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To cite this article: A Egusquiza *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **323** 012081

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Mapping of innovative governance models to overcome barriers for nature based urban regeneration

Egusquiza A¹, Cortese M², Perfido D²

¹Building Technologies, Tecnalía, 48146 Derio (Spain)

² R2M Solution s.r.l. – Via F.lli Cuzio 42, 27100 Pavia (Italy)

aitziber.egusquiza@tecnalia.com

Abstract. The implementation of urban Nature Based Solutions (NBS) projects is deeply determined by the novelty of the concept. Its innovation is both an opportunity and a challenge: as a new concept, it generates uncertainty due to lack of technical and operational preparedness, but it also allows to deploy innovative approaches, new ways to address old problems and more inclusive practices. Nature4Cities project has systematically conceptualized the barriers and drivers on NBS projects implementation by a review of the state of the art. To see how these barriers can be overcome by governance strategies, different urban and environmental governance models have been mapped and characterized to assess their suitability for different NBS projects. Five clusters have been identified where models are grouped according to the involved actors, their position in the spectrum from high to low government involvement and their level of participation. This theoretical model has been applied to real cases to check the incidence of the different clusters. Results show that urban and environmental governance is a map where the different models coexist in different degrees regarding some key axes such as level of innovation, polycentric vs. monocentric, involved sectors, level of participation and scale. Collaborative, multisector, polycentric and adaptive governance models address significant number of previously identified cross-domain barriers showing their suitability. The work presented in this paper can be the basis to define new institutional and governance arrangements that will foster multi-stakeholder involvement, citizens' engagement, leveraging both public and private funding of NBS in cities

1. Introduction

Nature Based Solutions (NBS) are defined by the EU as “*solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions*” [1]. They can enhance sustainable urbanisation, restore degraded ecosystems, support climate change adaptation and mitigation and develop strategies for improvement of risk management and resilience [2]. But, NBS is a new complex concept that is not totally clear for practitioners. The concept is frequently confused with other concepts such as biomimicry, sustainable development or green infrastructure. This loose definition of the concept and its novelty could be an opportunity for more flexible and inclusive dialogue and innovation [3], but also a challenge due to the diversity of required knowledge, stakeholders to be involved and challenges to be addressed [4]. Some authors believe that NBS concept includes the concept of integrative governance and participatory approaches to co-design, co-creation and co-management [5] and this could be one of the



key differences that distinguish the concept from more traditional and top-down conservation approaches [6]. Governance could be an ambiguous concept also and there is not an agreed and clearly defined governance theory [7]. In this paper we will use the term “governance” to refer to collective action arrangements designed to achieve the implementation of NBS projects, and government to refer to the formal organisations of the “public sector” as in [8]. In Nature4Cities (N4C) project the different urban and environmental governance models have been mapped and characterized in order to assess their suitability for different NBS projects. An Implementation Model Data Base for an extensive range of Nature-Based Solutions has been developed as open-source with the purpose of illustrating the single characteristics, the concerned NBS and the governance, financial and business aspects related to each Implementation Model (IM) identified. The process allowed gathering a large amount of information, which facilitates the systematization of the implementation modalities through which single NBS can be applied in specific urban contexts.

2. Methodology

For the literature survey a snowball approach has been followed. In a first step some primary documents have been identified [4][9][10] taking into account the research outputs that have been generated for similar research project [3][11][12]. These documents guided the posterior literature review to specific fields and issues. The literature review has been complemented by the results of several interviews, on-line surveys and workshops were conducted targeting experts, urban planners and municipality workers. Finally, the results have been verified comparing them with the experiences of the partner cities participating in N4C project. After developing the theoretical model, a database with different real cases was built in order to link the predetermined theoretical models with best practices and to study the incidence of them in practice.

3. Barriers and drivers

NBS-oriented urban planning can be considered a process of socio-ecological change. These processes are part of very complex systems with incomplete understanding and profound uncertainties [13] in need of interdisciplinary research [4], social engagement and feasible financing schemes. The literature shows that the main type of barriers for their implementation are the knowledge, governance and economic ones.

3.1. Barriers of NBS implementation (Process Inhibitors)

The identified barriers in the knowledge, governance and economic domains are highly linked to the novelty and complexity of the approach, since that amplifies some of the traditional barriers of urban planning. In addition to the lack of knowledge and evidence generation, integrated solutions, such as NBS, highlight the limited coordination among different actors with divergence of interests, competences and powers, especially in the public sector when different departments are required (urban planning, buildings licensing, infrastructures, water and waste management), all having their own targets, regulatory frameworks and budgetary constraints. Several reasons linked with this complexity and novelty can affect also the cost-effectiveness perception of NBS, such as technology maturity (subsidies to support technology maturing periods proved to be unsuccessful) and market uptake (some new products may be economically competitive only if commercialized at a significant scale). The following table shows the summary of the barriers and the correspondent literature sources (main and secondary).

Table 1. Identified barriers for NBS oriented planning (M=Main literature source, S=Secondary literature source)

CATEGORY	DESCRIPTION	SOURCE		CODE
		M	S	
Knowledge barriers				
Uncertainty	Operational unknown	Due to the newness of the approach there is a lack of protocols for design, implementation and maintenance for NBS projects.		BK1
	Performance unknown	Lack of evidence regarding the quantitative benefits of NBS, especially from policy makers and citizens' perspective. Designers may encounter		BK2
		[9]	[14] [15]	

		difficulties in implementing NBS when compared to traditional solutions, since they are more familiar with the later from technical and legal compliance.		[16]	
Accessibility to information	Information overload	Municipalities are already overloaded with knowledge making new concepts and approaches as NBS more difficult to reach.			BK3
	Unusable presentation of results	Presentation of scientific results in formats that are incomprehensible or not accessible to urban hinders the knowledge transfer between science, policy and planning.		[17]	BK4
Technical inadequacy	Lack of ready-to-apply scientific results, concepts and technologies	The lack of ready-to-use technologies, scientific results and concepts and simple and overarching theoretical framework makes the implementation and communication of NBS difficult even if a certain policy receptiveness exists. People in charge of design, implementation regulation and permit granting of NBS would need specialized training.		[17] [18] [19] [20]	BK5
Governance barriers					
Disconnection between short-term actions and long-term goals	Short-term action and decision-making cycles	Usual short-term decision-making and action cycles within municipalities do not match with the whole life cycle of NBS projects (planning, implementation, maintenance processes and sustainable financing)	[9]		BG1
	Establishment of long-term responsibilities	Responsibilities for the maintenance could remain unspecified and actors who will be implied in the maintenance are not implied in the decision and design leading to difficulties not previously foreseen.			BG2
	Gentrification	The willingness of improve life and urban quality with NBS projects in a short term could lead to risk of gentrification in a long term.			BG3
Institutional barriers	Lack of coordination	Lack of coordination between traditional departments traps knowledge in "sectorial silos" hampering e implementation of NBS which usually requires transdisciplinary coordination	[9] [10]	[18] [20] [21]	BG4
	Lack of flexibility of decision-making structures	The decision-making structure of municipalities where the different departments have clearly defined responsibilities could not be suitable for multilevel, multiscale and multi-thematic projects as NBS.			BG5
	Bureaucracy and unsupportive legal frameworks	Lack of knowledge due to the novelty of NBS as concept. Excessive legal rigidity, bureaucracy and lack of specific regulation (e.g. difficult agreements in multi-property dwellings).		[17]	BG6
Complexity of governance structure	Goal misalignment	Different goals of stakeholders within partnership arrangements could hinder collaboration.	[10]		BG7
	Apathy	A high number of stakeholders could generate inertia and apathy.			BG8
	Role ambiguity	A high number of involved stakeholders can cancel out some process enablers related with collaboration through unclear responsibilities			BG9
Participation and awareness	Perception	The perception of nature as source of problems and the fear due to uncertainty can hinder the participation of the citizens			BG10
	Lack of participation	Top down processes with no real citizen participation makes the NBS more difficult to accept by the citizens.			BG11
Economic barriers					
Perception of the benefits	Under appreciation of benefits	Benefits of NBS are perceived as mostly public and 'soft' and not directly related with economic growth-oriented issues as creating jobs and attracting investments.	[9]		BE1
	Short term vision	Lack of insight that investment now will prevent costs later. Economic benefits are long term			BE2
	Vandalism	Robbery or destructive actions, especially during early stages, could prevent the viability of NBS.			BE3
Budget constraints	NBS not a priority	City budgets for green development and the maintenance of green spaces often face severe budget constraints, while staff and related expertise is decreasing.		[17] [22] [23] [24]	BE4
	Lack of funding knowledge	Financing mechanisms are available, but they are complicated to apply for requiring additional administrative staff and time resources and, more importantly, require co- financing			BE5
Risk perception		Lack of incentives and motivation to attract private investment			BE6

3.2. Drivers of NBS implementation (Process Enablers)

Parallely, in literature can be found drivers and process enablers related to the knowledge, governance and economic barriers that take advantage of the co-benefits of the NBS approach. In the following table these drivers are summarised.

Table 2. Identification of drivers for NBS oriented planning (M=Main literature source, S=Secondary literature source)

CATEGORY		DESCRIPTION	Literature		CODE
			M	S	
Knowledge drivers					
Generation of evidence	Lesson learnt in implemented projects	Successfully implemented projects generate useful evidence regarding the benefits that can be used by other projects. Lessons learned from less successful projects are proved to be instrumental for an effective integration of NBS in urban planning.			DK1
	Research on benefits	Generation of quantified information and knowledge regarding benefits (direct and indirect)			DK2
	Research on cost effectiveness	Research on cost effectiveness of implementing NBS might help to justify new investments and to promote long-term funding or public-private arrangements.			DK3
Collaboration	Networks	Demonstration projects create collaborative networks and communities of practice that cross institutional boundaries and are drivers for legitimizing practices and approaches	[9]	[27] [28]	DK4
	Co-creation	Solutions to be developed could be based in collaboration between designers, citizens and companies in the early stages	[11]		DK5
Information accessibility and sharing	Knowledge platforms	Knowledge platforms focused on cities, accessible and open, can be used for knowledge gathering, aggregation and cocreation. Develop online NBS impact calculation tools.	[25] [26]	[11][29] [30][31] [32][33]	DK6
Awareness	NBS ambassadors	NBS ambassadors can promote NBS by making benefits and risks communicable to citizens and politicians. Strategically selected NBS could work as flagship projects			DK7
	Climate Change	Climate change is perceived as a new criterion for decision making and can be a driver for changing priorities and the vision of urban planning, raising awareness and changing			DK8
	Ecological memory	Processes that enrich and regenerate ecological memory can improve the understanding of different perceptions of urban nature and lead to higher levels of ownership of NBS projects by local communities.		[34]	DK9
Governance drivers					
Process efficiencies	Collaboration	The combination of the different strengths coming from different sectorial affiliations of a diverse stakeholders' partnerships lead to improved efficiencies			DG1
	Coordination role	A specific role that can serve to improve the coordination between departments can help to plan and implement transdisciplinary and multifaceted projects as NBS.		[37]	DG2
	Action- thinking approach	An action-thinking approach (problem-based governance) could help to focus on a better use of existing finance instruments and to coordinate biodiversity and climate change efforts in implementing strategies on NBS.			DG3
	Capacity building	Capacity building can balance the uncertainty that comes from the newness of the NBS approach.	[9]		DG4
Self-governance	Emerging partnerships	Innovative NBS projects can learn modes of self-governance from emerging partnerships between civil societies in cities	[10] [11]	[38]	DG5
	Grassroots innovations/transition initiatives	Grassroots innovations and transition initiatives as collaborative networks of citizens play a significant role in advocating and practicing NBS in cities as re-establishing green urban commons providing on-the-ground evidence of the multiple benefits	[35] [36]	[39][40]	DG6
Co-creation and participation	Reflexive/adaptive governance	An approach thought to include flexible ways to maximize learning opportunities and the experimentation and careful monitoring it is especially suited to overcome barriers related with uncertainty, complexity and system dynamics. Multiple actors possessing different types and degrees of knowledge could engage in a reflective way to update their planning, governance, knowledge production practice over time to continuously address arising risks and uncertainties. More reflexive approaches to urban and environmental governance bring together other drivers as networks and NBS ambassadors.		[9][4] [36][41]	DG7
	Involvement of urban government	The involvement of local governments is crucial for opening space for innovative approaches and solutions like NBS through a rapid transfer from concepts to action. An urban government can facilitate collaborative arrangements without losing its government role. Its new dual role (steering and orienting when partnerships exhibit capacity for delivering and regulating and directing when strategic planning is required)		[22] [42] [43] [36]	DG8
	Cross sectorial spaces and partnerships	Enabling cross-sectorial partnerships for NBS design implementation and maintenance. Creating different institutional spaces for cross-sectorial dialogue and interactions of different stakeholders for strengthening/fostering adaptive co-management and knowledge sharing about urban ecosystems.		[18][26] [44][45] [46][47] [48]	DG9
	Co-production	Design knowledge co-production processes to bring openness, transparency in governance processes, and legitimacy of knowledge from citizens/civil society, practitioners and policy stakeholders		[44] [48] [49]	DG10
	Tools to build a common vision	Stakeholders from different natures and backgrounds are unlikely to share a common vision. One way to reach the goal might be to include NBS in local planning and zoning regulations.		[50]	DG11
Economy drivers					
De-risking	Sharing risks	Collaborative arrangements enable the distributed responsibilities that can generate a shift from risk aversion to sharing the perception of risk of new approaches like NBS projects	[9] [10]	[51]	DE1
	Public de-risking	Due to the newness of the concept NBS is now in a beginning phase in the field of urban			DE2

	strategies	regeneration. This phase requires a great government support, due to methodologies and ways are not yet completely defined.		
Government support	Provisioning of incentives to attract private investment	The provisioning of incentives and/ or the removal of administrative barriers allows the creation of partnerships between government and businesses where citizen associations can participate also. The resource and governance synergies that can be generated in those partnerships can create new opportunities for an efficient uptake of NBS. Encourage methods to transfer the benefits of common goods provided by NBS to the initiators of NBS (e.g. tax reductions or subsidies). Public subsidies and tax cuts can stimulate private investments and make NBS more attractive	[36]	DE3
	Removal of administrative barriers			DE4
	Public-private partnerships	The inclusion of companies and private sector in the implementation and management of NBS projects can help to overcome budget constraints and limitation of resources.	[52]	DE5
	Create conditions for new business models and finance schemes	Divesting from dominant solutions as the one and only focus, can leverage private and public funding in strengthening NBS and can create conditions for new business and finance models		DE6
	Cooperative competition	A fair competition between private stakeholders, specially between companies, that does not hinder the collaboration, makes some processes more efficient and successful.		DE7
	Mid-Long-term financing	Allocation of a sufficient budget for implementing and maintaining NBS projects can give sustainability in tight financial periods. Widely using natural vegetation helps to decrease the costs associated with vegetation care.	[20][9]	DE8
	Real estate	Increased commercial and domestic property prices and attraction of businesses	[53][54][55]	DE9
	Self-financing and self-management	Self-financing and self-management projects can be sustainable and resilient and are less dependent of external changes.		DE10

3.3. Verification with surveys, case studies and pioneer experiences

The barriers and drivers identified in the literature survey have been checked with:

- Results from the report “Elicitation of needs and definition of urban and landscape planner requirements” developed within Nature4cities project [56] in which six experts from 13 countries were consulted through semi-structured interviews and 75 completed questionnaires were analysed by experts with strong development background in the fields of urban and landscape planning regarding, specifically, NBS.
- Case studies from partner cities (Ankara in Turkey, Milano in Italy, Alcalá de Henares in Spain and Szeged in Hungary).
- Pioneer experiences investigated in Spain, France, Austria, Germany, Switzerland, Italy, Turkey and Hungary.
- The verification of the barriers and drivers towards real cases was not homogeneous. The key parameter used pertained the previous experience in NBS projects. When this experience is not predominant (as in the interviews and surveys) the barriers were more evident. The Knowledge and Economic Barriers are the ones that are more recognized although only one of the identified barriers is identified in almost all cases (BK1: Operational unknown). The implementation contexts with more experience in NBS (such as Çankaya and German speaking countries) are more inclined to perceive the possible drivers compared to less experienced cases (e.g. most of the urban planners and municipalities interviewed).

4. Governance Implementation Models

Critical decisions about NBS projects (design, costs, location, scale or levels of management intensity) involve a wide range of stakeholders who surely have different ideas and backgrounds. Moreover, a ‘nature-based’ perspective has to adopt a ‘society-based’ perspective also in order to incorporate the notion that human beings have shaped the landscape [57]. These involvement of different groups can bring substantive, instrumental and normative benefits to the process of planning and delivering improvements in environmental management [58] and to the decision regarding role, scope and appropriateness of NBS interventions that will require governance models that can enable NBS with an inclusive, long-term and balanced approach [59].

4.1. Clustering and characterizing Urban NBS Governance Structures

The different urban and environmental governance models that can be found in literature cannot be packed in clearly delimited boxes. Urban and environmental governance is a map of spectrums where

the different models coexist in different degrees regarding some key axes [60]. Four dimensions have been considered to define our typology of governance models.

1. Polycentric vs. monocentric governance: One of the most important current trends in environmental governance is the shift from centralized control to the incorporation of lower-level administrative units and social groups into more democratic decision making processes through co-management, community-based natural resource management, and environmental policy decentralizations [61] [62]. Polycentric systems have advantages (resilience by redundancy, efficiency by competition, participation and accountability, facilitation of learning processes and experimentation and cross-scalarity) and disadvantages (economies of scales may be difficult, more complicated decisions, duplication of efforts and dispersed responsibilities) to be taken into account in governance models for NBS implementation [63][61]

2. Initiating actor: One classical way to characterize the governance structures considers the main actors promoting and interacting within the governance structures. Traditionally governance has been identified with the governmental institutions at different levels. However, non-governmental or private actors can also be involved in governing public goods like green infrastructures [7]. The typology of actors that are considered in this paper are classified in three main sectors: government, community and market. The initiative will come from one of these sectors and this will be one of the key parameters that will determine the nature and rules of the arrangement and the overall management of the intervention.

3. Levels of participation: Arnstein in 1969 described a ladder of participation writing about citizen's involvement in planning processes in the United States. The ladder has eight steps that range from non-participation to citizen power. The first two steps (*Manipulation* and *Therapy*) are not participatory approaches. Their goal is to manage to achieve public support for already made decisions through public relations. The next step is what Arnstein called "Tokenism" and comprises *Informing*, *Consultation* and *Placation*. These steps are one level higher in the legitimation scale, although the power is still retained by the government (by means as one-direction information flow and ritualized and not decisive participation). In the last step, *Delegated power* and *Citizen Control*, public has the power to assure the accountability or even to plan and manage without intermediaries. The intensity of participation can be also be classified according to the range of parties included in the decision making process, the intensity and direction of information flows and the level of influence in the decisions to be made [64].

4. Governance concepts and steering modes for clustering: The governance framework and its capacity to tie different areas and levels of government, has been identified as a critical factor for the success of integrated interventions such as NBS [65]. Glavovic, mainly based on the work of Hartley, differentiates three broad conceptions of governance that theoretically have evolved sequentially but in practice co-exist, overlap and compete [66]: "*Traditional public administration*", "*New Public Management*" and "*Networked Governance*". Van der Steen et al. added a fourth governance concept: "*Societal Resilience*" [67] (XX) and . These four concepts have been used to make the clustering of the types of governance models (see Figure 1): government-led traditional governance models (Cluster 1), market-oriented governance models (Cluster 2), community-based governance models (Cluster 4) and collaborative governance models (Cluster 5). Two additional key dimensions are the degree of involvement of public actors (government) vs. private sectors (communities and markets) [68] together with the hierarchical/non-hierarchical distinction. Using this two axes, Hall [60] classifies four frameworks of governance regarding their steering modes. This classification provides the fifth cluster: private-private partnership that considers all governance models between community and market sectors. Based on the previous references and in the triangle connecting government, market, and community, also used by Lemos and Agrawal [61], a framework for governance model analysis and clustering has been developed (see Figure 1).

4.2. Mapping and characterising the models of governance

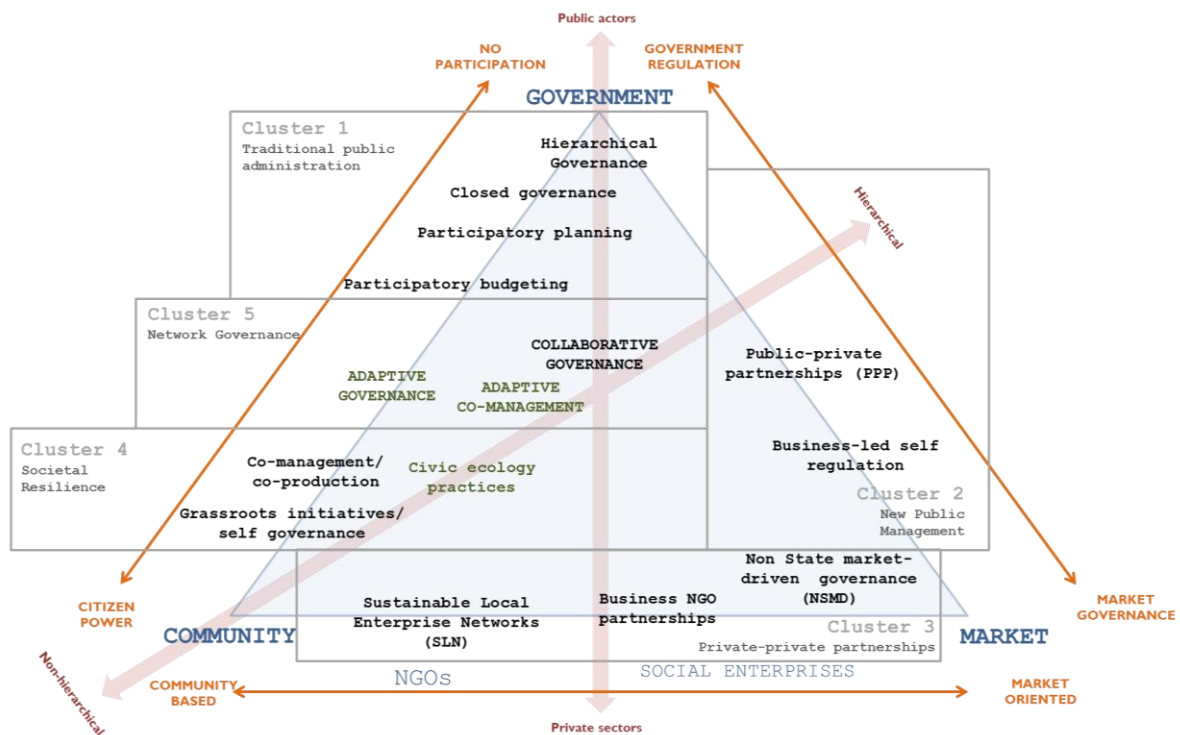


Figure 1. Mapping and clustering of governance models for NBS oriented planning

Many problems and urban challenges addressed by NBS (climate change, loss of biodiversity, resource scarcity...), are too broad and too complex to be solved by the government alone. It is necessary to move the focus from individual actors to network structures, to be able to inform about practices that support the emergence of purposeful network structures for ecosystem governance [69]. The identified governance models are not static or definitive. They can coexist in the same initiatives or change during the different stages of the projects. The Figure 1 shows the different analysed governance models clustered in 5 clusters and distributed according to the involved actors (government, community and market), their position in the spectrum from high to low government involvement and their level of participation. In the following sections, the different models are analysed from different perspectives: how they emerge, involved actors, the degree of government involvement, rules, contextual conditions and tools that can be used. Each cluster is also studied regarding the barriers that can help to overcome, drivers that can be triggered. Their suitability for NBS projects has been determined by assessing the capacity of these urban governance structures to allow processes required for the implementation of NBS such as engagement of different stakeholders, intersectoral coordination, transdisciplinary knowledge generation, socio-ecological innovation and continuous improvement and learning.

4.2.1. CLUSTER 1: Traditional public administration. The first cluster comprises government- and producer-oriented governance models. With different levels of low-moderate participation, the community role is mainly to be a client while the role of the government is to be the commander. The needs and problems are defined by professionals and since a key goal is to maintain stability they are uncertainty averse.

Table 3. Characterisation of Traditional Public Administration governance models (Cluster1)

	CLUSTER 1: Traditional Public Administration		
	Hierarchical governance	Closed governance	Participatory planning & budgeting
KEY WORDS	Centralized, government led, top-down, hierarchical	Hierarchical, closed participation, top-down	Hierarchical, open participation
HOW EMERGES	Default governance regime	Government defines the problem and the participants	Usually required by law.
INVOLVED ACTORS	Government. Citizens and community are always at the receiving end.	Access is restricted. Governmental actors are organised and complemented with a few non-governmental selected actors.	Government, citizens, NGOs
GOVERNMENT INVOLVEMENT	Leading role	Leading role	Very high
RULES	Instrumental vision on policy Administrations hierarchically controlled by electorally accountable governments. The interaction rules give government a leading role, whereas non-governmental actors follow. Coercion by the government is the predominant interaction type	Government has the power because it controls the resources that can be mobilised. The non-governmental actors can influence if the government allows it. Restricted cooperation. Government assigns certain tasks to the involved nongovernmental actors and then monitors them.	Hierarchically participation. There is a need to formalise the rules of the game and provide well established supporting tools (like websites, guidelines) to rebalance the information asymmetry. The stage when the stakeholders are involved depends of the level of collaboration.
CONTEXTUAL CONDITIONS	Often fails to provide effective solutions for highly contextualized situations	In cases of environmental issues with potentially catastrophic impacts, the predominance of "less than democratic" expert politics could be justified	Some countries have adopted national level instruments to promote different forms of public consultations at local levels providing guidelines and tools.
TOOLBOX	Top-down directives or command-and-control policies.	Top-down directives or command-and-control policies.	Neighbourhood planning. Participatory budgeting. E-tools for citizen involvement Workshops, professional moderation of debates. Interactive mapping
REFERENCES	[57] [75]	[57] [62] [76]	[23] [74] [77] [78]
BARRIERS	BG3, BG3, BG7, BG9, BE1, BE3		
DRIVERS	DG2, DG8, DE4, DE8, DE9		
SUITABILITY FOR NBS	Low. Often falls short in efforts to coordinate governance across large-scale ecosystems that cross multiple jurisdictional boundaries. Innovation is limited to some large-scale national and universal innovations being not enough for local innovation required. Large step-change improvements could be possible initially, but less capability for continuous improvement		

4.2.2. *CLUSTER 2: New Public Management and CLUSTER3: Private-private partnerships.* The idea beyond the involvement of market actors in environmental collaboration is to overcome the inefficiencies of government action by injecting competitive pressures through market actors that are regarded as capable of achieve bigger profitability in the utilization of environmental resources [61]. The different models for this kind of arrangements could be placed in a spectrum that goes from an almost fully public sector governance to an almost private sector governance.

Table 4. Characterisation of New Public Management and Private-Private Partnerships governance models (Cluster 2 and 3)

	CLUSTER2: New Public Management		CLUSTER 3: Private-private partnerships		
	Public-private partnership (PPP)	Business-led self-regulation	Non-State Market-driven governance (NSMD)	Business-NGO partnerships	SLEns (Sustainable Local Enterprise Networks)
KEY WORDS	Market-oriented, competitive, top-down	Business-led, decentralized	Market-oriented, decentralized	Hybrid governance, decentralized, non-hierarchical	Self-organizing, complex adaptive systems
HOW EMERGES	Usually from a flexible, opportunistic approach, drawing from experiences in other cases. Not always the most evident solution, but a widely acknowledged crisis can trigger the arrangement.	When government is not perceived anymore as the only source of legitimacy and market forces are strong enough.	NGOs develop their sets of responsible business practices due to the difficulty to influence the government providing recognition in the marketplace to responsible companies	A reactive approach is adopted by companies in the beginning, but partnerships could evolve, where pressures from NGO lead to go from mere compliance to strategic actions	Provide an integrating opportunity for stakeholders to acknowledge a shared asset base and construct a virtuous cycle

INVOLVED ACTORS	Government + private sector	Business sector. Efforts may be undertaken to include community	Environmental and social stakeholders participate with business interests	Markets + NGO	NGOs + civil society members + companies.
GOVERNMENT INVOLVEMENT RULES	Can range from high to low involvement.	Announcers and commissioners	Not necessarily	Medium-low	Not mandatory.
CONTEXTUAL CONDITIONS	PPP are deeply context based.	In neo-liberal contexts	General dissatisfaction with old policy instruments; neoliberal institutionalism and free trade agreements and a requirement for market innovations.	Differences in organizational cultures between business and NGOs due to differing missions and accountability systems.	Depend on mobilizing all four key assets: human, social, financial and ecological (natural) capital.
TOOLBOX	Outsourcing. Joint Venture Public-Private Partnerships	Voluntary agreements, third-party certifications, eco-labelling, corporate social responsibility	Forums for exchanges of expert information, databases of experiences and best practices. Norm generation and community building	Sponsorship. Short-term problem-solving. Sustained dyadic Eco-labelling. Industry sustainability standards.	Re-conceptualization of roles.
REFERENCES	[33] [49] [71]	[80], [81]	[62] [79] [80] [81] [82] [83] [84]	[86] [88]	[89] [90]
BARRIERS	BE2, BE6		BK4, BK5, BG7, BG10, BE1, BE2, BE5, BE6		
DRIVERS	DK3, DK4, DG3, DG9, DE1, DE6, DE7, DE9		DK7, DK8, DK9, DG1, DG3, DE6		
SUITABILITY FOR NBS	Low-medium depending the scale of the NBS project (the smaller the scale the easier to implement only market-oriented approaches). Risk aversion of the private sector often result in a choice for proven technology rather than for innovative solutions (such NBS).		Medium-high. But currently the required conditions for the more complex models are met only in rare cases. This implies the need for a significant change in relationships between enterprise-based activities in the developing world and broader social, economic and political systems in which they are embedded.		

4.2.3. *CLUSTER 4: Societal Resilience and CLUSTER5: Network Governance.* Societal Resilience comprises the governance models in the higher steps of the participation ladder when communities have the power for planning and managing without (almost) intermediaries. The Network Governance instead, aims to add the community and local voices to environmental governance models supported by the government with the hope to solve complex problems and allowing a more equitable allocation of benefits [61].

Table 5: Characterisation of Societal Resilience and Network governance models (Cluster4 and 5)

	CLUSTER 4: Societal Resilience			CLUSTER 5: Network Governance		
	Co-management	Civic ecology practices	Self-governance/grassroots initiatives	Collaborative governance	Adaptive governance	Adaptive co-management
KEY WORDS	Open participation, decentralized management, social learning	Small scale, local	Bottom-up, polycentric, self-organisation, self-management	Collaborative, multi-level, polycentric	Environmental governance, decentralized, polycentric, bottom-up	Community-based, resource management, polycentric

HOW EMERGES	When initiated by non-government, government supports implementation. When initiated by the government stakeholders are invited	Often are initiated by lay persons, generally as a community-based response to urban decline or sudden disturbances like hurricanes and war	Decision-making about societal development is no solely in the hands of government, but companies, scientists, media, new social movements and community.	Usually the model is initiated by the government trying to incorporate new resources, efficiency, knowledge and competences to solve complex problems.	May require “windows of opportunity” that appear as significant boost in capital or legitimacy	Usually triggered by a crisis.
INVOLVED ACTORS	Local authorities, citizens, NGOs, researchers	Scientists and NGOs helps to ensure larger impacts and longer-term sustainability, but it is not mandatory	Local authorities, citizens, NGOs, researchers	Involves a large group of governmental and non-governmental actors that engage in competitive and/or stimulating governing activities.	Requires a structure of nested institutions and cross-scale institutional diversity connected by formal and informal networks	Diverse set of stakeholders, operating at different levels, often through networks from local users to international bodies.
GOVERNMENT INVOLVEMENT	Medium	Not mandatory	It could have a semi-passive role	Government retains the formal authority	Medium.	Medium.
RULES	Local authorities have to take the responsibility for the urban environment which means that there is a limit for decentralization as far as public goods and services are concerned	Local authorities have to take the responsibility for the urban environment which means that there is a limit for decentralization as far as public goods and services are concerned	Grassroots movement have their own dynamic and they are an inherently unpredictable. Institutional diversity and multi-scalarity.	Actors are only loosely bound to one another. The model is formally organized and meets collectively. Participants are included in decision making process. Transaction costs are high.	Largely builds on human relationships and trust.	Leadership is essential by providing innovation, building trust, making sense, managing conflict, linking actors, compiling and mobilizing broad support for change. Iterative learning and action
CONTEXTUAL CONDITIONS	How co-operative management schemes are formulated and implemented depends on the task at hand and the responsibility shared	They reflect local environments and cultural traditions.	An active society is requirement.	Theoretically the model can be implemented at local, regional, state, national and even global levels (although at global level the decisions are voluntary)	Developed democracies and high-income countries where policy tends to leave room for and support innovation and bottom-up initiatives	Tailored to specific places and situations
TOOLBOX	Collaboration. Experimentation.			Analytical-deliberative approaches. Participatory evaluation. Collaborative scenario-building exercises. Urban Transition Labs	Assessment of multiple and non-monetary benefits. Qualitative, multi-criteria, iterative and experimental approaches.	Collaboration. Experimentation. Bioregional approach to resource management
REFERENCES	[74] [31], [94] [32] [37] [41]	[23] [95]	[65] [96] [73]	[21] [54] [57] [65] [86] [93] [99] [100]	[55] [61][101] [102]	[30] [41] [91] [102] [103][104]
BARRIERS	BG7, BG9, BG10, BG11, BE1, BE5			BG2, BG7, BG9, BG10, BE1, BE2		
DRIVERS	DK9, DG6, DG10, DE10			DK1, DK2, DK3, DK4, DK5, DK9, DG1, DG7, DG8, DG9, DG10, DE1, DE2, DE3, DE4, DE5, DE6, DE7		
SUITABILITY FOR NBS	High. Management of natural resources is one field especially well fitted for these types of governance. Reflexive governance is a model that may be the one applicable for social-ecological innovations such as NBS.			Very High. Collaborative governance is an approach thought for dealing with uncertainty, complexity and dynamics, therefore totally suited for NBS projects. “Transaction costs” (costs of consultations, reaching agreement, and enforcing such agreements) could be high		

5. Implementation model’s database and results

After developing the theoretical model, a database with different real cases was built to link the models with best practices and to study the incidence of them. To systematize all the information, all the

identified cases were included in the same “card template” which constitute the narrative. Implementation Models were organized in 56 detailed cards containing: i) Short description of the NBS with picture, ii) Implementation context (location, scale, urban density), iii) Classification/typology, iv) Urban challenges addressed, v) NBS Stakeholders and Governance, vi) NBS financial aspects, vii) Business model, and viii) Enablers and inhibitors. The complete database is available on-line [70]. The Implementation Model (IM) collection has been built at first taking into consideration the availability of information regarding a series of practical experiences that refer to different IM. The main aim was to have a catalogue with a reasonable number of examples. The database now comprehends 56 detailed examples. The analysis was conducted based on online and free information. All the existing databases (i.e. the EEA database [71], Naturvation database [72] and others) are based on the description of NBS classification, scale, and dimension of the expected effects and not on the way in which they can be realized and carried out as full projects. The aim of this database was to give the possibility to users to consult a list of real projects crossing different variables (features or characteristics) in order to build further levels of knowledge about NBS.

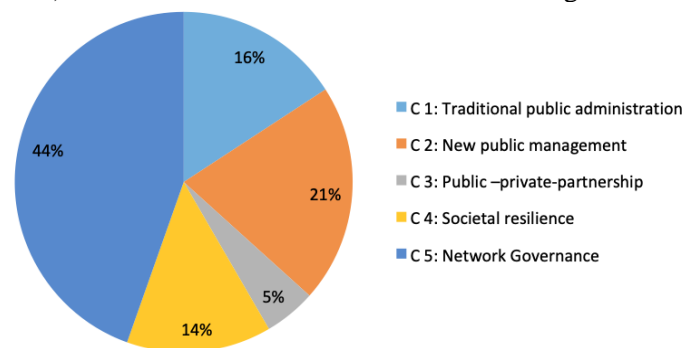


Figure 2. Governance Models incidence in the NBS IMs

The results that emerged from the governance models in the IM database (see Figure 2) showed that the more usual governance models are the ones from the Cluster 5 – “Network governance” (around 43% of the cases). Although, this confirms the theoretical conclusion that this type of governance is the most suitable for NBS oriented planning (see Table 5), this correlation between the suitability of the governance models and their incidence in real cases is not so evident for the rest of the models. The second is the Cluster 2- “New public management” (21%) and the third is the Cluster 1- “Traditional public administration” (16%) with a theoretical suitability level of “low” or “medium low”. The frequency of these types of governance could be more related with the traditional inertia of government structures than with the suitability of them.

6. Conclusions

The implementation of NBS projects is deeply determined by the opportunity and challenge that involves the novelty and complexity of the approach. As a new concept, it generates uncertainty due the lack of technical and operational preparedness, but it also allows to deploy innovative approaches, new ways to address old problems and more inclusive practices. Collaborative, multisector, polycentric and adaptive governance models have been considered the more suitable governance models for NBS projects, especially when urban scales are addressed. Drivers related to network governance models (such as coordination, co-production, cross-sectorial cooperation and reflexive/adaptive governance) are drivers that address a significant number of identified cross-domain barriers showing the suitability of these kind of governance models for NBS projects. The study of 56 real cases have demonstrated that the type of governance models that fulfils these requirements, “Network Governance” models, is decisively prevalent as compared to the other governance models. This result demonstrates that the collaborative and adaptive governance together with the scale-crossing borders are relevant aspects and play a crucial role in the regulatory and decision-making framework when it comes to NBS implementation in urban contexts. However, frequency cannot be

considered as the only indicator for suitability. The significant incidence of less suitable but more traditional governance models, shows the high inertia that remains in urban planning. The work presented in this paper could be the basis to define new institutional and governance arrangements and new finance and business models, that will foster multi-stakeholder involvement, citizens' engagement and empowerment, leveraging both public and private funding of NBS in cities.

Acknowledgement

This work has been developed in Nature4Cities project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730468. The authors would like to thank to Nature4Cities partners for the support received.

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