 1% of indirect connection (for ex. Inspiration)
Figure 3. The percentage of an object connected with water in the preliminary investigation of about 1000 examples [1]

The number of aquatic objects found during the seminary tests (14%), confirms preliminary calculation that aquatic architecture state about 13% of realized buildings. It confirms again that architecture related to water is an important set among contemporary designed buildings.

Of the 609 buildings studied, the percentage of specific functions was calculated (Figure 4). The most popular is the use of water in the building as a material. It is very interesting that water appears in architecture as three states of matter: solid, liquid, gas. There are buildings made of ice that have a function and a designed shape. Sometimes they are designed by famous architects such as Zaha Hadid or Asymptote [22]. Liquid water is part of the energy cycle in the building and decoration. Water in the form of a gas aerosol can create an architectural shape in the form of designed clouds, such as a “Blur building” designed by Diller Scofidio.

The fewest examples indicate inspiration as a function of water. The smallest number does not mean that it is not important. In this way, many buildings standing on land far from natural water can be described as aquatic. Inspiration can be based on cultural, formal and knowledge references. In the modern world, these references replace references to mysticism.

Figure 4. The percentage of specific water functions found in 623 examples of aquatic architecture
The function of the environment and the range of the goal at almost the same level in the aquatic architecture collection. Architecture using water, such as swimming pools, or standing on the shore of a lake or the sea or standing in them, are of course included in the aquatic architecture set. In this part of the tested set, there is an architecture group that is innovative, it is the underwater architecture.

Figure 5. The underwater recreation stuff for divers in open water. Training platform in Gossausee in Austria; The Zakrzówek lake in Cracow (Poland)

Underwater architecture (Figure 5, 6) is a set of specific buildings with divergent features [23]. They can be divided into a group of completed objects and conceptual designs. It is clear that there is a big discrepancy between futuristic concepts and implemented objects. Most concepts are impossible to build due to the ignorance of underwater conditions [24]. Space created underwater has a different perception than on land. All physical parameters are different than on land, starting from calmness and visibility. Despite the designs of futuristic residential colonies, it is now possible to create only simple underwater things for divers. These are swimming pools for divers up to 33m 40m and 44m deep, simple training devices, artistic installations, memorials. There are elements that bleed a real underwater architectural space. Attempts are being made to build an underwater hotel. These studies show that recreation is the main goal of creating an architectural space underwater [25].

Figure 6. The underwater space of diving pool at Nemo 33 in Brussels and The memorial of John Paul II in Zakrzówek lake in Cracow (Poland)
6. Discussion
The set of aquatic architecture contains several interesting groups of objects. There are the buildings standing in the space of water (at, over, in, under). There are the ones what is built to use the water like pools. Other buildings use the water as the internal environment regulation medium. The question is what is the prognosis for aquatic architecture? The method to establish it is SWOT (Table 1, 2).

Table 1. Matrix of strategic factors of contemporary aquatic architecture (author's elaboration)

|   | Positive | Negative |
|---|----------|----------|
|   | Strengths | Weaknesses |
| Internal | weight | weight |
| S1 | 0.2 | tradition, attractiveness and capacity of water to encompass various ideas in architecture |
| S2 | 0.3 | diversity of proposed architectural functions (building's purpose) |
| S3 | 0.3 | a big number of concepts – a young field |
| S4 | 0.2 | eco-technological role of water |
| External | O1 | 0.3 | interest in the construction in the centres of riverside cities |
| O2 | 0.3 | development of tourism and recreation in new areas of implementation |
| O3 | 0.2 | technological development |
| O4 | 0.2 | development of search and exploration in water areas (necessity of work and housing) |
| O | 0.3 | T1 | pollution of the natural water environment |
| T2 | 0.3 | difficult conditions of implementation |
| T3 | 0.2 | natural disasters and global warming effect (the rise of water levels) |
| T4 | 0.2 | economic crisis, fuel and energy crisis, food crisis, overpopulation |

(a) Analysis of mutual dependencies
In the course of the SWOT analysis the following comparative questions will be asked:
- Will the strength make it possible to take advantage of a given opportunity?
- Will the strength make it possible to overcome a given threat?
- Does the weakness limit the possibility of taking advantage of a given opportunity?
- Does the weakness increase the risk and impact of a given threat?

In the course of the TOWS analysis the following comparative questions will be asked:
- Does an opportunity strengthen the strengths?
- Does an opportunity make it possible to overcome a given weakness?
- Does a threat weaken the strengths?
- Does a threat increase weakness?
Table 2. Matrix of strategic factors of contemporary aquatic architecture (author’s elaboration)

|                      | opportunities (O) | threats (T) |
|----------------------|-------------------|-------------|
|                       | aggressive s.     | conservative s. |
| number of interactions| 18                | 19          |
| weighted number of interactions| 9,2            | 9,2         |
|                       | competitive s.    | defensive s.  |
| number of interactions| 19                | 16          |
| weighted number of interactions| 9,5            | 8           |

The absolute number of interactions points out to the competitive and conservative strategies. The competitive strategy is indicated by the weighted number of interactions, which is the highest in the matrix. It should be noted that the weights are based on a subjective assessment. It is advisable to investigate the differences between the competitive and conservative strategies for the sake of implementation of aquatic architecture.

It is recommendable to adopt the following terms referring to the development of the aquatic architecture: improvement (for instance, of technological solutions), an increase of resources (for example, knowledge or legal regulations), expansion (for instance, of a number of concepts), reduction of costs, search for the new (for example, areas), development of the new (for instance, trends).

The weaknesses which should be overcome in order to make progress are as follows:
1. (W2) Lack of legal regulations and standards, especially in the case of underwater and floating architecture (except ship building which is excluded from aquatic architecture).
2. (W1) Difficulty in the adaptation of human beings as land mammals to the water environment (humidity, temperature, pressure).
3. (W3) High cost of implementation.
4. (W4) Lack of well-known, typical technical solutions, especially in the case of ice as well as underwater and floating architecture.

Emphasis on developing opportunities can create conditions for the development of an aggressive strategy, so it is recommended to:
1. Maintain the interest in the construction of objects in the centres of riverside cities.
2. Direct the development of tourism and recreation towards new areas of implementation connected with water.
3. Follow technological development.
4. Define the scope of activities in which it is necessary to work or live in the water areas.

7. Conclusions
Once again it has been confirmed that the water architecture constitutes a significant part of the creative built environment. It is worth investigating the problem. About 13% of architecture has
a connection with water. The impact of water on architecture can have technical, material, environmental and psychological coverage.

One of the newest items in architecture is underwater architecture, where the futurist concepts significantly vary from realizations or technical possibilities. The perception of underwater space is very different from space on the surface.

To develop contemporary aquatic architecture, it should be taken competitive or conservative (as minimum) strategy. It must be paid attention to develop the knowledge about building in, on and under the surface of the water to avoid the utopian concepts.

The tourism and recreation are the aim to build with water especially underwater facilities and floating houses.

References
[1] Z. Bujniewicz, Contemporary aquatic architecture. Pt. 1, Study and investigations. Silesian University of Technology Gliwice 2019.
[2] Phaidon, The Phaidon Atlas of Contemporary World Architecture Phaidon Press Limited, London, New York 2004.
[3] E. Niezabitowska, Research methods and techniques in architecture. Silesian University of Technology Publisher, Gliwice 2014 (in Polish).
[4] L. Groat, D. Wang Architectural Research Methods. John Willey & Sons Inc. 2002.
[5] A. Humphrey, SWOT Analysis for Management Consulting. SRI Alumni Newsletter. Menlo Park, California 2005.
[6] E. Niemczyk, Four elements in architecture. Z. Narodowy im. Ossolińskich, Wroclaw 2002 (in Polish).
[7] D. Boeminghaus, Wasser im Stadtbild. Brunen, objects, plants, Munchen 1980 (in German).
[8] A. Wylson, Aquatecture: Architecture and the Water. Architectural Press, London 1986.
[9] A. Pancewicz, River in urban space, [in:] Konopka Z. (ed.), Rivers. Architecture and landscape, Katowice 2002 (in Polish).
[10] P. Zumthor, Atmospheres. Birkhauser, Basel-Berlin-Boston 2005.
[11] K. Kuma, Anti-Obiekt; The discussion and Disintegration of Architecture. Architectural Assotiations Publications, London 2008.
[12] R. Koolhaas, Project Japan Metabolism Talks. Tashen, Hong Kong-London-Tokyo 2011.
[13] T. Ando, New horizons in Architecture: K. Nesbitt Theorizing a New Agenda for Architecture. An anthology of Architectural Theory 1965 – 1995. Princeton Architectural Press, N. York 1991.
[14] Le Corbusier, Amede Ozefant, Le pentiure moderne. Paris 1925.
[15] S. Crafti, H20 architecture. The Images Publishing, Australia 2005.
[16] C. Burchard, and F. Flesche, Water House. Prestel Verlag, Munich, Berlin, London, N. York 2005.
[17] A. Januchta-Szostak, Water in the townscape. Poznan University of Technology, Poznań 2009.
[18] U. Myga-Piątek, Woda w przestrzeni przyrodniej i kulturowej. Cultural Landscape Commission PTG, Sosnowiec 2003 (in Polish).
[19] U. Fratino, A. Petrillo, A. Petruccioli, and S. Michele, Landscapes of Water. History, Innovation and Sustainable Design. Unioneografica Corcelli Editrice. Bari 2002.
[20] C. Moore, and J. Lidz, Water and Architecture. Abrams Publishers, New York 1994.
[21] L. Nyka, Architecture and water - crossing borders. Gdansk University of Technology, Gdańsk 2013 (in Polish).
[22] L. Fung, The Snow Show. Thames and Hudson, New York 2005.
[23] Z. Bujniewicz, The creation and perception of underwater built environment or architecture: 3rd
World Multidisciplinary Civil Engineering - Architecture - Urban Planning Symposium. WMCAUS Prague 2018.

[24] Z. Bujniewicz, The discrepancy between the concepts and realised objects of underwater architecture: Architecture in Perspective 9. V. S.B. Technical University Ostrava. 2017.

[25] Z. Bujniewicz, The Underwater Recreation Stuff – Some Examples Architecture in Perspective 11. V. S. B. Technical University Ostrava. 2019.