PACINAS
Public Adaptation to Climate Change

Case study cities: cost relevance of adaptation in cities

factsheet 1 2 3 4 5 6

Aim of PACINAS

The project PACINAS (Public adaptation – Investigating the Austrian adaptation strategy) addresses the costs of adaptation to climate change for the public budget and the associated macroeconomic effects. Case studies on city, provincial and federal level made it possible to estimate the current adaptation deficit and the potential future costs of adaptation up to 2050. The project focuses on adaptation costs due to extreme events such as flooding, mass movements and heat stress as well as on activity fields of the Austrian adaptation strategy (BMLFUW, 2012) with high relevance for the public budget (agriculture, forestry, water, protection from natural hazards, catastrophe management, transport, cities and urban green). PACINAS was carried out by the Wegener Center of the University of Graz in cooperation with the Umweltbundesamt, AIT and IIASA.

Adaptation-relevant expenses

Adaptation-relevant expenditures aim at avoiding or reducing current climate variability (adaptation deficit) as well as future effects of climate change on ecological, social and economic systems or exploiting resulting opportunities.

Relevance of climate change for cities and case study selection criteria

70% of Austria's population lives in cities, and the influx continues. Cities and urban areas are predominantly affected by climate change due to their large number of inhabitants, dense populations, and the concentrations of assets and critical infrastructure. Graz, Linz, Baden and Judenburg were investigated as case studies for an initial assessment of adaptation costs in cities.

In order to obtain the most comprehensive estimation of the adaptation-relevant costs, and in particular to damages already occurring, two cities with over 100,000 inhabitants (Graz and Linz) and two cities with a significantly lower population (Baden with approx. 25,000 and Judenburg with approx. 10,000) were selected. The selection criteria is based not only on size, but also on the affiliation of each city to regions of different geographical properties (terrain, altitude) and climatic zones. Graz and Linz are situated along the larger rivers Mur and Danube, Graz in the Illyrian climate zone, Linz in the Middle-European transitional climate,

Judenburg is located within the "Niedere Tauern" - mountain area in the Alpine climate zone and Baden near Vienna in the Pannonian climate zone.

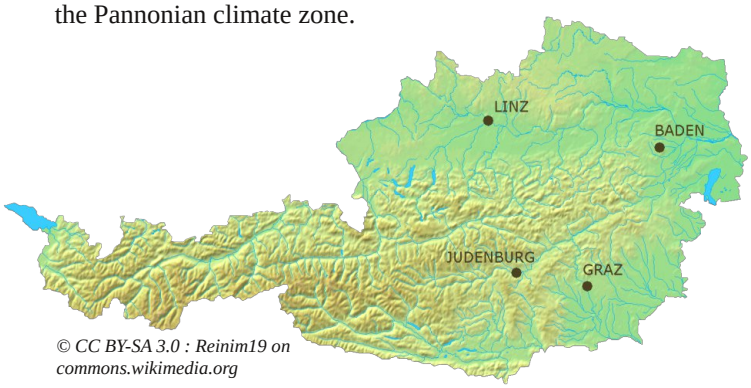

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Figure 1: top left: Baden; top right: Graz; bottom left: Judenburg; bottom right: Linz

© top left: GG Tourismus/Ovidiu Dehelean; top right; Stadt Graz/Fischer; bottom left: Stadtamt Judenburg; bottom right: Ing. Andreas Schimpl/Magistrat Linz

Method to estimate adaptation-relevant expenditures

As a first step, an analysis of selected budgetary areas addressing climate adaptation and damage repair measures was carried out for the four selected cities for the period 2001-2015, where extreme events have taken place. Publicly accessible budgetary data (*www.offenerhaushalt.at*) was used for Graz, Linz and Baden, and the budgetary data for Judenburg as well as budget details from the other cities were collected directly on site. Based on the clearance of accounts (Rechnungsabschluss), the expenses for damage recovery were identified for time periods after extreme weather

events. As far as possible, expenses for the anticipatory adaptation measures were also collected. More precisely, the ordinary and extraordinary budgets were considered to cover both the regular current expenditures and the individually planned and unforeseen, large and credit-financed expenditures.

In addition, interviews were conducted in all four cities with various representatives from the local government, some responsible for environmental, climate and energy issues, and others responsible for municipal building management, road infrastructure, for water and wastewater management, for green space management and planning, further for urban planning, for disaster and risk management as well as for financial and budget management. In this way, first quantitative and qualitative information on damage causes and costs for damage repair and partly for adaptation measures (e.g. on flood protection, on public green space improvement, replanting trees or plant nursing management) were collected. Additional information on long-term adaptation-relevant expenditures was obtained for these cities as well.

Challenges due to climate change for cities today and implications for city budget

Especially in the fields of spatial planning, land use and building management (incl. thermal refurbishment), maintenance of (local) roads, water and sewage management (E.g. renovation and adaptation of the channel network) and (to a lesser extent) lawn care and open green maintenance are cities required to deal with the already noticeable effects of climate change. Table 1 gives an overview of measures relevant for adaptation in cities as the basis of relevant fields of activity. These examples have also been used to attract the attention of city representatives on the topic of climate change impacts and adaptation to climate change:

Table 1: Adaptation measures in cities/municipalities

Examples of measures relevant for adaptationn
Green and open space
• Control, maintenance and remediation (improvement of location conditions) of city trees
• Use of "most urban" species and varieties (e.g., heat and dry tolerance, wind safety)
• Urban green space concept with step-by-step implementation (networking of green areas, balancing existing deficits in green areas)
• Planting of trees along treeless roads
• Intensive green space planning for all urban development projects
Water and waste water management
• Establishment of a rainfall retention system
• Construction of flood protection measures or flood retention basins
• Monitoring of rainfall
• Hydraulic check of the performance of the sewer network
• Expansion of the sewer network to improve hydraulic performance
• Analysis of the sewage treatment plant and its flood risk
• Precipitation water seepage in all construction measures
• Rainwater storage through retention basin
Transport
• Preferred conversions of paved tramway-routes into unpaved, green routes
• Restoration of road infrastructure
• Targeted greening of slope areas near traffic routes with root-growing plants for soil protection in case of severe rain events
• Rail and road drainage
Rescure and disaster control Organizations
• Recast and regular revision of alarm and catastrophe plans to better deal with risk and damage caused by extreme weather events
• Renewal of technical equipment for disaster control
• Catastrophe prevention training (with climate change scenario assumptions)
• Awareness raising of the population for self-sufficiency
Health
• Establishment of heat warning systems (cooperation with the country and health authorities)
• Consideration of thermal requirements, especially in new buildings of schools and kindergartens
• Publicly accessible drinking water dispensers: also in public facilities (for example, the town hall)
• Local control of newly immigrant pests

Currently, after extreme events, the focus is on damage elimination. Depending on the financial situation, some additional adaptation measures are taken to reduce the impact on future natural hazards (reactive adaptation). A distinction between pure damage repair and further adaptation measures is usually not carried out in the cities. This makes it difficult to distinguish between repair and adaptation costs.

Costs

In the annual accounts of Linz for “regular” years, costs for road construction and repair measures were about 25 - 30 M euro or 4 – 6 % of city budgets. In years with or after extreme events (heavy rainfall, floods) these costs were significantly higher reaching up to 60 M euro or 8 % of the city budgets of the respective year. The expenditures for flood protection construction show a peak in the years with or after extreme events. In Linz, the annual expenditures on flood protection construction are usually less than 1 million euro or < 0.1 % of the city budgets, while in peak years expenditures have reached 3 to 5 M euro or 0.1 to 0.8 % of city budgets. In Graz, the situation during the observation period was less serious. No pronounced peaks of expenditures in road construction and repair were observed, and the continuous increase in expenditure cannot be tied to specific events. In the case of flood protection construction, expenditures in regular years were between 0.5 and 1 M euro or < 0.1 % of the city budgets. During the peak years, expenditures of up to 3 M euro or 0.4 % of city budgets was observed. In smaller communities, the situation is similar, but varies according to topography and climate: in Baden, which is less affected by flooding, spent around 25,000 euro or 0.02 % of municipal budgets on flood protection construction during regular years. In or after years of heavy rainfall or flood events, the expenditures reached 0.1 to 0.25 M euro, which is 4 to 10 – fold of the regular value. Since the freely available funds are only a small proportion of the total budget, costs for unexpected damage repair and climate adaptation present themselves as large portions of the freely available shares.

As adaptive measures are usually taken after extreme weather events, most measures are reactive, accounting for current climate variability and spatial dimensions. The available planning guidelines are the local hazard zone plans outlining the risk of torrents, avalanches and erosion as well as flood risk. These are based on hydrological and geological-morphological investigations, taking into account previously observed extreme event impacts. Results from climate scenarios addressing possible future climate change effects are currently not included in the elaboration of hazard- or flood risk zones. To include future climate projections in detailed risk assessment would require additional studies aimed at better understanding how to cope with future climate challenges at both the regional and local level. In some cases, cities have started to deal more intensively with this topic.

Spatial planning is viewed as a key instrument for tackling the consequences of climate change through its controlling effect. Spatial planning is seen as particularly important in areas with a low potential for settlement expansion and where there is a high level of competition for land. Due to restrictions on zoning of new building land, or due to possible losses in value and the increase in the insurance risk of real estate by designation of hazard zones, there is a considerable potential for conflict between the population and the responsible policy makers.

In **wastewater management** the sewer network is a critical factor. The sewer network quality (tightness, hydraulic properties, capacity, and drainage capacity), which must be regularly checked. Costly expenditures include the construction of new sewage separation systems (separating sewage water and sewage) and the replacement of smaller pipes by ones with larger diameters, as well as capacity extensions of sewage treatment plants, which are necessary especially in the case of mixed channel systems.

Water management is a key area that has already been impacted by climate change. Measures include the erection of dams, newly constructed, reinforced or improved with new technical means. Retention basins are another measure, but tend to be expensive as lease or acquisition of the necessary land as well as compensation-payments for partial use rights is cost-intensive.

Municipal building management related to climate change, concentrates on damage repair carried out after extreme events.

Maintenance of open green spaces is gaining in importance. For example, following heavy rainfall events, the city of Baden must pay for the restoration of paths in parks and the replacement of existing trees with dry-resistant species. Furthermore, new methods for irrigation have been tested and pest control measures developed. In Graz, additional costs are also accrued through the alternative or additional irrigation of urban trees, as well as from a greater volume of green space planning effort. The use of "urban climate-robust" species requires a shift in resources and the greening of treeless roads, as a measure of cooling by shading, can entail considerable costs.

Future challenges for cities?

Some of the interviewed city officials, in all four of the cities surveyed, expect a further increase in the number of heat days, longer heat- and drought-periods, but also an increase in severe rainfall events and a correspondingly rising risk of flooding. Rising temperatures and longer heat periods result in required changes in plant selection in urban green spaces. In addition, steadily rising temperatures cause an increase in the number of air-conditioning systems, which in turn can have a negative effect on energy consumption provoking increased greenhouse gas emissions. A greater number of severe rainfall events are expected, which could in turn exceed the capacity of the sewer systems and damaging roads and walkways.

When developing and implementing adaptation measures, construction time, different periods of use, and more severe future climate impacts must be taken into account. This is

particularly the case for protective dams, retention areas, torrent control and the urban sewer network. Their implementation depends strongly on the potential risk, the current budgetary scope and the possibilities for external funding. Urban green spaces are considered to have a positive effect on urban climates. Some of the people responsible for urban green maintenance, however, do not recognize the additional costs arising from climate change effects as such. In fact, the worsening of the environmental conditions because of urban framework conditions (air pollution, sealing of the surface, deterioration of soil quality because of infrastructure installations) is often regarded as a larger, cost-causing burden.

At the moment, cities and their citizens focus primarily on climate mitigation measures (by reducing greenhouse gas emissions). Long-term adaptation measures and therefore adaptation costs are currently under-considered. As such, it is also apparent that the public authorities are increasingly appealing to citizens' responsibility for self-sufficiency.

The biggest **financial challenges** are that the cities have no way of providing reserves for future spending because of limited resources. Furthermore, the budget structure for assigning climate-relevant costs lacks transparency, and municipalities do not have a clear overview of the direct costs caused by climate change. Loans for major repairs and adjustments are covered in the extraordinary budget and are often assigned to the expenditure account "finance management" (Finanzwirtschaft), which makes it impossible to allocate annual expenditures to certain adaptation measures. Even if the annual loan repayments are allocated to the thematically correct expenditure account, the cost impacts of adaptation against damage repair remain unclear due to the relatively low annual pay back amounts. The refunds of costs from the disaster fund is, on the other side, allocated to the account "finance management" as income allocated to the ordinary budget.

What do cities focus on?

The fields of health and largely natural hazards management (in particular the handling of mass movements – e.g. landslides, mudslides, avalanches) are seen as federal or provincial tasks. Cities contribute their financial share through substantial co-financing while small municipalities must pay only little contributions for financing damage repair and adaptation measures.

In the field of health, responsibility is generally seen as province and federal issue (hospital). Exceptions are those where the city itself is owner of nursing homes, where the costs of construction and operation are borne by the city.

Key findings

A distinction between pure damage repair and further adaptation measures is usually not carried out in the cities. The cities focus mainly on damage elimination after extreme events, occasionally adaptation measures are being implemented.

Interviewed city officials, in all four of the cities surveyed, expect a further increase in the number of heat days, longer heat and drought periods, but also an increase in severe rainfall events and a correspondingly rising risk of flooding.

Long-term adaptation measures and therefore adaptation costs are currently under-considered.

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