



Building with Nature:

Definition

Final report November 2019

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Date: 20 August 2019



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1. Introduction

Good science requires the use of precise definitions (Aronson, 2011). When Building with Nature (BwN) develops, confusion about the concept may block or disturb its development and understanding. To seek the consensus among partners and enhance mutual understanding of BwN, we see the need to clearly define our subject, BwN. In this paper, we will talk about the following items:

1. Explore the History and the current status of Building with Nature.
2. Review the literature of BwN. A lot of BwN's literature is relatively young and aims to explain or describes the concepts, principles or provide practical examples reflecting the present situation. Although none of them strictly uses the word "definition" or "define" in the context of BwN, these scripts still could help us to identify today's (the newest) BwN.
3. Review other Nature-based Solutions concepts and approaches: Review the definitions of the other nature-based solutions from a hydraulic, or ecosystem perspective may also help the task of defining BwN . From their definition and practical examples, we aim to capture the relevance, similarities, and differences between these concepts. Therefore, this review will be helpful to finding the position of BwN.
4. Discussion. What should be included in a definition (of BwN)? We should clearly state a few items:
 - i. The purpose
 - ii. The range of application
 - iii. The approach

These three items above are necessary to explain BwN. We will discuss them step by step later. For an appropriate definition, we also suggest to follow some rules:

- iv. The category or class which the BwN is a part of.
- v. Avoid too narrow or too vague words.
- vi. Reduce unnecessary words, phrases, sentences.
5. Finally, trying to make an appropriate definition based on the results above and the feedbacks from partners, a comparison with the other Nature-based solutions will also be made.

2. History and the current status of Building with Nature

In 1979, the Dutch engineer Honzo Svaek developed the "Building with Nature" concept, which was further expanded by Ronald E. Waterman in 2002. Hereafter, the concept was actively developed by the Dutch organization "[EcoShape](#)" which has been set up to deploy the public- private innovation programme "Building with Nature" between 2008 - 2012.

Another origin of today's Building with Nature is the programme "Room for the River" (Room for the River, 2012). "Room for the River" provides more space in the main channel and floodplains to reduce flood disaster, removes obstacles to release the restricted water. The concept of attenuating the incoming waves instead of building taller, heavier dikes and more hard structures to resist the flow has been integrated into "Building with Nature"(De Vriend and Van Koningsveld, 2014; De Vriend et al., 2015).

In addition to the Netherlands, BwN is also implemented around the world starting from the same basic design philosophy. About 2010, a Belgium project "[Flanders Bay 2100](#)" selected ten specific cities and sites along the Flemish coastline for applying Building with Nature as their long-term coastal planning.

In Denmark, according to The Danish Coastal Authority, the coastal protection of the west coast of Jutland has primarily consisted of nourishment and slope protection in front of sand dunes and sand dikes since the 1990s¹. However today, the work almost only consists of nourishment. The coast is nourished with sand from the North Sea, which is either dumped on the sandbar or placed directly on the beach.

Several international organizations have deployed a lot of similar concepts recently. "Working with Nature" and the cross-cutting program "Engineering with Nature" has been developed under the auspices of the World Association for Waterborne Transport Infrastructure (PIANC 2011, p. 1). And the US Army Corps of Engineers (USACE) (Bridges et al. 2014), respectively. Although the names differ for all these concepts, the intention is the same.

3. Review the literatures of BwN

The concept of BwN is still very young as its development started only in the past decade. Several critical scholars or organizations have published relevant literature. Some of the literature describes BwN that show the author's understanding of BwN, and also reflects its position at the time of publication. Table 1 lists several of these descriptions about BwN. However BwN has continues to evolve and expand, they are not necessarily applicable today. We will discuss these views in the last two chapters.

¹ From: <http://eng.kyst.dk/coastal-protection-on-the-west-coast-of-jutland.html> (accessed on 31st July 2017)

Table 1 Descriptions of BwN

<p>R.E.Waterman (2008, 2010)</p> <p><i>Where nature allows it, the principle of Building with Nature should be applied as much as possible in the realization of new land. The essence of this principle is: flexible integration of land-in-sea and of water-in-the-new-land, making use of materials, and forces & interactions present in nature, taking into account existing and potential nature values, and the bio-geomorphology & geo-hydrology of the coast and seabed.</i></p> <p><i>"Building with nature" uses the mobile material sand/silt and the forces/interactions to which they are exposed being the action of tides, waves, currents, river outflow and interaction vegetation - sand/silt.</i></p>
<p>De Vriend et al. (2014, 2015)</p> <p><i>Building with Nature is about meeting society's infrastructural demands by starting from the functioning of the natural and societal systems in which this infrastructure is to be realized. The aim is not only to comply with these systems, but also to make optimum use of them and at the same time create new opportunities for them. This approach is in line with the need to find different ways of operation and it requires a different way of thinking, acting and interacting.</i></p>
<p>EcoShape</p> <ul style="list-style-type: none"> - <i>Building with Nature is a new design philosophy in hydraulic engineering. Natural elements such as wind, currents, flora and fauna are utilized in designing a hydraulic engineering solution, thereby creating additional benefits for nature, recreation and the local economy. (*This description are not available from EC SHAPE website now)</i> - <i>A new design philosophy that utilizes the forces of nature, thereby strengthening nature, economy and society.</i>
<p>IADC (International Association of Dredging Companies)</p> <p><i>Building with Nature (BwN) is a design philosophy that uses natural processes (ecosystem services) to realize structures and to create benefits for society and nature at the same time. Building with Nature concepts are typical multipurpose designs that are pro-actively founded on the working of the system (physical, ecological and societal) in which the development is taking place.</i></p> <p><i>Building with Nature comprises of two main principles – the first is to use natural forces as part of the engineering solution, or in other words to utilize ecosystem services (ES). The second principle is to provide extra opportunities for the further development of nature as part of the solution; in other words, provide extra ES as part of the infrastructure solution.</i></p>
<p>Sources:</p> <p>Waterman, R.E., 2008. Towards an integrated coastal policy via Building with Nature.</p> <p>Waterman, R.E., 2010. Integrated coastal policy via Building with Nature. Dissertation, University of Delft.</p> <p>De Vriend, H.J., Van Koningsveld, M., Aarninkhof, S.G.J., 2014. "Building with Nature": the new Dutch approach to coastal and river works. Proc. ICE - Civ. Eng. 167 (1), 18-24.</p> <p>De Vriend, Huib J., et al. 2015. Sustainable hydraulic engineering through building with nature. Journal of Hydro-environment Research 9(2):159-171.</p> <p>EcoShape website: https://www.ecoshape.org/en/</p> <p>IADC (INTERNATIONAL ASSOCIATION OF DREDGING COMPANIES) website: https://www.iadc-dredging.com/ul/cms/fck-uploaded/documents/PDF%20Facts%20About/facts-about-building-with-nature.pdf</p>

4. Review the definitions of the other Nature-based Solutions

International Union for Conservation of Nature (IUCN) defined Nature-based Solutions 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."

Among Nature-based Solutions, some technologies or concepts developed some decades ago are similar to BwN concepts with regards to certain aspects. Ecological Engineering (EE), Low impact development (LID) and green infrastructure (GI) are three examples. These three terminologies already have been implemented rapidly over the last ten years (see Figure 1 & Figure 2). All these terms have repeatedly been defined. But here we only list the current definition of each term to represent.

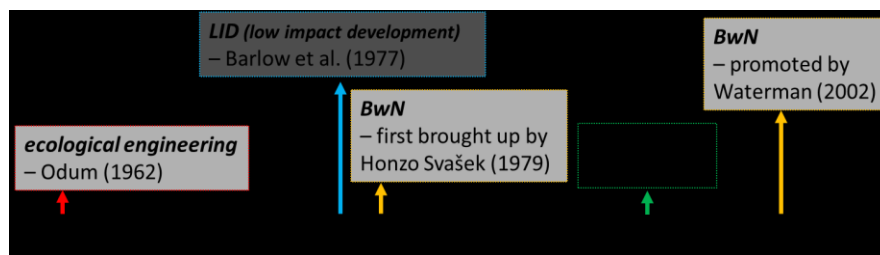


Figure 1 Time Line of Nature-based solutions- EE, LID, GI & BwN.

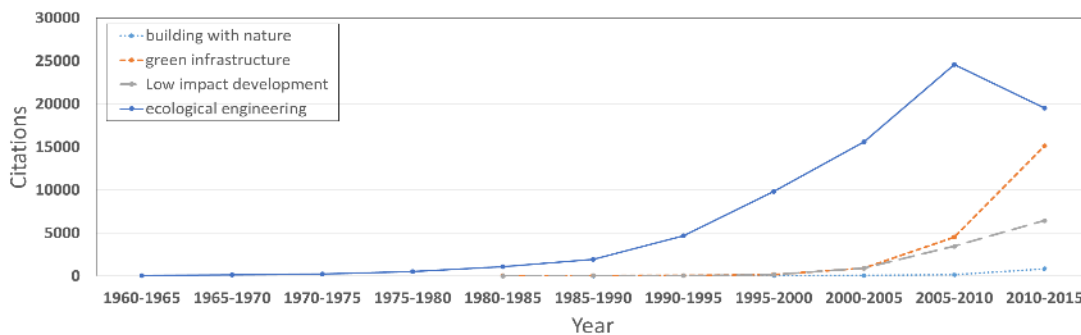


Figure 2 the number of citations of EE, LID, GI & BwN.

1. Ecological Engineering (EE)

At an ecological engineering workshop on sponsored by the National Research Council (New Discipline, 1993), ecological engineering was defined as "the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both."

2. Green Infrastructure (GI)

GI is defined variously a current definition is "green infrastructure is a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings." (European Union, 2013). On the other Realm, In the US stormwater management literature as "a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permeable pavement, that can capture and infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of surrounding waterways" and is

now “more often related to environmental or sustainability goals that cities are trying to achieve through a mix of natural approaches”

3.Low-Impact Development (LID)

LID means “an approach to stormwater management that mimics a site's natural hydrology as the landscape is developed. Using low impact development approach, stormwater is managed on-site and the rate and volume of predevelopment stormwater reaching receiving waters is unchanged. The calculation of predevelopment hydrology is based on native soil and vegetation” (MN Statute 2009, Section 115.03, subdivision 5c).

It is interesting that in the definitions EE only focuses on the purpose, but GI (in stormwater aspect) & LID emphasize of the measures or treatments. This difference is caused by the core ideas of them. These two stormwater management approach, GI & LID, have similar objective with the traditional approach, and what they want to emphasize is the measures they want to use. The situation of BwN is as same as GI & LID. On the other hand, EE emphasizes at its aim, and the measures of EE might have merits and demerits but not limited.

The realms, objectives, approaches, objects, etc. of EE, LID, and GI are listed in Table 2. Because these three technologies have been well-developed, discussed, and defined, researchers and engineers already have a consensus, so their answers of these grids may only have small discrepancies. BwN is relatively young and may wrongly diverge or cause confusion in development, however, in Figure 3, we illustrate a category of flood type and the corresponding NbSs. This figure clearly stated that although they are all belong to flood-related NbSs, the problems BwN dealt with is totally different with the others.

Table 2 Compare GI, LID, EE in different aspects

CRITERIA	EE	GI	LID	BwN
Realm	Ecosystem (& Pollution)	Urban ecosystem services/ Stormwater	Stormwater	???
Primary objective	Ecosystem preservation & Ecosystem utilization		Flood Safety; Reduce nuisance from floods;	
Approach	1. Use or imitate ecosystem to reduce pollution, disturb of environment. 2. Use engineering to restore ecosystem.	Use vegetation and soil for managing. Phytotechnologies.	Mimic a site's natural hydrology (Not limited to vegetation or soil treatment devices)	
Objects	Urban & Nature environment	Urban	Urban	
Additional / Secondary benefits	Human health and wellbeing, biological habitat, landscape, urban amenity			

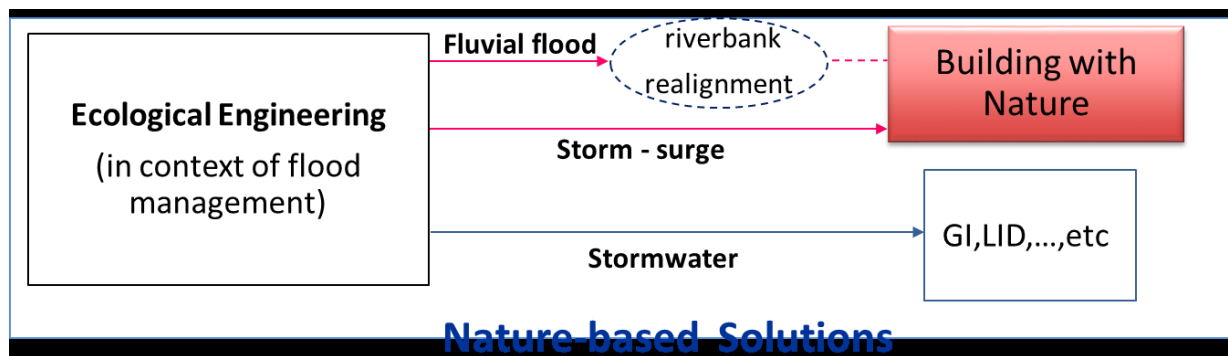


Figure 3 The inter-relationship between flood-related NbSs

5. Review the definitions of the other nature-based solutions

We suggest three items are necessary to illustrate BwN's core concepts:

- i. The purpose
- ii. The range of application
- iii. The approach

These three above are necessary for completely explaining BwN. To find out the possible answers, we use the descriptions we collected in Table 1 and have marked the keywords of each items with different colors. (see Table 3)

Table 3 Descriptions of BwN with Color markings

Marked: Purpose , the range of application, the approach .	
(A) R.E. Waterman (2008, 2010):	Where nature allows it, the principle of Building with Nature should be applied as much as possible in the realization of new land. The essence of this principle is: flexible integration of land-in-sea and of water-in-the-new-land, making use of materials, and forces & interactions present in nature, taking into account existing and potential nature values, and the bio-geomorphology & geo-hydrology of the coast and seabed. "Building with nature" uses the mobile material sand/silt and the forces/interactions to which they are exposed being the action of tides, waves, currents, river outflow and interaction vegetation - sand/silt.
(B) De Vriend et al. (2014, 2015)	Building with Nature is about meeting society's infrastructural demands by starting from the functioning of the natural and societal systems in which this infrastructure is to be realized. The aim is not only to comply with these systems, but also to make optimum use of them and at the same time create new opportunities for them. This approach is in line with the need to find different ways of operation and it requires a different way of thinking, acting and interacting.
(C) Ecoshape	

Building with Nature is a new design philosophy in hydraulic engineering. Natural elements such as wind, currents, flora and fauna are utilized in designing a hydraulic engineering solution, thereby creating additional benefits for nature, recreation and the local economy.

A new design philosophy that utilizes the forces of nature, thereby strengthening nature, economy and society.

(D) IADC

Building with Nature (BwN) is a design philosophy that uses natural processes (ecosystem services) to realize structures and to create benefits for society and nature at the same time. Building with Nature concepts are typical multipurpose designs that are pro-actively founded on the working of the system (physical, ecological and societal) in which the development is taking place.

1. The purpose

(A): The purpose is not clearly expressed in the excerpt above, but from the original book "Integrated Coastal Policy via Building with Nature," BwN is used to solve the problem of the scarcity of space in coastal and delta regions and provides an essential instrument for improving coastal safety.

To sum up, (A) emphasizes the use of space in coasts, then mentions coastal safety. However, space utilization might not directly connect with BwN example nowadays.

(B), (C), & (D) are broadly similar, they all indicate that BwN is used to serve society and nature (on the basis of meeting local flood safety demand?).

Some questions might need to be answered:

- Do we have consensus that the purpose should be "creating benefits for society and nature on the basis of meeting local flood safety demand?"
- More specifically, what kind of benefits? What is essential? What is optional?
Recreation, the local economy, flood safety, optimum use of space, ecosystem, etc.

2. The range of application

The application range may be explained in two aspects: location & the category of discipline or engineering.

i. Location:

Before, the location is limited to the coastal and delta regions. (In (A))

ii. The category:

In (B), the range is limited to society's infrastructural demands.

In (C), it is limited to hydraulic engineering.

Suggestions:

- "Society's infrastructural demands" are too broad. For example, Aviation, Rail, Schools, Solid Waste, Wastewater, electrical grid, and telecommunication are all infrastructure. But some of them are irrelevant to BwN.
- "Hydraulic engineering" might be appropriate.
- "Coastal regions" are too narrow for BwN now. According to Figure 3, we suggest "coasts and watersheds" as the application area. Which also echoes our project.
-

3. The applied approach

(A):

- Making use of **materials, and forces & interactions present in nature,**
- Taking into account **existing and potential nature values,** and the **bio-geomorphology & geo-hydrology** of the coast and seabed.

(B):

- Starting from **the functioning of the natural and societal systems** in which this infrastructure is to be realized.

(C):

- **Natural elements** such as wind, currents, flora and fauna are utilized in designing a hydraulic engineering solution
- Utilizes **the forces of nature.**

(D):

- Uses **natural processes** (ecosystem services).

Suggestions:

It is, of course, that all indicate that the core concept of BwN is using natural resources, but how to use and what kind of services/product of nature need to be explained. Maybe (B) is too indirect. It's not easy to image what is BwN from (B)'s description. Besides, the term "Nature elements" may make people confused with "elements." Although providing examples might be helpful, but our preference is to use precise words. From current practical examples, materials and dynamics might be good to describe the tangible and intangible BwN used.

4. Results:

After finding consensus about the purpose, the application range and the approach of BwN, the next step is to resonate these three features in the definition with some necessary complements. This section is going to be finished after receiving feedback from the partners.

(An example might be: *BwN is a concept used in design a local hydraulic engineering solution in the coast or watershed, with additional objective of creating benefits for society and nature via using nature materials and natural dynamics in the layout.*)

We also try to fill in the comparison. The current result is shown in Table 4.

Table 4

CRITERIA	EE	GI	LID	BwN
Realm	Ecosystem	Urban ecosystem services/ Stormwater	Stormwater	Hydraulic engineering
Primary objective	Ecosystem preservation & Ecosystem utilization		Flood Safety; Reduce nuisance from floods;	
Approach	1. Use or imitate ecosystem to reduce pollution, disturb of environment. 2. Use engineering to restore ecosystem.	Use vegetation and soil for managing.	Mimic a site's natural hydrology	Use nature materials and natural dynamics in the layout to create benefits for society and nature
Objects	Urban & Nature environment	Urban	Urban	Coasts & Catchments and cities
Additional / Secondary benefits	Human health and wellbeing, biological habitat, landscape, urban amenity			Nature, recreation and the local economy

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