European Green Cities Development

enabling Nature-based Solutions

by **European Green Cities Development Foundation (April 2020)**

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https://www.eugreencities.org/

The foundation: A spin-off of a 3-year program of the Dutch Enterprise Agency (RVO)

While Europe is in the midst of the Covid-19 crisis and most people are working from home, it did not stop a group of entrepreneurs to plan and prepare for their future activities when the situation settles. Dutch Sino Business Promotions together with Nautilus Eco-Solutions and Hanging Water Tank recently initiated the European Green Cities Development Foundation, which is a platform that aims at sharing knowledge, promoting best practices, facilitating researches and knowledge exchanges, and collaborating with partners to provide design and solutions that contribute to sustainable urban development. The basis of the foundation is that Nature-based solutions (NbS) can play an important role in relieving pressures on the environment that urban development causes. The concept of NbS is based on the natural processes of the ecosystem, which is dynamic and adaptive to the surrounding environment and is defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" by IUCN* .

This foundation is a continuation and spin-off of a 3-year program of the Dutch Enterprise Agency (RVO) that supported a consortium of companies and knowledge institutes providing integrated sustainable solutions for urban challenges such as flood risk, environmental governance and spatial development. This program was specifically targeted at the Chinese market, but the solutions are applicable worldwide. Therefore, these entrepreneurs joined forces again to launch this new initiative to further dedicate their experiences and knowledge to the development of future green cities.

* https://www.iucn.org/commissions/commission-ecosystem-management/our-work/nature-based-solutions

Figure 1. Illustration for urban challenges

Urban challenges

"Traditional hard engineering in city development and infrastructure become a vulnerable target in the events of frequent cloudbursts, heat stress, air pollution."

Our cities and urban areas face several major challenges these days. Urban areas cover less than 3 percent of the land surface on earth, yet more than 50 percent of the world's population lives in these urban areas, and these 3 percent of land and 50 percent of popolation account for 70 percent of global emission (Fig.1) . It is expected that in 2050 the world population will reach about 9,7 billion according to the UN. The rising number of urban residents forces the city to create more space through redevelopment of old towns and expansions at the urban fringe. Resources such as food, energy and water can be in competition when the city is continually growing, and it is important to seek a dynamic balance rather than looking at trade-offs and compromises. Meanwhile, climate change creates additional pressure to the cities in all forms of damages to urban infrastructure and threats to human well-being. Traditional hard engineering in city development and infrastructure become a vulnerable target in the events of frequent cloudbursts, heat stress, air pollution, and so on, they are not flexible and adaptive in coping with such dynamic situations.

Take cloudburst or sudden heavy rainfall as example. Massive paved roads and concrete objects that usually cover highly populated areas leave little green and natural spaces in the city, resulting in flooding due to the limited water infiltration capacity from the conventional drainage system. The instant water volume flows fast without any barriers and the carrying capacity of the drainage system overflows in a short time. A solution is to increase the water infiltration capacity and regulate the infiltration speed. This can be achieved by using the natural functions of for example soil and by creating green spaces in the city. Ecosystem processes can cope with changing conditions and adapt accordingly. Therefore, implementing NbS in the city means bringing in the adaptive

functions to increase the resilience of the urban environment against the changing climate. Yet NbS goes beyond environmental functions, because people also benefit from nature in many ways, it develops our public and private social well-being. Natural areas like parks, beaches, riversides and lakes provide opportunities for leisure, tourism, spiritual meanings to people, meanwhile granting room for biodiversity and habitat for local flora and fauna. Therefore the application of a nature based approach is an integrated solution, it not only serves the purpose of its function when implemented, for example green roofs for rainwater catchment and distribution, it also cools down the building by giving shade through a green cover and absorbing heat, as well as increases urban biodiversity. By achieving these multiple purposes, it strengthens the resilience of the city in multiple perspectives, which is why nowadays there are more and more cities as well as regional or national governmental bodies adopting NbS approaches in their development plans under the overarching climate adaptation strategy.

Ecosystem Services & Nature-based solution

"NbS incorporates the concept of Ecosystem Services, brings it to actionable level and addresses to societal challenges."

CICES				CASCADE			
Sec.	Div.	Group	Class	1. Structure	2. Function	4. Benefit	5. Value
PROVISIONING SERVICES	Nutrition	Biomass	Berries and mushrooms	Berry and mushroom habitats (ha)	Average annual production (kg/A or kg/ha/A)	Harvest (kg)	Sales, picking income (€) berry and mushroom pickers (n, %), health and intrinsic values
			Game	Game habitats (ha)	Game population (n), wildlife richness	Game bag (kg)	Game bag (€), social, health and intrinsic values
			Reindeer	Reindeer pastures (ha)	Reindeer population (n), birth rate (%)	Culled reindeer (kg)	Sales of reindeer meat (€) employment (n), intrinsic and health values
			Fish and crayfish	State of surface waters (qualitative scale), stream fragmentation	Population dynamics of fish and crayfish	Total catch (kg)	Total catch (€), employment (n), health and intrinsic values
			Crops	Area under crop cultivation (ha)	Nutrient dynamics (kg/ha), fertilizer and pesticide use (kg/ha)	Harvest (kg)	Agricultural income (€), employment (n), health and intrinsic values
			Reared animals	Number of animals (n), area of pastures (ha)	Nutrient and energy uptake (organic vs. conventional)	Animal products (kg, l)	Agricultural income (€) employment (n), health and intrinsic values
		Water	Clean water	Undisturbed habitats and aquifers (ha)	State of surface water and groundwater (EU classification)	Use of raw water (m^3)	Value of domestic, irrigation and process water use (€), health, social and intrinsic values
	Materials	Biomass	Wood	Managed forests (ha)	Growing stock increment, impact of management (m^3/ha)	Roundwood removals (m^3)	Roundwood trade (€) employment (n), health and intrinsic values
			Genetic material	Number of varieties (n), area of gene reserve habitats (ha)	Breeding, genetic variance, evolution	Breeding and discovery potential/benefit	Genetic variance and evolution, economic value of modified organisms (€), intrinsic, social and health values
	Energy	Biomass	Bioenergy	Area under bioenergy crops (ha)	Annual growth of biomass (tons/ha/year)	Harvest (m^3) energy content (PJ)	Produced energy (€) employment (n), health and intrinsic values

Figure 2. The Common International Classification of Ecosystem Services and cascade comparison with Finish ES indicators (Provisioning services)

To understand the advantages of applying NbS and the benefits of replacing traditional hard engineering solutions, it is essential to know what 'nature' can do through its 'natural processes'. We should refer to the earlier mentioned term, Ecosystem Services, the services that an ecosystem delivers that benefits human well-being. People often take for granted that freshwater resources, harvests from agriculture, resources for energy, oxygen produced and carbon stored by plant species, all these natural phenomena come from the existence of the ecosystem where human beings benefits from. These natural processes

can be categorized in four main Ecosystem Services* :

1. **Provisioning services** – ecosystem services that describe the material or energy outputs from ecosystems. They include food, water and other resources. E.g. food through agricultural practices, raw materials (wood, biofuels, oils), fresh water, medicinal resources
2. **Regulating services** – the benefits obtained from the regulation of ecosystem processes such as climate regulation, natural regulation, water purification and waste management, pollination or pest control;
3. **Habitat services** – provides everything that an individual plant or animal needs to survive: food, water, shelter and maintenance of genetic diversity.
4. **Cultural Services** – Recreation and mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design. Spiritual experience and sense of place.

Within these 4 categories, specific indicators have been identified in below diagram to understand how ecosystem functions can be implemented into solutions and create value for future cities.

NbS incorporates the concept of Ecosystem Services, brings it to actionable level and addresses to societal challenges.

* http://www.teebweb.org/resources/ecosystem-services/

Sec.	Div.	Group	Class	1. Structure	2. Function	4. Benefit	5. Value
REGULATING AND MAINTENANCE SERVICES	Mediation of waste, toxics and other nuisances	Mediation by biota	Mediation of waste and toxins	Suitable ecosystems (ha), soil organisms	Decomposition, mediation or storage of waste by biological processes	Improvement of water and soil quality	Health value, avoided costs of waste management (€), social and intrinsic values
			Air quality	Urban green infrastructure (ha)	Retention of small particles	Improved air quality	Health values of clean air, avoided medical costs (€), social and intrinsic values
		Mediation by ecosystem	Water filtration	Undisturbed habitats and aquifers (ha)	Groundwater production (recharge rate, mm/ha/year)	Groundwater and surface water quality	Value of groundwater and surface water (€), health, social and intrinsic values
			Nutrient retention	Undisturbed habitats (ha)	Nutrient retention rate	Improved water and soil quality (qualitative scale)	Avoided costs of fertilizer use and water protection measures (€) social, health and intrinsic v.
			Noise reduction	Vegetation in urban areas (ha)	Acoustic absorption	Reduced noise level	Health values of reduced-noise environment, avoided medical costs (€), social and intrinsic v.
	Mediation of flows	Mass flows	Erosion control	Undisturbed soils (ha)	Particle retention rate	Avoided erosion, improved water quality	Avoided costs of fertilizer use (€) high quality surface water (€), intrinsic and health values
		Liquid flows	Water retention	Undrained habitats, vegetation type and cover (ha)	Detention time (per habitat type, natural vs. modified)	Flood and flow control (natural levelling of flow)	Avoided costs of flood prevention and avoided damages (€), health, social and intrinsic values
	Maintenance of physical, chemical and biological conditions	Lifecycle maintenance, habitat...	Pollination	Pollinator nesting and foraging habitats (ha)	Pollination	Increase in yield (kg/ha)	Improved production (€), health, intrinsic and social values
			Nursery habitats	Area and state of nursery habitats (n, ha)	Shelter and nutrition (measured as reproduction success)	Viable populations	Avoided costs of stock replenishment and other management measures (€), intrinsic, social and health values
		Soil formation & compos.	Soil quality	Functional diversity of soil organisms	Cycling of substances	Soil quality	Avoided costs of soil improvement (€), increased harvest (€), health, intrinsic and social value
			Nitrogen uptake	Nitrogen-fixing vegetation (ha)	Nitrogen fixation rate	Improvement of nutrient balance and soil quality	Avoided costs of fertilizer use (€) health, intrinsic and social values
		Atmospheric compostion ...	Climate regulation	Carbon-storing habitats (ha)	Carbon balance, sequestration rate	Climate regulation, stable climate	Avoided costs of negative climate impacts (€), intrinsic, health and social values of stable climate

Figure 3. The Common International Classification of Ecosystem Services and cascade comparison with Finish ES indicators (Regulating and maintenance services)

Sec.	Div.	Group	Class	1. Structure	2. Function	4. Benefit	5. Value
CULTURAL SERVICES	Physical and intellectual interactions with biota, ecosystems and land/seascapes	Physical and experiential interactions	Recreation	Preferred natural areas (ha), accessibility	Natural events, phenology	Experience; participation in recreational activities (n, %)	Avoided medical costs (€), health value, participation in outdoor activities (n), intrinsic value
			Nature tourism	Preferred natural areas (ha), accessibility	Natural events, phenology	Employment (n), recreation, experience	Tourism revenue (€), health value, employment (n), intrinsic value
		Intellectual and representative intreactions	Science and education	Areas of particular interest (ha)	Natural events, phenology	Source of knowledge	Social, economic, intrinsic and health value of knowledge and innovations
			Nature-related heritage	Cultural heritage in natural landscapes (n)	Natural events, phenology	Cultural continuity	Social, intrinsic, economic and health values of nature-related cultural heritage.
			Landscape	Valuable/preferred landscapes (n, ha)	Natural events, phenology	Aesthetic experience	Identity and aesthetics, marketing value of landscape (€) intrinsic and health values
			Arts and popular culture	Emblematic species and landscapes (n)	Natural events, phenology	Aesthetic experience, recreation	Market value (€), identity and aesthetics, intrinsic and health values of cultural representations

Figure 4. The Common International Classification of Ecosystem Services and cascade comparison with Finish ES indicators (Cultural services)

Figure 5. Nature-based Solution IUCN

Category of NbS approaches	Examples
Ecosystem Restoration Approaches	- Ecological restoration - Ecological engineering - Forest landscape restoration
Issue-specific ecosystem-related approaches	- Ecosystem based adaptation - Ecosystem based mitigation - Climate adaptation service - Ecosystem-based disaster risk reduction
Infrastructure related approaches	- Natural infrastructure - Green infrastructure
Ecosystem-based management approaches	- Integrated coastal zone management - Integrated water resources management
Ecosystem protection approaches	- Area-based conservation approaches, incl. protected area management

There are six main societal challenges that NbS aims to address: climate change, disaster risk, water security, food security, human health and socioeconomic development. In order to tackle these challenges, NbS is an umbrella concept in which five categories of ecosystem-related approaches are defined*.

* https://www.biodiversity.fi/ecosystemservices/cices

Application cases

"Many projects related to NbS have been realized around the world under different urban development themes."

Many projects related to NbS have been realized around the world under different urban development themes. Among these, 'Climate Adaption' becomes an emerging theme for regional and local governmental bodies. The goal of being adaptive to climate change is to eventually becoming resilient to disasters and crises, so that the function of the city and the well-being of the residents can be ensured in terms of safe living environment, stable resource supply, and normal social activities. The city of Rotterdam is a front runner in the resilient city development. It is part of the 100 Resilient Cities Initiative which was initiated by Rockefeller Foundation. Under the main theme of 'Resilient City', they developed their climate adaptation strategies and turned into a ratified program called Rotterdam Climate Proof (RCP*), part of the Rotterdam Climate Initiative. The aim of the program is to move forward to a climate proof city by 2025.

* http://rdcrotterdam.com/projects/rotterdam-climate-adaptation-strategy/

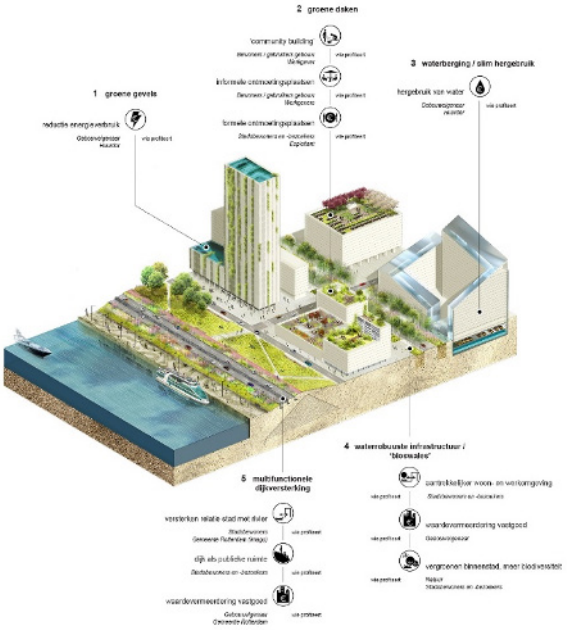

Figure 6. Rotterdam Climate Adaptation Approach

NbS and European Green Cities Development Foundation

"The Foundation is established to help solve these urban challenges with Nature-based Solutions, by offering expert trainings, consultancy..."

Water is a key element that is incorporated in the climate adaptation strategies because the city is on the frontier of the rising sea level and 80% of the city is below the sea level. The city has been committed to enhance its water-proof infrastructures around the city, where NbS is adopted in several projects. NbS plays an important role through the function of regulating water by increasing the water retention time, collecting and distributing water, as well as absorbing heat stress during warmer weathers. Mayor Aboutaleb explained it in a recent interview," Cities are concrete jungles. Water can't infiltrate in the soil

anymore, everything is being paved. That's why we have to invest in green roofs, parks, green walls, rain gardens, etc. With a special campaign we create awareness and with subsidies we encourage citizens to invest in green roofs and in depaving their gardens. Actually you could say that we are restoring the sponge function of our city*."

Each city has its own features and challenges according to their geographical location. From the growing internal and external pressures, decision makers must evaluate the current threshold of the city as well as the vulnerable aspects in terms of resilience to different crises and disasters and draw scenarios in order to roll out urban (re)development strategies and approaches so that the risk of residing can be minimized and the health and wellbeing of people can be maximized.

The European Green Cities Development Foundation is established to help solve these urban challenges with Nature-based Solutions, by offering expert trainings, consultancy, networking events, knowledge sharing platform, and facilitating research for enhancing the resilience of future cities around the world.

* https://ideas4development.org/restoring-the-sponge-function-of-rotterdam/

Figure 7. Sponge Garden Rotterdam, URBAN STEIN*

* http://rdcrotterdam.com/projects/rotterdam-climate-adaptation-strategy/

Figure 8. Groothandelsgebouw, Rotterdam
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* https://www.urbangreenbluegrids.com/projects/water-sensitive-rotterdam/

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