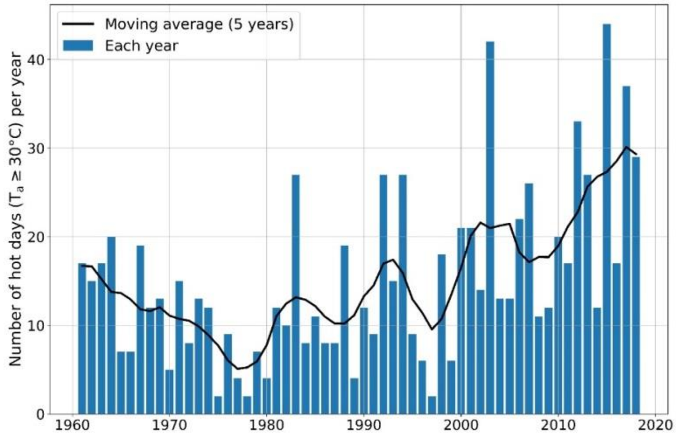
ADAPT URBAN HEAT ISLANDS

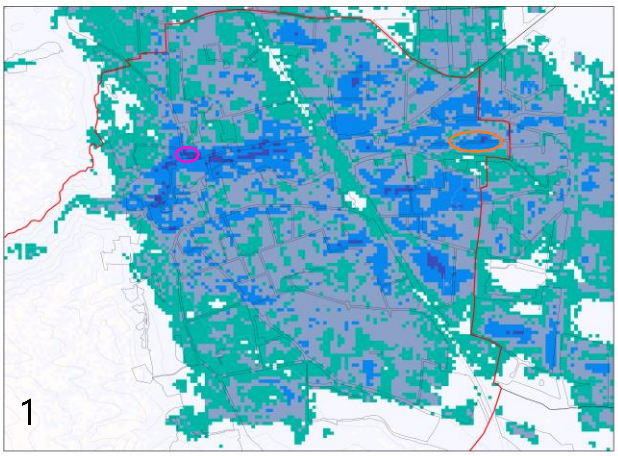
Climate Change Adaptation Scenarios for Mödling

The average number of days per year where air temperature reaches 30°C (called hot days, HD) has increased considerably over the last decades. With climate change, this warming trend is expected to continue. Hence, climate adaptation measures are needed to reduce the heat load in the region of Mödling.

Based on urban climate model results, the average value for the city is currently 15.5 HD, ranging from 3 HD in green areas and 24 HD in the city center. The effects of different adaptation measures in reducing the heat load were evaluated by comparing HD values with or without adaptation measures implemented in the model.



Observations in Gumpoldskirchen



Scenario 1 (White City): Double the reflectivity of sealed surfaces (i.e., roofs, walls and streets/sidewalks). By using lighter-colored roofing materials or brighter concrete surfaces, more sunlight is reflected & less heat is absorbed.

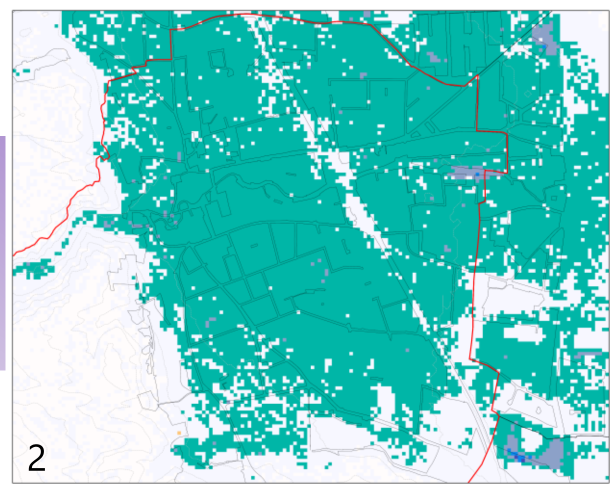
Key Findings

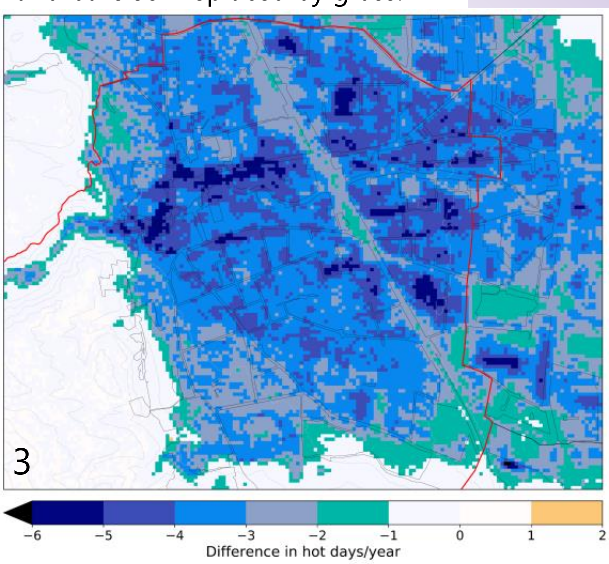
- ✓ Highest reduction is **4.5 HD**
- ✓ Freiheitsplatz would have **17.5 HD** instead of 22 HD

Scenario 2 (Green City): Increase in green surfaces to provide more evaporative cooling. Sealed areas are decreased by 30%, green roofs installed on 50% of roof areas, number of trees increased by 50% and bare soil replaced by grass.

Key Findings

- ✓ Highest reduction is **4.4 HD**
- ✓ Hyrtl Park would have **8.8 HD** instead of 11.9 HD





Scenario 3 (White and Green Combined): Increase in reflectivity of sealed surfaces and green surfaces combined. The 'cooling' effect is the largest, and almost the entire city shows a reduction in heat load by 3 HD or more.

Key Findings

- ✓ The highest reduction is **6.3 HD**
- ✓ Freiheitsplatz would have **16.2 HD** instead of 22 HD
- ✓ Hyrtl Park would have **7.8 HD** instead of 11.9 HD

For further information:

- ZAMG Urban Modelling – Scientific base for climate sensitive urban planning, ZAMG, 2017

International Institute for Applied Systems Analysis IIASA www.iiasa.ac.at
ZAMG
powered by klima+ energie fonds
ipak
umweltbundesamt ENVIRONMENT AGENCY AUSTRIA

ADAPT URBAN HEAT ISLANDS

What Adaptation Measures are Implemented?

Different climate change adaptation measures can be implemented in a city. Below is a list of individual measures that were evaluated with the urban climate model and their grouping together to form Scenario 1 (White City – increasing reflectivity of surfaces), Scenario 2 (Green City – changing the evaporation of the surface) and Scenario 3 (Combined – reflective and green surfaces). The model results are shown in terms of the reduction in the percentage and number of hot days for each measure and scenario.

Adaptation Measure	Description	Illustration	Average Reduction in Hot Days	Largest Reduction in Hot Days
Double roof albedo	Increase the reflectivity of the roof, e.g., use lighter roofing materials		5.8% (1.0)	10.0% (2.2)
Double wall albedo	Increase the reflectivity of the wall, e.g., paint the wall a lighter color or use a lighter rendering		3.1% (0.5)	7.1% (1.6)
Double street albedo	Use more pervious, brightly-colored paving or paint the streets lighter colors		3.8% (0.7)	9.9% (2.3)
Decrease sealed areas	Implement grassland instead of paved areas in the city		2.0% (0.3)	5.2% (1.2)
Increase green roofs to 50%	Add green roofs to 50% of buildings in suburban areas of Mödling	 [1]	1.9% (0.3)	7.3% (1.0)
Increase in number of trees by 50%	Plant more trees in public areas		2.1% (0.4)	21.7% (3.8)
Decrease unvegetated, pervious areas	Add grass to bare soil areas in the city		2.4% (0.4)	15.3% (1.8)
White City (Scenario 1)	Increase reflectivity of roofs, walls and streets	 [2]	13.2% (2.3)	20.3% (4.5)
Green City (Scenario 2)	Decrease sealed areas, add green roofs, increase trees and vegetated, pervious areas		7.8% (1.4)	25.1% (4.4)
Combination (Scenario 3)	Implement all adaptation measures from the White and Green City	 [3]	20.0% (3.5)	34.4% (6.3)

For further information:

- Stadtverkehrsflächen – Optimierter Beton für den innerstädtischen Bereich, Peyerl M., 2018
- Bäume kühlen Städte wie natürliche Klimaanlagen, botanikguide.de, 2018
- Weiße Dächer kühlen heiße Städte, n-tv.de, 2019
- Warum Wien mehr grüne Dächer braucht, energieleben.at, 2019

Photographs

1. Flickr @Grand River Conservation Authority
2. Flickr @Harvey Barrison
3. https://talkofthecities.iclei.org/paradoxes-of-a-smart-city-3-open-data-vs-data-management/

IIASA International Institute for Applied Systems Analysis www.iiasa.ac.at

ZAMG

powered by klima+ energie fonds

IPAK

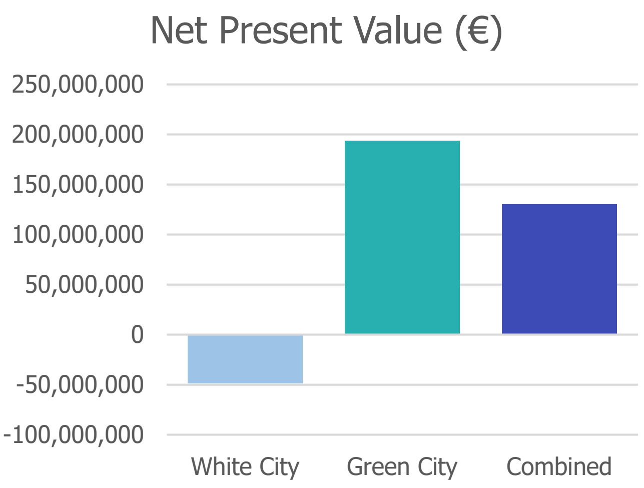
umweltbundesamt ENVIRONMENT AGENCY AUSTRIA

ADAPT URBAN HEAT ISLANDS

A Cost-Benefit Analysis of Climate Change Adaptation for Mödling

A cost-benefit analysis involves comparing the costs of implementing climate change adaptation measures with the benefits that these measures produce. We can quantify the benefits in monetary terms by taking reduced mortality, hospitalization and worker productivity loss as well as numerous ecosystem services such as habitat creation, stormwater management, heating and cooling savings, pollution and carbon reduction, improved aesthetics and longevity of buildings into account.

A cost-benefit analysis was undertaken for Scenario 1 (White City), Scenario 2 (Green City) and Scenario 3 (White and Green combined) for the city of Mödling. The results show that Scenarios 2 and 3 yield the highest benefits to society. Scenario 1 also results in benefits such as reduced mortality, morbidity and worker productivity loss, but no other societal and ecological issues are addressed with this scenario.

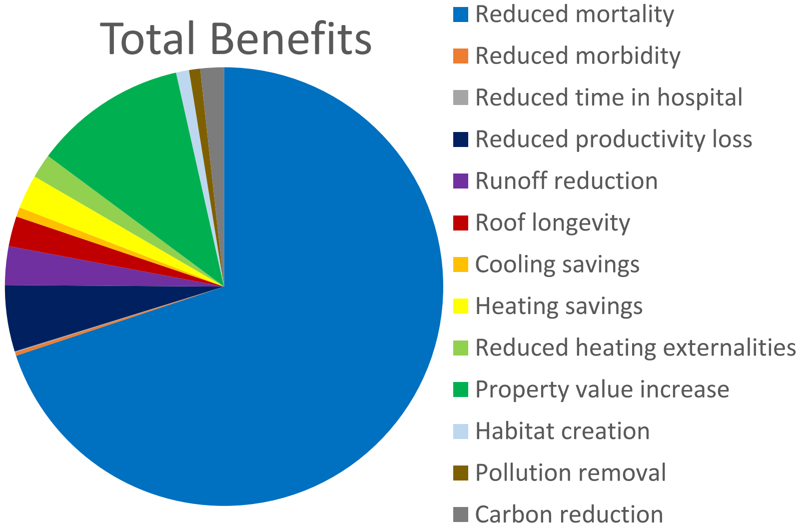


The main indicator for the cost-benefit analysis is the **Net Present Value**.

Net Present Value = total present value of all benefits minus the present value of all costs discounted over a 50-year time horizon.

Both Scenario 2 (Green City) and Scenario 3 (Green and White combined) result in high net present values. Thus, both scenarios indicate a **net benefit to society**.

To the right, we show the total benefits for Scenario 3 (Green and White combined).



Key Findings

- ✓ Reduced heat-related mortality results in the highest benefits to society.
- ✓ The increased provision of ecosystem services results in €142 million or 25% of the total benefits for Mödling.

By implementing climate change adaptation measures, particularly those associated with the Green City such as surface unsealing and the addition of green roofs, trees and vegetated areas, Mödling can aid stormwater management, increase biodiversity, reduce heating and cooling costs, reduce pollution and carbon emissions, and increase the value of buildings and their longevity. These are all benefits that the residents of Mödling will value in the future.

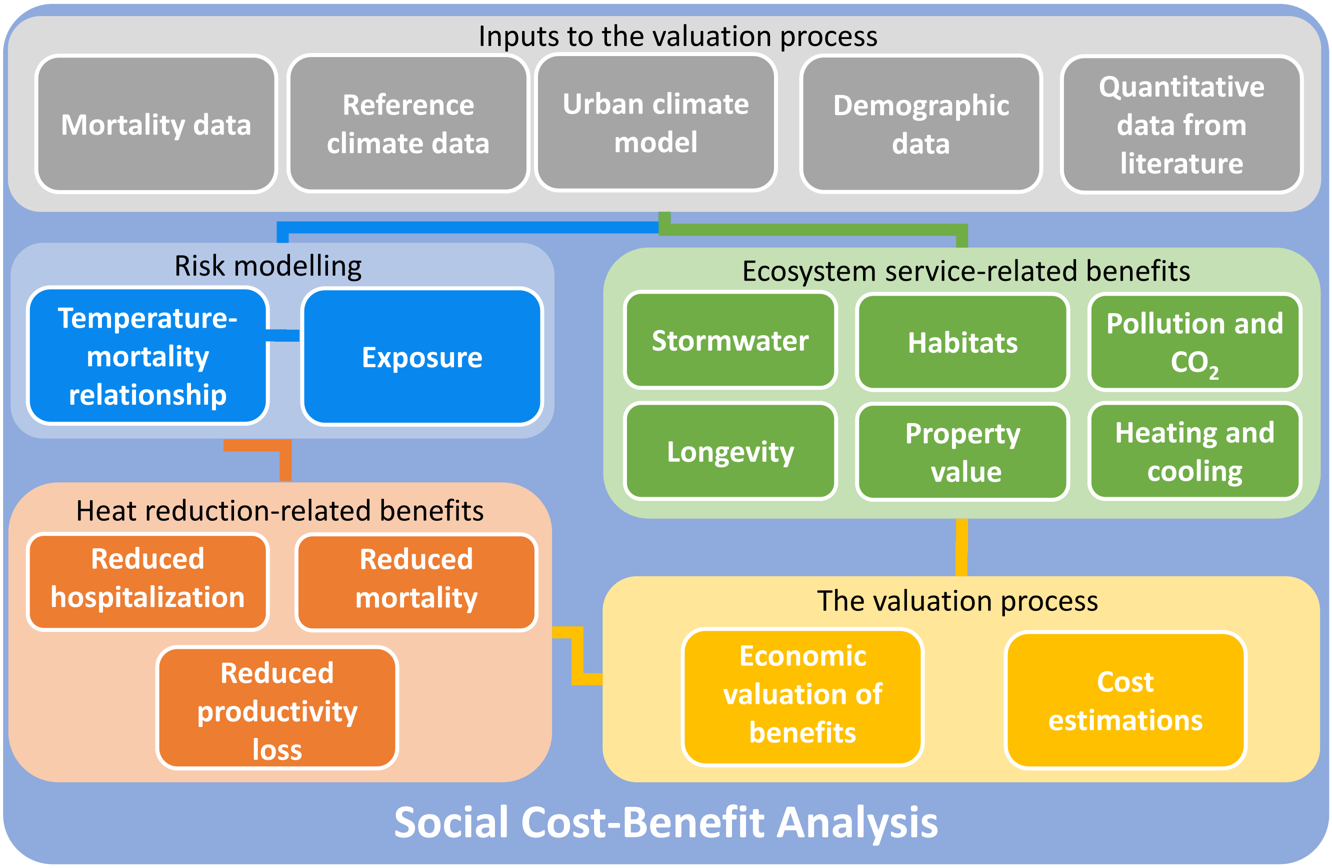
International Institute for Applied Systems Analysis IIASA www.iiasa.ac.at
ZAMG
powered by klima+ energie fonds
ipak
umweltbundesamt ENVIRONMENT AGENCY AUSTRIA

How do we Value the Benefits of Climate Change Adaptation?

ADAPT URBAN HEAT ISLANDS

Below we illustrate how **social cost-benefit analysis** is undertaken, in particular how we value the benefits associated with the implementation of climate change adaptation measures.

We start with input data from a variety of sources including mortality, climate and demographic data. We then use these inputs to produce a temperature-mortality relationship from which we can quantify the exposure of Mödling residents to extreme heat.



We then consider two main types of benefits. The first are **heat-related benefits**, which include reduced mortality, hospitalization and worker productivity loss. We calculate the economic benefits as a result of the reduction in the number of hot days after implementing climate adaptation measures. For example, on a hot day, worker productivity is reduced by around 7% on average. With an average reduction of 1.7 hot days in a year, Mödling saves an estimated €1.3 million in annual gross regional product while €1.8 million is saved in hospitalization costs.

The second are **ecosystem service-related benefits**, which result from the implementation of green measures such as green roofs, unsealing of paved surfaces, adding more trees and vegetated areas, etc. For Scenario 3 (Green and White City combined), we have determined the value of the ecosystem service benefits for Mödling over the next 50 years as follows:

- ✓ € 16 million in reduced stormwater runoff
- ✓ € 13 million in reduced replacements of roofs due to the longevity of green roofs
- ✓ € 65 million in increased property values
- ✓ € 5.5 million in additional habitat space
- ✓ € 15 million in pollution and carbon dioxide (CO_2) reduction
- ✓ € 18 million in heating and cooling savings

We then calculate the costs associated with the adaptation measures and compare these to the total value of all benefits. For Mödling, implementing climate change adaptation measures is beneficial!

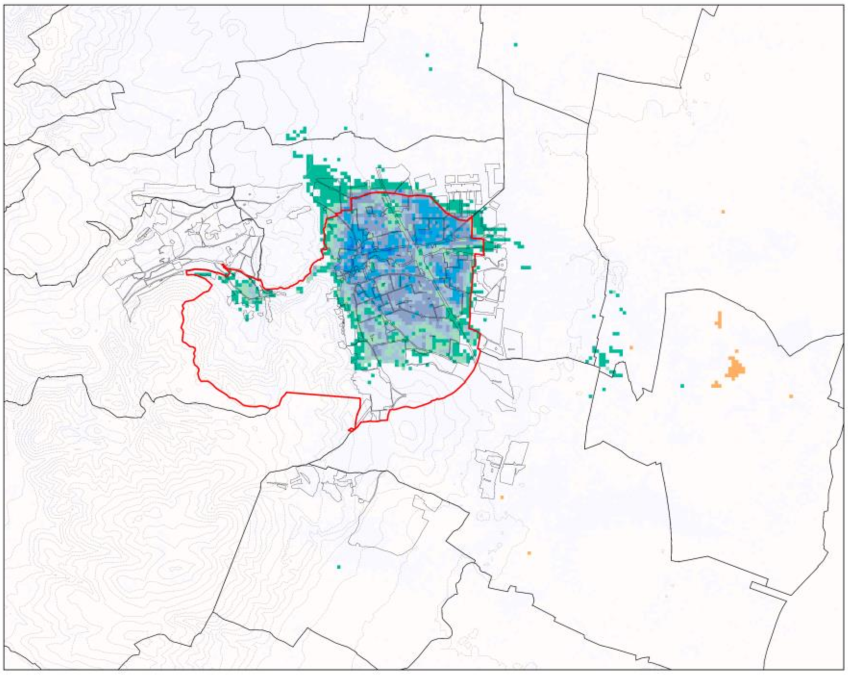
International Institute for Applied Systems Analysis IIASA www.iiasa.ac.at
ZAMG
powered by klima+ energie fonds
iPAK
umweltbundesamt ENVIRONMENT AGENCY AUSTRIA

ADAPT URBAN HEAT ISLANDS

Extending Climate Change Adaptation to Neighboring Areas

Climate change does not stop at political boundaries. Other municipalities are also affected by increased Hot Days (HD), ranging from 3 HD in green areas to 29 HD. Instead, there are many benefits in working with neighboring districts to combat climate change together.

Here we show the cooling effect of the combined adaptation measures (Scenario 3) if all the surrounding municipalities of Mödling would implement the proposed measures compared to local implementation in the city of Mödling only.



The figure on the left shows the reduction in heat load in the city of Mödling and neighboring municipalities when the combined set of adaptation measures are implemented only in the city of Mödling.

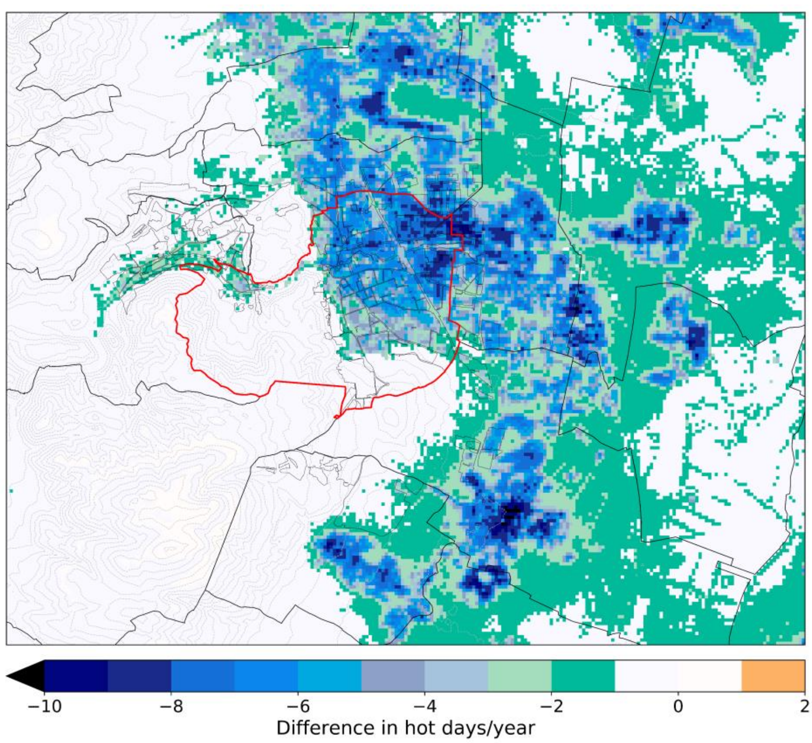
Key Findings

- ✓ Minor or no cooling effect can be seen in the neighboring areas
- ✓ Maximum reduction is 7.2 HD, similar to Scenario 3 considering only Mödling

The figure on the right shows the effect of the combined adaptation measures implemented in all municipalities of Mödling district. The intensity and spatial extent of the cooling is enhanced.

Key Findings

- ✓ The maximum reduction in the number of HD reaches **9.5** in Mödling (inside the red border)
- ✓ The maximum reduction is 11.1 HD across the whole area (located in Guntramsdorf)



International Institute for Applied Systems Analysis
IIASA www.iiasa.ac.at
ZAMG
powered by klima+ energie fonds
iPAK
umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA