The report of the LIFE+ project Nr.LIFE08 ENV/LV/000451 "Integrated Strategy for Riga City to Adapt to the Hydrological Processes Intensified by Climate Change Phenomena" on the best practices and experience in identifying and managing flood risk zones in three European cities.

Summary.

Business visits to Antwerp in Belgium, **the Hague** in the Netherlands (8.–12.11.2010.) and **Hamburg** in Germany (14.–17.11.2010.)

The aim of visits: to get acquainted with the experience and best practices in flood risk assessment and management in three European cities.

Members of delegation: as it was stated in the project inception report, both delegations consisted of seven people – two officials from Riga City Council, two representatives from City Development Department and three project team members (project manager, environmental expert and territory planner).

During the visits in Antwerp, the Hague and Hamburg the delegation met representatives from state and municipality institutions, as well as specialists, scientists and researchers representing agencies and private companies, who shared their experience in flood management – research, forecast, flood prevention planning and implementation. During the visits the delegation got an insight into both theoretical and practical flood management, visiting actual sites with engineer technical solutions – dams, polders, protective walls, watergate, sluice, pump stations and other flood prevention constructions. In all countries visited the delegation made important contacts with specialists in the field who can provide additional information and consultations if necessary.

Flood Management

Antwerp, the Hague and Hamburg are located in the North Sea tide impact zone that determines fluctuations of water level. Antwerp and Hamburg, similarly to Riga, are situated beside estuaries of major rivers, and fluctuations of water level in the river vary from 2 to 5 m every day.

The main factors causing flooding of territories are:

- storm-induced sea water surges or wind surges,
- inland water draining in case of intense precipitation.

Like in Riga city, wind surges, induced by strong NW wind, are considered to be the main cause for flood. The greatest flood risk is posed by wind surges that combine with high tide, which can beget the water level to reach very high water mark (+7 m and higher above the norm).

In all the cities visited research and protection planning is carried out separately for flood risks induced by wind surges and intense precipitation. Both factors are very different in their cause, extent, and in solutions for territory protection.

Additional attention to flood management in Antwerp, the Hague and in Hamburg was given after major flood catastrophes in the previous century that took the cities by surprise – caused severe damage and took many lives.

Despite the first attempts in flood protection – with the ratification of *"Delta plan"* (initially the only flood prevention solution envisaged in the plan was building hydro technical installations for closing river estuaries during storms) and the first completed construction work in 1950, the Netherlands faced the imperfections of flood management already in 1953 when the northern part of the country suffered substantial damage from flood caused by a combination of wind surges and high tide. After this event *"Delta plan"* was revised and significantly amended.

Hamburg experienced flood catastrophe in 1962. Specialists admit that main problems were posed by incomplete flood forecasting, poor communication with inhabitants that were subjected to flood risk as well as deficient or poor-quality hydro technological solutions for flood prevention. After this catastrophe the above mentioned imperfections were eliminated, thus creating a practically new flood management system for Hamburg.

Antwerp experienced unforeseen flood in 1976. Immediately after that in 1977 a flood prevention plan *"Sigma plan"* was created. Its aim was to protect all the Schelde River basin, including Antwerp city, from wind surges. Taking into consideration the impact of climate change *"Sigma plan"* was updated in 2005.

The specialists met indicated that the mentioned flood catastrophes have changed people's, including politicians', attitude towards flood threat – because of the previous negative experience, flood management is one of the state's priorities at the moment and for this reason financial resources are sufficient.

In all the cities visited flood prevention systems are based on:

- preventive protection measures,
- technical protection measures,
- operative protection measures.

Preventive protection measures encompass various hydrological research, forecasting, risk management, calculations of safe flood height marks, cooperation with neighbouring countries and other. Mathematical calculations of flood level, the probability of its recurrence and also safe flood height marks are based on measurements, forecasts, scientific literature and calculations of economic loss. In different territories in all three European cities various probabilities of flood recurrence have been determined for which counter flood prevention measures are planned, designed and implemented. Territories that cause greater economic loss in case of flooding, are protected against flood with lower probability and vice versa. The lowest wind surge probability from which a great part of Belgium and the Netherlands is protected is 1: 10 000 (floods at least once in 10 000 years), whereas in Hamburg the decision was made to protect the territories that are in the impact zone of wind surges in the direct proximity to Elba River with the probability of 1:500 (floods at least once in 500 years). So the safe height marks also differ in various territories, for example in Antwerp on the banks of Schelde River it is 9.25 m, but in Hamburg it varies from 7 m to 7.80 m.

Technical protection measures are generally based on three kinds of flood prevention:

1) damming the site under protection,
2) individual protection of the site,

3) earthwork up to the level of the safe height mark.

Typical technical flood prevention elements are dams, protective walls, shutters and sluice, wind surge barriers, mobile or easy-to install flood barriers, hydro isolating fences and gates, polders, pump stations and others.

Typical individual counter flood protection elements are hydro isolating gates, door and window shutters, that are closed only in the case of flood, the use of water and crash resistant glass for the building facades and others.

For instance, in Hamburg flood prevention system polders have a great role as technical means of flood prevention. In Antwerp a 5.5km long stationary flood barrier (concrete wall) was built along the river and it is equipped with hydro isolating gate that is closed only in case of flood. According to *"Sigma plan"*, one of the most important flood prevention measures in Belgium is the establishment of Flood Control Areas. These are vacant territories on the banks of Schelde River that are allowed to flood regularly and in a controlled manner, thus considerably lowering the overall water level in the river and preventing the neighbouring inhabited areas from flooding. At the same time such territories fulfil nature conservation and recreational functions. Finally, the most characteristic element of flood prevention in the Netherlands is building hydro technological installations for closing river estuaries during storms.

The Role of Climate Change in Flood Management

Scientists all over the world share the opinion that the water level in the world's ocean and also in the North Sea will rise due to climate change. Long-term observations show that maximum water level during high tide on the SW coast of North Sea is already increasing with the speed 20 to 30 cm in 100 years. Scientists' forecasts suggest that in 2100 the water level on this coast will have risen by 50 to 130 cm. The research also shows that the climate will become warmer in future, wind surges – stronger and more frequent. Long term water level observations in the cities visited confirm this tendency.

All above mentioned will inevitably influence flooding of territories in the cities; therefore they treat the impact of climate change very responsibly. Adaptation to climate change in cities is most frequently prescribed by a separate planning document that influences the determination of safe height mark and consequently the overall flood management planning.

The Role of Territorial Planning in Flood Management

In the course of time the cities visited have come to the conclusion not to fight the water, but learn how to coexist**.** Already during city development and planning process some space in the city should be allocated to water; certain city parts and buildings, if necessary, should be adjusted to regular flooding and should be equipped with individual flood prevention elements.

Experts are working on integration of flood prevention constructions in the city environment, without degrading the city landscape and preventing the inhabitants from relaxation on the river banks. At the moment Antwerp and Hamburg cities have launched reconstruction projects with the aim to increase the height of protective constructions on river banks. The projects envisage creating high-quality public space for the inhabitants and guests of the city, which will also perform the function of a dam.

Main conclusions and recommendations

As flood management in Riga, similarly to all Latvia, is not sufficiently developed, currently the identification of flooding territories in the cities visited and in Riga is based on completely opposite grounds (in Europe institutions try to protect people from the negative impact of water, but in Riga and Latvia – waters are protected from the negative influence of people).

We have to admit that Riga city has a lot to learn from Antwerp, the Hague and Hamburg, as Riga faces similar flood threats and flood prevention management in these cities is at high level. Riga city can use the experience from the cities visited in devising flood management system and plan, in implementation and maintenance of technical flood prevention measures as well as in organizing operative measures.

When creating the flood management system in Riga city it is worth taking into account the experience of the cities visited and to explore the territory flooding caused by wind surges and intense precipitation separately.

The examples of the cities visited are very useful for Riga in choosing the probability of flood that Riga should be protected from. Even though the research of flood with the probability lower than 1:10 (at least once in 10 years) and 1:100 (at least once in 100 years) has not been necessary for Riga yet, the experience of European cities show that planning flood prevention measures for the flood with the probability once in 100 and 200 years is the least permissible.

It is worth paying attention to the approach of the cities visited and, when planning flood prevention, setting different flood likelihoods to different territories of Riga, substantiating the choice with economic calculations – flooding territories that cause greater loss, should be protected from low likelihood flood and vice versa. It is also highly important to take into account the impact of climate change.

Riga city can use the experience of European cities successfully in carrying out technical flood prevention measures, for example, construction of dams. The cities visited have examined in practice dams of different size and profile, as well as their effectiveness, safety and other significant factors.

The experience of the cities visited in territorial planning in flood impact zones is also significant.

It is equally important to develop preventive, technical and operative flood prevention measures. The experience of the cities visited shows that only and integrated approach in flood management has been successful.

Concerning the allocation of responsibility in flood management, it is more difficult to relate the experience of the cities visited to Riga, because in Belgium and in the Netherlands it is the state’s responsibility, whereas Hamburg is an independent city or a “country in the country”. In case of Latvia flood management is a shared responsibility of the country and municipality.