STORMWATER MANAGEMENT: WINTER FUNCTIONALITY

Godecke Blecken
Professor Urban Water Management
Luleå University of Technology, Sweden
godble@ltu.se

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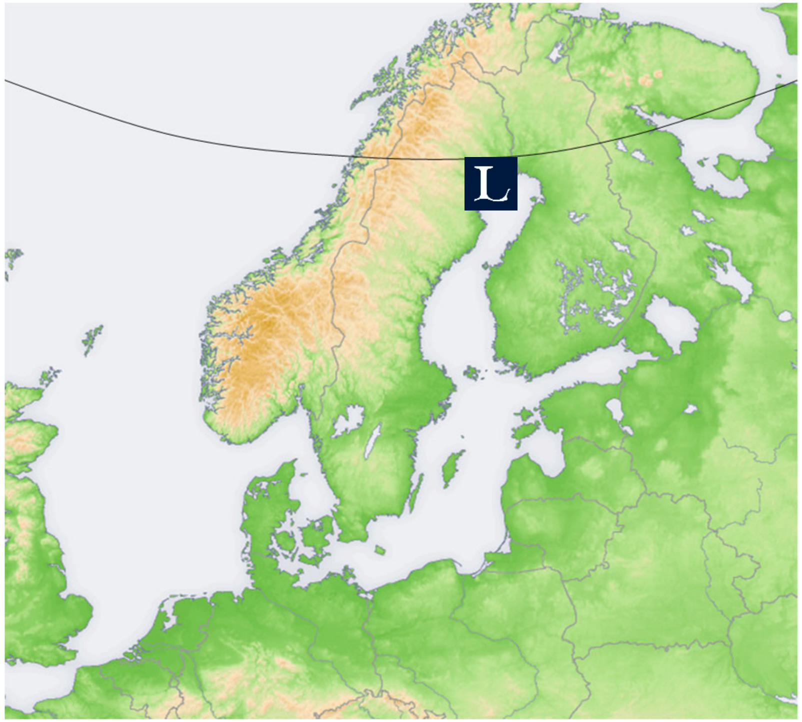
Stormwater research at LTU

- Stormwater Pollution:
  Sources & transport
- Stormwater quality treatment
- Retention & climate change adaptation
- Snow management
- Sampling methods
- Multi-functional BGI
- Modeling: stormwater
  transport & quality



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Stormwater research at LTU

- Stormwater Pollution: Sources & transport
- Stormwater quality treatment
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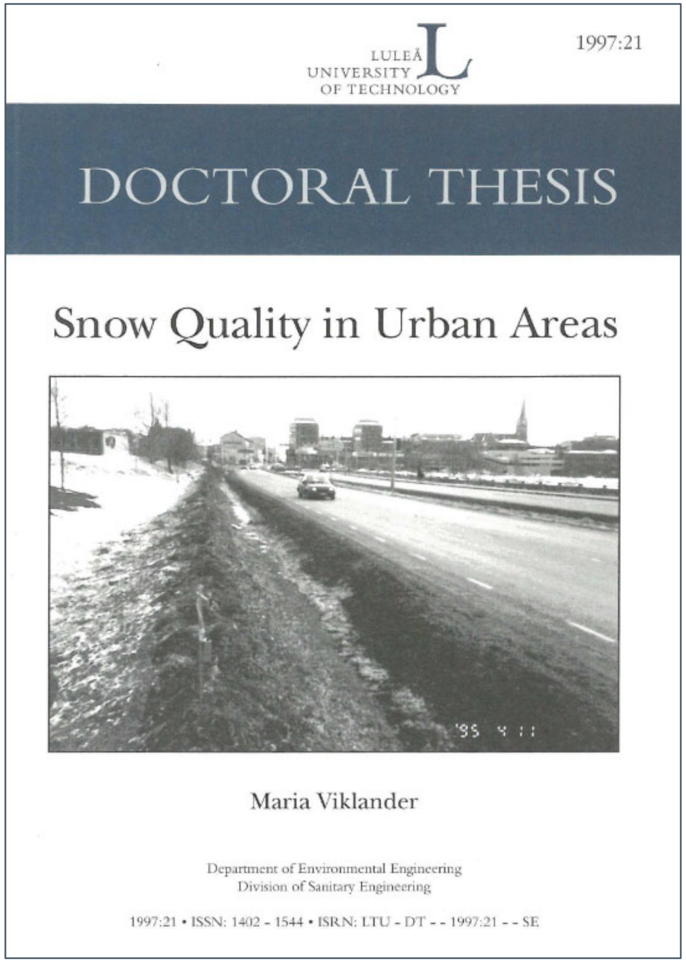
Knowledge base
Planning & development
Design & dimensioning
Construction
Operation & maintenance
End users
Sources and distribution of pollutants in urban snow
Sources and characterization of stormwater pollutants
Microplastics in stormwater
Pollutants of emerging concern
Integrating novel field data sets
Cost-Benefit Analysis
Reducing uncertainties
Area efficient stormwater treatment
Sensitivity analysis for uncertainty quantification
Performance under a changing climate
Översiktlig utvärdering av funktionaliteten av 26 dagvattenbiofilter
Stormwater ponds: improved efficiency, characterisations and risks of accumulated sediment
Gully pots as pollutant sinks and sources
Public perception

Stormwater management – winter considerations

- What are the conditions we have to deal with?
- How do stormwater management facilities perform?
- Do we have to adapt them to these conditions?

Stormwater & snowmelt quality


1997:21

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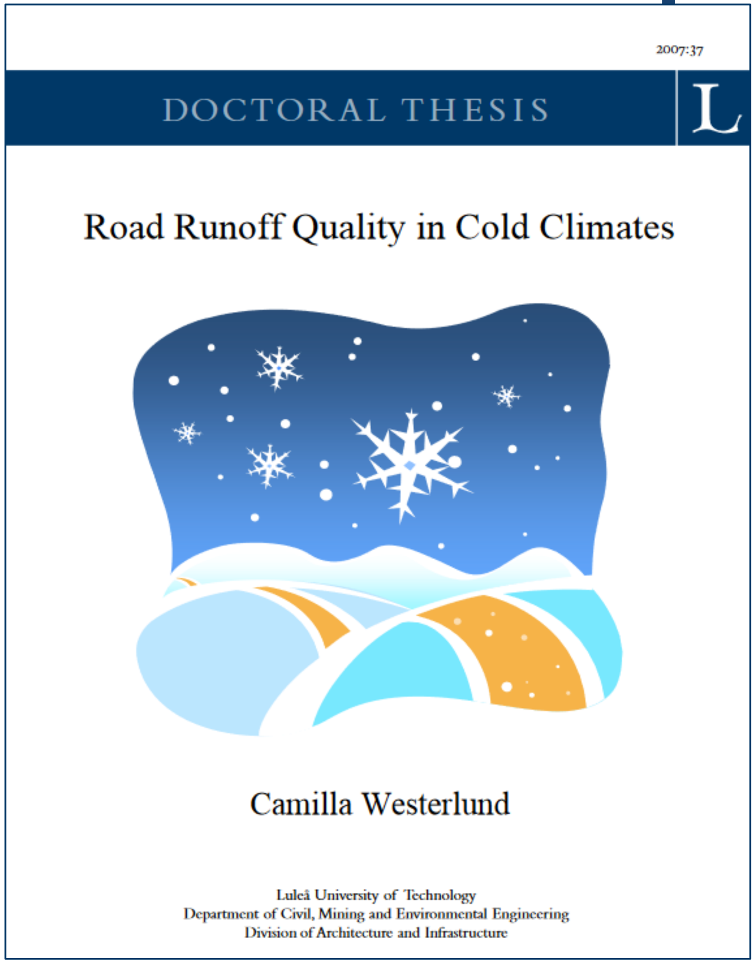
DOCTORAL THESIS

Snow Quality in Urban Areas

Maria Viklander

Department of Environmental Engineering
Division of Sanitary Engineering

1997:21 • ISSN: 1402 - 1544 • ISRN: LTU - DT - - 1997:21 - - SE


2007:37

DOCTORAL THESIS

Road Runoff Quality in Cold Climates

Camilla Westerlund

Luleå University of Technology
Department of Civil, Mining and Environmental Engineering
Division of Architecture and Infrastructure

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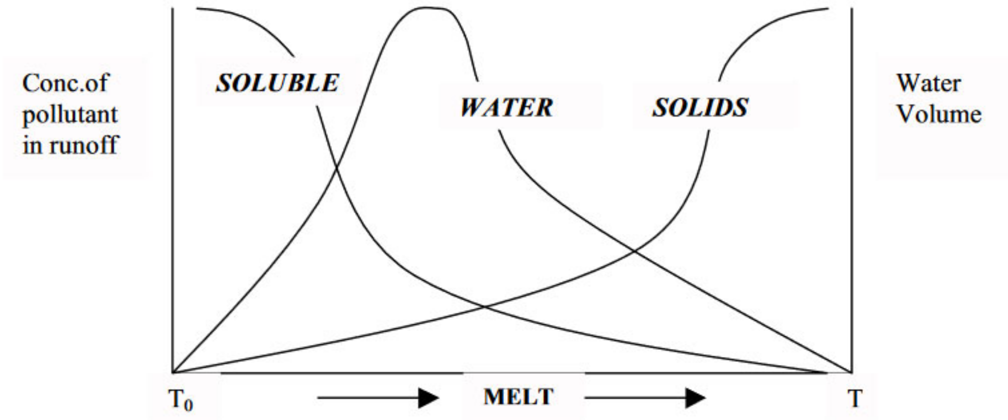
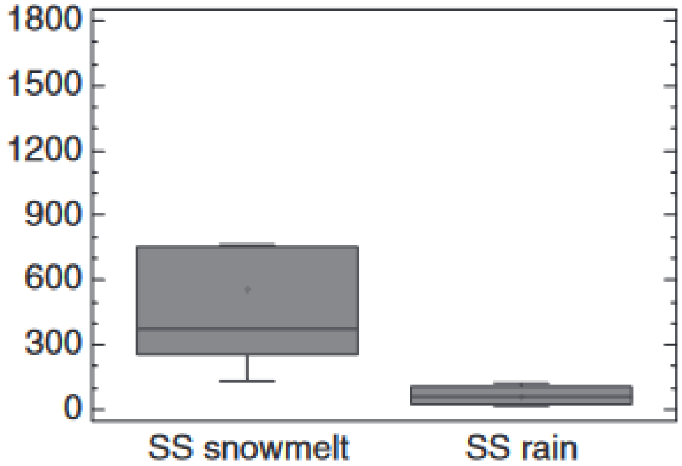
Stormwater & snowmelt quality





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Stormwater & snowmelt quality

Science of the Total Environment 851 (2022) 158306

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Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

ELSEVIER

Microplastics (MPs) in urban roadside snowbanks: Quantities, size fractions and dynamics of release

Arya Vijayan [a,*], Heléne Österlund [a], Kerstin Magnusson [b], Jiri Marsalek [a], Maria Viklander [a]

[a] Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology, 97187 Luleå, Sweden

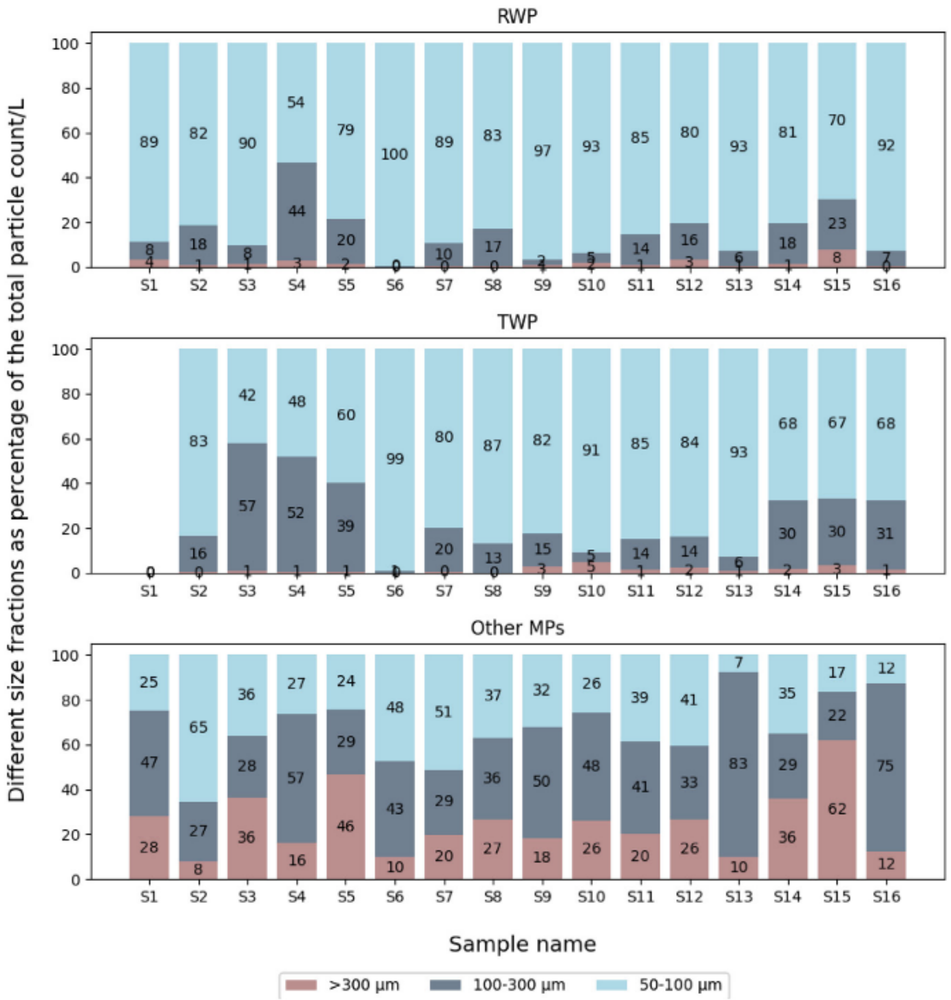
[b] IVL Swedish Environmental Research Institute, Kristineberg Marine Center for Marine Research and Innovation, 451 78 Fiskebäckskil, Sweden

HIGHLIGHTS

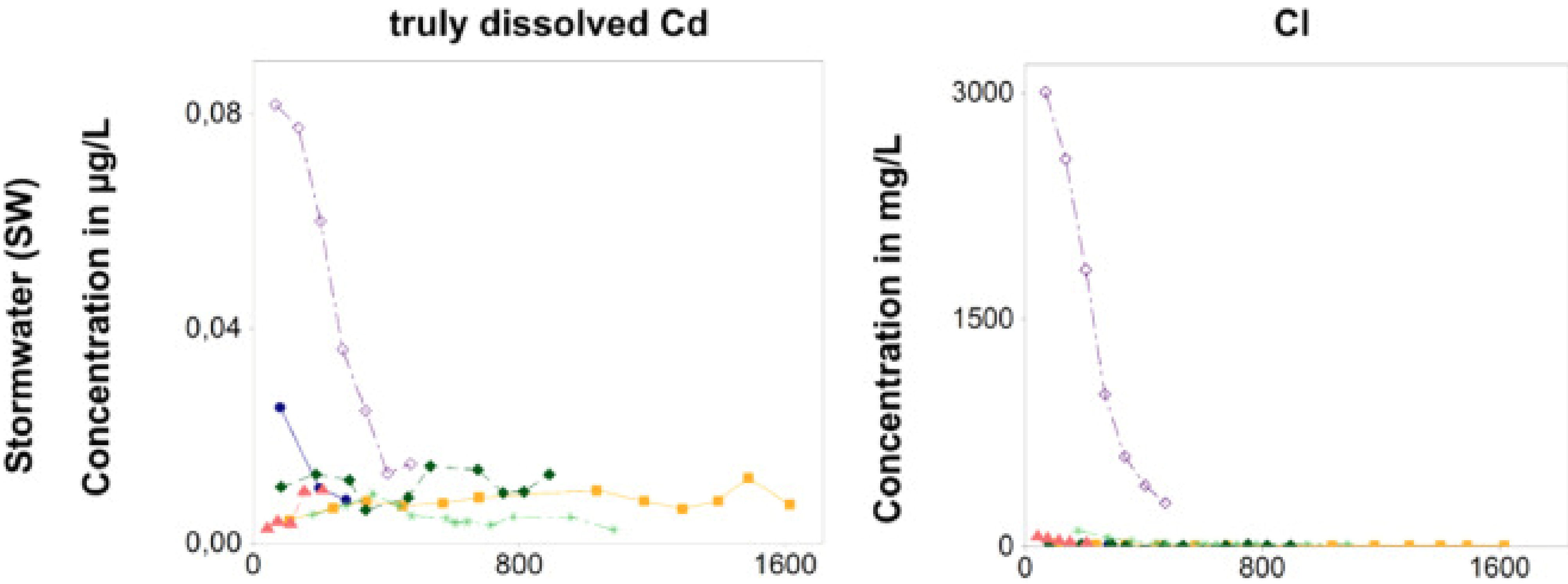
- First study investigating three different size fractions of MPs in urban snow.
- Road snowbanks contained high concentrations of tyre & road wear particles (T&RWP).
- The smallest fraction (50–100 μm) of T&RWPs occurred in the highest concentrations.
- Snowbanks accumulate MPs, which are released during melting to the environment.

GRAPHICAL ABSTRACT

09/pdf



Stormwater & snowmelt quality



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What to do?

- Understand the **site / climate specific** challenges, incl. seasonal variations!
- Understand how stormwater control measures (SCM) / blue green infrastructure (BGI) are impacted by these.
- Adapt BGI / SCM according to these challenges.

Winter BGI

Winter BGI

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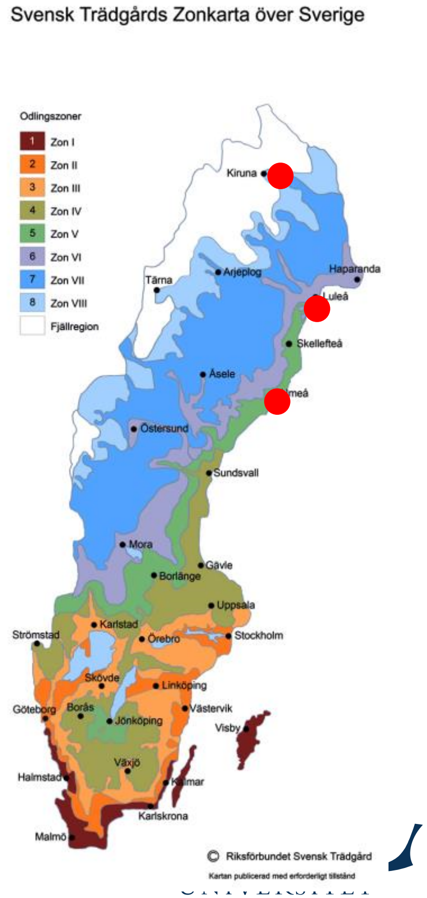
Green roofs: vegetation survey

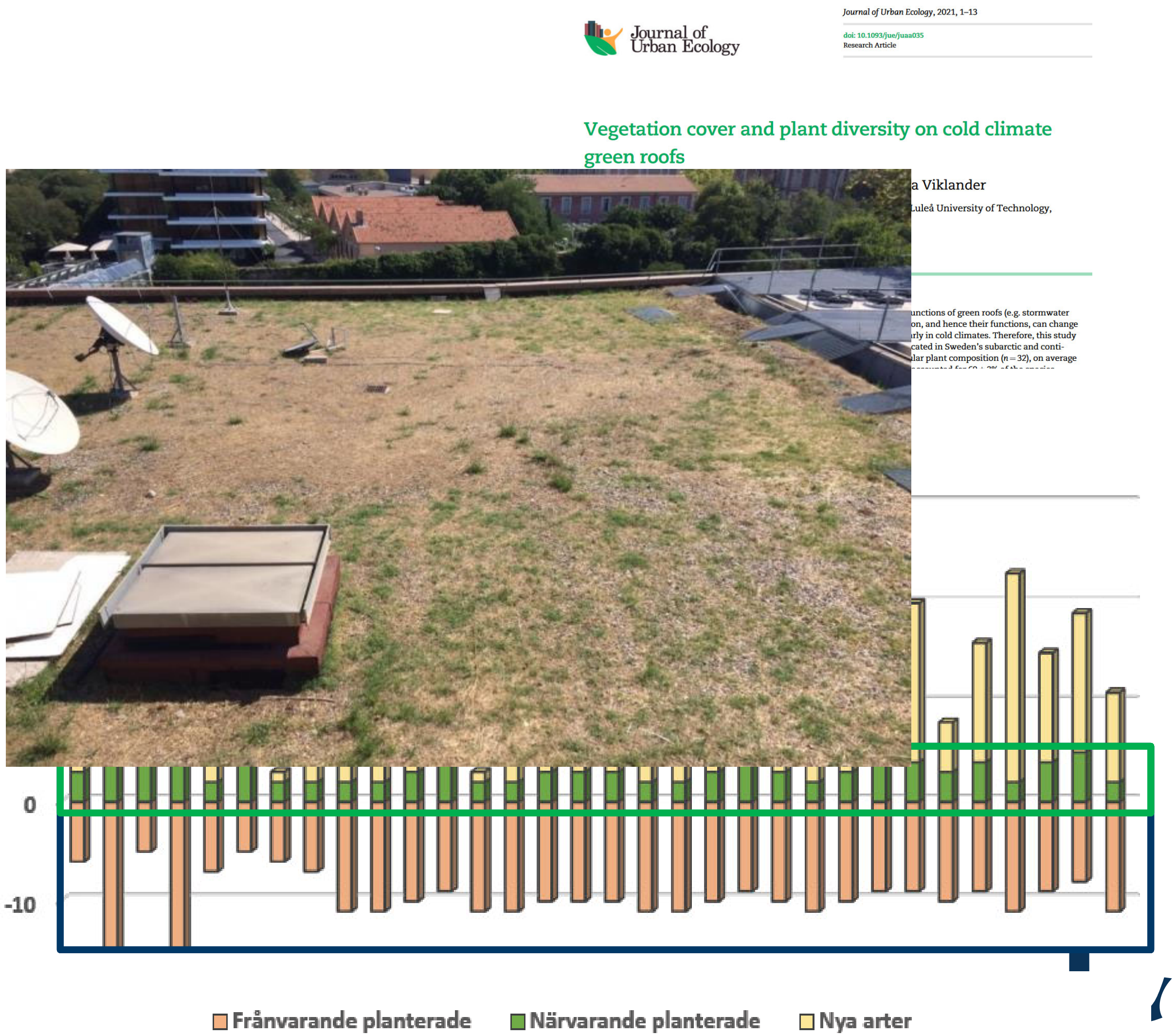
Kiruna (n=12)

Luleå (n=5)

Umeå (n=24)

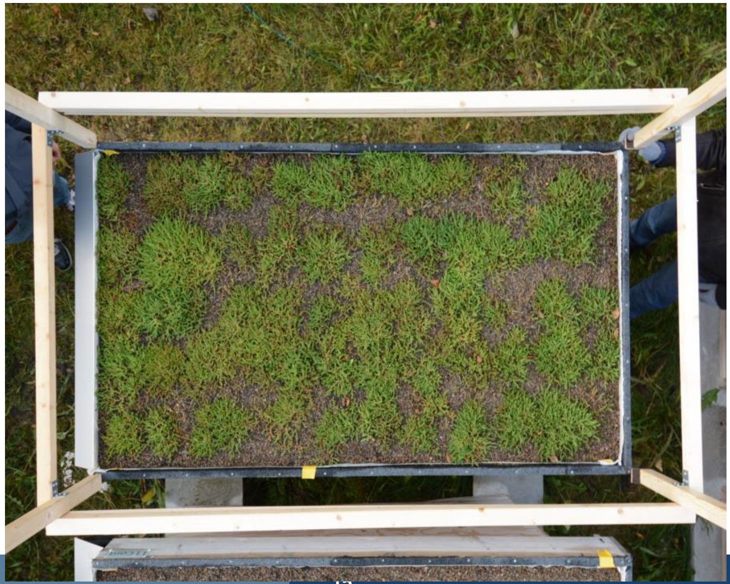


Green roofs: vegetation survey

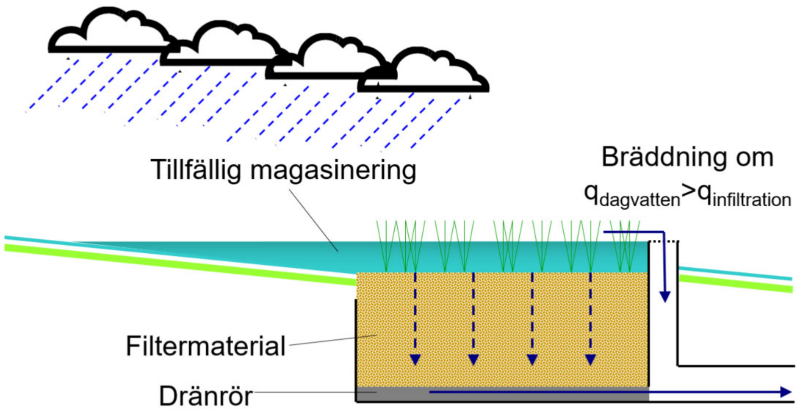









Bioretention



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Bioretention

Winter performance:

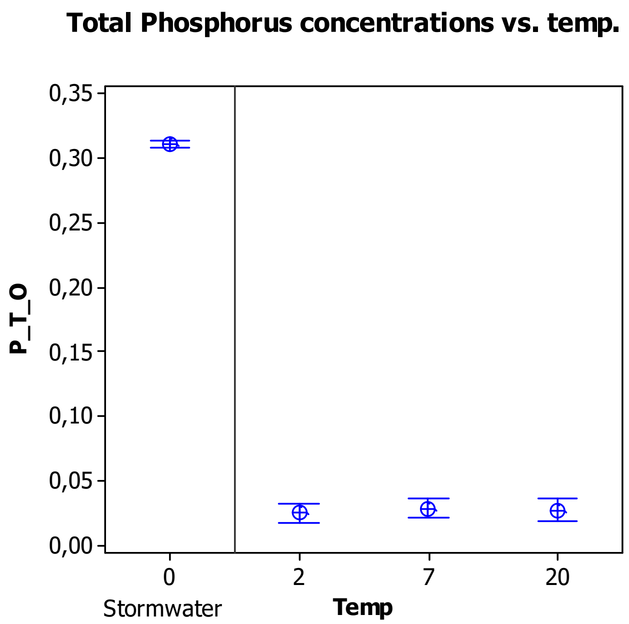
- cold temperatures
- Lab experiment

Biofilters at

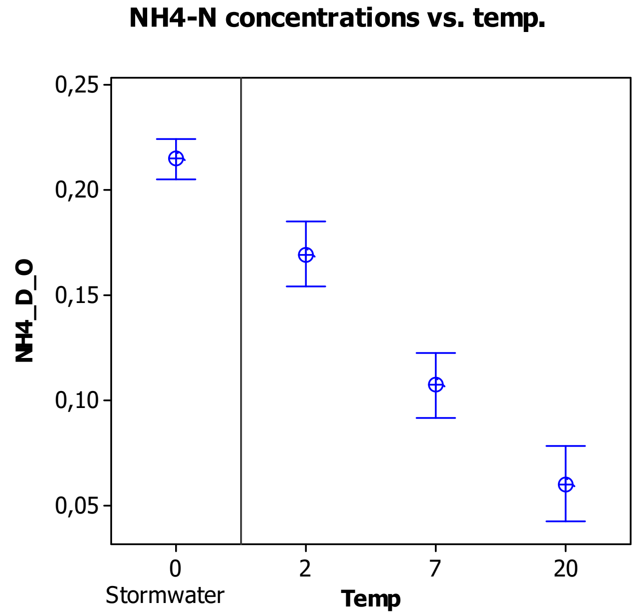
2, 7 and 20 ° C

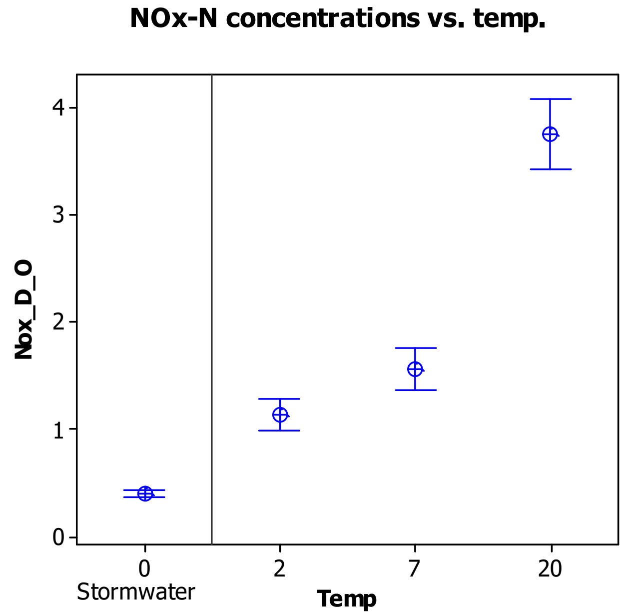
Bioretention

Phosphorus



Nitrogen





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Water Air Soil Pollut (2011) 219:303–317
DOI 10.1007/s11270-010-0708-2

Laboratory Study of Stormwater Biofiltration in Low Temperatures: Total and Dissolved Metal Removals and Fates

Godecke-Tobias Blecken · Jiri Marsalek · Maria Viklander

Received: 17 September 2010 / Accepted: 24 November 2010 / Published online: 8 December 2010

Abstract Stormwater biofilters, which are recommended for application in both Water-Sensitive Urban Design and Low Impact Development, can remove up Zn removals in general, but Cu removals increased with decreasing temperatures. This was explained by increased biological activities in the filters at warmer

Journal of Hydrology 394 (2010) 507–514
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Journal of Hydrology
journal homepage: www.elsevier.com/locate/jhydrol

Laboratory study on stormwater biofiltration: Nutrient and sediment removal in cold temperatures

Godecke-Tobias Blecken [a,*], Yaron Zinger [b], Ana Deletić [b], Tim D. Fletcher [b], Annelie Hedström [a], Maria Viklander [a]
[a] Urban Water, Department of Civil, Mining and Environmental Engineering, Luleå University of Technology, 971 87 Luleå, Sweden
[b] Facility for Advancing Water Biofiltration, Department of Civil Engineering, Monash University, Victoria 3800, Australia

ARTICLE INFO

Article history:
Received 29 March 2010

ABSTRACT

Stormwater biofilters have the ability to remove nutrients from stormwater. Reliable pollutant removal during the cold season is particularly important due to the comparably high contamination levels. How-

WATER RESEARCH 41 (2007) 4061–4072
Available at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/watres

Snowmelt pollutant removal in bioretention areas

Tone Merete Muthanna [a,], Maria Viklander [b], Godecke Blecken [b], Sveinn T. Thorolfsson [a]*
[a] Department of Hydraulic and Environmental Engineering, Norwegian University of Science and Technology, S.P. Andersensv. 5, N7491 Trondheim, Norway
[b] Division of Sanitary Engineering, Luleå University of Technology, S-971 87 Luleå, Sweden

ARTICLE INFO

Article history:
Received 12 November 2006

ABSTRACT

Snow accumulating in urban areas and alongside roads can accumulate high pollutant loads and the subsequent snowmelt can produce high pollutant loads in receiving waters.

Science of the Total Environment 579 (2017) 1588–1599
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journal homepage: www.elsevier.com/locate/scitotenv

Do salt and low temperature impair metal treatment in stormwater bioretention cells with or without a submerged zone?

Laila C. Søberg *, Maria Viklander, Godecke-Tobias Blecken
Urban Water, Luleå University of Technology, 97187 Luleå, Sweden

HIGHLIGHTS

- Evaluated the effect of salt, temperature and submerged zone on bioretention performance.
- Full-scale bioretention columns in a controlled 2^3 full factorial design.

GRAPHICAL ABSTRACT

Water Air Soil Pollut (2020) 231: 270
https://doi.org/10.1007/s11270-020-04646-3

Phosphorus and TSS Removal by Stormwater Bioretention: Effects of Temperature, Salt, and a Submerged Zone and Their Interactions

Laila C. Søberg · Ahmed M. Al-Rubaei · Maria Viklander · Godecke-Tobias Blecken

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Abstract To prevent deterioration of receiving water bodies, phosphorus and total suspended solid (TSS) removal from stormwater is commonly targeted, e.g., by bioretention. However, their removal may vary due

Keywords Urban hydrology · Stormwater biofilter · Phosphorus · Road salt · Internal water storage · Temperature

Ecological Engineering 169 (2021) 106302
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Ecological Engineering
journal homepage: www.elsevier.com/locate/ecoleng

Nitrogen removal in stormwater bioretention facilities: Effects of drying, temperature and a submerged zone

Laila C. Søberg *, Maria Viklander, Godecke-Tobias Blecken
Urban Water, Luleå University of Technology, 97187 Luleå, Sweden

ARTICLE INFO

Keywords:
Stormwater biofilter
Internal water storage

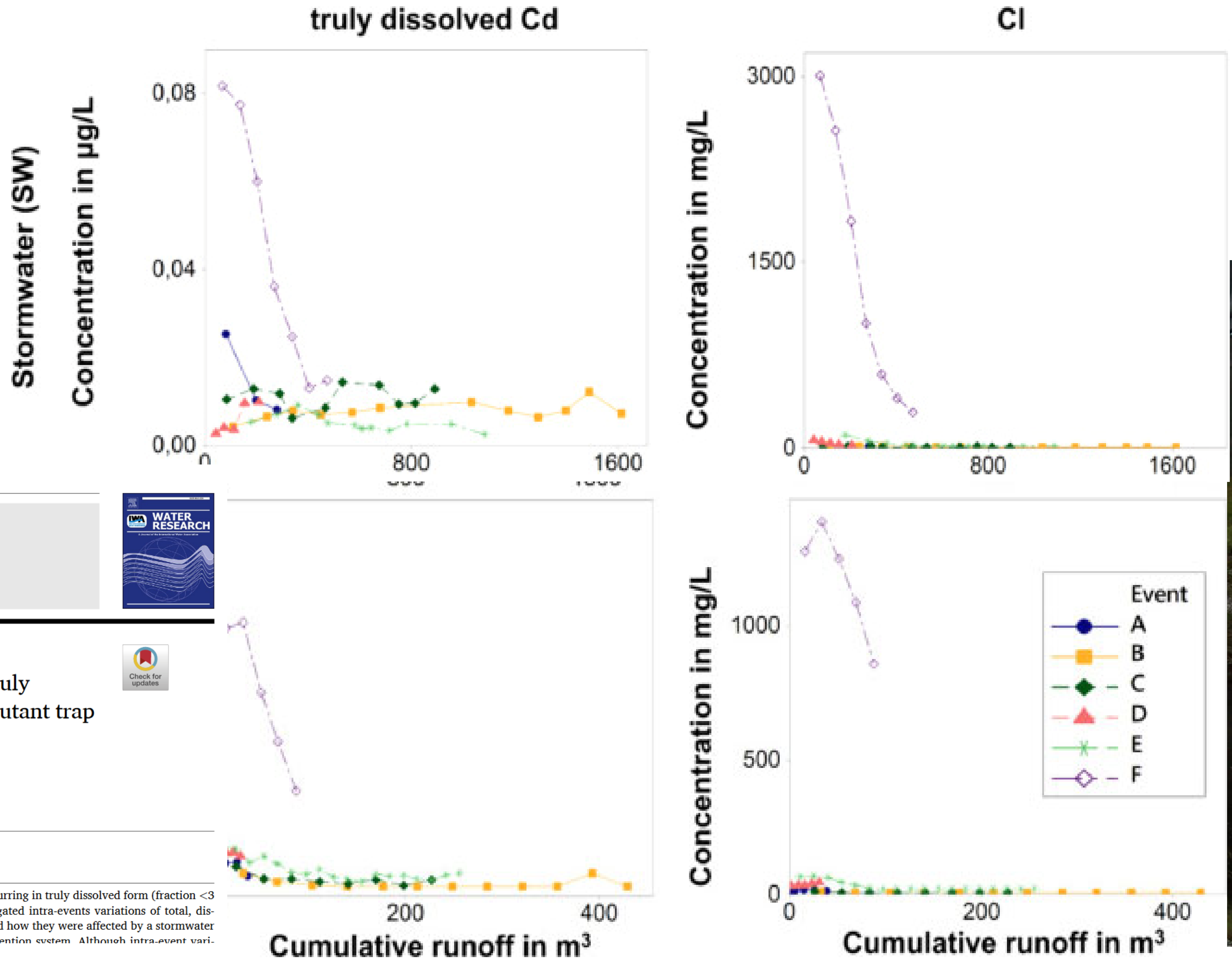
ABSTRACT

Removal of ammonium-nitrogen (NH_4-N), nitrite/nitrate-nitrogen (summarized as NO_x—N) and total nitrogen (TN) was examined in pilot-scale bioretention columns with and without a submerged zone under varied temperature and length of antecedent dry periods. The experiment was divided into wet and dry periods and samples

Bioretention

Winter performance:

- Impact of road salt
- Field test



Water Research 216 (2022) 118284

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Investigation of intra - event variations of total, dissolved and truly dissolved metal concentrations in highway runoff and a gross pollutant trap – bioretention stormwater treatment train

Katharina Lange*, Maria Viklander, Godecke-Tobias Blecken

Urban Water Engineering, Luleå University of Technology, Luleå 97187, Sweden

ARTICLE INFO

Keywords:
Biofilter
Metals
Intra-event variations

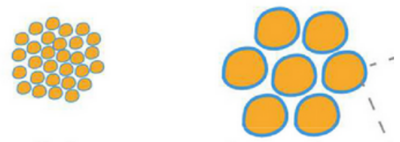
ABSTRACT

Metals in stormwater can be toxic to organisms, particularly when occurring in truly dissolved form (fraction <3 kDa). Here, using 153 samples collected during six rains, we investigated intra-events variations of total, dissolved and truly dissolved metal concentrations in highway runoff, and how they were affected by a stormwater treatment train, comprising a gross pollutant trap (GPT) and a bioretention system. Although intra-event vari-

Bioretention

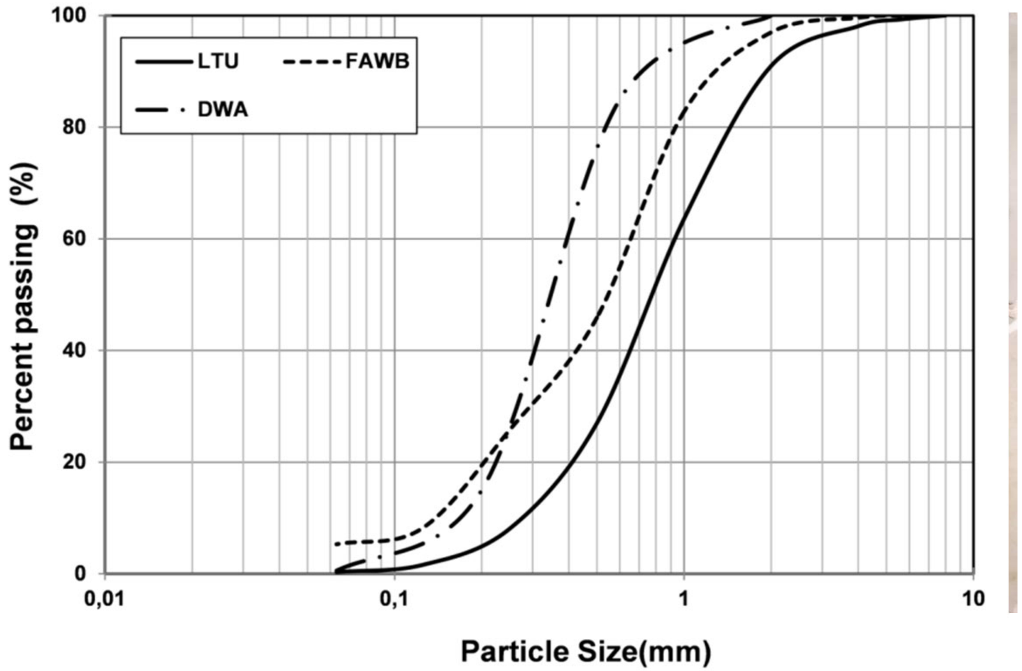
Filter Material

Effect of physical properties of BSM



Effects	● Small size	⬤ Large size
Infiltration	↓ decrease	↑ Increase
water retention	↑ increase	↓ Decrease
clogging;	↑ increase	↓ Decrease
Pollutant removal	↑ increase	↓ Decrease

Tirpak et al 2021



Lower percentage of fines in cold climate (e.g. “LTU”) to avoid freezing pore water

Compromise between treatment and infiltration

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Adapted management

Example: Infiltration facilities

Challenge: clogging

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Blue green white infrastructure

	Importance during annual cycle											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
	Winter			Spring snow melt		Summer		Autum			Winter	
Blue Structure			++	+++	+++	++	++	++	++	+		
Green Structure					+	++	+++	+++	++	+		
White Structure	+++	+++	+++	++	+				+	+	++	+++


Forum

ASCE

Blue-Green Infrastructure for All Seasons: The Need for Multicolored Thinking

Pär Öhrn Sagrelius

Ph.D. Student, Dept. of Civil, Environmental and Natural Resources Engineering, Luleå Univ. of Technology, Laboratorievägen 14, SE-971 87, Luleå, Sweden; Tyréns AB, Garvaregatan 4C, SE-602 21, Norrköping, Sweden (corresponding author). ORCID: https://orcid.org/0000-0003-1714-4919. Email: par.sagrelius@ltu.se

Lian Lundy

Professor, Dept. of Civil, Environmental and Natural Resources Engineering, Luleå Univ. of Technology, Laboratorievägen 14, SE-971 87, Luleå, Sweden. ORCID: https://orcid.org/0000-0003-1155-4132. Email: lian.lundy@ltu.se

Godecke Blecken

Professor, Dept. of Civil, Environmental and Natural Resources Engineering, Luleå Univ. of Technology, Laboratorievägen 14, SE-971 87, Luleå, Sweden. Email: godble@ltu.se

Agatino Rizzo

Professor, Dept. of Civil, Environmental and Natural Resources Engineering, Luleå Univ. of Technology, Laboratorievägen 14, SE-971 87, Luleå, Sweden. ORCID: https://orcid.org/0000-0001-6831-8857. Email: agatino.rizzo@ltu.se

Maria Viklander

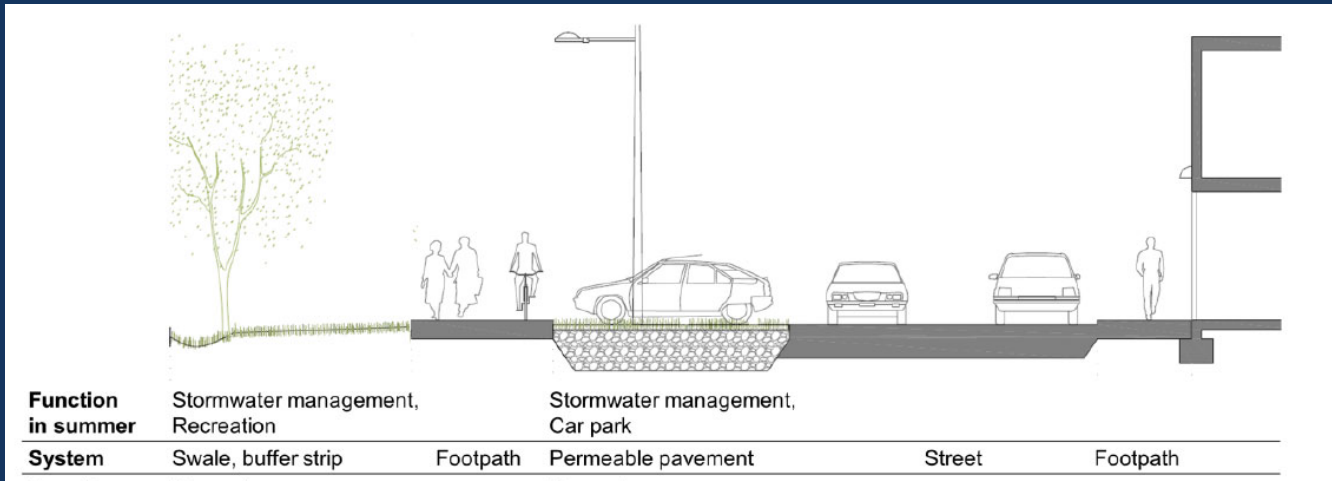
Professor, Dept. of Civil, Environmental and Natural Resources Engineering, Luleå Univ. of Technology, Laboratorievägen 14, SE-971 87, Luleå, Sweden. Email: maria.viklander@ltu.se

international (e.g., UN Sustainable Development Goals), European (e.g., the European Green Deal's zero pollution ambition), and national (sustainable planning) requirements. Within urban areas, several studies have evaluated the delivery of a range of ESs by urban blue-green infrastructure (BGI) (also referred to as nature-based solutions) whose primary function is the mitigation of surface runoff quantity and quality (e.g., Ashley et al. 2018). As a concept, BGI goes beyond stormwater (Fletcher et al. 2015), with authors such as Wright (2011) highlighting that connectivity, natural elements, and multifunctionality are core concepts of (blue-)green infrastructure. Consequently, BGI has been promoted as an opportunity to contribute to healthier urban lifestyles, create economic value, increase the resilience of urban spaces in the face of a rapidly changing climate, and reduce the impacts of polluted stormwater on receiving waters (Tzoulas et al. 2007; Fletcher et al. 2015; Ashley et al. 2018).

Though a range of types of BGI have been implemented within a diversity of environments and climates, to date its conceptualization has been a "one size fits all" in that ESs and benefits derived from the blue and green components have been the focus of research and practice. However, in many regions, blue-green spaces are neither blue nor green for extended time periods but, e.g., white (snow covered) or yellow/brown (dormant vegetation or drought). The implications of this for BGI systems at locations outside the temperate climate zones are yet to be robustly evaluated regarding both their technical-environmental functioning and the delivery of ESs.

Hence, in this paper we propose a novel theoretical framework to expand the BGI concept for consideration of ESs from BGI

Blue green white infrastructure



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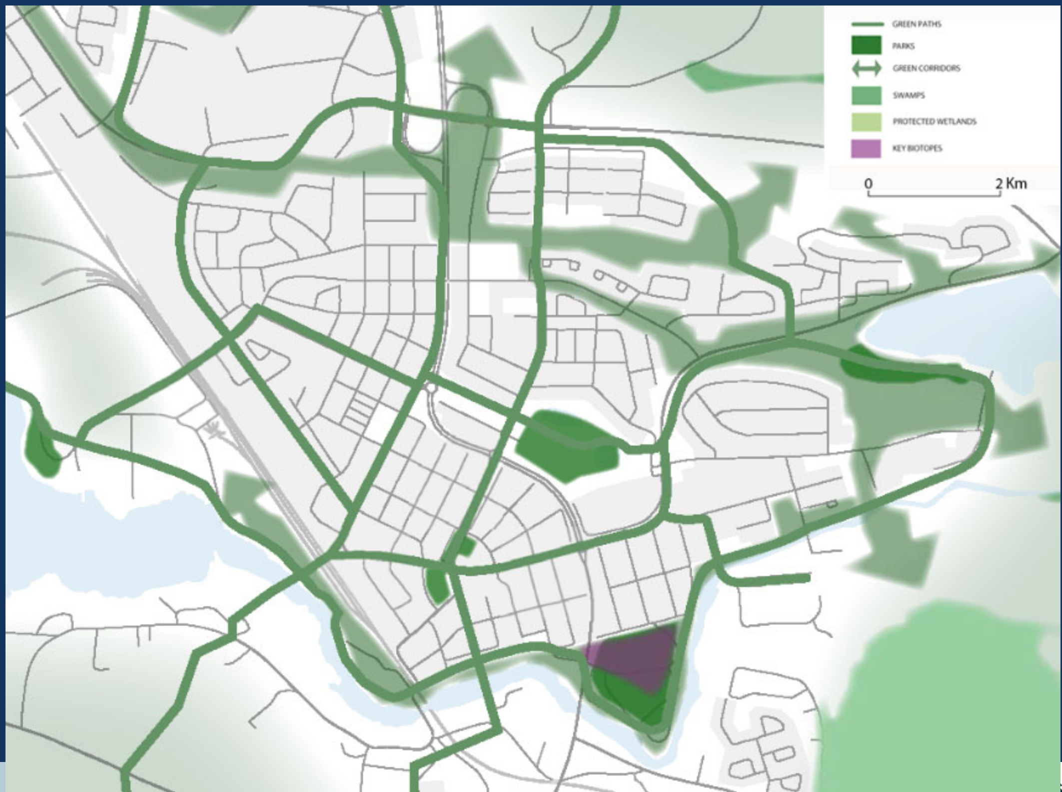
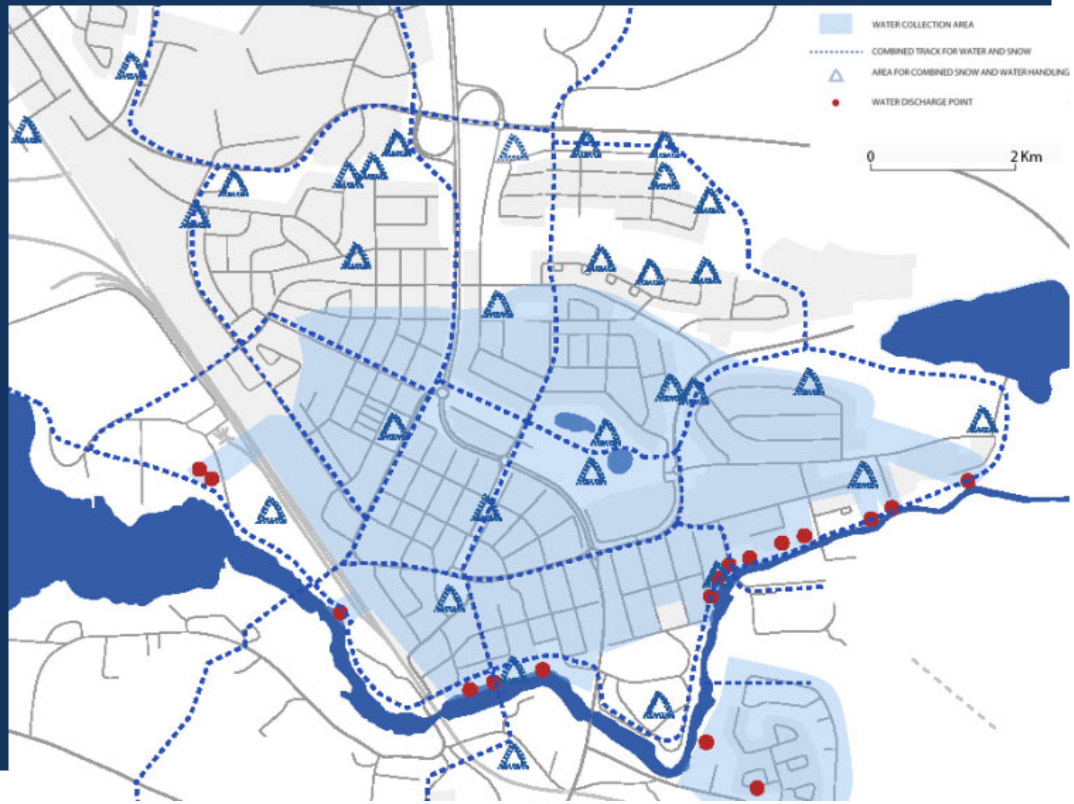
Blue green white infrastructure

Blue green white infrastructure

Example: City of Gällivare, Northern Sweden





Blue green white infrastructure
or
Blue green brown/grey infrastructure

	Importance during annual cycle											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
	Winter		Spring			Summer				Autum		
Blue Structure	++	++	++	+++	+++	+++	+++	+++	++	++	++	++
Green Structure			+	++	++	+++	+++	+++	++	++		
Brown/grey Structure (dormant vegetation)	+++	+++	+						+	+	++	++

	Importance during annual cycle											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec
	Winter			Spring snow melt		Summer		Autum			Winter	
Blue Structure			++	+++	+++	++	++	++	++	+		
Green Structure					+	++	+++	+++	++	+		
White Structure	+++	+++	+++	++	+				+	+	++	+++

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What to do?

Understand the **site / climate specific** challenges, incl. seasonal variations!

Understand how stormwater control measures (SCM) / blue green infrastructure (BGI) are impacted by these.

Adapt BGI / SCM according to these challenges.

It's sometimes challenging, we need more knowledge.

But it's possible!

STORMWATER MANAGEMENT: WINTER FUNCTIONALITY

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Professor Urban Water Management
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godble@ltu.se

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