Report

Scoping opportunities, barriers and enablers of nature-based solutions in Russia

The REACT programme's UK–Russia exchange on climate change transition

Paul Sayers, Olena Borodyna, Beatrice Tanjangco and Alexandra Didcock

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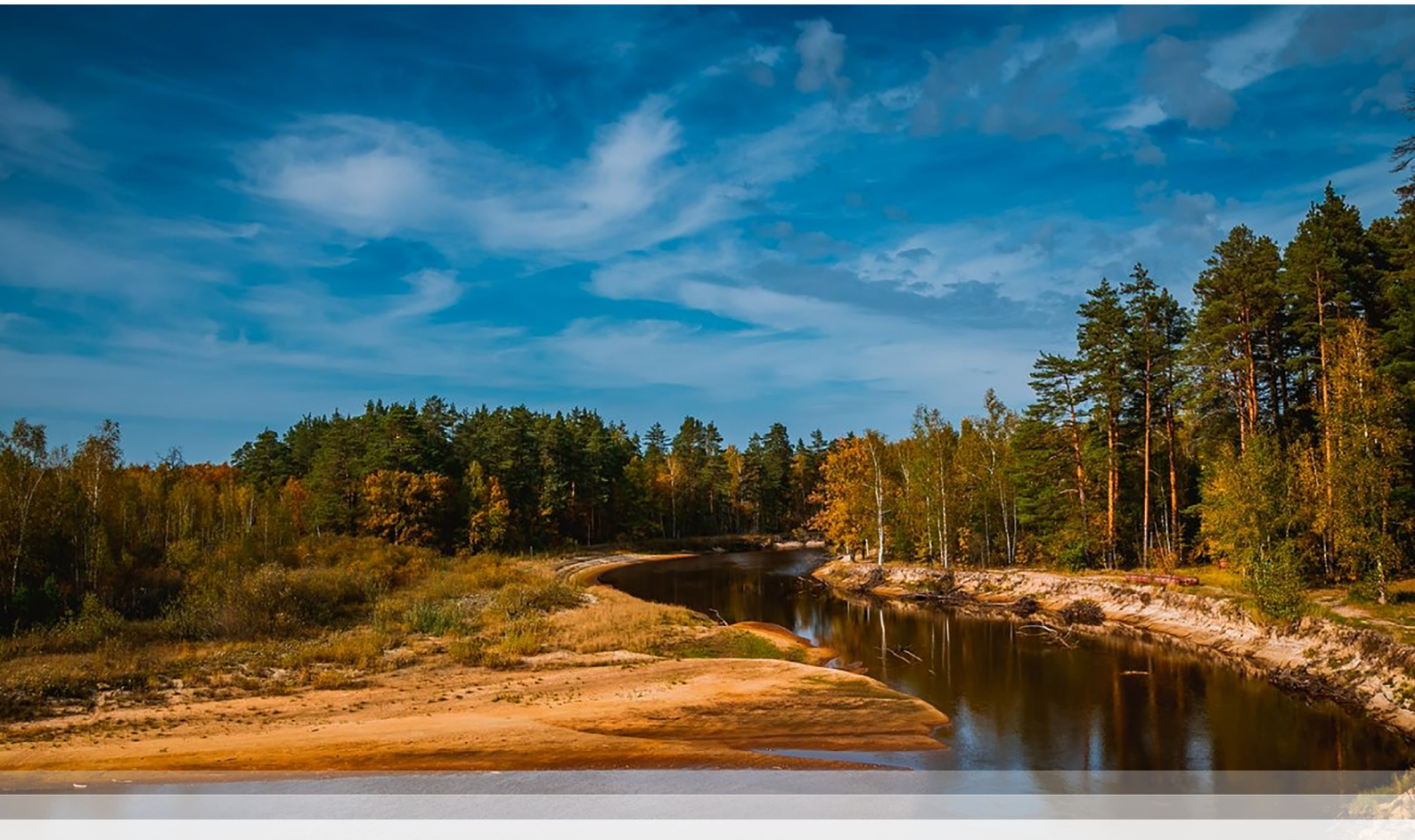

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About the authors

ORCID numbers are given where available. Please click on the ID icon next to an author's name in order to access their ORCID listing.

Paul Sayers

Senior Research Associate within the ODI Global Risks and Resilience programme and a partner at the applied research consultancy Sayers and Partners LLP. Paul has over 25 years of international experience in policy, planning and practice of adaptation and specialises in developing strategic approaches to climate adaptation, including using blending nature-based and conventional responses.

Olena Borodyna

Research Officer within the ODI Global Risks and Resilience programme. Her research focuses on political and environmental, social and corporate governance risks, and China's role in digital infrastructure, Arctic development and humanitarian action.

Beatrice Tanjangco

Research Fellow within the ODI Global Risks and Resilience programme. She is an economist by training, having worked in the corporate sector, with think tanks and with international financial institutions. Her interests span macroeconomics, international trade, climate resilience, competition, and financial markets and risk.

Alexandra Didcock

Graduate researcher at Sayers and Partners specialising in nature-based solutions for climate adaptation and mitigation.

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Acronyms

ABS	asset-backed securities
AR4	the greenhouse gas emissions limited by the Kyoto Protocol
BRICS	Brazil-Russia-India-China-South Africa
CC	climate change
CCRA	climate change risk assessment
CO_2	carbon dioxide
COP26	2021 United Nations Climate Change Conference
EBRD	European Bank for Reconstruction and Development
EDB	Eurasian Development Bank
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ESG	environmental, social, and governance
GCF	Green Climate Fund
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GHG	greenhouse gas
GIO	Global Infrastructure Outlook
IBRD	International Bank for Reconstruction and Development
ICMA	International Capital Markets Association
IFC	International Finance Corporation
IFI	International Finance Institutions
IUCN	International Union for Conservation of Nature
LMA	Loan Market Association
LVC	land value capture
NAP	national adaptation plan
NBS	nature-based solution
NDB	New Development Bank
NEFCO	Nordic Environment Finance Corporation
OECD	Organisation for Economic Co-operation and Development
PA	protected areas

PECC	Russian Programme for Environment and Climate Co-operation
PPP	private–public partnerships
RCP	Representative Concentration Pathway
SEA	Strategic Environment Assessments
SEEA	System of Environmental-Economic Accounting
RUSEFF	Russian Sustainable Energy Financing Facility
SGIS	Skyrise Greenery Incentive Scheme
SUDS	sustainable urban drainage systems
TEEB	the economics of ecosystems and biodiversity
TEN-T	Trans European Transport Network for Transportation
UN	United Nations
UNCEEA	United Nations Committee of Experts on Environmental–Economic Accounting
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wide Fund for Nature

Executive summary

In the coming decades Russia will need to invest significantly in infrastructure to meet its development goals. The investment need through to the 2040s is projected to exceeded $1.7 trillion (Global Infrastructure Hub and Oxford Economics, 2017), $762 billion more than projected based on current trends. Given this context, Russia faces a choice: to ramp up investment in conventional infrastructure solutions or to embrace nature-based solutions (NBS) that contribute 'triple win' long-term outcomes for people, the economy and the environment. This choice will be made against a backdrop of increasing public desire to restore and safeguard health ecosystems[1] set against the limited priority given to environmental conservation within recent national budgets.[2] Russia also faces a uniquely diverse range of climate risks (from permafrost melting and flooding to heat risks and desertification) as well as rising greenhouse gas (GHG) emissions from both anthropogenic sources (with the fossil fuel based energy sector accounting for 1,810 Mt CO_2/year, around 80% of GHG emissions) (Gütschow et al., 2021) and ongoing methane emissions from the loss of permafrost and peatlands. There is now a timely opportunity to harness the public pressure to address environmental issues as an entry point to develop NBS that both support ecosystem health, and help Russia to adapt to, and mitigate, climate risks.

NBS approaches across all sectors and scales have an important future in supporting Russia's adaptation and mitigation efforts. Developing a greater awareness of these NBS opportunities (from local treatment of effluents to regional-scale wetland or forest restoration) and articulating these opportunities in policy-relevant terms is now needed to make progress. The ability to make the case for NBS is a common challenge faced not only by Russia but also by the United Kingdom (UK) and other countries, demonstrating the continued disconnect between the acknowledged potential of NBS and the reality of limited implementation at scale.

Accessing finance will also be central to realising these opportunities in practice. Green finance in Russia is gaining traction with the Central Bank and other authorities. Many national financing instruments and vehicles, however, are yet to be adapted to prioritise NBS and much of the growing array of international green financing vehicles has yet to achieve recognition in Russia. But the investment landscape is rapidly evolving, and there is significant scope to influence and upscale access to NBS finance within Russia.

These challenges and opportunities provide the backdrop to the REACT programme (funded by the UK Foreign, Commonwealth and Development Office). The first stage of this programme has been to share learnings around NBS between the UK and Russia, and to identify some of the challenges Russia faces in responding to climate change and the opportunities NBS may provide. From these discussions, four priority recommendations for future collaboration have

1 Recent opinion polls suggest almost half of all Russians view environmental degradation as the greatest global threat (Levada Centre, 2020).

2 Environment conservation accounts for less than 1% of the annual spent (https://roskazna.gov.ru/en/budget-execution/the-information-on-execution-of-budgets-of-budgetary-system-of-the-russian-federation/6883/)

emerged, designed to help the UK and Russia accelerate and upscale the on-the-ground implementation of NBS.

1. Upscaling NBS finance: mapping the landscape of opportunity and overcoming barriers

A detailed mapping of the financing landscape in Russia and what forms a bankable proposition is needed to help release nascent financing potential. For example, conventional financing mechanisms remain based on well-defined criteria and can be difficult to apply to the multiple benefits that underpin the case for NBS. Approaches to leveraging conventional private finance are made more difficult by the lack of clarity around the credit ratings for state enterprises and private firms and the limited (but evolving) ability to account for the full range of benefits in support of a bankable proposition.

There are several innovative vehicles and instruments now available to help scale investment in NBS. Grants are available to Russian groups and innovators, and concessional and non-concessional loans are available from international initiatives such as those provided through the Global Environment Facility (GEF) or New Development Bank (NDB). Beyond international funds, private financing options for NBS are burgeoning as the private sector seeks to offset emissions and deliver broader corporate sustainable agendas. Capital markets also offer support for NBS through green bonds and other earmarked market instruments. Blended finance is increasingly seen a means to deliver NBS at scale. This includes the use of catalytic financing mechanisms to leverage private sector contributions with the use of allied public sector support, concessional funds, or development agency investment. These multi-funder approaches can help to de-risk private sector investment.

Innovative financing opportunities are now starting to emerge as part of the evolving landscape for green financial instruments in Russia. In August 2019, for example, the Moscow Stock Exchange launched, for the first time, a Sustainable Development sector. The understanding of the range of financing mechanisms and the opportunities they provide, however, remains limited, and financing continues to be repeatedly cited as a barrier to NBS.

What is clear is that opportunities for green finance are growing and evolving rapidly in the UK, Russia and elsewhere. Understanding the dynamic landscape of available financing vehicles, the market structures needed to facilitate them and how to package bankable propositions to access them will underpin the success, or failure, of mainstreaming NBS.

Summary research recommendation:
To undertake a deep dive into the landscape of green financing in Russia. This should include a detailed review of the current and emerging opportunities and associated perceived and real constraints to access (including market structures, the sharing of risk and reward and the development of bankable collaborative propositions).

2. Quantifying the national NBS opportunity: identifying the 'hotspots' for action

Delivering NBS at scale requires collaboration (between departments, infrastructure providers, developers, etc.). Different departments and institutions have different visions, goals and legal

structures, which can prevent collaboration. Consequently, these agencies rarely come together to look for integrated solutions to climate-related socio-economic and environmental problems; often choosing to tackle each individually according to their mandate. This 'silo thinking', which is common around the world, is frequently cited as a barrier to the successful adoption and implementation of NBS (Gütschow et al., 2021).

Motivating collaboration is central to achieving the multiple benefits that NBS offers. In turn, this requires an understanding of where these opportunities are greatest and across which sectors. This spatially explicit understanding of the potential benefits (from reduced flooding, pollution and fire risk to improved air and water quality) underpins an evidence-based national dialogue on the uptake of NBS. Large-scale spatially explicit assessments of the opportunity for NBS (benefits and costs) have been shown to be instrumental in promoting the policy and investment case for NBS within the UK and elsewhere. Developing a similar understanding for Russia would provide a powerful incentive for policy change and increased investment in NBS. Properly accounting for the multiple benefits of NBS within investment and pricing models, and illustrating their distribution in space and time, makes it easier to attract investment. There have been steps in this direction. For example, the translation of the System of Environmental–Economic Accounting (SEEA) framework into Russian and harmonisation of the terminology used with that of Russia's national legislation is positive progress. This type of accounting, however, relies upon credible evidence of the benefits of NBS; without this, national-scale appreciation of the potential benefit investment is likely to be constrained to local activities and the opportunity to embed NBS as a legitimate element in meeting the projected infrastructure gap may be missed.

Summary research recommendation:
To undertake a national-scale quantified assessment of the NBS opportunities across Russia under present and future scenarios. This assessment should necessarily consider economic, well-being and biodiversity metrics and enable disaggregated insights by region, settling (urban and rural), demographic and sector.

3. Generating confidence in NBS performance through exemplar studies: Meshchera Lowlands

Many remain sceptical of the ability of NBS to deliver its intended benefits in helping society adapt to and mitigate climate change. Such scepticism is found in the UK, Russia and elsewhere and continues to hinder progress, particularly when expressed in the absence of a clear political commitment. The formal ratification of the 2016 Paris Agreement by Russia in late 2019, followed by the publication of the National Adaptation Plan in January 2020,[3] provides a positive step towards accelerating Russia's climate action. In October 2020, however, the Russian government reiterated that it had no plans to introduce carbon taxes, citing difficult economic conditions and a reluctance to pass on higher costs to consumers (Interfax, 2020a); although this may change in the coming months with the first regional Emission Trading Scheme (ETS) being introduced in Sakhalin. This lack of consistent policy commitment to addressing climate risks can act to undermine the case for NBS.

3 Presidential Executive Office (2020) Decree of the President of the Russian Federation 04.11.2020 No. 666 (http://kremlin.ru/acts/bank/45990).

Communicating the performance and success of pilot NBS projects can overcome such scepticism and help leverage both policy change and new planning practices (as illustrated in the recent publication of the UK Flood and Coastal Risk Management Strategy that emphasises natural flood management). Such studies can challenge the misconceptions of higher whole-life costs and illustrate the tangible local outcomes for people and the economy NBS provide. The rewetting of the Meshchera Lowlands pilot studies, for example, provide local biodiversity gains, reduce the chance of fire and hence act to limit GHG emissions and prevent a repeat of the devastating smog and associated loss of air quality in Moscow in 2010. Effective monitoring and promotion of pilot activities provide an opportunity to demonstrate the local environment and global climate win–win benefits that are perhaps of central importance to progress in Russia.

Summary research recommendation:
To develop NBS planning, design and monitoring guidance. The proposed research will bring together lessons from pilot studies across Russia and to extend insights through collaborative working in the Meshchera Lowlands (focusing on peatland restoration). The pilot activities should include demonstrating the use of alternative methods and tools to make the case for NBS, and plan and monitor NBS that deliver outcomes for nature and people.

4. A collaborative knowledge agenda: research and capacity-building

The UK and Russia have much to share regarding the policy, practice and science of NBS. The REACT scoping process has highlighted a real appetite for knowledge-sharing on NBS from Russian academia and policy-makers alike. Such knowledge-sharing opportunities include science leadership, training and educational programmes, and sharing lessons on implementation. The development of a framework of knowledge collaboration between the UK and Russia offers an opportunity to underpin the implementation of NBS through awareness-raising and the exchange of methods and tools. Focused training and educational programmes (for student and early-career training modules, as well as professional development courses), supported by a collation of NBS examples and field trips, will help to provide a common understanding to be shared by a cohort of future decision-makers. Sharing implementation lessons through peer-to-peer learning is also proposed to provide an opportunity to 'show and tell' stories of success and reasons for failures. It is envisaged that such exchanges would include convening high-level investor and policy community workshops as well as themed exchanges (e.g. on wetland restoration or city greening) between UK and Russia.

Summary research recommendation:
To develop a platform of sustained exchange that builds capacity and shares skills and expertise around the theory and practice of NBS delivery.

1 Introduction

This scoping report forms part of the wider REACT project that is exploring UK–Russia collaboration around the delivery of climate resilient transitions. Following Russia's approval in January 2020, of its national action plan (NAP) to take forward climate adaptation through to 2022, the REACT project comes at a strategic juncture to share knowledge and expertise between the UK and Russia.

A central motivation underlying REACT is the increasing global ambition to develop climate resilience and to mainstream NBS as part of adaptation response. REACT provides a timely contribution to the 2021 United Nations Climate Change Conference (COP26), to be chaired by the UK, which places an emphasis on delivering NBS at scale.

Objective

REACT aims to catalyse the development of a long-lasting engagement between UK and Russian partners that can be used to support the translation of Russia's NAP to specific regional and sectoral actions. The objective of this scoping report is to support this aim by exploring the climate risks faced by Russia and the opportunities for, and barriers to, mobilising green investment as part of the climate adaptation response.

Report structure

The scoping report is structured as follows:

- Chapter 2 provides a brief introduction to Russia's complex social, economic and natural setting, and the recently observed and projected climate change.
- Chapter 3 presents NBS case examples from Russia and elsewhere to illustrate the range of opportunities and potential benefits they provide.
- Chapter 4 explores the increasing range of green investment vehicles and the opportunity they provide to support NBS.
- Chapter 5 explores the continuing challenges and opportunities for mainstreaming NBS.
- Chapter 6 sets out four priority areas for strategic collaboration between the UK and Russia around the policy, planning and delivery of NBS.

2 Russia in context

Russia faces significant climate challenges, including the increased severity and frequency of extreme weather events (floods, droughts, wildfires, etc.) (Roshydromet, 2020). The annual damage caused by extreme weather and hydro-metrological events is estimated to cost 30–60 billion rubles ($406–812 million) and this is predicted to increase with climate change (ibid.). The NAP[4] (Plan of Measures for the First Adaptation Period 2019–2022) is the first adaptation-related national policy document issued in Russia. It states that both current (observed) and expected climate change is impacting the social and economic development of the country, life conditions and public health. This chapter explores some of the socio-economic, biodiversity, and climate change drivers that provide the backdrop to the NAP and the context within which the opportunities for NBS to contribute to adaptation will emerge.

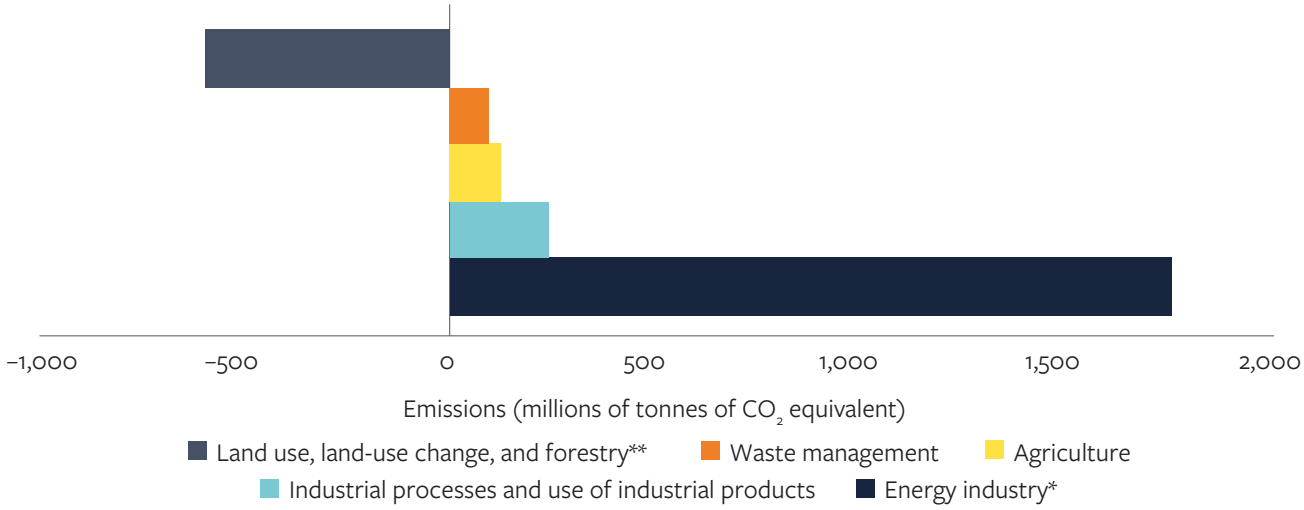
Socio-economic setting and emissions

Russia is home to around 144.5 million people (as of 2018, Eurostat) with a GDP of $4 trillion (in 2017), and with services accounting for 62.3%, industry 32.4% and agriculture 4.7% (World Bank, 2020). Most people live in urban centres (~100 million people, including many in Moscow, St Petersburg and Novosibirsk) with around 45 million people living in more rural settings. Approximately 19 million are estimated to live below the poverty line as of 2019 (ibid.).

Russia is a major producer of GHG, contributing 4.5% of global GHG emissions annually (emissions have since increased to 2,220 Mt CO_2/year in 2018 (Climate Transparency, 2017); a level of national emissions that is classified as 'highly insufficient' and consistent with a high global warming future (estimated to be 3–4°C, Climateactiontracker.org, 2021). The energy sector accounts for 79.7% of emissions (1,810 Mt CO_2 /year), industrial processes and product use accounts for 10.2% (232 Mt CO_2 /year), agriculture for 5.6% (127 Mt CO_2 /year), waste for 4.2% (95.6 Mt CO_2 /year) and other sectors for 0.2% (5.41 Mt CO_2 /year) (Gütschow, 2019; see Figure 1). Russia's Energy Strategy to 2035 (Mitrova and Yermakov, 2019) is currently focused on expanding domestic production and consumption of fossil fuels, especially natural gas exports. In the coming decades Russia faces a significant challenge to meet its emission targets without accelerating policy and implementation change.

4 The National Plan of Measures of the First Climate Change Adaptation Period (till 2022). Approved by the Government Ordinance of 25 December 2019 No 3183-r.

Figure 1 Greenhouse gas emissions in Russia in 2018, by source



Notes: * Considering gas losses and technological emissions. ** Negative figures refer to sinks, or absorption of greenhouse gases from the atmosphere. The data were obtained from the Russian national inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol.
Source: Russian Federal State Statistics Service

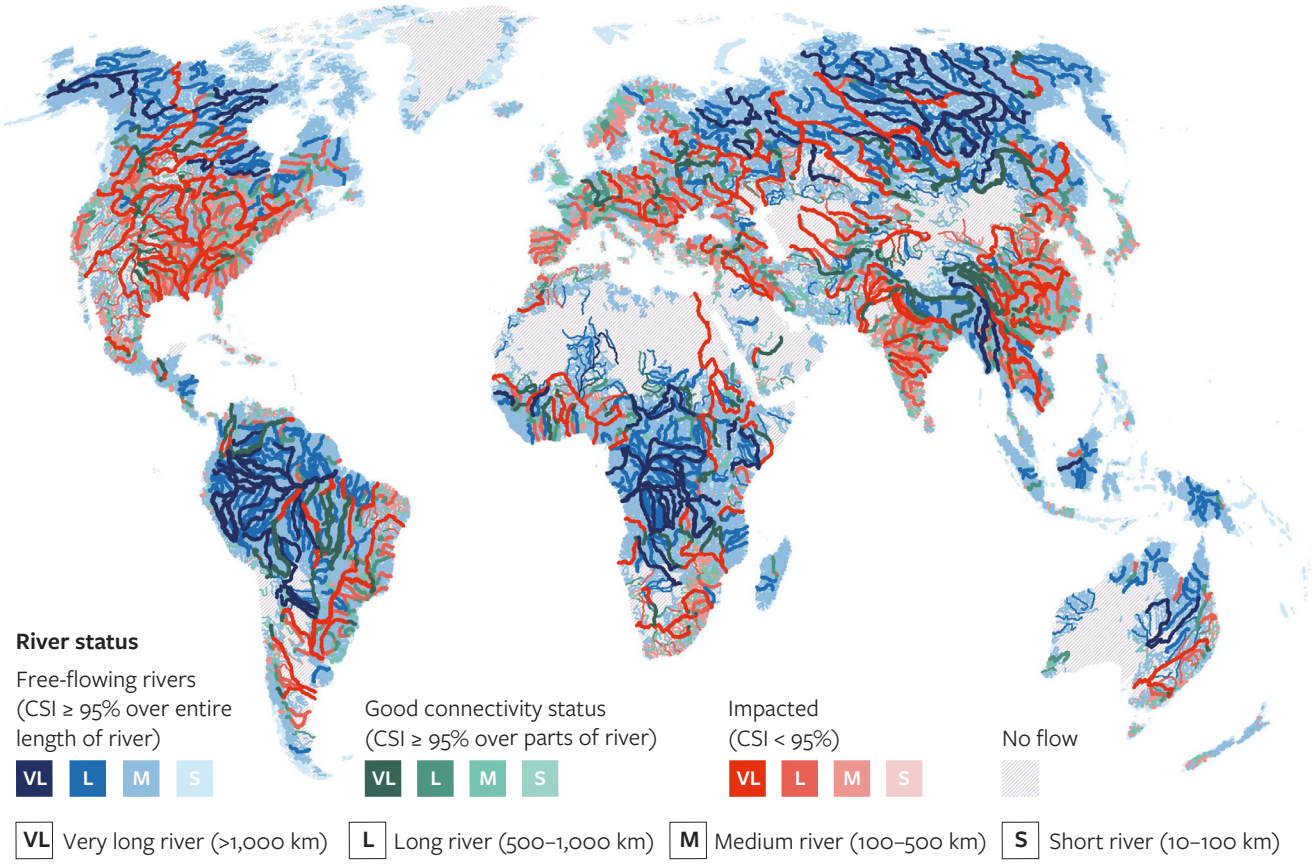
Physical geography and changing climate hazards

The Russian landscape is diverse, but is dominated by rolling, treeless plains (the steppes) stretching southwards, sprawling coniferous forests in the north (the taiga or Boreal forest) and tundra bordering the northern coast. Russia has an extensive river network (including the Volga, Yenisei and Ob) and associated deltas and wetlands. Many rivers remain free flowing (as defined by Grill et al., 2019 – see Figure 2) and rich in wildlife, whilst others are significantly impacted by development and pollution and disrupted by infrastructure (including large hydroelectric dams, such as Sayano-Shushenskaya (the largest in Russia), Bratsk, UstIlim and Saratov Dams).

Russia borders three oceans (the Atlantic, Pacific and Arctic) with an extensive and economically active Arctic coastline. Located almost entirely north of the Arctic Circle, these waters are frozen for much of the year but towards the west are warmed by the Gulf Stream currents, enabling the port of Murmansk to function year-round. The eastern coast borders the Pacific Ocean and to the west, the shoreline is much shorter and borders the Atlantic Ocean.

The climate is changing in Russia. Significant warming trends are already evident. Since the mid-1970s, Russia's rate of warming has been significantly faster than the global average (Roshyromet, 2020), with its average temperature increasing by 1.6°C since pre-industrial times, compared with approximately 0.9°C for the global average (Valentini et al., 2020). Given this physical and changing context, many regions of Russia are experiencing changing climate-related hazards.

Figure 2 River status – free flowing rivers



Source: WWF (www.worldwildlife.org/publications/free-flowing-rivers-study-full-map); Grill et al., 2019

Flooding

Russian is experiencing extensive fluvial, pluvial, groundwater and coastal flooding, with climate change already influencing these processes. For example, snow melt in the Yenisei, Lena, Ob and Kolyma catchments is being influenced by warmer and earlier springs driving increased river flows during May and reduced summer flows (Suzuki et al., 2020). At the coast, sea levels are rising and will increasingly influence the dynamics of the coastal deltas, increasing flood risk in coastal cities and ports, from St Petersburg on the Baltic to the warm water ports such as Novorossiysk on the Black Sea.

Heat waves

Summer extreme heat events in the Urals are between 0.5 and 2°C hotter than they were prior to 1980 (Shikhov et al., 2020) and both drought and heat events have been significant in recent years. The Amur basin area experienced extreme drought and fire conditions in 2008 (Semenov et al., 2017), and in 2010 much of Russia suffered a record-breaking heat wave and drought conditions, with peak temperatures reaching 38.2°C in Moscow in July and remaining above 30°C for over 30 days (Maier et al., 2011; Gennadevna, 2018). The 2010 heatwave resulted in over 50,000 extra heat-related deaths,

many exacerbated by the poor air quality from widespread wildfires east of Moscow and in eastern Siberia (Kaiser et al., 2011; see Figure 3).

Precipitation

Rainfall patterns across Russia are complex and changing. Seasonal precipitation is changing across the country (Sun et al., 2020) with the greatest rise in precipitation observed in spring, and the lowest in summer (Roshydromet, 2020). Intense heavy rains have become rarer in the north and northeast, while the European region and parts of Irkutsk Oblast have experienced more frequent extreme precipitation (Zolotokrylin and Cherenkova, 2017). Future climate projections suggest these general trends will continue (Valentini et al., 2020; Khlebnikova et al., 2019; Streletskiy et al., 2019).

Glaciers, snow cover and permafrost

Increases in surface air and ground temperatures are affecting glaciers and vast areas of permafrost across Russia. Ice cap and glacial mass budgets have been decreasing across the Russian Arctic (e.g. Kotlyakov et al., 2010). Of the 65 glaciers examined by the United States Geological Survey in 2010, all had experienced significant retreats between 1987–2004 (USGS, 2010). In recent decades the rate of loss has been accelerating; for example, Russian tidewater glaciers retreated 2–2.5 times faster between 2000 and 2010 than between 1992 and 2000 (Carr et al., 2017, cited in Meredith et al., 2019). Permafrost melting and instability is spreading (e.g. Romanovsky et al., 2010) and, in places, already damaging infrastructure (Streletskiy et al., 2019). In regions such as Chukotka and Yakutia with large swathes of continuous permafrost, for example, various studies estimate up to 20% of infrastructure foundations could be experiencing deformation through ground subsidence and decreased bearing capacity (Khrustalev and Davidova, 2007; Streletskiy and Shiklomanov, 2016).

These changes are influencing river dynamics throughout the country. For example, river ice events are also becoming less frequent (Frolova et al., 2011) and the number of complete ice coverage days reduced (ibid.). Spring snow cover is also indicating a downward trend (Estilow et al., 2015; Robinson, 2019).

Figure 3 Meschera Lowlands: impact of 2010 heatwave exacerbated by wildfires

Left: 2010 Forest Fires in Meschera Lowlands. Right: 2010 Moscow smog caused by the fires in Moscow, Ryazan and Vladimir Regions. Photo credit: EIPC (left); Nikolay Markov/Flickr (right)

Sea levels and sea surface temperatures

Mean sea levels have risen along the extensive cold and warm water coasts of Russia (e.g. rising 3.4 ± 0.7 mm/yr in recent decades in the Baltic, (Madsen et al., 2019)), a trend that is projected to continue with the potential to accelerate in future decades. Future mean sea surface temperatures are also changing, with increased sea-ice thickness projected for some northwest regions (e.g. Barents Sea, Kara Sea) and decreased sea winter ice thickness and extent in other seas (e.g. Sharmina et al., 2013). Although there is little work on the impact of climate change on Russia's coastal regions, such changes have the potential to profoundly influence marine biodiversity, coastal morphology and coastal flood risk (to people and commercial operations). Economic activity may also be influenced. As Arctic ice melts, sea routes will become navigable for longer, potentially providing alternative trade pathways. Many resources, including oil and gas, will become more accessible and Arctic logistics will improve with longer shipping seasons.

Biodiversity and changing ecosystems

Russia possesses several ecologically significant habitats, including the largest global wetland systems and nearly a quarter (22%) of all forest resources, both of which are key carbon sinks. Additionally, much of Russia's wild spaces (65% of its 17 million km^2) remain almost pristine, untouched and undisturbed by human activities. A fifth of the country, however, has suffered considerably due to human impact.

The Convention on Biological Diversity estimates the economic benefits of Russia's biodiversity and ecosystem services to be $5–6 trillion annually, but this contribution is under pressure from climate change and local anthropogenic disturbance. The impact of these combined pressures is already associated with observed large-scale forest diebacks (Zamolodchikov et al, 2020). Forest dieback, insect invasion and wetland and peatland degradation are all projected to accelerate. It is also likely that species shifts will continue; for example, some coniferous forests are already being displaced by deciduous species, whilst forests are expanding into the tundra in West Siberia and the polar Ural Mountains (Sokolova et al., 2019; Zamolodchikov et al, 2020).

3 Nature-based solutions in action

The concept of NBS seeks to conserve, restore or enhance natural ecosystems whilst simultaneously delivering benefits for humans, including managing flood flows, reducing soil erosion, improving water resources (quantity and quality) as well as providing food, fuel and medicines. Even relatively small measures, such as green roofs or roadside wildflower meadows, can yield significant advantages, such as reducing urban heat island effects or attracting crop pollinators.

NBS are often misunderstood as designs that mimic nature to afford a narrow set of economic benefits (for example, plastic sub-surface storage ponds used in the management of urban run-off, or technological solutions to extract carbon). If such solutions offer no benefit to nature, then – while they are useful – they cannot be considered NBS (Sayers et al., 2019a). NBS must improve the health of an ecosystem (including biodiversity) as well as providing economic or people benefits. NBS may need to be supported by complementary conventional infrastructure, technological innovations or non-structural responses to deliver the desired outcomes, but within an NBS context these complementary actions are considered as supplementary to the role of natural infrastructure and not vice versa (ibid.).

Despite the limited uptake of NBS at scale, several successful NBS case studies have taken place in the UK, Russia and around the world. Many of these focus on restoring degraded and threatened ecosystems and rely on the support of large international intergovernmental organisations including the World Wide Fund for Nature (WWF), the United Nations and Global Environment Facility. The recognition that NBS have a role within urban environments is also growing through garden city and sustainable urban drainage initiatives in the UK and Europe, urban river restoration in Moscow and the Sponge City programme in China, but many of these continue to manage hazards and improve well-being rather than necessarily prioritising ecosystem health and biodiversity.

This chapter presents selected NBS case studies that focus on adapting to climate change in a way that contributes economic, social and biodiversity benefits. The examples are based around water-related issues, reflecting the importance of restoring degraded rivers and wetlands as part of Russia's adaptation efforts. The examples are drawn from Russia, the UK and further afield and illustrate the implementation of NBS in three different settings: wetland restoration and reconnection; river catchment restoration; and urban greening. NBS operate at a range of scales, from small local projects such as rainwater harvesting systems to large-scale regional schemes such as sustainable catchment management programmes. All successful NBS provide sustainable benefits to people and nature and accumulate the greatest impacts when strategically connected and working in unison.

Wetland restoration and reconnection

The restoration of wetlands and the reconnection of functional floodplains can 'slow the flow' of flood waters; provide storage to reduce flood peaks; increase storage time to promote infiltration, increase dry season flows and improve water quality; promote biodiversity; enable the exchange of nutrients and sediment flows; and reduce/slow the release of GHG through oxidation. Wetland restoration offers opportunities to both

reduce emissions from degrading peatlands, improve water quality and reduce flooding. There is increasing focus on peatland and wetland restoration as a central component of climate mitigation and adaptation, with examples of both below.

Restoring peatlands, Russia (2011–2023)

Peatlands (wetlands rich in organic carbon) historically covered over 8% of Russian land, but this cover has significantly declined in recent decades due to land-use change, including drainage for agriculture, forestry and peat extraction. Drained peatlands are exposed to wind and water erosion, resulting in peat oxidation, which produces large quantities of carbon dioxide. The widespread peatlands also act to dampen fire and thus restrict the spread of wildfires.

Wetlands International, the Institute of Forest Science of the Russian Academy of Sciences and the Michael Succow Foundation started a large-scale peatland restoration project in 2010 within the Moscow region. The project focuses on restoring the hydrological and biological functions of the wetlands to reduce oxidation and increase carbon dioxide sequestration whilst simultaneously rewetting the peatland to reduce the chance of fire. The project is developing an inventory of peatlands across Moscow Province to help prioritise action and identify the most effective restoration and rewetting techniques. The project includes experimental studies and educational programmes about the benefits and ecosystem services provided by peatlands and to promote sustainable peatland management programmes.

Within the Meshchera Lowlands, efforts to restore the wetlands started at the beginning of the 2000s. The restoration efforts are focusing on rewetting (through engineered leaky dams and by protecting beaver populations to encourage the creation of natural dams – both with some success). In the Vladimir part of the Meshchera National Park, nearly 10,000 ha of former peat-cutting areas has been restored through engineered inventions, while around 35,000 ha has been restored across the whole Moscow region as a result of beaver dams and rewetting projects. To date, about 90% of the disturbed bog systems within Meschera National Park have been restored, including the bog complexes of Orlovsky, Ostrovsky, Baksheevsky and Tasin Borsky.[5] The fire dampening effects of functioning peatland were demonstrated during the extreme wildfires in 2010, when the flooded areas of the Orlovsky and Tasin Borsky bog complexes were unaffected by fires. The restoration of the park's biotopes has improved species diversity and abundance.

Rewetting efforts have been accommodated by the natural process of reforestation, aided by sprigging activities to restore the wetland vegetation and to plant local tree species (Figure 4). An internet portal was also created that enables people to select an area of the park to restore, purchase seedlings and either visit to plant them or entrust the park rangers to plant them. Since the start of the replanting project in 2013, 130.2 ha of new forest has been planted. Traditional paludiculture practices (cultivating plants in waterlogged conditions) are also used to manage the restored sites to prevent future degradation and maintain the restored habitat.

5 www.park-meshera.ru/activity/science/activities/

Figure 4 Restoring a flooded peat field in Vladimir Meshchera, December 2020

Left: flooded peat field. Right: restoration efforts in Vladimir Meshchera. Photo credit: EIPC

Although these activities remain in their infancy, over 35,000 ha of peatland has been restored using NBS within the Moscow region. The total amount of emission reduction achieved is currently estimated at 175,000–220,000 tonnes CO_2 equivalent per annum, with increased biodiversity across the restored sites whilst the fire hazard has reduced.

Yangtze River wetland reconnection, Hubei Province China

The Yangtze river covers an area of 1.8 million km^2 and, at 6,300 km, it is the third longest in the world. Historically, the vast wetlands and floodplains in the central and lower stretch of the river would have collected and retained flood water in the wet season; however, the construction of dikes and embankments has prevented these natural processes. As a result of this extensive development, many lakes have become disconnected from the river, reducing wetland areas by 80% and flood retention capacity by 75%.

The Yangtze has always flooded, but since the loss of floodplain storage and floodplain development, damaging flood events have increased. The loss of connection to the Yangtze River prevents diluting flows and the migration of fish and, under climate change, increased temperatures and drought are expected to worsen eutrophication.

In 2002, the WWF initiated a programme to reconnect the lakes to the river by reforming sluice gate management and reintroducing native fish species (see Figure 5). The programme focused on three lakes: Zhangdu (40 km^2), Hong (348 km^2) and Tian'e Zhou (20 km^2). Since 2004–2005, the sluice gates have been seasonally re-opened, resulting in a restored wetland capacity of 448 km^2 that can store up to 285 mm^3 of floodwaters, reducing downstream flood peaks in the central Yangtze region.

Figure 5 Poyang Lake in the Yangze river basin

Critically endangered Siberian cranes at Poyang Lake in the Yangze river basin. Photo credit: Blake Matheson/ Flickr

The programme also included addressing illegal and uneconomic aquaculture facilities with significant impact on water quality. In Lake Hong, for example, pollution fell from national pollution level IV (fit for agricultural use only) to II (drinkable) on China's five-point scale. The reduced levels of pollution and the ability to exchange nutrients between the river and floodplain has supported an increase in wild fisheries' species diversity and populations. Within six months of reconnecting Zhangdu Lake, for example, the catch increased by 17% and nine fish species returned to the lake. Similarly, the catch in Baidang Lake increased by 15%.

The project also supported local people (with many living in poverty) to find alternative and sustainable livelihoods, including certified eco-fish farming, bamboo farming (within added benefits for land banks) and wild fishing (with 12 migratory fish species returning to the lakes).

As a result of the demonstrable benefits to river health and the people, in 2006 the Hubei provincial government adopted a wetlands conservation master plan and allocated resources to protect 4,500 km² of linked nature reserve and wetland systems. The success of the Yangtze reconnection programme in delivering multiple outcomes highlights the need to combine natural and conventional infrastructure (allowing for the seasonal opening of engineered sluice gates to reconnect regional lakes to the Yangtze River) and softer management measures (including some aquaculture businesses and the reintroduction of native fish species) to boost local incomes (Sayers et al., 2019a).

Coastal wetland restoration, New Orleans, USA

In 2005, Hurricane Katrina breached the flood protection levees and flooded 80% of New Orleans, Louisiana, USA. Around 1,300 people lost their lives in the flood and almost a million people were displaced. Hurricanes are common in the Gulf of Mexico, and like many coastal cities around the world, New Orleans has a high flood risk, a risk that will increase with climate change and continued subsidence of the Mississippi Delta.

Coastal wetland restoration is now seen as a critical component of responding to this threat, attenuating storm waves and protecting backshore levees (Figure 6). The wetlands of the Mississippi Delta continue to constitute 30% of the total coastal wetlands in the United States, but also account for 90% of the country's wetland losses. The loss is primarily due to a lack of sediment supply from the Mississippi River, which results from many years of dam and levee building, preventing the flow of sediment to, and deposition at, the coast. Industrial activity and hurricanes have also contributed to sediment losses from the Delta.

Figure 6 Wetlands along the Mississippi, New Orleans

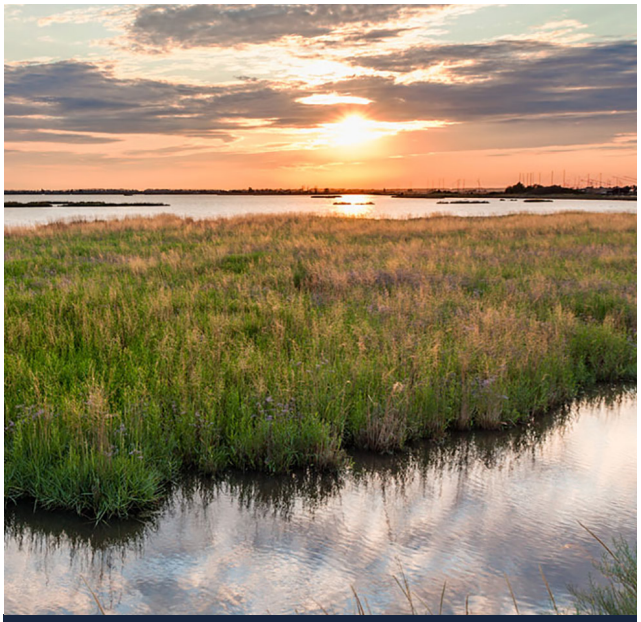


Photo credit: mississippiriverdelta.org

Reinstating the sediment flows through the Mississippi to restore the processes that initially created the Mississippi Delta and restoring the barrier islands are part of a strategy that involves multiple lines of resistance, including strengthening conventional levees and sluices (Kazemierczak and Carter, 2010). Restoration of the wetlands around New Orleans is seen as essential to protecting the city from coastal flooding and restoring the ecosystem services the wetlands provide. This is recognised in the New Orleans Master Plan, although implementation remains more limited than set out in the Master Plan, partially due to the impacts of Hurricane Katrina (Moore, 2019).

Restoring rivers and catchment functions

As around the world, urbanisation, industrial pollution and agriculture have all impacted the natural functioning of Russia's rivers, and some are now significantly degraded. Industrial pollution and functional constraints reduce water quality and increase flooding, increasing the requirement for water treatment and flood control infrastructure. Restoring these functions offers the opportunity to reduce costs (and the emissions associated with those activities), and provide recreational space for people and improved biodiversity and habitat connectivity.

'Slowing the flow', Pickering, UK

In 2007, severe flooding caused £3 billion in damages across the UK and led to the recommendation that Catchment Flood Management Plans and Shoreline Management Plans should work with natural processes to reduce flood risk (Pitt, 2008). Pickering, a small town in North Yorkshire, UK, was one of the places affected, but it was soon apparent that a conventional flood defence response was not appropriate and in 2009 the 'slowing the flow' project was initiated.

The project works with natural processes to retain water in the upstream catchment in order to reduce peak flows in the town. The whole catchment response included 167 'leaky dams' made from large woody debris (allowing the passage of fish) (Figure 7); 187 heather bale dams in moorland drains; planting 44 ha of new woodland; re-seeding 3 ha of bare peat; and improving land management to reduce runoff and erosion. Importantly, the NBS measures were complemented by 1 km 'earth bund' (embankment) creating a large flood storage area upstream of the town.

Figure 7 Slowing the flow of floodwater in Yorkshire

Source: www.ice.org.uk

Hydrological modelling indicated that woodland planting efforts should be concentrated in the upper catchment to minimise the risk of increasing flood peaks by inadvertently synchronising peak flows from different tributaries. Modelling suggested a reduction in annual flood risk of between 4%–25% due to the increased flood storage area, woodland expansion and other NBS interventions (Nisbet et al., 2015), benefits that were realised in 2012 and 2015 when heavy rainfall led to flooding in neighbouring areas but not Pickering (McAlinden, 2016). Co-benefits include carbon storage, habitat provision, erosion regulation, community engagement and education.

Restoration of Yauza River, Moscow (2017–2019)

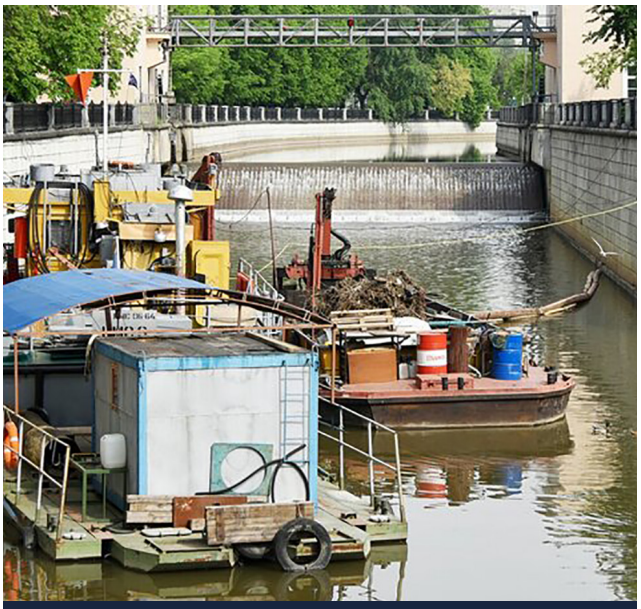
The restoration project aimed to restore 10 km of the Yauza river, mostly in the Mytishchi district of the Moscow region.[6] The project was part of the State Programme 'Revamping the Moscow region rivers' to restore the ecological balance and self-cleaning functions of the rivers. The goal was to improve the flow by removing excess silt, debris and invasive marsh plants and by deepening the channel; to reduce erosion by strengthening the banks; and to increase biodiversity by adding fish fry. The river's ecological condition had severely worsened in recent decades, due to the bed becoming heavily silted and overgrown with vegetation. Stormwater and pollution were flowing directly into the river, causing a build-up of harmful chemicals and slurry.

Various measures were undertaken to restore the natural hydrological functions of the Yauza River. Riverbanks and riverbeds were cleaned, the river was deepened, illegal discharges were identified, and owners were requested to stop discharging water (mostly town surface runoff).

Over 100,000 tonnes of sludge were removed from the Yauza bottom in 2018 using heavy machinery and by divers (Figure 8). Over 6,000 shrubs and over 1,000 fallen and dead trees were removed. Several artificial islands were formed to host waterfowl. The area was also restored for recreational use, with bike paths cleared and the area's natural beauty enhanced. The project was well-received by the local population, although there is an ongoing issue with the continued dumping of waste into the river, threatening to undermine the success of the project.

6 www.m24.ru/articles/ehkologiya/21092018/153767

Figure 8 Clean-up operation of the Yauza River, Moscow District



The technical vessels of Mosvodostok (municipal sewage company) have the important task of cleaning the Moskva River of sewage and debris. Photo credit: www.mos.ru

Since completion of the project in 2019, the rivers are regularly monitored.[7] Monitoring involves a visual inspection of coastal strips, water protection zones and water areas for littering, overgrown vegetation and fallen trees. Many of the local residents are involved in preserving the river; in the town of Mytischi, volunteers help environmental inspectors to monitor riverbanks and clean sites covered by rubbish.

Lower Danube Green Corridor: restoring and renaturing Bulgaria, Romania, Moldova and Ukraine

The Lower Danube is one of Europe's last free-flowing rivers, and the Danube Delta is the largest natural wetland area in Europe. Together, they form one of the world's major biodiversity hotspots, supporting over 5,000 species, including 42 mammals, 85 fish (including the threatened Beluga sturgeon, up to 7 m in length), and over 300 birds (WWF, n.d.) (Figure 9). However, agriculture and industry has led to 75% of the natural floodplains along the river being drained; dredging and straightening of the river has also been undertaken to improve navigation. Subsequently, the river now cuts down into the floodplain, the groundwater table has been lowered and local water sources threatened (Ebert et al., 2009). The loss of natural floodplain habitats has also removed the natural flood storage capacity, destroyed fish spawning grounds and allowed heavy loads of pollution to enter the Black Sea, forming a hypoxic dead zone (ibid.).

Figure 9 Belene Island, Bulgaria

Top: The marsh that has been reconnected with the river, restoring fish spawning habitat. Bottom: Map of green corridor. Photo credit: Александър Иванов. Map source: Awsassets.panda.org

7 https://mytischiriamo.ru/article/zabota-o-rekah-mytisch-ekomonitoring-ochistka-reabilitatsiya-yauzy-409986

In 2000, in recognition of these challenges, the governments of Bulgaria, Romania, Ukraine and Moldova signed up to the most ambitious initiative ever undertaken to restore and conserve wetlands in Europe. They proposed to establish a 11,500 km² green corridor along the lower 1,000 km of the Danube. The overarching aim was to enhance the existing protection for 775,000 ha of wetlands, establish 160,000 ha of new protected areas and reconnect 224,000 ha of floodplains to the Danube. The measures implemented included removing dikes and reconnecting meanders with the main river (WWF, 2012). In 2012, protection targets were exceeded, with over 1.4 million ha protected. However, restoration efforts have been less successful due to delays and difficulties with multiple landowners. Regardless of these issues, 60,000 ha had been restored by 2012 (Climate-ADAPT, 2014).

The benefits resulting from the habitat restoration include increased floodwater retention, reduced flood risk and higher water quality. Restoration of all the potential floodplain areas along the Danube has the potential to retain 2,100 million m³ of flood water and reduce flood peaks by up to 40 cm (Schwarz et al., 2006, cited in Ebert et al., 2009). Sustainable sources of income have replaced the intensive cultivation of monoculture crops, which was extremely vulnerable to climate change and often unprofitable for local people. For instance, in Romania, the restoration of 3,680 ha of wetlands has produced benefits for fisheries, tourism, grazing and reed harvesting valued at €140,000 per year. Each hectare of restored floodplain is worth an estimated €500 per year in ecosystem services, and management costs are reduced compared with the pre-existing hard infrastructure flood defences (Ebert et al., 2009). Based on experience to date, the total cost of restoring all 37 potential floodplain sites is estimated at €183 million – less than the damages of €400 million resulting from the 2005 flood – and will be offset within a few years by ecosystem service benefits valued to equate to €111 million per year (ibid.).

Nevertheless, further restoration is critical to improving ecosystem health and the programme faces threats to its success. The restored habitats are threatened by the Trans-European Transport Network for Transportation (TEN-T), which plans to further straighten and canalise the river to remove a perceived transport 'bottleneck'.

Greening urban and industrial areas

As Russia's urban population grows, temperatures rise and precipitation changes (see Chapter 2), NBS approaches within an urban setting offer multiple opportunities to help manage the associated risk. Greening urban spaces can range from single actions such as green roof projects, to city-scale planning of greenways and sustainable urban drainage systems. Such actions help reduce urban heat, improve air quality, enhance degraded habitat, promote biodiversity, reduce surface water flooding and improve water quality (and/or reduce the treatment by burden). Restoring brown field locations degraded by legacy industries provides opportunities to make room for the river, improve water quality and provide recreation benefits. Efforts to improve parks and green spaces and plant more trees are already underway in Russia, including in the capital, Moscow, where 550 parks and green zones and parks were improved or created since 2011, and 90,000 trees and 1.3 million shrubs planted since 2013 (Moscow Mayor, 2021a). Parks are also being added as part of the redevelopment of industrial zones on the territory of the city (Moscow Mayor, 2021b).

Green roofs and sustainable urban drainage

In 2000, as part of an initiative of the Environmental Protection Agency to reduce the air pollution and urban heat island effect within Chicago, a 38,000 square foot green roof was constructed on City Hall (Figure 10). Completed in 2001, this was one of the first green roof projects and is now host to over 20,000 herbaceous plants of over 150 species including woody shrubs, vines and trees. The rainwater is harvested and used to irrigate the plants. Green roofs have since been widely promoted. In 2009, for example, Toronto was the first city in North America to adopt a by-law to require and govern the construction of green roofs on new development. Widespread retrofitting, however, remains limited due to a combination of incentive and technical challenges.

Figure 10 The green roof at Chicago City Hall

Chicago's City Hall building, the first municipal building in the US to have a green roof. Photo credit: TonytheTiger, CC BY-SA 3.0 wikipedia

Embedding NBS within city planning processes is also gathering pace. Singapore is widely recognised as one of the most liveable cities in the world. A central reason for this has been the focus on urban 'greenery', including mandatory roadside plantings (Mountford et al., 2018). Trees, parks and other green infrastructure help to reduce urban temperatures, filter air pollution and buffer street noise (Haq, 2011). The Singapore landscape is heavily fragmented by past agriculture and settlements, roads, housing and other infrastructure, but since 1985 consideration has been given to distribution of the linear greenways and connectivity of parks, not just on the total area of parkland. In response to these initiatives, green cover in Singapore has continued to grow – between 1986 and 2007, for example, it grew from 36 to 47%, despite a 68% increase in population (Tan et al., 2013) – and average city temperatures have reduced (Jusuf et al., 2007).

In the UK, the concepts of sustainable urban drainage (SUDs) are now widely embedded in urban development. This includes the design of natural drainage features that can slow, store and clean runoff; improve water and air quality; and improve water security, biodiversity net gain and social and community value (Ballard et al., 2015). At Lambhill Stables in Glasgow, Scotland, the Local Authority and local community are collaborating to implement bioremediation ponds, community gardens and constructed wetlands as part of a broader climate adaptation process[8]. More broadly, the principles of 'Garden Cities' have developed renewed vigour in recent years, with five new garden towns across the UK identified in 2019.[9] The principle of 'Garden City'

8 www.adaptationscotland.org.uk/get-involved/our-projects/climate-ready-lambhill
9 www.gov.uk/government/news/37-million-to-fund-5-new-garden-towns-across-the-country

(proposed by Howard, 1898) has continued to develop and seeks to provide space for people to relax and work with room for nature.

In China, the concept of a 'Sponge City' has gathered significant momentum in recent years, with a first round of pilot projects started in Xiamen in 2015, followed by additional pilots across China and a second round started in 2016. The aim is to create cities that, like a sponge, absorb water and store water, as well as attenuate run-off, filter and treat water. The 34 ha Qunli Wetland Park in Harbin is considered a demonstration of 'Green Sponge Technology for Urban Rainfall and Flood Management', helping to deliver multiple benefits. This focus on multiple benefits is seen as an important advance in the concept. Not all Sponge City pilots have had this focus; some concentrate solely on infiltration and attenuation of rainwater, missing the broader opportunity offered by combining conventional and natural infrastructure that is at the heart of the original concept of a 'Sponge City' (Sayers et al., 2019a).

Russia, restoring industrial landscapes, extractives, Kuzbass

The Kuznetsk coal basin, in the Kemerovo region, is one of the largest coal reserves in the world. In Russia, open-cast coal mining remains the dominant method, which results in significant areas of land and biodiversity disturbance.[10,11] One particularly acute environmental issue of open coal mining is the reclamation of disturbed land. Historically, reclamation projects have had limited success in Russia as many failed to consider impacts on biodiversity. For instance, typically only five species of trees are replanted, which depletes the ecosystem's genetic resources and creates ideal conditions for invasive species to take hold. Even worse are the monoculture plantations that prevent the formation of shrub and herbaceous layers, reduce biodiversity and lead to diminished ecosystem services. The largest areas of disturbance by open coal mines falls on the steppe core Kuznetsk Basin. This region was chosen as the focus of pioneering research to develop new reclamation technologies to restore the steppe and the surrounding meadow plant communities.

In 2014, the United Nations Development Programme (UNDP) and Global Environment Facility (GEF) supported a Ministry of Natural Resources project to restore the natural steppe vegetation of the degraded areas (UNDP, GEF and Ministry of Natural Resources, n.d.). The project had the support of local authorities along with the PJSC Kuzbasskaya fuel company. Between 2014 and 2017 a restoration experiment took place in the open coal mine Vinogradovsky, with 4 ha of degraded area and coal dumps sown with a seed mixture of steppe vegetation. The seeds were harvested from Bachatskie Sopki, a nearby nature reserve (Figure 11). Within two years, vegetation cover had increased by 70% and the degraded areas were recolonised by over 30 species of steppe and meadow plants. This positive experience is encouraging the development of national standards for the reclamation of coal mines across Russia.

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10 www.kuzbs.ru/images/stories/pdf/izdania/sbornik_innovacionnih_reshenyi.pdf

11 http://bd-energy.ru/documents/%D0%98%D1%81%D1%82%D0%BE%D1%80%D0%B8%D0%B8%20%D1%83%D1%81%D0%BF%D0%B5%D1%85%D0%B0/CASE-KEMEROVO.pdf

Figure 11 Steppe habitats in Kuzbass coal basin

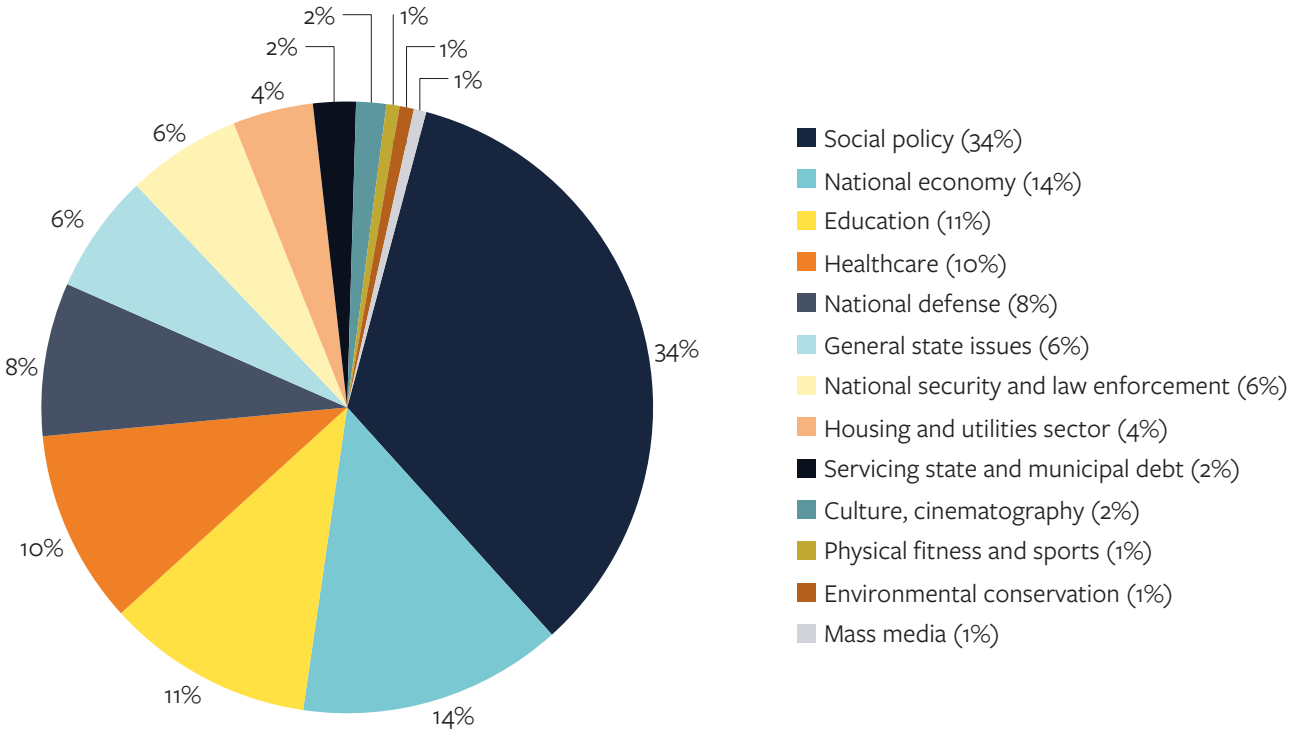
Restored degraded coal dumps in Kuzbass coal basin to steppe habitat with endemic vegetation.
Photo credit: UNDP/GEF – Ministry of Russia

4 Green investment: scale of the opportunity

Russia's consolidated budget expenditure shows the largest spending allowance was allocated to social policy (pension benefits and social security), with less than 1% of the budget spent on environmental conservation (Figure 12).

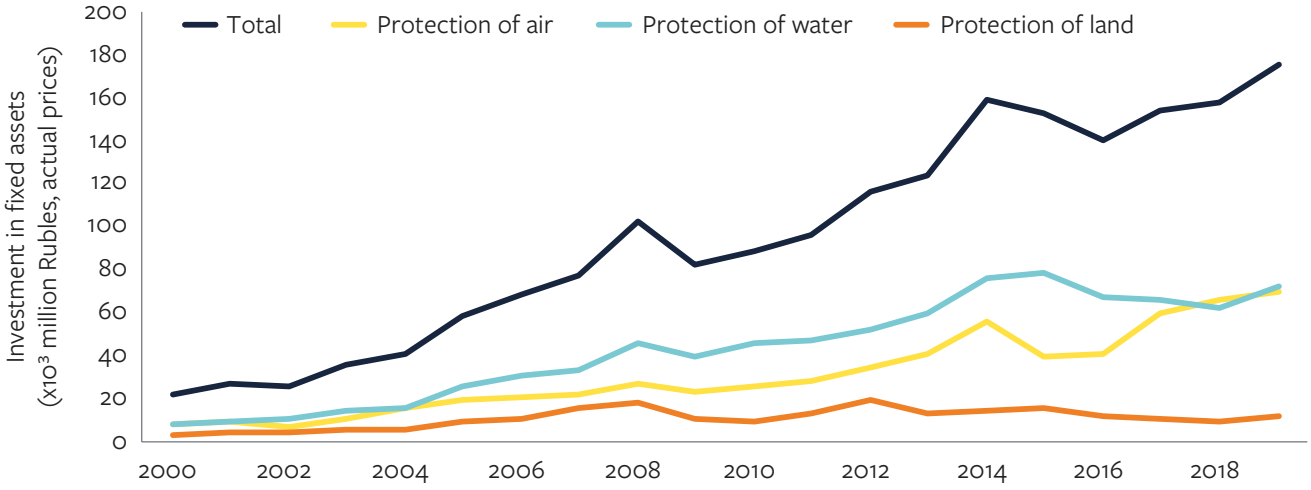
Investments in fixed assets for environmental protection and better control of the use of natural resources in Russia has more than doubled between 2009 and 2019, from 81,914 million ruble (RUB) (~£800m) to RUB175,029 million (~£1700m) (Figure 13). Expenditure on the protection of water and air account for much of this investment. Operating expenditures on environmental protection have also increased in recent years, from RUB239,170 million in 2012 to RUB374,411 million in 2019. Most of this is for the collection and treatment of wastewater and waste management; a significant portion, however, is derived from a more reactive 'polluter pays' principle rather than the proactive investment for environmental protection or improvement (Figure 14).

Figure 12 Consolidated government expenditure breakdown, 2019



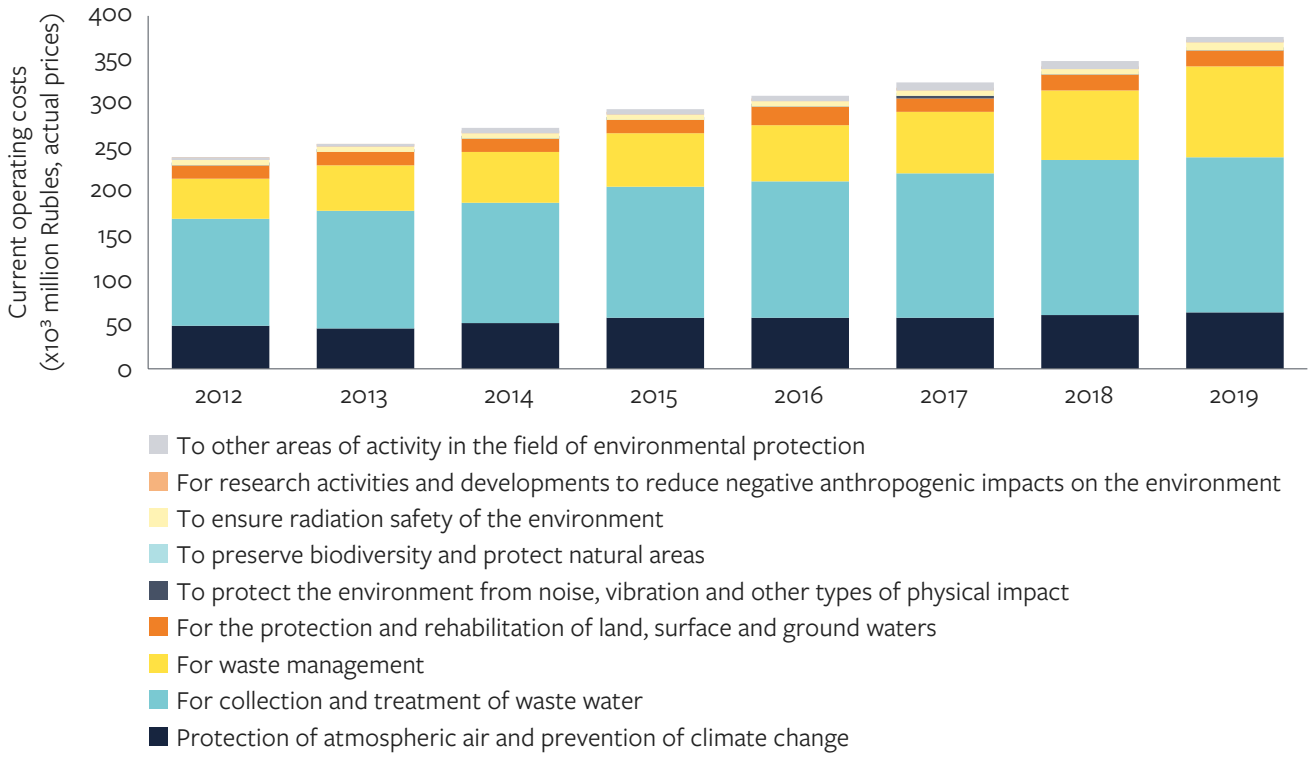
Source: Russia Federal Treasury (https://roskazna.gov.ru/en/budget-execution/the-information-on-execution-of-budgets-of-budgetary-system-of-the-russian-federation/6883/)

Figure 13 Investment in fixed assets for environmental protection and rational use of natural resources



Source: Russia Federal State Statistics Service

Figure 14 Current operating costs of environmental protection in Russia



Note: This includes all costs carried out at the expense of the company's own or borrowed funds, or funds from the state budget.

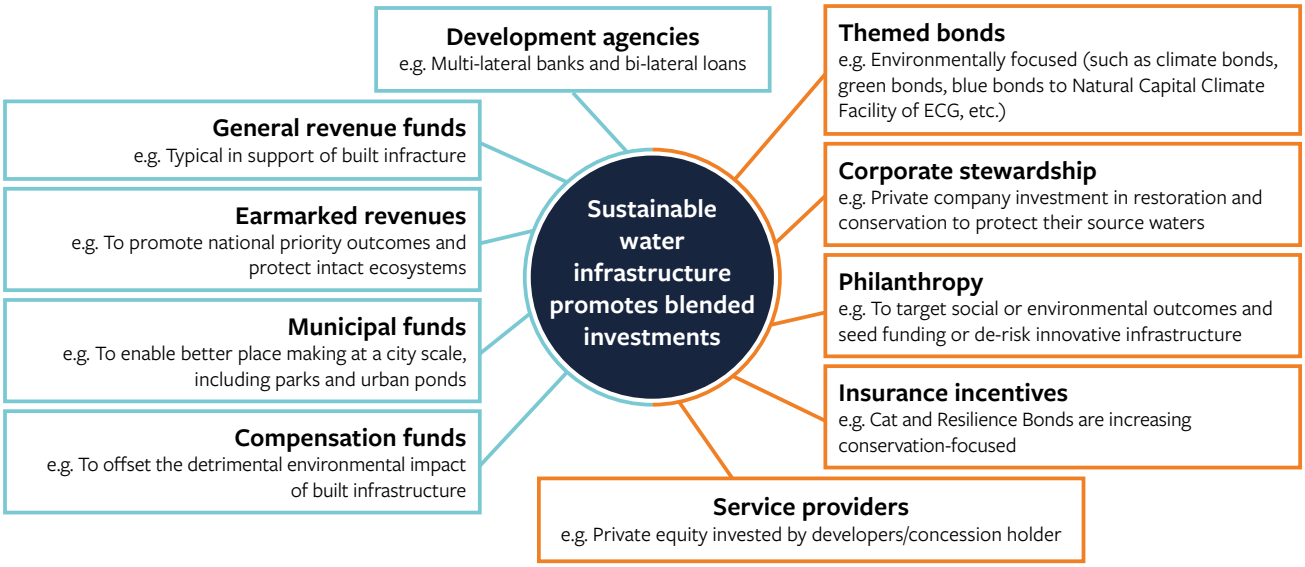
Source: Russia Federal State Statistics Service

Looking to the future, Russia (like many countries) will need to increase investment in infrastructure to meet the demands of society. The Global Infrastructure Outlook (GIO)[12] suggests that an increase of 68% in infrastructure spending in Russia will be necessary to service its expected demand under current trends. Specifically, investments in roads, electricity and airports trail behind what is needed by 2040 (Global Infrastructure Hub and Oxford Economics, 2017). For example, the GIO estimates the infrastructure investment needs to be $1,792 billion (cumulative from 2016 to 2040) with a projected shortfall in investment of $762 billion if current trends continue. Given this context, like many other countries Russia faces a choice: to continue to invest in conventional infrastructure solutions and risk further degrading ecosystem services, or to adopt NBS where possible to help deliver the required services for people while simultaneously restoring and safeguarding biodiversity in a way that embeds mitigation and adaptation to climate change (Sayers et al., 2015; Haase, 2017).

In response to growing public and private demand to support better environmental outcomes, the government is becoming more cognisant of the need to protect the environment. Under the guidance of the Ministry of Natural Resources and Ecology, for example, the national Project Ecology was introduced in 2018, with the aim to improve environmental protection in the country by 2024.[13]

To help respond to this demand there are an increasing number of financing vehicles and instruments available to scale up investment in NBS (Figure 15). The majority of these are open to Russia in various forms, with selected sources within international public finance, private finance and other financing options as discussed below.

Figure 15 Nature-based solutions: investor universe



Source: Sayers et al. (2019)

12 The Global Infrastructure Outlook (2017) was produced by the Global Infrastructure Hub and Oxford Economics. https://outlook.gihub.org/countries/Russia

13 http://government.ru/info/35569/

International public finance

Grants and concessional funds

Grant financing often comes from NGOs, philanthropic funds or government programmes, which are not limited to domestic sources. For example, grants available to Russia include funds from the Nordic Environment Finance Corporation (NEFCO) where the Nordic-Russian Programme for Environment and Climate Co-operation (PECC) provides grant financing for projects on the environment and climate. Therein, grants range from €30,000 to €200,000 and certain regions of northwest Russia are eligible to apply. Another example is the One Planet: Environment, Health, and Science grant from the US Mission to Russia, which offers grants up to $200,000 for projects that support the promotion of environmental, health and scientific issues in Russia. This would allow for broader collaboration between the US and Russia.[14]

Notably, grant financing can be limited in size and constrained by their funding cycle length, requiring developers to reapply for funding periodically if the grant does not cover the lifetime of the project (European Investment Bank, 2020). Other types of grants are also limited in scope. For example, grants provided by the City Climate Finance Gap Fund (implemented by the World Bank and European Investment Bank), just cover the early stages of a project. With that said, although grant financing has its limitations, such funding can be instrumental in providing start-up funds for projects. For example, the GreenTech Startup Booster environmental program of the Skolkovo Foundation and their partners provide winners with a grant worth RUB5 million for the implementation of their pilot project.[15] This is in addition to receiving other types of support such as mentoring and expert consultation. One of the five winners in 2020,[16] a company called Green Investments,[17] works on green asset solutions such as plantations of fast-growing CO_2-absorbing trees to help companies reduce their carbon footprint.[18]

Concessional loans from international finance institutions

International finance institutions (IFIs) provide access to investment funds through loans (often extended through credit lines to local financial institutions) and other financial instruments. Many IFIs view applications for NBS investment positively.[19] Such institutions include the International Finance Corporation (IFC) and the International Bank for Reconstruction and Development (IBRD) of the World Bank Group, and the Nordic Environment Finance Corporation (NEFCO). As of early 2021, the European Bank for Reconstruction and Development (EBRD) has a lending ban in place with Russia (although in the past they have funded projects, such as the Russian Sustainable Energy Financing Facility credit line and may again in the future) (Sconosciuto, 2013).

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14 See www.grants.gov/web/grants/view-opportunity.html?oppId=330127
15 https://greentech.sk.ru/
16 https://greentech.sk.ru/novosti1/nazvany-pobediteli-greentech-startup-booster/
17 https://ccs-russia.ru/prirodnye-ochistitelnye-zavody
18 https://russia.edf.com/en/edf/edf-took-part-in-russia-s-first-green-startup-booster
19 www.citygapfund.org

Many of these IFIs participate in global funds and multilateral instruments that target climate initiatives, and NBS are increasingly recognised under this heading. These include, for example, the Green Climate Fund (GCF) and the Global Environment Facility (GEF). The GEF was founded in 1992, predating the GCF, and it manages several trust funds and provides financial assistance (i.e. grants, co-financing) for global environmental projects.[20] Recently, the GEF announced partnerships that would support the use of NBS. In July 2020, they approved a $2 million grant for an initiative that will use financial modelling to make the business case for NBS (GEF, 2020a). In November 2020, they became the anchor investor in the Nature+ Accelerator Fund of IUCN, a fund for NBS projects of various maturity (GEF, 2020b). The Russian Federation has had experience with the GEF, with several projects in biodiversity and climate change approved between 2007 and 2010.[21]

Within the GCF, Russia is considered an Annex I party and is ineligible for GCF support. Instead, Russia plays the role of international donor and has a contribution arrangement with the GCF (an arrangement recently renewed) (GCF, 2020). Established in 2010 as a multilateral financing mechanism for the United Nations Framework Convention on Climate Change (UNFCCC), the GCF disperses funds through accredited entities through various instruments such as grants, loans, equity and guarantees. Russia also acts through other international donor programmes to help least developed countries address climate change, such as the UNDP–Russia partnership (UNDP, 2018).

Other loans from international finance institutions

Russia has the opportunity to avail of loans on non-concessional terms, and not necessarily through commercial banks. For instance, they can avail of funds for green projects from the New Development Bank (NDB), a multilateral lender established by the Brazil-Russia-India-China-South Africa (BRICS) group of countries. One key purpose of the bank is to support infrastructure and sustainable development projects in BRICS. They have established an Environmental and Social Framework to manage the environmental and social risks of projects, ensuring they are sound and sustainable (NDB, n.d.a.). It is worth noting the NDB does not necessarily lend on concessional terms and will use interest rates that reflect their funding costs and appropriate margins (NDB, 2016). Russia already has a few approved projects with the NDB, including a project on sustainable infrastructure for ZapSibNefteKhim, a project to develop the renewable energy sector with Eurasian Development Bank (EDB), and a water supply and sanitation program also with the EDB.[22] These projects use a two-step loan modality that allows the EDB to finance sub-projects in renewable energy, water supply and sanitation. While it has not yet been done, this sub-project lending can be extended to smaller projects such as NBS.

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20 www.thegef.org/about/funding

21 www.thegef.org/country/russian-federation

22 See www.ndb.int/zapsibneftekhim; www.ndb.int/development-of-renewable-energy-sector-in-russia-project ; and www.ndb.int/water-supply-and-sanitation-program-in-russia/

Private finance

Commercial banks

Debt and equity can be important tools where a lender or investor can reap a return from either general revenues, reduced costs or project-specific revenues. Companies can secure green loans directly from financial institutions to fund green initiatives. For example, in 2019, Metalloinvest, a steelmaker and iron ore producer and supplier in Russia, signed a sustainability-linked bilateral credit line with ING. The interest rate was tied to the corporate social responsibility rating done by EcoVadis (Metalloinvest, 2019). In 2020, Polymetal, a gold producing metal company in Russia, signed a green loan with Societe Generale to help the company transition to a sustainable and low-emissions economy. The loan structure follows the company's green financing framework (Polymetal, 2020).

VEB.RF, a non-profit state development corporation, has been collaborating with ministries, the central bank and the business community to create a national green finance system. This development should allow Russian firms access to favourable terms when applying for loans for green projects. The system is expected to be based on the Russian Green Finance Guidelines the VEB.RF is also working on (VEB.RF, n.d.). Notably, the current draft includes NBS in the Russian National Taxonomy of Green Projects, as it considers the 'development and introduction of nature-based solutions to restore certain types of ecosystems and natural landscapes'. This will apply to other green financial instruments to be discussed below.

Capital market financing

Green finance is a rapidly growing niche in financial markets and green bonds are the most used vehicle. Green bonds are similar to conventional bonds except that proceeds are earmarked for green investments. The current landscape for green financial instruments in Russia, however, is relatively new and remains sparsely populated. But this is changing. In August 2019, the Moscow Stock Exchange recently launched a Sustainable Development sector; the following November, Centre-Invest Bank launched the first green bond within this framework. The bond itself was worth RUB250 million to be used in line with the Green Bond Principles (2018) of the International Capital Markets Association (ICMA) as well as the bank's own Environmental and Social Policy (Moscow Exchange, 2019). Even before the launch of the sustainable development sector, two companies (a waste processing company called Resursosberezhenie KhMAO and Russian Railways),[23] were able to issue the country's first green bonds at the end of 2018 and 2019, respectively (RSB-HMAO, 2018; Russian Railways, n.d.). New green bonds have been issued in 2020; this includes a 10-year secured instrument issued by Solar Systems LLC (LLC 'SFC RuSol 1'), with proceeds looking to fund solar energy projects, and the second green bond issuance of Centre-Invest Bank (Climate Bonds Initiative, 2020; Centre-Invest Bank, 2020).

While the market for green bonds is still young, its potential has been recognised by Russian authorities. The Central Bank of Russia stipulates in their 'Russian Financial Market Development Program for 2019–2021' that the country will need to adhere to the global trend and develop financial markets that can stimulate sustainable development, including the development of

23 https://eng.rzd.ru/en/9643/page/5160?id=144

green bonds.[24] Early in 2020, the Central Bank of Russia issued rules for issuers planning to issue green, social and infrastructure bonds (Central Bank of Russia, 2020a).

Other instruments such as transition bonds or green securities are also available. Transition bonds can be used to help a company become less 'brown' and shift to 'greener' activities. These typically focus on processes and technologies for reducing pollution or GHG emissions from oil, gas, metals and mining companies, but could be accessed to support nature-based approaches to deliver similar outcomes alongside biodiversity gains.

Smaller projects can also access funding from asset-backed securities (ABS). Green ABS are assets collateralised or secured by a class of other assets and are considered green if the collateral used is green or the proceeds are used for green initiatives. ABS often allow access to relatively limited capital but at a lower cost; a context particularly useful for local scale NBS in the shorter term as a large-scale green finance market in Russia matures.

In-house company financing

NBS projects do not necessarily have to be large and can even be as contained as a rain garden or a green roof or façade. Many of these examples can be incorporated into privately built infrastructure, the funding and building of which is under the purview of firms or private individuals. In some cities, incentives are given to the private sector to adopt green infrastructure. For example, the New York City Green Infrastructure Grant Program offers grants for people to install green infrastructure on private property (City of New York, n.d.). In Singapore, the Skyrise Greenery Incentive Scheme (SGIS) offers a grant of up to 50% of the installation costs for green roofs or vertical greenery (National Parks Board, n.d.). Other European cities have also explored providing incentives for green infrastructure through co-financing, tax subsidies, reduced stormwater fees, legal requirements and other non-financial options. Similar schemes are not yet widely available in Russia, but some inherent benefits of NBS may be enough to entice private investment. For larger projects, other options such as public–private partnerships (PPPs) may be available.

Other financing options

Public–private partnerships

For projects that deliver an attractive return, developers can opt to use PPPs to finance NBS. PPPs are used for a variety of infrastructure projects and involve a long-term arrangement between the public and private sector, often in the implementation and provision of public services. Various forms of PPP arrangements exist but, in general, it comprises three elements: (1) a formal relationship between the public and private sector; (2) shared risk for parties involved; and (3) a financial reward for private sector participants (Gardiner et al., 2015).

Equitable risk-sharing between the public and private sectors make investments in new projects such as NBS more viable. The appetite for new types of projects such as NBS will likely be low. Green investments, particularly those involving infrastructure, often require high upfront costs and have long-term payoffs, translating to higher costs of capital. Private

24 https://cbr.ru/Content/Document/File/87952/fm_development_program_2019-2021.pdf

sector investors may find these terms difficult when the required investment is large (David and Vankatachalam, 2018). Thus, PPPs forge alliances with both sectors, allowing for a more favourable investment climate for NBS. Citizens and local firms of various sizes may be interested in making their cities greener and more liveable, providing opportunities for local engagement (Droste et al., 2017). Currently, there is no known use of PPPs in Russia to fund climate initiatives, green infrastructure or NBS, but there are some examples of PPPs in solid municipal waste management (Tolstoloesova, 2019).

Steps towards coordinated funding partnerships are, however, gathering momentum. In November 2020, for example, the Russian government took a positive step towards developing green finance by designating the Ministry of Economic Development to coordinate the development and financing options for sustainable (including green) finance projects (Box 1).

Box 1 Recent institutional developments in Russia in support of green finance

The Ministry of Economic Development will lead an interdepartmental working group including representatives from the Central Bank of Russia, development institutions and the business community to approve basic parameters of the green financing system, including definitions of 'green project' and 'green debt instrument'. This should result in the adoption of the Methodological Recommendations on Green Finance and Taxonomy of Green Projects – under development at the state development corporation Vnesheconombank since 2020 – as well as a plan for implementing measures that will allow for the state to support green projects (Ministry of Economic Development, 2020; Zubkov, 2020).

In 2019, the Central Bank of Russia, which leads the ESG investing working group (established in 2017), joined the Central Banks and Supervisors Network for Greening the Financial System (Central Bank of Russia, 2019a). The Central Bank of Russia is an increasingly vocal voice in addressing climate change, noting 'climate risks pose a threat to the sustainable progressive development of the financial system of the Russian Federation' (Central Bank of Russia, 2020b) and is exploring the introduction of climate stress testing and mechanisms to attract socially responsible financing, including green projects (Central Bank of Russia, 2019b; 2020c).

Land value capture

Land value capture (LVC) instruments are used for grey infrastructure projects but can be adapted to green infrastructure interventions such as NBS, though this remains untested, particularly in Russia (Grafakos et al., 2019). LVC refers to 'the idea of capturing the valorisation of the price of the land generated by the provision of urban infrastructure and services in order to finance this development' (Blanco et al., 2016). Interventions that increase the price of land (including land transformation from rural to urban, provision of new infrastructure, etc.) can add potential benefits to relevant properties and lead to higher land prices (ibid.). If the public and private sectors can use LVC instruments to capture the property price increase resulting from NBS, it can create a virtuous cycle where funds can be re-channelled back to green investments. LVC instruments could, for example, include betterment levies or fees, sale of building rights or taxes, etc. (Grafakos et al., 2019).[25]

Challenges

Opportunities to finance NBS do not come without challenges. In general, the current lack of knowledge of NBS can make finding financing difficult and there is a need to develop a means to de-risk projects. The lack of familiarity with NBS can lead to uncertainty among investors and higher perceived risk. Moreover, credit ratings for state enterprises and other firms are difficult to interpret. This higher associated risk will make it difficult and expensive to fund NBS projects, attract investors and/or provide access to serviceable commercial debt. In other words, it would be difficult for these firms to take on debt, green or otherwise. Catalytic financing mechanisms (with the aid of the public sector, concessional funds, development agencies) to de-risk projects and attract commercial investors would be necessary to improve uptake.

Another challenge to overcome is the need to properly incorporate the benefits accrued from NBS, creating and adapting valuation and accounting methodologies that can be integrated into investment and pricing models (Toxopeus and Polzin, 2017). If the benefits from sustainable NBS can be accounted for, this could improve the ability of NBS solutions to attract investments and factor into financial decision-making. There is an initiative from the UN Committee of Experts on Environmental-Economic Accounting to mainstream natural capital accounting to give countries a credible source of data linking the environment and the economy for the development of NBS for climate change. They use the SEEA framework developed by the United Nations Statistical Commission in 2012.[26] Russia published a 2017 revised official translation of the SEEA Central Framework where the terminology is harmonised with national legislation and distributed to institutions involved in environmental issues.[27] This can eventually be applied and adapted to NBS in Russia.

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25 The Curitiba (Brazil) Flood Protection Transfer of Development Rights (TDR) program was an example that used LVC concepts for green initiatives. Curtiba allowed for the transfer of development rights to preserve green areas for flood protection. They transferred development rights meant for conversion into parks to receive overflow and contain floodwaters.

26 See United Nations Committee of Experts on Environmental-Economic Accounting (2019) accessed here: https://wedocs.unep.org/handle/20.500.11822/28788

27 See Tatarinov et al. (2018), and the slides related to the paper here: https://unece.org/fileadmin/DAM/stats/documents/ece/ces/ge.33/2018/mtg2/S4_6_SEEA_Russia_Fomenko_EN_v2.pdf

Practical constraints to environmental lending

Environmental lending does come with caveats and requirements. Most financial institutions require credit line structures to impose criteria for eligibility that requires borrowers to meet minimum standards before an investment is considered acceptable. Lenders often require outcomes to be monitored as part of the loan agreement, such as energy savings or emissions data, as well as fairness and equality issues (OECD and EaP Green, 2014). It is likely that these requirements will be extended beyond climate mitigation outcomes to biodiversity and adaptation outcomes; as this happens, the case for NBS (over conventional infrastructure) will become increasingly clear. Beyond monitoring and evaluation targets, some participants are required to buy-in themselves. For the Financing Energy Efficiency in the Russian Federation project of the GEF implemented by the IFC/World Bank, financial institutions were required to pay a commitment fee, associated interest rates as well as an annual fee to access credit lines (GEF, 2014).

A long-term investment commitment is as important to NBS as many other infrastructure investments. NBS projects have national and infinite design life but require continued maintenance to sustain their performance and continue to accrue benefits. Ongoing monitoring and evaluation will be needed, as with any investment, to reassure investors. The many benefits of NBS also provide opportunities for multiple investors, and risk-sharing arrangements are feasible using multiple financing sources (Seddon et al., 2020).

In general, within much of the environmental lending space, there is a need to ensure real outcomes for nature as part of any NBS. There is a maturing framework to ensure outcomes are as stated, including the Green Bond Principles headed by the International Capital Market Association (ICMA), the EU Taxonomy Regulation[28] and EU Green Bond Standard, and in loan markets, the Green Loan Principles issued by the Loan Market Association (LMA) and the Asia Pacific Loan Market Association (Asian Development Bank, 2020). Many of these, however, focus on the narrow case of climate mitigation actions and emission reductions, but less so on NBS that seek to address a broader range of issues and place outcomes for nature (as well as people) as a central aspect of the solution. However, this is changing too. For example, the IUCN Global Standard for Nature-based Solutions can be used to make sure NBS projects meet a certain quality and credibility (IUCN, 2020).

28 This was released in June 2020 and put in force in July 2020. The EU Taxonomy launched the first green list classification for sustainable economic activities. This is expected to drive more investments in the green and sustainable projects as it provides a standardised definition of what is considered a 'green' project (https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en).

5 Challenges to up-scaling nature-based solutions in Russia

Some of the most important challenges to overcome in upscaling NBS in Russia are discussed below, with many, if not all, relevant to the UK and more widely.

Political support for climate action and environmental regulation

The formal ratification of the 2016 Paris Agreement in late 2019 and the publication of a NAP were positive steps towards accelerating Russia's climate action. The NAP sets out the regulatory, methodological and institutional foundations for adaptation. This momentum has been further reinforced with a Presidential Decree instructing the government to work towards meeting the Paris Agreement (Bershidsky, 2019; Kozin, 2020). The Decree, published in November 2020, requires that by 2030 there is a 'reduction in greenhouse gas emissions by up to 70 percent compared to the 1990 level, taking into account the maximum possible absorbing capacity of forests and other ecosystems and subject to sustainable and balanced socio-economic development of the Russian Federation' (Presidential Executive Office, 2020). Although welcome, the reality of the ambition embedded in the 30% emission target is limited given Russia already emits GHGs at 52% of 1990 levels (Osborn, 2020).

The recently published Presidential Decree on 'Measures to implement the state scientific and technical policy in the field of environmental development of the Russian Federation and climate change' builds on the November Decree and stipulates that within six months of publication (February 2021) the government should develop a technical programme on ecological development and climate changes at a federal level. The aim of the programme is three fold, and includes provision of ecological security, studying climate change, including adaptation, and securing stable socio-economic development with low GHG emission (Presidential Executive Office, 2021).[29] However, the impact the programme will have on the country's GHG emissions is unclear owing to the limited ambitions of Russia's GHG emissions target.

In Russia, environmental legislation has obliged developers to undertake an Environmental Impact Assessment (EIA) and submit these for a State Environmental Expertise (Review) since the 1990s. An EIA does not necessarily lead to greater uptake of NBS approaches. EIAs often happen only once the promoter has decided on the approach and often fail to influence the option choice. The use of Strategic Environment Assessments (SEAs) should allow for an evaluation of the interconnections between the different systems, including human and natural systems, have the potential to influence NBS take up. All major programmes are required to undertake SEAs and should explore these alternatives. There is no clear conception of ecosystem approach, however, and limited tools are available to aid this assessment. Because of this, as in many other countries, the options appraisal is often too narrowly cast.

29 The Decree also stipulates creating conditions to implement GHG reduction as well as an increased capacity to absorb GHG gases.

Russia is a member of Global Environmental Monitoring System (GEMS) and, in general, monitoring functions in accordance with GEMS principles. Industrial environmental monitoring (largely self-monitoring) is a well-established system with requirements that are set in the environmental legislation and in the national standards. For example, Sakhalin Energy operates a large monitoring programme in the Okhotsk Sea and the Sea of Japan, and Lukoil monitors water and sediment quality as well as aquatic life of the Caspian Sea. In general, however, the focus on self-monitoring limits the ability for independent oversight and the establishment of more strategic monitoring activities.

Despite positive policy initiatives, the willingness to take action in response to an observed or projected environmental change is unclear. For example, although not a NBS per se, proposals for a new national carbon trading system and penalties were scrapped in response to pressure from major hydrocarbon and commodity producers. Instead, a more basic monitoring requirement was introduced as part of a five-year green audit (Burmistrova, 2019). Most recent announcements indicate that a government commission on legislative activities supported the draft law on limiting GHG emissions that involves establishing a national regulation system and project mechanisms to reduce GHG. Russia is also looking to create target indicators for limiting GHG emissions and methods to assess them. A pilot study in support of this ambition to establish a carbon trading system is taking place in Sakhalin. The aim is to be carbon neutral in the region by 2025 (Gulalieva, 2021).

Public support for climate action and restoring ecosystems

The public desire for restoring and safeguarding the environment is increasingly strong in Russia; recent opinion polls suggest that almost half of Russians view environmental degradation as the greatest global threat, ahead of global terrorism, armed conflict and wars, and climate change (Levada Centre, 2020). Addressing air and water pollution, recycling of household waste and the management of nuclear waste are major issues of public concern. In 2018 the Russian government introduced National Project Ecology which aims to improve environmental performance across 11 pillars, including addressing household waste, air and water quality, and implementing best available technologies.[30] Yet, despite the links between the two, greater concerns about environmental degradation do not necessarily translate into greater concerns about climate change and its impacts, with many continuing to view climate change as part of a natural cycle (Snakin, 2014).

The high importance attributed to environmental issues by the public and the more limited concern associated with climate change was reinforced in August 2020. A survey by the Russian Public Opinion Research Centre and National Energy Security Fund found that Russians view addressing environmental issues with more urgency than climate change (VCIOM, 2020). While many Russians were greatly concerned about the Siberian wildfires in 2019 – particularly from a wildlife and human health perspective – expert explanations linking the fires with climate change

30 National Project Ecology pillars include: clean country, eliminating illegal landfills; integrated system for municipal waste management; infrastructure for handling especially hazardous waste; fresh air; clean water; revamping the Volga river; preservation of Lake Baikal; preservation of unique water objects; conservation of biological diversity and ecological tourism development; forest preservation; and implementing best available technologies.

were not readily accepted by the public. Instead, the public linked the fires with illegal logging and poor government response (Levada Centre, 2019).

Long-term commitment to nature-based solutions

In every country, political decision-making is often characterised as biased towards short-term outcomes and the demand for immediate results. NBS are a long-term commitment and often take time to establish; for example, tree planting or wetland restoration. Coupled with the inherently longer time many NBS take to yield their benefits, and the perceived uncertainty in those benefits when compared with conventional alternatives, this can restrict their use (Primmer and Furman, 2012; Sayers et al., 2015; Gillard et al., 2017).

In order to make progress, there are significant hurdles to overcome: the high level of long-term political commitment required, and lack of political will to tackle businesses' vested interests and perceived scepticism of NBS. In October 2020, the Russian government reiterated that it had no plans to introduce carbon taxes, citing difficult economic conditions and reluctance to pass on the higher costs to consumers (Interfax, 2020b), although this may change in the coming months with the first regional ETS being introduced in Sakhalin. This lack of national commitment to carbon reduction may foretell the fate of financing for environment outcomes, but more NBS projects often also afford locally tangible outcomes for people (reduced smog and recreation) as well as nature, a case that is perhaps central to progress in Russia.

Perceived uncertainty and resistance to change

The implementation of innovative solutions challenges the status quo, and NBS approaches often meet with resistance (Walport, 2014). NBS are often perceived as less tried and tested and uncertainty around performance and maintenance gives rise to a tendency to adopt conventional interventions (a 'bias to build' (Sayers et al., 2019b)). City planners and engineers responsible for the development and implementation of plans often choose interventions that provide certain outcomes that deliver benefits over a short period of time. NBS, however, are known to involve more uncertain and long-term outcomes, such that developers report a fear of failure with NBS (Kronenberg, 2015). Risk aversion and a concern with financial loss has led to a strong resistance to change and a preference to install traditional built infrastructure as opposed to NBS (Davies and Lafortezza, 2019).

This perspective is underpinned by a perceived lack of information regarding the performance and benefits of NBS (Sarabi et al., 2019). To date, the NBS knowledge base has remained mostly in scientific literature, within published papers and as theoretical concepts, and in the context of a particular implementation (including, in recent years, an increasing number of pilots and case studies). There remains, however, a need to translate this collective experience into broadly applicable and practical guidance and assessment tools.

Communicating the performance and success of demonstration projects helps leverage policy change and new planning practices (as illustrated in the recent publication of the UK Flood and Coastal Risk Management Strategy that emphasises natural flood management). At a local scale, the use of NBS ambassadors also acts to improve communication with the local community and develop confidence within it (Moore and Westley, 2011). Creating accessible open-access knowledge platforms can be

influential in increasing support and leading to the development of shared guidelines and best practices.

'Breaking free of the silo' – nature-based solutions demand a more integrated approach

NBS are most appropriate when used as a solution to address multiple, interlocking challenges, but these might fall to different levels and sectors of government to address. The multifunctional benefits that a well-designed green space in a city could yield, for example, are health benefits (by improving air quality and encouraging physical activity); economic benefits (by increasing tourism); reducing the need for heating and cooling; and reducing flooding and treatment requirements (by improving purification, infiltration and storage of water). Achieving these multiple benefits, however, requires collaboration (between departments, infrastructure providers, developers, etc.); but these agencies rarely come together to look for integrated solutions to these problems – they tackle each one individually according to their particular mandate. This 'silo thinking' is frequently cited as a barrier to the successful adoption and implementation of NBS; different departments and institutions have different visions, goals and legal structures, which can prevent collaboration and transitioning to NBS approaches. 'Breaking free of the silo' (Sayers et al., 2019b) argues that multi-sectoral collaboration is essential in successful implementation as the solutions deliver multifunctional benefits (Pasquini and Cowling, 2015; Davis and Naumann, 2017).

Siloed perspectives not only exist across disciplines and policies but also spatially. Investments tend to focus on project scale support rather than enjoying a strategic system scale (e.g. catchment) level response. Consequently, infrastructure development is only focused on local level impacts and fails to consider the interconnectedness of the whole system. For instance, hydrological infrastructure projects are often isolated from the broader functioning of the river and the wider catchment, ultimately limiting the potential benefits and even harming the ecosystem in some cases (Speed et al., 2016; Fuller and Death, 2018).

In Russia this siloed perspective often equates NBS to 'protected' areas – suitable only in the context of national parks, not necessarily for businesses or in urban environments. Although growing evidence suggests that more regional governments are starting to recognise NBS – as shown by initiatives in Moscow that include an ambition to restore natural landscapes, including parts of the Skhodnya river (Moscow Mayor, 2020), and Kuzbass (UNDP, GEF and Ministry of Natural Resources, n.d.).[31] A similar attitude dominated early approaches to green infrastructure in the US (focusing on national parks) and is a common perspective in many ministries in Russia. Quantified assessment tools and strategic catchment and city planning

31 See http://bd-energy.ru/documents/%D0%98%D1%81%D1%82%D0%BE%D1%80%D0%B8%D0%B8%20%D1%83%D1%81%D0%BF%D0%B5%D1%85%D0%B0/CASE-KEMEROVO.pdf and www.kuzbs.ru/images/stories/pdf/izdania/sbornik_innovacionnih_reshenyi.pdf.

frameworks offer a means of overcoming this narrow perspective; any area that lends itself well to a UK–Russia collaboration.

Design and maintenance standards and monitoring guidelines

As NBS have only recently become a mainstream choice of implementation, there is much uncertainty around best practices and ways to monitor NBS (Sarabi et al., 2020). In particular, context-specific guidelines are missing that facilitate effective responses to the specific challenges a city or region faces (Zuniga-Teran et al., 2020). To plan, design, implement and monitor effective NBS, an understanding of local context is required to recognise specific resource management and socio-cultural challenges. Effective monitoring and assessment guidelines require knowledge of local conditions, making the provisioning of commonly applicable and transferable frameworks a regular challenge (Schmalzbauer, 2018).

Specific sectors are gradually recognising NBS as effective. For example, in Volgograd region, restoration of former pesticide dumping sites includes both mechanical and chemical operations and bioremediation. Implementation in broad contexts (to aid flood management, water quality, etc.), however, lack design and monitoring guidance.

Political support (as discussed earlier) is vital to promote NBS as well as a supportive regulatory and incentivised environment to facilitate encourage investors (Zuniga-Teran et al., 2020).

Making the investment case: developing bankable propositions

The case for NBS is well accepted in concept but various barriers have slowed progress. This is often attributed to issues of uncertainty in performance, difficulty in articulating the benefit in terms comparable with conventional infrastructure, and investment complexity (Sayers et al., 2019a). This is changing as public support and political ambition increase, supported by various tools that are emerging to help make 'nature's values visible' (such as global frameworks around The Economics of Ecosystems and Biodiversity (TEEB, 2010)) and assess the contribution of NBS to thematic adaptation (see Box 2).

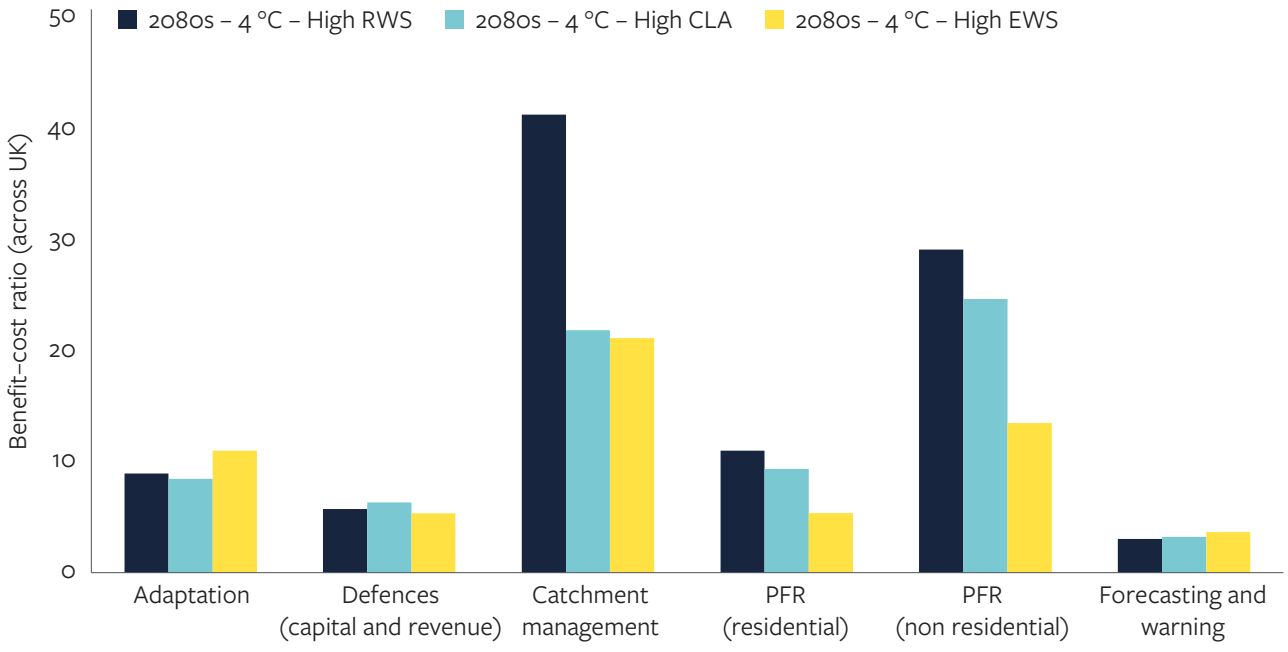
A common misperception appears to be that the implementation, and particularly the maintenance, of NBS results in higher costs than conventional infrastructure. This is despite the evidence that NBS are associated with lower whole life overall costs (Li et al., 2017). In addition to the perceived high costs, a lack of available financial incentives has been reported as a barrier (Li et al., 2019), preventing collaboration between the public sector, business owners and the public. Financial incentives such as cost-sharing or tax breaks would likely increase the chances of owners and developers investing in NBS (Dhakal and Chevalier, 2016). Consequently, the strengthening of the business case for NBS is urgently required to increase development opportunities and public-private partnerships (Davis and Naumann, 2017).

Box 2 Making the case for nature-based solutions within flood management, UK

The future flood projections included in the latest UK Climate Change Risk Assessment (CCRA3) explore future flood risk at a national scale under a range of future population, climate and adaptation scenarios (Sayers and Carr, 2020). The analysis highlights that within the alternative adaptation portfolios, conventional flood defences (both capital and revenue investment) remain the most important flood risk management measure; but natural flood management makes a significant contribution to reducing expected annual damages (particularly reflecting their ability to contribute to the management of more frequently occurring events). The importance of their contribution increases in more severe climate futures (offering a greater contribution in a 4°C future compared to a 2°C future). In addition, the associated costs of the natural flood management are small compared to the benefits, hence the benefit–cost ratio is high (Figure 16).

There is strong spatial component to the benefits of natural flood management, an aspect illustrated in a recent downscaling of the analysis to consider adaptation benefits within the Oxford–Cambridge strategic development corridor in the UK. The estimated present value benefits for natural flood management (through to the 2100s) for this region are also significant, as illustrated in Figure 17.

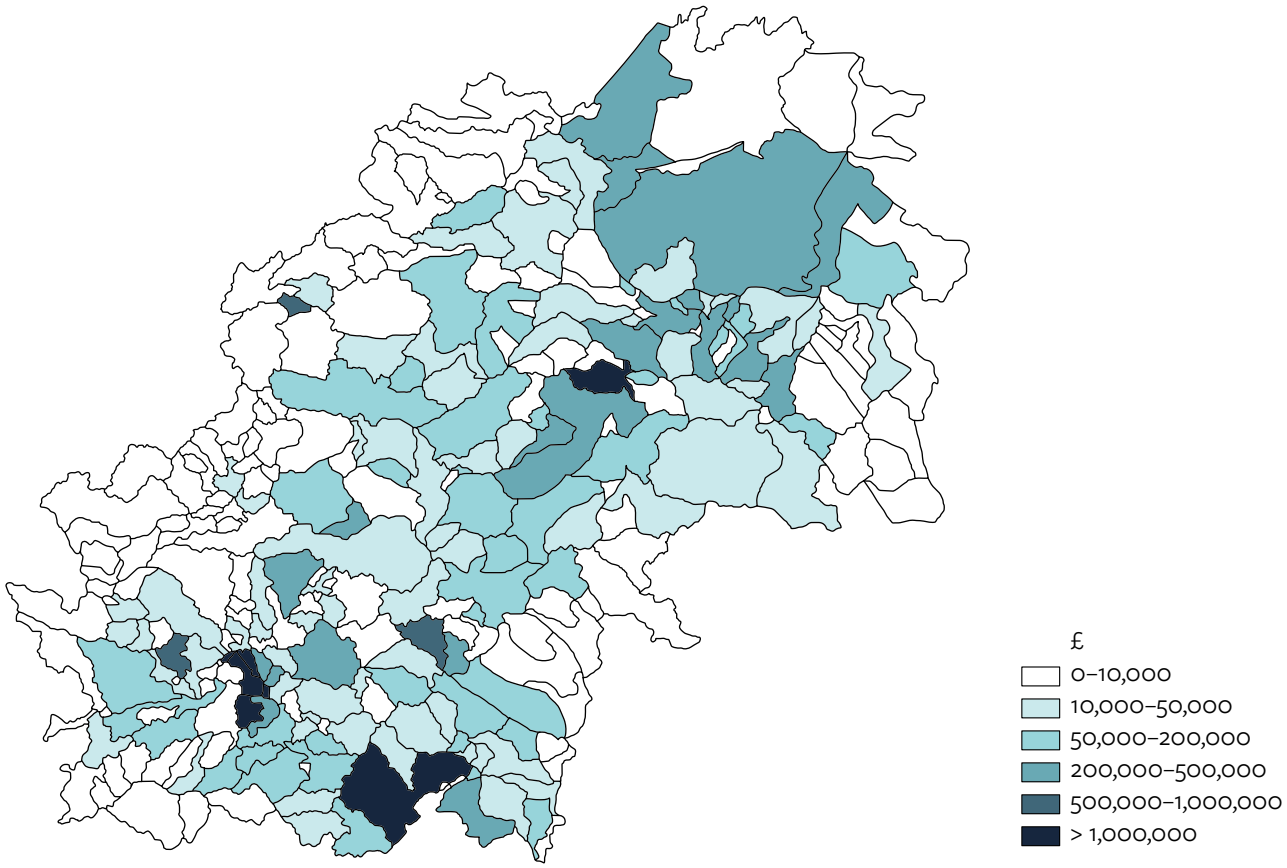
Figure 16 Benefit–cost ratios of individual adaptation measures as part of alternative adaptation portfolios



Note: RWS, reduced whole system adaptation; CLA, continuation of current levels of adaptation; EWS, enhanced whole system adaptation; PFR, property flood resilience.

Source: Sayers and Carr (2020)

Figure 17 Understanding the spatial variation in the benefit of natural flood management across the Oxford–Cambridge development corridor



Source: Sayers and Carr (2020)

6 Conclusions and recommendations

Report conclusions

NBS approaches across all sectors and all scales have an important future in supporting Russia's adaptation and mitigation efforts. Developing a greater awareness of these NBS opportunities (from local treatment of effluents to regional-scale wetland or forest restoration) and articulating these opportunities in policy-relevant terms is now needed to progress. The ability to make the case for NBS is a challenge not only faced in Russia but also in the UK and elsewhere. Through this scoping report several thematic areas have emerged that will need to be addressed if this potential for NBS is to be realised.

Policy and strategy – environmental protection and restoration

The recently published NAP provides several 'hooks' to promote NBS. The plan identifies negative impacts of climate change, such as greater risks to public health; extreme weather events – more frequent and intense droughts in some regions and extreme precipitation and floods in others; and growing electricity consumption due to higher demand for air conditioning. The adaptation measures will include 'preventative (proactive) adaptation', reducing risks associated with climate change through flood dam construction and forest shelter belts, and adaptation of population, infrastructure and economy to direct and indirect impacts of climate change. Making a case for 'green' and 'blue' infrastructure instead of 'grey' – for instance, creating parks and restoring wetlands to absorb floodwaters rather than building river and sea walls, or planting trees to cast shade instead of using air conditioners – can help mitigate negative risks identified in the NAP, which can be useful in increasing uptake in planned adaptation measures.

An area of focus that combines public desire and the opportunity for NBS perhaps most readily is the restoration of degraded ecosystems. Many landscapes across Russia have been degraded through the exploitation of natural resources, including oil, coal and ore mining operations. Historical pollution and landfill (both legal and illegal) have also led to significant degradation. Focusing on the restoration of these landscapes affords a significant opportunity at scale for NBS; an opportunity recognised within the framework of the Federal Project 'Clean Country' (2018–2024) that is focused on addressing the accumulated environmental damage from past industrial activities.[32]

Making the investment case – accessing finance

Accessing finance will be central to realising the NBS opportunities in practice. Green finance in Russia is starting to be recognised by the Central Bank and other authorities. Many national financing instruments and vehicles, however, are yet to be adapted to prioritise NBS and many of the growing array of international green financing vehicles have yet to achieve traction in Russia. But the investment landscape is rapidly evolving and there is significant scope to influence and upscale access to NBS finance within Russia.

32 http://static.government.ru/media/files/pgU5Ccz2iVew3Aoel5vDGSBjbDn4t7FI.pdf

Public procurement – promote NBS through procurement

Damianova et al. (2018) highlight that Russia's 'public authorities are major consumers', spending 'trillions of rubles [RUB] annually, representing around one third of Russia's GDP'. They propose introducing environmental performance in government public procurement processes to facilitate green finance. Similarly, the country could use public procurement to promote NBS. Russia's national development goals for the period until 2030 include improving living conditions of at least 5 million families annually and increasing annual housing construction and associated facilities (hospitals, etc.) to at least 120 million square metres.[33] Moscow, Russia's capital and the country's most populous city, plans to greatly increase its housing stock, disposing of the old housing stock and modernising existing buildings as part of urban development plans until 2025. At the same time, promoting a safe ecological environment is a key pillar of the Moscow Smart City 2030 Master Plan. Its goals include achieving efficient use of resources, adaptation to climate change, and better environmental situation in the city. In terms of urban planning, 'green' construction concepts and 'smart house' technologies will be used to maintain 'a comfortable and healthy urban life environment'.[34] Integrating green options, including NBS, in public procurement therefore aligns with strategic goals for the city's development.

Accessing innovative financing vehicles

Increasing global interest in addressing issues such as climate change makes opportunities from international public finance a viable option. Several grants are available to Russian groups and innovators, and concessional and non-concessional loans are available from international initiatives such as those provided through the GEF or NDB. Beyond international funds, private financing options can be used by firms who want to find ways to incorporate NBS in their infrastructure projects. Capital markets can be tapped with the development of green bonds and other green financial market instruments that cater to smaller-scale projects like NBS. Commercial loans can be availed of especially as the national green finance system is developed. In-house financing can be tapped if firms can recoup their investments back, especially for smaller projects such as green roofs or community gardens. Otherwise, the private sector can work with the public sector through options such as PPPs or use other options such as capturing the increased value of properties that use NBS like user fees. In sum, many of these financing opportunities are just starting to emerge, and those that are nascent have the potential to be used more conventionally in the future. Realising the opportunities these provide and accessing them will underpin the upscaling of NBS.

Design guidance – influencing infrastructure and development design and material choices

Encouraging large infrastructure providers and developers to adopt NBS as part of their infrastructure investments is a core opportunity (both in Russia and elsewhere). This includes multiple strands of persuasion, from developing mechanisms to enable strong community and public engagement in the choices made through to mandated requirements within the EIA and

33 http://kremlin.ru/events/president/news/63728
34 https://2030.mos.ru/netcat_files/userfiles/documents_2030/strategy_tezis_en.pdf

SEA process (although legislation change is often the most difficult to enact). There are also various best practice guides and tools that could be used to encourage the mainstreaming green investments, through building regulations and urban planning guidelines to aid sustainable choices. For example, assessments such as BREEAM[35] provide sustainability monitoring though third-party certification for master planning projects, infrastructure and buildings. BREEAM certification recognises the environmental, social and economic sustainability performance of an asset, by monitoring impacts during planning, design, construction, operation or refurbishment. BREEAM-rated developments promote the well-being of residents, help to conserve natural resources and are more attractive property investments.

Knowledge sharing

Opportunities to share knowledge and practices on NBS exist through a growing number of projects seeking to support Russia on mainstreaming NBS and related issues such as biodiversity conservation. In addition to the current project, European Agenda on Nature-Based Solutions and Re-Naturing Cities for Russia (EARth), jointly implemented by the Pskov State University and partners from Estonia and the Netherlands, is looking to support Russia on NBS. The project runs between 2018 and 2021 and identifies and analyses the gaps and constraints for the application of NBS and update EU research and innovation policy with a focus on northwestern regions. As part of a project that aimed to mainstream biodiversity conservation in policies and programmes for Russia's energy sector, UNDP/GEF and the Ministry of Natural Resources published a collection of innovative solutions for conservation of biodiversity for the coal mining sector in Kemerevo, Novokuznetsk.[36]

Other opportunities to share knowledge on NBS also exist under the framework of the National Ecological Security Strategy, which suggests that between 2017 and 2025 the country should establish a multi-sectoral system for sharing knowledge on the modern environmental technologies and practices with government bodies, commercial enterprises and educational institutions. Other opportunities may exist under the framework of Federal Project 'Clean Country' under the National Project 'Ecology'.

Recommendations for further UK–Russia collaboration

There are many common challenges in delivering NBS at scale in Russia and the UK, and multiple pathways for sharing knowledge and expertise.

From the discussion and reviews that have supported this scoping report, four priority recommendations for future collaboration have emerged, designed to help the UK and Russia accelerate and upscale the on-the-ground implementation of NBS. These are set out below.

Upscaling nature-based solution finance: mapping the landscape of opportunity and overcoming barriers

A detailed mapping of the financing landscape in Russia and what forms a bankable proposition is needed to help release nascent financing potential. For example, conventional financing mechanisms remain based on well-defined criteria and can

35 www.breeam.com/
36 https://earth.pskgu.ru/

be difficult to apply to the multiple benefits that underpin the case for NBS. Approaches to leveraging conventional private finance are made more difficult by the lack of clarity around the credit ratings for state enterprises and private firms and the limited (but evolving) ability to account for the full range of benefits in support of a bankable proposition.

There are several innovative vehicles and instruments now available to help scale investment in NBS. Grants are available to Russian groups and innovators, and concessional and non-concessional loans are available from international initiatives such as those provided through GEF or NDB. Beyond international funds, private financing options for NBS are burgeoning as the private sector seeks to offset emissions and deliver broader corporate sustainable agendas. Capital markets also offer support for NBS through green bonds and other earmarked market instruments. Blended finance is increasingly seen as a means to deliver NBS at scale. This includes the use of catalytic financing mechanisms to leverage private sector contributions with the use of allied public sector support, concessional funds, or development agency investment. These multi-funder approaches can help to de-risk private sector investment.

Innovative financing opportunities are now starting to emerge as part of the evolving landscape for green financial instruments in Russia. In August 2019, for example, the Moscow Stock Exchange launched, for the first time, a Sustainable Development sector. The understanding of the range of financing mechanisms and the opportunities they provide, however, remains limited, and financing continues to be repeatedly cited as a barrier to NBS.

What is clear is that opportunities for green finance are growing and evolving rapidly in the UK, Russia and elsewhere. Understanding the dynamic landscape of available financing vehicles, the market structures needed to facilitate them and how to package bankable propositions to access them will underpin the success, or failure, of mainstreaming NBS.

Summary research recommendation:
To undertake a deep dive into the landscape of green financing in Russia. This should include a detailed review of the current and emerging opportunities and associated perceived and real constraints to access (including market structures, the sharing of risk and reward and the development of bankable collaborative propositions).

Quantifying the national NBS opportunity: identifying the 'hotspots' for action

Delivering NBS at scale requires collaboration (between departments, infrastructure providers, developers, etc.). Different departments and institutions have different visions, goals and legal structures, which can prevent collaboration. Consequently, these agencies rarely come together to look for integrated solutions to climate-related socio-economic and environmental problems, often choosing to tackle each individually according to their mandate. This 'silo thinking', which is common around the world, is frequently cited as a barrier to the successful adoption and implementation of NBS (Gütschow et al., 2021).

Motivating collaboration is central to achieving the multiple benefits that NBS offers. In turn, this requires an understanding of where these opportunities are greatest and across which sectors. This spatially explicit understanding of the potential benefits (from reduced flooding, pollution and fire risk to improved air and water quality) underpins an evidence-based national dialogue on the uptake of NBS. Large-scale

spatially explicit assessments of the opportunity for NBS (benefits and costs) have been shown to be instrumental in promoting the policy and investment case for NBS within the UK and elsewhere. Developing a similar understanding for Russia would provide a powerful incentive for policy change and increased investment in NBS. Properly accounting for the multiple benefits of NBS within investment and pricing models, and illustrating their distribution in space and time, makes it easier to attract investment. There have been steps in this direction. For example, the translation of the SEEA framework into Russian and harmonisation of the terminology used with that of Russia's national legislation is positive progress. This type of accounting, however, relies upon credible evidence of the benefits of NBS; without this, national-scale appreciation of the potential benefit investment is likely to be constrained to local activities and the opportunity to embed NBS as a legitimate element in meeting the projected infrastructure gap may be missed.

Summary research recommendation:
To undertake a national-scale quantified assessment of the NBS opportunities across Russia under present and future scenarios. This assessment should necessarily consider economic, well-being and biodiversity metrics and enable disaggregated insights by region, settling (urban and rural), demographic and sector.

Generating confidence in NBS performance through exemplar studies: Meshchera Lowlands

Many remain sceptical of the ability of NBS to deliver its intended benefits in helping society adapt to and mitigate climate change. Such scepticism is found in the UK, Russia and elsewhere and continues to hinder progress, particularly when expressed in the absence of a clear political commitment. The formal ratification of the 2016 Paris Agreement by Russia in late 2019 followed by the publication of the National Adaptation Plan in January 2020[37] provides a positive step towards accelerating Russia's climate action.

Communicating the performance and success of pilot NBS projects can overcome such scepticism and help leverage both policy change and new planning practices (as illustrated in the recent publication of the UK Flood and Coastal Risk Management Strategy that emphasises natural flood management). Such studies can challenge the misconceptions of higher whole-life costs and illustrate the tangible local outcomes for people and the economy that NBS provide. The rewetting of the Meshchera Lowlands pilot studies, for example, provide local biodiversity gains, reduce the chance of fire and hence act to limit GHG emissions and prevent a repeat of the devastating smog and associated loss of air quality in Moscow in 2010. Effective monitoring and promotion of pilot activities provide an opportunity to demonstrate the local environment and global climate win–win benefits that are perhaps of central importance to progress in Russia.

Summary research recommendation:
To develop NBS planning, design and monitoring guidance. The proposed research will bring together lessons from pilot studies across Russia and extend insights through collaborative working in the Meshchera Lowlands (focusing on peatland restoration). The pilot activities should demonstrate the use of alternative methods and tools to make the case for NBS, and plan and monitor NBS that deliver outcomes for nature and people.

37 Presidential Executive Office (2020) Decree of the President of the Russian Federation 04.11.2020 No. 666 (http://kremlin.ru/acts/bank/45990).

A collaborative knowledge agenda: research and capacity-building

The UK and Russia have much to share regarding the policy, practice and science of NBS. The REACT scoping has highlighted a real appetite for knowledge-sharing on NBS from Russian academia and policy-makers alike. Such knowledge-sharing opportunities include science leadership, training and educational programmes, and sharing lessons on implementation. The development of a framework of knowledge collaboration between the UK and Russia offers an opportunity to underpin the implementation of NBS through awareness-raising and the exchange of methods and tools. Focused training and educational programmes (for student and early-career training modules, as well as professional development courses), supported by a collation of NBS examples and field trips, will help to provide a common understanding to be shared by a cohort of future decision-makers. Sharing implementation lessons through peer-to-peer learning is also proposed to provide an opportunity to 'show and tell' stories of success and reasons for failures. It is envisaged that such exchanges would include convening high-level investor and policy community workshops as well as themed exchanges (e.g. on wetland restoration or city greening) between UK and Russia.

Summary research recommendation:
To develop a platform of sustained exchange that builds capacity and shares skills and expertise around the theory and practice of NBS delivery.

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