

## Climate Adaptation in Gothenburg - an overview

Gothenburg was founded in 1621 in a low-lying swamp area near the Göta älv River estuary, a place that was strategic but not ideal when it comes to future sea level rise and geotechnical problems. Göta älv River is the largest watercourse in Sweden and divides into two main streams north of the city. In central Gothenburg, several streams are flowing into the river. In special weather conditions sea water is pushed into the Göta älv River and water levels rise rapidly for a shorter time. During heavy rainfall, there is a risk of flooding in parts of Gothenburg. Several major landslides have occurred in the Gothenburg region. Extreme weather events will be reinforced by rising sea levels and increased precipitation, which is also a threat to the quality of raw water currently taken from the Göta älv River. In the future, Gothenburg may have major problems with heat waves and Heat Island Effect.

Adaptation to climate change has been on the agenda for a long time in Gothenburg and the responsibility to coordinate climate adaptation in the municipality lies with the City Planning Authority since 2004.

- In 2006, a local vulnerability and risk assessment analysis was made (Extreme Weather Phase 1) including a broad approach to investigate how various extreme weather conditions can affect the city.
- In 2008, a study focusing on the effects of rising sea levels was made, with estimates of the effects and costs in the low-lying area Gullbergsvass (Extreme Weather Phase 2).
- In 2010, several studies began in another low-lying area; the Free Port. This time various climate adaptation strategies were examined together with researchers and other organizations in the center Mistra Urban Futures (see other action)

For several years, there are regulations in Gothenburg on the minimum floor level for all new construction. For critical infrastructure, there are provisions with even higher margin. Most problematic, however, is to protect the existing city. Larger network stations are already secured and water treatment plants have installed additional purification steps to reduce the risk of infections from eg viruses. In the longer term Gothenburg needs to take a holistic approach to protect all threatened buildings against episodes of high sea levels. The municipality is at a crossroads between providing protection along the river or building an external protection at the outlet to the sea. The different options are now being examined thoroughly.

- A simplified pre study with a cost-benefit analysis of the two alternatives was completed in 2014. The results indicate that it is profitable to perform actions and that an external protection, if possible to implement, is a better option than protection along the river because larger areas are protected.

- A pre study on protective lock gates at the outlet of streams into the Göta älv River has also been completed during 2014. If the option of protection along the river is selected, protective lock gates and pumps are needed.
- A pre study on an external protection at the outlet to the sea was finished in 2015. The protection will require two movable storm surge barriers and pumping stations. One at the mouth of the river and one to lead water from the Lake Vänern through the other branch of the river.
- We have also fulfilled a pre study on river shelter during 2014
- In order to get more reliable information a *hydro model* is required. With a hydro model, it becomes possible to make more precise cost-benefit analysis. Various extreme weather events can be simulated as well as the effect of different measures. The model include land surface, streams, the river, the ocean and underground piping systems in integrated data models. The hydro model was completed in 2014 including four different models with 48 simulations.
- We have also completed modeling of heavy rainfall in the built up area in 2014.
- During 2014 we sat our strategy of how to protect the City in mid long term and in long term.
- A thematic Comprehensive Plan about water is ongoing and will be finished during 2017. Many of our pre studies, including storm water treatment and quality of storm water will be packed in this plan. The aim is to get all interests on the table before we go to our politicians with a decision of how to protect the City in the future.
- Parallel with this work we are now developing a method for risk analyses about flooding in detailed development plans

The cost of implementing climate adaptation measures are huge and is not economically feasible for the City of Gothenburg and many other municipalities in Sweden. Both the legal and financial responsibility for taking action are unresolved issues. The mayor in the City of Gothenburg has been lobbying at government level and we have also acted via the Swedish Association of Local Authorities and Regions (SKL) to raise the question of state responsibility.

The City of Gothenburg has also been active in several national transdisciplinary research projects on climate adaptation of urban areas (see other action). We also have an international exchange via the Making Cities Resilient Campaign and we exchange experiences in close collaboration with New Orleans (see other action).

During 2015 we participated in the ECCA (The European Climate Change Adaptation Conference) with two blocks, one together with Rotterdam and London, and another one together with Chalmers technical university.

### *More information*

Extreme Weather Phase 1 (in Swedish): <http://goteborg.se/wps/wcm/connect/202e8126-ff7c-4ef7-9161-9b57d8be71c9/OPAExtremvaderFas1.pdf?MOD=AJPERES>

Extreme Weather Phase 2 (in Swedish): <http://goteborg.se/wps/wcm/connect/15c5da78-05df-4829-b5b9-55f3f6a29ec5/OPAExtremvaderfas2NY.pdf?MOD=AJPERES>

Studies on climate adaptation strategies (in English):

<http://www.mistraurbanfutures.org/sv/projekt/klimatanpassad-stadsstruktur-scenarier-f%C3%B6r-framtida-frihamnen-pilotprojekt-2010-2011>

Cost-benefit analysis: [http://goteborg.se/wps/wcm/connect/d70cac55-13c5-404e-8846-9d0856eb4b28/Fallstudie+G%C3%B6teborg+140314\\_sv\\_mbil.pdf?MOD=AJPERES](http://goteborg.se/wps/wcm/connect/d70cac55-13c5-404e-8846-9d0856eb4b28/Fallstudie+G%C3%B6teborg+140314_sv_mbil.pdf?MOD=AJPERES)

Prestudy on protective lock gates at the outlet of streams into the Göta älv River:

[http://goteborg.se/wps/wcm/connect/dfc7ab34-1140-4954-a3d5-bb7edcb01174/F%C3%B6rstudie\\_skyddsportar\\_Rapport\\_140222.pdf?MOD=AJPERES](http://goteborg.se/wps/wcm/connect/dfc7ab34-1140-4954-a3d5-bb7edcb01174/F%C3%B6rstudie_skyddsportar_Rapport_140222.pdf?MOD=AJPERES)

ECCA conference:

<http://www.ecca2015.eu/about-ecca-2015>