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Gobierno  
de Colombia



In collaboration with  
Arup and AlphaBeta

# BiodiverCities by 2030: Transforming Cities' Relationship with Nature

INSIGHT REPORT  
JANUARY 2022



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# Foreword



**Iván Duque Márquez**  
President of the  
Republic of Colombia

Cities are hubs of opportunity, cross-cultural interaction and cohesion. They concentrate the majority of the world's population and deliver services to large numbers of people, creating jobs and driving innovation and economic growth. Between now and 2030, 1.5 million people are expected to arrive in urban areas every week, and 75% of the population on Earth will be living in cities by 2050, compared with 56% today.

The COVID-19 pandemic has put a spotlight on the fragility of our current economic models, including how we produce, consume and power our lives. Urban economies and livelihoods provide the context which will be increasingly under pressure from climate impacts and nature loss, therefore it is imperative that global and city leaders have the tools to understand the relevant risks and opportunities, and steer cities in a direction of sustainable growth.

A sustainable city is one that meets the needs of its dwellers without putting unsustainable pressure on the natural resources on which it depends, both locally and globally. Nature underpins the complex web of life and the life-sustaining ecosystems services upon which human livelihoods depend. A healthy biosphere is therefore fundamental to ensure inclusive, equitable, resilient and safe urban spaces.

Urban stakeholders have the opportunity to unlock the potential of nature as a solution to urban challenges, thereby paving the way for sustainable and resilient development. Taking nature into consideration as a key – albeit



**Klaus Schwab**  
Founder and  
Executive Chairman,  
World Economic Forum

voiceless - stakeholder in urban political and economic decision-making is now imperative to benefit human livelihoods and planetary wellbeing.

Cities that recognize biodiversity as the axis of their development are directly contributing to urban sustainability, climate resilience and human wellbeing. Urban transformation and innovation efforts must continue, embracing the opportunities offered by new technological developments, and addressing the global crises concurrently through the untapped potential of nature.

This report provides the guiding framework for cities to transform their relationship with nature and to drive an urban development that leaves natural capital enriched and not depleted, a vision that the Colombian government has defined as "BiodiverCities". Building on this country's leadership, the World Economic Forum and Colombia have partnered to scale a global initiative with a major ambition: **BiodiverCities by 2030**. We have the opportunity to design more resilient and adaptive futures for cities across the globe by drawing together multidisciplinary expertise and spurring nature-positive entrepreneurial approaches in the next decade.

We encourage city officials, the private sector and the whole urban community to harvest and spread the evidence on the real opportunities for cities to reverse their impact on nature and to build an enabling environment in their own city contexts whereby biodiversity and nature-based solutions are brought to the centre of the urban agenda.

# Preface



**Lena Chan**  
Senior Director, International  
Biodiversity Conservation Division,  
National Parks Board (NParks)  
of Singapore  
  
Co-Chair, Global Commission  
on BiodiverCities by 2030

To many people, “biodiversity in cities” is an oxymoron. On the contrary, there is much biodiversity in cities essential for sustainability, liveability and ecological resilience in urban life. As today’s major challenges of climate change and biodiversity loss are intricately interlinked, they must be addressed synergistically, leveraging nature-based solutions at local, regional and global levels. With more than half of the human population residing in cities, biodiversity conservation can only succeed - and climate change can only be reversed - if cities take the lead.

Recognizing that we are embedded in nature, we also wish to acknowledge its higher order and inherent value. In this context, this white paper harnesses and draws on current knowledge, data and workable initiatives to guide cities towards the implementation

and achievement of being BiodiverCities by 2030. To ensure that this movement is holistic, comprehensive, nature-based, multi-sectoral, multi-disciplinary, integrated and all-inclusive, we call for participatory and intergenerational approaches in urban design and planning which include the voices of indigenous peoples, citizen stewards of land, the majority of whom live in urban environments and local communities.

We hereby provide the case for urban leaders from the public and private sectors, as well as citizen movements, to conserve, connect, restore and enhance natural urban ecosystems, by outlining actions for nature-spatial integration, urban governance and investment mobilization. The time to act is now. Every individual must be involved to make a world of BiodiverCities by 2030.



**Mauricio Rodas Espinel**  
Visiting Scholar, University  
of Pennsylvania, USA  
  
Co-Chair, Global Commission  
on BiodiverCities by 2030

The rapid global urbanization process, which keeps adding pressure to cities’ service provision and infrastructure development, along with rising temperatures and increasingly severe natural disasters, has caused profound damage to the environment in cities. As city officials consider “building back better” towards the post-pandemic future, they have a priority to provide their citizens with a more equitable and prosperous quality of life by protecting natural resources.

Now, more than ever, the conservation of urban biodiversity and the reduction of cities’ ecological footprint are high priorities. We have in front of us a great opportunity to reimagine a harmonious

coexistence between humans and nature and to invest the resources needed to provide ecosystem services to urban dwellers and protect and maintain biodiversity in urban areas.

In this report, we offer actionable solutions to heal the relationship between cities and nature, thus enabling a healthier and more responsible environment for people to thrive in. We count on the support of city networks like Local Governments for Sustainability (ICLEI), the Resilient Cities Network and the C40 Urban Nature Declaration to achieve the vision of BiodiverCities across the globe by 2030, and we need all stakeholders to invest in urban nature.

## About the initiative for BiodiverCities by 2030

BiodiverCities by 2030 is a joint initiative of the World Economic Forum and the Alexander von Humboldt Institute, championed by the Government of Colombia. This initiative aims to support city governments, businesses and citizens, to enable cities to live in harmony with nature by 2030.

The initiative brings together multidisciplinary expertise, combines existing initiatives and surfaces innovative solutions to promote sustainable, inclusive and nature-positive urban development at a global scale. To deliver on its objectives, the initiative has curated a high-level commission of experts and practitioners from the public and private sectors, academia and civil society - the Global Commission on BiodiverCities by 2030 - to combine insights and co-create a forward-looking perspective on nature-positive cities. Artificial intelligence and crowdsourcing technologies have also been set as key tools for the initiative through the Forum's Strategic Intelligence and UpLink platforms to pool the latest innovations and conceptual developments linking biodiversity and urban development.

This report was developed as an output of the BiodiverCities by 2030 initiative and sets out:

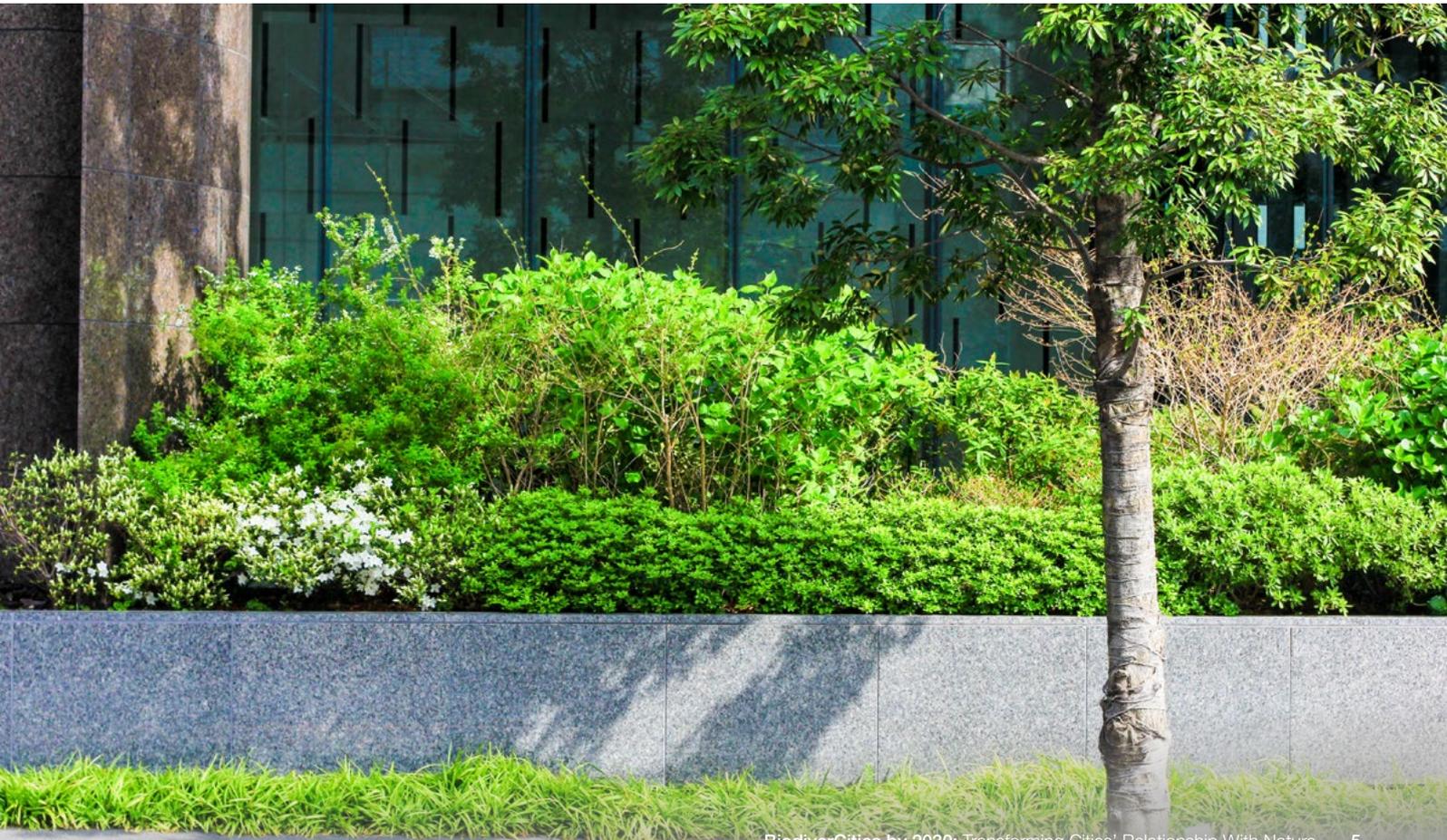
- The urgency of addressing cities' untenable relationship with nature.
- The opportunity to prioritize nature-positive interventions and investments to fight cities' challenges.
- A clear path for city leaders to embrace the BiodiverCities by 2030 vision and increase urban competitiveness and liveability through nature.

This report builds on the work of the World Economic Forum's New Nature Economy Report series, which identified nature-related economic risks (affecting more than half the world's GDP) and opportunities from nature-positive pathways, including an increase in business value by \$10.1 trillion and the creation of 395 million jobs by 2030.

## About the Alexander von Humboldt Institute

The Alexander von Humboldt Biological Resources Research Institute is an independent research institute linked to Colombia's Ministry of Environment and Sustainable Development. The Institute contributes to the knowledge, conservation

and sustainable use of continental biodiversity and its ecosystem services, supporting informed decision-making through a joint, coordinated and concerted action between the state, the private sector, academia and civil society.



# Executive summary

BiodiverCities by 2030 is a vision for cities as living systems, where the built environment, social structure and natural capital co-exist in harmony.

This report calls on cities, as one of the crucial players in reversing nature loss and climate change, to become BiodiverCities by 2030. It articulates the opportunity for urban leaders and citizens to transform their cities' relationship with nature through **nine key messages**.

- 1. An “urban era” is taking place.** Cities account for 80% of global GDP and will host 75% of the world's population by 2050. Urban leaders and decision-makers have a leading role to play in shaping a sustainable, resilient and prosperous future for all.
- 2. Exponential growth of the global built environment undermines nature's critical contributions to our societies and economies.** Rapid urban expansion has come at the expense of climate, nature and the economy. **Business as usual is no longer an option** – 44% of global GDP in cities is estimated to be at risk of disruption from nature loss. With the majority of future urban expansion forecast in the world's most biodiverse regions, cities must act now to rebalance their relationship with nature.
- 3. BiodiverCities by 2030 sets a vision of cities as living systems, where their economic, social and ecological functions come together in harmony.** BiodiverCities have five characteristics, guiding nature-positive actions on infrastructure, governance, economy, health and wellbeing.
- 4. By shifting investment to nature-based solutions (NbS) for infrastructure, cities can build a climate-resilient built environment while lessening their impact on biodiversity.** NbS are, on average, 50% more cost-effective than “grey” alternatives and deliver 28% more added value, yet they received just 0.3% of overall spending on urban infrastructure in 2021.
- 5. Expanding nature in the built environment creates significant economic and social value.** Spending \$583 billion on NbS for infrastructure and on interventions that release land to nature could create more than 59 million jobs by 2030, including 21 million livelihood-enhancing jobs dedicated to restoring and protecting natural ecosystems.
- 6. The impact of cities' nature-positive actions (through both NbS and land-sparing interventions) varies by sector, region and level of urbanization.** NbS for infrastructure are best applied to water supply, pollution and climate adaptation and mitigation projects, and are most effective for cities in Asia Pacific, Africa and Latin America. The building and transport sectors, as well as highly urbanized societies in Europe, China and India, may have more to gain from land-sparing interventions.
- 7. Shifting to a systems approach to urban governance is one of three key conditions to cities achieving the BiodiverCities vision and capturing these opportunities.** This shift must be steered by top levels of government, coordinated across stakeholders using strong city-level leadership and underpinned by policy that fosters innovation and accounts for the full value of nature.
- 8. Restoring nature as the backbone of cities' development is a foremost priority.** Re-integrating local ecosystems in the urban planning process is a second condition to realizing the BiodiverCities vision. It entails preserving existing natural habitats, re-naturing degraded or sub-optimized land and “growing smart” with new or upgraded infrastructure.
- 9. Increased investment in natural capital unlocks the benefits of NbS for infrastructure and should be further incentivized.** To be fulfilled, this third condition requires mainstreaming biodiversity data for investment decision-making, creating an inclusive market for investment and promoting new models to de-risk and crowd-in private and institutional capital.

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# Cities' relationship with nature

Rapid expansion of the built environment has proven detrimental for cities' natural ecosystems, denting economic prospects and necessitating a systemic transition in urban development.



## 1.1 Cities: The engine of the modern global economy

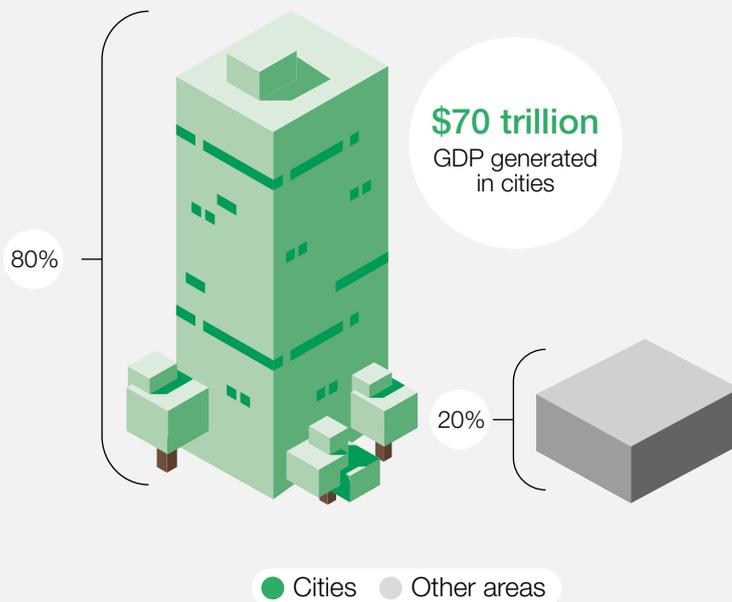
**Cities are at the heart of the global economy.** As the main stages for human activity, cities now generate over 80% of global GDP and contain 56% of the global population (Figure 1).<sup>1</sup> Cities around the world are projected to add 1.5 million people to their populations each week before 2030. This means that over 5.5 billion humans will be interacting, eating, collaborating, producing,

consuming, creating, breeding and sheltering in urban areas by 2030 – up from 4.4 billion today.<sup>2</sup> Cities, in turn, rely on nature to provide key services for these activities, such as sufficient safe, and clean water; productive and resilient food systems; and energy, medicine, and other materials.<sup>3</sup> By 2050, three out of every four people on Earth are expected to be living in cities.

FIGURE 1 **Cities are at the heart of our economies and societies, accounting for 80% of global GDP and 56% of global population**

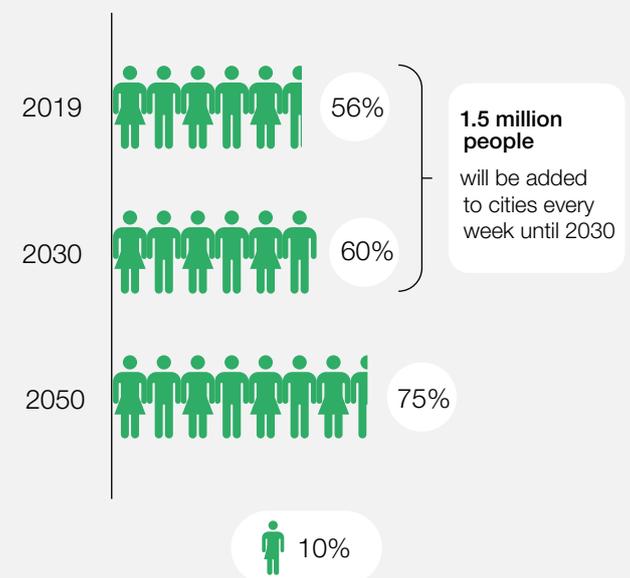
### Global cities' GDP

Percentage of 2019 GDP originating in cities



### Global cities' population

Percentage of global population living in cities



Source: World Bank; UN Population Division; Alphabetica analysis

## 1.2 Cities' impact on nature

**Coupled with this urban rise, the world is witnessing a sharp decline in biodiversity.**<sup>4</sup> Cities have historically been established and developed in or near ecosystems that provide abundant contributions to urban societies, including water, rich soils and areas protected from extreme weather events. This natural layer underpinning the built environment has been increasingly degraded through the direct and indirect impacts of urbanization.

**The most noticeable direct impact of urban growth on biodiversity is the loss of natural habitats.** The rapid expansion of the global built environment – a 66% area increase in the first 12 years of the 21st century<sup>5</sup> – has significantly impacted natural ecosystems. Much of the land in and around cities is degraded, threatening native habitats, the genetic and functional diversity of flora and fauna, and the quality of air and waterways.<sup>6</sup> A high proportion of the direct impact to nature from this urban expansion is forecast to occur in some

of the most biodiverse and environmentally-intact regions in Africa, Asia and the Americas.<sup>7</sup> Of the 423 cities located in the world's biological hotspots, 383 (90%) are projected to grow and expand into tropical moist forest biomes, predominantly in low- and middle-income countries.<sup>8,9</sup>

**Moreover, cities spatial footprint has expanded at a higher rate than urban populations.**

Between 1990 and 2015, the urban population increased an average of 1.9 times; in the same period, the urban footprint increased an average of 2.5 times.<sup>10</sup> This difference grows more stark when we look at developing countries, where the population increased 2.3 times and the area increased 3.2 times in the same period.

**From a spatial perspective, urban areas have a relatively small footprint, with just 1% of the earth's ice-free land surface being built-up.**

**However, the indirect impact of urban growth on land use is vast.** To feed the world's cities we require an area 36 times larger than cities' global urban footprint;<sup>11</sup> this leads to natural habitat destruction and biodiversity loss as we extract resources and create space to extract materials and produce food. The scale of this indirect impact varies locally, regionally and globally.

**Climate change is one of the indirect impacts of urbanization and accounts for 11-16% of global biodiversity loss.**<sup>12</sup>

Recent natural calamities, such as the Australian "Black Summer" of 2019-2020, have evidenced the deep link between climate change and nature loss. During the event, an area of the size of Cambodia was ravaged by extreme fires, killing or displacing nearly three billion

terrestrial vertebrates and driving endangered species to extinction.<sup>13</sup>

**Urban areas are responsible for over 75% of global carbon emissions.**<sup>14</sup>

Increased atmospheric greenhouse gas (GHG) concentrations affect biodiversity by leading to increased mean temperatures, altering precipitation regimes, increasing the frequency of extreme weather events and acidifying<sup>15,16</sup> aquatic environments. Climate action in cities remains insufficient. The 2021 State of Cities Climate Finance Report, from the Cities Climate Finance Leadership Alliance, the Climate Policy Initiative and the World Bank, estimates that a total of \$384 billion was invested in urban climate finance globally in 2017 and 2018—an amount far below the estimated \$5 trillion needed. This gulf between targets and actual progress in limiting carbon emissions is leading to devastating climatic changes, as underscored by the IPCC at COP26.<sup>17,18</sup>

**Cities' direct and indirect impacts on biodiversity have negative cascading effects that are threatening ecosystem stability at local, regional and planetary scales.**<sup>19</sup>

While there is an imperative need to reverse this impact, day-to-day challenges such as food security, poverty, housing, mobility and sanitation are often given higher priority. However, the complex interactions and feedback loops between climate, biodiversity and human activity are producing pronounced and unpredictable outcomes; climate and nature-related risks should therefore be regarded as factors that deepen the major constraints for future urban growth.



## 1.3 Nature-related socioeconomic risks to cities

“ More than 1.4 billion people living in the world’s largest urban centres are at high or extreme risk of environmental disaster.

**Cities’ impact on nature is a critical economic issue.** Climate action failure, extreme weather and biodiversity loss have been ranked as the top three risks humanity will face in the next 10 years, according to the World Economic Forum’s 2022 *Global Risks Report*.<sup>20</sup> But how or why does this matter for economic actors in cities? The *IPBES Global Assessment Report* outlines eighteen life-supporting contributions biodiversity makes to humanity. It supports key economic activities through air quality, water cycles and flood regulation, and underpins the production of energy, food and medicine.<sup>21</sup> Despite cities around the world occupying different ecosystems, these contributions are essential to support the economies and societies of all. As a consequence of biodiversity loss, critical economic activities depending on nature are at risk of disruption.

**Environmental change is compromising cities’ stability.** Among the 576 largest urban centres in the world, 414 (over 70% of the total) – and their more than 1.4 billion inhabitants – are deemed to be at high or extreme risk from pollution, compromised water supplies, extreme heat and natural hazards.<sup>22</sup> As of July 2018, nearly 58% of global cities were highly exposed to at least one of the six main natural hazards – cyclones, floods, droughts, earthquakes, landslides and volcanic eruptions.<sup>23</sup>

**Flooding has been identified as the most common natural risk across more than 1,600 cities, each with over 300,000 inhabitants.** The loss of coastal habitats, such as carbon-rich and biodiverse mangrove forests, has significantly increased the risk from floods and hurricanes for cities within coastal zones.<sup>24</sup> In 2019, floods caused almost \$46 billion in economic losses and 4,500 deaths globally, accounting for almost half the deaths from natural disasters in that year.<sup>25</sup> The World Bank estimates that over 1.47 billion people globally are highly vulnerable to flood-related economic losses and mortality<sup>26</sup> and over 600 million of these are already living below the poverty line.

**Recent studies have found that capital stock damage due to flood risk is expected to double by 2030 (from 2020 levels) and - in terms of freshwater flooding events in cities- quadruple by 2050.** This equates to an increase from \$35 billion per year to \$140 billion per year.<sup>27</sup> In terms of sea-level rise, and with coastal populations

expected to grow more than 300% in the next fifty years,<sup>28</sup> residual damage costs in cities could amount to over \$5 trillion in this century.<sup>29,30</sup>

**Droughts are considered the second most hazardous urban risk, affecting 411 million people worldwide.**<sup>31</sup> One in four cities today are already water-stressed, with the situation projected to deteriorate further in the coming decades.<sup>32</sup> According to the United Nations, half of all countries worldwide will face water stress or shortages by 2050, driven by drought, population growth and rapid urbanization. By 2050, three out of four people globally could be affected by water scarcity.<sup>33</sup> Water challenges are further aggravated by unsound waste disposal and wastewater management, and the costs from urban water pollution can be significant, both for human and environmental health.<sup>34</sup>

**Another economic/health risk in built-up areas is urban heat, often related to a lack of green areas or smart surfaces. As a result, energy use soars and labour productivity eases.** Tokyo’s temperature, for example, has increased by 3°C over the last 100 years due to the city’s heat island effect.<sup>35</sup> As a side effect of increased heating, air conditioning use now amounts to 10% of global electricity use and is projected to triple by 2050.<sup>36</sup> In 2016, carbon emissions from air-conditioning already amounted to 1.25 gigatons, equivalent to almost 3% of the global annual anthropogenic emissions.

**Poor air quality and lack of urban green space are also risk factors for human health and cities’ productivity.**<sup>37</sup> Exposure to air pollution cost the world’s economy around \$5.1 trillion in welfare losses in 2013, with a higher impact felt in low- and middle-income regions; welfare losses in South Asia, East Asia and the Pacific were equivalent to around 7.5% of regional GDP.

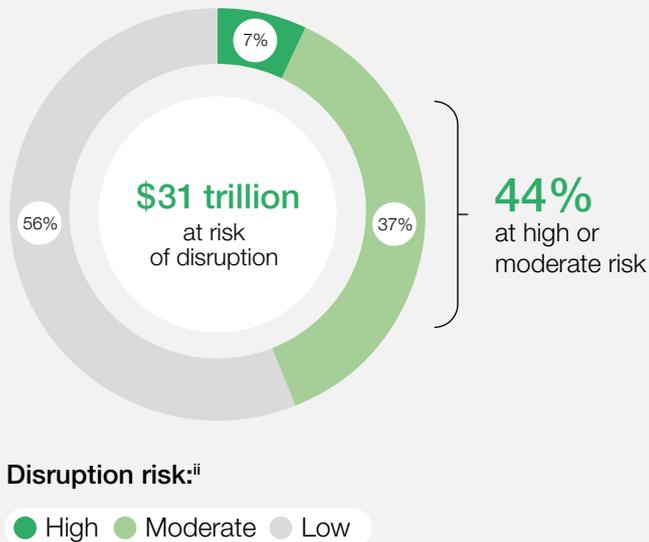
**Accounting for all potential disruptions to economic activities, 44% of GDP (\$31 trillion) in cities is currently estimated to be at risk from biodiversity and nature loss (Figure 2).** While this is lower than the global average (50% of GDP) due to cities hosting fewer primary activities relying on nature (i.e. agriculture and mining), multiple downstream sectors with activities concentrated in cities (i.e. transport, utilities and retail) are severely affected by disruptions to their supply of inputs.



FIGURE 2 | 44% of GDP in cities around the world – \$31 trillion – is at risk of disruption from nature loss

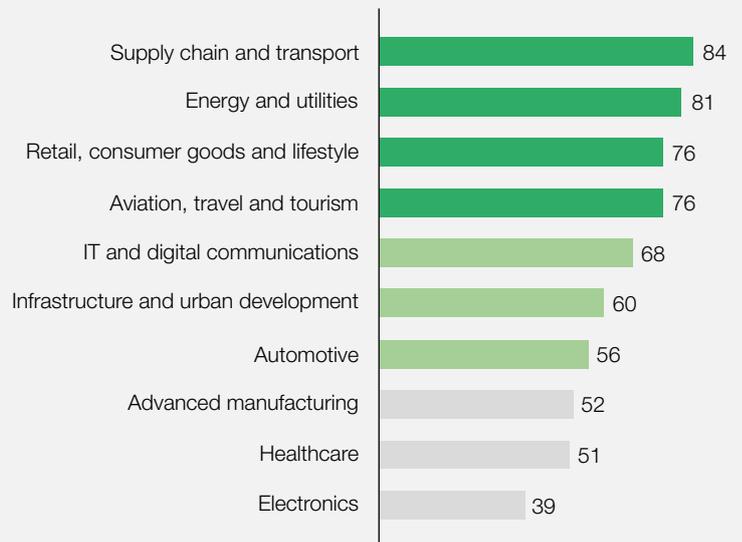
### Economic value at risk in global cities<sup>i</sup>

Percentage of 2019 GDP by disruption risk posed by biodiversity and nature loss



### Top 10 industry sectors at risk of disruption

Disruption risk (Max = 100)



**Notes:** i. GDP in cities considered in 2019. Total GDP was estimated at \$69.9 trillion for 2019.

ii. Disruption risk was calculated for 19 industry sectors as classified by the World Economic Forum and their estimated contributions to cities' GDP. Sectors were assigned disruption risk scores out of 100 based on the average number (up to 85%) of business operations disrupted by up to 27 drivers of environmental change through their impact on natural capital assets (through the form of up to 21 ecosystem services). A sector with over 80% of its production processes materially disrupted is considered "High" risk; over 55% is "Moderate" risk; and less than 55% is "Low" risk.

**Source:** World Bank; Natural Capital Finance Alliance; ENCORE database; World Economic Forum; Alphabeta

**Strengthening the resilience of global urban centres is, therefore, a matter of urgency for humanity, the economy and the Earth's stability.** Cities need to be prepared to cope with the social, environmental and financial consequences of ever-increasing natural hazards and act systemically to reverse such risks. Available data shows that cities are already enacting and reporting policies to advance this matter and build resilience. Of over 620 cities disclosing climate and environmental data to the Carbon Disclosure Project (CDP), flood mapping (167 cities), crisis management (126), community engagement (106), tree planting (99) and long-term planning (88) are the most reported actions used to build resilience.<sup>38</sup> These activities largely remain at policy level, however,

and the urgency of physical risks from climate change implies that policy alone will not suffice.

**By investing in the right infrastructure and services, cities can both improve the lives of their citizens and build resilience against natural hazards and nature-related risks, while addressing the twin challenges of climate change and biodiversity loss.** Cities are centres of innovation and offer enormous opportunities to reimagine a future where humans and other species can thrive. Urban green spaces such as parks, urban meadows, wetlands and forests, greenways and green roofs are important examples, yielding multiple benefits for carbon storage, heat reduction, preserving biodiversity and improving wellbeing.

## 1.4 | The cities of tomorrow: BiodiverCities by 2030

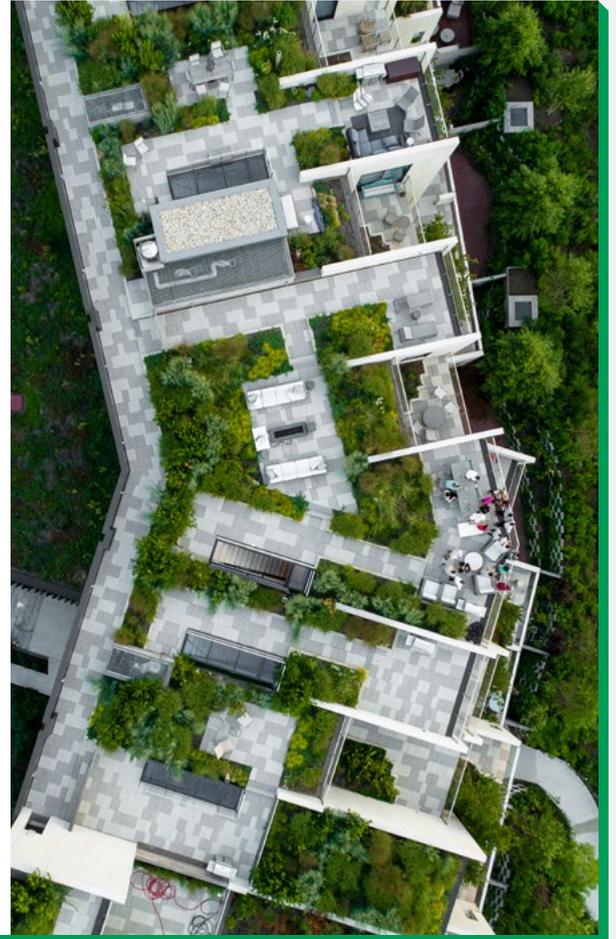
**Healing or resetting cities' relationship with nature requires a brighter paradigm of urban development.** The vision for BiodiverCities by 2030 is one such paradigm: **a vision of cities as living systems**, wherein economic, social and ecological functions are in harmony. This is consistent with the UN Convention on Biological Diversity's (CBD)

vision of "Living in harmony with nature by 2050" – reaffirmed within the post-2020 Global Biodiversity Framework.<sup>39</sup> BiodiverCities are defined by five key characteristics - each is a seed for transformation from which cities can start navigating towards a nature-positive future (Figure 3).

FIGURE 3 BiodiverCities as seeds for transformation

### BiodiverCities can restore balance between cities and nature by...

- 1 Increasing nature in their infrastructure and built environment.
- 2 Improving urban governance models to support nature-based solutions for cities' challenges.
- 3 Forging positive links between urban and rural settings and helping to safeguard global biodiversity.
- 4 Prioritizing bio-circular economy and bio-inspired innovations for economic competitiveness.
- 5 Nurturing nature-positive values in citizens for health and wellbeing.



Source: World Economic Forum, Alexander von Humboldt Institute

**Infrastructure and the built environment are critical entry points for cultivating nature-positive cities.** Reversing the impact of cities' built environment on nature remains critical as a larger, wealthier global urban population continues to materialize, and demands for housing, offices, commercial space, transport, energy, power and utilities increase. Societies have long relied on purely human-engineered solutions to fulfil these needs, however strategically deploying ecosystem services

from natural ecosystems - often in combination with conventional engineering - can provide far more viable and sustainable solutions (explored in detail in Section 2). Beyond transitions to address the built environment's impact on nature, future research will explore how cities can address the larger, indirect impact on natural ecosystems beyond their immediate surroundings, including via food and energy systems (Case study 1).

 Through their built environment, cities disturb their immediate natural surroundings; however, through the production and consumption models they support, cities' true impact on nature ranges far beyond the immediate space they occupy. The ever-greater production of food, fibre, energy and materials that support cities' societies, and the global supply chains that enable this consumption, are responsible for most land-use change, largely in ecosystems far away from cities' immediate vicinities. As such, socioeconomic transitions necessary to realize the BiodiverCities vision must address cities' impact on natural ecosystems both within and outside their territories. The World Economic Forum's *Future of Nature and Business* report identified 15 socioeconomic transitions for a "nature-positive economy", five of which are relevant to cities' built environment (Figure 4).<sup>40</sup> Future research by the World Economic Forum is intended to cover the other 10 transitions for a nature-positive economy in the light of urban development.



FIGURE 4 | 15 socioeconomic transitions for a nature-positive economy



Source: World Economic Forum

2

# Making the economic case for BiodiverCities

A potential \$589 billion investment opportunity for NbS for infrastructure and land-sparing interventions in cities awaits in 2030, paving the way for nature-based urban transformation.



## 2.1 Nature as an opportunity for infrastructure in cities

“ Nature-based solutions for infrastructure are 50% cheaper than grey alternatives and deliver 28% greater added value in terms of direct and environmental benefits.

**The rapid and often unplanned expansion of cities' built environment has led to substantial negative impacts on nature and society globally.**

The creation of grey assets is invariably harmful to nature, fostering land-use change, intense resource use, pollution, natural habitat degradation and long-term disruption of natural ecosystem functions. The evidence clearly shows that our current approach to traditionally-engineered grey infrastructure is no longer viable.<sup>41</sup>

**The continued expansion of urban infrastructure and buildings could lead to the loss of around two million hectares of arable land every year.**<sup>42</sup> Over 80% of the world's wastewater is discharged, untreated, from the built environment

into decreasingly biodiverse freshwater and coastal ecosystems in urban and peri-urban areas, which are then expected to support human consumption and irrigate cropland, with numerous knock-on effects.<sup>43</sup>

**The impact of buildings, roads and connecting infrastructure on biodiversity have also been widely studied, including the effects on mammal and bird populations within and around the areas of intervention.**<sup>44</sup> Grey infrastructure tends to be inflexible (i.e. serving specific needs), and incurs high lock-in costs, as design and operational details are often hard to change within a building's lifespan.

Today's decisions, then, on what, where, why and - most importantly - how to build have important long-term socio-ecological and economic implications.

**And yet, the ever-increasing urban population's needs for housing, office space, public space, commercial land, transport, energy and utilities cannot be neglected.** A smart way to reconcile the

competing demands of preserving/restoring nature in cities while keeping pace with urban growth is to strategically deploy nature-based solutions (NbS) for infrastructure. NbS seek to restore or utilize the existing natural extent, connectivity and diversity of cities' natural ecosystems to provide key functions of infrastructure, negating the long-term ecological disruptions caused by land conversion for grey infrastructure in the built environment. The difference between “nature” and “NbS” is that the latter entails conserving and intentionally managing critical, naturally-occurring ecosystems such as wetlands, mangroves and forests, to provide targeted and enhanced gains in community resilience, water quality and floodwater retention, among other benefits.<sup>45</sup>

**Practitioners and decision-makers have been pushing for the deployment of NbS for infrastructure since the late 2000s.**<sup>46</sup> In most instances, NbS could cost 50% less than grey infrastructure alternatives and deliver 28% in added value (measured in terms of infrastructure productivity), as well as providing gains from positive externalities in the built environment, such as the creation of carbon sinks, cleaner air and water, better health, recreational services, job creation and opportunities for growth in other sectors<sup>47</sup> (e.g. urban tourism). In addition, intact and/or functional natural ecosystems can limit human exposure to pathogens,<sup>48</sup> improve mental health,<sup>49,50,51</sup> encourage use of public and/or active transport<sup>52</sup> and enable a sense of belonging and community stewardship.<sup>53</sup>

**By and large, NbS for infrastructure have unequivocal value in expanding nature within the built environment and are compatible with the BiodiverCities by 2030 vision.**<sup>54</sup>

### CASE STUDY 2

#### The economic case for NbS for infrastructure using the Sustainable Asset Valuation (SAVi) methodology<sup>55</sup>



Infrastructure assessments carried out in urban areas using the SAVi methodology have shown that the potential returns from using NbS for infrastructure are superior to human-engineered alternatives. For instance, SAVi assessments show that in Johannesburg, South Africa, using nature for stormwater management offers a 47% cost reduction (as opposed to a grey culvert) in terms of upfront capital requirements. By reducing flood risk, avoided costs are forecast at up to three times the investment required. Overall, while the culvert barely breaks even, the nature-based alternative offers returns of up to \$5 per dollar.<sup>56</sup>

Overall, when using the infrastructure lens, a healthy ecosystem is an asset that appreciates over time, in contrast with grey infrastructure. This is especially important under climate change scenarios that show the impact of increased variability, frequency and strength of extreme events.

*Authored by Andrea M. Bassi and Liesbeth Casier from the International Institute for Sustainable Development*



## 2.2 Cities' current spending on nature-based solutions for infrastructure

Despite the clear benefits, cities currently invest less than 0.3% of their infrastructure spending on NbS – equivalent to around \$28 billion.<sup>57</sup> The majority of these applications (likely all stemming from domestic government investment) include harnessing natural systems to enhance water supplies and existing urban watersheds, soil management and pollution control, as well as pollution abatement through natural carbon sinks for air quality and wastewater management.

Low investment in NbS in cities, in terms of both volume and involvement beyond the public sector, constitutes a clear market failure in relevant investment networks. Given cities' significant spending on infrastructure, capital availability does not appear to be a major challenge. Sufficient evidence also indicates that NbS generate better returns and create greater socioeconomic value than traditional alternatives.<sup>58</sup> The major challenges to attracting the required investment for NbS for infrastructure (and associated solutions) are further discussed in Section 3.



## 2.3 The opportunity for nature-based solutions for infrastructure and land-sparing interventions in cities by 2030

**There is significant potential for cities to harness NbS beyond current levels of investment.** The evidence suggests that the investment opportunity<sup>59</sup> - used in the same major applications as today - could reach \$113 billion annually in 2030, which is more than four times greater than current levels (Figure 6). While this constitutes just over 1% of cities' overall projected spending on infrastructure in 2030, this is markedly larger than today's share of 0.3%. It is therefore critical for cities to harness this opportunity if they are to reverse nature loss and nature-related risks, to commit to a nature-positive future and realize the BiodiverCities by 2030 vision.

**Beyond NbS for infrastructure, land-sparing interventions in cities can have a significant positive impact, bringing nature back to the built environment, reducing the footprint of projected infrastructure spending, releasing land to nature and generating new economic value.**

While these opportunities do not directly invest in natural capital and its management, they reduce "business as usual" land requirements (e.g. by encouraging residential and office sharing, retrofitting stranded assets, reducing space used for landfill and repurposing areas such as car parks). In 2030, land-sparing interventions could be worth an additional \$469 billion in annual investment opportunities. While this estimate includes direct investment opportunities that alleviate the need for land in cities, it does not include adjacent business opportunities created by land-sparing/restoration that could offer cities even greater options for value creation (i.e. increased liveability, attractiveness and tourism).<sup>60</sup> As an example, New York's High Line park, built on a former freight railway, attracts almost eight million visitors annually and hosts a diverse line-up of free public events, community and teen engagement programmes, performances, and art shows, making it one of the most popular



attractions in the city.<sup>61</sup> Amager Nature Park in Copenhagen, Denmark used to be a military training facility and landfill site but now boasts over 1,200 hectares of biodiverse landscape, attracting important wildlife and hosting popular activities such as hiking, horseback riding, camping, windsurfing and bird watching.<sup>62</sup>

It is important to note that the relative benefits of land sparing depend on numerous factors, including levels of urbanization, the ecosystem services provided by restored or repurposed land, the time lag required for ecosystems to recover, and the ecological requirements for different species to thrive long-term, among others. It should also be noted that the increased density of the built environment, which is implied by releasing more land to nature, should not come

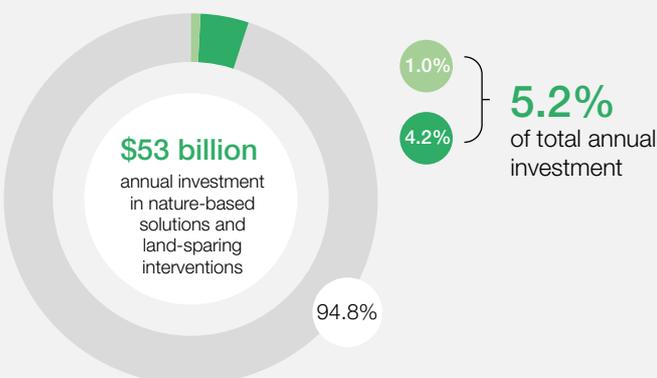
at the cost of liveability and resilience - other important components of the BiodiverCities vision. The conservation of high-quality, accessible, green, connected and communal urban spaces is essential for an equitable and liveable built-up environment.<sup>63</sup>

**The overall investment opportunity related to NbS for infrastructure and land-sparing interventions in cities' built environment can be broken down into 11 distinct investment opportunities;** the capital expenditure required for each of these to enable business opportunities is detailed in Figure 6. Case study 3 provides further details on the methodology used to derive these estimates. The rest of Section 2.3 details two of these investment/business opportunities (sustainable transport infrastructure and nature-based systems for water supply) in greater detail.

FIGURE 5 Nature-based solutions and land-sparing interventions could constitute 5.2% of infrastructure spending in cities by 2030 – equal to \$583 billion annually

### Global cities' investment in nature-based solutions and land-sparing interventions by 2030<sup>i</sup>

Percentage of total infrastructure investment

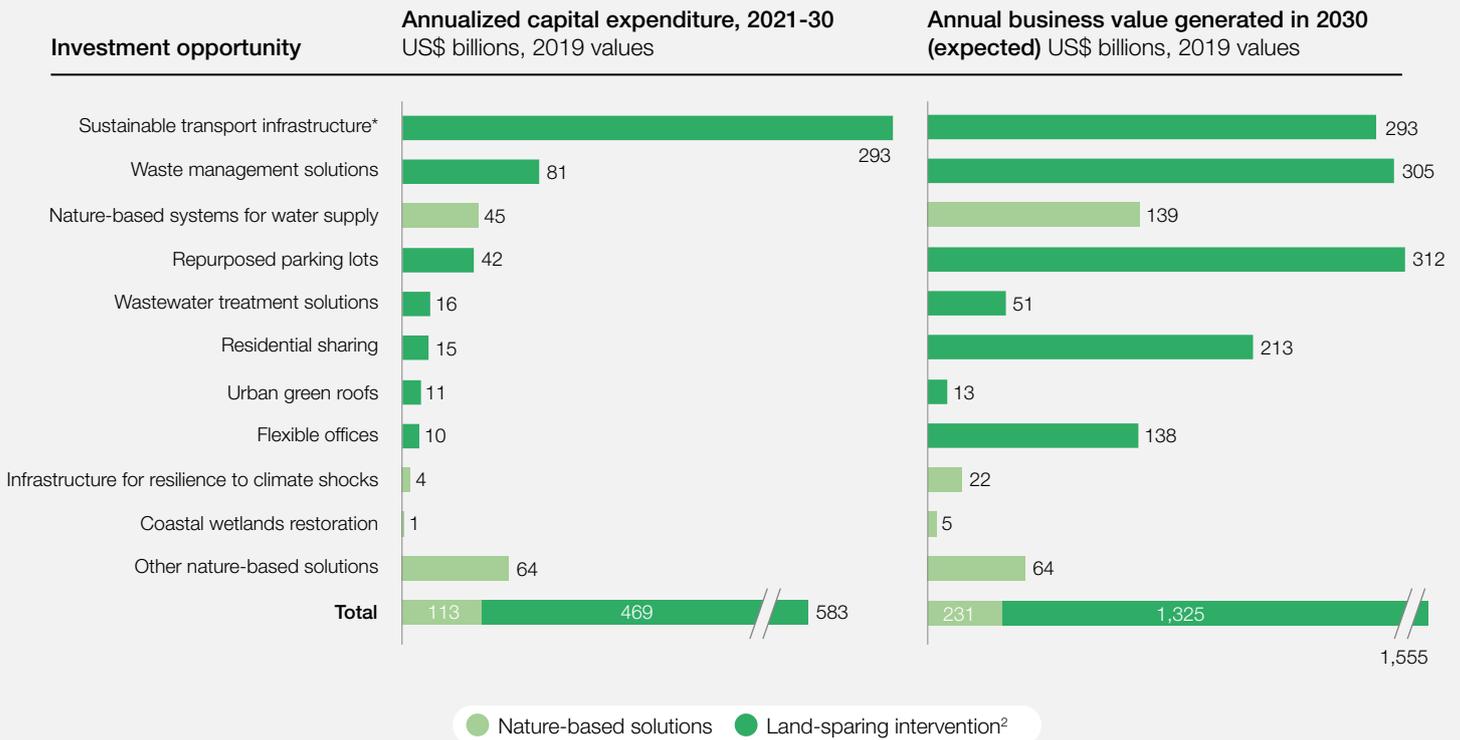


Infrastructure category	Annual investment in 2030 US\$ billions
Nature-based solutions <sup>ii</sup>	113
Land-sparing interventions <sup>iii</sup>	469
Grey infrastructure	10,548
<b>Total</b>	<b>11,131</b>

**Notes:** i. Calculated using nature-based solution spending data from the *State of Finance for Nature*, and total infrastructure spending in cities for 2021. ii. "Nature-based solutions" for infrastructure is an umbrella term referring to actions to protect, sustainably manage, and restore natural or modified ecosystems that provide the same infrastructure services as human-engineered grey infrastructure. Examples include reforestation of urban watersheds for natural water supply and wastewater and pollution cycling. iii. "Land-sparing interventions" is an umbrella term referring to those opportunities that release land to nature by reducing the footprint of the built environment, while also generating new economic value. Examples include repurposing land from unproductive existing uses (e.g. parking).

**Source:** UNEP; World Economic Forum; ELD; Vivid Economics (2021); *State of Finance for Nature*; IHS Markit (2021); AlphaBeta

FIGURE 6 | 11 investment opportunities could create over \$1.5 trillion in annual business value by 2030



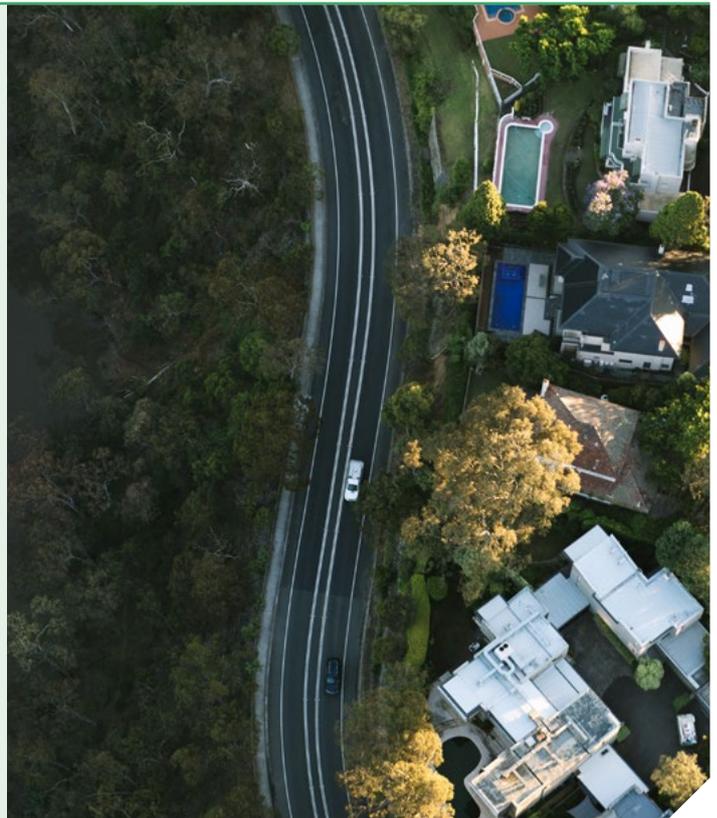
Source: Literature review; expert interviews; Alphabeta

### CASE STUDY 3 | Sizing the investment opportunity



It is important to note that the \$583 billion estimate for NbS for infrastructure and land-sparing interventions in cities is related to the *investment opportunity* (the capital expenditure required) and not the *business opportunity*. The latter constitutes returns for investors which evidence shows could be significantly higher - at least \$1.5 trillion in annual business value - by 2030 (Figure 6). It should be noted that these opportunities are based on existing commercialized business models or those with significant potential for commercialization, and greater research and development along with supportive public policy is required to unlock their full potential (Section 3 provides further details on key levers and actions that can do so).

Additionally, these are examples of potential business models, rather than being an exhaustive analysis of all available opportunities. In other words, the overall potential value created by NbS and land-sparing interventions within the infrastructure sector could be significantly higher, particularly given the likelihood of nascent technologies and new players emerging as markets develop. As a result, the analysis presented in this section should not be considered as a “substitution” analysis for NbS and land-sparing interventions vis-à-vis the use of all grey infrastructure in cities, but a relatively small investment opportunity that could have a transformative impact on cities’ relationship with nature.



“ ROI in sustainable infrastructure for the private sector could be 2.5 to 3.5 times the size of the initial investment.

## Sustainable transport infrastructure

Between 2015 and 2030, it is estimated there will be a \$730 billion annual infrastructure investment gap in the transport sector.<sup>64</sup> \$293 billion of this gap can be addressed by private and institutional investors alone by ramping up sustainable transport infrastructure,<sup>65</sup> which includes building more public transport, improving facilities for biking and walking and ensuring road, rail and port networks are constructed in a nature-compatible manner. This is a critical land-sparing opportunity that can both reduce the impact of connecting infrastructure and increase density in cities. Transport infrastructure currently uses large amounts of land, alters ecosystems during construction and requires vast quantities of construction materials, including steel and concrete – both of which negatively impact biodiversity through their production and supply chains.

**A mindset shift is required for transport infrastructure to utilize less land and better integrate nature.** Rather than purely optimizing for the built environment to improve journey times and distances, decision-makers must integrate positive biodiversity and climate outcomes and consider

citizens' wellbeing during the planning stage. A particularly useful framework is the “mitigation hierarchy”, which sequentially recommends projects to avoid, minimize, rehabilitate, offset and compensate for impacts on biodiversity in all infrastructure activities, to successfully balance conservation needs with development priorities.<sup>66</sup> Returns on investment (ROI) in sustainable infrastructure for the private sector – even with additional compliance and procurement costs – could be 2.5 to 3.5 times greater than the initial investment.<sup>67</sup> The COVID-19 pandemic has paved the way for urban reorganization and there is now a window of opportunity to make permanent changes to the urban transport landscape, accounting for social distancing and open public spaces. Common reorganization during the pandemic has included the widening of sidewalks and the introduction of pedestrian-friendly roads and pop-up cycling lanes. These have proven to be powerful tools, pushing back against the dominance of cars and roads,<sup>68</sup> and sparking the potential for lasting behaviour changes by fostering more sustainable modes of transport and integrating people- and nature-friendly spaces.

### CASE STUDY 4 Integrating nature with roads in Singapore



Singapore's land scarcity and high population density necessitates innovative land-sharing solutions to incorporate nature in infrastructure and service the city's needs.

Reducing the environmental impact of roads has proven particularly challenging, as they fragment habitats and require engineered materials (e.g. concrete) to provide safe passage for vehicles. Although the land used for roads can be minimized, important road networks face challenges in integrating nature within their design.

In response, Singapore has developed a system of roads called “Nature Ways” that feature native trees and shrubs. Singapore's National Parks Board has drawn key lessons from native tropical forests to successfully incorporate a diverse range of species alongside verges. By emulating the multiple layers of the forest ecosystem in multi-tiered tree planting systems, the Nature Ways mimic the structure of the rainforest. They create vibrant, natural niches for small mammals, birds, reptiles, amphibians and insects, providing ecological connectivity between green spaces across the city. A denser tree canopy helps to reduce ambient temperatures and curtail the urban heat island effect, as well as absorbing carbon and air pollution, retaining soil moisture and intercepting heavy rainfall, thereby lowering flood risk. The Nature Ways also improve the travel experience across the island for commuters, pedestrians and cyclists.

Despite being one of the world's most densely populated cities, thanks to its Nature Ways, Singapore is now the second-ranked city on Treepedia's global Green View Index – a tool developed by MIT's Senseable City Lab that measures tree canopy cover in cities.<sup>69</sup>

*Image below: The Lornie Nature Corridor in Singapore, featuring the “Nature Ways” road design.*

*Picture credit: National Parks Board, Singapore*

*Authored by the National Parks Board, Singapore*



“ The costs of building nature-based solutions for water supply can be as low as \$2 per person, per year.

## Nature-based systems for water supply

**NbS for water supply could save \$140 billion annually and provide clean and safe drinking water for 1.4 billion people by 2030.** The associated annual investment opportunity over 2021-30 is \$45 billion – although costs can be as low as \$2 or less per person, per year based on a variety of regional factors.<sup>70</sup> Water access and security are some of today’s main urban development priorities. Water depletion across urban watersheds is high around the world due to pressures from agriculture, mining and urbanization – in some regions, up to 60% of the area encompassed by source watersheds is at risk.<sup>71</sup> Reforestation and protection of

urban and peri-urban watersheds remains a key solution. The opportunity lies not only in restoring degraded landscapes and improving water security, but also in conserving the natural habitats of thousands of species, including several at risk of extinction. Additionally, significant carbon benefits could be felt by avoiding up to 603 million metric tonnes of carbon dioxide equivalent (MTCO<sub>2</sub>e) emissions per year from deforestation and sequestering up to 2,168 MTCO<sub>2</sub>e per year in preserved soils and forests. Cities could even see positive returns on their total project investment from savings generated through reduced annual water treatment costs.

### CASE STUDY 5

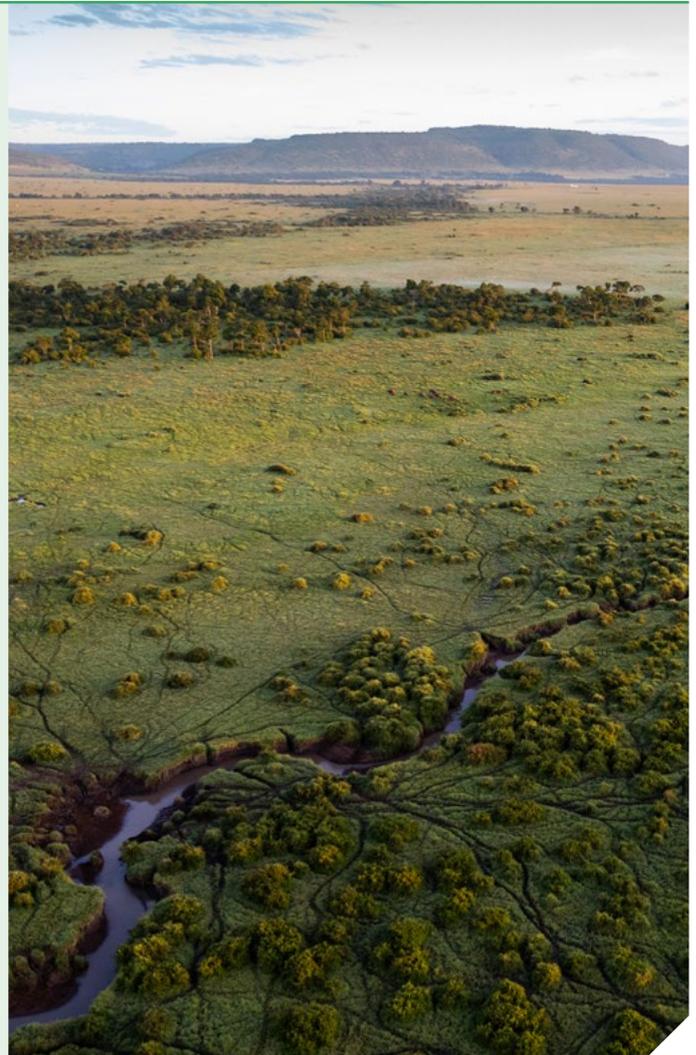
#### Upper Tana-Nairobi Water Fund - The business case for natural water supply<sup>72</sup>



Since the 1970s, Kenyan forests on steep hillsides and in wetlands have been converted for agriculture, removing natural areas for storing run-off and accelerating the sedimentation of rivers. The Tana River watershed, which supplies 95% of the water for Nairobi’s four million residents and another five million people living in the river’s catchment, has been subject to this type of land-use change. Due to changes in the hydrological cycle brought about by conversion, 60% of Nairobi’s residents now lack access to a reliable water supply.

In response, the Upper Tana-Nairobi Water Fund was created in 2015 to provide a secure source of water and conserve the watershed. A public-private steering committee was established, bringing together diverse stakeholders, including major utility companies, the Water Resources Management Authority and the Tana and Athi Rivers Development Authority, as well as prominent corporations. Contributors to the Fund include downstream users and upstream stewards, such as agricultural landholders and development organizations. Finances are used to promote sustainable land management practices, including strategic tree planting and land terracing to filter and regulate water supply to the river’s watershed. Funds are also used to distribute water-saving technologies for agricultural use, boosting productivity and generating cost savings.

The Fund’s activities now provide “several million more” litres of water to Nairobi each day. Furthermore, project monitoring revealed a 15% decrease in sedimentation, with Nairobi’s water supply achieving World Health Organization turbidity standards for the first time in 2016. It has been estimated that an investment of \$10 million in the Water Fund will return \$21.5 million in economic benefits over 30 years.

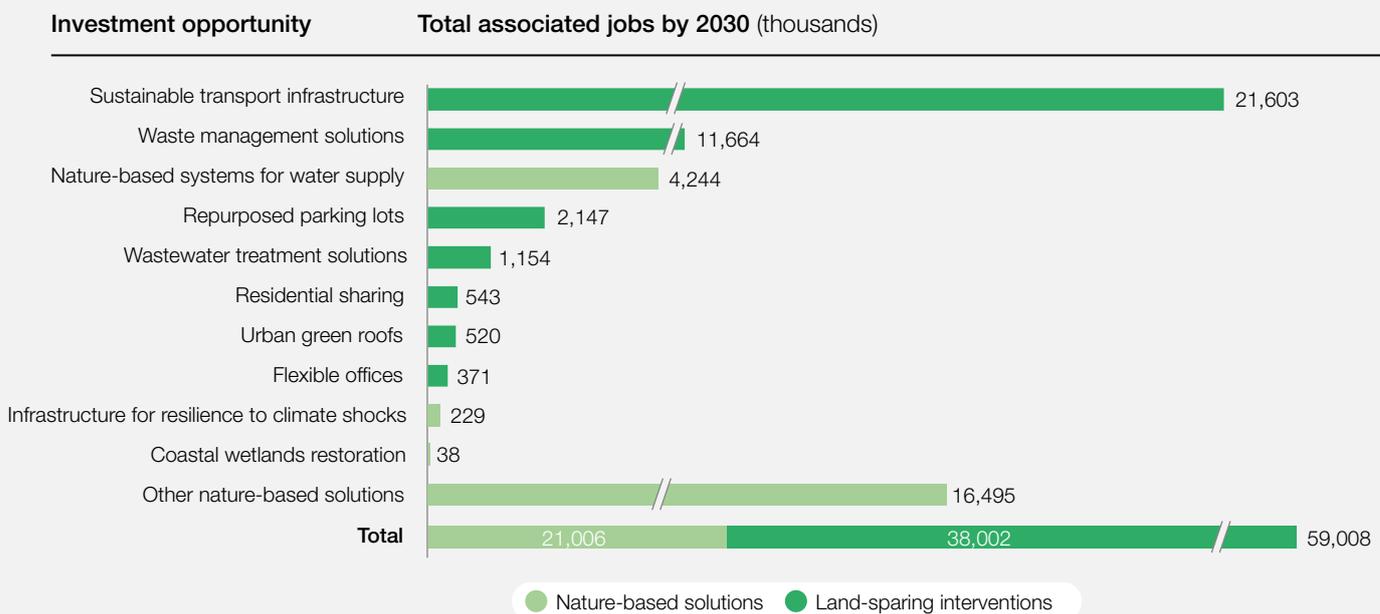


## 2.4 Job creation through nature-based solutions for infrastructure and land-sparing interventions in cities

Investment opportunities in NbS for infrastructure and land-sparing interventions in cities could, taken together, create over 59 million jobs by 2030 (Figure 8) – equivalent to 1.5% of the projected global labour force in 2030, and roughly the size of Italy's population today.<sup>73,74</sup> This includes 21 million jobs in NbS alone. This includes 21 million jobs in NbS alone due to watershed rehabilitation,

the management of invasive species, and other nature-based infrastructure interventions. These jobs are also expected to be resilient (i.e. less likely to be lost to shifts in technology, global value chains or market demand trends) and offer long-term stability and better livelihoods than jobs in business-as-usual models across ecosystems, geographies and countries with varying levels of economic development.<sup>75</sup>

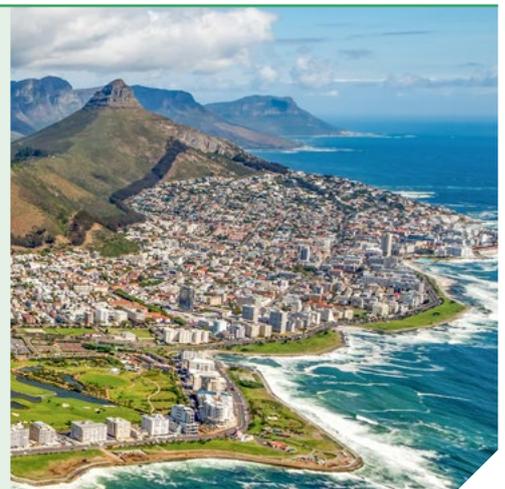
FIGURE 7 Nature-based solutions and nature-positive interventions could create 59 million jobs by 2030



Source: Literature review; expert interviews; Alphabet

### CASE STUDY 6 South Africa's Working for Water (WfW) programme<sup>76</sup>

South Africa's Working for Water (WfW) programme was established in 1995 to combat the threat of invasive alien plants. These species, including eucalyptus, are "thirstier" than native species and had reduced the capacity of urban watersheds by over 4% of the country's water supply (predicted to rise to 16% if left unchecked). The programme also provided a useful solution for the country's persistent unemployment problem, offering contracts to local people to remove invasive species from key water catchments, largely using NbS. To date, the programme has cleared invasive species from over one million hectares of watersheds, providing an additional 50 million cubic litres of water and creating over 20,000 jobs. WfW has been integrated into South Africa's larger set of programmes around sustainable land-based livelihoods, which include similar incentives for wetlands, coasts and fire-prone regions. Job creation for disadvantaged groups remains one of the cornerstones of these programmes. In the 2019-20 financial year, more than 60,000 jobs were created by WfW, with more than 70% going to youth, 55% to women and 1.5% to people with disabilities.



## 2.5 The relevance of investment opportunities by sector

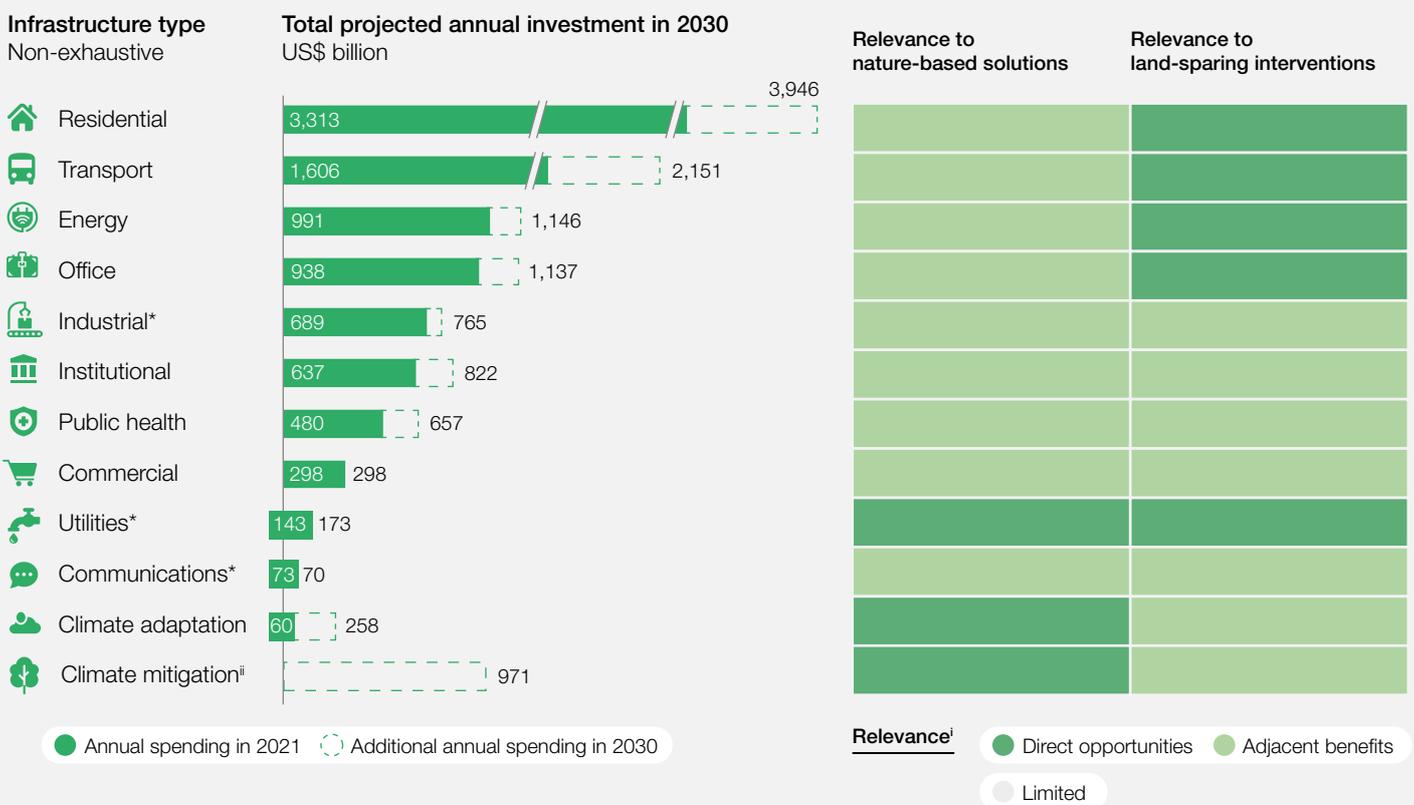
Investment opportunities in NbS for infrastructure and land-sparing interventions in cities are relatively concentrated in specific sectors, but adjacent benefits are widely applicable across multiple sectors (Figure 8).

Each sector should, therefore, evaluate the relevance of nature-based opportunities to help provide their infrastructure services. For instance, NbS and land-sparing interventions

have high significance for the utilities sector, particularly around providing natural water supplies and managing/reusing waste and wastewater. Additionally, all NbS - regardless of their principal purpose - and all land-sparing interventions are relevant, in varying degrees, to climate adaptation and mitigation goals, as releasing more land to nature allows the benefits of ecosystems to materialize.

FIGURE 8 Relevance of solutions varies significantly by sector

### Global cities' investment in infrastructure by sector, 2030<sup>i</sup>



**Notes:** i. Relevance scores for each category; Direct opportunities = multiple opportunities applicable; Adjacent benefits = at least one opportunity available; Limited = no direct opportunities available.

ii. Includes major infrastructure and built environment interventions to reduce emissions in cities. Challenging to size accurately in 2021 given varying definitions of infrastructure.

\* Reported spending in these categories contains overlaps with spending in other categories. Reported spending in these categories is also not representative of full spending due to data challenges.

**Source:** IHS Markit; expert interviews; team analysis

NbS have similar relevance for residential, office, communications, public health, industrial, institutional and commercial infrastructure, where these act as carbon sinks, reducing heat and air pollution. However, natural assets (in the form of functioning ecosystems) cannot be directly used to house residents, office workers, doctors, retailers or

service providers in line with modern requirements, despite the relevance of nature-derived solutions (e.g. renewable energy in the form of solar panels or district cooling systems), nature-inspired infrastructure design (e.g. biomimicry in buildings), and evergreen architecture (e.g. green roofs, green walls and plant-filled façades).

## 2.6 The relevance of investment opportunities by region

“ Pantropical countries hold a higher share of the global opportunity than their contributions to global GDP.

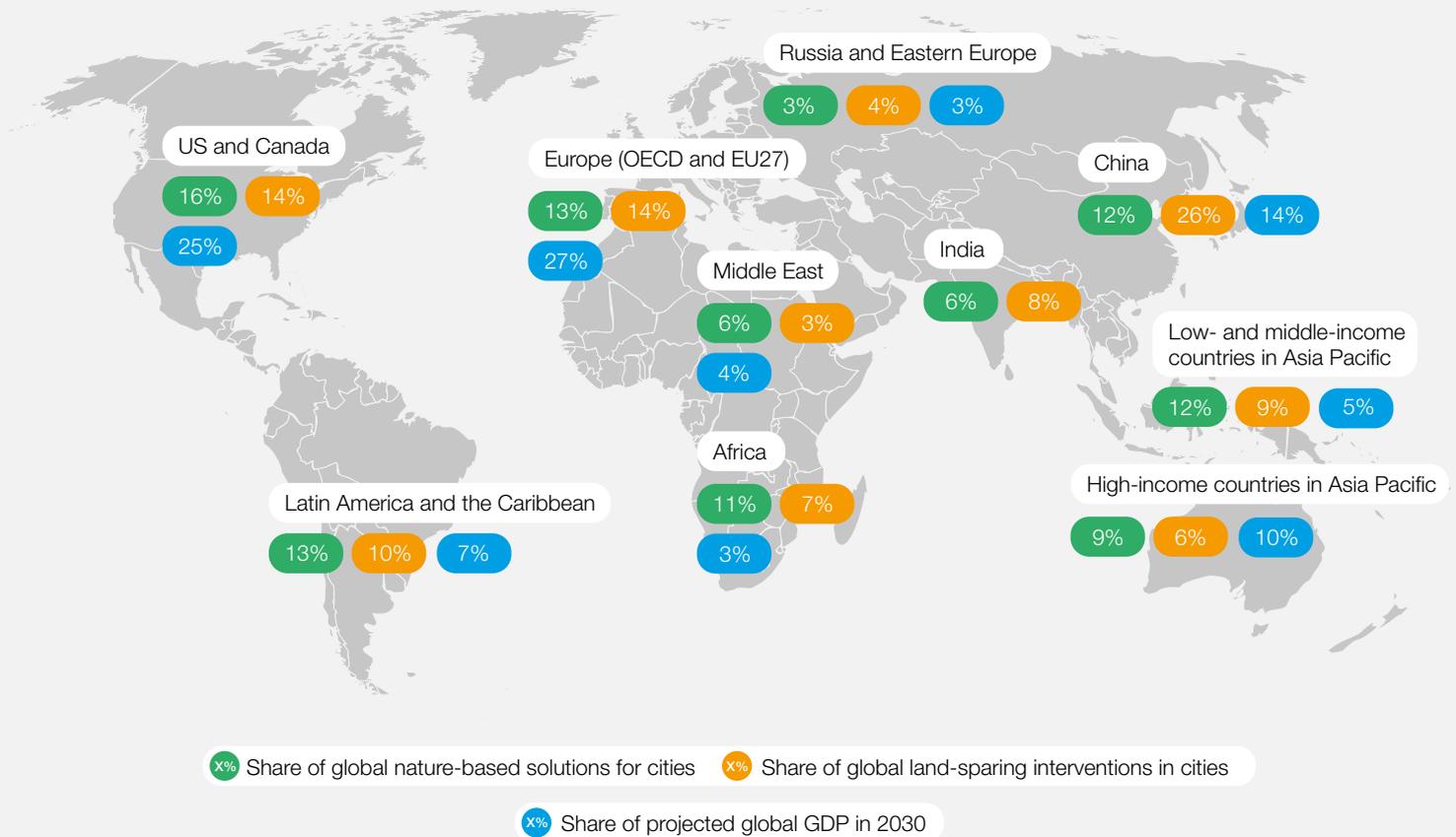
The relevance of NbS for infrastructure versus land-sparing interventions for cities varies significantly in different regions of the world. (Figure 9). What is clear, however, is that the opportunity to safeguard biodiversity in cities is global – and essential for achieving the BiodiverCities by 2030 vision.

NbS for infrastructure appear to be most relevant for regions with significant land endowment and/or endemic biodiversity, including the US and Canada (16% of the global opportunity), Latin America and the Caribbean (13%), low- and middle-income countries in Asia Pacific (12%), Africa (11%) and high-income countries in Asia Pacific (9%). In these regions, the share of the global opportunity for NbS is higher than for land-sparing interventions, implying that they have more to gain from conserving existing natural assets and reintegrating them within their built

environment. It is unsurprising that low- and middle-income regions are at the forefront of the NbS opportunity, given that the majority of projected spending on urban expansion, as well as the concentration of urban expansion risk in global biological hotspots, is expected to occur in Latin America, Africa and Asia Pacific.<sup>77,78</sup> For highly urbanized societies and those with larger populations, land-sparing interventions are extremely relevant; China has 26% of the global opportunity, Europe has 14%, and India has 8%.

Comparisons with pantropical regions’ share of global GDP reveal that the investment opportunities are more equitably spread. For instance, cities in Africa, Latin America, India and low- and middle-income countries in Asia Pacific have a significantly higher share of both types of opportunities than their global GDP – ranging between 3 and 8 percentage points higher depending on region and type of opportunity.

FIGURE 9 The relevance of opportunities varies significantly by region



Source: Alphabeta

3

# Enabling cities to live in harmony with nature

A nature-positive model of urban development requires a systemic shift in governance, spatial (re)integration of nature, and investment mobilization.



# 3.1 Three systemic shifts towards a nature-positive urban development

“Partnering with nature represents an investment opportunity allowing cities to tackle urban development priorities and conservation goals concurrently.”

The typical urban development paradigm has biodiversity and cities as antithetical – either biodiversity suffers as cities expand, or cities constrain themselves to conserve nature.<sup>79</sup>

However, Section 2 provides clear evidence that partnering with nature represents an investment opportunity allowing cities to tackle urban development priorities and conservation goals concurrently. Cities can capture these opportunities (Figure 10) by:

1. Adopting a systems approach to urban governance.

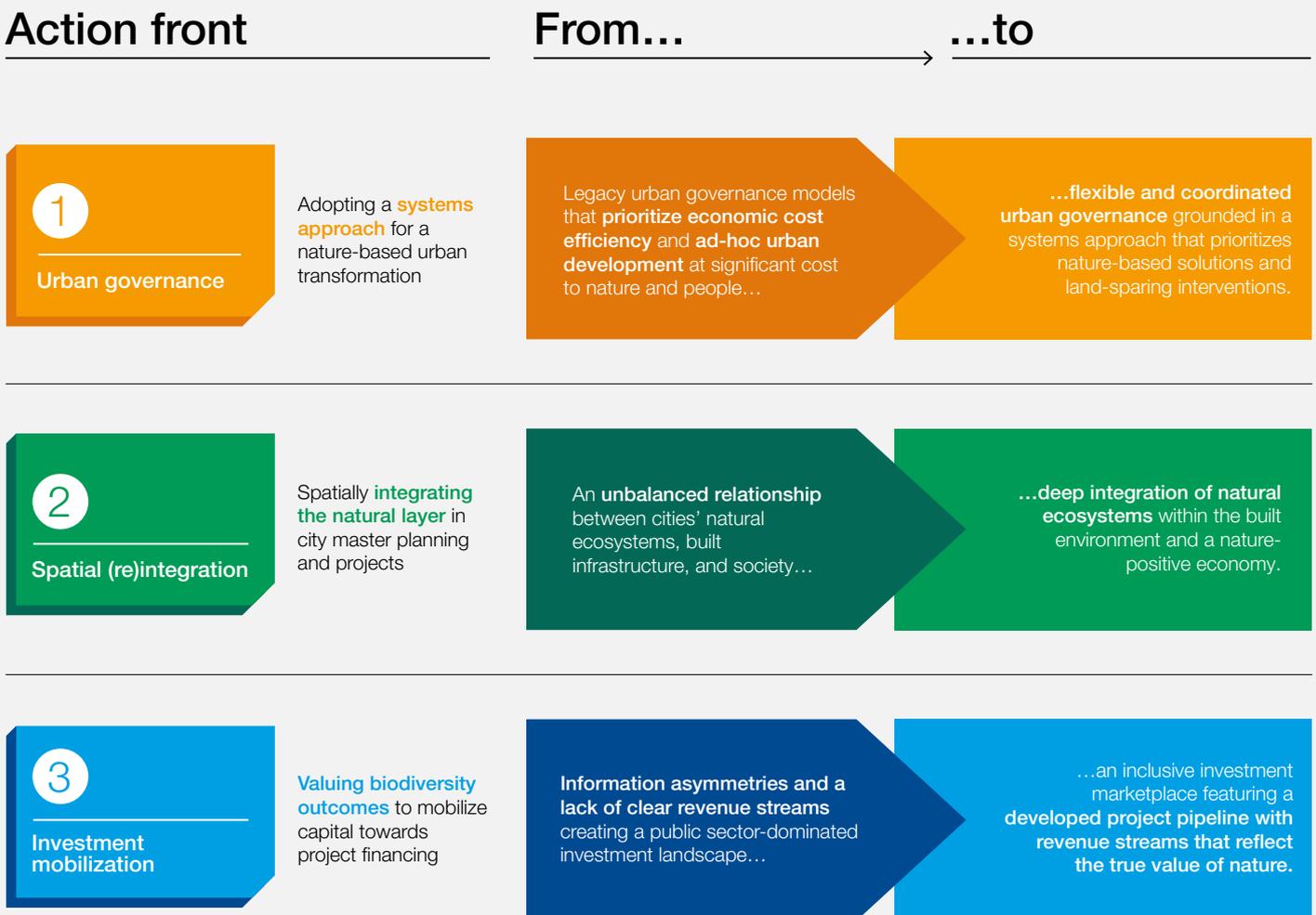
2. Spatially (re)integrating nature in urban planning.

3. Mobilizing investment for NbS for infrastructure and land-sparing interventions in cities.

**Each of these actions will pave the way for achieving the BiodiverCities by 2030 vision.**

This section presents each of these three systemic shifts, as well as success stories, in further detail.

FIGURE 10 Achieving the BiodiverCities by 2030 vision requires three systemic shifts in urban development models



Source: Team analysis

## 3.2 Urban governance transition: The need for a systems approach in decision-making

**Urban governance refers to the mechanisms and processes by which state agencies (at municipality, city, regional and national levels) and civil society decide how to plan, finance and manage urban living.**<sup>80</sup> Such mechanisms and processes are fundamental to decisions related to planning, constructing and operating in the built environment. The capacity to adapt and innovate therefore plays an important role in promoting nature-based urban transformation.<sup>81,82</sup> However, today's models of urban governance suffer from legacy issues that result in sector-based approaches with a lack of shared goals and a greatly undervalued role for nature in siloed agendas.

**Urban planning and design have historically prioritized economic cost efficiency and favoured “quick wins” when it comes to urban problems, however these have resulted in limited long-term public welfare.** Few city governments in low- and middle-income countries have the power, resources or trained staff to provide their burgeoning populations with the adequate utilities, services and facilities needed for integrated urban living.<sup>83</sup> Much consideration is given to the structural integrity of built structures and land-use or zoning regulations, therefore solutions for common urban problems such as water supply, transport or power are often considered in an isolated/centralized manner, usually favouring grey infrastructure that fails to account for other complex and interacting variables such as ecosystem services and impacts on the rural hinterland, which cities often attempt to encroach upon.

**These decisions are distorted by the insufficient accounting of environmental externalities in today's economic indicators and regulatory models.** Similarly, a lack of easily available and trusted data for decision-makers impedes the inclusion of NbS for infrastructure in urban decision-making. For instance, negative externalities associated with infrastructure (i.e. carbon emissions, disruptions in ecosystem services and water pollution) remain largely undervalued and underpriced by developers. Instead of holding developers

accountable for the impact of individual projects, city authorities face increasing costs associated with climate change adaptation, pollution and water scarcity, and often respond to these challenges with overexpenditures and new grey infrastructure solutions – feeding into a vicious cycle. Looking to the future, the economic costs of environmental externalities are forecast to be extremely high; it is estimated that the global value of environmental externalities is \$4.7 trillion across water use, GHG emissions, waste, air pollution, land and water pollution, biodiversity loss, and land-use change.<sup>84</sup>

**Many fiscal policies also make destroying nature cheaper than protecting or leveraging it.**

In particular, prevailing subsidies and tax reliefs for land transformation, fossil fuels, road and infrastructure development and water artificially lower the costs of nature-negative business models in these areas, and far outnumber existing incentives to protect nature, especially in cities.<sup>85,86</sup> Many expected the COVID-19 pandemic to be a turn-around opportunity, but according to the Greenness for Stimulus Index, the measures announced in response to the pandemic are predicted to have a net-negative environmental impact in the US, Russia, Mexico and all countries analysed in Asia Pacific, including China, India, Indonesia, the Philippines, Japan and South Korea.<sup>87</sup>

**In most cases, the responsibility for nature is dispersed across several entities** – vertically (i.e. between national, state and local governments), horizontally (i.e. across different ministries, departments and sectors), and externally (i.e. involving non-state actors and communities).<sup>88</sup> Investment institutions channel their funding through national governments or major infrastructure providers rather than working directly with city governments<sup>89</sup> and, as a result, local context is not sufficiently incorporated in urban master planning and project financing. Cities are complex systems, wherein multiple socioeconomic, technological and spatial realities intertwine and each city's unique context (i.e. geographic setting, size, maturity of urban development and political readiness to

“ Fiscal stimuli announced to combat COVID-19 will likely create net-negative environmental impacts across major economies.



address responsibilities towards people and the planet) is essential to overcome the standardized grey solutions that are generally applied.<sup>90,91</sup> One of the more recent attempts to support the critical role that sub-national governments play in differentially protecting cities' natural backbone is the Edinburgh Declaration, which has 130 signatory cities and was released by the Secretariat of the UN Convention on Biological Diversity in 2020. The Declaration acknowledges the need for vertical integration across national, subnational, city and local levels, to include wider society and private sectors in decision-making.<sup>92</sup>

**A systems approach cultivates a conditional view of development, in which complex interactions between systems (e.g. healthcare, education and environment,) are mapped, and the outcomes of each action are measured and reported in totality (as opposed to ad-hoc).**<sup>93</sup> A systems approach to urban development integrates the needs of all

## 1 Steering the direction from the top

**Emerging evidence has shown that institutional adaptability to urban challenges is stronger when political pressure is combined with scientific knowledge and social awareness.**<sup>96</sup>

High level decision-makers have great oversight across a range of systems key to urban development and can serve as champions to integrate and connect competing agendas. For instance, Singapore's Prime Minister Lee Hsien Loong elevated climate adaptation and mitigation to the top of Singapore's urban transformation agenda by announcing plans for SGD 100 billion (Singapore dollars - roughly \$74 billion) in funding for this purpose over 100 years.<sup>97</sup> With political backing, clear roadmaps can be developed for nature-based urban transformation. As part of Singapore's funding, an investment of SGD 19 billion (\$14 billion) has been committed to research and development around urban challenges.

## 2 Coordinating across stakeholders

**Systems approaches are grounded in close coordination among stakeholders with distributed rights and responsibilities in urban governance.** The adoption of city-wide systems approaches can work for both people and nature, but require interdisciplinary teams - including urban planners, ecologists, architects, engineers, developers, investors, social scientists and citizens of all ages - to pull together.<sup>103</sup> Private sector developers and infrastructure financiers, for instance, have important roles to play in planning and development. Participative governance, on the other hand, enables citizens to play an active role in adapting plans for their neighbourhoods and local context, with evidence showing that local stewardship is a

stakeholders and accounts for natural ecosystems by incorporating science-based methods to maximize each stakeholder's welfare.<sup>94</sup>

The Singapore Liveability Framework is a prime example of how a systems approach to urban governance can work well in practice, creating systemic innovation while supporting sustainable urban development. Many other cities have also adopted systems approaches successfully, including Bilbao, New York, Suzhou and Medellin.<sup>95</sup>

**Three key actions have been identified as levers for achieving an urban governance transition that enhances a systems approach, to enable cities to exist in harmony with nature:**

- 1 Steering the direction from the top.
- 2 Coordinating across stakeholders.
- 3 Fostering policy innovation.

**Advocacy and accountability from the highest levels of government for sustainable and nature-positive development in cities must be translated into practical plans.**<sup>98,99,100,101,102</sup> Action-

oriented strategies can create cross-departmental and sectoral engagement and disperse accountability, bolstering the push from the top for nature-based urban transformation. Leadership therefore has three key functions:

- **Motivate:** Align nature-based solutions with current measures of success and performance within urban planning and development.
- **Endorse:** Leverage trusted external advisory councils to refine resolutions and roadmaps.
- **Build capacity:** Increase knowledge and levels of expertise on the value of expanding nature in the built environment.

critical success factor for NbS<sup>104</sup> Good stakeholder engagement and coordination will enable city governments to benefit from local stewardship, leveraging greater positive impact and a more resilient, nature-positive urban development.<sup>105,106</sup>

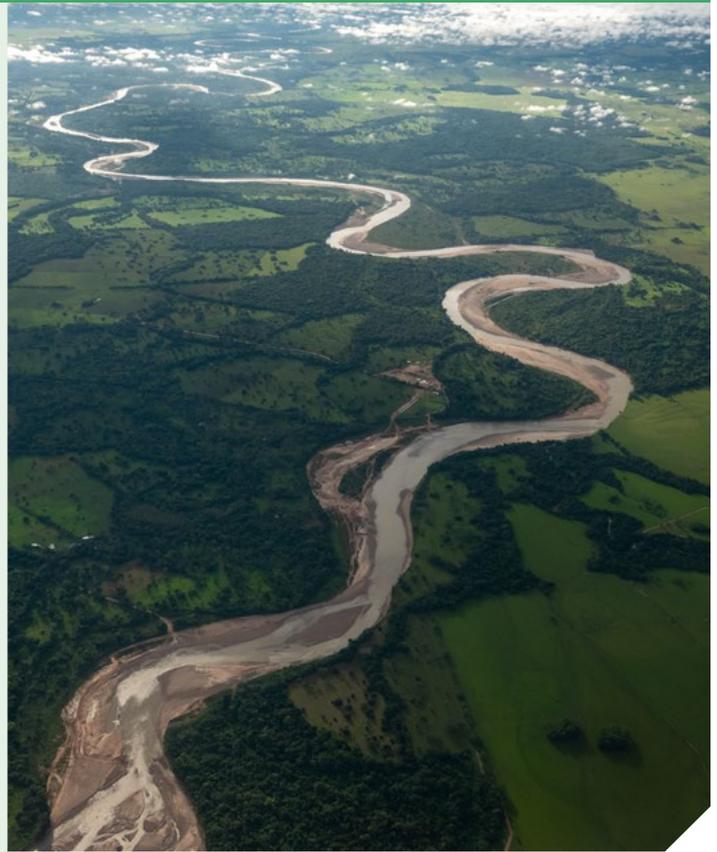
**Efficient coordination requires stakeholders to:**

- Prioritize a widely shared urban challenge.
- Facilitate participation which could inform, engage or consult.
- Seek benefit-sharing and build consensus over the best solution/s to address challenges.



The municipality of Villavicencio in Colombia has shown strong leadership and commitment to maintaining its urban wetlands through multisectoral governance. In 2017, the conservation, restoration, management and sustainable use of urban wetlands became a joint task, carried out by national and local governments, communities, organizations, academia and the private sector. In 2020, the municipality responded positively to citizen advocacy by officially recognizing the Interinstitutional Committee for the Protection of Urban Wetlands, together with a new legal act that emphasized the importance of coordination at multiple levels for the effective protection of these urban ecosystems.

Further incentives for the conservation of urban wetlands have since been put in place, in recognition of the ecosystems' social, cultural, economic and ecological value. In 2021, a second decree was established to reduce land conversion pressure on urban wetlands; in exchange for increasing the height and density allowances of the current owners' housing development projects, Villavicencio's government sought to regain land ownership. The licences were issued for suitable residential districts in alternative parts of the city and included rights for urban developers to increase social housing units. As a result, over 44,000 hectares of wetlands will be regained, more than 400,000 square metres of new building areas will be granted, and over 20,000 housing units will be created.



## 3

### Fostering policy innovation

“ Policy innovation does not simply involve coming up with something new; it is also necessary to adapt, make corrections and learn from the past.

**The success of a systems approach in urban development rests on policy innovation.** From pricing externalities and reforming perverse subsidies to monitoring the unforeseen impacts of siting NbS interventions in one place or another, innovation in policy-making is a top priority when it comes to putting transformative, systemic urban governance in place.<sup>109,110</sup>

**The siting and design of NbS for infrastructure in cities directly influences the services it provides and the people it benefits.** This is why, in some cities, policy-makers are now including additional criteria and technologies when spatially planning interventions, taking into account the distribution of burdens and benefits, historical and current public underinvestment, poverty levels, density and population growth among other aspects.<sup>111,112,113</sup> Policy innovation does not simply involve coming up with something new; it is also necessary to adapt, make corrections and learn from the past. As an example, an interdisciplinary research team coded city planning documents from 19 US cities to examine historic intentions for green infrastructure and understand their potential disservices, such as prevailing injustice and inequality.<sup>114,115</sup>

**Natural capital accounting, assessment and reporting is another prominent field of policy innovation.** There are nascent initiatives and standards around this, such as the UN System

of Environmental-Economic Accounting's Ecosystem Accounts, adopted by the UN Statistical Commission and the Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) initiative and set up by the UN, the EU and five other countries, including China and India.<sup>116</sup> At a country level, France has taken the lead on natural capital, transitioning from a voluntary to a binding approach, whereby asset managers and corporate issuers are obliged to disclose biodiversity- and climate-related risks by mid-2022, through the concept of double materiality.

**Embedding nature-related considerations into economic and financial decision-making requires a wholesale innovation in investment policies, criteria for compliance with environmental, social and governance quality goals, and new measures of economic success.** Such measures could significantly align private sector and urban developers' activities with national targets for emissions reduction and biodiversity conservation. Moreover, amendments to current regulations and company law could change companies' sole responsibility from maximizing risk-adjusted returns for shareholders to maximizing welfare for people, the planet and profit (i.e. [the “stakeholder” approach](#)), while also providing a significant boost for science-based targets for nature in urban areas and embedding nature-related considerations in urban planning.

### 3.3 Spatial (re)integration: Reviving cities' natural layer

“The vast majority of Earth’s 36 identified biodiversity hotspots encompass large urban areas.

Historically, human settlements that develop into cities are located near water, on fertile land and are shielded from extreme climatic conditions – in other words, they have evolved in places where nature readily provides for human needs. It’s no surprise that the vast majority of the planet’s 36 identified biodiversity hotspots encompass large urban areas including Brussels, Cape Town, Chicago, Curitiba, Ho Chi Minh City, Jakarta, Perth and Singapore.<sup>117,118</sup>

Cities can be seen to have three interdependent “layers” – the natural ecosystems that preceded their development and provide for their needs, the built environment constructed on top of this natural layer, and the social institutions and technologies that function and deploy within the built environment (Figure 11). Each layer has an important role to play in sustaining urban development; nature provides critical ecosystem services; the built environment supports key needs such as housing and transport, and societies build and distribute wealth and prosperity.

FIGURE 11 The three interdependent layers of a city – society, built environment and nature – have an unbalanced relationship

#### Layer

#### Constituents

#### Society



Citizens, governments, and their interactions<sup>i</sup> with nature and the built environment:

- Economy
- Culture
- Information

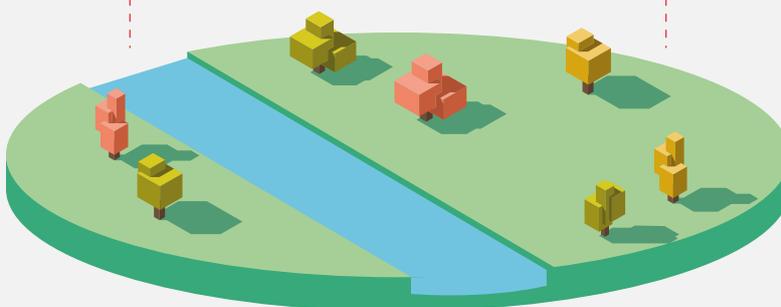
#### Built environment



Man-made structures:

- Residential, commercial, and industrial buildings
- Transport and utilities (power, water, telecommunications, sewerage)

#### Nature



Natural structures unique to each city:

- Flora and fauna, including fungi and microorganisms
- Air, soil/earth and water, including parks and waterways in and around city limits

<sup>i</sup> Icons represent interactions of society with nature and the built environment, including living, working, shopping, leisure, health, education, performing arts, sports and security, and are directly linked to the economy, culture and information.

Source: Arup; Sustainable Cities and Communities Standard adaptation (ISO/FDIS 37105)<sup>119</sup>

“ The Singapore Index on Cities’ Biodiversity is a self-assessment tool used by over 50 cities globally.

But these layers currently have an unbalanced relationship in cities around the world. Social institutions, technologies and the built environment are increasingly degrading nature and pushing it out of urban spaces. To a large extent, in most urban areas there are only traces of the underlying natural ecosystems that preceded urbanization. Natural ecosystems in cities’ territories are often severed from the wider natural catchment, to the fragmentation of natural habitats, diminished biodiversity and disturbed air, water and soil systems. The fashion in which urban built environments have emerged has reduced the ability of these ecosystems to provide the natural functions that first supported development. As discussed, urban governance models have an important role to play in changing the patterns of this nature-negative built environment.

It is critical that cities are underpinned by a fully functioning natural layer, as evidenced in Section 1. This requires deeper spatial (re)integration of natural ecosystems in city planning and new development projects that are supported by business models and interventions seeking to restore and/or utilize natural ecosystems. NbS for infrastructure and land-sparing interventions in cities’ built environment (discussed in Section 2) provide important opportunities to achieve this objective.

NbS and land-sparing interventions in cities may not uniformly maximize biodiversity outcomes in all cases. It is therefore important for mayors and city leaders to rigorously measure urban nature and set targets using science-based standards and indexes. The Singapore Index on Cities’ Biodiversity, for instance, is a self-assessment tool used by over 50 cities globally to evaluate and monitor the progress of their biodiversity conservation efforts over time.<sup>120</sup> The recently launched Urban Nature Index from the International Union for Conservation of Nature (IUCN) builds on the Singapore Index and sets robust, transparent and science-based targets to protect and restore nature in cities. It is envisioned that the data collected will be collated in a central platform to track urban ecosystem recovery and matched with global reporting frameworks such as the SDGs.<sup>121</sup>

Three key actions have been identified as levers for achieving spatial (re)integration of nature in cities:

- 1 Preserving existing natural habitats.
- 2 Renaturing degraded or sub-optimized land.
- 3 Growing smart with new or upgraded infrastructure.



## 1

## Preserving existing natural habitats

**Protecting cities' remaining intact natural habitat involves actions both within urban areas and the connected ecosystems that feed into a city's ecological cycles.** This is an essential step in the (re)integration of nature as, in some circumstances, intact habitats safeguard more biodiversity and generate greater ecosystem services than restored habitats, at lower costs and without the time delay

required for action.<sup>122</sup> Actions to protect existing habitats in cities - for instance, designating certain areas as “protected” land (Case study 8), as well as providing proper governance and local stewardship - are critical to increase resilience to climate shocks and support key ecosystem services such as water regulation and supply.

### CASE STUDY 8

#### Conserving remaining natural habitats in Curridabat - Costa Rica's “Sweet City”<sup>123</sup>

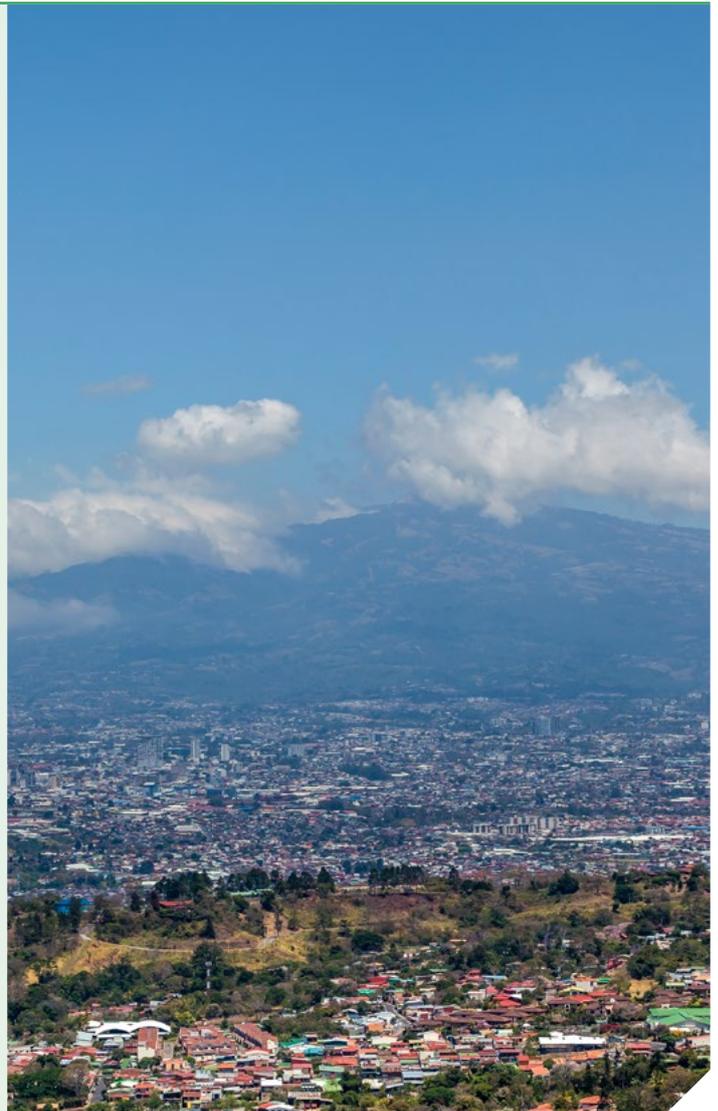


60% of Costa Rica's population lives in the Greater Metropolitan Area (GAM), which constitutes just 4% of the national territory. Curridabat, one of the

GAM's main urban centres, stands out for its multidimensional government plan - developed in 2015 under the name “Ciudad Dulce” (Sweet City) - and for being one of the first cities to create a series of Urban Natural Parks (PANU), a new protected area category issued in February 2021. Despite having significant environment protection afforded for nine other protected area categories, urban forests have not historically been protected by the country's National System of Conservation Areas (SINAC).

Driven by Curridabat's municipality, Ciudad Dulce's development model is based on five dimensions: biodiversity, habitat, infrastructure, coexistence and productivity. Curridabat treats green spaces as places within its urban infrastructure where all forms of life can coexist and productivity is constantly ensured. Pollinators, diverse plant species and people thrive in urban gardens and parks, producing fruits and vegetables, and promoting soil regeneration, leisure, tourism and cleaner air. New green areas are also being created to meet the needs of vulnerable plant and animal species through improved connectivity and habitat restoration.

City officials claim that the greatest achievements of Ciudad Dulce can be found in neighbourhood wellbeing. Air quality and the diversity of species and green spaces aren't the only improved aspects; peoples' spirits have also lifted thanks to increased participation, intergenerational and multistakeholder collaboration, and community activities. This biophilic approach has earned the city several awards, including “Best City Plan” from the Congress of New Urbanism (CNU), the “Wellbeing Cities Award” from New Cities, and the “Guangzhou International Award for Urban Innovation”.



## Renaturing degraded or sub-optimized land

**Restoration of degraded or sub-optimized land is another crucial component for (re)integrating nature in the built environment and optimizing biodiversity conservation and ecosystem services provision.** 60% of Greater London, for example, is open (undeveloped) land, yet only 33% includes natural habitats, which are dispersed across parks and private gardens; these are not extensive or connected enough and there is, therefore, a substantial opportunity for restoration or greater optimization of this land to provide ecosystem benefits commensurate with its area.<sup>124</sup>

**Many of the investment opportunities discussed in Section 2 are relevant for restoration-based activities,** which can be accomplished in combination with grey infrastructure or as standalone nature-based infrastructure (including coastal wetlands restoration and other NbS for urban ecosystems – see Case study 9). For example, restoration activities could be enhanced with the production of innovative bio-based products and services in urban areas, setting the stage for nature to become a model for greater competitiveness and sustainability in urban centres. The city of Surabaya, Indonesia, launched a “One Soul, One Tree” campaign with the twin focus of enhancing city forests and creating alternative means of income for residents living in poverty along the city’s beaches. In addition to protecting 5,000

mangrove trees, the project encouraged residents to harvest syrup from the mangroves to create batik (Indonesian dyed fabric) and other products, creating a new source of income.<sup>125</sup>

**Increasing tree cover in cities has been proven to provide significant economic, health and climate benefits,**<sup>126</sup> however, research suggests it is often unequally distributed across neighbourhoods. In cities in the United States, it has been found that, on average, low-income blocks have 15.2% less tree cover and are 1.5°C hotter than high-income blocks.<sup>127</sup> When tree planting and other NbS for climate-mitigation/adaptation are implemented without regard for local socioeconomic conditions and impact on land values, they can lead to “green gentrification”.<sup>128</sup> Equally, when these measures are implemented without appropriate maintenance budgeting, they may place a greater burden on populations already in financial stress.

**Beyond popular measures like tree planting, cities should deploy NbS and restoration strategies in combination with opportunities that release more sub-optimized land to nature.** This could include repurposing land used for parking, increased residential sharing, the introduction of flexible office spaces and integrated waste management infrastructure that reduces pressure on landfills.

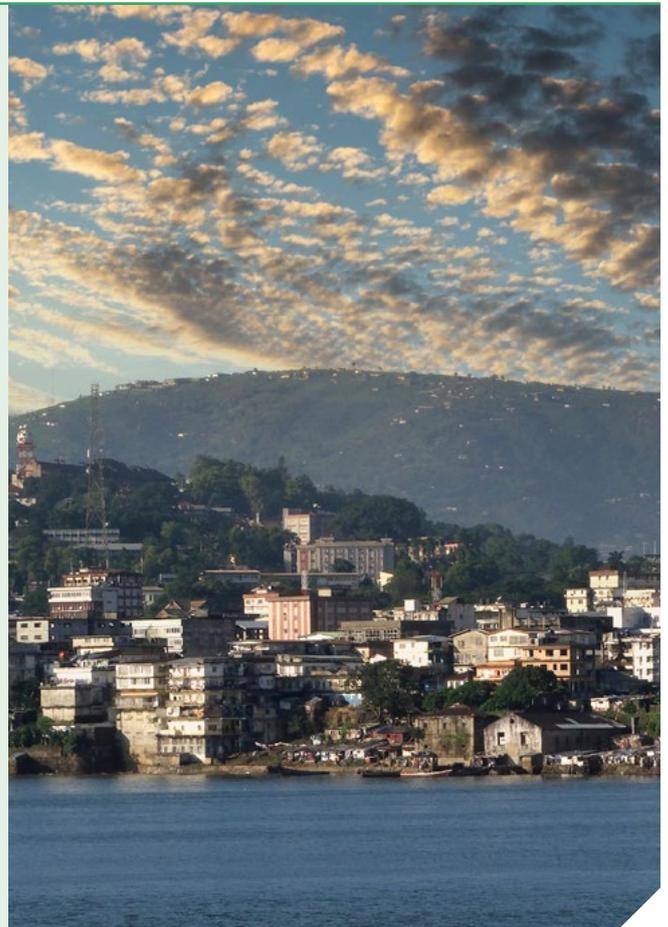
### CASE STUDY 9 Renaturing Freetown’s landslide<sup>129,130,131</sup>



Intensive rainfall over three consecutive days in 2017 triggered a major landslide above the city of Freetown, Sierra Leone, which destroyed hundreds of buildings in the city, killing 1,141 people and leaving more than 3,000 people homeless. The post-disaster recovery focused not just on earthworks to prevent future landslides but involved a nature-based landslide and flood risk management strategy which included the planting of 21,000 native trees by residents trained in forestry by the UN Office for Project Services (UNOPS). This programme helped to stabilize the slopes and reduced rainfall runoff that could lead to flooding.

As extreme weather patterns brought delayed rains, abnormally heavy rainfall and urban expansion, the Mayor of Freetown also ran a “Freetown the Treetown” tree planting campaign to increase vegetation cover by 50% by the end of 2022. This initiative is part of the capital’s three-year strategy “Transform Freetown” (2019-2022), which aims to enhance the productivity, liveability and resilience of the city through urban greening, resilient infrastructure and improved governance. To cultivate a sense of community ownership over the campaign, the trees’ growth is tracked by a community-based team using a “Treetracker” smartphone app; a unique geotagged record is created for every new tree. Locals who plant the trees make periodic visits to ensure that they are growing well and document their status on the app, in return for mobile micropayments.

As part of this campaign, 15 different species of trees were nursed on 11 sites across Freetown. By the end of 2020, more than 245,000 trees had been planted, covering 35 wards and engaging 300 communities, 76 schools, 11 health facilities and 66 religious institutions.



3

## Growing smart with new or upgraded infrastructure

**“Growing smart” is a complementary strategy for protection and restoration that ensures new urban development occurs in harmony with nature.** It involves actions that integrate nature in new or upgraded infrastructure – including those that utilize native ecosystems in conjunction with grey assets (e.g. sustainable transport infrastructure) or that incorporate natural elements in their design (e.g. urban green roofs). Regulatory tools and incentives can be used to mandate the

use of grow-smart elements. In cities like San Francisco and Córdoba there is a bylaw requiring all buildings - new or existing - with a rooftop space of 400m2 or more to be turned into green roofs.<sup>132</sup> Integrating principles such as “ecological compensation” into urban development policy and laws can encourage the strategic deployment of nature by encouraging decision-makers to operate at a broader level, rather than focussing on specific applications (Case study 10).

### CASE STUDY 10

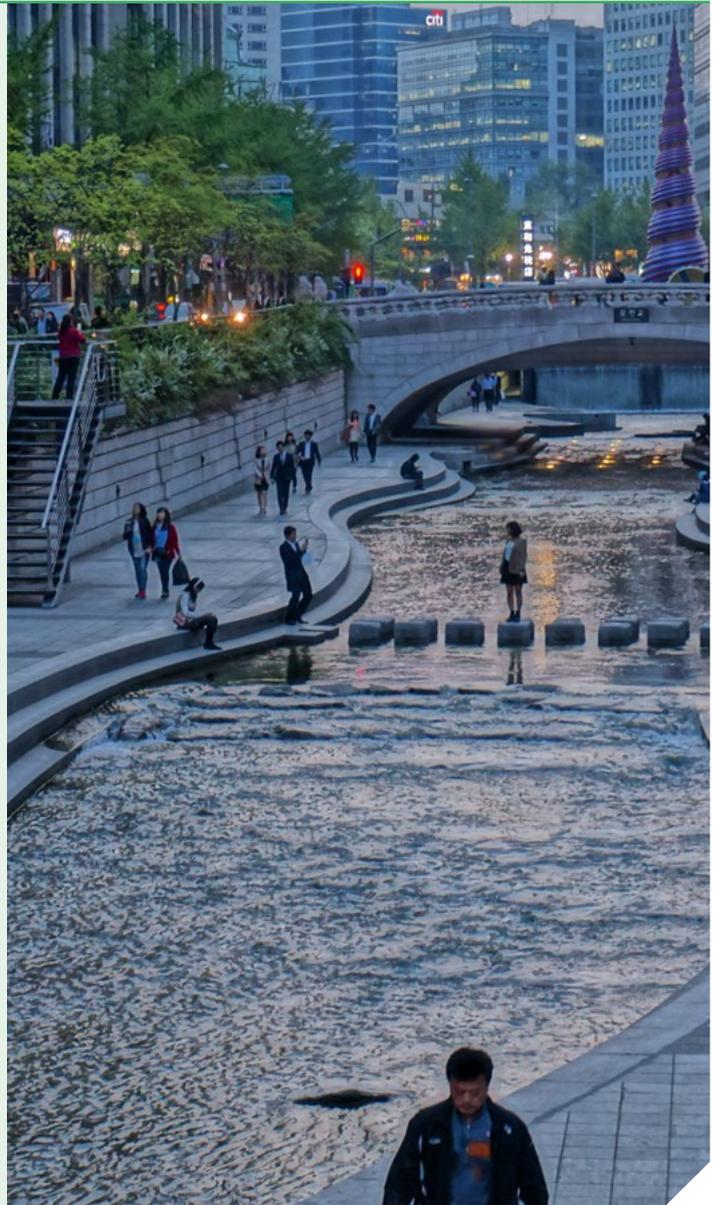
#### Seoul’s Cheonggyecheon river restoration project



The Cheonggyecheon river restoration project focussed on revitalizing the Cheonggyecheon Stream, a waterway that had been covered by a highway overpass for decades. An elevated freeway and concrete deck covering the stream was ageing and posed safety risks. The public avoided the area under the freeway due to criminal activity and illegal waste dumping, and the freeway itself was always congested, posing pollution issues.

Initially, transport experts were concerned that removing the elevated highway would increase congestion in the northern part of the city, since it carried around 170,000 vehicles per day. The Seoul Metropolitan Government chose to dismantle the elevated freeway and concrete deck and, to improve north-south linkages, proposed that 22 bridges – including 12 pedestrian bridges and 10 for automobiles and pedestrians – would be built to connect the two sides of the Cheonggyecheon Stream. To reduce congestion, car use was discouraged in the city centre, rapid bus services were introduced, and improved loading and unloading systems were implemented. Innovative governance and interagency coordination were critical to the process, as was extensive engagement with local communities, research groups and public-private players. Close to 4,000 meetings were held with residents and a programme was developed to encourage involvement, resulting in 20,000 participants.

After the restoration of the Cheonggyecheon Stream, land value in the adjacent area increased between 25% and 50%. The project served as a catalyst for an estimated KRW 22 trillion (South Korean won - or \$1.98 billion) worth of capital investment in redevelopment that would not have otherwise been invested. The project secured flood protection, increased overall biodiversity by 639% (between 2003 and the end of 2008), reduced the urban heat island effect and lowered small-particle air pollution by 35%. The redeveloped area now attracts an average of 64,000 visitors a day, including foreign tourists who contribute up to KRW 2.1 billion (\$1.9 million) to Seoul’s economy.



## 3.4 Investment mobilization: Mainstreaming nature for urban investors

“ 85% of all financing for nature-based solutions currently comes from local governments.

Section 2 highlighted the gulf between funding available for NbS for infrastructure in cities (\$28 billion) versus grey solutions (over \$9.3 trillion).

While the investment opportunity for NbS and land-sparing interventions will be much larger in 2030 (\$583 billion), mobilizing this finance will require systematic challenges to be addressed - specifically those associated with investing in nature as an asset class.<sup>133</sup>

**The lack of clear revenue streams associated with NbS is one of the most critical challenges to address.** Many of the benefits of using NbS for infrastructure largely accrue in the form of positive externalities or unpriced public goods that are not accounted for in existing economic practices and cost-benefit analyses, creating an unequal playing field when compared to grey infrastructure. Risk assessment techniques for infrastructure decisions also largely fail to incorporate physical risks associated with climate change and biodiversity loss.<sup>134</sup> As a result, there is a perceived lack of monetary value associated with nature and ecosystem services, which results in a low allocation of investment into natural assets and nature-based solutions.

**Moreover, investors often lack key information on business opportunities, ROI and risk profiles related to NbS.** Investors need to contend with a complicated landscape for ESG reporting – it is estimated that there are over 600 ESG reporting provisions globally.<sup>135</sup> The lack of harmonized standards creates gaps in measuring and comparing business performance for investors looking to invest in NbS.<sup>136</sup> According to the Global Sustainable Investment Alliance (GSIA), the proportion of sustainable investing relative to total managed assets was just over 26% globally in 2017.<sup>137</sup>

**These distortions in economic incentives and the lack of concurrent regulatory frameworks affect the attractiveness of NbS for private sector and institutional investors.** For instance, 85% of all financing for NbS currently comes from local governments, with private capital accounting for 14%. Public official development aid - provided by donors and international finance institutions (IFI) such as the World Bank and the Asian Development Bank - account for 2% of overall financing.<sup>138</sup>

**Smaller “ticket” sizes and the use of novel revenue models with returns led by the actions of micro, small and medium enterprises may also drive the perception that there are higher risks when investing in NbS.** For instance, some opportunities require beneficiaries to pay stewards (i.e. landowners) for ecosystem services (PES) in return for a guaranteed flow of services over and above what would be provided without payment.<sup>139</sup> For example, in India, there is a 20-year agreement where Palampur Municipal Council will transfer INR 10,000 (Indian rupees) annually to the Village Forest Development Society (VFDS) as PES for the protection and management of Bheerni forest. In return, the VFDS has agreed to protect and conserve the catchment area of the Bohal spring to ensure the sustainable supply of water to the city.<sup>140</sup>

**Clearly, today’s financial markets insufficiently value biodiversity outcomes and deter investment in NbS for infrastructure.** Systemic shifts and incentives are required to encourage urban investors to account for biodiversity in their decision-making and create markets that crowd in investment from a diverse set of stakeholders. Evidence from developments in the broader climate finance landscape indicates that this could be achievable. In recent years, by making it easier to understand, estimate, monitor and mitigate carbon emissions at scale, investors have been able to recognize the importance of climate-smart growth. Innovative business models and funding mechanisms have increased the attractiveness of returns from climate finance. In 2019, the global climate finance market was worth \$1.2 trillion, spread primarily across private equity funds (60%) and green bonds (23%); this is expected to grow to \$4.5 trillion by 2030.<sup>141</sup> Private capital finances 56% of global climate finance today.<sup>142</sup>

**Three actions can positively affect the wholesale change needed for financial markets to value biodiversity outcomes:**

- 1 Mainstreaming biodiversity data in decision-making.
- 2 Creating, supporting and scaling inclusive markets.
- 3 Utilizing novel investment models.

## Mainstreaming biodiversity data in decision-making

“ In 2020, 26 financial institutions with over €3 trillion in assets under management committed to collaborating, engaging and assessing their biodiversity impact. The number of signatories now stands at 84.

It is essential that the lack of clear revenue streams and information asymmetries are addressed, to counter the perceptions of higher risks related to investment in NbS. Key to this process is quantifying biodiversity outcomes and supporting comparisons across projects.

The good news is that the financial industry - in partnership with the private sector, governments and academia - are already developing tools that connect the natural and financial worlds (from a risk perspective) to help bring future risks into consideration during the investment decision-making process.<sup>143</sup> For instance, the Taskforce on Nature-related Financial Disclosures (TNFD), announced in July 2020, consists of various groups that make up the TNFD Alliance. The TNFD aims to support the required shift in global financial flows away from nature-negative outcomes via a science-based approach, by developing and delivering a risk management and disclosure framework that organizations can use to report and act on evolving nature-related risks. Along with this effort, in September 2020, 26 financial institutions (banks, asset managers, insurers and impact funds) with over €3 trillion in assets under management committed to collaborating, engaging and assessing their biodiversity impact, setting targets and reporting on biodiversity matters by 2024, at the latest.<sup>144</sup> The number of signatories has since grown and currently stands at 84. In March 2021, the University of Cambridge's Institute for Sustainability Leadership published a handbook for understanding and identifying nature-related financial risks in four categories (credit, market, liquidity and business risks) utilizing existing typologies from the Network for Greening the Financial System and the Dutch Central Bank.<sup>145</sup> The Coalition for Climate Resilient Investment (CCRI) is another private sector-led initiative developing innovative and practical

solutions to help investors incorporate nature- and climate-related risks in infrastructure investment decisions. CCRI has developed models such as the National Investment Prioritization Tool, to support governments in prioritizing systemic resilience in urban planning, and the Physical Climate Risk Assessment Methodology, for asset design and structuring climate risks in the valuation process.<sup>146</sup> These tools help CCRI's 120+ members, including governments, private financiers, ratings agencies, infrastructure solutions providers and international organizations, to direct their \$20 trillion in assets under management to climate-resilient infrastructure investments.<sup>147</sup>

**Investors that anticipate regulatory or market pressure to reduce carbon emissions and biodiversity loss, and incorporate encompassing models on their asset's exposure to natural hazards, will be better positioned to increase asset value and avoid stranding.**<sup>148</sup> This is of most importance for banks, insurers and pension funds linked with the real estate sector and the urban infrastructure sector, which are facing the challenge of maintaining asset value while managing the low predictability, large scale, rapid onset and irreversible effects of nature-loss and climate change. Of Dutch financial institutions' €1,400 billion investment portfolio, a total of €510 billion - roughly 36% - is highly or very highly dependent on one ecosystem service: ground and surface water.<sup>149</sup> According to a recent report, approximately one-quarter of every euro invested in real estate activities is dependent on this ecosystem service.<sup>150</sup> For these investments, the loss of ecosystem services will lead to greater exposure of shares, corporate bonds and loans and, therefore, to a substantial disruption of business processes and financial losses critical to substantiate the full value of nature.



**Harmonization of biodiversity reporting standards is similarly of critical importance to ensure that project investment decisions are comparable across common biodiversity outcome indicators.** One promising initiative in this regard is the International Financial Reporting Standards Foundation's new International Sustainability Standards Board; this was announced at COP26, with the aim of developing globally-consistent climate

and broader sustainability disclosure standards for financial markets.<sup>151</sup> Efforts by securities regulators' to address the lack of common sustainability standards are also a positive step towards harmonization. These include the Securities and Exchange Board of India's mandatory ESG reporting standards for the top 1,000 listed companies by 2023 and the development of an associated index to help investors compare investment profiles.<sup>152</sup>

## 2

### Creating, supporting and scaling an inclusive market

**The public sector will play a critical role in creating, supporting and scaling an inclusive market for investing in nature in cities.** This should be underpinned by a project pipeline that adequately distributes the benefits of nature-based infrastructure projects to investors and society alike.<sup>153</sup> It is important for the public sector to provide early risk capital given the scale of investment required as well as the nascency of the market for NbS for infrastructure and land-sparing interventions in cities.

**A mix of policy actions that combine technical support and economic and regulatory incentives can increase the number of commercially-viable projects.** For instance, public sources of capital from governments, donors and IFIs in the form of grants and concessional finance can spur the development of an investment pipeline and de-risk private sector participation.<sup>154</sup> Such capital can also be used to aggregate nature-based projects, allowing private and institutional investors to

participate at scale by improving project viability and reducing transaction costs. Aggregating outcomes at the project level across sectors, catchments or regions (i.e. "stacking") is one such model.

**Establishing clear definitions of what qualifies as a land-sparing intervention or NbS for infrastructure in specific cities would support better data collection on investment, impact, costs and needs; in turn, this would provide investors with evidence for a business case.** Fiscal policy levers can also be used to incentivize to take nature into consideration and avoid negative impacts. This may be through appropriately structured taxes or subsidy schemes that reform nature-negative subsidies and level the playing field. Finally, gradually involving the private sector by providing access to an ecosystem of interventions and accelerators that support early-stage businesses will increase the likelihood of long-term commercial viability through skill transfers and capacity building.

#### CASE STUDY 11

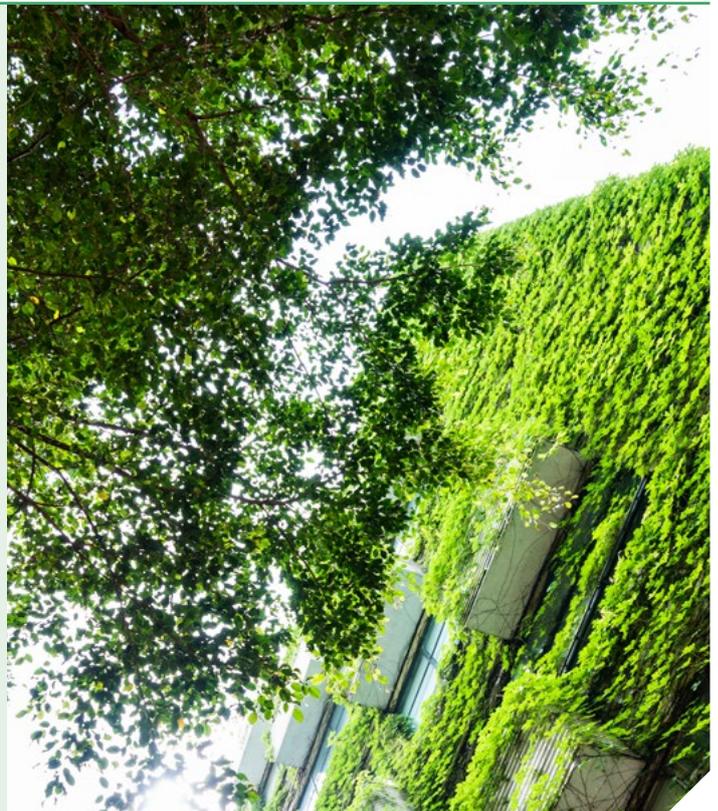
#### City Forest Credits - An investment model to support increased urban tree cover<sup>155</sup>



Carbon credits are part of the effort to keep cities green and equitable. The non-profit carbon registry, City Forest Credits, has developed Carbon+ Credits for city forests by working with scientists, urban forest professionals and carbon industry experts to develop credit issuing standards. The standards include rules for eligibility, ownership, quantification, monitoring, verification and issuance of Carbon+ Credits that quantify not just CO<sub>2</sub>, but stormwater reductions, air quality impacts and energy savings.

Increasing tree cover in cities not only has a quantified positive environmental impact, but also brings social and economic benefits through youth engagement, new workforces and nature enhancement in under-resourced neighbourhoods. In addition, it provides a way for the private sector to contribute to green, healthy and more equitable cities.

Carbon and sustainability leaders such as Microsoft, PayPal, Bank of America, Jonathan Rose Companies and Cloverly have purchased or funded urban forest credits and projects. Carbon programmes are now underway in 16 cities across the United States and the country's city forests provide \$18.3 billion in benefits per year. This value is expected to grow if urban areas continue to embrace City Forest Credits' funding opportunities and expand their tree cover.



## Utilizing novel investment models

“ In China, 7 of the 10 best performing exchange-traded funds (ETF) in the first half of 2021 were green energy-themed.

Novel investment models will play a critical role in mobilizing capital and driving scale, by shifting the risk-return dynamics of NbS for infrastructure and land-sparing interventions. Well-designed mechanisms and products have potential to address multiple market barriers, including perceived ROI risks and the availability of viable projects for investment. A few models hold significant potential:

- **Catalytic capital:** Governments and IFIs can serve as “cornerstone” investors and provide catalytic capital to funds and projects.<sup>156</sup> This includes support for result-based financing schemes such as green or conservation bonds, the expansion of the resilience bonds market, credit facilities for habitat restoration and water quality improvement, blended finance mechanisms, and credit guarantees. Blended finance, which combines development finance and philanthropic funding to de-risk and mobilize private capital flows, could potentially support smaller-scale investments and generate greater overall finance than traditional development projects.<sup>157</sup>
- **Exchange-listed funds:** The use of exchanges drives increased access to a wider base of investors and aims to address liquidity challenges typically faced by bonds.<sup>158</sup> The availability of these products opens access to retail investors previously excluded from such initiatives and crowds in more investors by decreasing the average investment per investor. Such funds have shown increasing scale and fruitful performance; in China, 7 of the 10 best performing exchange-traded funds (ETF) in the first half of 2021 were green energy-themed.<sup>159</sup>
- **Carbon exchanges:** These have also emerged as a market mechanism to scale the carbon market, allowing organizations to access carbon credits for emissions that are challenging to address, particularly those in hard-to-abate sectors. For instance, the Climate Impact X platform launched by DBS Bank, the Singapore Exchange, Standard Chartered and Temasek, aim to provide a global marketplace for high-quality, transparent carbon credits to large-scale buyers, including multinational corporations and institutional investors.<sup>160</sup> Carbon exchanges could be an effective way to scale existing efforts to renature urban areas (Case study 11).
- **Debt-for-nature swaps:** These are particularly relevant for governments in low- and middle-income countries with resource limitations to mobilize capital for nature. Debt-for-nature swaps could have wide-ranging applications and fund a nature-based urban transformation in cities. These are arrangements whereby national debt is forgiven or repaid at a significant discount in exchange for the conservation of critical habitats that provide key ecosystem services. One of the most recent examples is Belize’s debt-for-nature swap, used to restructure its sole sovereign bond in September 2021. The government bought back the country’s debt at just 55 cents per dollar, in exchange for increasing efforts to protect its marine environment.<sup>161</sup> The deal has received the backing of major creditors and over 85% of the bond’s value had been signed when the offer expired in October 2021.
- **Insurance for nature:** Finally, insurance has a critical role to play in innovations that mitigate risks associated with climate change and biodiversity loss in cities. Case study 12 provides an example of one such innovation.

### CASE STUDY 12

#### Underwriting Nature - Swiss Re’s innovative insurance for coral reefs in Mexico’s Yucatan Peninsula<sup>162</sup>



Mexico’s Yucatan Peninsula is home to the Mesoamerican Barrier Reef System that stretches 1,000 km – the longest in the Western hemisphere and second only to the Great Barrier Reef. It is home to some of the world’s most unique coral reefs, mangrove forests, fish species and marine mammals, and also protects Riviera Maya - Mexico’s primary tourism hub, which supports economic growth in the regions’ towns and cities. However, this ecosystem is under severe threat from disease, bleaching, algae overgrowth and, most importantly, hurricanes, which have become ever-more present as a result of climate change. A category 4 or 5 hurricane can destroy up to 60% of live coral cover and significantly reduce the resilience of built areas along the reef corridor.

In 2018, Swiss Re collaborated with The Nature Conservancy (TNC) and regional governments in Mexico to help protect against reef damage in the Mesoamerican Barrier Reef System by creating a new “parametric” insurance solution. The insurance product provides rapid payouts to fund essential reef restoration measures following strong hurricanes. Premium payments come from the Coastal Zone Management Trust, set up by the state government of Quintana Roo, with support from TNC. The Trust collects funds from tourism taxes and other government sources that benefit from the reef’s protection. By combining private capital with public resources to fund insurance, regional governments can plan more consciously to protect the reef system.



# Conclusion: A call for multistakeholder action

This report translates key insights into a collaborative action plan so that cities can live in harmony with nature.

The BiodiverCities by 2030 vision sets an ambitious paradigm for urban development, one that entails systemic shifts in how the built environment integrates nature to address today's urban development challenges – providing for the needs of an ever-growing urban population, while safeguarding and restoring biodiversity.

The evidence presented in this report indicates strong complementarities in addressing both. NbS for urban infrastructure can provide 28% greater value than grey infrastructure alternatives in terms of positive environmental externalities and more resilient jobs, while costing 50% less, using today's measures of economic cost. Land-sparing interventions in cities create new business models that can unlock further economic and ecological value. NbS for infrastructure and land-sparing interventions in cities also enable a range of investment opportunities with wide applicability across regions and sectors; both are critical to achieving the BiodiverCities by 2030 vision.

To capture the opportunities presented and realize this vision, however, major barriers must be faced. Legacy urban governance systems are unfit to

manage the complexity of urban challenges derived from cities' growing population and the changing climate while reversing the built environment's negative impact on nature. Cities' pre-existing natural ecosystems have either collapsed or are on the brink of doing so, and investment in nature remains low - both as a priority and in volume - despite an abundance of capital.

The action plan set out in this report takes these insights and translates them into a feasible roadmap for nature-based urban transformation. The level of ambition in this action plan matches that of the BiodiverCities by 2030 vision and seeks to systematically incorporate the value of nature into economics, politics and regulation, and thus reorientate urban planning and financial markets so that they reflect the true cost of nature. This approach to urban development requires deep and complex coordination between all city stakeholders, including governments (at all levels), the private sector, investors, civil society and academia. Each group has a critical role to play in delivering these outcomes – Figure 12 summarizes their required involvement in greater detail.

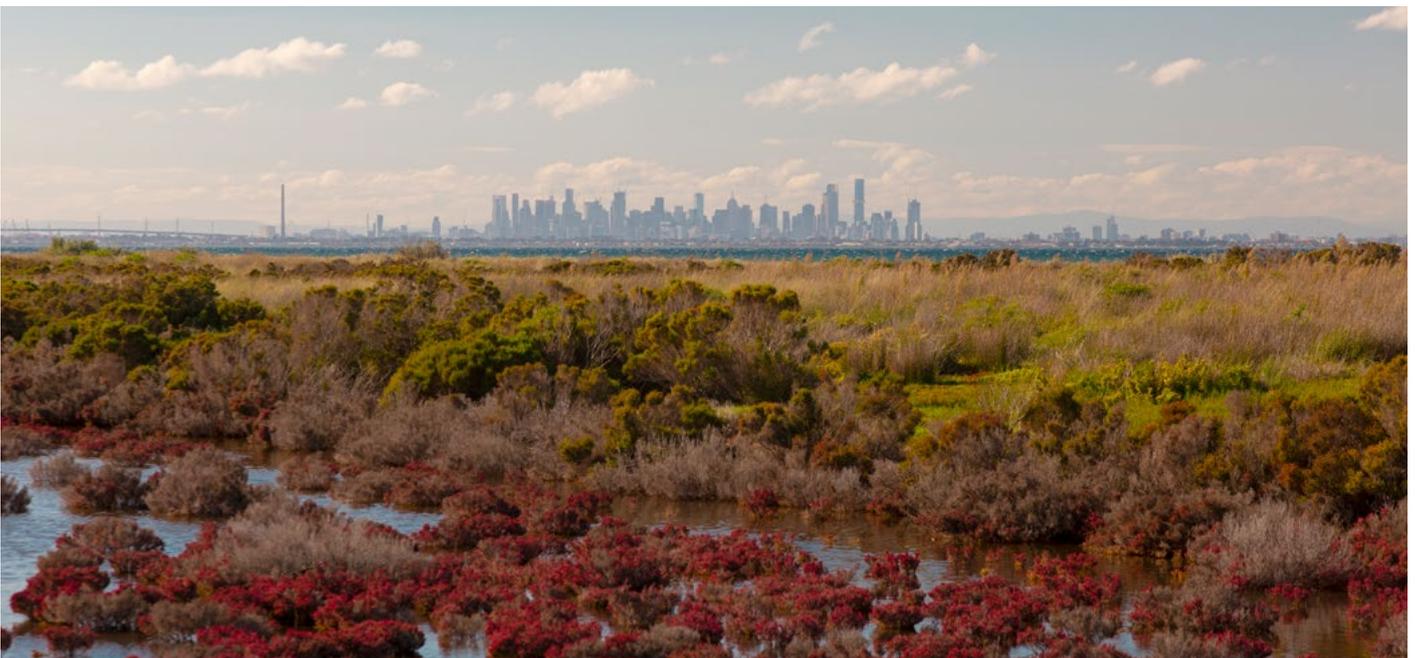


FIGURE 12 | The action plan involves stakeholders at varying stages

Action front	Action plan	Stakeholders						
		Government (international and national)	City administration	Private sector (including developers)	Private sector investors	International finance institutions	Civil society and advocacy organizations	Academic institutions and research
<b>1</b> Systems approach to urban governance	1. Steering direction from the top	Principal	Principal					
	2. Coordinating across stakeholders	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling
	3. Fostering policy innovation	Enabling	Enabling	Enabling	Enabling	Principal	Enabling	Principal
<b>2</b> Spatially (re)integrating the natural layer	4. Conserving existing natural habitats	Enabling	Enabling	Principal			Principal	Enabling
	5. Re-naturing degraded or suboptimized land	Enabling	Enabling	Enabling			Enabling	Enabling
	6. Growing smart with infrastructure	Enabling	Enabling	Enabling			Enabling	Enabling
<b>3</b> Mobilizing investment for nature-based urban transformation	7. Mainstreaming biodiversity data	Enabling	Enabling	Enabling	Principal	Principal	Enabling	Principal
	8. Creating, supporting and scaling an inclusive market	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling
	9. Utilizing novel investment models	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling

**Stakeholder role in transition**    ● Principal    ● Enabling

Source: Team analysis; literature review; expert interviews

# Appendix: Methodology

## A note on the approach taken to derive the quantitative estimates calculated for Section 2 of this report.

The World Economic Forum's *Future of Nature and Business* report identified 59 emerging business opportunities to engage in "nature-positive" business models, which seek to add capital back to nature, relative to a business as usual trajectory.<sup>163</sup> Of these, 10 business opportunities are relevant to nature-based solutions (NbS) for infrastructure and land-sparing interventions in cities. An additional category for "other NbS" was created to account for spending related to NbS, for infrastructure that was not included in the *Future of Nature and Business* (the total volume of NbS for infrastructure was sourced from *The State of Finance for Nature* report).<sup>164</sup>

Each of these business opportunities has an associated value, which constitutes an annual cost saving or revenue upside, each worth at least \$5 billion in 2030 (expressed in 2019 US dollars). The methodology for sizing each of these opportunities may be found in the *Future of Nature and Business* report's methodological note.<sup>165</sup> This is not intended to be an exhaustive assessment of business opportunities related to biodiversity, but rather serves to highlight some of the most important opportunities; as such, they are a subset of the total business opportunities available. These figures are also not an attempt to estimate the full value of the benefits provided by nature but instead focus on financial shifts in revenue or profit pools. From the size of the global opportunity, regional "scaling factors" were used to determine the share that each region could capture. Scaling factors are essentially the best available metrics related to each opportunity and indicate the potential share available to each region based on its comparative advantages in production and/or exports (in the case of production-related opportunities), and potential market size (in relation to demand-related

opportunities). For instance, opportunities related to NbS are allocated to various regions based on their share of potential carbon mitigation across forest, peatland and grassland ecosystems, and account for differences between regional ecosystems (i.e. tropical and boreal forests) and estimations of the cost efficiency of relevant mitigation activities. To reflect the COVID-19 pandemic, demand forecasts were revised to incorporate the impact of the crisis on GDP growth in 2020 and 2021, as forecast by the International Monetary Fund.<sup>166</sup>

The capital expenditure related to each of the business opportunities which are reported in this paper was calculated using one of three methods:

- 1. Direct inputs:** Where business opportunities that had been sized by past literature had estimated investment requirements, these were directly utilized after making necessary adjustments to estimate annual capital expenditure requirements in 2030, 2019 US dollar values.
- 2. Using net capital expenditure to sales ratios:** For new business opportunities, a range of global estimates of net capital expenditure to sales ratios by relevant sector and industry were considered, to calculate capital expenditure requirements for new business opportunities.
- 3. Case studies and expert inputs:** A range of case studies with capital expenditure estimates related to new business opportunities (extrapolated to global estimates) were also used. Expert inputs, particularly from the private sector, were sought and "sanity test" assumptions taken.

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# Endnotes

1. World Bank, *Urban Development Overview*, 2021, <https://www.worldbank.org/en/topic/urbandevelopment/overview#1>.
2. "World Population Prospects", *UN Department of Economic and Social Affairs*, 2019, <https://population.un.org/wpp/DataQuery/>.
3. Bucholz, Katharina, "How has the world's urban population changed from 1950 to today?", *World Economic Forum*, 4 November 2020, <https://www.weforum.org/agenda/2020/11/global-continent-urban-population-urbanisation-percent/>.
4. IPBES, *Global Assessment Report on Biodiversity and Ecosystem Services*, 2019, <https://ipbes.net/global-assessment>.
5. Ibid.
6. Chen, Zuoqi et al., "Mapping Global Urban Areas from 2000 to 2012 Using Time-Series Nighttime Light Data and MODIS Products", *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 12 (4), 2019, pp. 1143-53, <https://ieeexplore.ieee.org/document/8667084>.
7. Huang, Kangning et al., "Projecting global urban land expansion and heat island intensification through 2050", *Environmental Research Letters*, 14, 2019, pp. 114037, <https://iopscience.iop.org/article/10.1088/1748-9326/ab4b71>.
8. McDonald, Robert et al., "Nature in the Urban Century", *The Nature Conservancy*, 2018, <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/nature-in-the-urban-century/>.
9. Weller, Richard et al., "Hotspot Cities: Identifying Peri-Urban Conflict Zones in the World's Biodiversity Hotspots", *Journal of Landscape Architecture*, 14(1), 2019, pp. 36-47, <https://www.tandfonline.com/doi/abs/10.1080/18626033.2019.1623542>.
10. Angel, Shlomo, "Urban Forms and Future Cities: A Commentary", *Urban Planning*, 2(1), pp. 1-5, <https://doi.org/10.17645/up.v2i1.863>.
11. McDonald, Rob et al., "The Future of Global Urbanization and the Environment", *Solutions*, 5(6), 2015, pp. 60-69, [https://www.researchgate.net/publication/271707020\\_The\\_Future\\_of\\_Global\\_Urbanization\\_and\\_the\\_Environment](https://www.researchgate.net/publication/271707020_The_Future_of_Global_Urbanization_and_the_Environment).
12. IPBES, *Workshop Report: Biodiversity and Climate Change*, 2021, [https://ipbes.net/sites/default/files/2021-06/20210609\\_workshop\\_report\\_embargo\\_3pm\\_CEST\\_10\\_june\\_0.pdf](https://ipbes.net/sites/default/files/2021-06/20210609_workshop_report_embargo_3pm_CEST_10_june_0.pdf).
13. "3 billion animals killed or displaced in Black Summer bushfires, study estimates", *ABC News*, 28 July 2020, <https://www.abc.net.au/news/2020-07-28/3-billion-animals-killed-displaced-in-fires-wwf-study/12497976>.
14. UN Environment Programme, *Cities and Climate Change*, 2020, <https://www.unenvironment.org/explore-topics/resource-efficiency/what-we-do/cities/cities-and-climate-change>.
15. IPBES, *Global Assessment Report on Biodiversity and Ecosystem Services*, Diaz, Sandra et al. (Eds.), 2019, <https://ipbes.net/global-assessment>.
16. IPBES, *Workshop Report: Biodiversity and Climate Change*, 2021, [https://ipbes.net/sites/default/files/2021-06/20210609\\_workshop\\_report\\_embargo\\_3pm\\_CEST\\_10\\_june\\_0.pdf](https://ipbes.net/sites/default/files/2021-06/20210609_workshop_report_embargo_3pm_CEST_10_june_0.pdf).
17. IPCC, "AR6 Climate Change 2021: The Physical Science Basis – Working Group I Contribution to the Six Assessment Report of the IPCC", 2021, [https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC\\_AR6\\_WGI\\_Full\\_Report.pdf](https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf).
18. "COP26 keeps 1.5 C alive and finalises Paris agreement", *UN Climate Change Conference UK - COP26*, 2021, <https://ukcop26.org/cop26-keeps-1-5c-alive-and-finalises-paris-agreement/>.
19. Keesing, Felicia et al., "Impacts of biodiversity on the emergence and transmission of infectious diseases", *Nature* 468, 2010, pp. 647-652, <https://doi.org/10.1038/nature09575>.
20. World Economic Forum, *The Global Risks Report 2022*, 17th edition, 2022, [https://www3.weforum.org/docs/WEF\\_The\\_Global\\_Risks\\_Report\\_2022.pdf](https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2022.pdf).
21. IPBES, *Global Assessment Report on Biodiversity and Ecosystem Services*, Diaz, Sandra et al. (Eds.), 2019, <https://ipbes.net/global-assessment>.
22. UN Department of Economic and Social Affairs, *Exposure and vulnerability to natural disasters for world's cities*, 2019, <https://www.un.org/en/development/desa/population/publications/pdf/technical/TP2019-4.pdf>.
23. The Global Commission on the Economy and Climate, *The 2018 Report of the Global Commission on the Economy and Climate: Unlocking the inclusive growth story of the 21st century*, 2018, <https://newclimateeconomy.report/2018/>.
24. Sanderman, Jonathan et al., "A global map of mangrove forest soil carbon at 30m spatial resolution", *Environmental Research Letters*, Volume 13, Number 5, 2018, <https://iopscience.iop.org/article/10.1088/1748-9326/aabe1c/meta>.
25. World Resources Institute, *New Data Shows Millions of People, Trillions in Property at Risk from Flooding – But Infrastructure Investments Now Can Significantly Lower Flood Risk* [Press release], 23 April 2020, <https://www.wri.org/news/release-new-data-shows-millions-people-trillions-property-risk-flooding-infrastructure>.

26. Rentschler, Jun Erik and Melda Salhab, “1.47 billion people face flood risk worldwide: for over a third, it could be devastating”, *World Bank Blogs*, 2020, <https://blogs.worldbank.org/climatechange/147-billion-people-face-flood-risk-worldwide-over-third-it-could-be-devastating>.
27. Woetzel, Jonathan et al., *Climate risk and response: Physical hazards and socioeconomic impacts*, McKinsey, 2020, <https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-response-physical-hazards-and-socioeconomic-impacts>.
28. Miller, Megan and Manoochehr Shirzaei, “Land subsidence in Houston correlated with flooding from Hurricane Harvey”, *Remote Sensing of Environment*, vol. 225, 2019, pp. 368- 378, <http://dx.doi.org/10.1016/j.rse.2019.03.022>.
29. “Responding to Rising Seas: OECD Country Approaches to Tackling Coastal Risks”, *OECD Publishing*, 2019, <https://dx.doi.org/10.1787/9789264312487-en>.
30. Ashley, Colette et al., “Sinking cities: what economic and governance conditions lead to greater resilience?”, *Second International Conference on Water, Megacities and Global Change*, 2021, <https://en.unesco.org/sites/default/files/ashley.pdf>.
31. Gu, Danan et al., “Risk of Exposure and Vulnerability to Natural Disasters at the City Level: A Global Overview”, *United Nations Department of Economic and Social Affairs Population Division*, Technical Paper No. 2015/2, 2015, <https://population.un.org/wup/Publications/Files/WUP2014-TechnicalPaper-NaturalDisaster.pdf>.
32. World Economic Forum, *Circular Cities: A circular water economy for cleaner, greener, healthier, more prosperous cities*, 2021, [http://www3.weforum.org/docs/WEF\\_Imagine\\_IF\\_Water-Series\\_2021.pdf](http://www3.weforum.org/docs/WEF_Imagine_IF_Water-Series_2021.pdf).
33. Asia Society, *Asia’s Next Challenge: Securing the Region’s Water Future*, 2021, <https://asiasociety.org/asias-next-challenge-securing-regions-water-future-0>.
34. Hutton, Guy and Mili Varughese, *The costs of meeting the 2030 sustainable development goal targets on drinking water, sanitation, and hygiene*, The World Bank, 2016, <https://www.worldbank.org/en/topic/water/publication/the-costs-of-meeting-the-2030-sustainable-development-goal-targets-on-drinking-water-sanitation-and-hygiene>.
35. “Urban heat islands” occur when cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat, and block wind and shade. This effect increases energy costs (e.g. for air conditioning), air pollution levels, and heat-related illness and mortality. In Tokyo, climate change contributed to a temperature increase of one degree over the past 100 years, with the urban heat island effect accounting for another two degrees. See “Tokyo’s Heat Island Effect”, *Google Earth*, 2021, <https://earth.google.com/web/@31.49556194,135.54192701,-3182.99759588a,18634878.46366651d,35y,0h,0t,0r/data=CjASLhlgYTk3NzMwMDc0NjE3MTFIYWJjNDlyN2FkODE2NGU5NzciCnZveV9zcGxhc2g>.
36. Chandran, Nair, “The cost of cooling our cities”, *NOEMA*, 3 December 2018, <https://www.noemamag.com/the-cost-of-cooling-our-cities/>.
37. Floater, Graham et. al., *Global Review of Finance for Sustainable Urban Infrastructure*, The New Climate Economy Working Papers, LSE Cities and PwC, 2017, [https://secities.net/wp-content/uploads/2018/01/NCE2017\\_CUT\\_GlobalReview\\_final.pdf](https://secities.net/wp-content/uploads/2018/01/NCE2017_CUT_GlobalReview_final.pdf).
38. Carbon Disclosure Project, *Cities at risk: dealing with the pressures of climate change*, 2019, <https://www.cdp.net/en/research/global-reports/cities-at-risk>.
39. See UN CBD, 2021, “Introduction”, <https://www.cbd.int/intro/>; “Conferences”, <https://www.cbd.int/conferences/2021-2022>; and “The Nagoya Protocol brings fairness, equity, and sustainability to the new Global Agenda for Biodiversity”, <https://www.cbd.int/article/abs-we-all-need-campaign>.
40. World Economic Forum, *The Future of Nature and Business*, 2020, [http://www3.weforum.org/docs/WEF\\_The\\_Future\\_Of\\_Nature\\_And\\_Business\\_2020.pdf](http://www3.weforum.org/docs/WEF_The_Future_Of_Nature_And_Business_2020.pdf).
41. Chen, Zuoqi et al., “Mapping Global Urban Areas From 2000 to 2012 Using Time-Series Nighttime Light Data and MODIS Products,” *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 12 (4), 2019, pp. 1143–53, <https://doi.org/10.1109/JSTARS.2019.2900457>.
42. Angel, Shlomo et al., *The Dynamics of Global Urban Expansion*, Department of Transport and Urban Development and the World Bank, 2015, [https://www.researchgate.net/publication/260317174\\_The\\_Dynamics\\_of\\_Global\\_Urban\\_Expansion\\_Transport\\_and\\_Urban\\_Development\\_Department](https://www.researchgate.net/publication/260317174_The_Dynamics_of_Global_Urban_Expansion_Transport_and_Urban_Development_Department).
43. Johnson, Andrew et al., “What Works? The Influence Of Changing Wastewater Treatment Type, Including Tertiary Granular Activated Charcoal On Downstream Macroinvertebrate Biodiversity Over Time”, *Environmental Toxicology and Chemistry*, 2019, <https://doi.org/10.1002/etc.4460>, <https://www.ceh.ac.uk/news-and-media/news/increased-biodiversity-linked-improved-sewage-treatment>.
44. Benítez-López, Angélica et al., “The Impacts of Roads and Other Infrastructure on Mammal and Bird Populations: A Meta-Analysis”, *Biological Conservation*, 143 (6), 2010, pp. 1307–16, <https://www.sciencedirect.com/science/article/abs/pii/S0006320710000480?via%3Dihub>.
45. Ecosystem services are defined as the gains acquired by humans from their surrounding ecosystems, examples of which include climate regulation, disease control, food and fibre, flood and storm protection, ground water, pollination and water quality. See: “ENCORE – Ecosystem Services”, *Natural Capital Finance Alliance*, 2021, <https://encore.naturalcapital.finance/en/data-and-methodology/services>.
46. “How SAVi works”, *International Institute for Sustainable Development*, 2021, <https://www.iisd.org/savi/how-savi-works/>.

47. Bassi, Andrea et al., “How can investment in nature close the infrastructure gap?”, *Nature-Based Infrastructure Global Resource Center*, International Institute for Sustainable Development - IISD, 2021, <https://www.iisd.org/publications/investment-in-nature-close-infrastructure-gap>.
48. World Health Organization Europe, *Nature, Biodiversity and Health: an overview of interconnections*, 2021, <https://apps.who.int/iris/bitstream/handle/10665/341376/9789289055581-eng.pdf>.
49. Bratman, Gregory et al., “Nature and mental health: An ecosystem service perspective”, *Science Advances*, 5, 2019, <https://cpb-us-w2.wpmucdn.com/voices.uchicago.edu/dist/d/1690/files/2019/10/75Nature-and-Mental-Health-An-Ecosystem-Service-Perspective.pdf>.
50. Natural England, *Good practice in social prescribing for mental health: the role of nature-based interventions*, 2017, <http://publications.naturalengland.org.uk/file/5863897012109312>.
51. Shanahan, Danielle et. Al., “Nature–Based Interventions for Improving Health and Wellbeing: The Purpose, the People and the Outcomes”, *Sports*, 7(6), 2019, pp. 141, <https://www.mdpi.com/2075-4663/7/6/141>.
52. “Active transport” refers to physical activity undertaken as a means of transport and includes travel by foot, bicycle and other non-motorized vehicles. It is often used in combination with public transport.
53. C40 Cities Climate Leadership Group, *The case for a green and just recovery*, 2020, <https://c40.my.salesforce.com/sfc/p/#36000001Enhz/a/1Q000000gRCH/24OgSbRwj1hZ305yJbyPMZJQKhXXWNYE8k8sr2ADsi8>.
54. As discussed in Section 1, this report seeks to understand the direct impact of the built environment in cities’ immediate territories, with future research exploring broader transitions to reverse cities’ broader impact on nature.
55. “How SAVi works”, *International Institute for Sustainable Development*, 2021, <https://www.iisd.org/savi/how-savi-works/>.
56. Wuennenberg, Laurin et al., *Sustainable Asset Valuation (SAVi) of Stormwater Infrastructure Solutions in Johannesburg, South Africa - Assessing climate resilience and socio-ecological benefits*, International Institute for Sustainable Development, 2021, <https://nbi.iisd.org/report/stormwater-infrastructure-south-africa/>.
57. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
58. “How SAVi works”, *International Institute for Sustainable Development*, 2021, <https://www.iisd.org/savi/how-savi-works/>.
59. “Investment opportunity” in this section refers to the capital expenditure required for NbS for infrastructure and business models associated with land-sparing interventions. “Business opportunity” on the other hand, includes returns on this investment valued in the form of annual cost savings or revenue upside generated by the opportunities in question. Please refer to the Appendix for more details on the methodology used to size these opportunities.
60. Rice, Louis, “Nature-based solutions for urban development and tourism”, *International Journal of Tourism Cities*, 6(2), 2019, pp. 431–448, <https://doi.org/10.1108/ijtc-05-2019-0069>, [https://www.researchgate.net/publication/335670102\\_Nature-based\\_solutions\\_for\\_urban\\_development\\_and\\_tourism](https://www.researchgate.net/publication/335670102_Nature-based_solutions_for_urban_development_and_tourism).
61. “History”, *The High Line*, 2021, <https://www.thehighline.org/history/>.
62. Foreningen By&Natur, *Amager Nature Park*, Koben Havner Gron, 2021, <https://www.kobenhavnergron.dk/place/naturpark-amager/?lang=en>.
63. Wolch, Jennifer et al., “Urban green space, public health, and environmental justice: The challenge of making cities ‘just green enough’”, *Landscape and Urban Planning*, vol. 125, 2014, pp. 234-244, <https://doi.org/10.1016/j.landurbplan.2014.01.017>.
64. Bielenberg, Aaron et al., *Financing change: How to mobilize private sector financing for sustainable infrastructure*, McKinsey Center for Business and Environment, 2016, [https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Financing\\_change\\_How\\_to\\_mobilize\\_private-sector\\_financing\\_for\\_sustainable\\_infrastructure.pdf](https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Financing_change_How_to_mobilize_private-sector_financing_for_sustainable_infrastructure.pdf).
65. “Sustainable transport infrastructure” includes all transport infrastructure that minimizes disruption to its immediate natural surroundings, leverages nature-based, nature-derived, or nature-inspired elements for co-benefits (e.g. green zones to assist with drainage and cooling) and offsets unavoidable impacts by adding natural capital back to surrounding ecosystems.
66. Arlidge, William et. al., “A global mitigation hierarchy for nature conservation”, *BioScience*, vol. 68, no.5, 2018, pp. 336-347, <https://www.cbd.int/doc/strategic-plan/Post2020/postsbi/biodiversify2.pdf>.
67. Global proxies are calculated using inputs from various sources, including: Bielenberg, Aaron, et al., *Financing change: How to mobilize private sector financing for sustainable infrastructure*, McKinsey Center for Business and Environment, 2016, [https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Financing\\_change\\_How\\_to\\_mobilize\\_private-sector\\_financing\\_for\\_sustainable\\_infrastructure.pdf](https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/04/Financing_change_How_to_mobilize_private-sector_financing_for_sustainable_infrastructure.pdf).
68. World Wide Fund and HSBC, *Greening the Belt and Road Initiative: WWF’s Recommendations for the Finance Sector*, 2017, <https://www.sustainablefinance.hsbc.com/mobilising-finance/greening-the-belt-and-road-initiative>.
69. “Exploring the Green Canopy in cities around the world”, *MIT Senseable City Lab - Treepedia*, 2021, <http://senseable.mit.edu/treepedia>.
70. Based on estimates of cost savings in natural water supply projects. See: The Nature Conservancy, *Beyond the Source: The environmental, economic and community benefits of source water protection*, 2017, [https://s3.amazonaws.com/tnc-craft/library/Beyond\\_The\\_Source\\_Full\\_Report\\_FinalV4.pdf?mtime=20171025195759](https://s3.amazonaws.com/tnc-craft/library/Beyond_The_Source_Full_Report_FinalV4.pdf?mtime=20171025195759).

71. The Nature Conservancy, *Beyond the Source: The environmental, economic and community benefits of source water protection*, 2017, [https://s3.amazonaws.com/tnc-craft/library/Beyond\\_The\\_Source\\_Full\\_Report\\_FinalV4.pdf?mtime=20171025195759](https://s3.amazonaws.com/tnc-craft/library/Beyond_The_Source_Full_Report_FinalV4.pdf?mtime=20171025195759).
72. The Nature Conservancy, *The Greater Cape Town Water Fund: Assessing the Return on Investment for Ecological Infrastructure Restoration – Business Case*, 2018, [https://www.nature.org/content/dam/tnc/nature/en/documents/GCTWF-Business-Case\\_2018-11-14\\_Web.pdf](https://www.nature.org/content/dam/tnc/nature/en/documents/GCTWF-Business-Case_2018-11-14_Web.pdf).
73. Employment figures represent gross job creation and were calculated based on regional labour productivity rates in relevant sectors that enable these opportunities. See Appendix for further details on the methodology used to size employment impact.
74. “Labour force by sex and age – ILO modelled estimates, July 2019 (thousands) Annual”, *ILOSTAT Explorer*, 2020, [https://www.ilo.org/shinyapps/bulkexplorer57/?lang=en&segment=indicator&id=EAP\\_2EAP\\_SEX\\_AGE\\_NB\\_A](https://www.ilo.org/shinyapps/bulkexplorer57/?lang=en&segment=indicator&id=EAP_2EAP_SEX_AGE_NB_A).
75. Lieuw-Kie-Song, Maikel and Vanessa Pérez-Cirera (Eds), *Nature Hires: How nature-based solutions can power a green jobs recovery*, World Wide Fund and International Labour Organization, 2020, [https://wwfeu.awsassets.panda.org/downloads/nature\\_hires\\_report\\_wwf\\_ilo.pdf](https://wwfeu.awsassets.panda.org/downloads/nature_hires_report_wwf_ilo.pdf).
76. Ibid.
77. The Nature Conservancy, *Nature in the Urban Century*, 2018, <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/nature-in-the-urban-century/>.
78. Chen, Zuoqi et al., “Mapping Global Urban Areas from 2000 to 2012 Using Time-Series Nighttime Light Data and MODIS Products”, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 12 (4), 2019, pp. 1143–53, <https://ieeexplore.ieee.org/document/8667084>.
79. “Analysis of UN World Population Prospects”, *UNDESA*, 2018, <https://population.un.org/wup/>.
80. *Metropolis, Nature in and across cities: Metropolitan approaches for biodiversity conservation*, Metropolitan Comparative Studies, ICLEI and AMB, 2021, <https://www.metropolis.org/sites/default/files/resources/Nature-in-across-cities-metropolitan-biodiversity-Dickey-Oke.pdf>.
81. Avis, William R., “Urban governance”, *GSDRC, University of Birmingham*, 2016, <https://gsdrc.org/topic-guides/urban-governance/concepts-and-debates/what-is-urban-governance/>.
82. Russel, Duncan et. al., “Mainstreaming the environment through appraisal: Integrative governance or logics of disintegration?”, *Environment and Planning C: Politics and Space*, vol. 36, issue 8, 2018, <https://doi.org/10.1177/2399654418767656>.
83. Patterson, James et al., “Finding feasible action towards urban transformations”, *Urban Sustainability*, 1, 2021, pp. 28, <https://doi.org/10.1038/s42949-021-00029-7>.
84. Rastandeh, Amin and Meghann Jarchow, “Urbanization and biodiversity loss in the post-COVID-19 era: complex challenges and possible solutions”, *Cities and Health*, 2020, <https://www.tandfonline.com/doi/full/10.1080/23748834.2020.1788322>.
85. Trucost PLC, *Natural Capital at Risk: The Top 100 Externalities of Business*, TEEB for Business Coalition, 2013, [https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/natural\\_capital\\_at\\_risk\\_the\\_top\\_100\\_externalities\\_of\\_business\\_Trucost.pdf](https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/natural_capital_at_risk_the_top_100_externalities_of_business_Trucost.pdf).
86. “Economics, Trade and Incentive Measures: Perverse incentives and their removal or mitigation”, *UNCBD*, 2021, <https://www.cbd.int/incentives/perverse-info.shtml>.
87. Ji, Li and Wei Zhang, “Fiscal Incentives and Sustainable Urbanization: Evidence from China”, *Sustainability*, 12(1), 2020, pp. 103, <https://www.mdpi.com/2071-1050/12/1/103>.
88. Finance for Biodiversity Initiative, *Greenness of Stimulus Index*, 2021, [https://www.vivideconomics.com/wp-content/uploads/2021/07/Green-Stimulus-Index-6th-Edition\\_final-report.pdf](https://www.vivideconomics.com/wp-content/uploads/2021/07/Green-Stimulus-Index-6th-Edition_final-report.pdf).
89. Bulkeley, Harriet et al., *Realising the urban opportunity: Cities and post-2020 biodiversity governance*, PBL Netherlands Environmental Assessment Agency, 2021, <https://www.pbl.nl/sites/default/files/downloads/pbl-2021-realising-the-urban-opportunity-4247.pdf>.
90. Alexander, James et al., *Financing the sustainable urban future: Scoping a green cities development bank*, ODI, C40 Cities, Climate Works Foundation and Baker McKenzie, 2019, <https://cdn.odi.org/media/documents/12680.pdf>.
91. Wickenberg, Björn et al., “Advancing the implementation of nature-based solutions in cities: A review of frameworks”, *Environmental Science and Policy*, vol. 125, 2021, pp. 44-53, <https://doi.org/10.1016/j.envsci.2021.08.016>.
92. Scottish Government, *Edinburgh Declaration on post-2020 global biodiversity framework*, 31 August 2021, <https://www.gov.scot/publications/edinburgh-declaration-on-post-2020-biodiversity-framework/>.
93. Systems approaches by definition incorporate and build on other approaches to urban development, including advocacy planning, comprehensive master city planning and ad hoc planning. See: Khoo Teng Chye, “Adapting to disruptions with urban systems innovation”, *Urban Solutions*, issue 17, 2020, <https://www.clc.gov.sg/docs/default-source/urban-solutions/urban-solutions-17-adapting-to-a-disrupted-world.pdf>; and Cooper, W.W. et al., “Systems approaches to urban planning: Mixed, conditional, adaptive and other alternatives”, *Policy Sciences*, 2, 1970, pp. 397-405, <https://link.springer.com/article/10.1007/BF01406140>.
94. Chaffin, Brian et. al., “A decade of adaptive governance scholarship: synthesis and future directions”, *Ecology and Society*, 19, vol. 3, 2014, pp. 56, <https://www.ecologyandsociety.org/vol19/iss3/art56/>.

95. Chye, Khoo T., "Adapting to disruptions with urban systems innovation", *Urban Solutions*, issue 17, 2020, <https://www.clc.gov.sg/docs/default-source/urban-solutions/urban-solutions-17-adapting-to-a-disrupted-world.pdf>.
96. Patterson, James. "More than planning: Diversity and drivers of institutional adaptation under climate change in 96 major cities", *Global Environmental Change*, vol. 68, 2021, pp. 102279, <https://doi.org/10.1016/j.gloenvcha.2021.102279>.
97. Chye, Khoo T., "Adapting to disruptions with urban systems innovation", *Urban Solutions*, issue 17, 2020, <https://www.clc.gov.sg/docs/default-source/urban-solutions/urban-solutions-17-adapting-to-a-disrupted-world.pdf>.
98. Kiesnere, Aisma and Rupert Baumgartner, "Top Management Involvement and Role in Sustainable Development of Companies", *Responsible Consumption and Production*, 2020, [https://doi.org/10.1007/978-3-319-95726-5\\_11](https://doi.org/10.1007/978-3-319-95726-5_11).
99. Department for Environment, Food and Rural Affairs, *Biodiversity 2020: A strategy for England's wildlife and ecosystem services*, 2011, [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69446/pb13583-biodiversity-strategy-2020-111111.pdf).
100. Sinclair, Sam et al., *Developing a Corporate Biodiversity Strategy: A primer for the fashion industry*, University of Cambridge Institute for Sustainability Leadership, 2020, <https://www.cisl.cam.ac.uk/system/files/documents/developing-a-corporate-biodiversity-strategy.pdf>.
101. Steinberg, Paul, *Environmental Leadership in Developing Countries*, MIT Press, 2001, <https://mitpress.mit.edu/books/environmental-leadership-developing-countries>.
102. Cramer, Aron, et al., *Redefining Sustainable Business: Management for a Rapidly Changing World*, BSR, 2018, <https://www.bsr.org/en/our-insights/report-view/redefining-sustainable-business-management-for-a-rapidly-changing-world>.
103. Hughes, Jonny and Lena Chan, "How to measure the ecological performance of cities so people and nature can thrive", *World Economic Forum*, 6 November 2021, <https://www.weforum.org/agenda/2021/11/how-to-measure-ecological-performance-cities/>.
104. Lieuw-Kie-Song, Maikel and Vanessa Pérez-Cirera (Eds), *Nature Hires: How nature-based solutions can power a green jobs recovery*, World Wide Fund and International Labour Organization, 2020, [https://wwfue.awsassets.panda.org/downloads/nature\\_hires\\_report\\_wwf\\_ilo.pdf](https://wwfue.awsassets.panda.org/downloads/nature_hires_report_wwf_ilo.pdf).
105. IIED, *Urban stakeholder engagement and coordination: Guidance note for humanitarian practitioners*, 2017, <https://pubs.iied.org/sites/default/files/pdfs/migrate/10821IIED.pdf>.
106. IUCN, *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*, 2020, <https://doi.org/10.2305/IUCN.CH.2020.09.en>.
107. Alcaldía Villavicencio, Decree 1000/21-304, 2020, Colombia, <http://historico.villavicencio.gov.co/Transparencia/Normatividad/Decretos/Vigencia%20a%C3%B1o%202020/DECRETO%20No.%201000-21%20-%20304%20DEL%2024%20DE%20JULIO%20DE%202020.pdf>.
108. "Humedales de Villavicencio pasan a manos públicas, para ser conservados y sostenibles", *Cormacarena*, 9 July 2021, <https://www.cormacarena.gov.co/humedales-de-villavicencio-pasan-a-manos-publicas-para-ser-conservados-y-sostenibles/>.
109. Beck, Donizete and Jose Storopoli, "Cities through the lens of Stakeholder Theory: A literature review", *Cities*, 118, 2021, pp. 103377, <https://doi.org/10.1016/j.cities.2021.103377>.
110. Soma, K. et al., "Stakeholder contributions through transitions towards urban sustainability", *Sustainable Cities and Society*, 37, 2018, pp. 438-450, <https://doi.org/10.1016/j.scs.2017.10.003>.
111. Gerlak, Andrea et al., "Agency and governance in green infrastructure policy adoption and change", *Journal of Environmental Policy & Planning*, vol. 23, issue 5, 2021, <https://doi.org/10.1080/1523908X.2021.1910018>.
112. Matsler, Marisssa et al., "The multifaceted geographies of green infrastructure policy and planning: socio-environmental dreams, nightmares, and amnesia", *Journal of Environmental Policy & Planning*, vol. 23, issue 5, 2021, <https://doi.org/10.1080/1523908X.2021.1976565>.
113. Zuniga-Teran, Adriana, et al., "Challenges of mainstreaming green infrastructure in built environment professions", *Journal of Environmental Policy & Planning*, vol. 63, issue 4, 2021, <https://doi.org/10.1080/09640568.2019.1605890>.
114. Hoover, Fushcia-Ann et al., "Environmental justice implications of siting criteria in urban green infrastructure planning", *Journal of Environmental Policy & Planning*, vol. 23, issue 5, 2021, <https://doi.org/10.1080/1523908X.2021.1945916>.
115. See article and related sources from: "5 Big Ideas to Address the Climate Crisis and Inequality in Cities", *World Resources Institute*, 2020, <https://www.wri.org/insights/5-big-ideas-address-climate-crisis-and-inequality-cities>.
116. United Nations, *Natural Capital Accounting and Valuation of Ecosystem Services Project - NCAVES*, System of Environmental Economic Accounting, <https://seea.un.org/home/Natural-Capital-Accounting-Project>.
117. "Explore the biodiversity hotspots", *Critical Ecosystem Partnership Fund*, <https://www.cepf.net/our-work/biodiversity-hotspots>.
118. "The biodiverse city", *Stockholm Resilience Centre*, 8 June 2012, <https://www.stockholmresilience.org/research/research-news/2012-06-08-the-biodiverse-city.html>.
119. This framework leverages the ISO 37105:2019 standard on Sustainable Cities and Communities. See: <https://www.iso.org/standard/62064.html>.
120. "City Biodiversity Index (or Singapore Index)", *UNCBD*, 2021, <https://www.cbd.int/subnational/partners-and-initiatives/city-biodiversity-index>.

121. Developed by the IUCN Urban Alliance, which consists of IUCN members and commissions and representatives of 28 local governments. See: Hughes, Jonny and Lena Chan, "How to measure the ecological performance of cities so people and nature can thrive", *World Economic Forum*, 6 November 2021, <https://www.weforum.org/agenda/2021/11/how-to-measure-ecological-performance-cities/>.
122. Possingham, Hugh et. Al, "Optimal Conservation Outcomes Require Both Restoration and Protection", *PLOS Biology*, 2015, <https://doi.org/10.1371/journal.pbio.1002052>.
123. "Costa Rica Creates a New Category of Protected Area to Conserve Forests in Urban Areas: Reinforcing its commitment to being a "green" country", *The Costa Rica News*, 26 February 2021, <https://thecostaricanews.com/costa-rica-creates-a-new-category-of-protected-area-to-serve-forests-in-urban-areas/>
124. "Key London Figures", *Greenspace Information for Greater London CIC*, 2019, <https://www.gigl.org.uk/keyfigures/>.
125. Grinspan, Delfina et al. "Green Space: An Underestimated Tool to Create More Equal Cities", World Resources Institute, 29 September 2020, <https://www.wri.org/insights/green-space-underestimated-tool-create-more-equal-cities>
126. "How Cities Can Harness the Public Health Benefits of Urban Trees", *The Nature Conservancy*, 2017, [https://www.nature.org/content/dam/tnc/nature/en/documents/Public\\_Health\\_Benefits\\_Urban\\_Trees\\_FINAL.pdf](https://www.nature.org/content/dam/tnc/nature/en/documents/Public_Health_Benefits_Urban_Trees_FINAL.pdf); and Wolf, K. et al., "Multiple health benefits of urban tree canopy: The mounting evidence for a green prescription", *Health and Place*, 42, 2016, pp. 54-62, [https://www.researchgate.net/publication/308126856\\_Multiple\\_health\\_benefits\\_of\\_urban\\_tree\\_canopy\\_The\\_mounting\\_evidence\\_for\\_a\\_green\\_prescription](https://www.researchgate.net/publication/308126856_Multiple_health_benefits_of_urban_tree_canopy_The_mounting_evidence_for_a_green_prescription).
127. McDonald, Robert et al., "The tree cover and temperature disparity in US urbanized areas: Quantifying the association with income across 5,723 communities", *PLoS ONE*, 16(4), 2021, <https://doi.org/10.1371/journal.pone.0249715>.
128. Anguelovski, Isabelle et al., "Opinion: Why green "climate gentrification" threatens poor and vulnerable populations", *PNAS* 116 (52), 2019, pp. 26139-26143, <https://doi.org/10.1073/pnas.1920490117>.
129. "How do you help a city recover from a devastating landslide?", *Arup*, <https://www.arup.com/projects/freetown-landslide>.
130. ACP-EU, "Sierra Leone: Post-Mudslides and Floods Needs Assessment and Recovery Framework", *Natural Disaster Risk Reduction Program*, 2019, <https://www.gfdr.org/en/sierra-leone-post-mudslides-and-floods-needs-assessment-and-recovery-framework>.
131. Toya, Akiko et al., "#FreetownTheTreeTown campaign: Using digital tools to encourage tree cultivation in cities", *Global Environment Facility*, 5 August 2021, <https://www.thegef.org/blog/freetownthetreetown-campaign-using-digital-tools-encourage-tree-cultivation-cities>.
132. Davies, Nick and Michael Hardman, "Green roofs can make cities healthier and happier. Why aren't they everywhere?", *Fast Company*, 10 July 2019, <https://www.fastcompany.com/90413645/green-roofs-can-make-cities-healthier-and-happier-why-arent-they-everywhere>.
133. A number of sources have been referenced to assess investment barriers, including: <https://www.unep.org/resources/state-finance-nature>; and "New Nature Economy: Asia's Next Wave", *Temasek/World Economic Forum/AlphaBeta*, 2021, <https://alphabeta.com/our-research/new-nature-economy-asias-next-wave/>.
134. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
135. Ernst & Young Global Limited, *The Future of Sustainability Reporting Standards: The policy evolution and the actions companies can take today*, 2021, [https://assets.ey.com/content/dam/ey-sites/ey-com/en\\_gl/topics/sustainability/ey-the-future-of-sustainability-reporting-standards-june-2021.pdf](https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/sustainability/ey-the-future-of-sustainability-reporting-standards-june-2021.pdf).
136. Bernow, Sara et al., "More than Values: The Value-Based Sustainability Reporting that Investors Want", *McKinsey Sustainability*, 7 August 2019, <https://www.mckinsey.com/business-functions/sustainability/our-insights/more-than-values-the-value-based-sustainability-reporting-that-investors-want>.
137. "Green Finance, Explained", *Development Asia*, 10 April 2018, <https://development.asia/explainer/green-finance-explained>.
138. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
139. Department for Environment and Rural Affairs, *Payments for Ecosystem Services: A best practice guide*, 2019, <https://www.cbd.int/financial/pes/unitedkingdom-bestpractice.pdf>.
140. Dash, Ashish, "Payment for Ecosystem Services: Palampur in Himachal has a model in place", *Down to Earth*, 30 July 2019, <https://www.downtoearth.org.in/news/environment/payment-for-ecosystem-services-palampur-in-himachal-has-a-model-in-place-65908>.
141. The Paulson Institute, The Nature Conservancy and Cornell Atkinson Center for Sustainability, *Financing Nature: Closing the global biodiversity financing gap*, 2020, [https://www.paulsoninstitute.org/wp-content/uploads/2020/10/FINANCING-NATURE\\_Full-Report\\_Final-with-endorsements\\_101420.pdf](https://www.paulsoninstitute.org/wp-content/uploads/2020/10/FINANCING-NATURE_Full-Report_Final-with-endorsements_101420.pdf).
142. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
143. UNEP Finance Initiative, *Changing Course – Real Estate: TCFD pilot project report and investor guide to scenario-based climate risk assessment in Real Estate Portfolios*, 2019, <https://wedocs.unep.org/bitstream/handle/20.500.11822/33633/CCRE.pdf>
144. "Financial institutions launched finance for biodiversity pledge during UN event", *Finance for Biodiversity Pledge*, 25 September 2020, <https://www.financeforbiodiversity.org/launch-the-pledge/>.

145. Rudgley, Grant et al. "Handbook for Nature-related Financial Risks: Key concepts and a framework for identification", University of Cambridge, 2021, <https://www.cisl.cam.ac.uk/resources/sustainable-finance-publications/handbook-nature-related-financial-risks>.
146. Coalition for Climate Resilience Infrastructure, <https://resilientinvestment.org/who-we-are/>.
147. Ibid.
148. Woodward, Alistair, "Climate change: Disruption, risk and opportunity", *Global Transitions*, Volume 1, 2019, pp 44-49, <https://doi.org/10.1016/j.glt.2019.02.001>.
149. Van Toor, Joris et al., "Indebted to nature Exploring biodiversity risks for the Dutch financial sector", De Nederlandsche Bank (DNB) and PBL Netherlands Environmental Assessment Agency, 2020, [https://www.pbl.nl/sites/default/files/downloads/4215-indebted\\_to\\_nature\\_-\\_exploring\\_biodiversity\\_risks\\_for\\_the\\_dutch\\_financial\\_sector\\_0.pdf](https://www.pbl.nl/sites/default/files/downloads/4215-indebted_to_nature_-_exploring_biodiversity_risks_for_the_dutch_financial_sector_0.pdf).
150. Ibid.
151. "Today's Top of the COP: Finance goes green and resilient", *UNFCCC*, 3 November 2021, <https://racetozero.unfccc.int/finance-goes-green-and-resilient/>.
152. Cruz, Bayani, "Asian securities regulators tackle sustainability standards", *The Asset*, 16 October 2020, <https://theasset.com/article-esg/41973/asian-securities-regulators-tackle-sustainability-standards>.
153. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
154. Ibid.
155. McPherson, Mark and Jordan Wildish, "Carbon Credits to Fund Urban Forests: City Forest Credits", *Trillion Trees Initiative*, 2021, <https://us.1t.org/stories/carbon-credits-to-fund-urban-forests/>.
156. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
157. World Economic Forum and OECD, *Blended Finance Vol. 1: A Primer for Development Finance and Philanthropic Funders*, 2015, [https://www3.weforum.org/docs/WEF\\_Blended\\_Finance\\_A\\_Primer\\_Development\\_Finance\\_Philanthropic\\_Funders.pdf](https://www3.weforum.org/docs/WEF_Blended_Finance_A_Primer_Development_Finance_Philanthropic_Funders.pdf).
158. Climate Bonds Initiative, *The Role of Exchanges in Accelerating the Growth of the Green Bond Market*, 2017, <https://www.climatebonds.net/files/files/RoleStock%20Exchanges.pdf>.
159. Leung, Chloe, "China green energy ETFs deliver best performance in first half", *Financial Times*, 2 August 2021, <https://www.ft.com/content/80ffb1e9-238c-4f23-a6e4-85c3efcf8a81>.
160. SGX, "Introducing Climate Impact X (CIX)", *Singapore Exchange*, 2021, <https://www.sgx.com/climate-impact-x-cix>.
161. *Oxford Business Group*, 4 November 2021, <https://oxfordbusinessgroup.com/news/will-belize-debt-nature-swap-trigger-blue-finance-revolution-emerging-markets>.
162. "Designing a new type of insurance to protect the coral reefs, economies and the planet", *Swiss Re*, 27 September 2021, <https://www.swissre.com/our-business/public-sector-solutions/thought-leadership/new-type-of-insurance-to-protect-coral-reefs-economies.html>; "Protecting coral reefs against hurricane damage", *Swiss Re*, 2018, <https://reports.swissre.com/corporate-responsibility-report/2018/cr-report/solutions/strengthening-risk-resilience-2018-highlights/protecting-coral-reefs-against-hurricane-damage.html>.
163. World Economic Forum, *The Future of Nature and Business*, 2020, [http://www3.weforum.org/docs/WEF\\_The\\_Future\\_Of\\_Nature\\_And\\_Business\\_2020.pdf](http://www3.weforum.org/docs/WEF_The_Future_Of_Nature_And_Business_2020.pdf).
164. United Nations Environment Programme, *State of Finance for Nature*, 2021, <https://www.unep.org/resources/state-finance-nature>.
165. For more information, please refer to the Methodological Note for the *Future of Nature and Business* for further details: <https://www.alphabeta.com/our-research/methodology-note-NNER-II/>.
166. This adjustment is made to the growth rates of consumer demand-related opportunities (e.g. organic food demand, eco-tourism) for the next two years, and then it is assumed the pre-COVID estimates of growth return. Fourteen of the opportunities sized, largely in the food, land and ocean use system, are impacted by these adjustments. For further details, see IMF, April 2020, *World Economic Outlook, April 2020: The Great Lockdown*, <https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020>.



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