



Environmental impacts of different stormwater management systems

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Innovation Fund Denmark

RESEARCH, TECHNOLOGY & GROWTH

Overview

Background

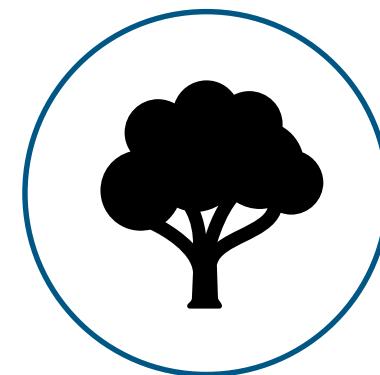
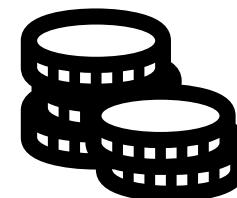
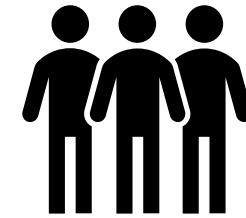
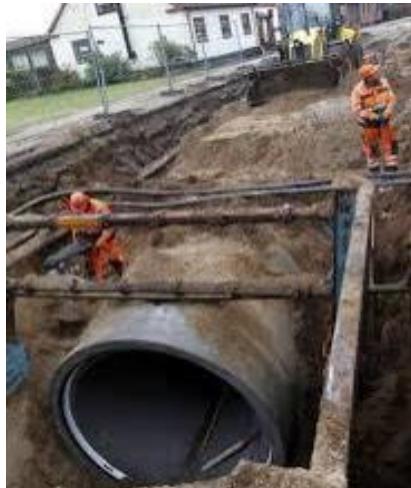
Method: life cycle assessment

Application: Skibus, Odense

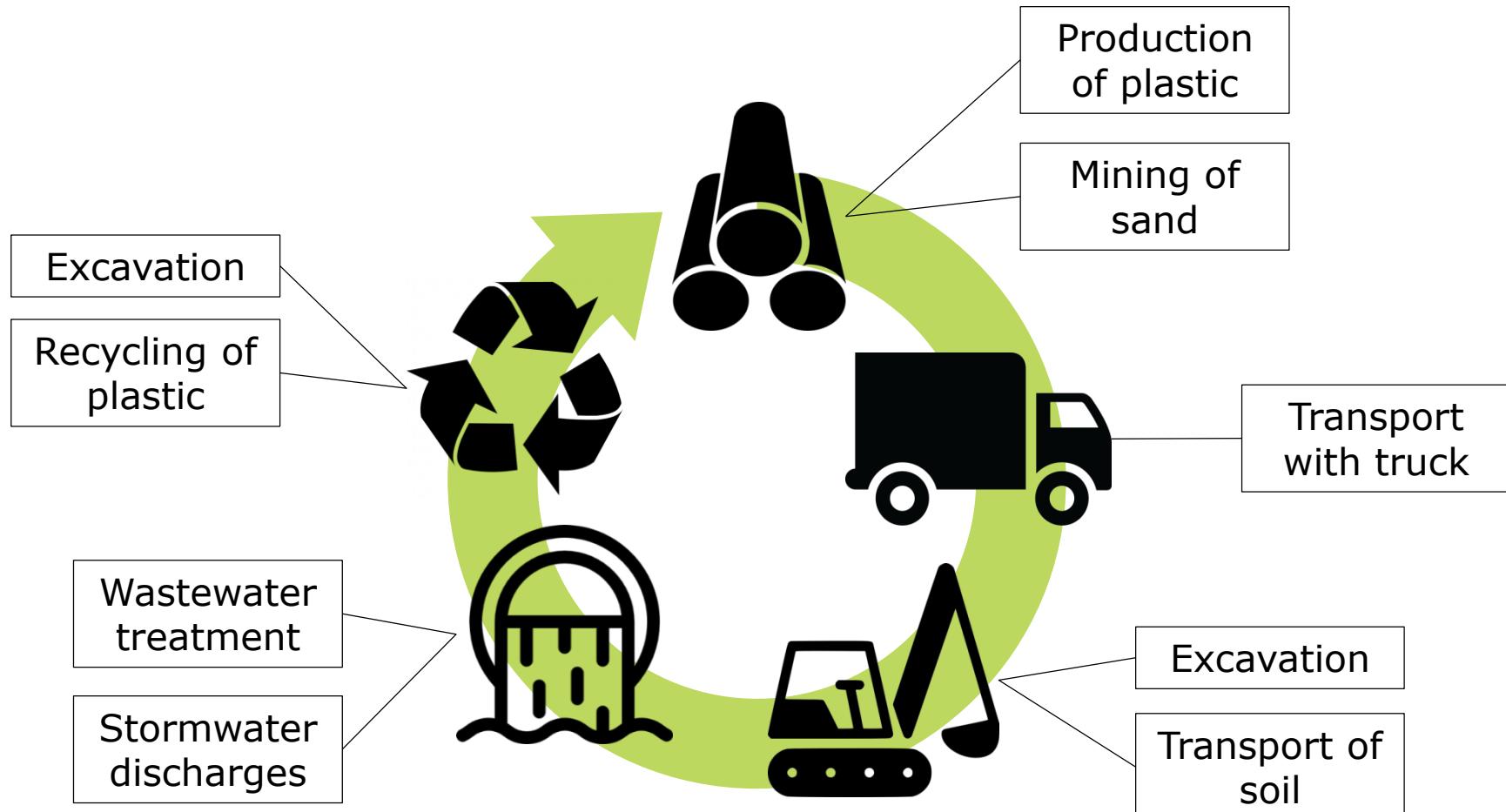
Implementation

Conclusions

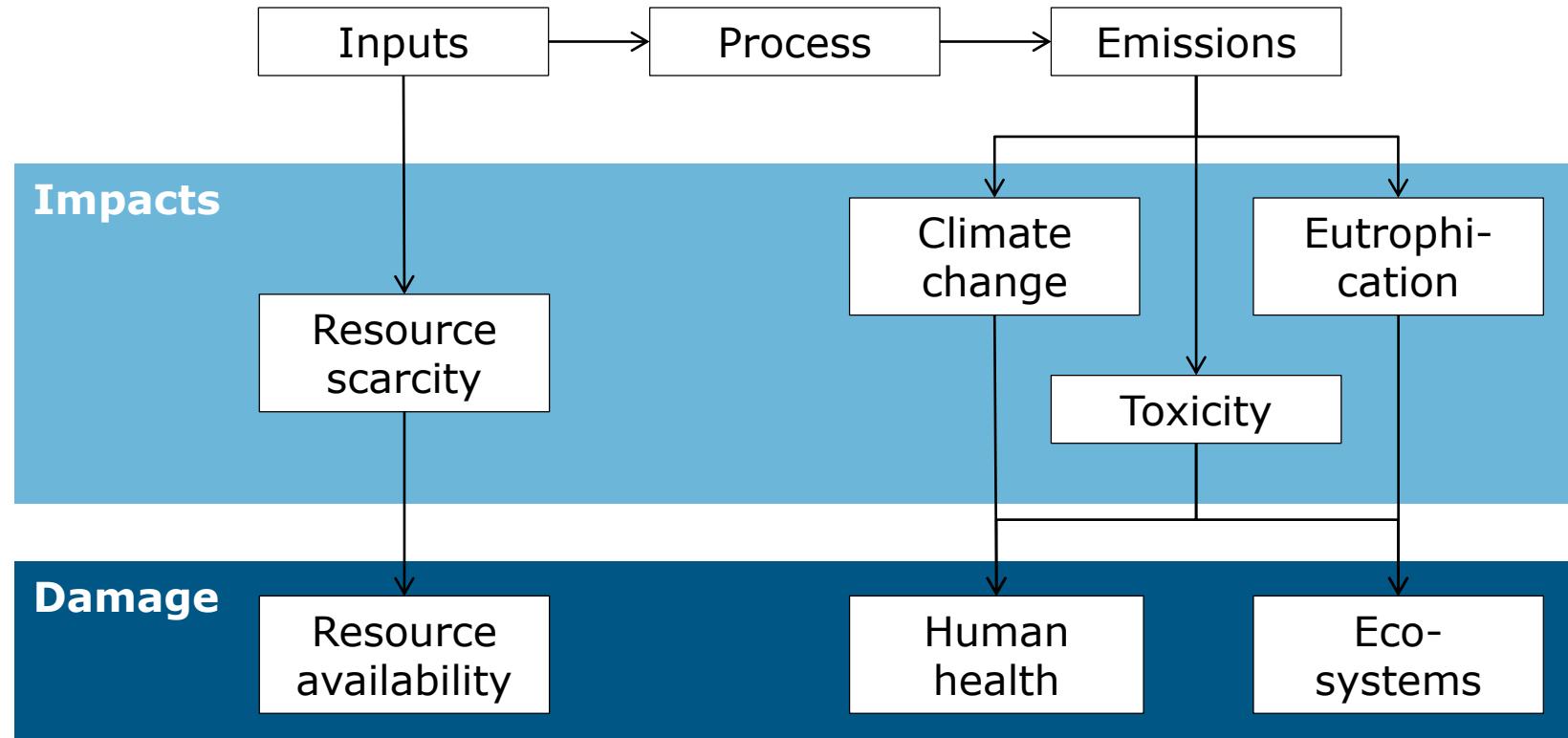
Comparison of systems



Stormwater management life cycle



Steps of life cycle assessment

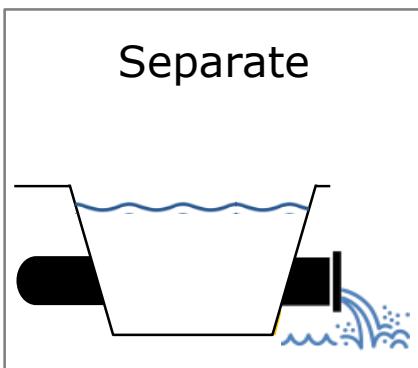
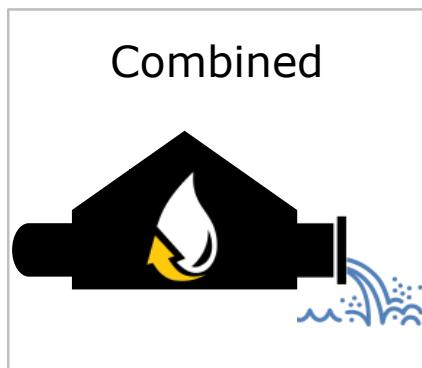


Case study: Skibhus, Odense

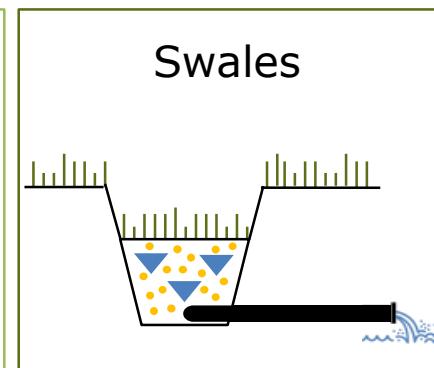
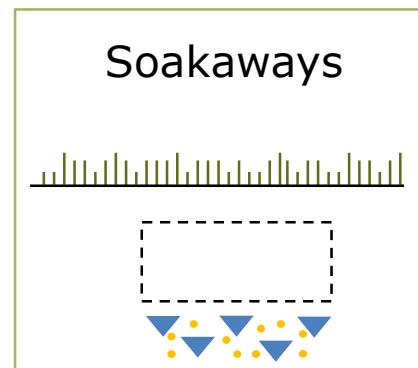


- 260ha (100ha reduced)
- Low-density housing
- Danish flood safety standards (skrift 27)

Subsurface systems

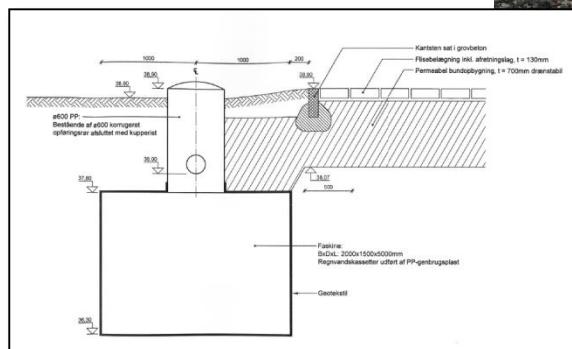


Green infrastructure



Process inventory

Odense Kommune BELLINGE Bæredygtig Byggemodning, etape 1		TBL
Dato: 2013-06-17		
Arbejder der udføres i forbindelse med Bellinge Bæredygtig Byggemodning, etape 1.		
Post 1	Byggeplads	kr.
Post 2.1	Jordarbejde - Udgraving	kr.
Post 2.2	Jordarbejde - Tørholdelse	kr.
Post 3.1	Jordarbejde for ledninger - Udgraving	kr.
Post 3.2	Jordarbejde for ledninger - Tørholdelse	kr.
Post 3.3	Jordarbejde for ledninger - Tilfyldning	kr.
Post 4.1	Afløb i jord - Brønde og dæksler	kr.
Post 4.2	Afløb i jord - Dränledninger	kr.
Post 5 Befastelser		kr.
Post 6 Beplantning		kr.
Post 7 Variable ydelser		kr.
Post 8 Optionsmængder		kr.
Samlet sum Post 1-6, ekskl. moms at overføre til tilbudslisten side 2		kr.



Aalborg Universitet, 2012

Faktablad om dimensionering af våde regnvandsbassiner

Faktabladet med faktabladet er at give en kort vejledning om hvordan vi laver regnvandsbassiner dimensioneres.

Faktabladet er udarbejdet som et led i projektet "Teknologier til håndtering og renning af separat regnvand", støttet af Miljøstyrelsen's program "Innovationsdrivende miljøeffektiv teknologi", Naturstyrelsen. I projektet deltag fra Aalborg Universitet: Jes Vollertsen, Thorkild Hvilsted-Jacobsen, Astbjørn Haering Nielsen. Fra Orbicon A/S deltog Søren Gabril. Fra Teknologisk Institut deltog Inge Padager. Fra Danmarks Tekniske Universitet deltog Karsten Amborg-Nielsen.

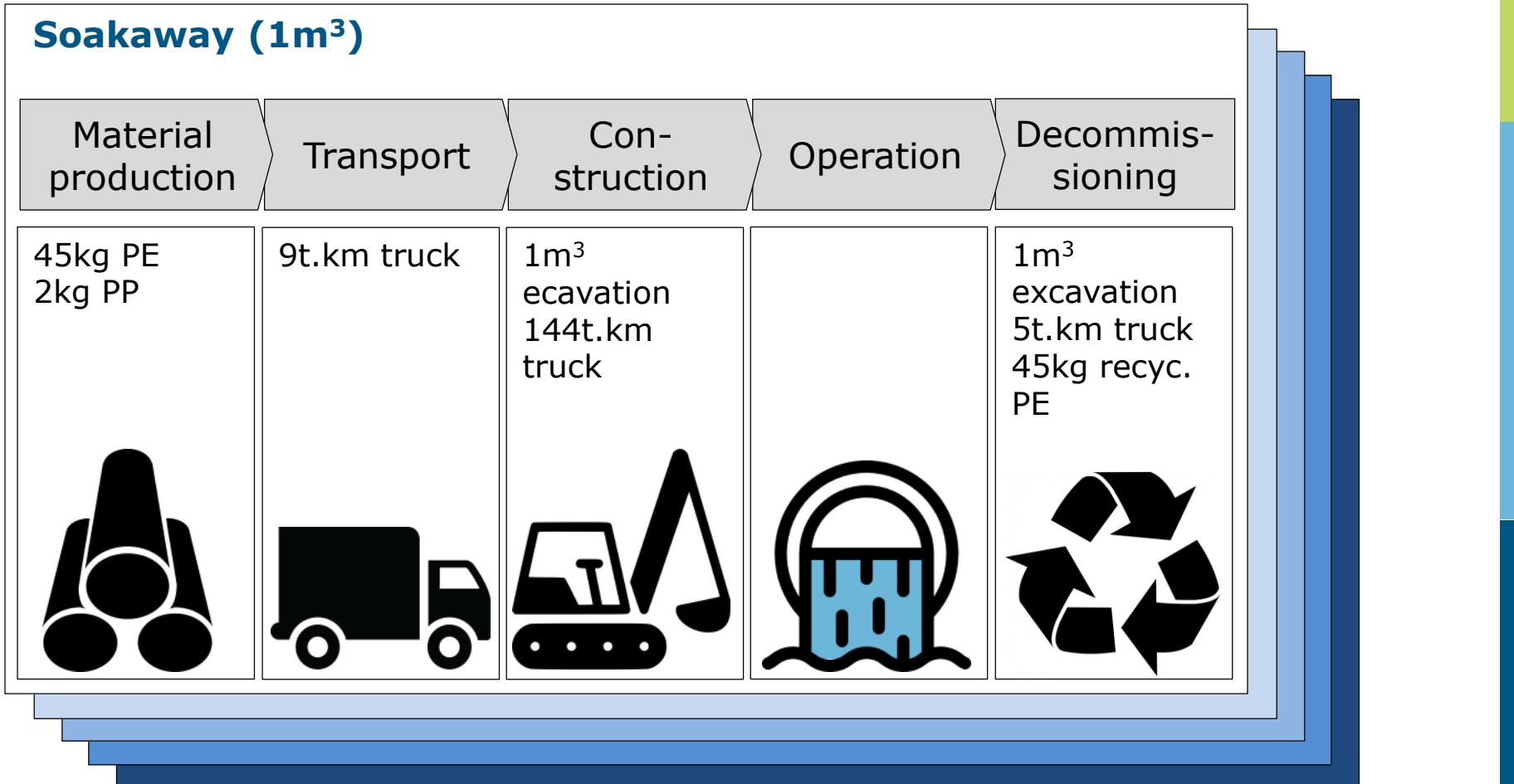
Jes Vollertsen, Thorkild Hvilsted-Jacobsen, Astbjørn Haering Nielsen

AALBORG UNIVERSITET
DTU
TEKNOLOGISK INSTITUT
ORBICON

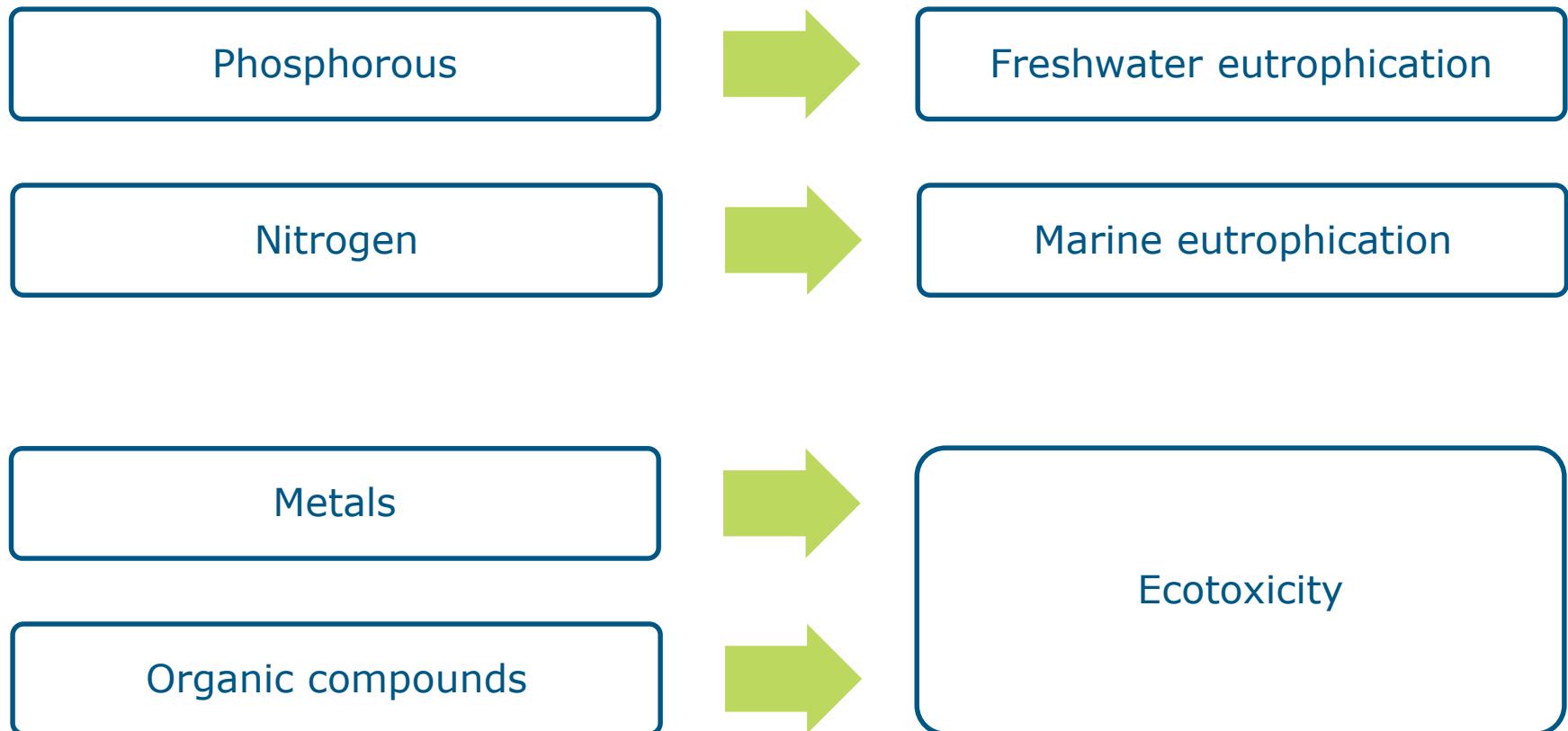


ciria
Department Environment Food & Rural Affairs
Sustaining Infrastructure with Regeneration

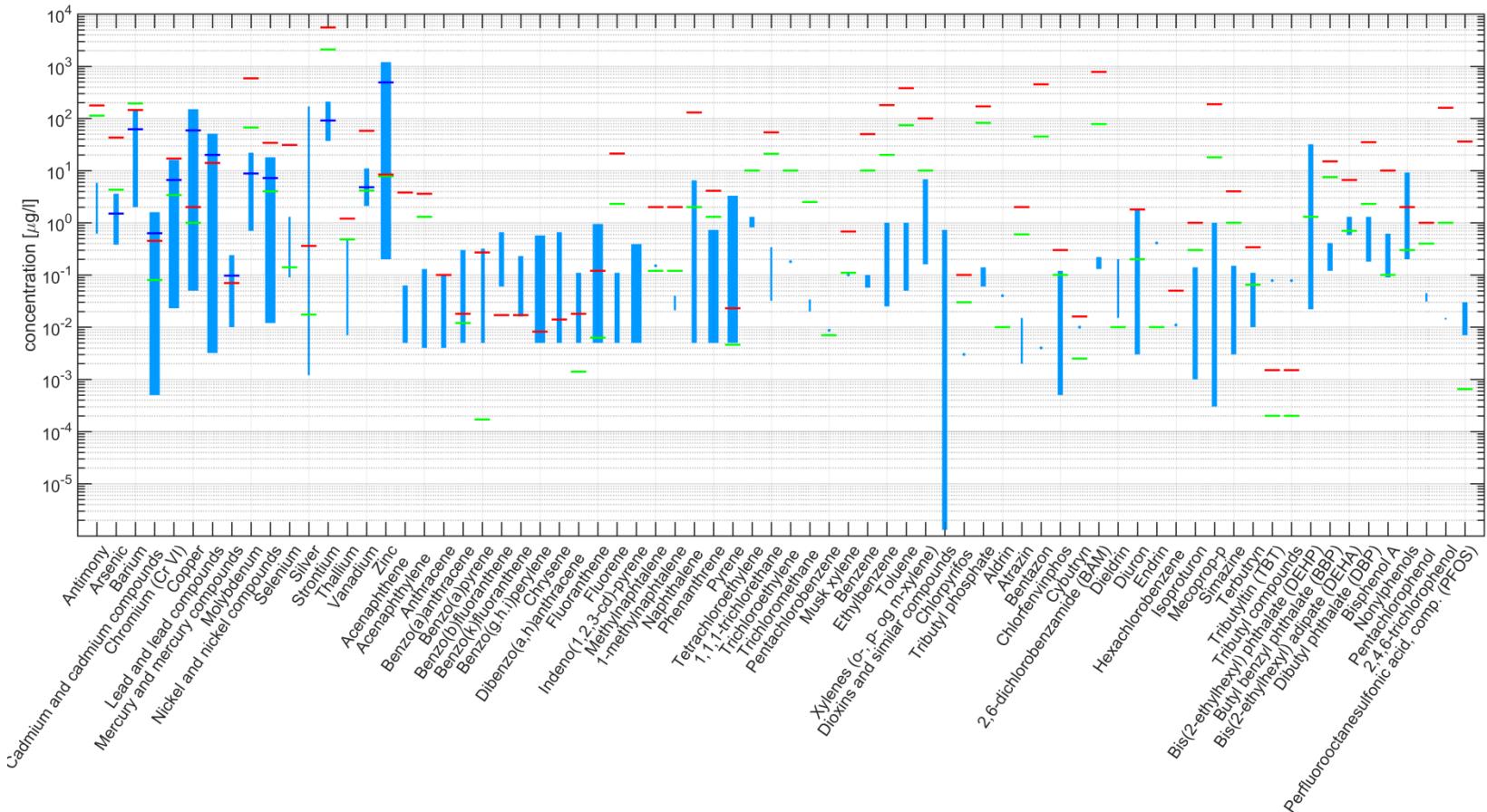
Process inventory



Point source emission inventory



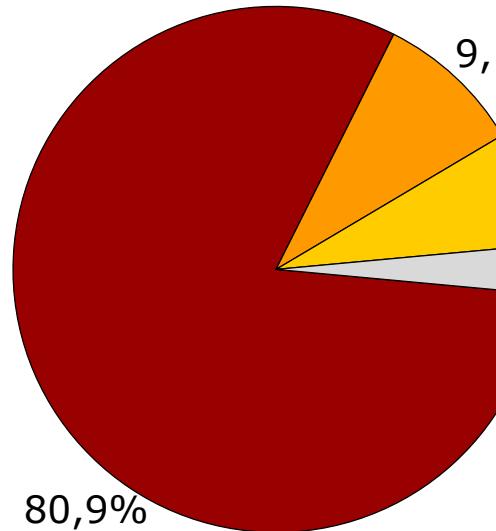
Point source emission inventory



Brudner et al. (2019). Pollution levels of stormwater discharges and resulting environmental impacts. *Science of the Total Environment* 663, p.754-763.

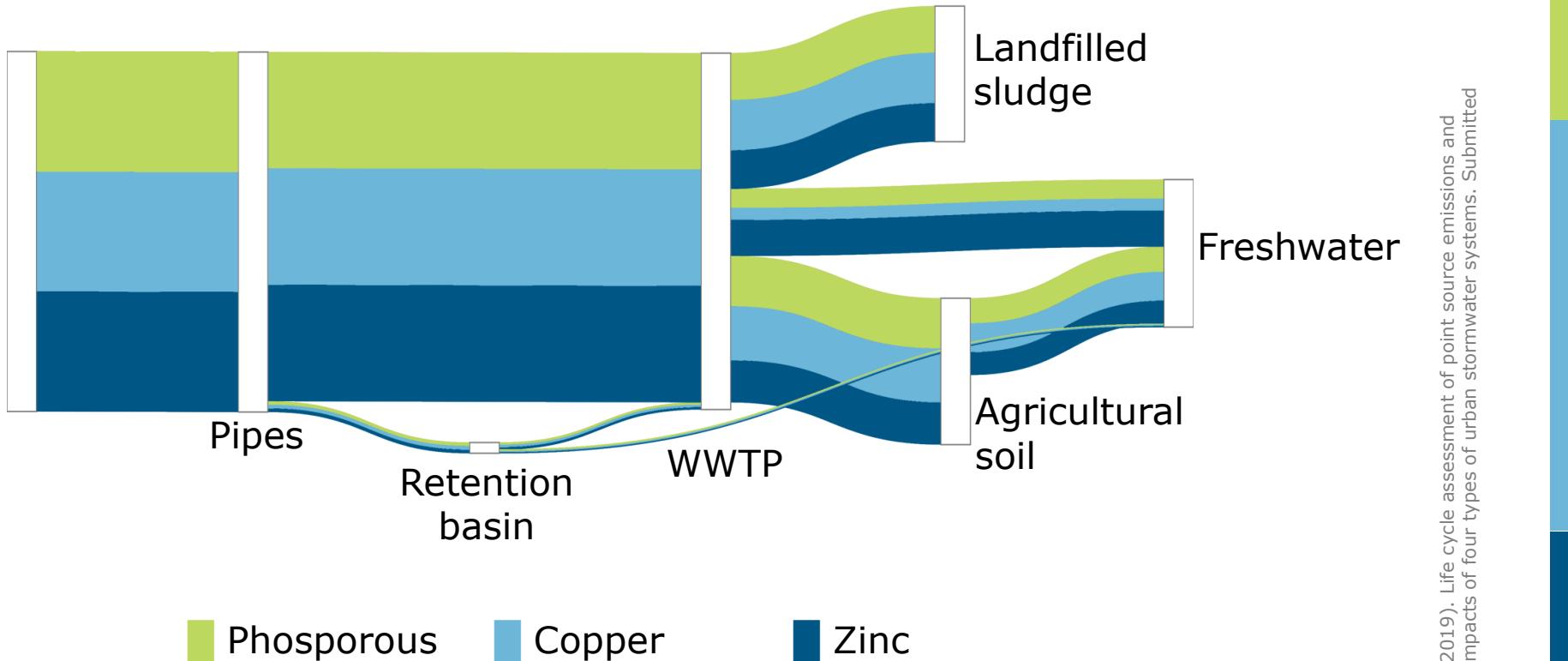
Stormwater discharges: ecotoxicity

Freshwater ecotoxicity



Brudler et al. (2019). Pollution levels of stormwater discharges and resulting environmental impacts. Sci. Total Environ. 663, p.754-763; Photo: Jens Lindhe

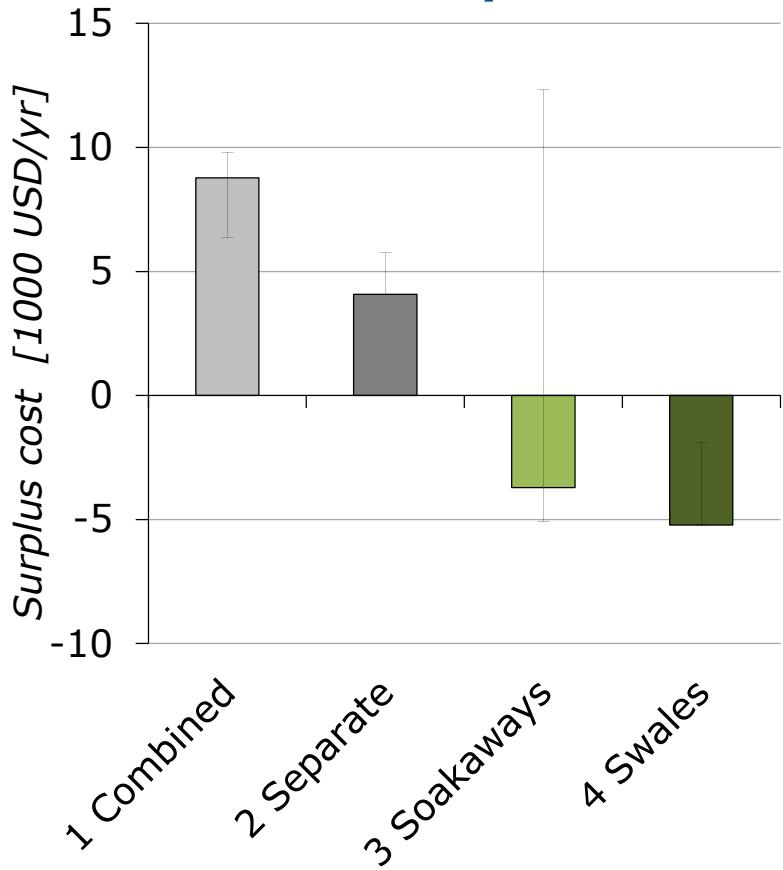
Point source emission inventory



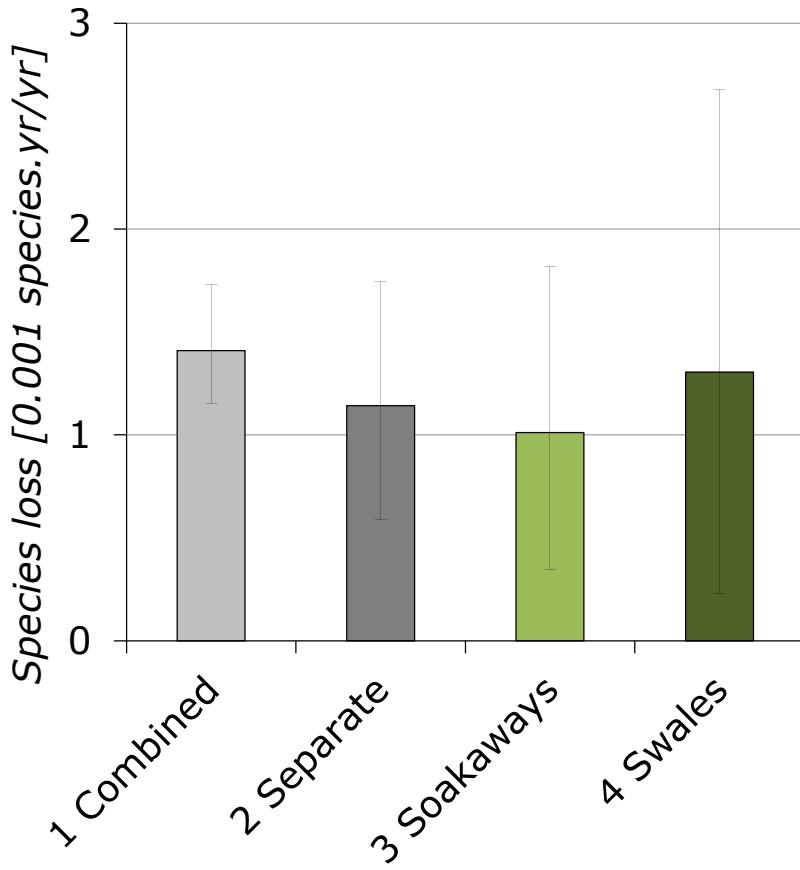
Brudler et al. (2019). Life cycle assessment of point source emissions and infrastructure impacts of four types of urban stormwater systems. Submitted

Environmental damage

Resource availability



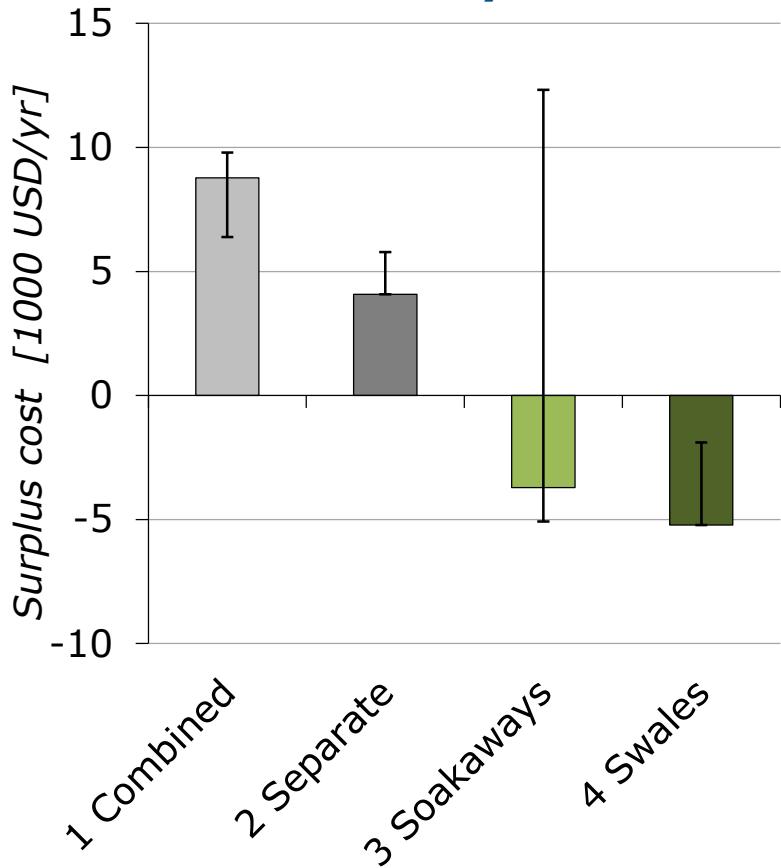
Ecosystems



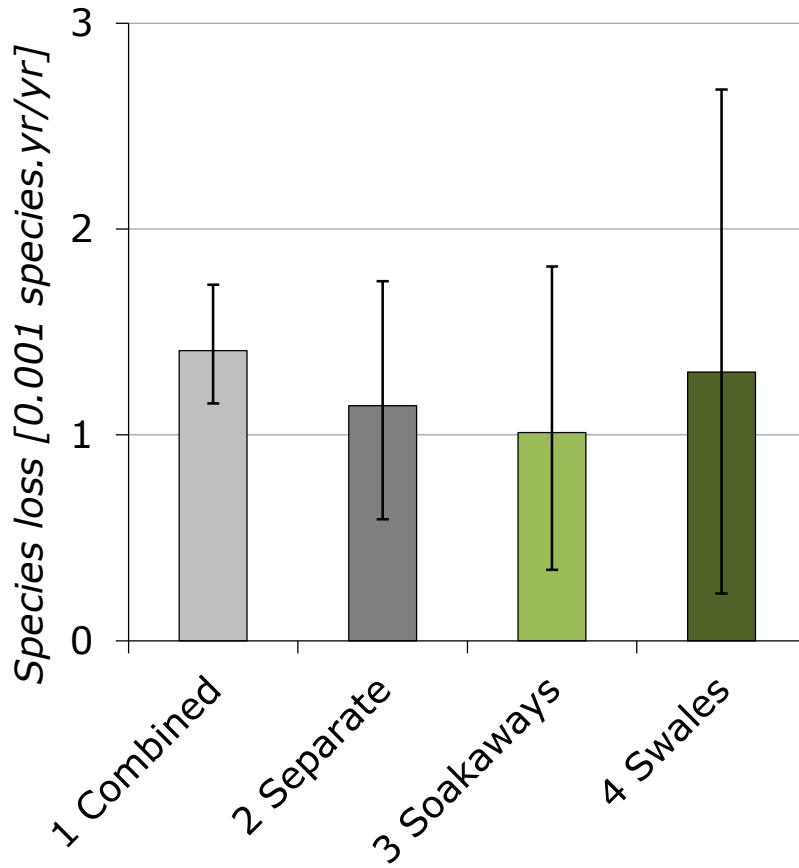
Brudler et al. (2019). Life cycle assessment of point source emissions and infrastructure impacts of four types of urban stormwater systems. Submitted

Uncertainty analysis

Resource availability



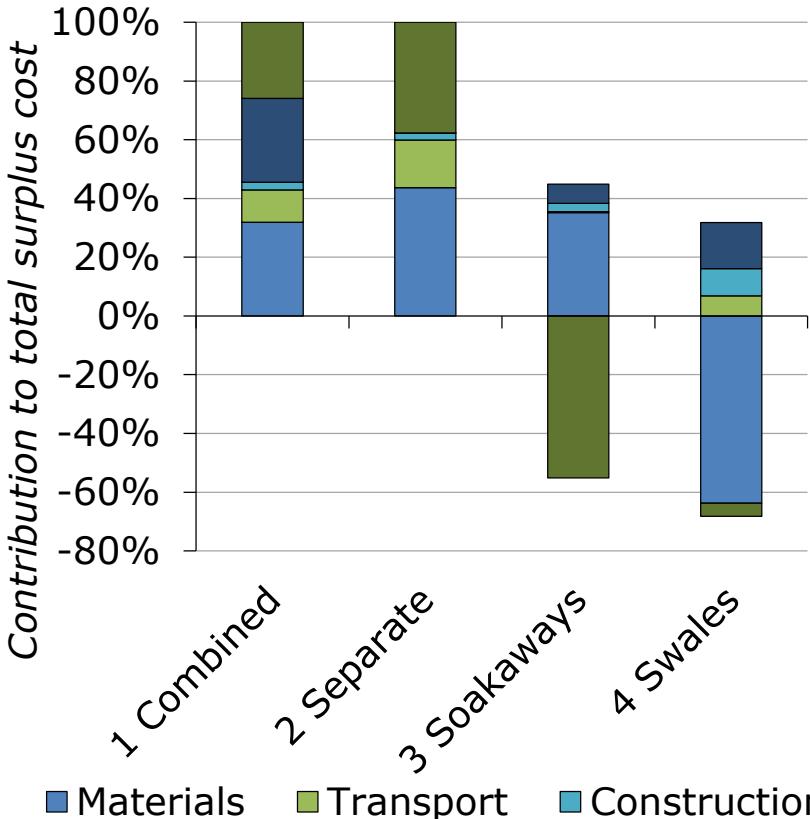
Ecosystems



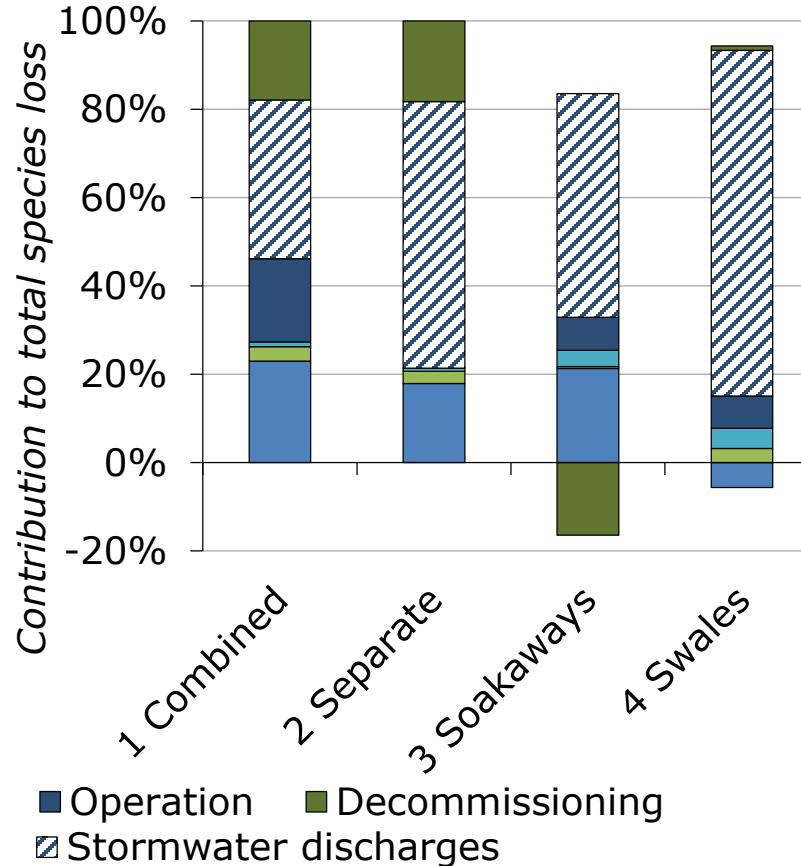
Brudler et al. (2019). Life cycle assessment of point source emissions and infrastructure impacts of four types of urban stormwater systems. Submitted

Contribution analysis

Resource availability



Ecosystems

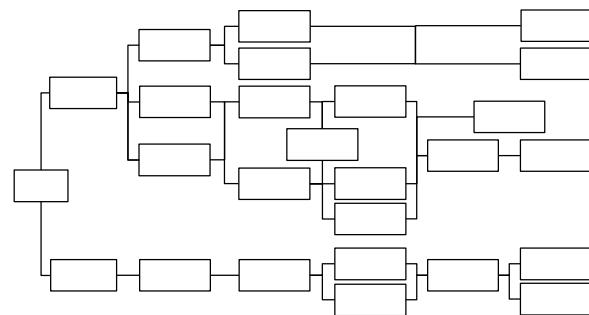


Brudler et al. (2019). Life cycle assessment of point source emissions and infrastructure impacts of four types of urban stormwater systems. Submitted

Stormwater management planning

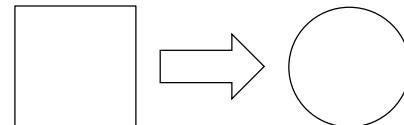
The **planning process** is

- dependend on utility, planner, project...
- iterative



Existing tools are

- either demanding significant resources and knowledge
- or providing only limited information



Development of a **quantative tool** with

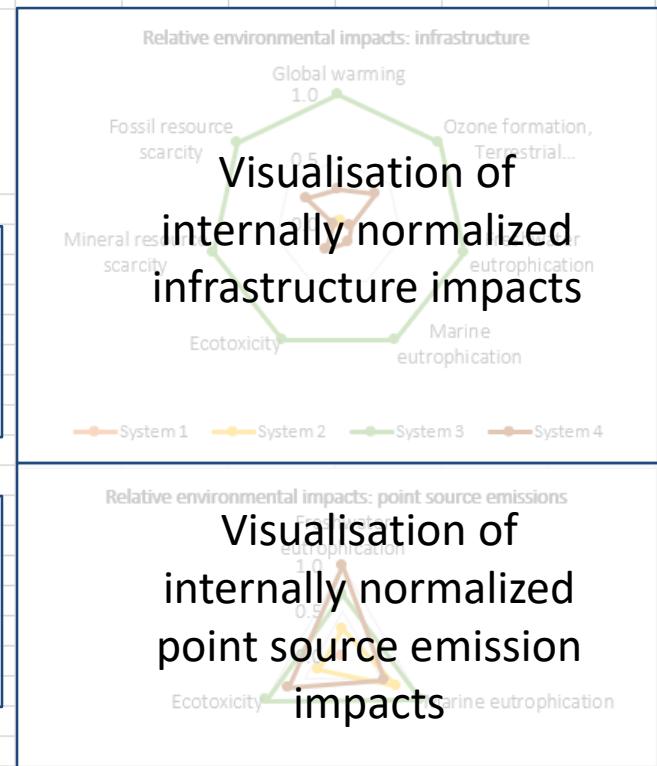
- limited user input
- comparitive and detailed output

Life cycle assessment based tool

	A	B	D	E	F	K	L	M	N	O	P	Q	R	S	AD
1	General information	Assessment period		50 yrs											
2		Catchment area		130 ha											
3		Reduced catchment area		100 ha											
4		Annual rain depth		700 mm											
5															
6	Infrastructure	Element	Material			Quantity									Additional information
7		<input checked="" type="checkbox"/> Subsurface basin	reinforced concrete	Volume:	100 m ³										
8		<input checked="" type="checkbox"/> Pipe, Ø 200-500mm	concrete	Length:	400 m										Iron manhole lids
9		<input type="checkbox"/> Pipe, Ø 600-1500mm	(select)	Length:	m										(select)
10		<input type="checkbox"/> Pipe, Ø 1600-2500mm	(select)	Length:	m										(select)
11		<input type="checkbox"/> Drainage pipe, Ø 50-145mm	PVC	Length:	m										
12		<input type="checkbox"/> Surface basin	(select)	Volume:	m ³										
13		<input type="checkbox"/> Low-lying area	(select)	Area:	m ²	Depth:	m								(select)
14		<input type="checkbox"/> Channel	concrete	Length:	m	Dimensions:	(select)	m							(select)
15		<input type="checkbox"/> Trench	grass	Length:	m	Depth:	m	m							(select)
16		<input type="checkbox"/> Discharge on road	asphalt	Length:	m	Width:	m	m							(select)
17		<input type="checkbox"/> Green strip	grass	Length:	m	Width:	m	m							implemented on road area
18		<input type="checkbox"/> Permeable surface	(select)	Area:	m ²										(select)
19		<input type="checkbox"/> Soakaway	PE	Volume:	m ³										(select)
20		<input type="checkbox"/> Gravel volume	gravel	Volume:	m ³										(select)
21		<input type="checkbox"/> Filter soil	sand / soil	Volume:	m ³										(select)
22		<input type="checkbox"/> Trees		Units:											
23		<input checked="" type="checkbox"/> Wastewater treatment		Volume:	m ³										
24															
25	Point source emissions	Flow path	Fraction of runoff			Elements									Recipient
26		<input checked="" type="checkbox"/> Flow path 1	95 %	WWTP		→ (none)									Marine water
27		<input checked="" type="checkbox"/> Flow path 2	5 %	(none)		→ (none)									Freshwater
28		<input type="checkbox"/> Flow path 3	%	(none)		→ (none)									(select)
		Definition of flow paths				Selection of treatment steps									Recipient

Tool: comparative output

	A	B	I	J	L	P	Q	T	U	V	W	X	Y	Z	AA	AB
1		Midpoint impacts						Endpoint damage								
2		Global warming	Freshwater eutrophication	Marine eutrophication		Ecotoxicity	Mineral resource scarcity	Fossil resource scarcity		Ecosystems	Ressource availability					
3		kgCO2eq	kgPeq	kgNeq	CTUe	kgCueq	kgoileq	species.yr	USD							
4	Infrastructure															
5																
6	Absolute values	Annual infrastructure impacts						and damage								
7	System 1	1205	0	0	5	12	277	1	102							
8	System 2	1107	0	0	7	329	1	128								
9	System 3	25401	8	0	62	472	5203	31	1720							
10	System 4	7382	1	0	16	26	1825	8	716							
11																
12																
13																
14																
15																
16																
17																
18	Point source emissions															
19																
20	Absolute values	Annual point source emission						impacts and damage								
21	System 1	5.82E+02	9.31E+01	2.19E+08			1.10E+08									
22	System 2	8.10E+02	1.00E+02	1.05E+08			4.34E+08									
23	System 3	1.14E+03	2.01E+02	2.34E+09			1.17E+09									
24	System 4	1.40E+03	1.52E+02	1.73E+09			8.67E+08									
25																
26																
27																
28																
29																
30																
31																



Conclusions

- Both the **infrastructure** and **stormwater discharges** contribute to the environmental damage caused by stormwater management
- Subsurface systems cause higher damage to both **resource availability** and **ecosystems** than green infrastructure systems
- **Material choices** and appropriate **decommissioning** processes are important factors for the environmental sustainability of systems
- Low-tech elements like soakaways and surface basins can be optimized regarding their **removal efficiency** to further increase their sustainability
- A simplified **LCA** based tool can provide valuable information during the **planning** of stormwater management systems



Thank you for your attention!

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