

Počítáme s vodou 2018 ("We take water into account") Stormwater management as a tool for sustainable development of cities Invited lecture, Prague/Czech Republic, 23rd October 2018



Planning for Multifunctional Stormwater Infrastructure using the Three Point Approach (3PA)

Peter Steen Mikkelsen Professor, DTU Environment Head of Water DTU, Center for Water Activities at DTU



DTU Environment Department of Environmental Engineering **MEZINÁRODNÍ KONFERENCE**



POČÍTÁME S VODOU 2018

HOSPODAŘENÍ S DEŠŤOVOU VODOU JAKO NÁSTROJ K ROZVOJI MĚST

PRAHA / 23 / 10 / 2018

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Konferenci po/ádá 01/71 20 ČSOP Koniklec, p. s. v rámci projektu Počitárne s vódou, jehož cilem je informovat především zástupce veřejně správy a občany o principéch přírodě blízkého hospodaření s deštovými vodami (HDV) a prosazovat systémy decentralizovaného odvodnění a využívání deštové vody. Je nutné, aby se nejen v odborných kruzich vědělo, co HDV je a jaký má společenský význam, a aby bylo vnímané jako perspektivní řešení odvodnění urbanizovaných území v duchu udržitelného rozvoje.

> Nad konferenci převzal záštitu ministr životního prostředí a ministr zemědělství. Konference se koná v rámci projektu Počítáme s vodou, spoluřinancovaného Státním fondem životního prostředí České republiky na základě rozhodnutí ministra životního prostředí.





A rainfall event that changed my life, 14th August 2014



I live here, just North of Copenhagen

My garden party, the same evening



Rainfall statistics





The suroundings where I live, the next day



Copenhagen City center 2 July 2011 (the year after) Copenhagen Lyngbyvej 16 Aug 2010 (two days later)

Photo: Bente Schou

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- 150 mm rain in 2 hours
- Damages 1 billion dollars
- Damages to critical infrastructure
- A game changer for the city
- Development of a Cloudburst management Plan

The traditional system thinking is changing

Limiting release through:

- Substitution
- Minimising release from products
- Legislation and regulations
- Voluntary use reductions

Treatment options:

- Stormwater BMPs
- Household treatment & reuse of WW
- On-site industrial treatment
- WWTPs
- Sludge disposal

Real time monitoring, modeling, and control:

- WWTP monitoring and control
- Rainfall measurement and forecasting
- Flow and water quality monitoring
- Data assimilation into models
- Model predictive control

Adaptation and resilience:

- Climate change -> Cities are changed
- Opportunities arise for source control

Main challenges: Maintenance, climate change, micropollutants, creating attractive jobs, ... => Creating *smarter* and *more liveable* cities

Example: <u>Combined</u> system:



D+T



Some approaches to climate adaptation





Use classical urban drainage solutions?





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Seek inspiration in Holywood for fun?





... or to understand the *climate threat* ?



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Or listen to artists?



http://sla.dk, 26/07/2015 - Bryggervangen and Skt. Kjelds Plads



Terms in literature (Google Scholar, Sep 2013)



Fletcher, T.D., Shuster, W., Hunt, W.F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J.-L., Mikkelsen, P.S., Rivard, G., Uhl, M., Dagenais, D., Viklander, M. 2015. "SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage". *Urban Water Journal*, **12**(7), 525–542. <u>http://dx.doi.org/10.1080/1573062X.2014.916314</u>



Worldwide terminology in urban drainage



Stormwater Control Measures (SCMs) seems to be the most neutral term!

Fletcher, T.D., Shuster, W., Hunt, W.F., Ashley, R., Butler, D., Arthur, S., Trowsdale, S., Barraud, S., Semadeni-Davies, A., Bertrand-Krajewski, J.-L., Mikkelsen, P.S., Rivard, G., Uhl, M., Dagenais, D., Viklander, M. 2015. "SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage". *Urban Water Journal*, **12**(7), 525–542. <u>http://dx.doi.org/10.1080/1573062X.2014.916314</u>

Context = Urban area



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Conklin, J. (2001-10): Wicket problems and social complexity. CogNexus Institute.

Three Point Approach (3PA)

• Rainfall is dynamic, frequency and magnitude is important to consider, and to communicate

Fratini, Geldof, Kluck & Mikkelsen, 2012, Urban Water Journal, 9(5), 317-331.

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Three Point Approach (3PA)

• Climate change, Possibilities for adaptation

Fratini, Geldof, Kluck & Mikkelsen, 2012, Urban Water Journal, 9(5), 317-331.

Conclusions – 1/2

- Many different stakeholders play a role
- Both technical, and social and environmental aspects are important
- People do not act "rationally" and politicians focus on success and power
- Climate adaptation is a "wicked" problem, i.e. it cannot be "solved"
- There are many uncertainties and tacit knowledge (experience) is powerful
- The 3PA is a thinking system that simplifies the complex decision processes related to climate adaptation into **three domains**
 - A. The domain of *day-to-day values*
 - B. The domain of *technical optimization*
 - C. The domain of *spatial planning*
- It has a strong communicative power and is suitable for organising transdisciplinary processes with many stakeholders with different backgrounds and different interests
- It highlights that **multifunctional solutions** are needed to provide value in all three domains where decisions are formed

Three Point Approach (3PA)

• Making the 3PA quantitative

Sørup, Lerer, Arnbjerg-Nielsen, Mikkelsen & Rygaard, 2016, Environ. Science & Policy, 63, 19-26.

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Quantitative use of the 3PA, example

- Rainwater harvesting tank for rood runoff, water used for toilet flushing, technical design for point A to avoid too long storage periods
- Calculations for the city of Copenhagen

Efficiencies	Α	В	С	Total
Rainwater harvesting	8%	1%	_	9%
from roofs	100%	29%	18%	83%
Reduced potable water demand	16%	1%	-	17%
Reduced wastewater production	9%	1%	-	10%

Sørup, Lerer, Arnbjerg-Nielsen, Mikkelsen & Rygaard, 2016, Environ. Science & Policy, 63, 19-26.

Technology foresight: Copenhagen's 1st "climate resilient neighborhood"

Lerer, Righetti, Rozario & Mikkelsen, 2017, Water, 9(11), 883.

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Technology foresight: Scenarios based on disconnection and cloudburst roads/tunnels

Lerer, Righetti, Rozario & Mikkelsen, 2017, Water, 9(11), 883.

Communicating results using the 3PA

Lerer, Righetti, Rozario & Mikkelsen, 2017, Water, 9(11), 883.

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This was an example using complex hydraulic simulations

Complex and heavy to run

Imagine a tool for use in early stage design?

Draw

Simplified and fast to run

Lerer, S.M., Sørup, H.J.D., Arnbjerg-Nielsen, K., Mikkelsen, P.S. (2016): A new tool for quantifying the hydrological effects of LID retrofit designs – the power of simplicity. 2016 International Low Impact Development Conference, Beijing, China, 26-29 June. Paper ID 479, 7 pp.

Conclusions

- The 3PA is a thinking system that simplifies the complex decision processes related to climate adaptation into **three domains**
 - A. The domain of *day-to-day values* ... and *rainwater resource utilization*
 - B. The domain of *technical optimization* ... and *urban stormwater drainage*
 - C. The domain of *spatial planning* ... and *pluvial flood mitigation*
- In Denmark, the terms **everyday rain**, **design rain** and **extreme rain** are now increasingly understood and used
- The 3PA allows us to discuss *pleasure and pain*, and *risk and opportunity* in the same conversation, and to connect better to the **smart liveabile city** discourse
- It can be used as a frame for technical calculations related to climate adaptation and when discussing the efficiency if various stormwater control measures
- This may **help communicating technical insights** to experts outside the water engineering community

Thank you!

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