



# Nature- Based Solutions for Urban Resilience

---

by Julia Knollmann, Jenni Ottilie Keppler,  
Laila Heising, Ipek Genc, Alina Haenler,  
Felix Faller and Deira Linke

26 March 2021



# Structure

## A. Analysis

1. Global climate urban risks and their impacts
2. Defining (Urban) Nature-based Solutions
3. Nature-based solutions and their impacts on urban climate risks
4. Examples of mentioned NbS

## B. Case study – Istanbul

5. Case study: Urban climate risks and impacts on Istanbul
6. NbS for Istanbul
7. Evaluation of NbS



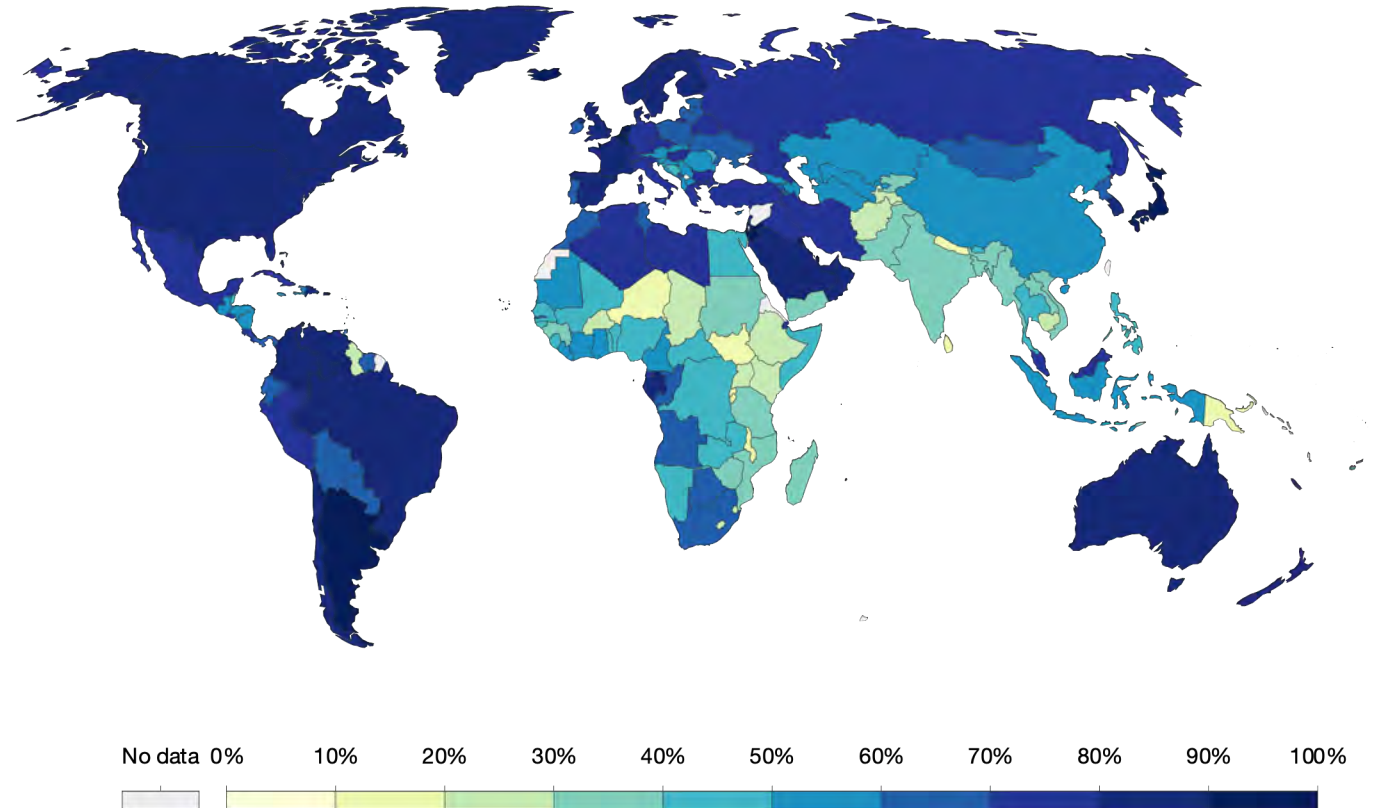
Why nature-based solutions for urban resilience?

---

## Global climate urban risk and impacts

- 55 % of the global population lives in urban areas
- To mitigate and adapt to the consequences of climate change is one of the greatest challenge's society faces today

Share of people living in urban areas, 2017



Source: UN World Urbanization Prospects (2018)

Note: Urban populations are defined based on the definition of urban areas by national statistical offices.

OurWorldInData.org/urbanization • CC BY

Source: <https://ourworldindata.org/grapher/share-of-population-urban>, last access 24.03.2021



What are  
climate related  
drivers of  
impacts?

What are  
climate related  
drivers of  
impacts?



Warming  
trend



Extreme  
temperature



Drying  
trend



Extreme  
precipitation



Ocean  
acidification



Snow  
cover



Damaging  
cyclone

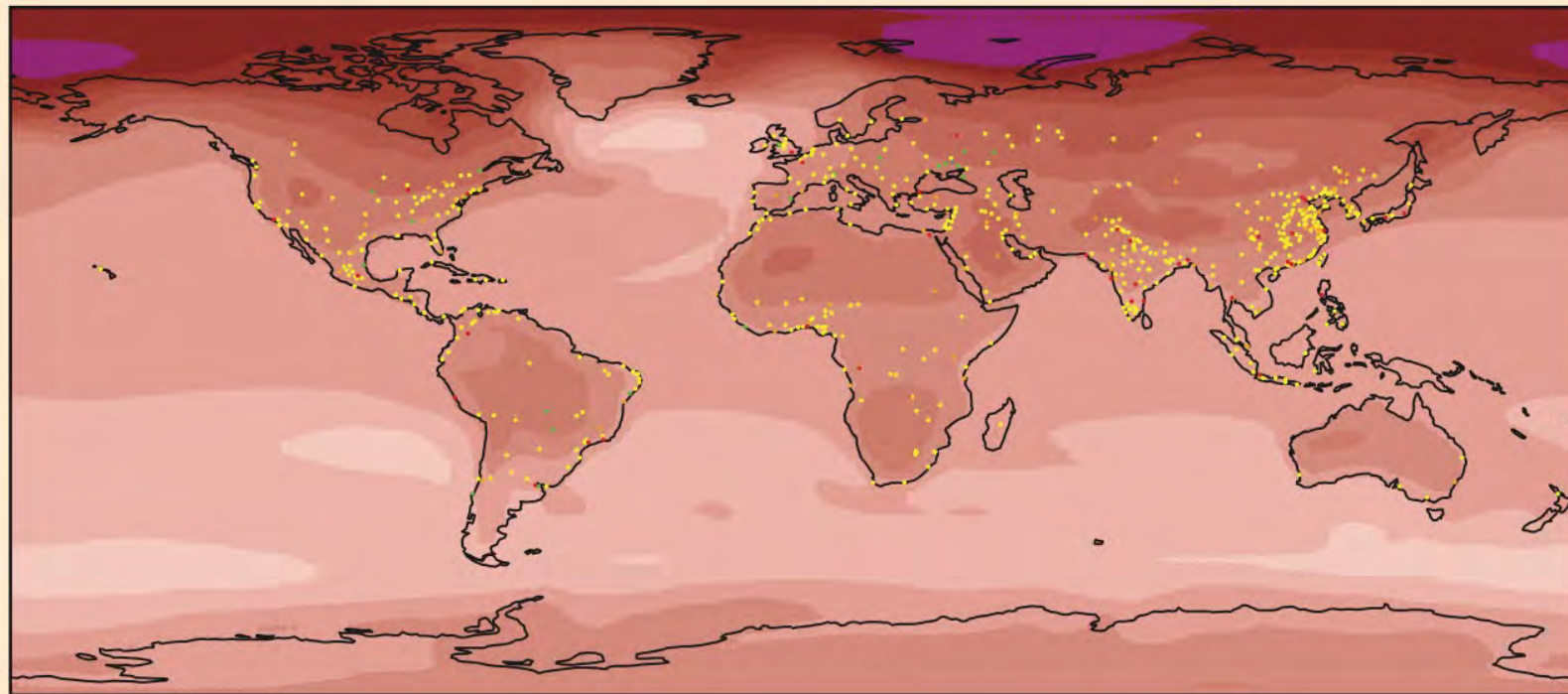


Sea  
level



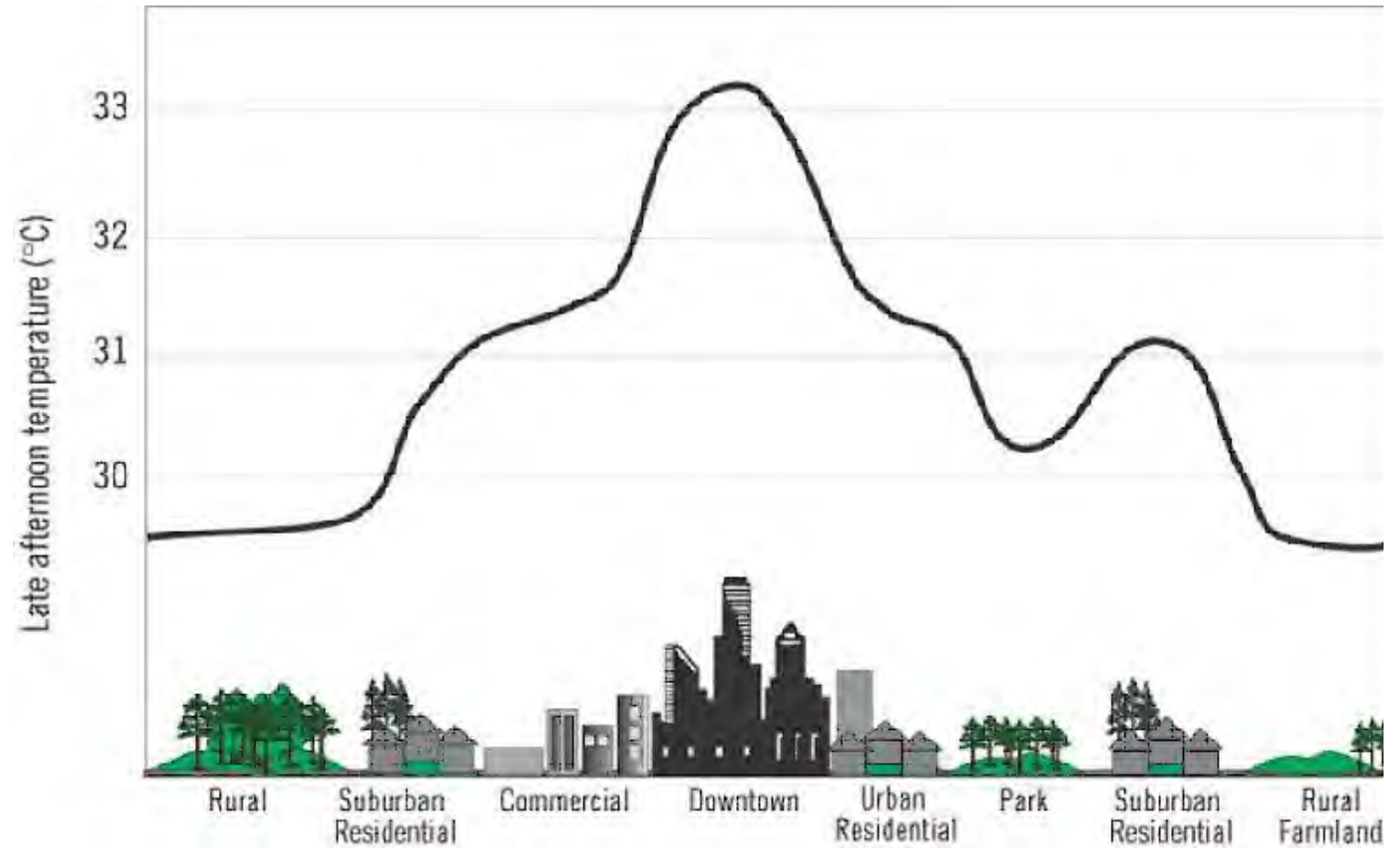
Flooding

# Urban agglomerations 2025 with projected climate change (RCP8.5)



# Urban Heat Island Effect

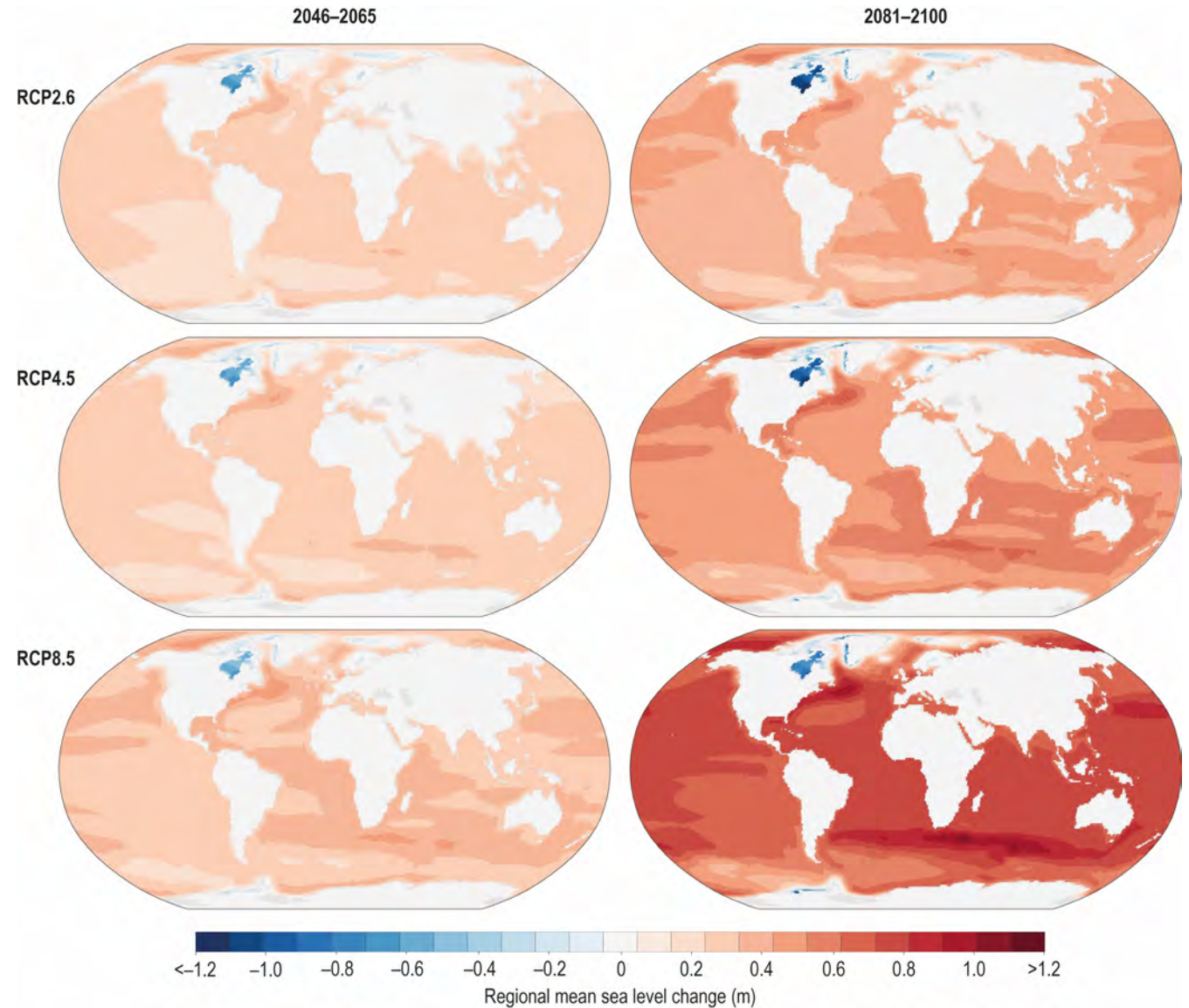
- Experience higher temperatures than the outlying areas and cool down slower
- Structures (buildings, roads, and other infrastructure) absorb and re-emit radiation more than natural landscapes (forests & water bodies)
- major problem of urbanization





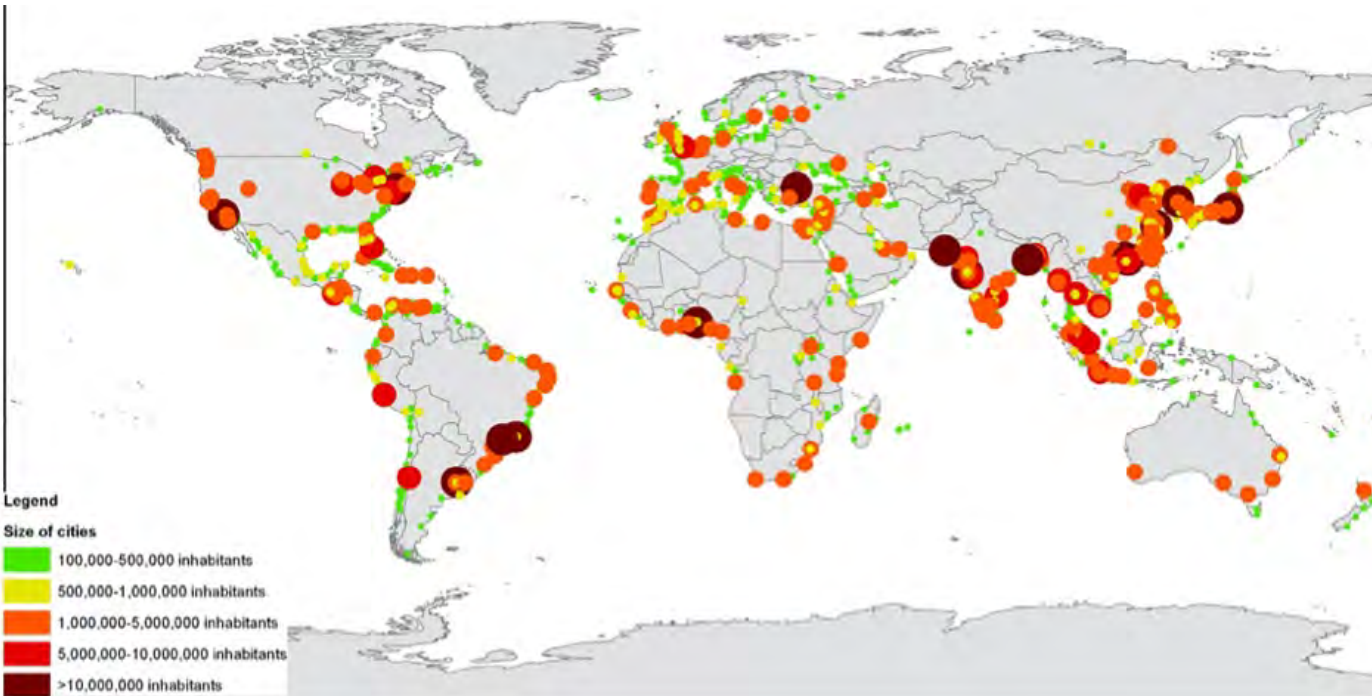
## Sea level rise

- Caused by the thermal expansion of ocean water and ocean mass gain induced by climate change
  - Accelerating over time and will become more common by 2100 under all emission scenarios
- Severe flooding

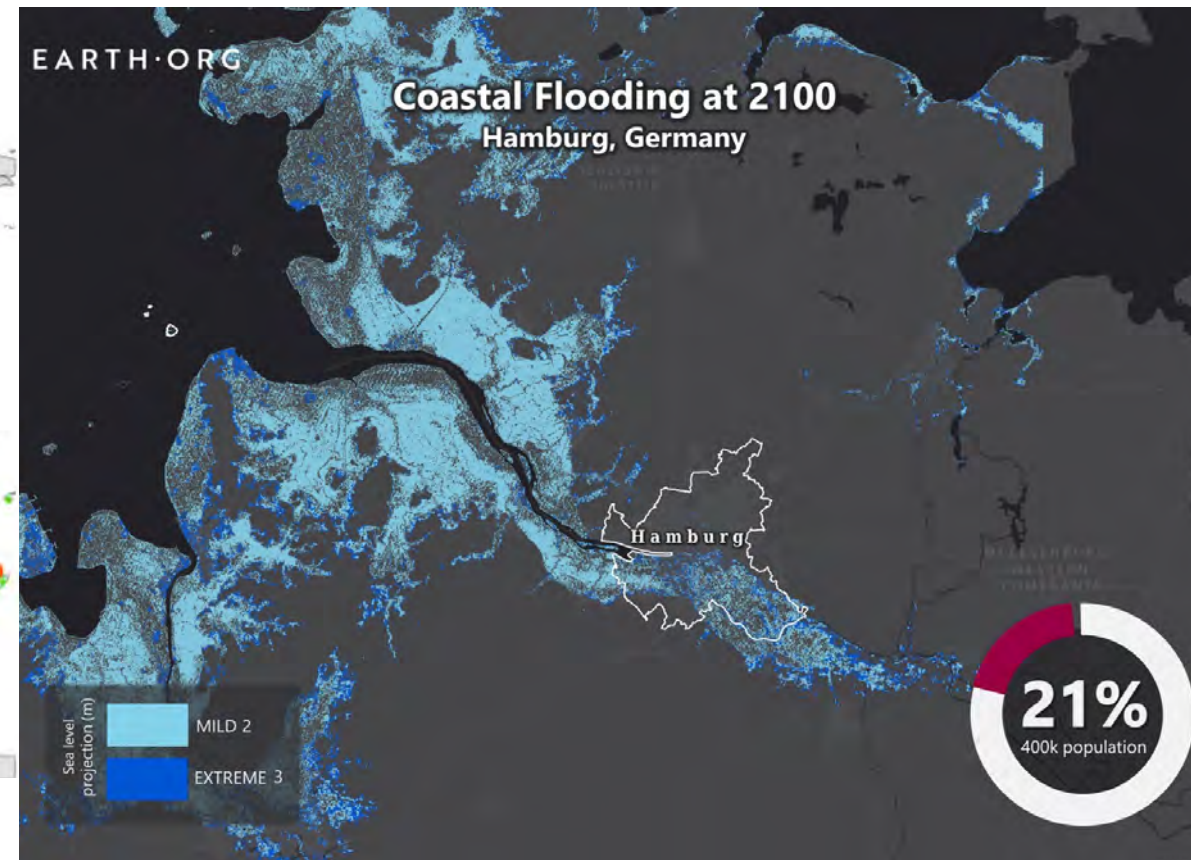


# Coastal cities

Future risks for low-lying coastal cities



Source: Barragán, J. M., & de Andrés, M., 2015



Source: [https://earth.org/data\\_visualization/sea-level-rise-by-2100-hamburg/](https://earth.org/data_visualization/sea-level-rise-by-2100-hamburg/), last access 24.03.2021

Defining  
(Urban)  
Nature-based  
Solutions

---



# IUCN framework for NbS

## 1. Definition by IUCN:

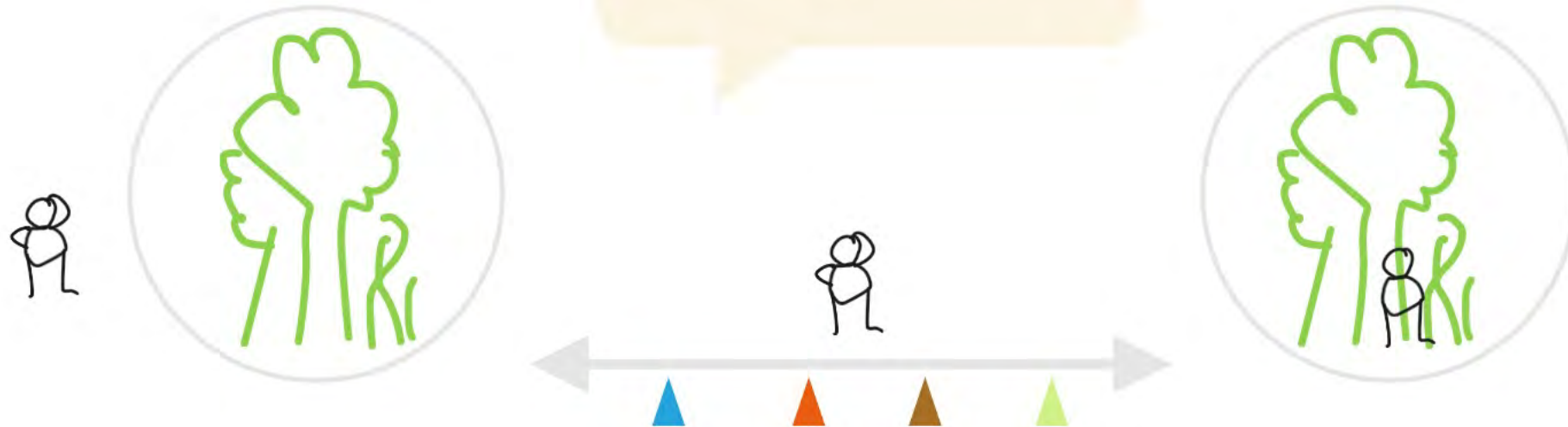
Nature-based Solutions are defined as “actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”

– Umbrella concept for ecosystem-related approaches —>



Figure 6. NbS as an umbrella term for ecosystem-related approaches

# What or Who is Nature anyway?



# What or Who is Nature anyway?



# Features specific to urban areas



Image: Melbourne Sprawl – <https://bit.ly/39dJyU>

high population density

NbS are embedded in social system

environment dominated by built, non-living (infra)structures

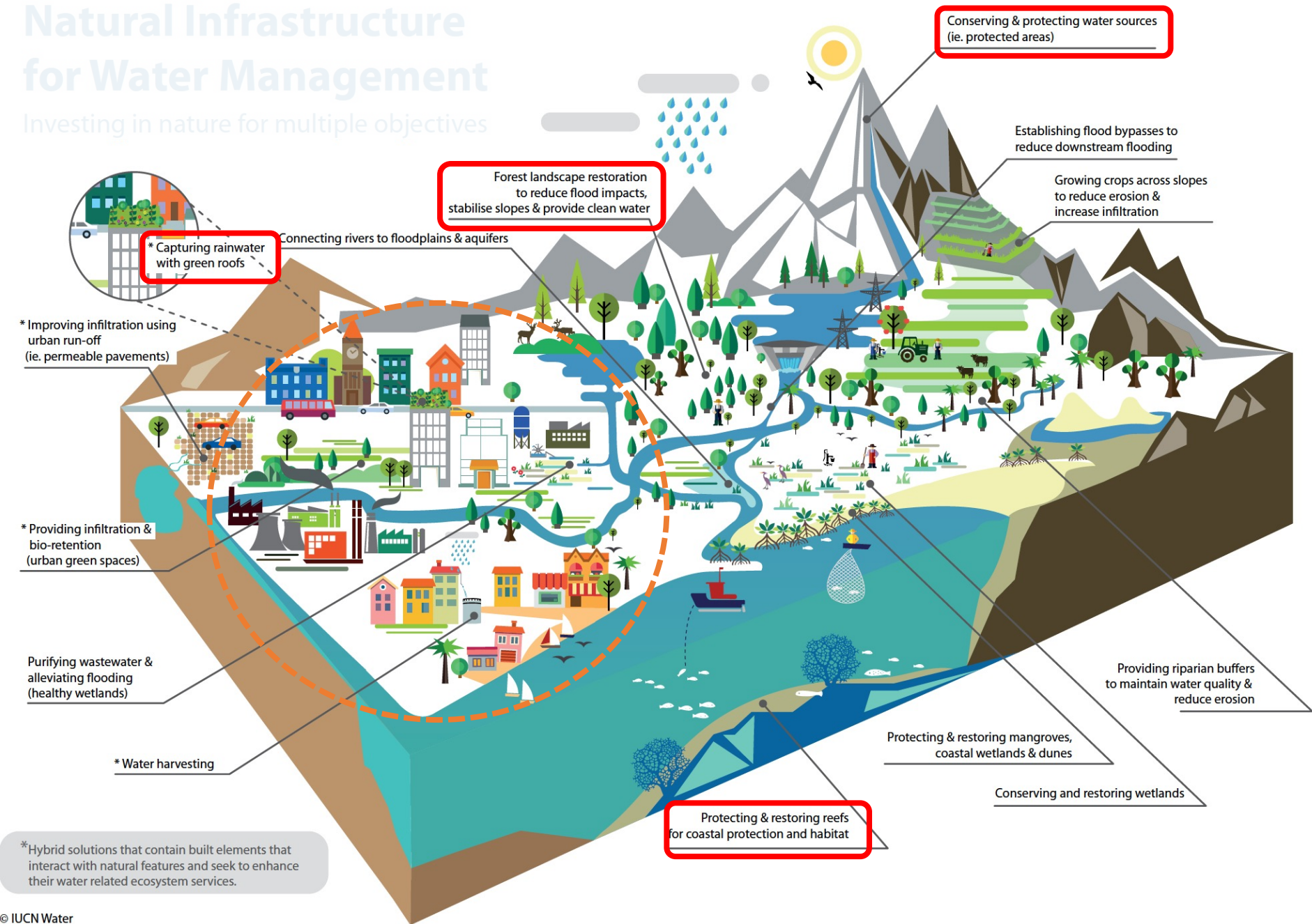
living structures are highly fragmented

few opportunities to observe and engage with natural processes

# Urban or peri-urban?

## Natural Infrastructure for Water Management

Investing in nature for multiple objectives



© IUCN Water

Source: IUCN (as part of 'WISE-UP to Climate' project). See <http://www.iucn.org/theme/water/our-work/wise-climate>

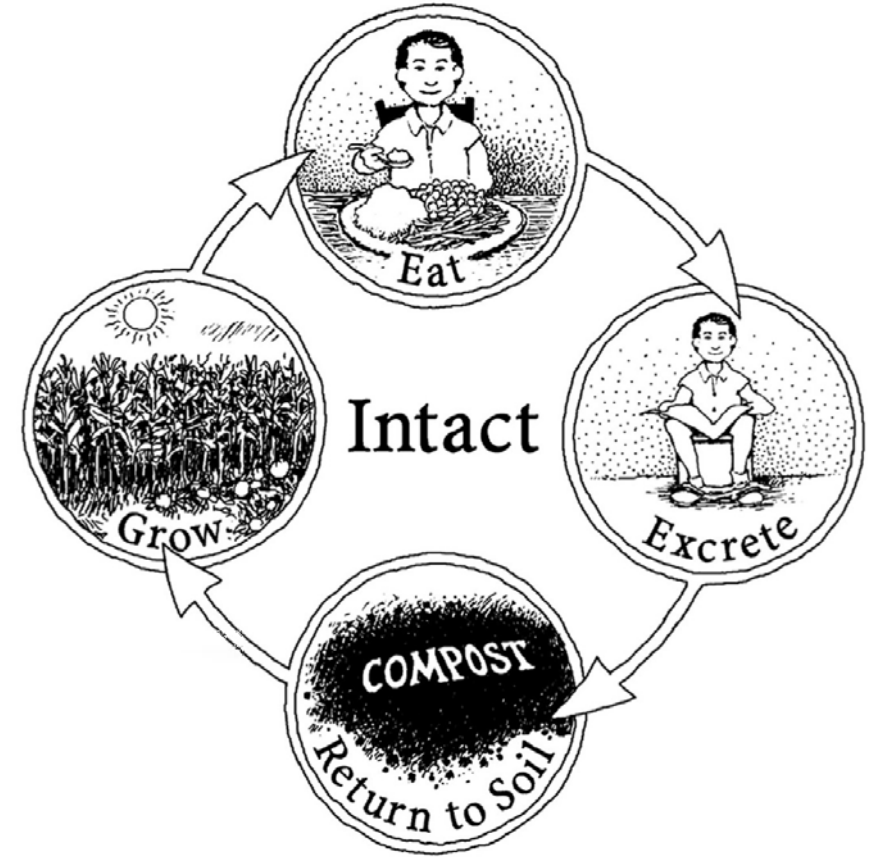


# Human or nature or humanure?



— less than 2% of 2.8 billion tons of organic waste from cities are looped!

— if we are part of nature, we need to fix that!



The Human Nutrient Cycle is an endless natural cycle. In order to keep the cycle intact, food for humans must be grown on soil that is enriched by the continuous addition of organic materials recycled by humans, such as humanure, food scraps and agricultural residues. By respecting this cycle of nature, humans can maintain the fertility of their agricultural soils indefinitely, instead of depleting them of nutrients, as is common today.

# Our definition



## Urban Nature-based Solutions (UNbS)

are actions based on **natural processes** to address societal challenges, providing benefits for both human well-being and biodiversity **resilience in highly fragmented and densely populated built environments.**

They increase against impacts from extreme events, supporting and creating **regenerative and self-sustaining capacity** of the city.

Specifically, they involve the creation, protection, restoration or management of natural and semi-natural **ecosystems in and around the city.**

Actions and interventions are based on **trans-disciplinary approaches** designed and implemented with the **participation** of local communities and Indigenous Peoples.

# NbS and their impact on urban climate risk

---

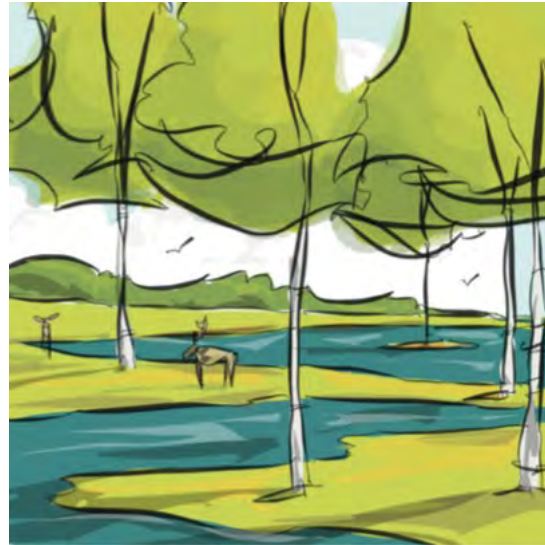


### 3.NbS on the watershed scale and their impact on urban climate risk



Land conservation

Cooling effect  
Risk reduction of droughts



Wetland and floodplain restoration and protection

Flood prevention  
Increases biodiversity



Greenways

Linkage of habitats  
Precipitation uptake

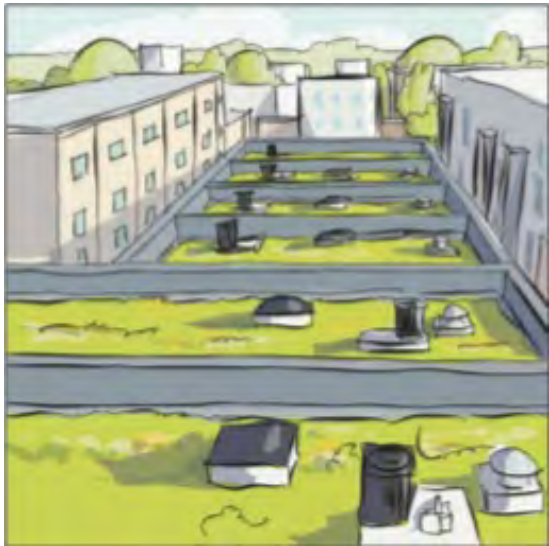


Source: FEMA RiskMAP

Stormwater parks

Treating floodwaters  
Improved water quality

# 3.NbS on the site scale and their impact on urban climate risk



Green roofs and rain gardens

Cooling effect  
Rainfall uptake



Rainwater harvesting

Drought protection  
Extreme precipitation



Permeable Pavement

Precipitation uptake  
Reduced flood risk



Source: FEMA RiskMAP

Tree Canopy and Tree Trenches

Extreme weather protection  
Protection to extrem temperatures

# 3. NbS on costal areas and their impact on urban climate risk



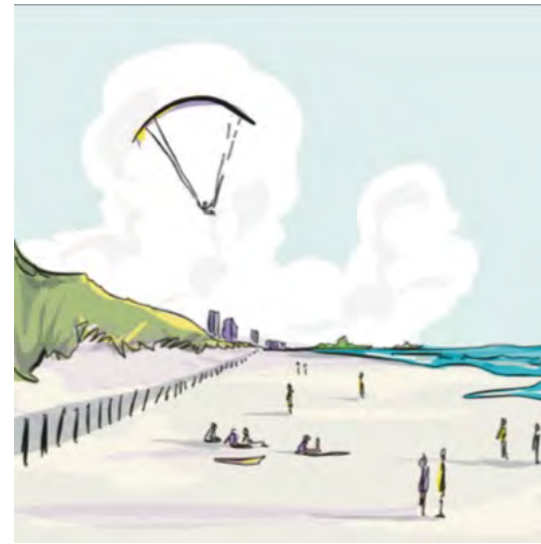
Costal Wetlands and Mangroves

Storm protection  
Increased biodiversity



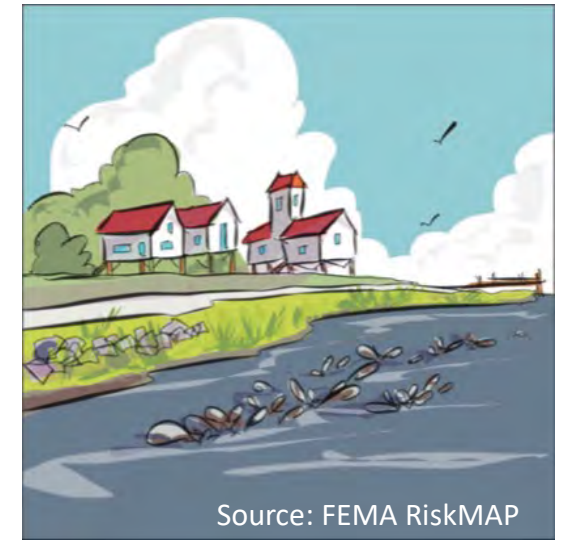
Waterfront Parks

Flood protection  
Increases biodiversity



Dunes

Sea level rise protection  
Protection from extreme weather



Source: FEMA RiskMAP

Living Shorelines and Oyster Reefs

Reduced erosion  
Improved water quality

## 3.NbS and their co-benefits



Impact on urban climate risk

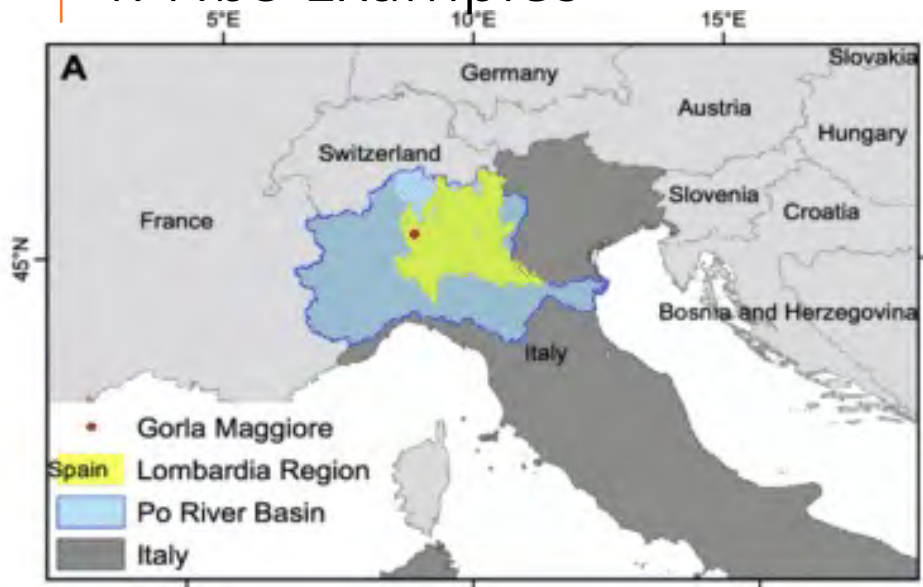
Flood prevention  
Cooling effect  
Increase biodiversity  
Increased air quality

Co-benefits

New recreational site  
Health benefits for citizens  
Increased social cohesion  
Increase life quality

Source: Ramboll Studio Dreisteil

# 4. NbS Examples



Gorla Maggiore Water Park (Source: ResearchGate, 2021)



## 4. NbS Examples

---

- Project duration: 2008 – 2013
- Project cost: 500 000 - 2 000 000 EUR
- Financing sources: Public regional budget, Private Foundation



Pond in Gorla Maggiore Water Park  
(Source: Fabio Masi, 2018 in Naturvation, 2020)



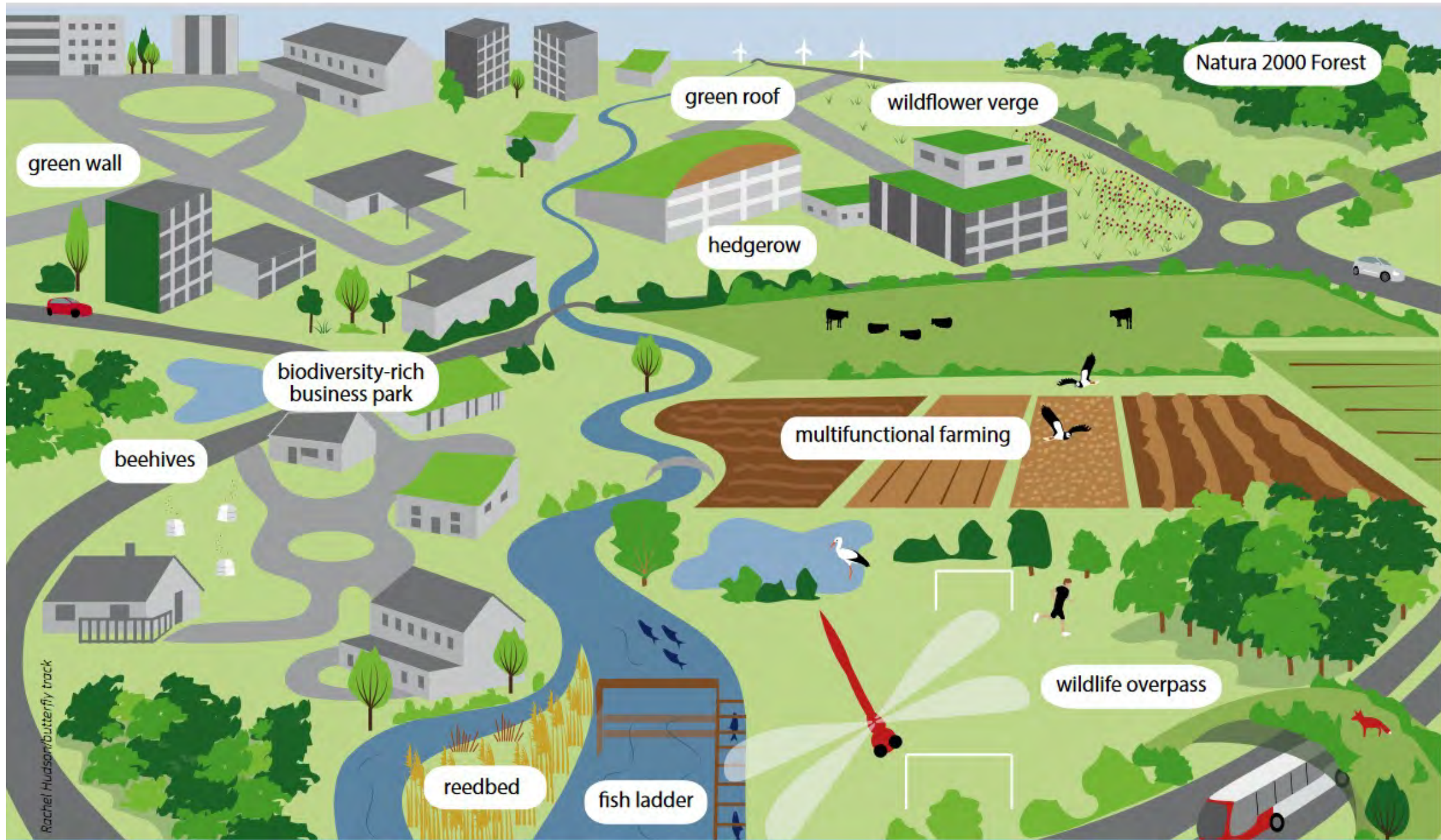
## 4. NbS Examples

---

Constructed Wetland in Gorla Maggiore  
Water Park

Source: Fabio Masi, 2018 in Naturvation, 2020





Potential components of Green Infrastructure (Source: European Union, 2013)

## 4. NbS Examples



Green design for Londons Roofs

Source: Arup in Enzi et al., 2017

## 4. NbS Examples

---

Zero-emission Boutique Hotel  
Stadthalle, Vienna





## 4. NbS Examples

---

Living Wall, Vienna



## 4. NbS Examples

---

### Sengkang Floating Wetland





## 4. NbS Examples

### ABC Waters Programme in Singapore

- Completion Date: 2010
- Site Area: 2500 m<sup>2</sup>
- Project cost: SGD 8.000.000 SGD  
--> 5.044.340 €
- Financing: the national water agency Singapore (PUB)



## 4. NbS Examples

---

### Sengkang Floating Wetland

Source: PUB Singapore's National Water Agency, 2021





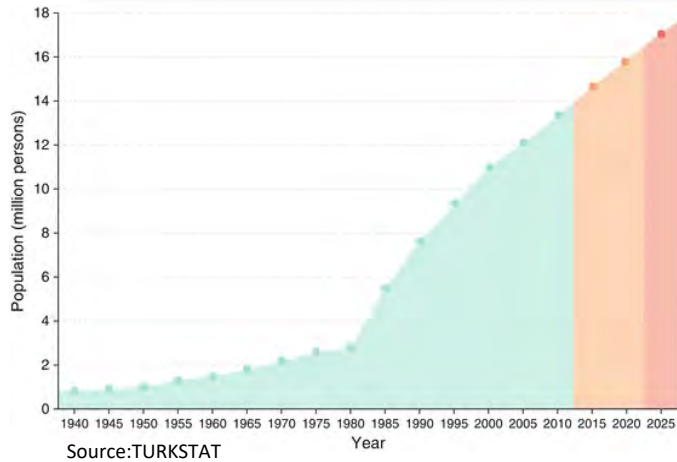
## B. Implementation

5. Case study: Urban climate risks and impacts on Istanbul

6. NbS for Istanbul

7. Evaluation of NbS

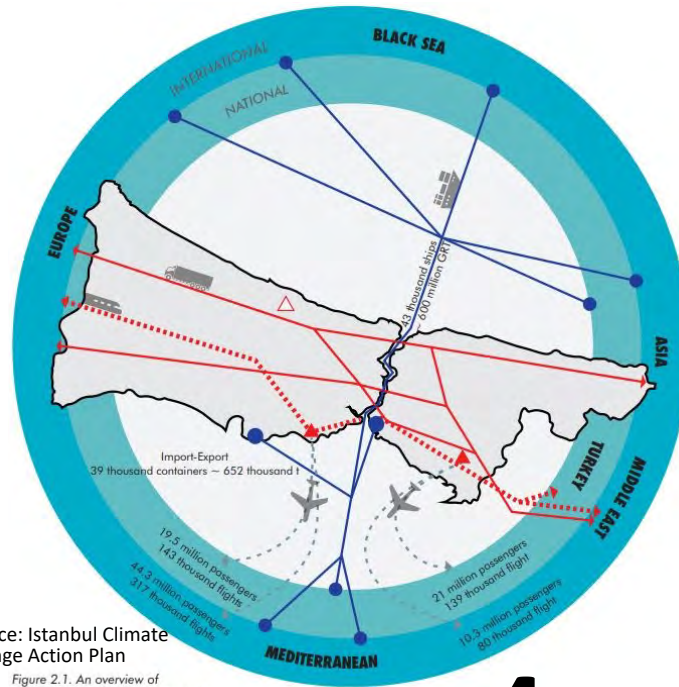
# 5. Case study: Urban climate risks and impacts on Istanbul



**1**  
15.46 million people

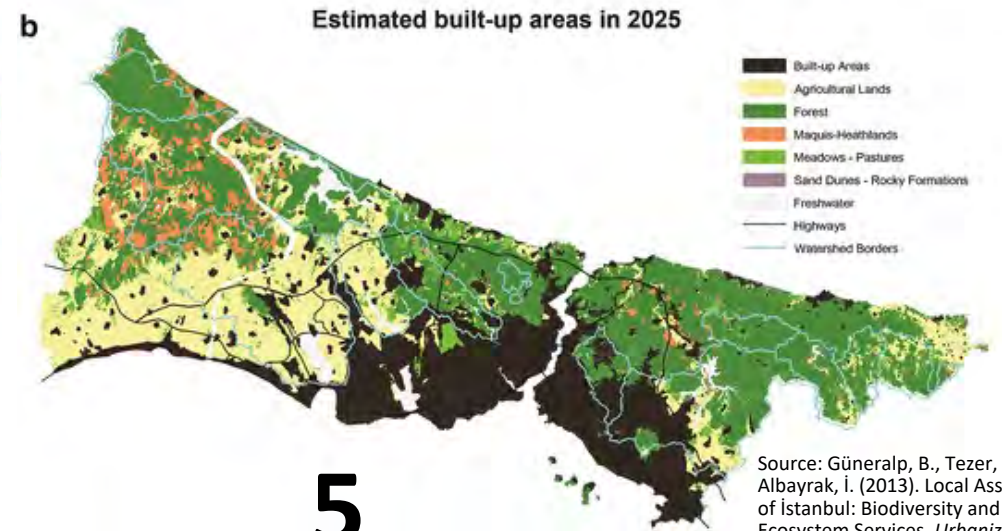
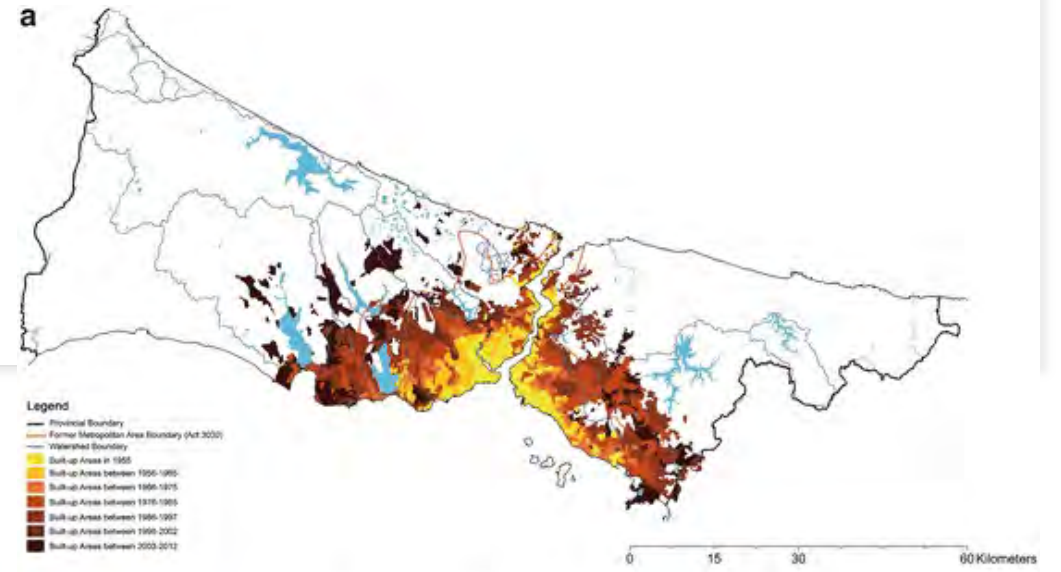
**2**  
Most populated city in Europe

Source: Istanbul Climate Change Action Plan  
Figure 2.1. An overview of multi-faceted networks of Istanbul



**3**  
Trade and industrial networks

**4**  
Mediterranean climate and interacts with the surrounding climate zones



**5**  
Increased built-up area and urban sprawl threat

Source: Güneralp, B., Tezer, A., & Albayrak, İ. (2013). Local Assessment of Istanbul: Biodiversity and Ecosystem Services. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*, 291–311. [https://doi.org/10.1007/978-94-007-7088-1\\_16](https://doi.org/10.1007/978-94-007-7088-1_16)

# 5. Case study: Urban climate risks and impacts on Istanbul



## Change in Heat

Annual mean temperature increase **1 - 4.5°C**

The hottest day temperature **40+°C**

The coldest day temperature **0+°C**

Summer temperature increase = **1,5** x Winter temperature increase

Number of hot days to increase

Number of cool days to decrease

Days with frost to reduce significantly



## Change in Precipitation

Total annual precipitation decrease maximum **12%**

Heavy rain days to increase maximum **20%**

Precipitation during heavy rain days to increase maximum **59%**

Severity of precipitation to increase maximum **9%**



## Drought

Longest dry period to prolong maximum **23 days**



## Sea Level Rise

**45-75 cm**



## Urban Heat Island

Additional mean temperature increase due to dense urbanization **1 - 2°C**

Source: Istanbul Climate Change Action Plan



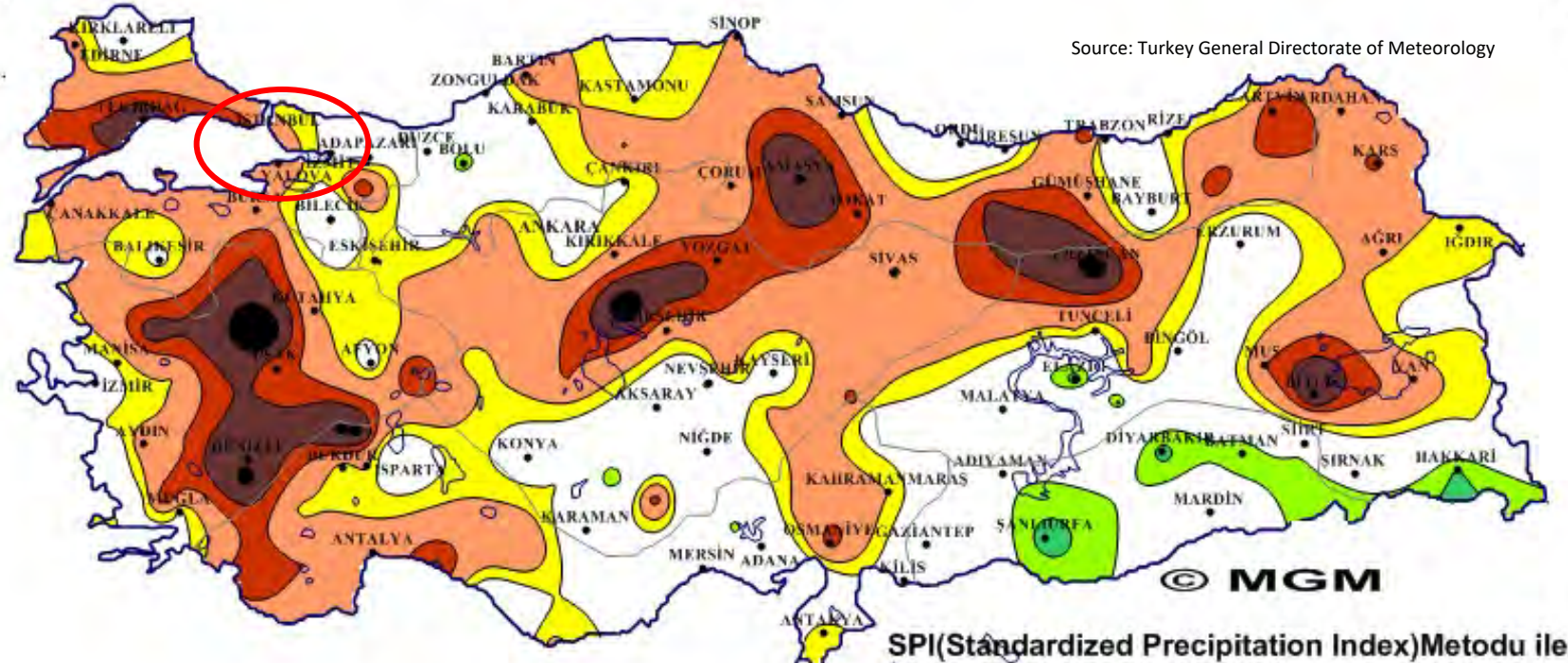
## Air Quality

Due to urbanization along East-West axis, prevalent winds along North-South axis to be affected, thus reducing air quality which exacerbates climatic threats

# 5. Case study: Urban climate risks and impacts on Istanbul, Drought

## Reasons

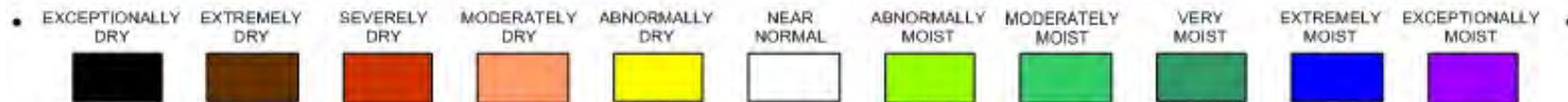
- Rising temperatures
- Changes in precipitation
- Population growth
- Rapid urbanization
- The impact of industrial activities



Source: Turkey General Directorate of Meteorology

\* Bu veriler kalite kontrolden geçmemiştir.

SPI(Standardized Precipitation Index)Metodu ile  
Meteorolojik Kuraklık Haritası  
24 Aylık (Mart 2019-Şubat 2021)  
Hazırlanış Tarihi: Mart 2021



# 5. Case study: Urban climate risks and impacts on Istanbul, Drought

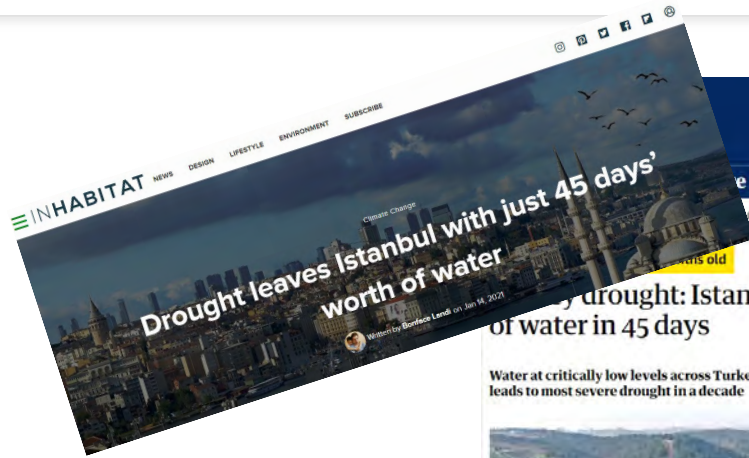
## Impacts

Increasing water needs

Lack amount of fresh water in reservoirs

Urban economy/ecosystem/socio-cultural asset

Meteorological droughts



Source: INHABITAT  
The Guardian  
DailyMail

Water at critically low levels across Turkey after lack of rainfall leads to most severe drought in a decade



Table 3. Average annual occupancy rate of Istanbul's dams 2009 to 2014 [8].

Year	2009	2010	2011	2012	2013	2014 (first 8 months)
Occupancy rate (%)	76.11	73.14	70.2	61.63	60.77	27.77



Agricultural droughts



Hydrological droughts

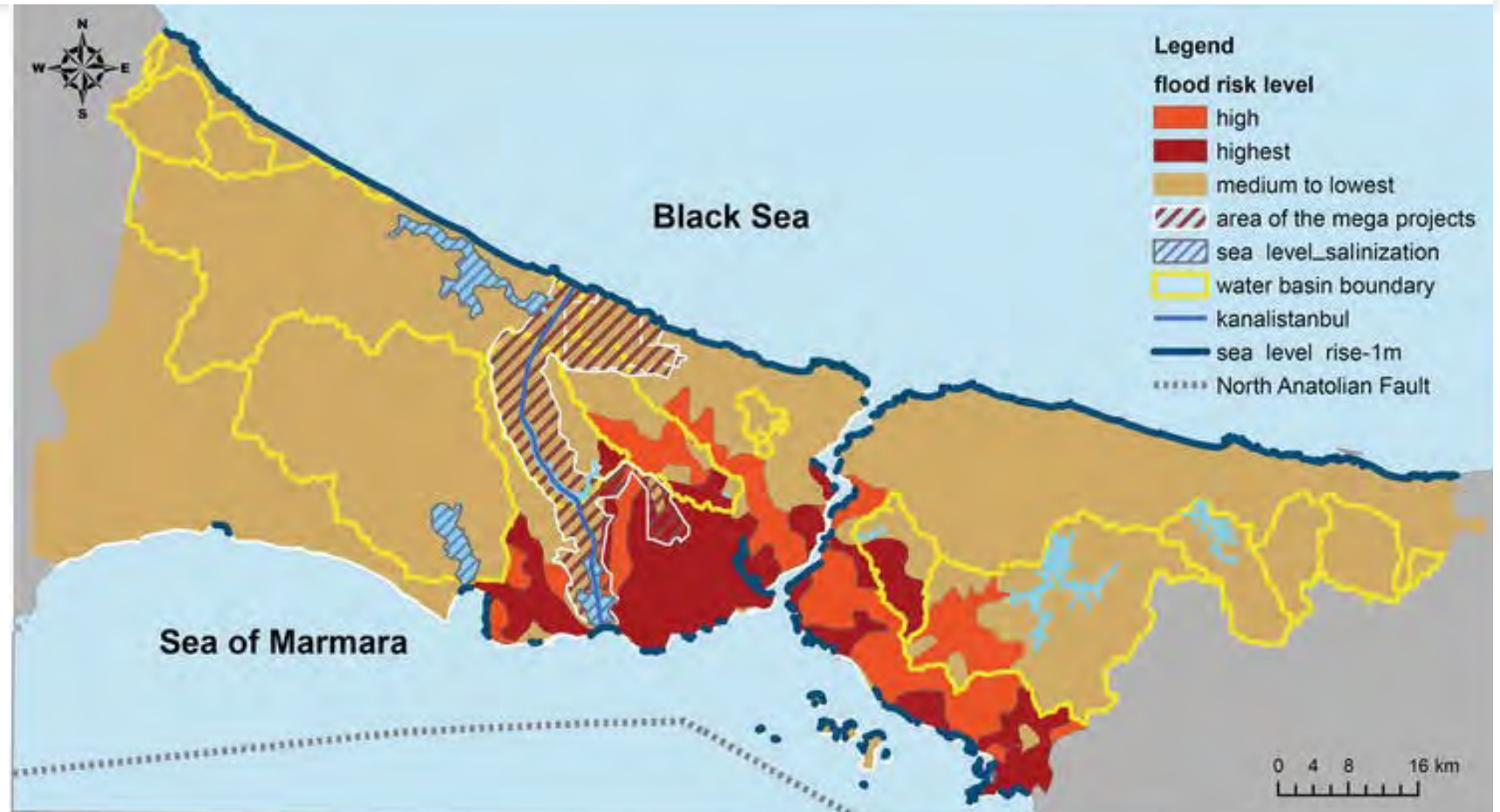


Source: Hüseyin Turoğlu. (2016, July 4). Hydrology and Water Resources DROUGHT HAZARD AND WATER SHORTAGES IN ISTANBUL, TURKEY. Retrieved March 25, 2021, from ResearchGate website: [https://www.researchgate.net/publication/311103486\\_Hydrology\\_and\\_Water\\_Resources\\_DROUGHT\\_HAZARD\\_AND\\_WATER\\_SHORTAGES\\_IN\\_ISTANBUL\\_TURKEY](https://www.researchgate.net/publication/311103486_Hydrology_and_Water_Resources_DROUGHT_HAZARD_AND_WATER_SHORTAGES_IN_ISTANBUL_TURKEY)

# 5. Case study: Urban climate risks and impacts on Istanbul, **Flooding**

## Reasons

- Deforestation
- Irregular urbanization
- Mega projects
- Wrong land uses
- Non-rehabilitation of urban streams
- Wrong intervention to urban streams



# 5. Case study: Urban climate risks and impacts on Istanbul, **Flooding**

## Impacts

- Loss of life
- Loss of property
- Damage to historical areas
- Interruption of life
- Financial loss

Source: CBS News  
DW





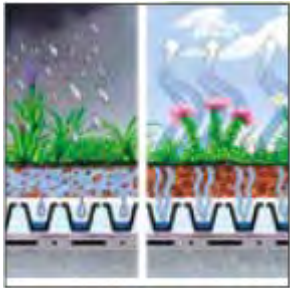


## 6. NbS-Solutions for Istanbul

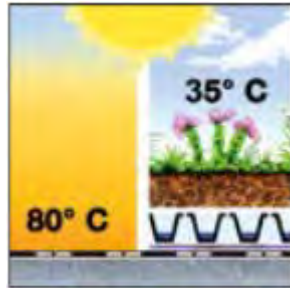


## Option 1: Green Roofs

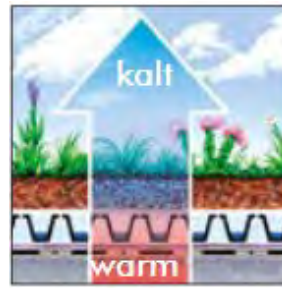
## 6.1 Solutions for Istanbul: Green Roofs



rainwater capture  
cooling evapotranspiration



Heat protection



insulation



pollutant  
and carbon  
capture

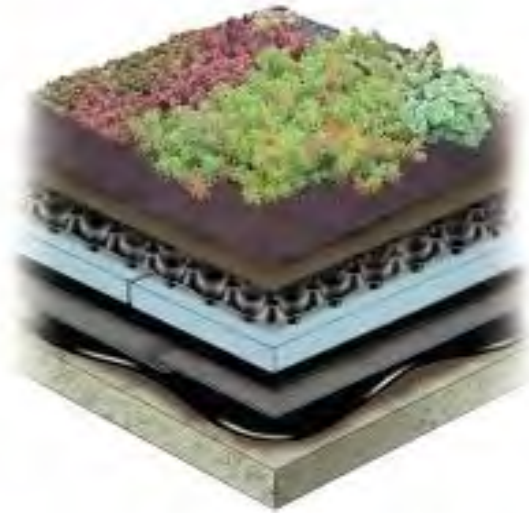


stepping stones  
for biodiversity

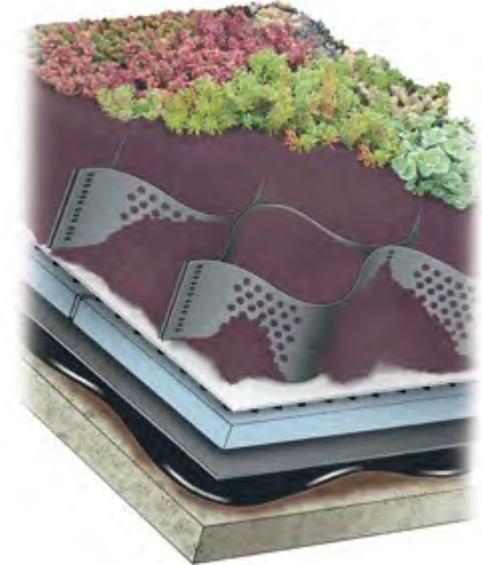
## 6.1 Solutions for Istanbul: Green Roofs



intensive



extensive



sloped

## 6.1 Solutions for Istanbul: Green Roofs



modified from Copernicus Sentinel-2, ESA  
via Wikimedia Commons



modified from Selda Yildiz and Erol Gülsen  
via Wikimedia Commons

Option 2:  
Atatürk Climate  
Park





---

Picture by Ercan Karakaş via Wikimedia Commons



## 6.2 Solutions for Istanbul: Atatürk Climate Park



-  rain gardens with diverse native vegetation
-  native, drought resistant trees
-  cultural/recreational area
-  info boards

*Participatory planning process!*



## 7. Evaluation of the NBS





# Option 1: Green Roofs

---



Kagithane Gardens in Istanbul by JDS Architects.  
Source: <https://bit.ly/3sqYXLo>

# Challenges – Option 1: Green Roofs



Many pointed roofs in old city center



Variable Precipitation



Only selected plants can withstand the arid climate



Hybrid solutions necessary to implement water storing mechanisms



Kapali Carsi (Grand Bazaar), Istanbul. Rooftops. Source: ©iharsten, flickr.

# Benefits – Option 1: Green Roofs



Implementation in existing infrastructure



Severe urban risks are being addressed: droughts and flooding



Many other co-benefits




More appealing cityscape



Creates venues for citizens



Zorlu Center in Istanbul. Source: <https://zinco-greenroof.com/references/zorlu-center-istanbul>



## Option 2: Recreation of Istanbul Atatürk Airport

---

- <https://bit.ly/3d4gyCG>



# Challenges – Option 2: Atatürk Airport



Conflict of interest between different stakeholders



Fight for space – need for housing, medical infrastructure etc.



Gentrification of neighborhood



Habitat creates risk for invasive species



Narrow streets in Istanbul. Copyright © 2016-2017 Corneliu Cazacu.

# Benefits – Option 2: Ataturk Airport



Unused Space



Cooling effect of vast space (946ha)



Located next to the sea – Reduction of Floodings



Recreational space for citizens



Increase of Tourism



Increase of property value



Istanbul Ataturk Airport from Above. Source: <https://bit.ly/3IPtWym>

# OUR CHOSEN NBS ARE ...



FEASIBLE



AFFORDABLE



SUSTAINABLE



Together for a sustainable future!

---



# Sources

- Bodur, A. (2018) Sel ve İstanbul: Sel Riskine Karşı Yapılan Dere Islah Çalışmaları ile İlgili Bir Değerlendirme. Retrieved from: [https://www.researchgate.net/publication/327722562\\_Sel\\_ve\\_Istanbul\\_Sel\\_Riskine\\_Karsi\\_Yapilan\\_Dere\\_Islah\\_Calismalari\\_ile\\_Ilgili\\_Bir\\_Degerlendirme](https://www.researchgate.net/publication/327722562_Sel_ve_Istanbul_Sel_Riskine_Karsi_Yapilan_Dere_Islah_Calismalari_ile_Ilgili_Bir_Degerlendirme) (March 25, 2021)
- Anand, C.K., Apul, D.S. (2014) Composting toilets as a sustainable alternative to urban sanitation – A review, *Waste Management*, Volume 34, Issue 2, Pages 329-343, <http://www.sciencedirect.com/science/article/pii/S0956053X13004923>
- Aygün, A. (2015). Climate Change and Urban Resilience: Vulnerability and Risk Assessment for Istanbul. Retrieved from: [https://www.researchgate.net/publication/340105274\\_CLIMATE\\_CHANGE\\_AND\\_URBAN\\_RESILIENCE\\_VULNERABILITY\\_AND\\_RISK\\_ASSESSMENT\\_FOR\\_ISTANBUL](https://www.researchgate.net/publication/340105274_CLIMATE_CHANGE_AND_URBAN_RESILIENCE_VULNERABILITY_AND_RISK_ASSESSMENT_FOR_ISTANBUL) (March 26, 2021)
- Baskaya, F. A. T. (2018) Revealing Landscape Planning Strategies for Disaster-Prone Coastal Urban Environments: The Case of Istanbul Megacity. *Sea Level Rise and Coastal Infrastructure*. <https://doi.org/10.5772/intechopen.73567>
- Cohen-Shacham, G Walters, C Janzen, S Maginnis (2016) Nature-based Solutions to address global societal challenges, IUCN, Gland, Switzerland
- Department of Environmental Protection and Developmen İBB Beyoğlu Ek Hizmet Binas (2017) Istanbul Climate Change Action Plan. Retrieved from: <https://www.iklim.istanbul/wp-content/uploads/%C3%96zetRapor%C4%B0ngilizce.pdf>
- Barragán, J. M., de Andrés, M. (2015) Analysis and trends of the world's coastal cities and agglomerations. *Ocean & Coastal Management*, 114, 11-20.
- Ellen MacArthur Foundation (2019) Cities and Circular Economy for Food. Retrieved from: [https://www.ellenmacarthurfoundation.org/assets/downloads/CCEFF\\_Full-report-pages\\_May-2019\\_Web.pdf](https://www.ellenmacarthurfoundation.org/assets/downloads/CCEFF_Full-report-pages_May-2019_Web.pdf) (April 30, 2020)
- Enzi, V., Cameron, B., Dezsényi, P., Gedge, D., Mann, G., Pitha, U. (2017) Nature-Based Solutions and Buildings – The Power of Surfaces to Help Cities Adapt to Climate Change and to Deliver Biodiversity. In: *Nature-Based Solutions to Climate Change Adaptation in Urban Areas*. pp.159-183.
- EP (2021). Heat Island Effect. Retrieved from <https://www.epa.gov/heatislands>. (Ap2021)
- Erkens, G., Bucx, T., Dam, R., Lange, G., & Lambert, J. (2015). Sinking coastal cities. *Proceedings of the International Association of Hydrological Sciences*, 372, 189-198.
- FEMA (2020): *Building Community Resilience with Nature-Based Solutions: A Guide for Local Communities*.
- Güneralp, B., Tezer, A., & Albayrak, İ. (2013) Local Assessment of İstanbul: Biodiversity and Ecosystem Services. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*, 291–311. [https://doi.org/10.1007/978-94-007-7088-1\\_16](https://doi.org/10.1007/978-94-007-7088-1_16)
- Turoğlu, H. (2011) Flashfloods and Floods in Istanbul. Retrieved from: [https://www.researchgate.net/publication/265682972\\_Flashfloods\\_and\\_Floods\\_in\\_Istanbul](https://www.researchgate.net/publication/265682972_Flashfloods_and_Floods_in_Istanbul) (March 26, 2021)
- Turoğlu, H. (2013) Possible Effects of Climate Change on Water Management in Istanbul. Retrieved from: [https://www.researchgate.net/publication/290805169\\_Possible\\_Effects\\_of\\_Climate\\_Change\\_on\\_Water\\_Management\\_in\\_Istanbul](https://www.researchgate.net/publication/290805169_Possible_Effects_of_Climate_Change_on_Water_Management_in_Istanbul) (March 26, 2021)
- Turoğlu, H. (2016) Hydrology and Water Resources DROUGHT HAZARD AND WATER SHORTAGES IN ISTANBUL, TURKEY. Retrieved from: [https://www.researchgate.net/publication/311103486\\_Hydrology\\_and\\_Water\\_Resources\\_DROUGHT\\_HAZARD\\_AND\\_WATER\\_SHORTAGES\\_IN\\_ISTANBUL\\_TURKEY](https://www.researchgate.net/publication/311103486_Hydrology_and_Water_Resources_DROUGHT_HAZARD_AND_WATER_SHORTAGES_IN_ISTANBUL_TURKEY) (March 25, 2021)

# Sources

Jenkins, J. (2005) The Humanure Handbook – A guide to composting, 2005, [http://skrconline.net/content/images/stories/documents/Humanure\\_Handbook\\_all.pdf](http://skrconline.net/content/images/stories/documents/Humanure_Handbook_all.pdf) (April 30, 2020)

Kabisch, N., Korn, H., Stadler, J., & Bonn, A. (2017): *Nature-based solutions to climate change adaptation in urban areas linkages between science, policy and practice*. Cham, Switzerland: Springer International Publishing.

Kurnaz, L. (2014) *DROUGHT IN TURKEY IPC-MERCATOR POLICY BRIEF*. Retrieved from: <https://ipc.sabanciuniv.edu/Content/Images/CKeditorImages/20200323-16034017.pdf> MGM. (2021). Kuraklık Analizi- Meteoroloji Genel Müdürlüğü. Retrieved March 25, 2021, from Mgm.gov.tr website: <https://mgm.gov.tr/veridegerlendirme/kuraklik-analizi.aspx>.

Naturvation (2021) Gorla Maggiore Water Park. <https://naturvation.eu/nbs/milano/gorla-maggiore-water-park>. (March 25, 2021).

Oppenheimer, M., B.C. Glavovic, J. Hinkel, R. van de Wal, A.K. Magnan, A. Abd-Elgawad, R. Cai, M. Cifuentes-Jara, R.M. DeConto, T. Ghosh, J. Hay, F. Isla, B. Marzeion, B. Meyssignac, and Z. Sebesvari (2019): Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

ResearchGate (2021) Going green? Ex-post valuation of a multipurpose water infrastructure in Northern Italy- Scientific Figure on ResearchGate. Retrieved from: [https://www.researchgate.net/figure/Location-and-characteristics-of-the-Gorla-Maggiore-water-park\\_fig1\\_320358119.\(25.03.21\)](https://www.researchgate.net/figure/Location-and-characteristics-of-the-Gorla-Maggiore-water-park_fig1_320358119.(25.03.21)).

Revi, A., D.E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R.B.R. Kiunsi, M. Pelling, D.C. Roberts, and W. Solecki (2014) Urban areas. In: *Climate Change (2014) Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 535-612.

PUB Singapore's National Water Agency (2021) Sengkang Floating Wetland. [https://www.pub.gov.sg/Pages/album.aspx?24PW07of9GVLHNefpqi+FVCjcfBEN2iPMSSzTs6q/J/vLW4QFZh+pNM3uCWYHkGuJzh88TAaUFRyRJBFEFAG==\(25.03.2021\)](https://www.pub.gov.sg/Pages/album.aspx?24PW07of9GVLHNefpqi+FVCjcfBEN2iPMSSzTs6q/J/vLW4QFZh+pNM3uCWYHkGuJzh88TAaUFRyRJBFEFAG==(25.03.2021)).

Sara Favargiotti (2018) Renewed landscapes: Obsolete airfields as landscape reserves for adaptive reuse, *Journal of Landscape Architecture*, 13:3, 90-100, DOI:10.1080/18626033.2018.1589147

Seddon, N. (2018) Evidence Brief—How effective are Nature-based Solutions to climate change adaptation? Nature Based Solutions Initiative. University of Oxford.

Soz, S. A., Kryspin-Watson, J., Stanton-Geddes, Z. (2016) The Role of Green Infrastructure Solutions in Urban Flood Risk Management. World Bank, Washington, DC. <https://openknowledge.worldbank.org/handle/10986/25112> License: CC BY 3.0 IGO.”

ZinCo (2020) Planungshilfe: Systeme für begrünte Schrägdächer. Retrieved from: [https://www.zinco.de/sites/default/files/2020-08/ZinCo\\_Schraegdachbegruenung.pdf](https://www.zinco.de/sites/default/files/2020-08/ZinCo_Schraegdachbegruenung.pdf) (March 26, 2020)