Nature and Artifice. An holistic approach to environmental and technological design

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Abstract: After a brief introduction to the conditions that make it necessary to resort to natural solutions, the chapter illustrates the meaning of Nature-based Solutions (NbS), a concept that has evolved over time and has now reached a widely shared formulation. The *Catalogue of NbS and Case Studies* of the National Biodiversity Future Center (NBFC), developed within the research project to which the University of Florence group contributed with specific reference to applications in urban areas, also refers to this "umbrella concept". The chapter proposes a reinterpretation of the relationship between nature and artifice, which today can no longer be understood as antithetical, but must instead take into account their interaction in order to absorb increasingly pervasive technological innovations. This is especially relevant at a time when the boundaries between nature and artifice are becoming increasingly blurred, and creativity and innovation are now the result of shared, collaborative and multidisciplinary processes. The mediation between nature and artifice becomes even more necessary in urban spaces, where artefacts, but also critical issues, are most concentrated, and where it is essential to combine the objectives of reintegrating nature with ordinary planning processes. The chapter presents a holistic approach based on the collaborative relationship between forms of natural, artificial and collective intelligence. These forms of intelligence can guide the coexistence of living beings in the built environment and lead to adaptation and mitigation scenarios capable of counteracting the drastic changes that are putting the survival of our planet at risk. Therefore, the theme of dwelling and urban life cannot be addressed through natural elements alone, however fundamental they may be, but must also act on the artificial and technological components, including AI, and on the ideational capacity expressed by communities in response to complex problems. In rethinking the built environment, the role of architectural and urban designers also changes, as do the skills required to address new scenarios that outline a new approach to the use of available resources, inspired by biophilic design and circular design.

Keywords: Nature, Artifice, NbS, Architectural and urban regeneration, Environmental and technological design.

1. The context of the research

In reports investigating the state of health of our planet, the use of nature is identified as one of the priority areas of intervention across all ecosystems—marine, terrestrial and urban—in an effort to counteract negative forecasts for the future (IPBES 2019; IPCC 2023).

Recognising the complexity and dynamism of socio-ecological systems, the sustainable use of nature has been proposed at both practical and political levels as a means of addressing societal challenges. Nature-based Solutions (NbS) have the capacity to generate benefits for both people and the environment by addressing the risks to which our habitat is increasingly exposed. They focus attention on human beings by associating biodiversity conservation and management aspects with social factors such as people's well-being, poverty reduction, socio-economic development and governance principles (Eggermont et al. 2015).

The urban environment, particularly that of large cities, is where the effects of the Anthropocene produce some of the most catastrophic consequences, since cities are

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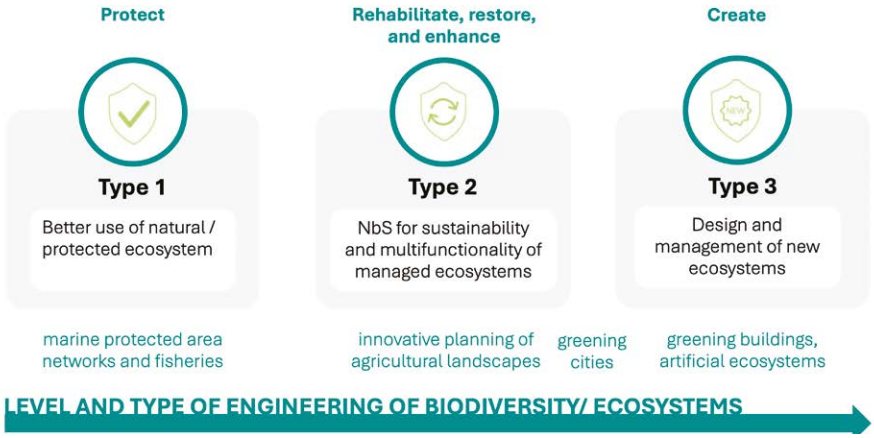

Fig. 1 – Schematic representation of the range of approaches to NbS (Author's elaboration adapted from Eggermont et al. 2015).

exposed to the greatest risks: they are densely populated, housing, services and infrastructure are highly concentrated, and they constitute the fulcrum of social relations and economic activities. Interventions aimed at restoring ecosystems, improving the health and well-being of living beings and increasing biodiversity—specifically through the application of NbS—can play a decisive role in enhancing the resilience of human settlements and supporting their transition towards a sustainable future.

The *Catalogue of NbS and Case Studies* developed within the National Biodiversity Future Centre—the NbS CataTool/NBFC—with the contribution of researchers from the University of Florence, is configured as a Decision Support System designed to provide users across the national territory with up-to-date and evidence-based knowledge on NbS.

2. What are NbS?

The term NbS became widespread in the early 2000s, and its meaning and definition have evolved over time, incorporating both the scientific guidelines emerging from research and the political-strategic orientations of major international institutions.

The acronym NbS was initially used in the search for new solutions for mitigating and adapting to the effects of climate change, while at the same time protecting biodiversity and improving sustainable living conditions. The International Union for Conservation of Nature (IUCN) used the term NbS with reference to the fight against climate change (IUCN 2009), after which it was adopted in policy contexts to indicate an innovative means of creating jobs and growth within a green economy system (EC 2015).

In view of the multiple meanings associated with the role and significance of NbS, Eggermont et al. (2015) propose a characterisation of NbS according to three types:

Type 1: consists of no or minimal intervention in ecosystems, with the objective of maintaining or improving the delivery of a range of ecosystem services both within and beyond these preserved ecosystems;

Type 2: corresponds to the definition and implementation of management approaches that develop sustainable and multifunctional ecosystems and landscapes, whether extensively or intensively managed, improving the delivery of selected ecosystem services compared with what would be obtained through more conventional interventions;

Type 3: consists of managing ecosystems in highly intrusive ways or even creating new ecosystems, such as artificial ecosystems with new assemblages of organisms for green roofs and walls designed to mitigate urban warming and clean polluted air.

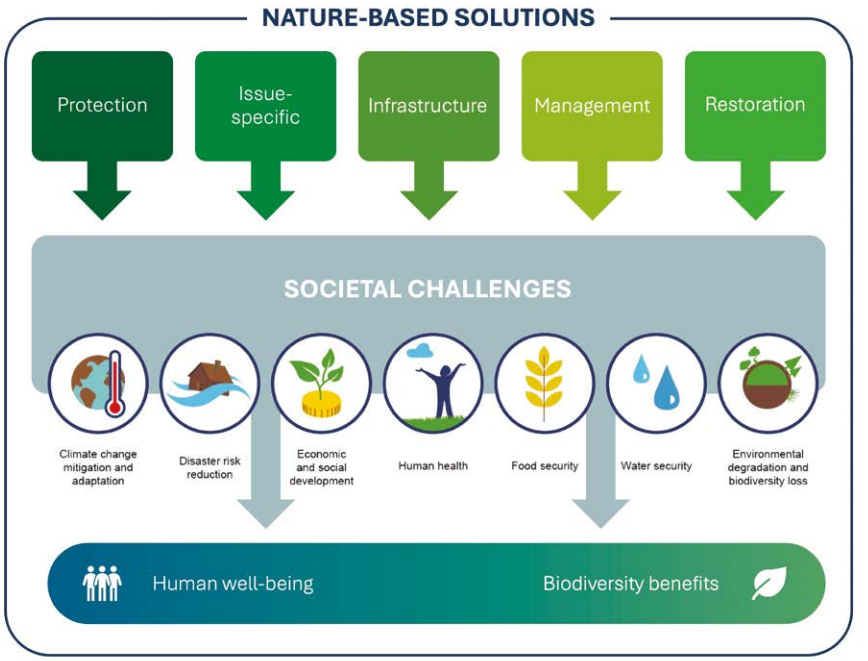

Fig. 2 – The definition scheme of NbS (Author's elaboration adapted from IUCN 2020)

The three types take into account two gradients: the degree to which biodiversity and ecosystem engineering are involved in NbS; and the number of ecosystem services and stakeholders targeted by a given NbS (Eggermont et al. 2015) (see Fig. 1).

NbS have gradually acquired a broader value, extending their meaning to a set of actions aimed at providing environmental, social and economic benefits. The European Commission and, subsequently, the IUCN identify NbS as a combination of different types of intervention: not only solutions "based" on nature, but also solutions "inspired" by nature and solutions "derived" from nature, in order to move towards a sustainable and low-carbon future. While nature-based solutions harness the power of functioning ecosystems as infrastructure to provide natural services for the benefit of society and the environment, nature-derived solutions operate through production methods derived from natural sources. Nature-inspired solutions include the innovative design and manufacture of materials, structures and systems that are modelled on biological processes and inspired by nature (EC 2015; IUCN 2020).

The meaning of NbS thus becomes a general "umbrella concept" under which different approaches to environmental sustainability and ecosystem management are integrated (see Fig. 2).

To be considered an NbS, an intervention must address one or more societal challenges in an integrated way. The IUCN identified a list of societal challenges (IUCN 2020), later updated according to *The NetworkNature EU Roadmap to 2030* (El Harrak and Lemaître 2023): 1) Climate resilience, 2) Water management, 3) Food security, 4) Social justice and social cohesion, 5) New economic opportunities and green jobs, 6) Participatory planning and governance, 7) Natural and climate hazards, 8) Health, well-being and air quality, 9) Green space management, 10) Place regeneration, 11) Knowledge and social capacity building for sustainable urban transformation, 12) Biodiversity enhancement.

Following growing interest in NbS, the IUCN deemed it necessary to define a standard allowing practitioners to regulate the design and application of each NbS accord-

ing to the principles established in 2016 (see Tab. 1). This provides a common basis for understanding what can be considered an NbS and for contributing to change by improving NbS practice and supporting NbS-related development policies (IUCN 2016; IUCN 2020).

Tab. 1 – NbS principles according to the NbS definition (Author's adaptation from IUCN 2016).

Principle 1	NbS embrace nature conservation norms and principles
Principle 2	NbS can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions)
Principle 3	NbS are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge
Principle 4	NbS produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation
Principle 5	NbS maintain biological and cultural diversity and the ability of ecosystems to evolve over time
Principle 6	NbS are applied at a landscape scale
Principle 7	NbS recognize and address the trade-offs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services
Principle 8	NbS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge

The Standard consists of eight Criteria, each of which is divided into a series of Indicators (see Tab. 2).

Tab. 2 – Criteria and Indicators of the IUCN Global Standard for NbS (Author's adaptation from: IUCN 2020).

	Indicatori
Criterion 1 NbS effectively address societal challenges	C- 1.1 The most pressing societal challenge(s) for rights-holders and beneficiaries are prioritised
	C-1.2 The societal challenge(s) addressed are clearly understood and documented
	C-1.3 Human well-being outcomes arising from the NbS are identified, benchmarked and periodically assessed
Criterion 2 Design of NbS is informed by scale	C-2.1 The design of the NbS recognises and responds to the interactions between the economy, society and ecosystems
	C-2.2 The design of the NbS is integrated with other complementary interventions and seeks synergies across sectors
	C-2.3 The design of the NbS incorporates risk identification and risk management beyond the intervention site
Criterion 3 NbS result in a net gain to biodiversity and ecosystem integrity	C-3.1 The NbS actions directly respond to evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss
	C-3.2 Clear and measurable biodiversity conservation outcomes are identified, benchmarked and periodically assessed
	C-3.3 Monitoring includes periodic assessments of unintended adverse consequences on nature arising from the NbS
	C-3.4 Opportunities to enhance ecosystem integrity and connectivity are identified and incorporated into the NbS strategy

	Indicatori
Criterion 4 NbS are economically viable	C-4.1 The direct and indirect benefits and costs associated with the NbS, who pays and who benefits, are identified and documented
	C-4.2 A cost-effectiveness study is provided to support the choice of NbS including the likely impact of any relevant regulations and subsidies
	C-4.3 The effectiveness of the NbS design is justified against available alternative solutions, taking into account any associated externalities
	C-4.4 The NbS design considers a portfolio of resourcing options such as market-based, public sector, voluntary commitments and actions to support regulatory compliance
Criterion 5 NbS are based on inclusive, transparent and empowering governance processes	C-5.1 A defined and fully agreed upon feedback and grievance resolution mechanism is available to all stakeholders before an NbS intervention is initiated
	C-5.2 Participation is based on mutual respect and equality, regardless of gender, age or social status, and upholds the right of Indigenous Peoples to Free Prior and Informed Consent (FPIC)
	C-5.3 Stakeholders who are directly and indirectly affected by the NbS have been identified and involved in all processes of the NbS intervention
	C-5.4 Decision-making processes document and respond to the rights and interests of all participating and affected stakeholders
	C-5.5 Where the scale of the NbS extends beyond jurisdictional boundaries, mechanisms are established to enable joint decision-making of the stakeholders in the affected jurisdictions
Criterion 6 NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits	C-6.1 The potential costs and benefits of associated trade-offs of the NbS intervention are explicitly acknowledged and inform safeguards and any appropriate corrective actions
	C-6.2 The rights, usage of and access to land and resources, along with the responsibilities of different stakeholders, are acknowledged and respected
	C-6.3 The established safeguards are periodically reviewed to ensure that mutually agreed trade-off limits are respected and do not destabilise the entire NbS
Criterion 7 NbS are managed adaptively, based on evidence	C-7.1 An NbS strategy is established and used as a basis for regular monitoring and evaluation of the intervention
	C-7.2 A monitoring and evaluation plan is developed and implemented throughout the intervention lifecycle
	C-7.3 A framework for iterative learning that enables adaptive management is applied throughout the intervention lifecycle
Criterion 8 NbS are sustainable and mainstreamed within an appropriate jurisdictional context	C-8.1 The NbS design, implementation and lessons learnt are shared to trigger transformative change
	C-8.2 The NbS informs and enhances facilitating policy and regulation frameworks to support its uptake and mainstreaming
	C-8.3 Where relevant, the NbS contributes to national and global targets for human well-being, climate change, biodiversity and human rights, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)

From an operational point of view, the IUCN Global Standard for NbS has two functions: to support the design of an NbS and to provide a tool for verifying that the design meets the requirements of the NbS Standard. It therefore establishes a self-assessment methodology based on a process sequence that includes the following phases: *Design*, in which the design and subsequent implementation of an intervention must

correspond to the eight criteria in order for the intervention to qualify as an NbS; *Scaling up*, in which the NbS acquires consistency in relation to the specific context and territorial dimension; and *Verification*, in which the Standard can be used to ascertain whether a designed solution is actually an NbS.

Finally, the resolution of the United Nations Environment Assembly (UNEA), recognising the important role that NbS can play in the global response to climate change and its social, economic and environmental effects, defines NbS more extensively as «actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits» (UNEA 5.2 Resolutions 2022).

The NbS CataTool/NBFC adopts this definition, with particular attention to terrestrial ecosystems and, more specifically, the urban environment.

3. The role of nature in the urban context

The need to integrate natural elements into urban systems emerged with particular urgency in the nineteenth century, when the city began to reveal the most harmful consequences of the massive urbanisation of the population and of the transformations produced by human activities, to the point of causing an imbalance in ecosystems.

Ebenezer Howard's Garden City project, launched at the end of the nineteenth century, represents a concrete experience that led to the creation of two garden cities, Letchworth and Welwyn in Great Britain, and inspired many other developments. The proposal to include public parks and private gardens in order to protect health and purify the air aimed to combine the benefits of the countryside and the city, while avoiding the disadvantages present in both.

The sociologist Lewis Mumford points out that Howard's great innovation was to have developed the organic concepts underpinning the physical form of the city, introducing a new idea of development and a new model of urban planning and construction (Mumford 1977, 639; 643).

The application of biological criteria of dynamic and organic balance to control urban development and ensure the functionality and containment of movement, the presence of continuous green belts designed to safeguard the health and well-being of inhabitants, and the external delimitation of the settlement by a permanent agricultural area are principles that inspired Howard's proposal and that can still be considered valid, even in a completely different context. Yet the planning model proposed by Howard, apart from its initial achievements, has been largely ignored in practice.

Today, the urban environment is the place where construction activity is most concentrated and constitutes a complex system in which artefacts—buildings, roads and infrastructure—are present to a predominant extent. In urban areas, natural spaces remain limited in comparison with artificial surfaces (EEA 2021). The scarcity of green areas and new urbanisation increase vulnerability to the disruptive impacts of climate change, such as flooding, extreme heat and droughts (IPCC 2023), and place pressure on biodiversity by altering ecosystems and causing the extinction of many animal and plant species (IPBES 2019). Furthermore, these transformations have serious impacts on the population and worsen the quality of life, well-being and health of inhabitants (Pereira Barboza et al. 2021). Abandoned or underused urban green areas, even in small towns, still represent a critical issue, and their recovery can have a positive impact on community life.

Natural spaces in cities play a key role in counteracting climate change and restoring biodiversity (Maudsley and Wallsten 2024). NbS provide essential habitats for many species of flora and fauna, contribute to urban biological diversity by fostering ecological balance, and increase ecosystem services. Furthermore, NbS support the rebalancing of outdoor comfort in terms of surface and ambient temperature control, relative humidity and air quality, and also improve the hydrogeological performance of soil and water basins, with positive effects on human health (UNEP 2022).

In recent years, ongoing research has shown how climate change and biodiversity loss can be countered by proposing new urban models that adopt NbS capable of increasing the adaptation and resilience of the built environment while improving ecosystem biodiversity (EC 2024a).

The application and diffusion of NbS in the urban domain must be considered an absolute priority, since the greatest risks and the most devastating consequences for inhabitants are concentrated in cities.

The role of NbS is strengthened by the recent promulgation of the European Nature Restoration Law, related to the European Green Deal, which aims to restore ecosystems, habitats and species across all terrestrial and marine areas of the EU in order to enable the long-term and sustained recovery of biodiversity and nature's resilience, while contributing to the achievement of the EU's climate change mitigation and adaptation objectives. EU countries are required to submit their national restoration plans within two years of the entry into force of the regulation, namely by mid-2026, indicating how they will achieve the targets. In particular, the regulation introduced by the Nature Restoration Law sets, for urban ecosystems, the goal of no net loss of urban green space and tree cover by 2030, followed by a constant increase in their total area from 2030 onwards. This is to be achieved through the restoration and expansion of green spaces—including forests, parks and urban gardens, urban farms, tree-lined streets, lawns and hedgerows—and by integrating green infrastructure and nature-based solutions, such as green roofs and walls, into building design (EC 2024b).

Despite growing political interest at higher levels, a comprehensive understanding of these alternative urban models and their adaptation to different urban settings, as well as their actual implementation at the local level, remain limited. In order to fill the gap related to the need to stimulate the widespread implementation of natural solutions, adopt the principle of natural infrastructure and respect planetary limits, it is crucial to provide municipalities with appropriate tools—including methodologies, guidelines, best-practice reports and pilot case studies—to properly integrate NbS into current urban planning processes and drive urban transition.

4. The integration between nature and artifice

In the typological classification described above, and also implemented in subsequent studies and reports on NbS, it can be seen that higher degrees of engineering and artificial ecosystems are exemplified particularly in urban areas. In the field of NbS, technical innovations are increasingly being developed; these appear in all types of NbS, but are mainly concentrated in the design and management of new ecosystems. In urban areas, innovative solutions mostly consist of smart engineering solutions (Somarakis, Stagakis, Chrysoulakis 2019).

As a decision support system, the NbS CataTool/NBFC organises NbS according to the same typological classification, correlating it even more explicitly with the type of intervention that a user intends to apply through an NbS: type 1) Protect; type 2) Manage/Restore; type 3) Create. This classification of NbS indicates the need to main-

Fig. 3 – The *Polinature* pavilion (Source: Ecosistema Urbano Creative Common CC by 4.0).

tain a broad interpretation of the term, an issue that presents certain difficulties but also favours a wider reading, one that takes into account not only the creative contribution of design but also the uncertain boundary that establishes what is nature and what is artifice.

The relationship between nature and artifice is a theme that touches on various fields, such as philosophy, art, science, technology and literature. It may refer to contrast, but also to the interaction between what is natural and what is created by human beings. If, in 2015, the European Commission established that NbS exclude methods that artificially alter nature, such as genetically modified organisms (EC 2015), today, following the rapid transformations induced by the use of artificial intelligence and by the simulation of natural processes, to what extent can this statement still be considered valid? According to the philosopher of science Pievani, the boundary between natural and artificial is no longer so clear: both terms represent the result of evolution, considering that even what is natural is now, in fact, also the result of human intervention (Pievani 2024). In an era in which we are able to manipulate the genetic bases of evolution and simulate natural behaviours through processes that are not spontaneous but induced by human beings, the dualistic vision between nature and artifice has now been superseded by the fusion between civilisation and environment (Buttafuoco 2025).

Only recently has the need for a holistic approach emerged, especially in architectural and urban regeneration interventions. This approach views nature and artifice as complex systems in continuous interaction, where the whole is capable of representing greater complexity and diversity than the mere sum of its individual elements. A concrete example of this approach is represented by the Polinature pavilion, an urban ecosystem that integrates nature, technology and AI as a trigger for a broader process of urban transformation (Tato, Vallejo, Rizzetto, Liebes 2025) (see Fig. 3).

This primarily cultural instance is well represented by the 2025 Venice Architecture Biennale, entitled *Intelligens. Natural. Artificial. Collective*, which addresses the collaborative relationship between forms of natural, artificial and collective intelligence. These forms of intelligence can guide the coexistence of living beings in the built en-

vironment and lead to adaptation and mitigation scenarios capable of counteracting the drastic changes that are putting the survival of our planet at risk.

The curator of the exhibition, Carlo Ratti, states that the theme of dwelling and urban life cannot be addressed solely through the contribution of natural elements, however fundamental they may be, but must also act on the artificial and technological components, including AI, and on the ideational capacity expressed by communities in response to complex problems. This is especially true at a time when the boundaries between nature and artifice are increasingly undefined, and creativity and innovation are now the result of shared, collaborative and multidisciplinary processes (Ratti 2025). This therefore implies a collaboration between living species that expands to include the robotic and cyborg worlds, integrating the intelligence of the natural world as well as the most advanced technologies.

Through the works on display, the exhibition proposes a wide range of links between living environments and biology: from biotopia, biomimicry and neurobotany to epidermitecture—the coexistence between urban surfaces and microbial biopatinas—baubotanik, understood as the fusion of architecture and biology, and bioacoustics, namely beneficial frequencies for the well-being of plants and people.

The architectural and urban dimension is explored through hybrid natural-artificial interweavings by Kengo Kuma, suspended multi-material structures by Ensamble Studio, cockpits shielded by living networks by SO-IL, translucent diaphragms by EMBT Architects, multi-species habitats by Studio Gang, and nomadic shelters designed to "metabolise toxic artefacts" by Emanuele Coccia. These works manifest their innovative characteristics while also expressing the potential of the interconnections between science and nature, biology and technology. More generally, all the proposals on display recall the need not to consume and waste materials, but to reuse, recycle and even combine techniques and materials in innovative ways, in search of a new aesthetic capable of implementing the principles of circularity.

With a concluding message that is as clear as it is unsettling, Ratti states that the purpose of the research brought to the fore in this edition of the Venice Biennale is to make everyone understand that we no longer have to build (Banti 2025). In echoing transformative processes of natural origin, the urban context can only evolve through its own metamorphosis.

5. Scenarios of architectural and urban regeneration

Considering the urban scope of application of NbS and the role of architectural and urban designers, including landscape architects, nature becomes a resource, like any other material, to which we can turn in order to find a sustainable response to development. This response is based on an approach that integrates nature into habitats and reconnects it with people, with the aim of increasing biodiversity and regenerating urban spaces as natural ecosystems. This means adopting the principles of biophilic design, which is based on the search for a new relationship between living species—animals or plants—in which human beings are part of the natural ecosystem, just like other living beings.

The search for new NbS will have to become a frontier that further advances the creative project integrating environmental and technological devices, while exploring new links and interdependencies between the natural and artificial worlds, which are increasingly challenged by technological evolution and the growing use of artificial intelligence. NbS will have to develop according to the logic of an evolutionary process that takes into account the dynamic character of the structures generated and trans-

formed over time. The capacity of the natural world to implement mechanisms of renewal should inspire design towards the principles of resource circularity and economy. These approaches demonstrate how NbS and circular design can work in synergy to create multifunctional, low-impact and community-driven urban solutions.

Urban regeneration will increasingly have to be carried out by taking into account governance principles, on the basis of which NbS must not only be applied, but must also be compatible with the objectives of ordinary planning and design, which are necessary to ensure the transition of a complex organism—the city—towards a sustainable future.

In rethinking the built environment, the role of architectural and urban designers changes, as do the skills required to address new scenarios that outline a new approach to the use of available resources. It will not only be necessary to acquire the knowledge and skills needed to use natural matter, in its broadest sense, as a resource for design; it will also be necessary to develop multidisciplinary attitudes and collaboration mechanisms capable of addressing the close relationship between architecture, urban planning, landscape and all the other fields of expertise within the natural and physical sciences. Similarly, it has now become necessary to conceive design no longer as a strongly authorial act resulting from a monocentric process, but rather as a global approach based on the participation and sharing of multiple stakeholders representing different social, cultural and economic needs.

This multidisciplinary character will also need to be matched by mechanisms of consultation, co-design and cooperation, such as living labs, which can guarantee the highest possible level of acceptance and effectiveness of the proposed solutions. Such effectiveness is something we are not yet fully able to achieve, except through evidence derived from the monitoring of solutions already applied—which require a long time to achieve the expected objectives—or through very complex predictive design simulations, for which we are not yet fully equipped. Nevertheless, these simulations represent an important evolution of the design process, grafted onto the digitalisation of architectural and urban design through specific applications.

References

Banti, Sara. 2025. "Una Biennale post Antropocene." *Abitare Newsletter*. https://www.abitare.it/it/eventi/2025/05/12/biennale-venezia-2025-la-visione-di-carlo-ratti/ (2025-10-17).

Barboza, Evelise P., Marta Cirach, Sasha Khomenko, Tamara Iungman, Natalie Mueller, Jose Barrera-Gómez, David Rojas-Rueda, Michelle Kondo, e Mark Nieuwenhuijsen. 2021. "Green space and mortality in European cities: a health impact assessment study." *The Lancet Planetary Health* 5, 10: e718-e730.

Buttafuoco, Pietrangelo. 2025. "Introduzione." In *Intelligens. Natural. Artificial. Collective. Biennale Architettura 2025*. Venezia: La Biennale di Venezia.

Eggermont, Hilde, Estelle Balian, José Manuel N. Azevedo, Victor Beumer, Tomas Brodin, Joachim Claudet, Bruno Fady, Martin Grube, Hans Keune, Penelope Lamarque, Katrin Reuter, Matt Smith, Chantal van Ham, Wolfgang W. Weisser, e Xavier Le Roux. 2015. "Nature-based Solutions: New Influence for Environmental Management and Research in Europe." *GAIA* 24, 4: 243-48. https://doi.org/10.14512/gaia.24.4.9.

El Harrak, Mariem, e Frederic Lemaître. 2023. *European Roadmap to 2030 for Research and Innovation on Nature-based Solutions*. NetworkNature. https://networknature.eu/sites/default/files/old_files/uploads/eu-ri-roadmapweb.pdf (2025-10-17).

European Commission. 2015. *Towards an EU Research and Innovation policy agenda for nature-based solutions & re-naturing cities. Final Report of the Horizon2020 expert group on nature-based solutions and re-naturing cities*. Brussels: European Commission. https://publications.europa.eu/resource/genpub/PUB_KI0215162ENC_PDFX.1.4 (2025-10-17).

European Commission. 2024a. *Nature-based solutions – EU-funded NbS research projects tackle the climate and biodiversity crisis*. Publications Office of the European Union. https://data.europa.eu/doi/10.2848/8542246.

European Commission. 2024b. "Nature Restoration Law." https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-regulation_en (2025-10-17).

European Environment Agency. 2021. *Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2800/919315.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 2019. *Summary for policymakers of the global assessment report on biodiversity and ecosystem services*. Bonn: IPBES secretariat. https://doi.org/10.5281/zenodo.3553579.

International Panel on Climate Change. 2023. *Climate Change 2022 – Impacts, Adaptation and Vulnerability – Summary for Policymakers*. Switzerland. https://doi.org/10.1017/9781009325844.001.

International Union for Conservation of Nature. 2009. *No time to lose: Make full use of nature-based solutions in the post-2012 climate change regime*. Gland, CH: IUCN. https://iucn.org/sites/default/files/import/downloads/iucn_position_paper_unfccc_cop_15_1.pdf (2025-10-17).

International Union for Conservation of Nature. 2016. *Resolution 69 on Defining Nature-based Solutions (WCC-2016-Res-069). IUCN Resolutions, Recommendations and Other Decisions 6–10 September 2016. World Conservation Congress Honolulu, Hawai USA*. https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf (2025-10-17).

International Union for Conservation of Nature. 2020. *Guidance for using the IUCN Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of Nature-based Solutions*. Gland, CH: IUCN. https://doi.org/10.2305/IUCN.CH.2020.09.en.

Maudsley, Ann, e Bjorn Wallsten. 2024. *Towards Regenerative Neighbourhoods: European Cases, Insights, and Initiatives. A Curated Compilation made by the Circular Urban Economies Transition Pathway in the Driving Urban Transitions Partnership (DUT)*.

Mumford, Lewis. 1977. *La città nella storia*. Milano: ETAS Libri, Bompiani.

Pievani, Telmo. 2024. *Tutti i mondi possibili*. Milano: Raffaello Cortina.

Ratti, Carlo. 2025. "Introduzione." In *Intelligens. Natural. Artificial. Collective. Biennale Architettura 2025*. Venezia: La Biennale di Venezia.

Somarakis, Giorgios, Stavros Stagakis, e Nektarios Chrysoulakis, a cura di. 2019. *ThinkNature Nature-Based Solutions Handbook*. ThinkNature project funded by the EU Horizon 2020 research and innovation programme under grant agreement No. 730338. https://doi.org/10.26225/jerv-w202.

Tato, Belinda, Jose Luis Vallejo, Marco Rizzetto, e Lily Liebes. 2025. "Polinature, a prototype for a plug-in bioclimatic urban oasis." *TECHNE - Journal of Technology for Architecture and Environment* 29, 1: 45-51. https://doi.org/10.36253/techne-17672.

United Nations Environment Agency. 2022a. *Resolution adopted by the United Nations Environment Assembly on 2 March 2022 5/6. Biodiversity and health*. https://wedocs.unep.org/bitstream/handle/20.500.11822/39840/BIODIVERSITY%20AND%20HEALTH%20%20-%20English.pdf?sequence=1&isAllowed=y (2025-10-17).

United Nations Environment Programme. 2022b. *Nature-based solutions for supporting sustainable development – Resolution adopted by the United Nations Environment Assembly on 2 March 2022*. https://wedocs.unep.org/handle/20.500.11822/39864 (2025-10-17).