Green Roofs as Tools for Urban Wastewater Management

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Challenges in Urban Areas

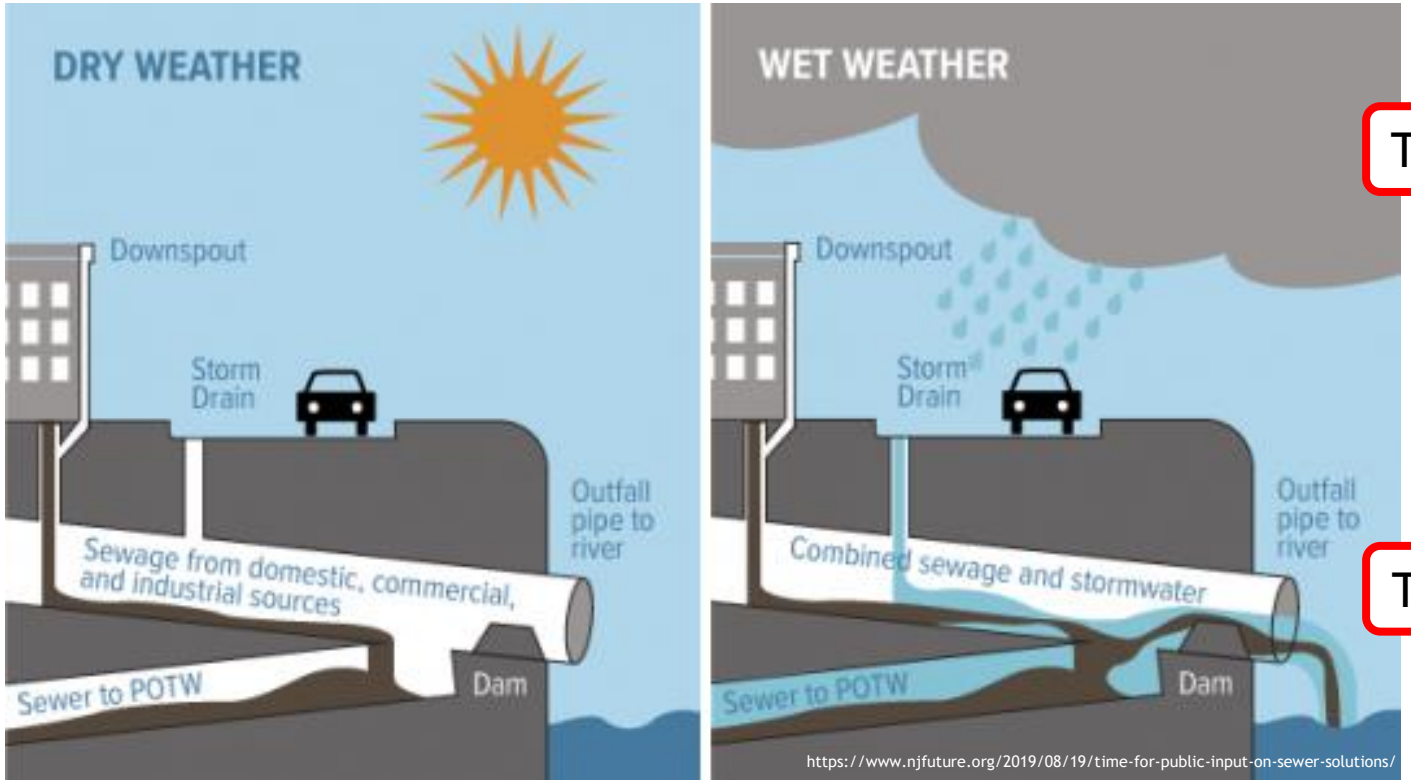
caused and reinforced through climate change

Climate Change Impacts:

- Increasing number of extreme weather events including storms and droughts
  (Masson-Delmotte et al., 2019)
- Intensification of the Urban Heat Island
  (Ward et al., 2016)
- 16 % increased precipitation in urban areas compared to rural surrounding
  (Liu & Niyogi 2019)

Overloaded Sewage Systems

and the threats to environment and health



Bacterial pathogens

Threat to public health

Viruses

Pathogens

Wastewater contaminants

Threat to aquatic ecosystems

Eutrophication

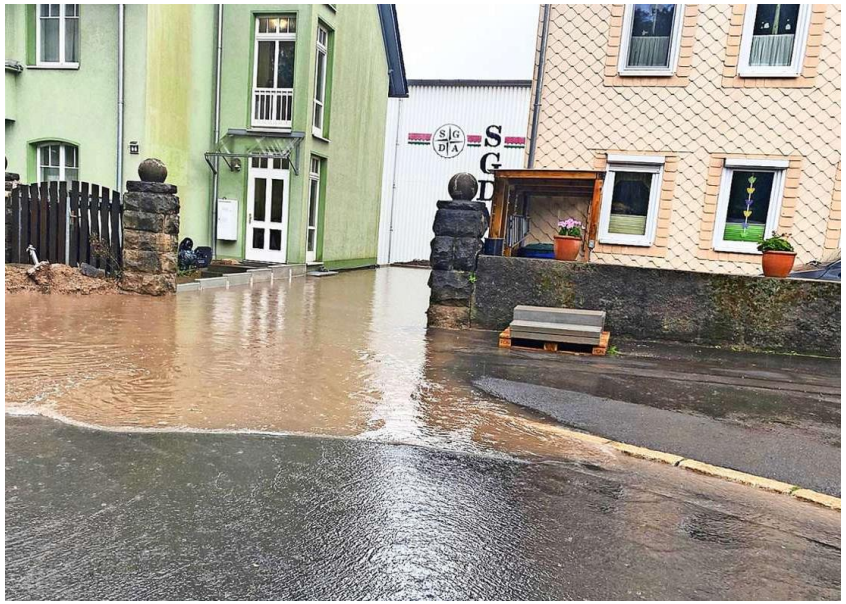
Increased turbidity

(Botturi et al., 2020)

Sewage Systems in Europe

An overview

- 2.2 Mio km of sewer system pipes in Europe (Botturi et al., 2020)
- 70 % combined system (Botturi et al., 2020)
- Stormwater is a key concern to the goals of the Water Framework Directive in Germany (UBA, 2012)



Combined Sewage Overflow in Thüringen, Germany (2021)

https://www.insuedthueringen.de/inhalt.faekalien-gemisch-in-haus-und-auf-hof-die-ekelgrenze-ist-laengst-ueberschritten.d77c08ed-7b01-447f-96a7-ea542eb6f146.html

Combined Sewer Overflows

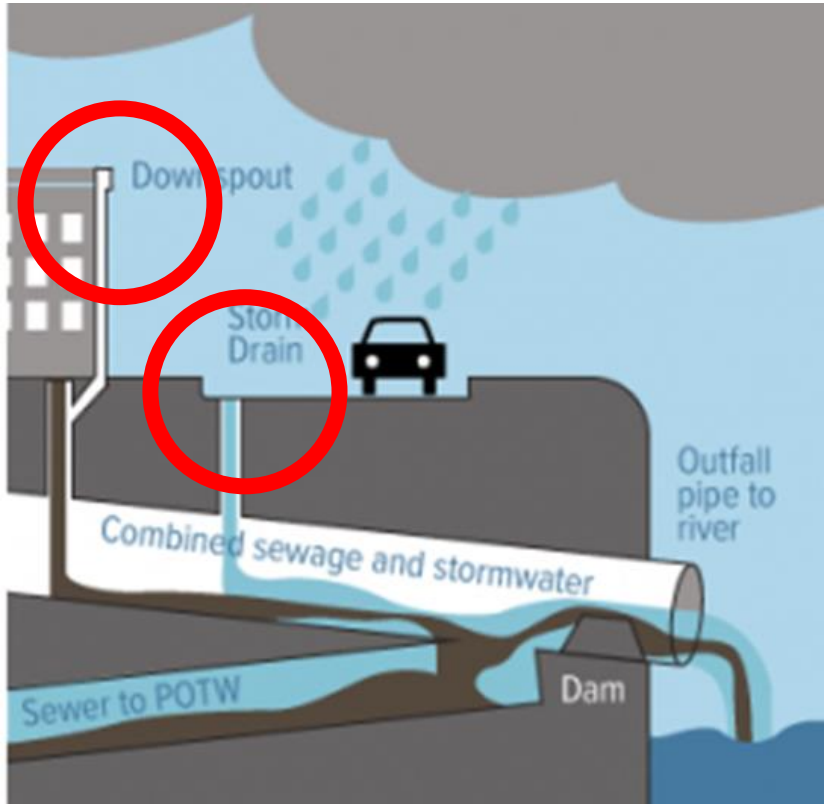
OPTIGRÜN®
DIE DACHBEGRÜNER

adapted from Botturi et al. (2020)

Area	Monitoring Strategy	No. of events in the study area	No. of events analyzed	Period of study	Rain amount (mm)	Overflow discharged volume (m^3)	Reference
Lodz, Poland	Sewer flowmeters located in the cathment	9–28/year	60	3 years		3.600–49.822/year	Brzezińska et al. (2016)
Po Valley, Italy	The CSO outfalls are located within the lifting pump stations	–	41	3 months (2014)	740/year	18–30,383/event	Al Aukidy and Verlicchi (2017)
Gallusquelle, Germany	–	10/year	5	5 months (2005)	–	23.000 (five events)	Heinz et al. (2009)
Stuttgart, Germany	Flowmeter	–	7	3 months (2014)	–	–	Launay et al. (2016)
Spain	–	–	46	–	–	2752–41.566/ event	Suárez and Puertas (2005)
Berlin, Germany	179 CSO discharge points	37/year (from 2000 to 2007)	–	–	–	7 × 106/year	Weyrauch et al. (2010)
La Garriga, Spain	14 CSO infrastructure with low-cost temperature sensors	36–49 (in 11 month)	–	1 year (2011–2012)	0.4–51.4/episode	–	Montserrat et al. (2015)
Paris, France	Dry weather: daily samples for the four upstream sites. Wet weather: four of the 45 CSO sampled	–	–	–	20.1/rainfall event	3.2 × 106/year	Gasperi et al. (2008)
The Aire and Calder catchements, West Yorkshire, UK	Samples from WWTP, CSO and receiving water	–	5	–	–	–	Kay et al. (2017)
City of Santiago de Compostela, Spain	–	–	925	4 years (1995–1999)	1600/year	–	Diaz-Fierros et al. (2002)
Gorla Maggiore, Italy	69 CSO events	69 CSO events	69	1 year (2014–2015)	–	87–579/event	Masi et al. (2017)

Recognizing the Issue

and implementing suitable measures

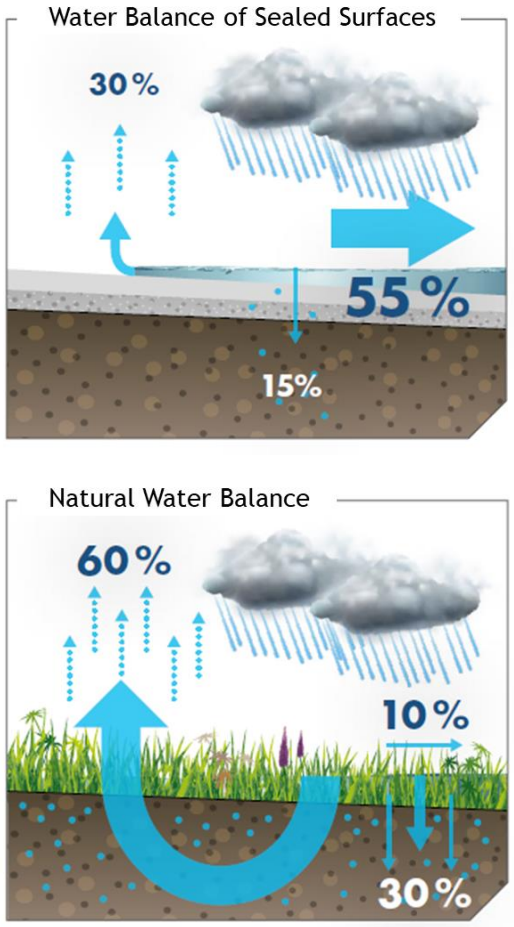


Reducing the discharge from urban surfaces

Delaying the discharge from urban surfaces

Blue-Green Infrastructure

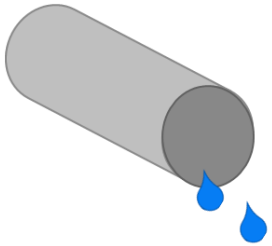
and nature-based solutions



Restorating the Natural Water Cycle

Decentralized Stormwater Management

Resulting in:



- No/minimal discharge
- Local flood control
- Mitigation of extreme temperatures and the UHI
- Building insulation
- Improved air quality
- Increased biodiversity

Blue-Green Roofs

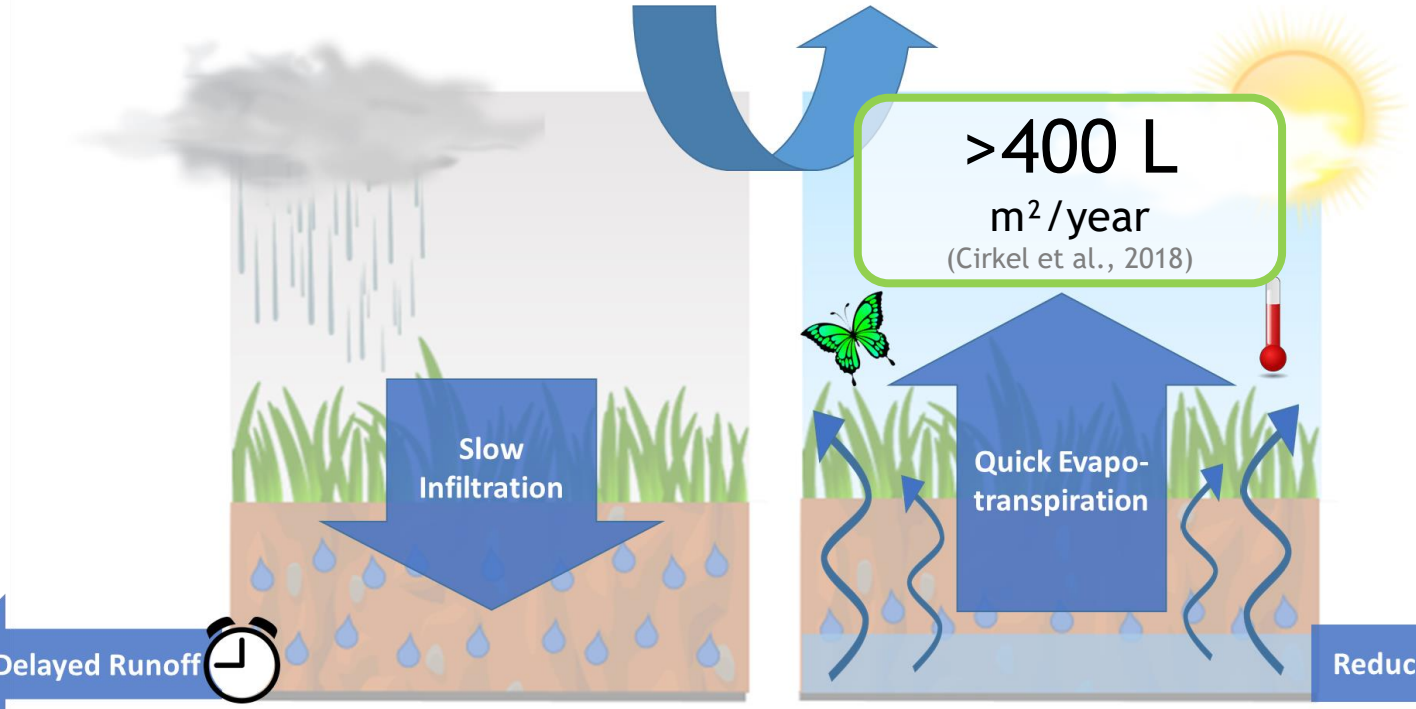
as space-saving solutions for dense urban areas

https://climate-adapt.eea.europa.eu/metadata/case-studies/four-pillars-to-hamburg2019s-green-roof-strategy-financial-incentive-dialogue-regulation-and-science/fig-1_skyline.jpg/view

Blue-Green Roofs

as space-saving solutions for dense urban areas

Maintenance of the Natural and Local Water Cycle



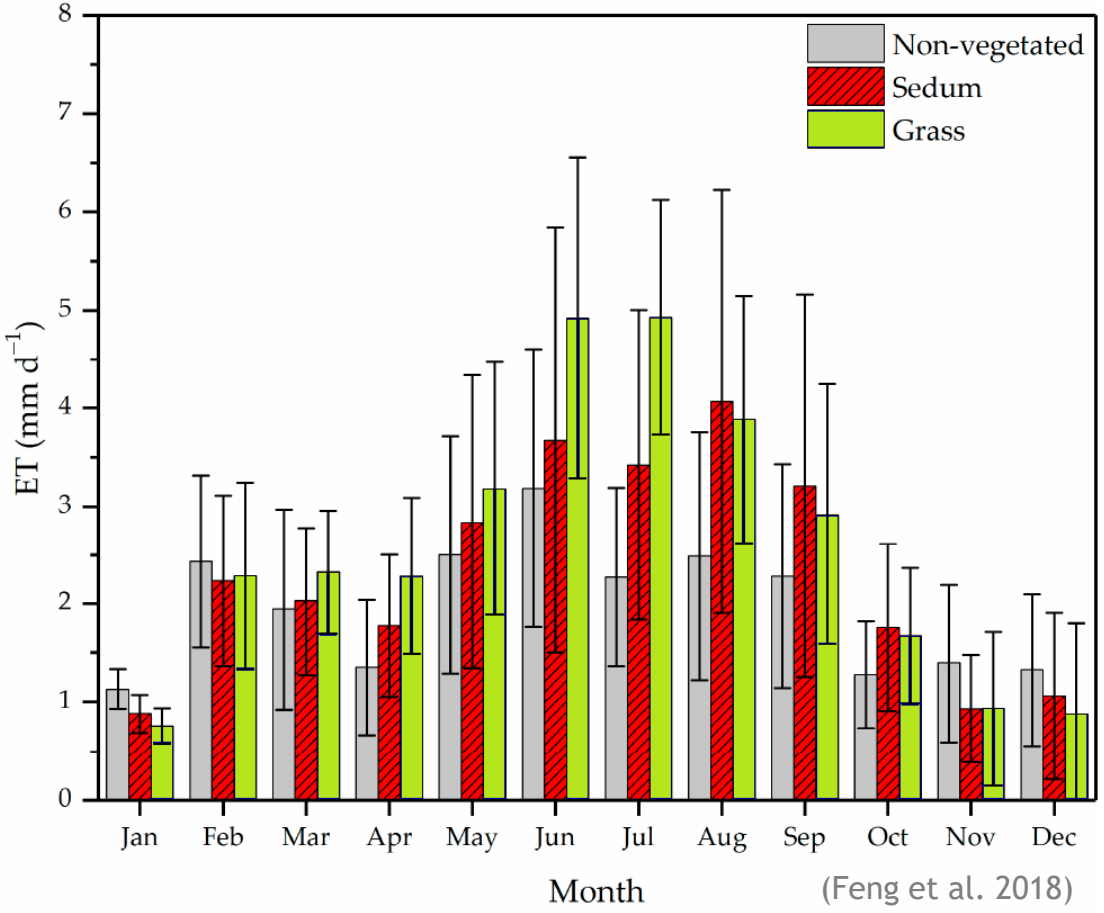
up to 90 %
compared to non-vegetated roofs
(Manso et al., 2021)

80 %
compared to non-vegetated roofs
(Manso et al., 2021)

1 l/sec
instead of 200 l/sec
(own simulations)

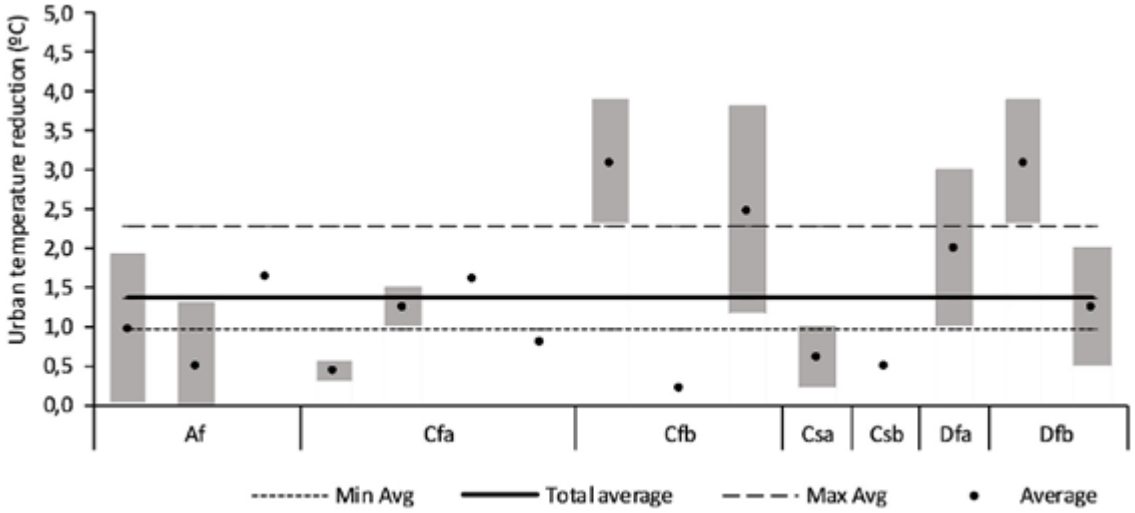
Blue-Green Roofs

as natural cooling systems in hot summers



(Feng et al. 2018)

Reduction of summer air temperature in different climate zones



(Manso et al., 2021)

Mission Possible

Offenbach City Quarter

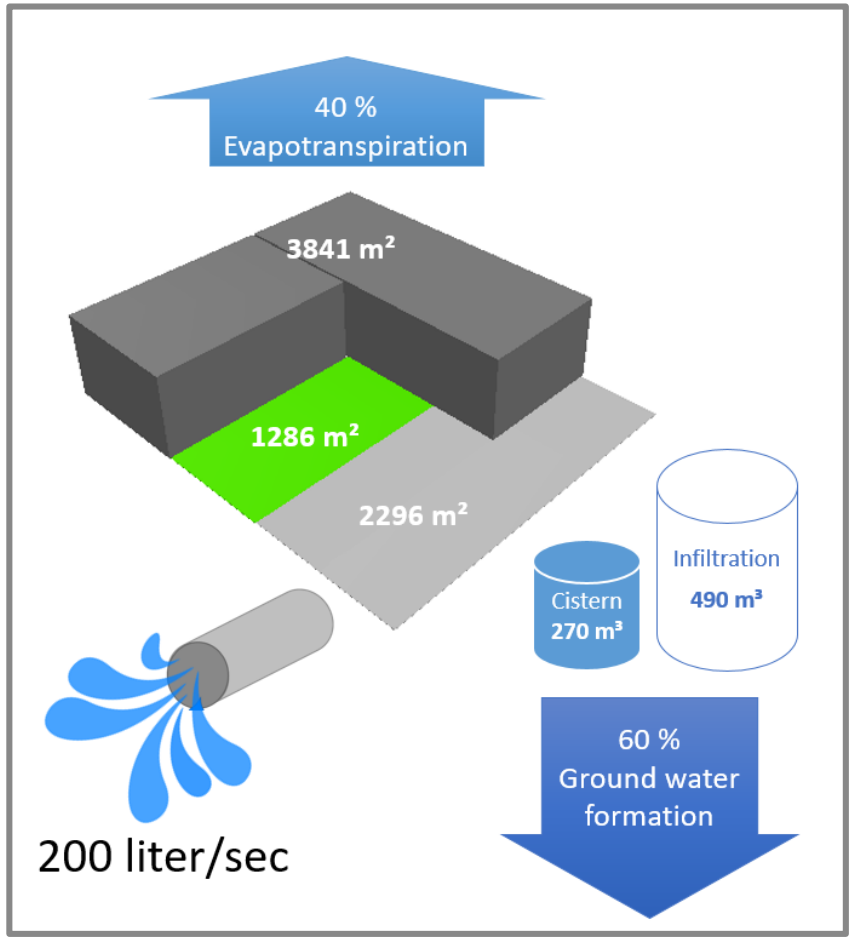
Image Source: Google Maps

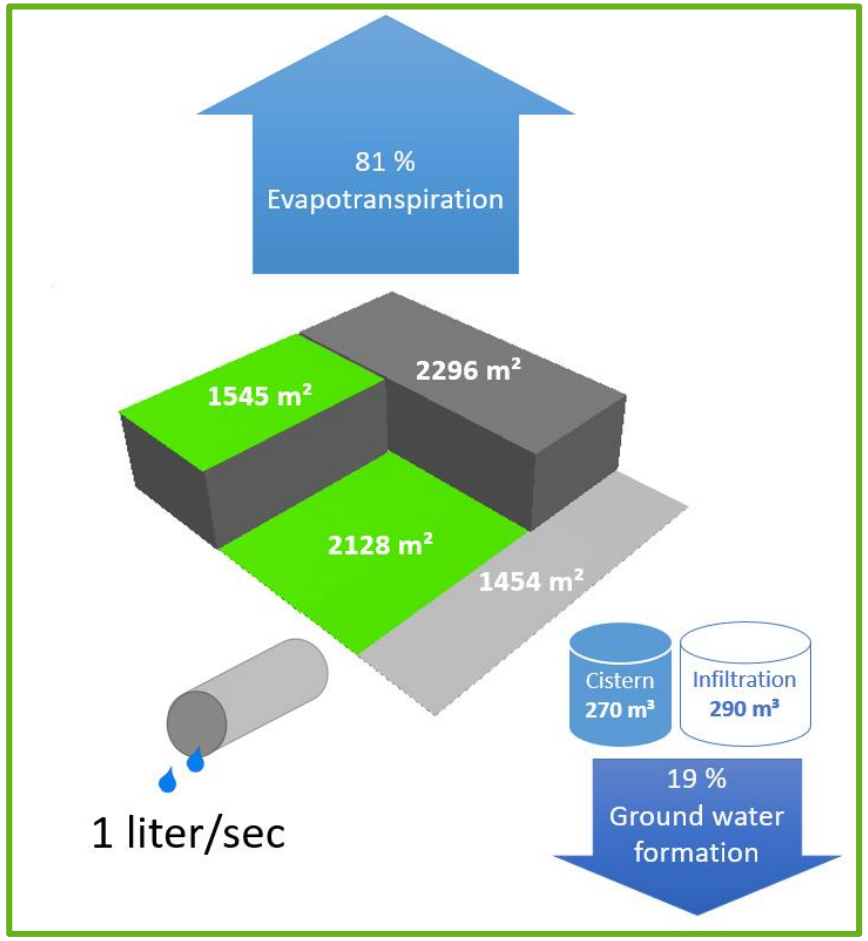
Water Balance	mm/year	%
Precipitation	649	100
Evapotranspiration	505	78
Infiltration	144	22
Discharge into Sewer	**0**	**0**

For 10-year simulation including a 30-year and a 100-year model storm

Planning the Next City Quarter

„Leipziger BlauGrün“





Summary

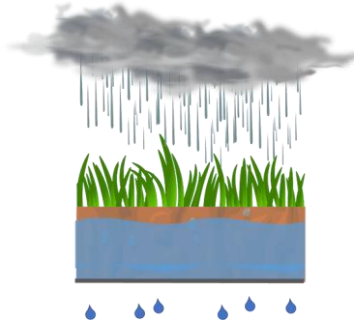
Green Roofs…

… delay stormwater runoff **by 90 %**

… reduce outflow **by 80 %** and minimize speed to **1 l/sec**

… relieve the burden to the sewer systems with outflows

- preventing combined sewer overflows
- alleviating the water quantity in separate sewer systems
- reducing the load of wastewater treatment plants



… restore the natural water cycle

… provide additional benefits such as UHI mitigation

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Thank You!