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Beyond Demonstrators—tackling fundamental problems in amplifying nature-based solutions for the post-COVID-19 world

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Nature-based Solutions (NbS) are currently promoted as a panacea for improving human-nature relations. Yet the way of amplifying and mainstreaming NbS beyond scientific demonstrator projects into policy contexts is still bearing shortcomings, in particular in the uncertain futures of a post-COVID-19 world. Successful NbS amplification may be achieved by (1) using multi-scalar action to balance differing interests and reconcile governance levels, (2) providing financial and other institutionalized incentives and strategies for integrated participation processes, (3) using appropriate governance and management scales effectively integrating mediators, (4) using opportunities for transformative change offered by crisis, and (5) learning from worldwide amplification experiences.

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CURRENT PRACTICE OF AMPLIFYING NATURE-BASED SOLUTIONS

In face of the twin crises of climate and COVID-19¹, people-nature relations have to be rethought in cooperation with science and policy to secure the continued existence of humans and nature on our planet. Nature-based Solutions (NbS)—understood as actions which are inspired by, supported by, or copied from nature and which address ecological, social, and economic challenges in sustainable ways²—can lead a way forward. NbS arguably provide a promising approach to help achieve many of the United Nations' Sustainable Development Goals (SDGs), such as good health and well-being (SDG 3), sustainable cities and communities (SDG 11), and sustainable land use (SDG 15)^{3,16,9}. Examples of NbS include coastal management to mitigate the effects of climate change impacts, reestablishing green spaces to reduce the impact of urbanization, restoring floodplains and wetlands to reduce the risk of downstream flooding, transforming arable land into grasslands, and cooperation among land users to enhance ecosystem services delivery^{4,5}. The term is used as an umbrella term for existing concepts such as e.g., Ecological Restoration, Ecological Engineering, Green and Blue Infrastructure⁶, Ecosystem Services^{7,8}, Ecosystem-based Management, Ecosystem-based Adaptation, Ecosystem-based Disaster Risk Reduction, or Building with Nature⁹.

Currently, there are several initiatives to amplify NbS (for a typology of amplification processes see¹⁰). At a global policy level, 131 nations—66% of all signatories to the Paris Agreement—include NbS for climate change mitigation and adaptation in their Nationally Determined Contributions (NDCs)¹¹. At a regional scientific level, the European Commission currently supports numerous research and innovation projects, such as Connecting Nature, BlueGreenCities, UrbanGreenUp, RECONNECT, NATURVATION, and PHUSICOS, that engage in establishing demonstrator cases for designing and implementing NbS mainly in urban,

suburban, and rural areas and assessing their impacts and co-benefits for people and nature¹². As requested by the Commission, the projects focus on NbS testing in demonstration sites or frontrunner regions and cities and envision subsequent knowledge transfer to other areas as a form of amplifying out NbS (Fig. 1). The intended transfer of NbS knowledge thereby often follows, not necessarily explicitly but by content, the concept of experimentalist governance which allows the testing of different governance arrangements in a “process of provisional goal-setting and revision based on learning from the comparison of alternative approaches to advancing them in different contexts.”^{13,3}. The aim is, that by comparing and learning from different approaches, policy ends and means can be further developed, evidence-based policy making can be supported, and broader transformative change be initiated^{14,15}.

We agree that the experimentalist approach to amplifying NbS is advantageous. Most importantly, it enables early testing of novel and flexible solutions to the complex, context-specific, and ambiguous challenges and delivers empirical evidence on NbS effectiveness in approximated real-world situations. This includes the testing of implementation options despite significant barriers, such as existing infrastructures, inhibiting social practices as well as hindering governance systems, and economic instruments in place. It provides opportunities to study unconventional, non-regulated, and untested interventions which otherwise would not materialize because of economic reasons (funding of innovative solutions is usually not provided by public budgets), practical reasons (working routines do not include time for experimentation) or lacking knowledge (innovative ideas are simply not on the table). In this light, the experimentalist approach may allow changing “material arrangements, cultures, norms, and conventions, and in the process, create a new political space”^{16,5}.

While the COVID-19 pandemic reveals the importance of NbS and current opportunities enabled by the public attention to

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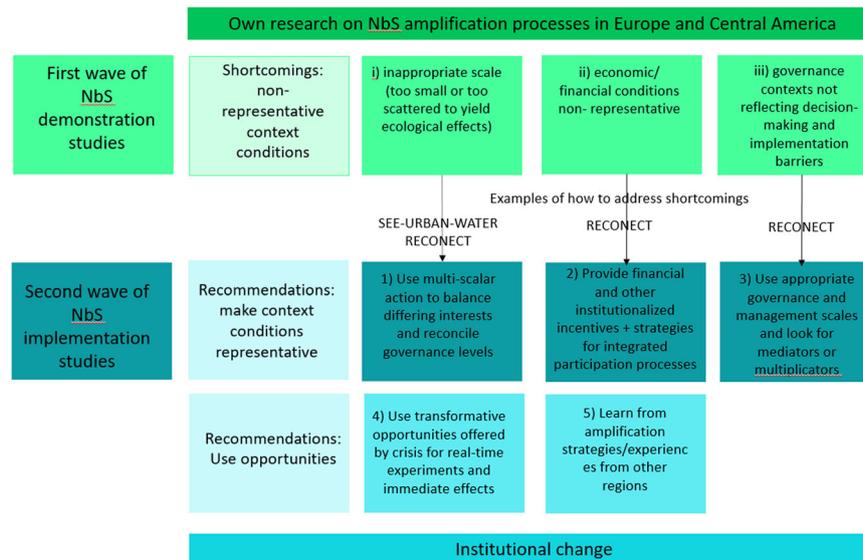


Fig. 1 From shortcomings of NbS demonstrator case studies to recommendations for institutional change. Green tiles refer to the content derived from first wave NbS demonstration studies, blue tiles refer to the content derived from second wave implementation studies, SEE-URBAN-WATER and RECONNECT are project examples referred to in this article that address the shortcomings of the first wave of NbS demonstration studies.

people-nature relations, we identify three shortcomings of the current practice of amplifying NbS. Although science is on its way to address these shortcomings, it needs support from policy to succeed. That is why the recent experiences gained in policy experimentation and initiatives for green recovery emerging from the COVID-19 pandemic should be harnessed. Science and policy can implement key strategies for amplifying NbS if both are effectively working together.

We argue that due to the pressing global challenges, NbS need to contribute to transformative change that can no longer be reached by amplifying planning approaches, but requires a more radical re-thinking of key driving factors¹⁷ and combinations of structural, systematic, and enabling approaches¹⁸.

Our objective is to reflect on the barriers and opportunities of NbS amplification in a post-COVID-19 world. Our argumentation is based on an iterative reflection of our experience on investigating amplification processes of NbS in Europe and Central America and supported by the experience reported in recent studies of NbS planning and implementation efforts^{19,20}. Starting from highlighting amplification opportunities arising from the COVID-19 pandemic, we argue that ‘first wave’ NbS demonstration studies had been set up in non-representative context conditions. Although providing valuable case study insights, they neither allow to demonstrate their full potential (too small, too diverse) nor how to overcome some key challenges (e.g., path dependency, financing, non-supportive actors, legislation etc.²¹). As an implication, their amplification potential beyond their particular contexts is at least limited and certainly still needs to be demonstrated. However, to really demonstrate the full potential of NbS and to show ways of how to overcome key challenges, demonstration sites need to both unravel their full potential (large-scale) and be representative of key barriers (context conditions). Based upon lessons learned from the first wave and stressed by examples of how to address the shortcomings, ‘second wave’ demonstration studies do not only have to be representative in physical terms, but also in terms of key amplification challenges. They need to go beyond individual demonstration studies and be more systematically coordinated and organized in a complementary way to each other. We conclude with five recommendations on how science and practice

can further enhance successful NbS amplification in the current turbulent times of crises and beyond (Fig. 1).

REVEALED OPPORTUNITIES ARISING FROM THE COVID-19 PANDEMIC

The implications of the COVID-19 pandemic relate to the NbS implementation context in different ways. Firstly, lockdown policies decreased environmental pollution and let many people realize the benefits of a healthy natural environment. Those impacts are e.g., cleaner air - the reduced economic activity and traveling as a consequence of the COVID-19 situation temporarily reduced China’s CO₂ emissions by a quarter in only a relatively short time²², cleaner water—Venice’s canal water looks clearer as Corona virus keeps visitors away, and less noise which leads to a (increased) perception of silence and sounds of nature (e.g., bird singing). Secondly, the pandemic can be understood as another societal challenge which, similar to climate change, can be tackled by NbS, e.g., by providing more green spaces for outside activities to secure peoples’ health during the crises. NbS therefore offer resilience for maintaining well-being especially in cities²³. Finally, the pandemic can also be seen as a window of opportunity or critical juncture that can break the path dependence of hitherto science-policy efforts and allow for a truly greener recovery, harnessing the chances of substantially amplified NbS uptake^{24,25}.

The raise of opportunities for climate adaptation, more sustainability and degrowth due to the pandemic has been recently discussed, e.g., for energy²⁶, electricity and mobility²⁷ or sustainable consumption and supply chains²⁸, biodiversity^{29–31}, and nutrition^{32,33}.

In case of breaking the traditional path in favor of NbS, the underlying mechanisms of change can be direct and indirect. Direct changes in the sense that measures that include NbS become more functional through the pandemic, and indirect changes as human behavior and possibly even values transform as a result of pandemic effects. An example combining these three ways of pandemic impact are green spaces in cities. On the one hand, green spaces became more functional as available space for recreation during lockdown restrictions. On the other hand, people noticed the impact of physical outdoor activities on their health and valued green spaces more than before. This may

Box 1 Examples of nature-based recoveries in a post-COVID19-world

Leaving buffer-strips or green areas as done in the 'Biodiverse road verges campaign' of Conservation Charity Plantlife (UK).

"Roads have fallen quiet as lockdown is observed, as has the drone of many councils' mowers. Councils are under considerable pressure due to the Coronavirus crisis and many have understandably reduced grass cutting down to essential management to maintain visibility and ensure road safety. There's hope that reduced cutting frequencies might be a silver lining for verge wild flowers, giving once-familiar flowers, such as white champion, betony, greater knapweed and harebell, the chance to grow, flower, and set seed. As well allowing precious wild flowers the opportunity to thrive, reducing cutting and adopting a more wildlife-friendly management regime will also help tackle the climate crisis. Over 300 local authorities have now declared a climate emergency, so sustaining reduced cutting regimes, as recommended in our management guidelines, will also help councils bring down carbon emissions."⁶⁸

Investing in ecosystem restoration (as proposed by the EU green deal proposal: https://ec.europa.eu/info/research-and-innovation/strategy/european-green-deal/call_en) can substantially enhance the extent and quality of green infrastructure and deliver various nature-based solutions. Proposed focal areas are ecosystem services and biodiversity. One of the expected impacts is that "Nature-based solutions are adapted, integrated and demonstrated in governance, financing, public procurement, economic development, infrastructure and regional strategic landscapes"⁶⁹. Delivering higher quality and quantity, and more equitable distribution of nature in cities as proposed by researchers at the Swinburne University of Technology in Melbourne³⁴ can provide nature-based solutions to address stress and enhance psychological human well-being through delivering nature-based recreation opportunities. Exposure to and experiences with nature have proved to substantially contribute to human well-being⁶¹.

Rethinking the design of our traffic infrastructure²⁷ and the use of public spaces⁶² can also provide ample opportunities, for example, if the shift to autonomous vehicles requires less traffic space for car traffic, so that many parts of existing streetscapes can be re-designed to allow much more green strips, wider walking, and cycling paths. Unused spaces like gray rooftops may be converted to rooftop gardens⁶³. Those green spaces can deliver several nature-based solutions, including solutions to air pollution through filtering of pollutants, to heat island effects through natural cooling, to stormwater flood risks through de-sealing and local infiltration, and to provide local food through urban agriculture.

support decisions in favor of setting up or renovating green spaces in the future as the demand increased and the functionality became more visible³⁴.

The pandemic also presents opportunities for ad-hoc experiments that are visible right now and seize the crises as a chance. For example, because of less vehicular traffic, some cities like Berlin, Bogota, and Brussels established so-called pop-up infrastructure to allow for increased physical distancing, safe walking and cycling during the pandemic. More innovations of these types using NbS are imaginable (Box 1).

In comparison to the outlined current experimental practice for amplifying NbS, these initiatives are "real time experiments"²⁸: they result from ad-hoc political decisions, as governance structures have changed faster than before²⁷ and the political will is suddenly there, applying ideas already approved by science. The COVID-19 window of opportunity can be actively used by testing ideas and scenarios independently from scientific funding and usual policy issues.

SHORTCOMINGS OF THE CURRENT PRACTICE OF AMPLIFYING NBS

While we consider 'experimentalist upscaling' an important step forward towards a broader implementation of NbS, we argue that the current application of the approach bears some fundamental shortcomings.

First, NbS interventions proposed in ongoing research and innovations projects are often too small, frequently due to sheer practical reasons, as they need to be realized during a project duration of maximum 5 years, or too dispersed in space to substantially yield ecological effects and address the societal challenges we face³⁵. The interventions thus provide only limited learning opportunities when not linked to wider contexts of policies and planning strategies for establishing NbS at larger

areas that could actually yield relevant ecological changes and improvements³⁶. Furthermore, the focus on smaller scale interventions misses opportunities to explore options for planning, implementing, and governing larger-scale NbS at the landscape scale beyond single cities, which require the tackling of much more complex polycentric and multilevel governance structures. Apart from that, smaller interventions usually require less coordination among diverse actors^{37–39}.

Second, the economic context conditions within which ongoing projects are implemented are often not representative of real-world situations. Demonstrator projects are usually equipped with sufficient resources from the funding agencies, are mainly supported by public investment⁴⁰ and rarely need to explore innovative financing options or develop appropriate business models. However, NbS interventions initiated through research projects still experience challenges to secure funding needed for post-implementation efforts beyond project lifetime (i.e., maintenance and monitoring)⁴¹. Therefore, not every city or community might have the potential and necessary conditions to become a demonstrator or follower (for a detailed analysis see⁴²).

Third, and most importantly, the governance contexts in which existing projects implement NbS do not fully reflect or even consider the substantial decision-making and implementation barriers faced by efforts to establish NbS in real world situations⁴³. The policy and decision-making contexts of frontrunner cities and regions are—by design—very supportive for NbS implementation and thus do not represent the complicated governance contexts of practice. For example, project regions are selected which provide supportive governance conditions, decision-makers, and policy instruments. The opportunity to study unconventional NbS is usually provided by the selection of a 'willing' partner contributing the required setting for the desired NbS. Diverging interests of stakeholders have usually been negotiated before the start of the funding or are homogeneous in favor of the NbS implementation. While such supportive governance conditions where collaboration is a precondition to set up the project are helpful to smooth the technical implementation process, their analysis provides only limited insights regarding the situations in real-world policy settings. In fact, the implementation of NbS in real world cases is often much less aligned, and sometimes even in conflict with prevailing stakeholder interests, ways of thinking, legacies of governance, and funding schemes^{44,45}.

Although project calls usually require the analysis of the political context, questions of governance are often not systematically investigated in research⁴⁶ or the results are not published. Case studies based on demonstrators can reveal that NbS work in terms of technology, stakeholder involvement, and management. Concerning the institutional arrangements, the analysis rather leads to insights into which framework conditions were supportive or at least not hindering in a certain location. But the request of a "recursive review of implementation experience in different local contexts"^{13:3} is hardly done by science. In the Urban Nature Atlas from the NATURVATION project, e.g., governance and financial shortcomings of case studies are collected and documented in detail but not scientifically compared.

Some research and innovation projects currently try to tackle the outlined problems in amplifying NbS. Shortcomings related to scale issues are exemplarily tackled by the SEE-URBAN-WATER project by connecting smaller-scale NbS interventions across a larger landscape context. Here, NbS are being implemented in an urban real world lab in a co-designed manner to address waterborne challenges^{47,48}, such as water contamination and flooding, resulting from urbanization in the Great Metropolitan Area of San José, Costa Rica⁴⁹. The lab is a representative neighborhood within a larger metropolitan area. Besides its socio-economic representativeness for similar areas in the river catchment in terms of building density, population structure, drainage and sewage systems, it is also naturally defined by its



Fig. 2 Ecological connectivity and socio-economic accessibility is improved by nature-based solutions in the Cantón Flores, Heredia Province, Costa Rica. Drone image from the Quebrada Seca River next to the real world lab of the SEE-URBAN-WATER project. Source: Dennis Jöckel.

hydrological boundaries which are representative for the larger river basin it is part of. The connection to these socio-economic and hydrological landscape levels is achieved with the concepts of ecological connectivity and socio-economic accessibility (see Fig. 2). The experimental NbS demonstrators improve ecological connectivity within the larger river basin and socio-economic accessibility for the larger metropolitan area. Thus, the lab delivers empirical evidence of the potential to amplify experimental NbS for a representative socio-ecological subsystem that is nested within a larger system⁴⁹. The project is engaged in amplifying out through transferring processes, that is doing a similar initiative in a similar context, and amplifying beyond, that is trying to change rules through the process of scaling up¹⁰.

The RECONNECT project tries to address all three shortcomings by explicitly analyzing the financial and governance frameworks and by a within-project-upscaling strategy. RECONNECT integrates more than two dozen demonstrators and collaborators worldwide through a co-creation methodology as part of a social-innovation concept. The collaborators want to implement in a non-supportive environment (governance and finance) and on a large scale. Therefore, they try to learn from the demonstrators which have implemented NbS more or less successfully so far. Governance, financial, and scalar potentials or barriers for amplifying NbS are assessed by the social scientific partners. In addition, demonstrators are integrated who have already successfully implemented relatively large NbS in the past in European countries like Austria, Switzerland, France, the Netherlands and Denmark. The Austrian demonstrator for instance, represents a case that allows for a better understanding of how NbS have become a mainstream measure in the management of Alpine hazards in torrential catchments. Already during the 1950s and 1960s major advancements were made in the Alpine area with respect to changing the paradigm of reducing torrential risks by the rapid and intensive application of NbS. Accordingly, other RECONNECT cases are in the phase of NbS implementation but have proofed a specific amplification potential, e.g., for the Italian demonstrator it is expected to also be high as hundreds of small catchments along the Mediterranean coast face similar challenges. Governance analysis in RECONNECT will also conduct surveys/interviews with

relevant decision makers identified, discussing how to improve the legal and political framework to ensure the amplification of experiences from these demonstrators.

Besides the current activities promoted by the EU, there are also other programs that try to amplify NbS, e.g., the Working with Nature Approach in the USA, the Sponge City concept in China, the Room-for-the-River program in the Netherlands or the Renaturation of Rivers in Switzerland (Table 1). They face similar (USA, Netherlands) or different shortcomings (China, Switzerland) than NbS demonstrator case studies, nevertheless NbS implementation case studies can learn from them.

RECOMMENDATIONS FOR AMPLIFYING NATURE-BASED SOLUTIONS

Amplifying NbS by replicating or transferring demonstrator projects disregards political realities and takes a long time that we, due to pressing climate scenarios, do not have.

To overcome the shortcomings we identified so far and based on the initial attempts described to overcome the scalar, financial, and governance misfits as well as reflecting on chances the COVID-19 pandemic offers, we have five recommendations for the second wave of NbS implementation studies, to foster NbS amplification with noteworthy environmental-political influence beyond demonstrators and for a post-COVID-19 world (Fig. 1).

Use multi-scalar action to balance differing interests and reconcile governance levels

Enhance the consideration of power constellations and actors' interests, discourses, resources and perceptions, and develop a mainstreaming concept, e.g., based on multi-scalar action⁵⁰. The often vested, persistent, and frequently also diverging interests of different stakeholders at different levels of governance need to be studied and ways need to be found of how to balance these interests. By this analysis, veto-players and main legal or financial obstacles are identified as well as actor's strategies to successfully transform gray to more nature-based solutions. Future research and innovation projects need to study linkages to larger governance scales to better connect bottom-up (grass-root

Table 1. International programs for amplifying NbS.

Country	Program	Amplification strategy	Shortcomings
USA	Working with Nature ⁶⁴	Guidelines of the World Association for Waterborne Transport Infrastructure (PIANC) for practitioners	Provides information and recommendations on good practice as an expert guidance and state-of-the-art. Conformity is not obligatory.
Netherlands	Room for the River ⁶⁵	Main goal of the Room for the River program started in 2007 by the Dutch government was to manage higher water levels in rivers by NbS like, e.g., water buffers, relocating levees, and the construction of flood bypasses. Over 30 projects were completed by 2018.	Successful NbS frontrunner program applying a mixed centralized–decentralized governance approach for integrated water management, collaboratively organized and financed, to tackle 1990s flooding events. Is having the status of being a blueprint worldwide, but not addressing unlikely governance contexts, nor the continuity of NbS implementation.
China	Sponge City ⁶⁶	National governmental program fostering the implementation of NbS in urban contexts. Top-down approach with massive financing and political support.	Space and cost constraints as well as barriers for inter-sectorial and stakeholder collaboration, which limit the speed of city-wide upscaling and full realization of benefits.
Switzerland	Renaturation of Rivers ⁶⁷	National law as well as long-term investment program was set up. Requires and supports the renaturation of rivers and lakes to increase biodiversity, flood protection, and quality of life. Clear target defined; the aim is to restore 4000 km of rivers until 2090.	Large proportions of Switzerland's rivers have been channeled and cut off from their flood plains. The program aims at restoring river beds. While the aim is ambitious, its realization is also facing multiple challenges. To reach the official goals, processes need to be speeded up, which appears to be realistic.

movements) with top-down approaches. Power issues and contestations have to be addressed with a pro-active, conflict resolution approach to deal with inherent conflicts and contestations often involved in implementing Nature-based Solutions¹⁸.

Provide financial and other institutionalized incentives and strategies for integrated participation processes

Investigate specific solutions for NbS funding in non-supportive contexts. If possible, examine different approaches that provide financial and other institutionalized incentives, e.g., payments for ecosystem services, public-private partnerships or water or forest funds⁵¹ which support actors at many different scales and places to favor NbS over gray infrastructures or to increasingly combine them. Participation in NbS design is welcome, but will be widely ineffective if no strategy is developed beforehand and implemented regarding how the participation process can be linked up with the required formal decision-making processes and instruments in order to lead to actual implementation. Approaches to co-design NbS in a participatory multi-actor action should be encouraged to the degree possible by facilitating a continuous expectation management⁵², clarifying opportunities for individual contributions, and transparently communicating the way formal decisions will finally be made³⁶. The design of locally-led business models, together with suitable governance models, could be a step towards this goal but knowledge co-creation in this respect is still in its early stages⁵³.

Use appropriate governance and management scales and look for mediators or multipliers

Develop sustainable solutions for governing environmentally effective NbS at different governance levels. Joined-up planning and implementation at the landscape scale will be needed to introduce this change, thus requiring much cross-sectoral and multi-level coordination and cooperation³⁶. NbS projects and initiatives have to be linked much better to existing governance and planning instruments. Possibly, different actions, i.e., different governance and management instruments, will be needed for different governance levels and/or to explicitly connect these different levels to prevent scale mismatches^{54–56}. Efforts to identify and define appropriate governance and management scales to effectively achieve NbS amplification may as well be

necessary since existing jurisdictions could not represent the required cross-sectoral and multi-level characteristics. It seems that mediators or multipliers are needed to bring the different levels together.

Use opportunities for transformative change offered by crisis for real-time experiments and immediate effects

Use the opportunities for transformative change offered by crises like the COVID-19 pandemic widely. These can include the establishment of more flexible governance structures that allow the implementation of pop-up nature-based recoveries as real-time experiments that make immediate effects obvious and in consequence larger scale NbS more acceptable. This can also include the use of COVID-19 recovery programs as additional financing option for NbS¹.

Learn from amplification strategies and experiences from other regions

Examine the shortcomings of other international programs for amplifying NbS and learn from their experiences. For instance, make meaningful use of stakeholder engagement to identify possible win-win opportunities at all project phases—derived as an experience from Working with Nature. Try to take advantage of possibilities of simultaneous change in the cognitive, normative, and regulative conditions—derived from experiences of the Sponge City program. Or change the national law and set up a long-term investment program as in Switzerland (see Table 1).

We argue that due to the pressing global challenges—and current negative news on the impact of the pandemic on the fulfillment of SDGs⁵⁷ and climate change⁵⁸—NbS need to contribute to transformative change. This can no longer be reached by amplifying planning approaches and requires institutional change to enhance cooperation. Beyond demonstrator projects there is an ‘accountability trap’: cooperation for NbS needed across different sectors and governance levels, but no one feels responsible and puts aside own institutional interests. Therefore, we need institutional change to foster cooperation and we need more instruments than demonstrator projects. Structural, systematic, and engaging approaches¹⁸ are necessary as well as coordinated, well planned policy-mixes²⁰ in concert with

a wide range of other processes such as cultural, technological, social, and environmental to foster formations⁵⁹.

In summary, we plea for more social science research and support for the amplification of NbS planning and implementation across levels and scales, as well as for real time cooperation with policy to improve financial and governance structures suitable for NbS. The COVID-19 pandemic presents the chance for NbS to truly integrate solutions true as overlapping societal challenges become transparent. The crises have converged, so have the solutions (Christiana Figueres in Financial Times Interview: <https://www.ft.com/video/c28e5efb-a8f4-45ed-b26b-18e87a38c94c>). Better understanding and creativity is needed on how NbS innovation can be amplified across sites and levels, and how it can be best supported to address societal challenges and advance as many of the SDGs as possible—in urban areas and beyond.

DATA AVAILABILITY

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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ADDITIONAL INFORMATION

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