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Enviromental factors az the elements determing the development of floating homes

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Abstract

The popularity of Floating Homes in Western Europe and North America is noticeable. The interest in these facilities in Poland is also constantly growing. The popularity of Floating Homes is due to climate change, rising land prices and population density in city centers. However, environmental factors play a significant role in their development. The publication presents the results of research on the impact of environmental factors on the development of Floating Homes in Poland. As part of the research, the most important environmental factors were identified and then, using the State of the Surroundings Scenarios (SSS) method, an initial scenario of their development was developed. The most probable scenario was developed, the purpose of which was to identify the most favorable factors - strengths and unfavorable factors - weaknesses responsible for the development opportunities of Floating Homes in Poland. Additionally, a surprise scenario was prepared, which indicated factors that may unexpectedly accelerate the development of Floating Homes in Poland or slow it down.

Keywords: Floating Homes, scenario methods, State of the Surroundings Scenarios (SSS), environmental factors, future.

1 Introduction

Sustainable urban areas resistant to the external factors require innovative and adaptable housing development in order to face the problems connected with the shortages of land and the consequences of the climate change and floods. Floating structures offer flexibility and, multifunctionality necessary to effectively confront these challenges and conditions [4, 6]. The majority of structures colloquialy referred to as Floating Homes (FH for short) are located in the Netherlands (Figure 1), England (Figure2) and Germany (Figure 3). Nevertheless, more and more frequently residential floating structures can be observed in Polish towns (Figure 4).Therefore, an increasing number of Polish researchers are concerned with the subject of floating structures, as evidenced by publications [10, 13, 14, 19–28]

The positive and negative environmental impact of FH are both still unspecified and additional research is essential in this area. The identified knowledge gap causes certain difficulties to various decision makers (including the decision makers dealing with water areas) and municipalities in creating a framework for spatial policy and regulating as well as facilitating the development of new projects connected with FH [5–7]. Unfounded concerns about harm to the environment due to the introduction of such structures to water, hider the implementation of new innovative floating developments, which in certain circumstances can provide more adequate, cost-effective and friendly solutions for the natural environment [6];

Currently, the majority of studies in this respect refers to the impact of Floating Homes (FH) on the quality of water [3–8, 11, 15]. However, there are more environmental factors associated with the future of FH and the inclusion of multi-dimensional and multi-variant environmental states is necessary in order to accurately assess it. The scenario methods provide such a possibility [12]. The essence of the scenario methods comes down to the statement that a scenario presents a collection of pictures (projections) of a random system or a forecasted situation in the future [29]. The scenario method relies on building a few variants of future scenarios, namely on constucting a logical, likely description of events which can take place in the future, in order to determine the appopriate action stategies [2, 12].

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Figure 1. Estate of floating homes in Amsterdam [16]

Figure 2. Narrowboats moored next to Kew Bridge in London [1]

The State of the Surroundings Scenarios (SSS) evaluate the impact strength of individual processes (factors) on the research subject. The knowledge of the scenario creators and consultants are the basis of the evaluations.

This publication presents just the environmental aspect based on the State of the Surroundings Scenarios (SSS), which constitutes a part of the analysis of FH development possibility.

Figure 3. Floating House in Eibekkanaal, Hamurg, Germany [17]

Figure 4. Floating house located in the center of Gdańsk, Poland [18]

2 Methodology of conducting studies using the State of the Surroundings Scenarios (SSS)

The procedure of conducting studies connected with the development of FH followed the methodology used in the works [9, 12] is composed of 4 stages:

Stage 1 - Identification of the environmental factors, which have a decisive impact on the development of FH.

Stage 2 - Building a scenario focusing on an assessment of the identified processes in the environment in terms of strength (on a scale of -5 to +5) and determination of the likelihood of the influence of the factors concerned (0-1) within the framework of the trend considered (regression, stagnation, growth). The strength of the impact is measured in accordance with the ten-point scale adopted in the methodology, which is presented in Table 1.

Table 1. The strength of the impact of the factor influencing the future scenario – a 10-point scale (own study based on [9])

The strength of a negative impact					The strength of a positive impact				
-5	-4	-3	-2	-1	+1	+2	+3	+4	+5
Very high	High	Moderate	Low	Very Low	Very low	Low	Moderate	High	Very High

Stage 3 - Arranging the trends according to particular scenarios:

- optimistic- based on the factors, which have the most positive influence- disregarded in the study,
- pessimistic- based on the factors, which have the most negative influence- disregarded in the study,
- surprise scenario- taking into account the factors, which are least likely to take place,
- the most probable scenario- based on the factors, which are most likely to take place, irrespective of a positive or negative strength of the impact.

Stage 4 - Implementation of accounting calculations, graphical presentation of the results, summary and drawing the conclusions.

3 Identification of the environmental factors influencing the development of FH

In the conducted analysis, the environmental factors, aggregated in groups of factors (also known as spheres), which are relevant for the object of the study are called determinants. The environment is understood as overall processes, phenomena and institutions influencing the object of the study. Within the research on the environment, 6 main spheres have been distinguished, i.e. environmental, socio-cultural, demographic, economic, technological and political-legal. Groups of factors have been identified based on literature review, interview and self study. In the course of research, 46 factors were identified,10 of which were allocated to the environmental sphere. The environmental sphere factors under the research in this publication have been reported in Table 2.

Table 2. A listing of the environmental factors for the future scenarios of Floating Homes (FH)

Sphere	Factors
Environmental	1. Revitalization of the urban areas
	2. Monitoring the aquatic environment
	3. Uncontrolled expansion
	4. Eco-friendly solutions
	5. Alternative for land drainage
	6. Rising sea and ocean levels
	7. Rapid change in groundwater level
	8. Hydrological drought
	9. Surface water resources
	10. Land protection by relocating towns to water

4 Building a scenario of future Floating Homes (FH)in the aspect of the environmental factors

In order to build a surprise and the most probable scenario, a commercial spreadsheet has been used. On the grounds of the answers provided by the experts (individuals with professional experience in the field of the subject under examination), the arithmetic mean for the allocated probability values following the formula (1) and the arithmetic mean of the impact force assessment following the formula (2) for each factor, for 3 possible trends have been calculated and listed in Table 3. The factors with the highest probability of occurring were marked in green, similarly the factors with the lowest probability of occurring were marked in red. The arithmetic mean of the probability determination for the trend considered is as follows:

$$m_{aP} = \frac{\sum_{i=1}^{n} P_i}{n} \tag{1}$$

indications:

m_{aP} - the arithmetic mean of probability P for a particular trend of a factor under examination,

$\sum_{i=1}^{n} P_i$ - the sum of the probability assessment of a factor for particular trend,

P_i - determination of the probability of a factor occurring, determined by individual experts for three possible trends according to the range from 0 to 1, which was adopted in the scenario method,

n - the number of responses provided by the experts.

Table 3. Summary of the results of the experts' final replies regarding the probability and severity of the impact of the individual trends and the environmental factors concerning the future of Floating Homes (FH) (own study)

Factors / trends in the surroundings	Trends	The strength of the impact of -5 to +5	Probability
1. Revitalization of the urban areas	Growth	3	0.37
	Stagnation	1	0.47
	Regression	-2	0.16
	Sum		1.00
2. Monitoring the aquatic environment	Growth	3	0.28
	Stagnation	1	0.58
	Regression	-1	0.14
	Sum		1.00
3. Uncontrolled expansion	Growth	-3	0.37
	Stagnation	0(-1)	0.42
	Regression	2	0.21
	Sum		1.00
4.Eco-friendly solutions	Growth	3	0.49
	Stagnation	1	0.39
	Regression	-2	0.12
	Sum		1.00

Table 3. Summary of the results of the experts' final replies regarding the probability and severity of the impact of the individual trends and the environmental factors concerning the future of Floating Homes (FH) (own study)

Factors / trends in the surroundings	Trends	The strength of the impact of -5 to +5	Probability
5. Alternative for land drainage	Growth	3	0.30
	Stagnation	0(1)	0.56
	Regression	-2	0.14
	Sum		1.00
6. Rising sea and ocean levels	Growth	3	0.35
	Stagnation	1	0.53
	Regression	-1	0.12
	Sum		1.00
7. Rapid change in groundwater level	Growth	3	0.38
	Stagnation	0(-1)	0.47
	Regression	-2	0.15
	Sum		1.00
8. Hydrological drought	Growth	-2	0.17
	Stagnation	1	0.54
	Regression	2	0.29
	Sum		1.00
9. Surface water resources	Growth	2	0.33
	Stagnation	1	0.52
	Regression	0(-1)	0.15
	Sum		1.00
10. Land protection by relocating towns to water	Growth	2	0.21
	Stagnation	1	0.61
	Regression	-1	0.18
	Sum		1.00

The arithmetic mean of the impact force assessment for the trend considered:

$$m_{aR} = \frac{\sum_{i=1}^{n} R_i}{n} \tag{2}$$

indications:

m_{aR} - the arithmetic mean of the impact force R of a given trend for the factor considered,

$\sum_{i=1}^{n} R_i$ - the sum of the severity impact assessment for a given trend,

R_i - the severity impact defined by individual experts for three possible trends according to the scale [-5;-4;-3;-2;-1; 1; 2; 3; 4; 5] adopted in the scenario method,

n - the number of responses provided by the experts.

5 Trends of the environmental factors for particular future scenarios

5.1 The Surprise scenario

The design of a surprise scenario is based on the choice of factors, which are least likely to take place regardless of the potential influence strength of a positive or a negative trend under consideration [9] and calculating the arithmetic mean using the formula (3). The results have been presented in Table 4.

The arithmetic mean of the environmental sphere impact strength assessment- the surprise scenario:

$$m_{aN} = \frac{\sum_{i=1}^{n} m_{aR}}{n} \tag{3}$$

indications:

m_{aN}- the arithmetic mean of the evaluation, the arithmetic mean of the influence forces m_{aR} of the trend with the lowest value of probability of the factor being examined,

$\sum_{i=1}^{n} m_{aR}$ - the sum of the arithmetic mean of the influence force of the trends with the lowest probability value of the factors considered within the analysed sphere,

m_{aR} - the arithmetic mean of the impact force R of a given trend for the factor considered,

n - the number of factors in a given sphere.

Table 4. The structure of the surprise scenario of the future (own study based on [9])

Scenario elements	Probability	The strength of a negative impact	The strength of a positive impact
Environmental factors			
1. Revitalization of the urban areas	0.16	-2	
2. Monitoring the aquatic environment	0.14	-1	
3. Uncontrolled expansion	0.21		2
4. Eco-friendly solutions	0.12	-2	
5. Alternative for land drainage	0.14	-2	
6. Rising sea and ocean levels	0.12	-1	
7. Rapid change in groundwater level	0.15	-2	
8. Hydrological drought	0.17	-2	
9. Surface water resources	0.15	-1	
10. Land protection by relocating towns to water	0.18	-1	
Medium strength of influence		-1.56	2

5.2 The most probable scenario

The final stage of the analysis is to summarize the trends for each factor with the highest probability of occurrence, including the value of the impact strength and calculating separately the arithmetic mean for the positive and negative impact strength following the formula (4). The results have been presented in Table 5.

The arithmetic mean of the environmental sphere impact strength assessment- the most probable scenario:

$$m_{aNP} = \frac{\sum_{i=1}^{n} m_{aR}}{n} \tag{4}$$

indications:

m_{aN}- the arithmetic mean of the evaluation, the arithmetic mean of the influence forces m_{aR} of the trend with the highest value of probability of the sphere being examined,

$\sum_{i=1}^{n} m_{aR}$ - the sum of the arithmetic mean of the influence force of the trends with the highest positive value and the lowest negative value of the factors considered within the analysed sphere,

m_{aR} - the arithmetic mean of the impact force R of a given trend for the factor considered,

n –the number of factors in a given sphere.

Table 5. The structure of the most likely future scenario (own study based on [9])

Scenario elements	Probability	The strength of a negative impact	The strength of a positive impact
Environmental factors			
1. Revitalization of the urban areas	0.47		1
2. Monitoring the aquatic environment	0.58		1
3. Uncontrolled expansion	0.42	-1	
4. Eco-friendly solutions	0.49		3
5. Alternative for land drainage	0.56		1
6. Rising sea and ocean levels	0.53		1
7. Rapid change in groundwater level	0.47	-1	
8. Hydrological drought	0.54		1
9. Surface water resources	0.52	1	
10. Land protection by relocating towns to water	0.61		1
Medium strength of influence		-1.00	1.25

6 The analysis of Floating Homes (FH) development opportunities in the aspect of the environmental factors

Preparation of the State of the Surroundings Scenarios provides an opportunity to learn about future restrictions of formulating strategy. It allows to evaluate the surroundings of the object of study according to the leading criterion and building so-called early warning systems [9, 12]. In order to achieve this, it is necessary to create a summary as shown in Figure 1, which shows the State of the Surroundings Scenarios system for the environmental sphere under consideration. The factors listed in the summary have been identified not only by name, but also by number in brackets for easier reading of tables and graphs.

6.1 The evaluation of the environment heterogeneity

It is possible to observe heterogeneous and poorly structured environment when the extent of the most likely scenario in the individual spheres is large [9, 12]. The largest span in the most probable scenario can be observed between the factors with the most negative probability of occurrence, namely the uncontrolled expansion (3) and rapid change in groundwater level (7) and the factors with the most positive probability of occurrence, such as eco- friendly solutions

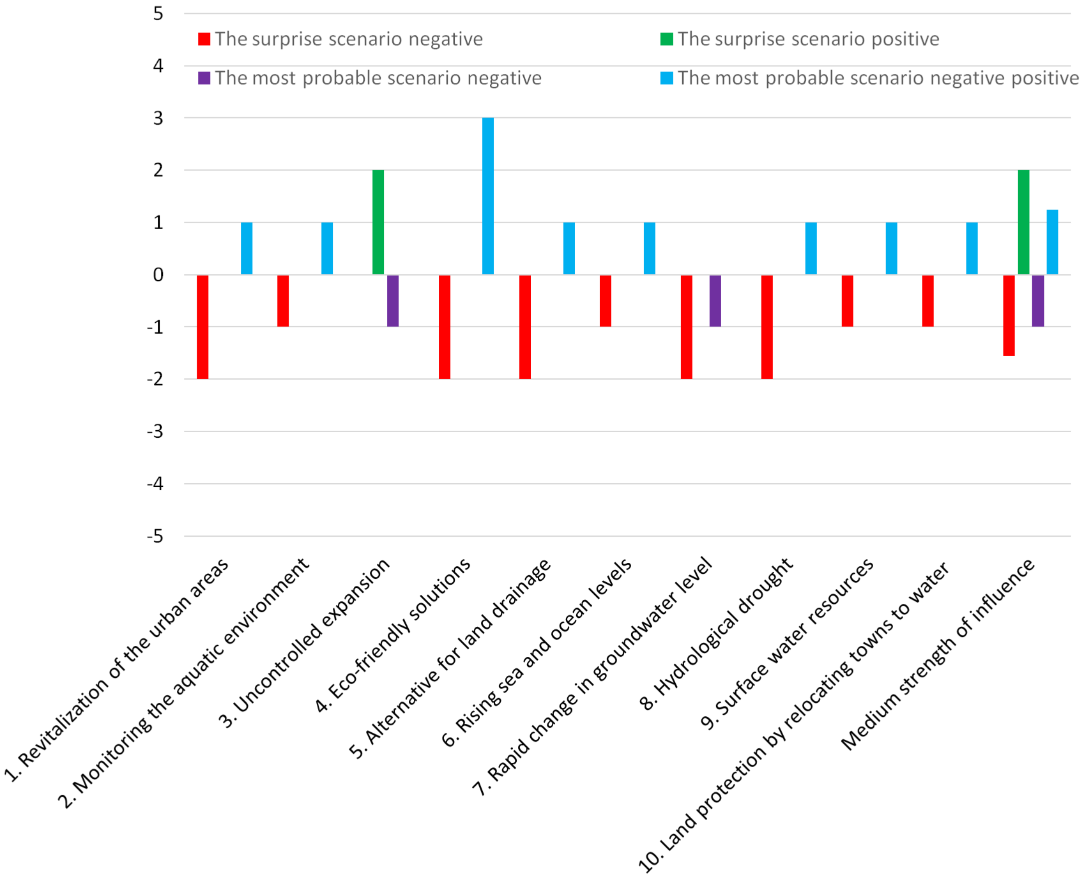

Figure 5. The structure of the most likely future scenario (own study based on (Gierszewska, and Romanowska, 2009)

(4). This means that the issues and problems contibuting to the factors indicated, are difficult to identify and structure. The scope of their definition is broad and contains plenty of smaller elements requiring detailed review. On a basis of an example of the uncontrolled expansion, it can be shown that the environment should be considered heterogeneous because legal regulations do not define objects such as FH, there are no rules to enforce the creation of such facilities without supervision of the institutions such as the Maritime Office, the Polish Ship Register or the Inland Navigation Office. Furthermore, there are no designated areas for locating FH, therefore they can be found not only in places where they are permitted to moor, but also where mooring is prohibited.

7 The leading processes

The leading processes are considered to be the factors from the scenario, which are the most likely to occur with both-the positive and the negative consequences [9, 12]. They are the foundation for the development and implementation of the strategy drawn up on the basis of them. The most likely positive factors are respectively, land protection by a relocation of towns to water (10) - 61%, monitoring the aquatic environment (2) - 58% and an alternative to wetland drainage (5) – 56%. The most likely negative determinants are the rapid change in groundwater level (7) – 47% and monitoring the aquatic environment (2) – 42%.

7.1 Early warning systems

The surprise scenario allows to estimate the potential strength of the phenomena which can unexpectedly influence the implementation of the strategy [9, 12]. In Figure 1, it can be seen that 9 out of 10 factors (except for factor 3) can negatively affect the development of FH. This indicates that according to experts, the environmental development of FH is generally positive in nature. Observation of the potential changes in the predicted changes will result in the inhibition of the process which in turn will negatively impact the research subject. The most unexpected phenomenon would be the admission to uncontrolled expansion (3), which would actually increase the number of water construction structures - value 2. However, according to experts, the number will grow even more if some unexpected factors will inhibit this by suspension of revitalization in the urban areas (1), no eco-friendly solutions in such structures (4), constant move towards land drainage for development (5), introduction of comprehensive protection against rapid change in groundwater level (7) and halting the hydrologic drought process in Poland. All of these factors were valued at -2.

8 Conclusions

Based on the studies conducted using the State of the Surroundings Scenarios method, instead of one consistent picture of the future, two extreme scenarios are obtained, namely the most likely and the surprise scenario. On that basis we are able to point out the factors which should be addressed in the process of building a strategy of FH development. The development of Floating Homes will continue and the future connected with the environmental factors can be considered positive.

The strongest feature which should be used and promoted is the eco-friendly solutions (4) that are willingly applied in this type of structures. The biggest weakness of this process is considered to be the uncontrolled expansion (3) and the rapid change in groundwater level (7).

The FH development process in Poland will be unexpectedly brought to a halt due to the occurance of factors such as the suspension of the urban areas revitalization (1), no implementation of eco-friendly solutions in such structures (4), constant move towards land drainage for development (5) and introduction of comprehensive protection against rapid change in groundwater level (7). In contrast, the admission to uncontrolled expansion of such structures will effectively lead to a significant increase in their numbers (3). The continuous monitoring of the factors specified in the surprise scenario enables the building of an early warning system, that is to implement a plan to prevent the adverse effects of FH development for the environment.

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