MOKSLAS – LIETUVOS ATEITIS
SCIENCE – FUTURE OF LITHUANIA
ISSN 2029-2341 / eISSN 2029-2252
http://www.mla.vgtu.lt

K. ŠEŠELGIO SKAITYMAI – 2016
K. ŠEŠELGIS' READINGS – 2016

2016 8(1): 29–37

http://dx.doi.org/10.3846/mla.2016.863

TERRITORY PLANNING PERSPECTIVE IN FLOOD-PRONE AREAS IN RIGA

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Abstract. The flood risk problems in Riga city due to global warming and climate change are studied based on the European experience incorporated in European and Latvian legislation. Amendment to the Protection Zone Law of Latvia is studied and compared with the likelihood of the flood risk and development possibilities in the flood risk zones. The study focuses on the case of the Vecdaugava River neighbourhood as the potential flood risk zone in Riga city.

Keywords: waterfront, flood risk, urban planning in Riga, sustainability.

Introduction

Definition of the flood risk – the probability of flood and of the potential adverse consequences for human health, the environment, cultural heritage and economic activity caused thereby (Water Management Law 2002).

The flood risk problem has become particularly topical due to climate change and global warming, resulting in water level rise in the World Sea. Many European cities suffer from flood hazards. Predictions show that in future climate change will be connected with heavy storm water increases, increasing the likelihood of fluvial flood in Central, Northern and Northeast parts of Europe. Intergovernmental Panel on Climate Change (IPCC) has worked out several scenarios for climate change. The IPCC scenario A1B predicts an increase of water level with the rate of 4.8 mm per year. This is the reason why various countries are changing their legislation related to flood risk (Eiropas Kopienu Komisija 2006). Research results of Ltd PAIC (Rīgas pilsētas... 2010: 10) forecast an increase in the water level rate in Riga city reaching 3.6 mm per year, which is close to that foreseen in the IPCC prognoses.

Global warming causes different problems such as water level changes in the water bodies, increase in the amount of precipitation, expansion of subtropical deserts etc. As a result of geological processes caused by the movement of tectonic plates, the terrain in the Northern part of the Baltic Sea is increasing by approximately 10 mm per year, whilst in the Southern part it is decreasing by approximately 1 mm per year. This leads to the loss of territory in Latvia compared to Scandinavia where the territory is increasing (Zorita, Hünicke 2010).

Solutions for flood risk problems are incorporated in the Riga city development plan, according to the European Directive 2007/60/EC (Eiropas Kopienu Komisija 2006) on the assessment and management of flood risks, which came into force on 26 November 2007. The Northern European countries have accumulated extensive experience in flood risk management, and its adaptation to the national legislation in Latvia provides good perspectives for assessment and minimization of corresponding risks in Riga.

The main part of this paper is devoted to the amendment to the Protection Zone Law, which determines development exception in the flood risk zones. The weather conditions in the North part of Europe are similar to Latvia, however European countries next to the North Sea are exposed to high and low tide daily. In these territories flood risk may combine with wind storms. In European countries such as the Netherlands, Germany etc. the flood risk management plan was significantly improved after serious floods.

Human desire to live next to waterfronts is strong, and it is based on the necessity for water as one of the main sources of life. People enjoy spending their time and living next to waterfronts. Nowadays, the possibility to develop territories closer to waterfronts, at the same time avoiding flood risk, is increasing due to advances in technology and human abilities. At various historical moments the depth of human knowledge about the impact of water level change

on lowlands and territories next to waterfronts, caused by unforeseen weather conditions, was different. The development strategy for flooded areas must be devised at the national level for each country. Consequences of climate change include minor or major calamities related to flood, that may result in damage or loss of people's properties and could even cause fatalities; hence the necessity to create a management plan of the flood protection systems in built-up areas located in lowlands, where flood can occur frequently. As Jan Gehl says: *Feeling safe is crucial if we hope to have people embrace city space. In general, life and people themselves make the city more inviting and safe in terms of both experienced and perceived security* (Gehl 2010).

Research question: Impact of amendments to the Protection Zone Law of Latvia increasing the allowed index of flood risk in development areas from 1% to 10% on the spatial environment planning of Latvia, Riga city and the Vecdaugava River neighbourhood case.

Methods

The following research methods are used to evaluate the development possibilities in flood-prone areas raised by amendments to Latvian legislation:

- Comparative Analysis – to study the amendment to legislation and to identify the necessary proposals to develop the required activities. Flood risk management in Latvia (Riga city) is compared to that of the Netherlands and Germany.
- Graphical Analysis – to study the case of the Vecdaugava River neighbourhood.

Discussion

European experience

During the last century flood risk management plans were developed and improved in many European countries and cities, struggling with disasters caused by flood. In many cases flood risk management plans were developed and improved after big disastrous floods, for example, the Delta plan for the Netherlands and the flood management plan for Hamburg City in Germany.

Having extensive experience in fighting flood, the Netherlands is the key country in Europe for the flood risk management. Half of the area of the Netherlands lies below the sea level, therefore, a strong protection system has been created to safeguard the lower parts of the country and areas next to the seaside from flood. The flood management system has reached the national level in legislation (Deltawerken online 2014a). Continuous struggle for the territory and with the sea has been going on for many centuries in the Netherlands. On February 1, 1953, the Dutch part of the North Zealand was hit by extreme flood, which destroyed part of the territory and killed around 2,000 people (Deltawerken online 2014b). Even though the flood risk management plan for the country called *Delta plan* was started before 1953, its implementation for the North part of the country was not finished until this flood disaster. The *Delta plan* was started working out around the 1950. It was extensive and covered all of the territory – mostly all parts of the river estuary. The implementation of the plan is still in progress and will be finished in the nearest future. River deltas are characterized in the magazine for the conference "Deltas in Times of Climate Change", 2010 by Ria de Wit: *Deltas are economic and environmental hot spots. They are fertile, strategic sites with rich ecosystems. But deltas are vulnerable to flooding and draught, especially in the face of climate change, challenges and opportunities aplenty* (De Wit 2010).

A similar situation is observable in the City of Hamburg in Germany, which is connected to the North Sea by the River Elbe crossing the city. The River Elbe has a bottle neck not far from the city. Hamburg is exposed to high and low tide daily, around 2 m above the sea level, which in combination with storms may create major disasters. The city experienced a combination like that on February 16–17, 1962, when a large part of the city was flooded and around 315 people were killed (Arkadia 2012). After this devastating event the flood risk management strategy was developed including an improved system of dams, locks etc. During the later years the city was successfully shielded from storms, usually caused by cyclones over the North Sea. A special place is *Hafencity* – the new part of Hamburg city which is built outside the dam systems. The flood protection systems in *Hafencity* were incorporated in architecture of the buildings. Nowadays, the City of Hamburg has a practical and smart flood risk management plan which has been integrated in the development plan of the city.

Storm water management

A special regulation for the storm water management should be incorporated in city development plans, because of predicted increase in the amount of precipitation (Plūdu riska 2010: 44). The flood risk management plan, which has been worked out for Riga city, also includes a part that deals with storm water management. Storm water management has been studied in SWITCH project – a research project funded by the European Union. According to the SWITCH project a method which is closely linked to the natural water cycle is used. The water system is incorporated in city life,

trying to solve flood risk problems by building systems and developing places for holding bigger amount of additional storm water. These tendencies have been described in Water Sensitive Urban Design (WSUD). According to the principles and inspiration for Sustainable Storm Water Management in the City of the Future (Hoyer *et al.* 2011), the WSUD is the interdisciplinary cooperation of water management, urban design, and landscape planning. It considers all parts of the urban water cycle and combines the functionality of water management with principles of urban design. WSUD develops integrative strategies for ecological, economical, social, and cultural sustainability. The objective of Water Sensitive Urban Design is to combine the demands of sustainable storm water management with the demands of urban water cycle closer to a natural one.

A similar project dealing with this issue exists also for Latvia and Estonia. It is the project "(D)rain for Life" which is a year-long project "Promoting Sustainable Urban Drainage Systems (SUDS) in Estonia-Latvia cross border area to improve the environment for active and sustainable communities". SUDS are so called "green" methods and specific types of engineer design techniques that mimic ways of natural ecosystems, handling storm water runoff. In this project for Latvia there are two case study areas: one in Riga city and the other in Baldone city ((D)rain for life 2015). Both places suffer from storm water. Riga city case is located in the territory with low ground water level. Baldone city does not have SUDS system for all the city. Therefore, it was a challenge to work out a system with all calculations for both cases area in Latvia.

Flood aspect in Latvian Legislation

European experience in flood management, gained during a long struggle against floods, is incorporated in Latvian legislation. Table 1 shows structure the hierarchy of legislation. For many places in Latvia there is a high flood risk because of their location near a river's estuary. Due to climate change, wind storms are more frequent and the risk of flood increases. The territories, which are situated closer to the sea side, tend to be lower and more exposed to flood risk.

Building next to the waterfront offers possibilities and challenges regarding the norms, insurance of property etc. The norms regarding flood problems have changed at the national level of legislation. Important changes can be observed in the likelihood of flood risk. The Netherlands experience shows the worst scenarios of flood risk likelihood 1 time in 10 000 years next to the North Sea; also the time period alongside with the likelihood of flood and

Table 1. Hierarchy of legislation

Hierarchy of legislation		
European level	Directives	Flood directive, Water Framework directive etc.
National level	Laws, rules	Protection Zone Law, Water Management Law, Spatial Development Planning Law etc.
Regional level	Rules of regional planning	Daugava River Basin Plan, Lielupe River Basin Plan, Ventas River Basin Plan, Gaujas River Basin Plan, 5 Planning regions with region development strategies etc.
Municipality level	Associated rules	Riga Spatial Plan from 2006 to 2018

the anticipated water level were determined. In Latvian norms probability of flood risk is determined only 1 time in 10 years. Water level measurements and monitoring show tendencies of water level changes (Plūdu riska... 2010). Flood risk probability with time period give results stronger which must be determined together. In the project "Riga against flood" time period and probability for Riga city was worked out; it must be taken into account in lower territories and flood risk zones – probability: 1 time in 100 years in the time period 2050–2070 (Plūdu riska... 2010). This scenario was worked out after calculating various flood probabilities, and the data were taken from measurements of water level changes over a long period of observation. The economical aspect of housing exploitation period was also taken into account (Plūdu riska... 2010).

The legislative aspect from EU directive until local municipality norms has been taken into account in territory development processes, which in many cases have been finished with new building proposal. EU norms, which are incorporated in national level of legislation, are adapted in the norms to save nations and territories from disasters.

Construction field and development possibilities are dependent on legislation norms and their adequacy. Each situation of territory development possibilities next to the waterfront should be evaluated from the aspect of housing development and flood risk possibilities, without trying to eliminate flood risk but living together with it and being ready for possible flood. In Riga city case a water body constitutes one fifth part of its territory, offering many possibilities to build next to the waterfront, therefore norms are so important.

The most important law for development possibilities in flooded area is the Protection Zone Law. The Protection Zone Law determines exceptions for development possibilities in the flood risk zones.

Regarding water objects in Riga city, rules of water management plans exist, determining possibilities in the surface water body and it should contain also the surface water body coastal side. Documents like the Surface Water Body management plans should be worked out for all water bodies as a good praxis. These plans include more detailed information about development possibilities next to a special waterfront and also on the water body – possibilities of floating houses etc. This is the way how to avoid the existing problems with the water body planning, rent etc.

Amendment to the Protection Zone Law

The Protection Zone Law has been changed several times (Table 2). The law determines a flood risk zone – a territory of land, which, with an increase of water inflow into the body of water or water throughput in the watercourse, shall be flooded for a short time period. This law also determines actions prohibited in the flood risk zones, for example, raising the ground level or construction of buildings and structures with the exception of protective dams. A detailed proposal of the water body protection against flood should be brought forward by the authorities of the municipalities experts, which could afterwards be incorporated in national legislation. "Flood risk management plan" and also "Methodological guidelines for territorial planning in flooded area" have already been worked out for Riga city case (Plūdu riska... 2010). These documents will be incorporated in the new Riga spatial plan the development of which is in progress.

Table 2. Amendment to the Protection Zone Law

1997	Edition of the Protection Zone Law	In the first edition of the law construction of buildings in flood risk areas was not forbidden.
26.03.2002.	Amendment to the Protection Zone Law	Prohibiting building in areas with flood risk probability 1 time in 100 years. Exceptions were made for buildings of short term use and small buildings in rural areas with specially designed protection or raising the ground level (Likumi 2002).
06.03.2008.	Amendment to the Protection Zone Law	Important change of flood risk likelihood. The term of flooded area was changed – the flood risk likelihood 1 time in 100 years from the Law was eliminated. Since March 2008 the flood likelihood has been incorporated in "Methodology for the Determination of Surface Water Body Protection Zones". Now the flood risk likelihood is fixed as 10% (1 time in 10 years) instead of previous 1% (1 time to 100 years) (Likumi 2008).

The Protection Zone Law does not determine the time period for flood probability but only sets a strict regulation of development exceptions for flood risk zones. The flood risk likelihood is included in "Methodology for the Determination of Surface Water Body Protection Zones" – 1 time in 10 years. The European experience together with the Life+ project "Riga against flood" demonstrate the necessity to incorporate the time period and flood risk likelihood in flood risk management plans and also in spatial planning and norms (Plūdu riska... 2010).

Protection Zone Law Section 37 – "restrictions in Surface Water Body Protection Zones (1) ... the following restrictions shall be specified for surface water body protection zones: 4) the construction of buildings and structures in the territories with probability of flooding at least once in a hundred years is prohibited, except structures for short-term utilisation, small buildings in rural areas and protection structures especially provided for this purpose or the raising the ground level" (Protection Zone Law 1997).

Territories next to waterfronts are great challenges for architects and territory planners – how to reach the right balance between the development possibilities and natural aspect. The flood risk protective systems for territories and buildings should be both functional and aesthetic. For example, the worldwide architectural competition has been announced for the flood protective fence next to the River Scheldt in Antwerp city. All around the world great examples of architecture next to waterfronts have been created, which is so called Aquatecture, where the most important part of the aesthetic quality of buildings is due to the water magnificence. Examples of such world famous architecture are Opera houses of Sidney, Oslo, Hamburg etc. In her dissertation "Aquatecture: Architectural adaptation to rising sea levels" Erica Williams explains that Aquatecture is defined as an architectural adaptation typology used to mitigate and manage flooding (long and short term) (Williams 2009).

The main conclusion about the change of the floods legacy is that in 2002 the rules for flooded areas were stricter than those in effect. In 2002 it was forbidden to build in area with 1% flood risk probability, but now it is changed to 10% flood risk probability. For property owners the previous norm of 1% flood risk probability was more rigid than the currently existing norm. Nowadays, the flood risk for property owners has been reduced 10 times in the legislation. Therefore, people's safety has decreased 10 times as a consequence of changes in the law. At the same time the economical aspect is the weak point because the

responsibility for flood risk area from municipalities and private owners is changed 10 times.

There are a lot of examples in Riga city, where the officials of the city should pay attention to the flood risk problems (lower territories, buildings too close next to the waterfront etc.), especially during and after the storm time. Possibility to develop lower parts of territories and those next to the waterfront must be determined and included in the laws and in the norms, but the main responsibility should be assumed by the owner of the property. Insurance of the property is a good instrument to feel safe. However, there are many problems with insurance companies – there are companies which do not have offers for properties in flood risk territories. So, the owners of such properties should pay attention to all aspects of insurance to feel safe.

Riga Municipality has a good example of legislation assessment in "Building Regulations for Riga Historical Centre and its Protection Zones". This document has a chapter about territory planning process in the surface water body and also next to the waterfront.

The Vecdaugava River neighbourhood case

In the preface of Jan Gehl's book "Cities for people" Richard Rodger says "Everyone should have the right to easily accessible open spaces; just as they have the right to clean water". This idea is important in development planning process of territory and waterfront which have to be accessible and also in possibility to reach them.

Riga city has a lot of water bodies, covering approximately 1/5 part of its territory – there are the Gulf of Riga, rivers, lakes etc. Therefore, it is a great challenge to provide effective territory planning respecting all interests – natural and human together.

One of Riga's neighbourhoods is located next to the River Vecdaugava. The Vecdaugava River neighbourhood is situated in the North part of Riga city, close to the seaside and the Delta of the River Daugava. Especially important territory next to the Vecdaugava River is "The Vecdaugava natural reserve" with its fauna and flora, including around 40 different bird species and also special vegetation.

The Vecdaugava River in English translation means the Old Daugava River. From the geographical aspect the Vecdaugava River is an arm of the River Daugava. In the past the Vecdaugava River ran out of the Daugava River and made two ramifications. In the 1940s one arm was filled up and the other one still exists and is named the Audupe River. Until the end of the 16th century a connection of the Daugava River with the sea was only through the Vecdaugava River. In the past there was a ship way through the Vecdaugava River. In the end of the 16th century the Vecdaugava River lost it strategic importance, because the Daugava River changed its bed.

The west part of the Vecdaugava River is the Mangalu peninsula. Territory next to the waterfront is the natural protection territory and is not built up. The east part of the Vecdaugava River neighbourhood territory is occupied by the housing of low density. This territory has the green – blue structure, balancing the nature and the

Figure 1. The Vecdaugava River neighbourhood

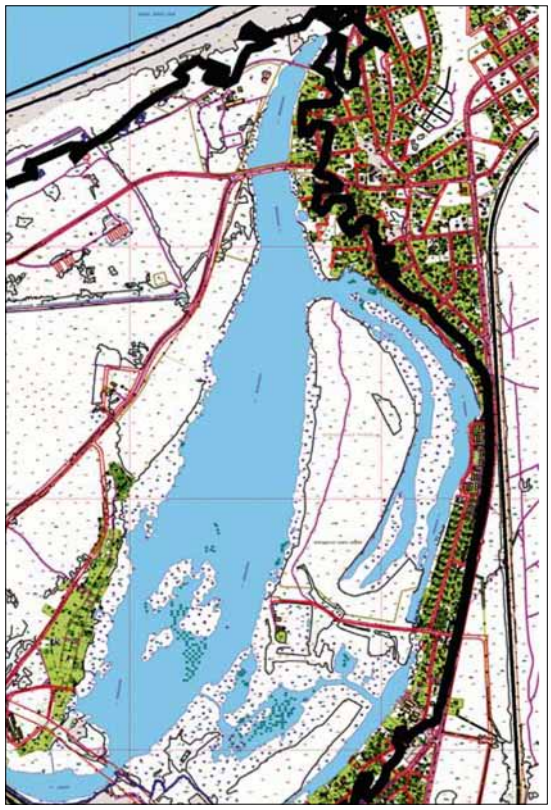

Fig. 2. The Vecdaugava River neighbourhood with 1% flood risk marked with a line in black colour (Plūdu riska... 2010)

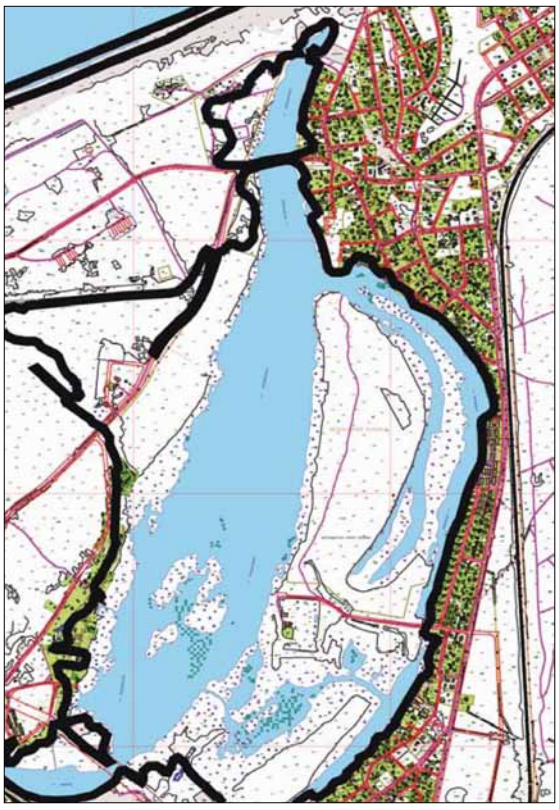

Fig. 3. The Vecdaugava River neighbourhood with 10% flood risk marked with a line in black colour (Plūdu riska... 2010)

water structure in the neighbourhood and next to the waterfront. The Vecdaugava River neighbourhood has linear structure along the Vecdaugava River and the main street is. Airu Street is located parallel to the Vecdaugava River and it was built in the early 1960s. Geographically, at the beginning of Airu Street (Fig. 1) there are mainly private family housings, some cottage type buildings and some two-storey apartment houses. The private family houses are mostly located close to flood risk zones. In the south part of the Vecdaugava River neighbourhood one can find mixed use buildings which are located close to the territory of the Riga Freeport (Apkaimes 2015).

The geographical features of the Vecdaugava River neighbourhood territory cause difficulties for construction. Groundwater levels are high (around 1.5 m) and the soil composition also proves to be a weak point for construction of housing. It is a plane territory, rising only around 0–1 m above the sea level. In the southern part of the territory, the level rises up to 7 m above the sea level because the ground level has been artificially increased. The area of the Vecdaugava River neighbourhood is 0,6 km wide and around 2 km long. The maximum height is around 13 m above the sea level in the south – east part.

The Vecdaugava River neighbourhood territory has considerable flood risk problems – it is regularly flooded and, therefore, is one of the worst parts in Riga city. For this neighbourhood it is determined that the likelihood of the existing flood risk is 10%. At the same time, there are also areas along Vecaku prospect where the flood risk could reach 1% likelihood. In the South-East part of that territory the situation is better because of the higher ground level, thus the flood risk practically does not exist. In Figures 2 and 3 the territories exposed to flood risk are marked with the black line.

On the one hand, the location of the Vecdaugava River neighbourhood is far from the centre of Riga city, but on the other hand, it is close to the seaside, which may be a tempting feature for those choosing a property. Besides, the Vecdaugava River neighbourhood has its own waterfront, which is so different, because of the existing private properties alongside inhabitants' attitude to the waterfront, and possibilities for inhabitants to reach this waterfront at different places.

It is important for people to have a possibility to reach the waterfront without problems in different areas as it has been determined in the Fishery Law. In this law the term of towpath is included. The towpath *is land strip along the sea shore for fishing or navigation of related activities and pedestrians* – it means that in land strips a possibility to reach the waterfront and to walk for pedestrians should

be provided (Fishery Law 1995). Access to public surface waterbodies for inhabitants should be provided. In the situation of real estate market this possibility to access the waterfront is hard to ensure. Private owners take care of their property till the waterfront, and they would like to use this territory themselves, including also the towpath. The towpath causes problems for the owners since it is a semi-public territory. The towpath should be accessible for all people during the day time. During the night time a walk through private property should be forbidden.

The Vecdaugava River neighbourhood was one of the case study territories in the project "Riga against flood" because of its frequent flood risk problems. Two possibilities for the flood risk protection systems have been worked out. The first possibility suggests a sluice across the Audupe River (Fig. 4), but the second one proposes dams and water regulation systems along the Vecdaugava River coast (Fig. 5). The first suggestion – building a huge sluice and maintaining it in good condition is very expensive, but this is a very safe development proposal for the territory and all inhabitants. The second possibility – building dams and water regulation systems, which consist of many pieces must be done all together for good result. Nowadays, building high dams next to the waterfront is not the best solution for the flood risk problems, instead of it, an integrated flood protection system in the architecture of a building is preferred. A good view to the waterfront is the most beautiful aspect for choosing property next to the water body.

As an example, two pictures are presented in Figures 6 and 7 that show private owners' self-made flood protection systems in the Vecdaugava River, demonstrating people's

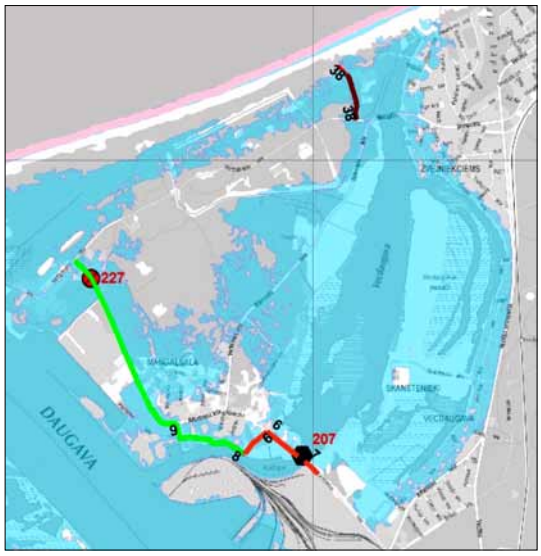

Fig. 4. Flood protection location (a sluice system) in the Vecdaugava River neighbourhood, the 1st case (Plūdu riska 2010)

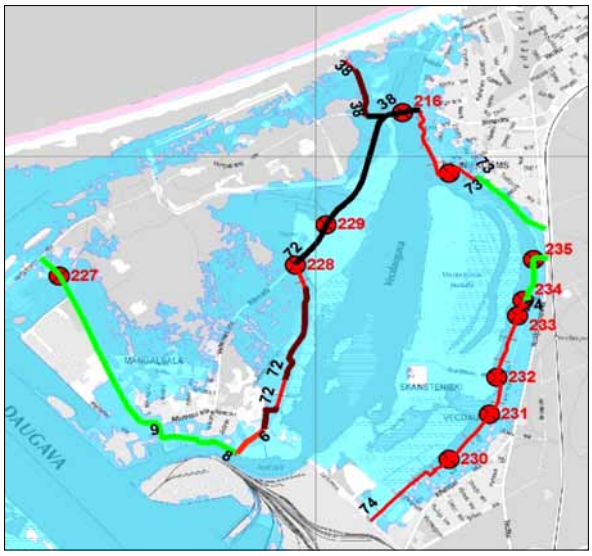

Fig. 5. Flood protection (the dams and water regulation system) location in the Vecdaugava River neighbourhood, the 2nd case (Plūdu riska 2010)

Fig. 6. Self-made protection against flood risk in the Vecdaugava River

Fig. 7. Good example of the waterfront development in the Vecdaugava River

attitude to the waterfront. The self-made protection system shown in Figure 5 gives evidence of regular flood risk likelihood, but from the aesthetic point of view, the construction does not evoke positive emotions, contrary to the case demonstrated in Figure 7. Both examples are located near each other and show inhabitants' attitude and possibility to take care of their own properties. A strict regulation for the development of the waterfront should be imposed for these territories, because people want to live in safe place.

Jan Gehl said: *We shape cities, and they shape us.* This idea refers not only to cities but also to the territories next to waterfronts. The water level changes determine the rules, which should be taken into account for the territory development process.

Survey of the inhabitants from the Vecdaugava River neighbourhood

It is important to know the attitude of the private owners who have their property or who live next or in the flood risk territory. On September 13, 2013, City Development Department of Riga City Council made a survey of population who have lived in the Vecdaugava River neighbourhood all their life. The main conclusions of this survey were summarised in the following (Līguma... 2013).

Around 1/3 of inhabitants is sure that the character of this territory is determined by the Vecdaugava River neighbourhood. Further priorities for the inhabitants are nature, forest and allotments.

Very important aspect for inhabitants (around 2/3) is close proximity of the sea and also existence of green structure – nature, forest etc.

59% of inhabitants consider that there is no necessity for new buildings within this neighbourhood. 36% of inhabitants consider that new buildings of detached and semi-detached houses should be developed.

Summary

The Protection Zone Law has assessment of flood likelihood and possibility to build in the flood risk area – changes from 1% to 10% likelihood since 2008. Due to this assessment, now it is possible to build in 1% flooded area, which was previously forbidden. Now the flood risk for these territories has increased 10 times for dwellings.

In the case of 10% flood risk likelihood the private owner, who would like to live in these territories, should be held responsible for the safety of the property. The municipality should not be economically responsible for an inhabitant's desire to live in the flood risk areas.

In the legislation, where the flood risk probability is determined, the time period of flood risk should be incorporated for possible development of such territories.

Investigation of flood-prone areas in Riga city safety, vulnerability, landscape quality and accessibility of water bodies will be continued.

Acknowledgments

Acknowledgment to professor Ugis Bratuskins for interest in this work and fruitful discussions.

References

Apkaimes. 2015. *Apkaimes vēsturiskais apraksts* [online], [cited 25 November 2015]. Available from Internet: http://www.apkaimes.lv/sakums/vecdaugava/history

Arkadia. 2012. *The Great Flood of 1962 in Hamburg*. [online], [cited 20 December 2014]. Available from Internet: http://www.environmentandsociety.org/arcadia/great-flood-1962-hamburg

Deltawerken online. 2014a. *The Delta Works* [online], [cited 20 December 2014]. Available from Internet: http://www.deltawerken.com/Deltaworks/23.html

Deltawerken online. 2014b. *Disasters* [online], [cited 20 December 2014]. Available from Internet: http://www.deltawerken.com/Floods/22.html

De Wit, R. 2010. Vulnerable deltas, difficult choices *in The Conference "Delta's in Time of Climate Change"*, September 2010, Rotterdam, The Netherlands.

(D)rain for life. 2015 [online], [cited 10 December 2015]. Available from Internet: www.drainforlife.eu

Eiropas Kopienu Komisija. 2006. *Eiropas Parlamenta un Padomes Direktīva par plūdu riska novērtējumu un pārvaldību* [SEK(2006) 66]. [Online], [cited 25 November 2014]. Available from Internet: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0015:FIN:LV:HTML

Fishery Law. 1995. Adopted by the *Saeima* of Latvia on 12 April 1995 [online], [cited 25 November 2014]. Available from Internet: http://likumi.lv/doc.php?id=34871

Gehl, J. 2010. *Cities for people*. Washington: Island Press. ISBN 10: 1-59726-574-8.

Hoyer, J.; Dickhaut, W.; Kronawitter, L.; Weber, B. 2011. *Water sensitive urban design*. Berlin: Jovis.

Līguma Nr. DA-13-80-lī. 2013. *Iedzīvotāju aptauja par dzīvi apkaimē 40. Vecdaugava* [online], [cited 30 December 2015]. Available from Internet: http://www.sus.lv/sites/default/files/media/faili/40_apkaime_vecdaugava_atskaite.pdf

Likumi. 2008. *Grozījumi Aizsargjoslu likumā* [online], [cited 25 November 2015]. Available from Internet: http://likumi.lv/ta/id/172554-grozijumi-aizsargjoslu-likuma

Likumi. 2002. *Grozījumi Aizsargjoslu likumā* [online], [cited 25 November 2015]. Available from Internet: http://likumi.lv/ta/id/59732-grozijumi-aizsargjoslu-likuma

Plūdu riska pārvaldības plāns Rīgas pilsētai. 2010 [online], [cited 30 December 2015]. http://www.rigapretpludiem.lv/data/doc/13535809481255.pdf

Protection Zone Law. 1997. Adopted by the *Saeima* of Latvia on 5 February 1997 [online], [cited 25 November 2015]. Available from Internet: http://likumi.lv/doc.php?id=42348

Rīgas pilsētas virszemes ūdeņu ietekmju novērtēšana, novēršana un ekoloģiskā stāvokļa uzlabošana [Integrated strategy for Riga city to adapt to the hydrological processes intensified by climate change phenomena]. 2010 [online], [cited 25 November 2015]. Available from Internet: http://www.riga-pretpludiem.lv/data/doc/13155523326803.pdf

Water Management Law. 2002. Adopted by the *Saeima* of Latvia on 12 September 2002, Available from Internet: http://likumi.lv/doc.php?id=66885

Williams, E. 2009. *Aquatecture: Architectural adaptation to rising sea levels* [online], [cited 25 November 2015]. Available from Internet: http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1084&context=etd

Zorita, E.; Hünicke, B. 2010. *Is the Baltic sea-level change accelerating?* Institute for Coastal Research, GKSS Research Centre, Germany.

TERITORINIO PLANAVIMO PERSPEKTYVOS POTVYNIŲ UŽLIEJAMUOSE RYGOS PLOTUOSE

D. Berzina

Santrauka

Tiriamos potvynio rizikos Rygos mieste keliamos problemos, atsiradusios dėl globalinio atšilimo ir klimato pokyčių, remiantis Europos patirtimi, atspindėta Europos ir Latvijos įstatyminėje bazėje. Analizuojami Latvijos Respublikos apsaugos zonų įstatymo pakeitimai, potvynio rizikos galimybės tam tikrose zonose. Tyrimas skirtas nagrinėti Vecdaugavos upės atvejį kaip potencialią potvynių zoną Rygos mieste.

Reikšminiai žodžiai: miesto pakrantės zona, potvynio rizika, urbanistinis planavimas Rygoje, tvarumas.