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NATURE BASED SOLUTION AS A POLICY AND PLANNING MEASURE TO MITIGATE CLIMATE CHANGE IMPACTS

A SYSTEMATIC REVIEW OF THE LITERATURE

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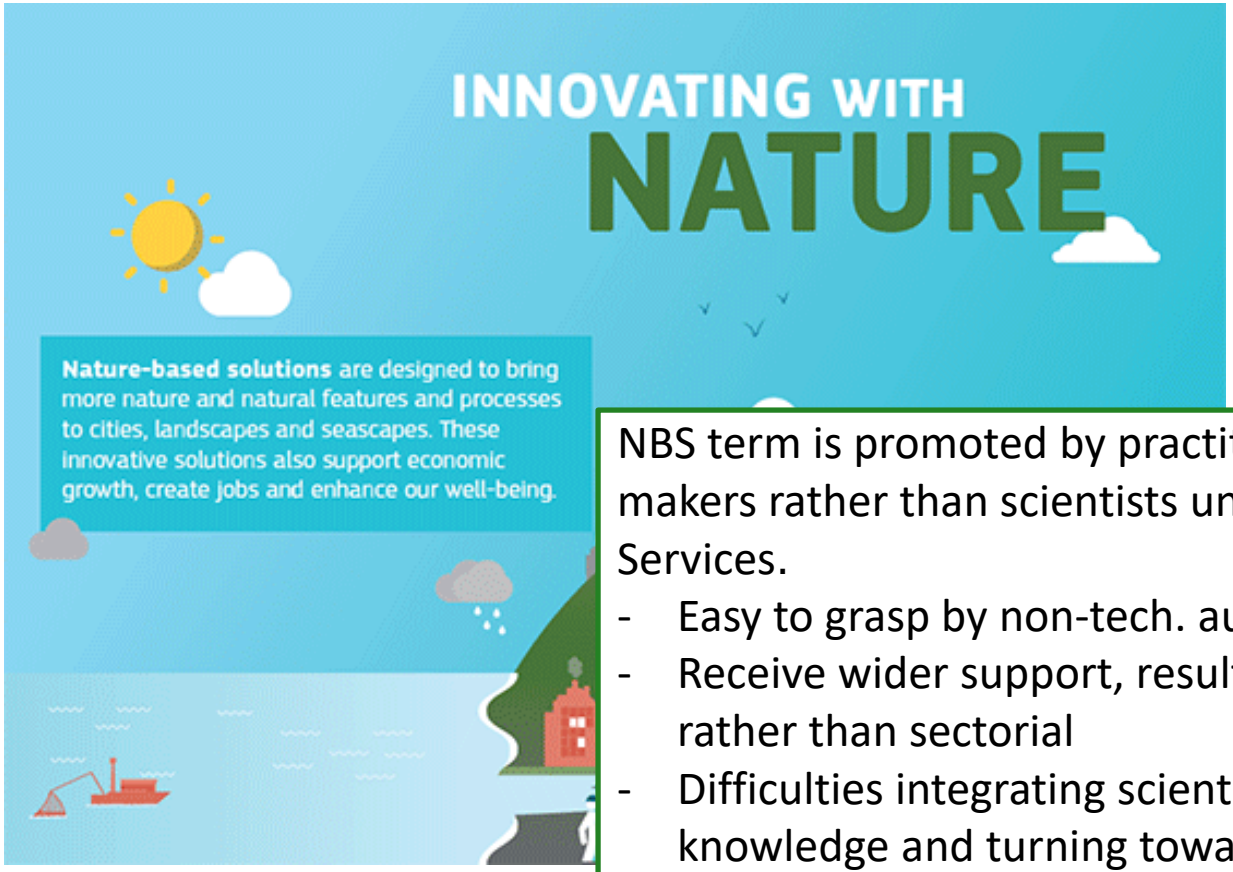
EUROPEAN COMMISSION

A Research and Innovation policy agenda for Nature-Based Solutions



How we can use nature's own resources to tackle environmental challenges

NBS term is promoted by practitioners and policy makers rather than scientists unlike Ecosystem Services.

- Easy to grasp by non-tech. audiences
- Receive wider support, result in systemic solutions rather than sectorial
- Difficulties integrating scientific ecological knowledge and turning towards new practices.

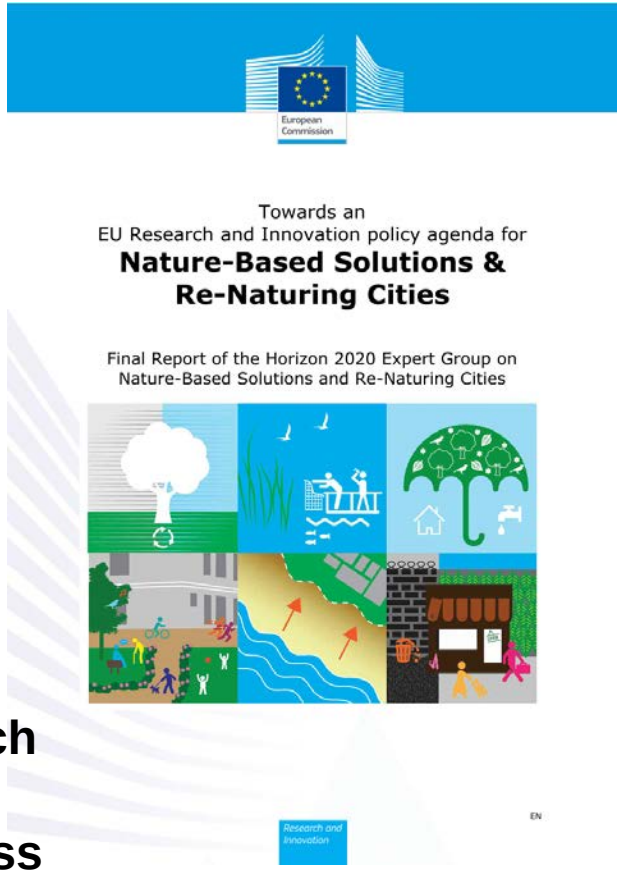
Eggermont et al. 2015

DEFINITION OF NBS

"…*actions which are inspired by, supported by or copied from nature…*" p.5

Aims:

- Enhancing sustainable urbanization to restore functionality of degraded ecosystems and their services
- Developing climate change adaptation and mitigation
- **Improving risk management and resilience through utilising nature-based design which combines multiple functions and benefits such as pollution reduction, carbon storage, biodiversity conversation, reducing heat stress and enhanced water retention.**



NEW URBAN AGENDA HABITAT III – OCTOBER 2016

New Urban Agenda brought together greening, health, and equity in urban planning. It highlighted that a green city which does not integrate social development, economic opportunities, environmental management and sound urban governance cannot create long-term sustainability.

Anguelovsk et al. 2018, Green Trajectories Book. BCNUEJ: Barcelona

HORIZON EUROPE 2021 - 2027

4. Smart, green and integrated transport	8.23%	6 339
5. Climate action, environment resource efficiency and raw materials	4%	3 081
6. Europe in a changing world - Inclusive innovative and reflective societies	1.70%	1 309
7. Secure societies – Protecting freedom and security of Europe and its citizens	2.20%	1 695
Science with and for society	**0.60%**	**462**
Spreading excellence and widening participation	**1.06%**	**816**
European Institute of Innovation and Technology (EIT)	**3.52%**	**2 711**
Non-nuclear direct actions of the JRC	**2.47%**	**1 903**
TOTAL EU REGULATION	**100%**	**77 028**

Tackling **climate change**
(35 % budgetary target)

Horizon Europe

European Commission

is the Commission proposal for a **€ 100 billion** research and innovatic funding programme for seven years (2021-2027)

to strengthen the EU's scientific and technological bases

to boost Europe's innovation capacity, competitiveness and jobs

to deliver on citizens' priorities and sustain our socio-economic model and values

Additional **€ 4.1 billion** are proposed to be allocated for defence research, in a separate proposal for a European Defence Fund

v. 25 June 2018

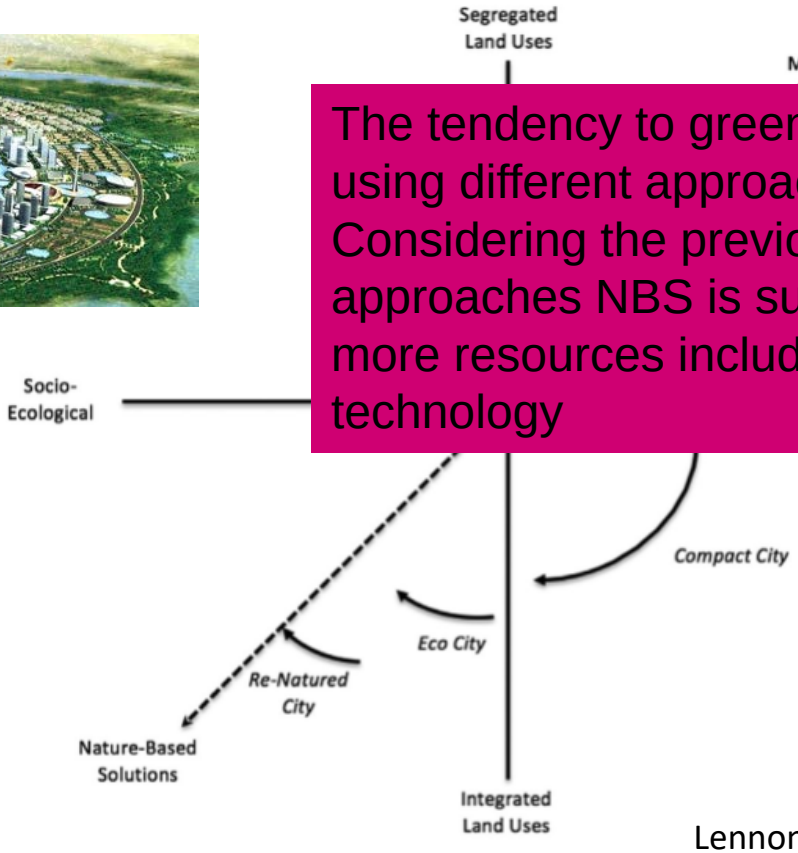
Pillar 2

Global Challenges & Industrial Competitiveness:

boosting key technologies and solutions underpinning EU policies & Sustainable Development Goals

Clusters implemented through usual calls, **missions & partnerships**	Budget (€ billion)
Health	€ 7.7
Inclusive and Secure Society	€ 2.8
Digital and Industry	€ 15
Climate, Energy and Mobility	€ 15
Food and Natural Resources	€ 10
Joint Research Centre supports European policies with independent scientific evidence & technical support throughout the policy cycle	€ 2.2

RETROSPECTIVE VIEW OF INVOLVING GREEN IN URBAN PLANNING



The tendency to greening cities by using different approaches. Considering the previous approaches NBS is supported by more resources including the smart technology

Lennon M. and Scott M. 2016. Re-naturing City. Planning Theory and Practice 17(2):270-276, p.271.

RESEARCH QUESTIONS

1) How can NBS, as a policy and planning measure, help to mitigate climate change impacts in urban areas?

2) Can NBS help to integrate the different dimensions, such as social, economic and environmental?

3) Whether NBS can contribute to more equity and social justice in cities?

SYSTEMATIC LITERATURE REVIEW

i) nature based solutions AND climate change AND urban /city/cities,

ii) nature based solutions AND equity/justice/justness/inequality/fair/fairness /honesty AND urban/city/cities,

iii) nature based solutions AND inclusive/integration AND urban/city/cities

iv) nature based solutions AND gentrification AND urban/city/cities,

v) nature based solutions AND disaster risk reduction AND urban/city/cities,

vi) nature based solutions AND societal challenges AND urban/city/cities,

vii) nature based solutions AND resilience/resilient AND urban/city/cities.

SYSTEMATIC LITERATURE REVIEW

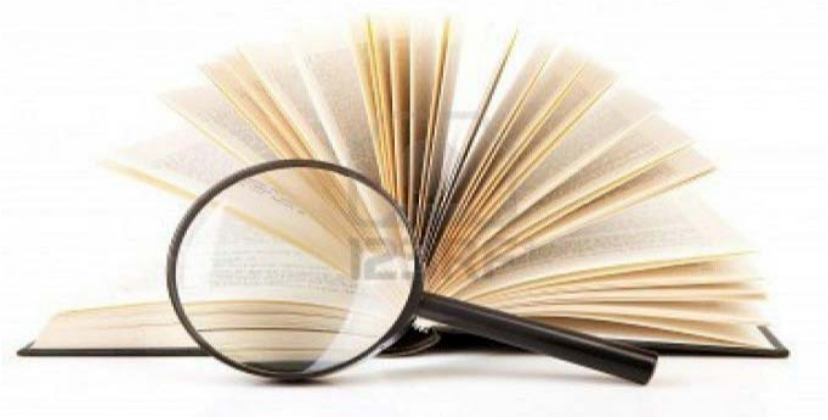
Keywords for the search					Number of articles	
					Scopus	Web of science
"Nature Based" OR "Nature-based" AND "Solutions"	AND	"climate change"	AND	"urban" OR "city*" OR "cities"	49	46
		"*equit*" OR "inequality" "*justice" OR "justness" OR "*fair*" OR "just city" OR "honest"			9	13
		"*inclus*"OR "integr*"			57	20
		"gentrification*"			1	0
		"disaster risk*"			11	5
		"*health*"			48	30
		"wealth*"			2	0
		"societal challenge*"			3	3
		"resilien*"			51	31
Total number of articles after removing multiple ones:						148

SYSTEMATIC LITERATURE REVIEW

Articles found in Scopus and Web of Science after the removal of double counting:	**148**
Initial screening (title – key words – topic)	148
Excluded by abstract:	25
Included after screening abstracts:	123
Included after screening full-text papers:	108

The existing literature studies cover

- Agriculture (Garcia-Llorente et al. 2018)
- Urban Forest in the Mediterranean (Krajter Ostaic et al. 2018)
- Green infrastructure and ecosystem services (Perrotti and Stremke 2018)
- Health benefits of NBS on children and elderly (Kabisch et al. 2017)
- Edible green infrastructure (Russo et al. 2017).



SYSTEMATIC LITERATURE REVIEW CODE BOOKS

SYSTEMATIC LITERATURE REVIEW CODE BOOK

The code of article:

General Information: (author, title, year)

Comments (if any):

CRITERIA	DESCRIPTION
Type of study	
Geographical location / case studies (if relevant)	
Problem definition	
Hypothesis	
Research question	
Aim	
Research Methods	
Scale	
Data collection Plan	
Data Analysis	
Involved actors (by whom)	
which social groups are targeted/researched	
how where they identified	
Definition of NBS	
Climate Change Framing	
Main Results	
Methodological Lessons Learnt (strengths – limitations)	
Suggestions for future research (if any)	

The code of article: 1

General Information: Albert, C., Schröter, B., Haase, D., Brillinger, M., Henze, J., Herrmann, S., . . . Matzdorf, B. (2019). Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? Landscape and Urban Planning, 182, 12-21

CRITERIA	DESCRIPTION
Geographical location / case studies (if relevant)	Lahn River / Hesse / Germany
Problem definition	-
Hypothesis	Nature-based solutions (NBS) in river landscapes, such as restoring floodplains, can not only decrease flood risks for downstream communities but also provide co-benefits in terms of habitat creation for numerous species and enhanced delivery of diverse ecosystem services.
Research question	-
Aim	This paper aims to explore how landscape planning and governance research can contribute to the identification, design and implementation of NBS, using the example of water-related challenges in the landscape of the Lahn river in Germany.
Objectives	(i) to introduce the NBS concept and to provide a concise definition for application in planning research, (ii) to explore how landscape planning and governance research might support a targeted use and implementation of NBS, (iii) to propose an agenda for further research and practical experimentation
Research Methods	1) the proposed scientific definition of NBS was developed based on suggestions for operationalization 2) in order to explore potential contributions from landscape planning and governance research to NBS implementation, a conceptual framework was developed (according to the method proposed by Tomich et al., 2010) and used as the basis for elaboration. 3) the complementary contributions of landscape planning for designing NBS, and governance instruments for implementation were identified in a meta-synthesis (Newig & Fritsch, 2009) of relevant publications.
Scale	River Landscape
Involved actors (by whom)	-
which social groups are targeted/researched	No clear definition – it is written "related actors"
how and where they identified	-
Definition of NBS	NBS is defined in several ways. Some examples: *"We define NBS as actions that alleviate a well-defined societal challenge (challenge-*

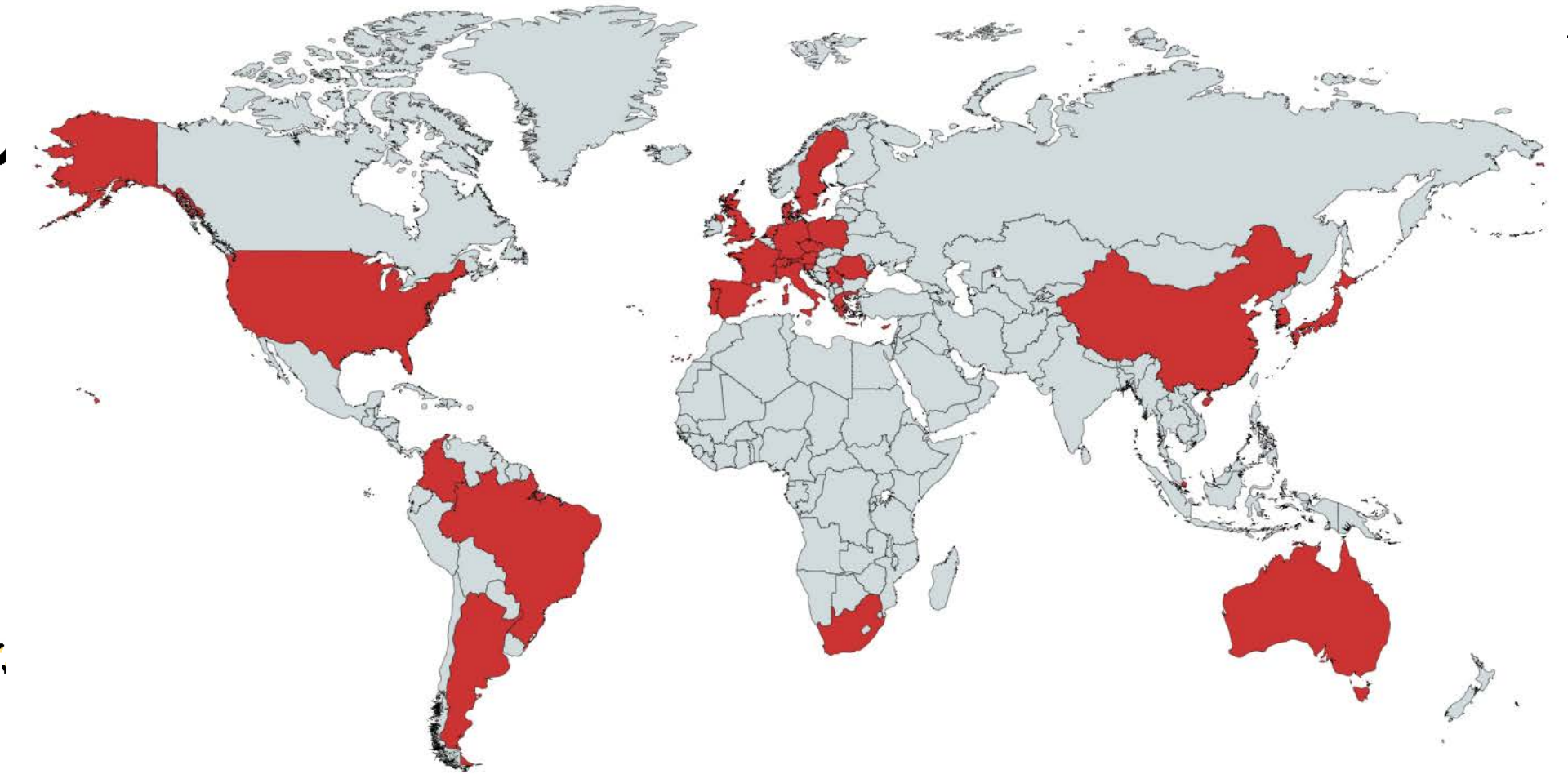
SYSTEMATIC LITERATURE REVIEW
CODE BOOKS

ELSEVIER Scopus® + WEB OF SCIENCE

Article	year	notes	Location	Scale	Focus	NBS	Climate Change	ecosystem services	green infrastructur	resilience	DRR	air pollution	sustainability	governance	health	cohesion	equity	justice	inclusio n	social-ecological	social dimension	economic dimension	environmental dimension	physical dimension	involve. actors
1	2019		Lund River – Germany	River Landscape	river basin management	x		x					x	x						x			x		
2	2018				ecosystem service design integrated into spatial planning			x						x					x		x	x	x	x	
3	2018				Changes in green space acc. to	x		x	x	x			x												
4	2017	(not related with Res. Q.s)	Edinburg / Scotland	Urban	pollinators																				
5	2018		South Africa		wetland management for drr	x wetlands					drought, fire and flood														
6	2018		Albufeira, Portugal	Urban	urban river recovery – NBS and biophilic design	x	x impacts (heat islands – flood)																		
7	2017		full text not available																						
8	2018		3 Swedish municipality	Urban		x	x climate change adaptati				x			x			x		x		x		x	x	x
9	2018		milan citta studi	neighbourh	pollution – health	x effects of green roofs on															x	x	x	x	
10	2018		melbourne – Australia	Urban	the role of policies in retaining urban green			x					x	x											
11	2019	literature review				x	x																		
12	2016		Barcelona, Spain	Neighbourh	ecosystem services provided by urban			x								societal cohesion					x		x		x
13	2019		Rome, Italy	Urban	setting priorities for urban forest planning	x only in the Keyword		x preparation of forestration															x	x	x academics only
14	2015		Rome, Italy	Urban	ecosystem services in urban green infrastructure planning			x	x			x									x expected benefits are mentioned	x expected benefits are mentioned	x expected benefits are mentioned		
15	2017		Spain	Urban Park	assessing allergenicity	x no class									x										

SYSTEMATIC LITERATURE REVIEW

Year	Number	
2019	23	
2018	41	
2017	31	
2016	11	
2015	2	Capotorti, G., et al. (2015). "Setting priorities for urban forest planning. A comprehensive response to ecological and social needs for the metropolitan area of rome (Italy)." Sustainability (Switzerland) **7**(4): 3958-3976. Eggermont, H., et al. (2015). "Nature-based solutions: New influence for environmental management and research in Europe." GAIA **24**(4): 243-248.



Citizen engagement

Ideas – General Framework – Policy Agenda

Agriculture - Edible solutions | Urban Forest

Landscape

Urban Gardens | Urban Parks

Health - Wellbeing

Walkability | Wellbeing - Wealth | Mental Health | Air

Nature Based Solutions

Sustainability | Built Environment | Governance

CCA - DDR

Heat | Flood Risk | Coastal Defense

Hydrological Resilience

Q1 HOW CAN NBS, AS A POLICY AND PLANNING MEASURE, HELP TO MITIGATE CLIMATE CHANGE IMPACTS IN URBAN AREAS?

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HOPE RUBBER PARKING LOT AND INDUSTRIAL WASTE SITE TRANSFORMED INTO A LUSH RIVERFRONT PARK IN FITCHBURG, MASSACHUSETTS

U.S. ENVIRONMENTAL PROTECTION AGENCY

Ziogou et al. (2018). Implementation of green roof technology in residential buildings and neighborhoods of Cyprus. *Sustainable Cities and Society, 40*, 233-243.

Russo et al. (2017). Edible green infrastructure: An approach and review of provisioning ecosystem services and disservices in urban environments. *Agr., Ecosys. and Envir. 242*, 53-66.

Song et al. (2019). Nature based solutions for contaminated land remediation and brownfield redevelopment in cities: A review. *Science of the Total Environment, 663*, 568-579.

Belle, J. A., Collins, N., & Jordaan, A. (2018). Managing wetlands for disaster risk reduction: A case study of the eastern Free State, South Africa. *Jamba: Journal of Disaster Risk Studies, 10*(1).

Q1 HOW CAN NBS, AS A POLICY AND PLANNING MEASURE, HELP TO MITIGATE CLIMATE CHANGE IMPACTS IN URBAN AREAS?

From sewage to Urban Park

Zevenbergen et al. (2018). Transitioning to sponge cities: Challenges and opportunities to address urban water problems in China. *Water (Switzerland), 10*(9).

Zolch et al. (2017). Regulating urban surface runoff through nature-based solutions - An assessment at the micro-scale. *Environmental Research, 157*, 135-144.

Zhang et al.(2019). Evaluating the reliability of stormwater treatment systems under various future climate conditions. *Journal of Hydrology, 568*, 57-66.

Zimmermann, E., Bracalenti, L., Piacentini, R., & Inostroza, L. (2016). *Urban Flood Risk Reduction by Increasing Green Areas for Adaptation to Climate Change.* Paper presented at the Procedia Engineering

Water treatment

Q1 HOW CAN NBS, AS A POLICY AND PLANNING MEASURE, HELP TO MITIGATE CLIMATE CHANGE IMPACTS IN URBAN AREAS?

- *A key challenge will be to align the sponge city initiative projects with infrastructure and urban renovation portfolios*.

  Zevenbergen et al. 2018

- …such as green roofs, parks and green spaces can make significant contribution to enhancing the provision of fundamental ecosystem services through NBS.

  Zimmermann et al. 2016

Q2 CAN NBS HELP TO INTEGRATE THE DIFFERENT DIMENSIONS, SUCH AS SOCIAL, ECONOMIC AND ENVIRONMENTAL?

Zwierzchowska, I., Fagiewicz, K., Poniży, L., Lupa, P., & Mizgajski, A. (2019). Introducing nature-based solutions into urban policy – facts and gaps. **Case study of Poznań**. *Land Use Policy, 85*, 161-175.

- a significant number of actions focus on GI changes towards its multifunctionality and better quality, while there are not many actions towards supporting citizens in using it.
- Linkages between GI and the wellbeing of inhabitants are well understood. However, the possibility to build and strengthen social cohesion based on GI is rather marginally noticed.
- The least recognised is the influence of NbS on the economic development potential

"- *Appropriate planning, design and management of GI towards building and strengthen social cohesion*
- *Consideration of NBS as aiming at supporting the citizen' health*
- *The influence of NBS on the economic development potential "*

Q2 CAN NBS HELP TO INTEGRATE THE DIFFERENT DIMENSIONS, SUCH AS SOCIAL, ECONOMIC AND ENVIRONMENTAL?

Wild, T. C., Henneberry, J., & Gill, L. (2017). Comprehending the multiple 'values' of green infrastructure - Valuing nature-based solutions for urban water management from multiple perspectives. *Environmental Research, 158*, 179-187.

"the potential opportunity to profit from green infrastructure at the community … is not matched by a market-led mechanism to deliver these goods and services"

"…the public sector has a key role to play at the regional scale in delivering long-term regeneration strategies to improve the image and identity of industrial areas, where the aim is to make those locations more attractive propositions for investors."

Q3 WHETHER NBS CAN CONTRIBUTE TO MORE EQUITY AND SOCIAL JUSTICE IN CITIES?

"NBS are
- *A human-centered utilitarian concept*
- *Include other knowledge systems beyond modern science"*

"NBS clearly refers to societal challenges (ontological dimension), pproblems defined by humans (epistemic dimension), and the sustainable use of nature (practical dimension)"

Eggermont et al. 2015, p.246

- *Considering **local actors' perspectives, needs and capacities, including cognitive/ emotional aspects and nonrational behaviour.***
- *Addressing existing power mechanisms and structures to ensure that the needs of the most vulnerable/ marginalised members of society are taken into account.*
- *Combining in order to address individual, communitarian and hierarchical patterns of social behaviour of different actors.*

Wamsler, C., & Raggers, S. (2018). Principles for supporting city-citizen commoning for climate adaptation: From adaptation governance to sustainable transformation. *Environmental Science & Policy, 85*, 81-89.

CONCLUSION

- *"Local planning practices that support these approaches are scattered, and emasures are neither systematically implemented nor comprehensively reviewed."*

- *"Existing measures are limited their focus regarding the ecological structures and the ecosystem services they support and the hazard and risk factors they address."*
  Warmsler et al. 2016

- *"Limited attention has been given to addressing the principles of spatial planning and how these may be translated into practice through the procedures."* Scott et al. 2016

- *"The shift is happening now toward a more holistic understanding... in general and particularly in human well-being and sustainable development."* Schubert et al 2019

- *"NBS have not been able to actively involve citizens and to address successfully food security, poverty alleviation, and inequality in urban areas*." Saumel et al. 2019

ADDITIONAL REFERENCES

Wamsler, C., Niven, L., Beery, T. H., Bramryd, T., Ekelund, N., Jönsson, K. I., . . . Stålhammar, S. (2016). Operationalizing ecosystem-based adaptation: Harnessing ecosystem services to buffer communities against climate change. *Ecology and Society, 21*(1).

Scott, M., Lennon, M., Haase, D., Kazmierczak, A., Clabby, G., & Beatley, T. (2016). Nature-based solutions for the contemporary city/Re-naturing the city/Reflections on urban landscapes, ecosystems services and nature-based solutions in cities/Multifunctional green infrastructure and climate change adaptation: brownfield greening as an adaptation strategy for vulnerable communities?/Delivering green infrastructure through planning: insights from practice in Fingal, Ireland/Planning for biophilic cities: from theory to practice. *Planning Theory and Practice, 17*(2), 267-300.

Saumel, I., Reddy, S. E., & Wachtel, T. (2019). Edible City Solutions-One Step Further to Foster Social Resilience through Enhanced Socio-Cultural Ecosystem Services in Cities. *Sustainability, 11*(4).

Schubert, P., Ekelund, N. G. A., Beery, T. H., Wamsler, C., Jönsson, K. I., Roth, A., . . . Palo, T. (2018). Implementation of the ecosystem services approach in Swedish municipal planning. *Journal of Environmental Policy and Planning, 20*(3), 298-312.

Eggermont, H., Balian, E., Azevedo, J. M. N., Beumer, V., Brodin, T., Claudet, J., . . . Le Roux, X. (2015). Nature-based solutions: New influence for environmental management and research in Europe. *GAIA, 24*(4), 243-248.

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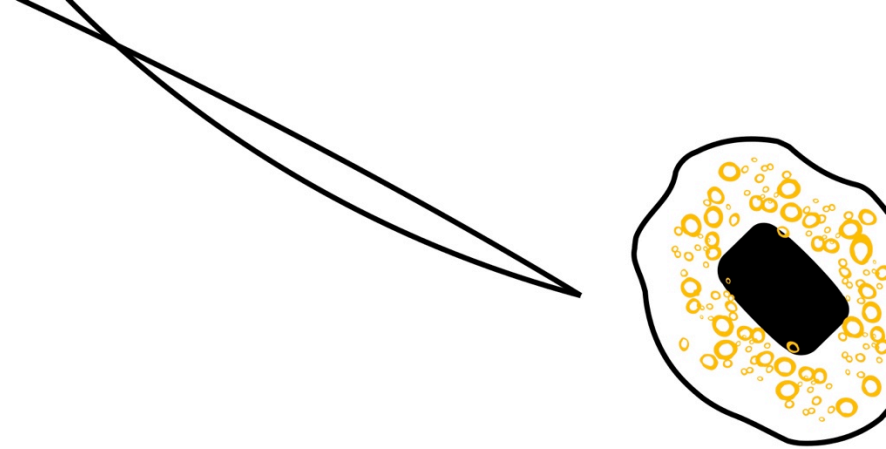

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