Helsinki

The most functional city in the world – despite weather and climate change

Main results of weather and climate change risk assessment

Climate change in Helsinki by 2050

Temperature

- Helsinki will become warmer in all seasons, more in winter than in summer.
- In winter, extremely low temperatures will become less frequent and temperature variation will decrease.
- The highest summer temperatures will increase at the same rate as the mean temperature does.

Precipitation

- In winter, precipitation (both mean and maximum) increases substantially and there will be more rainy days.
- In summer, the mean precipitation will remain largely unchanged, while heavy precipitation events will intensify.

Sea

- The sea level will rise in the Gulf of Finland of the Baltic Sea.
- Sea ice will become thinner on average and its extent will diminish.

Wind

- On average, wind speed will remain largely unchanged.
- Uncertainty exists about the direction of change of the strongest winds.

Main weather and climate risks in Helsinki by 2050

Flooding

- The risk of urban and sea flooding will increase – economic impacts may be significant.

Biodiversity loss

- Biodiversity is threatened by several factors – combatting invasive alien species creates significant costs.

Traffic and slipping injuries

- The risk of injuries will increase in winter – road maintenance costs and injury compensations are likely to rise.

The cross-border impacts

- The cross-border impacts of climate change will reach Helsinki – security of supply must be paid attention to.

Heat-related health problems

- Heat-related health risks will increase – the well-being of the vulnerable groups must be looked after.

Storm impacts

- The risk of damages caused by strong winds and thunderstorms will not change significantly – it is still important to prepare for them.

Tick-borne diseases

- Tick-borne diseases, e.g. Lyme disease (borreliosis) will become more common – human behaviour is a decisive factor.

The risk of climate change must be considered in all decision making of the city – improved weather and climate risk management requires knowledge and adaptation measures.

Societal exposure and vulnerability factors increasing the risks

- **Urbanisation** increases flood risk.
- The increasing utilisation of **home care services for the elderly** can, in turn, increase heat stress and mortality risk.
- **Insufficient resources for anti-slip measures** increases accident risk.
- **The lack of preparedness** among urban citizens increases accident and fatality risk.
- **The outsourcing of services** can lead to lack of control which increases the need for monitoring.

Photo: Antonin Halas/Studio Halas

Key measures for climate risk management

- Incorporation of **urban green** in land use planning should be encouraged to reduce urban flood risk.
- **Road maintenance and anti-slip measures for bicycle and pedestrian routes** should be efficiently organized and resourced in winter.
- **Procedures used during heatwaves** should be developed, especially for elderly care services.
- Risks associated with the **cross-border impacts** should be investigated.
- Citizens' preparedness level for urban risks should be increased through improved **communication**.
- **Weather and climate risk management should be integrated at all levels of decision making.**

Helsinki, the capital city of Finland

- Total area: 719 km^2, of which land 217 km^2
- Shoreland (mainland): 123 km
- Islands: 315
- Population (2017): 635 000
- Population density: 2 934 inhabitants per km^2 land

Climate in Helsinki (Kaisaniemi) in 1981–2010:

- Annual mean air temperature 5.9 °C:
  - Max 30.8 °C, min −34.3 °C
  - The warmest month: July, mean temp.17.8 °C
  - The coldest month: February, mean temp. −4.7 °C
- Annual total precipitation 655 mm
  - Daily maximum 79.3 mm

References:

Pilli-Sihvola, K. et al. 2018. Sään ja ilmastonmuutoksen aiheuttamat riskit Helsingissä (in Finnish). Helsingin kaupunkiympäristön julkaisuja 2018:6. 92 p. https://bit.ly/2rFYqbd

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Helsinki

FMI

Weather and climate risk assessment for Helsinki – Summary

Reference: Pilli-Sihvola, K., Haavisto, R., Leijala, U., Luhtala, S., Mäkelä, A., Ruuhela, R. & Votsis. A. (Finnish Meteorological Institute) 2018. Sään ja ilmastonmuutoksen aiheuttamat riskit Helsingissä (in Finnish). Helsingin kaupunginympäristön julkaisuja 2018:6. 92 p. https://bit.ly/2rFYqbd

The vision of Helsinki, the capital of Finland, is to become the most functional city in the world. A well-functioning city must also take into account the impacts and consequences of weather phenomena and climate change, and aim at reducing them. These impacts affect society's ability to function, its economy, surrounding environment and people's everyday life. Due to Helsinki's location in the north, weather and climate put many constraints on the city administration's activities; and have implications on the people and organizations living and operating in the city. The changing climate poses additional challenges. Compared to the current climate, average temperatures are predicted to rise by several degrees centigrade. Changes in extreme temperatures and their duration, as well as intensifying heavy rains, will create various societal impacts. In addition, the cross-border impacts of weather and climate change, taking place in Finland and internationally, will be felt in Helsinki and may prove to be significant.

Floods and extreme winter conditions are likely to be the most important climate hazards in Helsinki. Moreover, the risks to ecosystems are considerable, particularly due to other pressures on the natural environment. Integration of the increasing climate risk into all relevant decision-making levels and situations is key in reducing risk. Land use planning and construction play a major role in reducing climate risks. Although plenty of preparedness and adaptation measures have already been implemented in Helsinki, flood risk reduction in established areas and supplementary construction should be thoroughly considered. The use of urban green and other absorbing surfaces delaying storm waters should be carefully evaluated. Flood routes should also be designed in a way to direct floodwaters from the area in a controlled manner. Urban green also reduces discomfort caused by heat. The risk of heat waves is increasing in Helsinki due to urbanisation, an increasingly densely built environment and rising summer temperatures. The cost-effectiveness of various actions should be carefully assessed and the life-cycle cost of the various measures should be determined before implementation.

In 2017, Helsinki commissioned a weather and climate risk analysis, as outlined in the climate change adaptation guidelines developed in 2017. The Finnish Meteorological Institute conducted the analysis. The assessment includes an analysis of the changing climatological conditions and analyses the exposure and vulnerability of the city and its people, infrastructure and the economy to the various climatological hazards. The following provides a brief summary of the assessment.

Flood risk will increase

Based on an assessment carried out in 2011, there are no major urban flood risk areas in Helsinki. As a result of a more densely built environment and intensifying heavy rains due to climate change, the risk of a severe urban flooding is, however, likely to increase. As the increasingly dense built environment decreases the amount of naturally impermeable surfaces, more attention needs to be paid to stormwater management. The likelihood of urban flood risk causing major damage is greatest in downtown Helsinki, located on the southern part of the Helsinki peninsula. The area has few permeable spaces, such as parks and other urban greenery, and the building density is higher than elsewhere in the city. In addition, the vast underground facilities increase Helsinki's vulnerability to flood risk. In the event that floodwaters reach the underground structures, many key functions, such as energy and heat supply, would be compromised. In the city's downtown, the economic, social and health impacts of an extreme heavy rainfall can be high. However, understanding the floodwater patters and amount of heavy rainfall required to cause flooding entails detailed modelling that was outside the scope of this

risk assessment. Although downtown is most exposed to floodwaters, the socio-economic vulnerability to floods is highest in the suburbs of Southern Vuosaari, Western Herttoniemi, Roihuvuori, Viikki, Vallila/Itä-Pasila, Maunula-Suursuo and Northern Meilahti. A more detailed and up-to-date flood risk analysis for Helsinki will be conducted in 2018.

Located on the coast of Gulf of Finland of the Baltic Sea, Helsinki has invested substantial resources in the management of sea and river flood risk. Following the major, potentially disastrous flood from the Baltic Sea in 2005, Helsinki developed a flood strategy, and assessed the use of flood protection measures at risky locations which were then gradually implemented. Sea level rise due to climate change will slightly increase the risk of sea flooding. In new residential areas, the risk is already being taken into account during the planning and construction stages. For instance, in the new Jätkäsaari residential area, the lowest construction height is 3 metres higher than its previous height when used as a port. In the old seaside areas, the risk is greater. Furthermore, the amount of people living in Helsinki's sea and river flood risk areas is small, hence, exposure is quite low. Sea flood risk is heavily influenced by the self-preparedness of real-estate owners. River flooding in Helsinki is caused by either heavy rainfall or snowmelt. Particularly, the Vantaa River and some smaller streams are potential flood hazards. Flooding has swallowed property, momentarily hindered the recreational use of the areas, and increased the flow of nutrients and other pollutants into the waterways. Climate change is expected to increase the occurrence of river floods in winter.

Winter climate will change the most

Seasonally, climate change will affect winters the most. In winter, increases in temperature will be the highest, precipitation and cloudiness will increase, and an increasing share of precipitation will fall as rain, not snow. For example, January and February will be on average approximately two degrees warmer in 2050 compared to 1971–2000, and the average temperature in March will rise above zero. Helsinki's winters will become increasingly dark and damp, the extreme cold episodes will become less frequent, and the thickness and extent of the Gulf of Finland's ice cover will decrease.

Slippery conditions on roads and sidewalks cause a significant health risk, as well as economic impacts. The risk of pedestrian slipping accidents increases when rain or snow falls on an already icy sidewalk. Although the winter season in Helsinki will become shorter due to climate change, it is likely that in the coming decades, slippery conditions may become more common in mid-winter due to temperatures hovering around zero. This will increase the likelihood of accidents, the need for resources to prevent slippery conditions and the compensation paid for injuries. Slippery conditions need also to be considered in winter cycling, as Helsinki aims to promote winter cycling and develop the winter maintenance methods for cycling routes.

Although climate change is likely to shorten the duration of winter, heavy snowfalls will still create impacts for traffic and road maintenance. Snowdrifts with more than six centimeters of snow in a day will become rarer, but the number of days with heavy snowfall (over 10 cm/day) may increase slightly compared to current levels. Freezing rain, where water is supercooled, is a very rare event in the Finnish climate. The likelihood of freezing rain will somewhat increase due to climate change, which, for Helsinki, could mean an increase in the likelihood of slippery conditions. It is difficult to estimate the effects of changing winter conditions on, for example, accident risk, due to the rapid technological change in vehicle automation and control.

Climate change reduces the amount of sunlight in the winter months, which can lead to an increasing risk of seasonal affective disorders (SAD). SAD exposes people also on physical illnesses, such as the risk of a metabolic syndrome.

Increasing rainfall in winter may cause, among other things, problems with stormwaters, increase the risk of slipping injuries as well as nutrient loading in waterways. In winter, the lack of evaporation

increases the likelihood of the effects of rainfall, compared to summer. In addition, slipping injuries and traffic risks will increase, if heavy rainfall is followed by freezing.

Heat will pose excess risks

Heat worsens the symptoms of many chronic illnesses and increases the risk of premature death for people over 75 years of age. High summer temperatures will increase in the same proportion as the average temperature. Thus, in mid-century, + 32 °C temperatures would occur on average as often as + 30 °C temperatures at end of the 1900s (assuming that greenhouse gas emissions follow the RCP4.5 scenarios, i.e. the Paris Climate Agreement is reasonably implemented). As people become older and the utilization of home care services for the elderly is increased, it is expected that the health risk of heat waves will also increase. The health and elderly care sectors should prepare for this situation. Climate change will reduce the health risk from cold and cold waves, but these risks will still be present. Risk groups must still be prepared for cold temperatures.

The risk for strong wind and thunderstorm damages will not change substantially

In Helsinki, strong winds and thunderstorms do not cause major problems with power shortages, as 96% of the electricity transmission network of the largest transmission company is underground. However, strong winds and thunderstorms cause impacts on forests and parks. For example, in the summer of 2017, stormy weather felled or damaged approximately 10,000 trees, and the trees left untouched are exposed to new damage. Many major public events also take place in Helsinki, many of which are outdoors in summer. Sailing is also very sensitive to strong winds, and strong winds may surprise particularly inexperienced sailors. The self-preparedness of event organizers and others is crucial in preventing damage and accidents.

The risk of strong winds and thunderstorms will not necessarily change significantly due to climate change. However, the decrease in ground frost in winter will increase the exposure of trees to strong winds. In Helsinki and in the outer coast of Helsinki, the average wind speeds have slightly weakened over the last few decades. Climate scenarios predict that average wind speeds will increase in Helsinki by a few percent. The frequency of strong winds and thunderstorms is expected to increase somewhat in the future, but the changes will remain small.

Tick-borne diseases will become more common

Weather and climatic conditions affect the occurrence and activity levels of ticks. Climate change is likely to increase the number of ticks and tick-borne diseases as the growing season is becoming longer. In Helsinki, the disease risk is highest in the archipelago. Ticks are found almost everywhere in Helsinki, but no exact figure on the percentage of ticks carrying pathogens exists. In Finland, 15–20% of the ticks carry Lyme disease and approximately 1.5% carry tick-borne encephalitis (TBE). A large number of Lyme disease cases is reported annually in Helsinki, and TBE cases have increased in the Hospital District of Helsinki and Uusimaa since 2010. Whilst the ticks found on the islands of Helsinki carry TBE, a vaccine exists. There is no vaccine against Lyme's diseases, but it can be treated with antibiotics. The exposure to these diseases is largely related to the behavior of people, especially leisure time activities.

Biodiversity is threatened by several factors – combatting invasive alien species creates significant costs

As Helsinki is the capital of Finland—and faces major movements and high expected population growth figures—the impacts of climate change on ecosystems and biodiversity must be considered together with urban development. The urbanization of Helsinki will reduce the amount of naturally occurring green spaces and may have a negative effect on the quality of the remaining ecosystems. In Helsinki,

nature conservation areas are small and the network of green spaces is fragmented**.** Hence, there are many disturbances to ecosystems. Rapidly changing winters will affect the living conditions of many plant species. A significant risk is that certain species are not able to adapt by moving to new areas. It is still unclear how the disappearance of species affects habitats and ecosystem functions.

Due to climate change, plant diseases and pest infestations are more likely to spread to urban trees. Climate change increases the risk of new plant diseases and pests spreading. Increasing the range of plant species and urban trees to better fit into changing climate conditions can help to reduce this risk. The impacts of climate change on introduced species risk in Helsinki has not been studied in detail. However, combatting the spread of invasive alien species creates significant costs for ecosystem maintenance in Helsinki, now and in the future.

Climate change will affect the biodiversity of the Baltic Sea and invasive alien species will remain in the Baltic Sea more easily than before. The geographic distribution of organisms is also affected by the salinity of the Baltic Sea, which may decline due to increasing precipitation. Reducing salinity can threaten the so-called keystone species which play a critical role in maintaining the structure of the ecosystem. A rise in the carbon dioxide content of the atmosphere, in turn, increases the dissolution of carbon in seawater, increasing its acidity. The acidic water dissolves calcium compounds and damages the growth of marine calcifiers which will affect food webs. Climate change may increase eutrophication, which causes, inter alia, water turbidity and oxidation of the bottom layer in the Baltic Sea. Additionally, eutrophication increases filamentous algae that replace other species. In the Gulf of Finland, the temperature rise, the increased sedimentation of seawater and the release of phosphorus from the bottom can increase the amount of poisonous blue-green algae, unless the nutrient runoff is reduced. At the end of the century, most of the Gulf of Finland will be, on average, free of winter ice, as the length of the ice winters in the Baltic Sea will reduce by an average of 1–3 months from the present. This will affect both the ecosystems in the Baltic Sea as well as shipping.

Cross-border impacts will reach Helsinki

Cross-border impacts (or transboundary effects) are the interaction chains of weather and climate variability and climate change that begin outside Finland, but eventually reach Finland. In Helsinki, cross-border impacts can also begin elsewhere in Finland and be reflected for example through agriculture. They are felt particularly through the availability and prices of raw materials and various factors of production, as well as through changing demand in the export market. Helsinki's security of supply (e.g. energy, food, etc.) is highly dependent on production and industrial activities taking place elsewhere. The availability of goods and sudden increases in price, for example due to large-scale drought, can have a significant impact on low-income citizens. The Finnish energy sector is heavily dependent on energy imports, and the development of transmission connections, the potential for cross-border impacts will further increase.

Assessing climate change-induced migration is challenging, as interlinked political and economic reasons are the main drivers of migration. However, in the long run, climate change-induced migration may affect different aspects of demography and culture in Finland. Cross-border health impacts can arise when climate change-induced diseases can travel to Finland through migration, international trade, or tourism. Tourism in Helsinki has the potential to increase, because Finland has been identified as a country whose attractiveness as a tourist destination can increase due to changing climate or deteriorating security situation elsewhere. Long-term cross-border economic impacts are difficult to estimate. Climate change is estimated to decrease global Gross Domestic Product (GDP) which will be reflected in Helsinki. This can have a wide range of impacts on the city's activities. It is difficult to estimate the reaction of international financial markets to the changing climate.

Improved weather and climate risk management requires knowledge and adaptation measures

The risk of climate change must be considered at all decision-making levels in Helsinki, from the individual citizen to preparedness at the city level. Various preparedness and adaptation measures have already been implemented. However, there are still some areas in which the growing risk should be better taken into account. In particular, the reduction and management of urban flood and heat risk, as well as the impacts on the urban nature should be improved.

Helsinki's urban flood risk is a sum of many factors, of which increasing precipitation is just one factor; reduction of impermeable surfaces is contributing to the risk substantially. Increasing flood risk, particularly in downtown Helsinki, need to be carefully modelled. Based on the modelling, risk reduction measures need to be developed. In addition, it must be ensured that various actors are prepared for the situation. Urban flood risk must also be taken into account in complementary construction. Flood risk analysis for new areas should be done already in the planning phase. The use of alternative flood risk management methods, that is, in practice, the use of urban green should be explored and their use encouraged. The implementation of flood reduction measures should have a clear time, responsible agent and a budget. Flood risk maps should be updated regularly and should include, inter alia, catchment areas and risk reduction measures already implemented. Modelling of urban runoff waters could be implemented with the Helsinki 3D city model. The model should take into account flooding of sewers and the natural management of the runoff.

The risk related to high temperatures and heat waves in Helsinki has attracted little analysis. The functionality of new and renovated buildings during heat waves should be studied. Particular attention should be paid to cooling systems, their energy efficiency and cost implications. The preparedness for heat waves in the health care services for the elderly, especially when the elderly live at home, should be carefully evaluated, and procedures to be used during heatwaves should be developed.

Urban heat island (UHI) effect is also a little studied subject in Helsinki. Its evolution as a result of urban development should be evaluated, and measures to reduce its impacts should be assessed. For example, urban green has the potential to reduce UHI, but their cooling potential in Helsinki has not been evaluated. Moreover, the winter-time heat loss of buildings and their impact on the UHI should be investigated. The impact of climate change on the UHI is a complicated research topic, because urban development is the main reason behind UHI. However, climate change can indirectly affect it. These indirect effects have so far not been studied. A better understanding of the impacts could improve the evaluation of the need adaptation measures.

In Helsinki, high traffic volumes affect traffic jams and accident rates. A significant factor is also the behaviour of humans during snow storms and heavy snowfall. Using one’s own car increases traffic volumes on roads, and the risk of car accidents is considerably increased by reckless driving behaviour that does not take into account the weather. The growing share of rail transport in Helsinki’s public transport may increase the risk related to heavy snowfalls. Long-term effects can occur if, for example, rescue and healthcare services do not have enough resources in major pile-ups, which could delay people's access to treatment.

Winter-time risks to transport can be reduced, for instance, by means of the following actions:

1) Reduction of speed limits; this may reduce the amount or damage in pile-ups and damages.
2) Anti-slippage and snow removal; particular care should be paid to snow removal from sidewalks and bicycle lanes to prevent pedestrians and cyclists from moving to car lanes. In a city, snow removal requires space reservoirs for snow, which should also be taken into account in zoning/land use planning. For example, summer-time green spaces can be used for snow storage in winter.
3) Early warnings, real time warnings, and safety cars; which can increase drivers' preparedness for the situation.

4) Provision of information on public transport services and their uses; which a can increase the share of public transportation
5) Promotion of Remote Work; which can reduce the need for travel and thus reducing exposure.
6) Future possibilities provided by intelligent transport include, for example, the regulation of winter speed limitations in urban areas and the provision of real-time information on weather conditions, changing speed limits and abnormal situations on the roads.

Proper winter maintenance and residents' own preparedness are key measures to reduce slipping injuries. The City's winter maintenance needs to be efficiently organised and resourced. The preparedness of residents can be influenced by providing prior information. In the face of increasing immigration, information should also be provided in English and possibly in other languages. In addition to providing information, the city can also distribute anti-slippage equipment for residents and provide studding for shoes.

Impacts of climate change on ecological systems, while simultaneously being under pressure from other changes in the city, should be investigated further. Generally, ecological risks can be reduced by carefully observing the changes and taking care of species diversity. The prevention of introduced invasive species, prevention is often more cost-effective and environmentally friendly than tackling the already existing harmful impacts and eradicating the species once they have become established.

The risks associated with the cross-border impacts of climate change should be investigated. This should include not only effects coming outside Finland's borders but also how dependent Helsinki is from activities exposed to climate change elsewhere in Finland. Making sure that all actors are prepared for exceptional situations increases the preparedness for the cross-border impacts of climate change.

The city administration plays an important role in risk communication, as the preparedness of residents and other actors in the city is extremely important. Significant incidents in Helsinki are mostly associated with slipperiness and snowstorms. Urban preparedness for other exceptional circumstances caused by weather or climate variability may not be at an optimal level. For example, preparedness for urban flood risk should be increased, and people should be instructed on how to act in situations where basic infrastructure and vital functions do not work. The city has at its disposal, for instance, flood instructions distributed to citizens, as well as the Helsinki safety website (https://www.hel.fi/turva/en/preparedness/), which should include information on how residents can prepare for exceptional weather conditions.

Economic efficiency of risk management and adaptation measures should be an important criterion when choosing adaptation measures. Although the need for cost-benefit analysis in assessing adaptation measures has been identified, it is rarely used. Furthermore, economic assessments should include the investments and opportunity costs of various actions over the life cycle of the investment. For example, the initial investment and option costs of green areas in a new residential area are often larger than of drainage pipes. However, in the long term, due to, inter alia, increased uncertainty caused by climate change, the life cycle costs of green areas may be lower than drainage pipes.

As the effects of climate change will increase over time, various actors in Helsinki need to pay more attention to reducing these impacts. Among other things, the growing flood and heat risk, and the increasing impacts on nature, can have significant economic, health and ecological effects. In addition to the increasing flood and heat wave risk, it should be remembered that, despite climate change, Helsinki will be a wintery city also in the future. Slipperiness and its prevention should be an important part of Helsinki's climate risk management, as slipperiness injuries create substantial costs. Overall, a proactive, cost-effective risk mitigation is the best way to make Helsinki the world's most functioning city, despite weather and climate change.