I/ General description and characterization of the NBS entity

I.1 Definition and different variants existing

Definition	An urban single tree in a NBS context is an individually standing tree (independently of its age), which is recorded and managed independently from the other elements of the surrounding vegetation (e.g. trees of a nearby park). A single tree stands on an extended unsealed surface (in contrast to street trees). From the point of view of most of the urban challenges, small trees (<~2m) are functioning similarly to hedges and shrubs, thus they can be included in those categories.

Different variants existing

Most of the processes related to NBS functioning differ for deciduous and coniferous trees, which are distinguished in many NBS-related studies.

- **Deciduous trees:** the leaf senescence and death have considerable effect on many urban challenges-related effects (e.g. due to lower leaf area, shading effect or dry deposition of pollutants are lower during the winter period)
- **Coniferous trees:** in case of those services, which have high relevance at certain times of the year, the presence of leaves may cause an outstanding importance in NBS performance for coniferous tree species

Deciduous urban single tree

@SZTE

Coniferous urban single tree

https://austinbotany.wordpress.com

I.2 Urban challenges and sub-challenges related + impacts		
Main challenges and sub-challenges targeted by the NBS	01| Climate issues > 01-1 Climate mitigation > 01-2 Climate adaptation 04| Biodiversity and urban space > 04-2 Urban space development and regeneration > 04-3 Urban space management 07| Public health and well-being > 07.-2 Quality of life	- carbon sequestration - reducing the temperature and regulating the microclimate at the object scale (heat stress mitigation) by evapotranspiration and shading - aesthetic value - cognitive development, improvement of opportunities for exploration by children (reconnecting children with nature) - education, environmental education
Co-benefits and challenges foreseen	02| Urban water management and quality 03| Air quality 04| Biodiversity and urban space > 04-1 Biodiversity 05| Soil management 06| Resource efficiency 08| Environmental justice and social cohesion	- interception of stormwater - dry deposition of air pollutants - providing habitat for several species, promoting biodiversity - reducing the erosion caused by water run-off, Increase in soil organic matter - provide shading for buildings - facilitating social interaction and community attachment, interaction among neighbours, promoting social cohesion
Possible negative effects	07| Public Health and well-being > 07-3 Health	- in some cases: providing habitat for undesired insect species - in some cases: producing allergens and contributing to air pollution through the emission of biogenic volatile organic compounds (BVOC) - falling branches might cause human injuries

II/ More detailed information on the NBS entity

II.1 Description and implication at different spatial scales	
Scale at which the NBS is implemented	Object scale
Impacted scales	Neighbourhood

II.2 Temporal perspective (including management issues)	
Expected time for the NBS to become fully effective after its implementation	- 5-10 years - the growth of the trees (and thus the time when they reach the fully effective state in terms of provisioning ecosystem service) is highly dependent on species characteristics
Life time	- more than 10 years - although the theoretical life times of many tree species are high (might be above 100 years), the urban circumstances (heat stress, polluted air, limited water availability in the soil, etc.) and management interventions result in a much shorter life-span of urban trees
Sustainability and life cycle	- single trees are important elements of the cultural landscapes of the cities, but special sustainability or life cycle aspects are not connected to them

Management aspects (kind of interventions + intensity)	- Management activities: pesticides and herbicides applications, watering, raising of saplings, mulching, pruning, removing leaf litter - Determining the optimal time of tree cut is a complex question: ecosystem service provision is still high at high ages, but management activities and potential damages are much higher too  Tree pruning (Kiskunfélegyháza, Hungary) http://felegyhazikozlony.eu  Tree watering (Budapest, Hungary) www.fokert.hu

II.3 Stakeholders involved/ social aspects

Stakeholders involved in the decision process	Communication between stakeholders and common decision-making about single trees are often a place of land use conflicts: for example, nearby inhabitants may call for preservation of "symbolic" old-growth trees, which is often in conflict with some technical aspects such as dangerousness of the tree or planned building activities.
Technical stakeholders & networks	Urban planners, landscape architects, ecologists, local green spaces managers, nonprofit organizations, power supplier and other infrastructure companies
Social aspects	- Single trees which stand in important, highly used urban open spaces can have quite high recreational and other cultural values, and thus have an "inherent" social value - The importance of single trees might also be communicated to the inhabitants. As they have several ecosystem services which are easy to communicate, they can be a suitable place for environmental education activities.

II.4 Design / techniques/ strategy

Knowledge and how-know involved	Aspects of urban tree selection: • Site characteristics and natural distribution - Climatic characteristics (e.g. late frost risk, light regime) - Soil conditions (e.g. soil depth, soil moisture, soil compaction risk) - Natural distribution • Tree appearance - Habitus (e.g. maximum tree height, growth speed, crown shape) - Leaf (e.g. shape, autumn coloring) - Blossom (e.g. color, odor) - Fruit (e.g. color) • Ecosystem services - e.g. honey plant, edibility, particulates absorption) • Required management activities (maintenance, potential undergrowth) • Risks and interferences (e.g. allergy potential, toxicity, damages by roots) *(Vogt et al. 2017)* Correct and up-to-date urban single tree inventories are needed for NBS-based management of urban trees. Besides data about the sizes of the trees, these datasets should contain parameters that are important for the assessment of ecosystem services (e.g. health status) *(Takács et al. 2015)*. The creation and maintenance of these databases can be facilitated and improved with the help of airborne or terrestrial laser scanning *(Saarinen et al. 2014)*.

Materials involved	Artificial objects are not needed in the surroundings, or for the functioning of single trees.

II.5 Legal aspects related

If a single tree needs special protection, it can be named as a protected tree (in a decree by the local council).

II.6 Funding Economical aspects

Range of cost	*Soares et al. 2011 (Lisbon, Portugal):* - Tree management costs: 29,5 $/tree - Administration costs: 9,93 $/tree - Other costs: 6,2 $/tree *McPherson 2003 (Modesto, California, USA):* - Prune: 6-30 $/tree - Remove: 0,9-3,5 $/tree - Plant: 0,01-2,2 $/tree - Root-related: 0,1-2,15 $/tree - Storm/liability: 0,02-0,76 $/tree - IPM/other: 0,09-0,92 $/tree
Origin of the funds (public, private, public-private, other)	All kinds of funds are relevant, but trees in bigger stands (woods and parks) might be preferred by publicly funded tree managers for economic reasons. Single trees with high relevance for local inhabitants might be managed (and funded) by them (privately).

II.7 Possible combinations with other kinds of solutions (other environmental friendly solutions or conventional ones)

Single trees can be planted/maintained near urban parks or public spaces.

A single tree in Greenwich Park
www.foap.com

Trees in a playground (Celldömölk, Hungary)
www.ips-gyermekszem.hu

III/ Key elements and comparison with alternative solutions

III.1 Success and limiting factors

Success factors	Best practices in tree maintenance and urban forestry in general: - Strategic plan with goals - Wood and green waste recycling - Water conservation - Drought Tolerant Species Planting - Concrete/Soil Program - Certified Arborists *(Remien 2016)*
Limiting factors	Barriers to preserving urban trees: • Institutional barriers: - Insufficient funds - Unprofessional maintenance measures undertaken by greenery managers (e.g. drastic pruning) - Lack of local spatial management plans - Regulations which downplay the significance of urban greenery or limit the possibility to protect - Unprofessional actions of contractors maintaining trees and shrubs - etc. • Social barriers - Societies perceives other issues as more pressing (e.g. parking lots, building) - Trees are perceived as a problem (e.g. shade, allergies, need to clean up leaves) - Lack of awareness of the significance of trees among residents - Individual persons' bad habits (e.g. tree topping) - Lack of knowledge on the possibilities and ways of preventing tree damage - etc. *(Kronenberg 2012)*

III.2 Comparison with alternative solutions

Grey or conventional solutions counterpart	Empty open space, playground with concrete pavement
Close NBS	- public urban green spaces (squares, etc.), public urban green spaces with specific uses (school playgrounds, camp grounds, sport fields, etc.), - choice of plants, flower fields, woods, lawns, - composting

IV/ References

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