From COVID-19 to Green Recovery with natural capital accounting

Abstract

The COVID-19 pandemic and related social and economic emergencies induced massive public spending and increased global debt. Economic recovery is now an opportunity to rebuild natural capital alongside financial, physical, social, and human capital, for long-term societal benefit. Yet current decision-making is dominated by economic imperatives and information systems that do not consider society's dependence on natural capital and the ecosystems services it provides. New international standards for natural capital accounting (NCA) are now available to integrate environmental information into government decision-making. By revealing the effects of policies that influence natural capital, NCA supports identification, implementation and monitoring of Green Recovery pathways, including where environment and economy are most positively interlinked.

Introduction

The COVID-19 pandemic has disrupted economies, societies, and livelihoods around the globe. To mitigate health, unemployment, and other socio-economic impacts, Governments quickly responded with increased resources for health care, followed by economic support packages for *economic rescue* to ease the impacts of national lock-downs and disrupted supply chains. More recently, Governments moved to *economic recovery* spending, aiming to restore employment and economic activity to pre-pandemic levels. This spending on economic rescue and recovery is of an unprecedented size and type, with unclear

implications for sustainable development (O'Callaghan and Murdock, 2021). Depending on the measures taken and their implementation, spending can have either long-lasting positive or negative impacts on the environment (Hepburn et al., 2020; OECD, 2020, Piaggio and Siikamäki, 2021; Vivid Economics and F4B, 2021) and the natural capital on which society and the economy depend (IPBES, 2019; Dasgupta, 2021; UNEP, 2021).

Natural capital is a term commonly used and is defined by Bateman and Mace (2020) as "those renewable and non-renewable natural resources (such as air, water, soils, and energy), stocks of which can benefit people both directly (for example, by delivering clean air) and indirectly (for example, by underpinning the economy)". Biodiversity (genes, species and ecosystems) are a part of natural resources although they are not separately identified in the examples of this definition.

Governments have announced increasing levels of recovery spending, totalling US$2.14 trillion in the first 18 months since April 2019 (Fig.1). Most spending was by high-income countries. Dasgupta (2021) highlighted that investment in natural capital is an investment in the economy and society, but governments have not yet translated this understanding into economic recovery spending. Around 24% of announced recovery spending is 'green' (contributing to environmental objectives) and most is targeted at climate change mitigation, with 3% positive for natural capital, and up to 17% negative (O'Callaghan and Murdock, 2021).

Nevertheless, there is increasing recognition that recovery efforts should not only address economic recovery, but should also be green, inclusive, and resilient (Lucas and Vardon,

2021). *Green*, in strengthening natural capital and addressing biodiversity loss and climate change; *inclusive*, in tackling the inequalities that the pandemic has exposed; and *resilient*, in preparing for future crises and shocks, including the impacts of climate change and biodiversity loss. Inadequate attention to the environmental dimensions of economic recovery spending makes achieving international goals, such as in the Paris Agreement, the Post-2020 Global Biodiversity Framework, and the UN Sustainable Development Goals (SDGs) harder to reach.

Decisions are often made with insufficient information or consideration of environmental pressures (e.g., by CO_2 emissions, and waste, overexploitation of fish and forests) and dependencies on natural capital. This overlooks societal dependence on natural capital and economic and social gains from investments in natural capital (Dasgupta, 2021; Piaggio and Siikamäki, 2021; UNEP, 2021). Natural Capital Accounting (NCA) provides coherent environmental and economic data that can be used by existing policy analysis, models and tools (Vardon et al., 2016; Bassi, 2021; World Bank, 2021b). NCA serves as a bridge between economists and environmental scientists, enabling better decision-making for sustainable development, by including information on the impacts and dependencies of society on natural capital (Ruijs et al., 2019).

The aim of this perspective is to demonstrate how NCA can help design, implement and monitor a Green Recovery and put the world on a sustainable development pathway. While business has a role in Green Recovery, and has adopted various forms of sustainability reporting (e.g., International Integrated Reporting Framework and Natural Capital Protocol), the focus of this paper is on public policy and how to improve current national information

systems that do not properly account for natural capital, hindering decision-making for sustainable development. It is recognised that the COVID-19 pandemic has had impacts on the environment (e.g., Rume and Islam 2020) but an examination of this is beyond the scope of this paper.

Green Recovery and natural capital approaches

Economic recovery spending aims to increase aggregate demand and employment through direct capital investments, as well as expansionary fiscal and monetary policies and targeted sectoral policies, with high economy-wide spill-over effects (Lucas and Vardon, 2021). By bringing human and environmental challenges, such as climate change and biodiversity loss, to the forefront, Green Recovery can combine short-term socio-economic recovery with medium- to long-term transitions to address persistent human and environmental challenges. Green Recovery builds on notions of green growth, green economy, circular economy (Stahel, 2016) and sustainable development (WCED, 1987), notions which have been broadly harmonised in the 5 principles for "inclusive green economies" facilitated by the Green Economy Coalition (Partners for Inclusive Green Economy, undated).

Three Green Recovery strategies can be distinguished, each with different ways of linking socio-economic recovery to the achievement of societal goals, including the Paris Agreement and the SDGs, and related sustainability transitions (Maas and Lucas, 2021; Table 1). They describe a continuum of "shades of green," ranging from incremental improvement to stuctural reform of the economy (Hopkins and Greenfield, 2021) or transformative change of society (Díaz et al., 2019). Green Recovery initiatives are recent

but growing; The Green Recovery Tracker reports on 41 countries with Green Recovery policies and shows more countries are developing such initiatives.

Despite some differences, each Green Recovery strategy is concerned with maintaining or enhancing natural capital for the benefit of current and future generations. They recognise that protecting, sustainably managing, and restoring natural capital, provides short-term employment and boosts economic growth, while at the same time delivering social benefits (such as improving health and food security), improving ecosystem services (e.g., flood control and carbon sequestration), reducing physical risks (e.g., flooding and storm-related damage), and helping to prevent future pandemics (Cohen-Shacham et al., 2016; IPBES, 2019; Palomo et al., 2021; Seddon et al., 2019; WWF and ILO, 2020; Dobson et al., 2020).

Figure 2 is a conceptual model that shows how natural capital, society and the economy interact, and provides a framing for both Green Recovery and NCA. Spending on natural capital has two components: (1) enhancing natural capital through improved management and restoration to increase ecosystem extent and condition and the flow of ecosystem services, which is represented by the flow of investments from society for environmental protection and restoration at the top of Figure 2; and (2) reducing environmental degradation and resource depletion through economic restructuring, as represented at the bottom of Figure 2. Both components provide short-term economic benefits, while at the same time enhancing natural capital in the long-term.

Natural capital accounting

In response to the call in Agenda 21 for the values of nature to be recognised in the information systems of governments, the System of Environmental-Economic Accounting (SEEA) was developed. The SEEA represents the global standard for NCA and is used by public information agencies like national statistical offices. The SEEA Central Framework (UN et al. 2014) was adopted by the UN in 2012, and was followed by SEEA Ecosystem Accounting (UN et al. 2021) in 2021. These frameworks integrate environmental data with the economic data from the System of National Accounts (SNA) that has played such a key role in decision-making. Among other things the SNA produces the widely used Gross Domestic Product (GDP) that is commonly misused as measure of progress (Coyle, 2014). The integration of environmental and economic data serves to identify the *dependency* of people on the natural capital and ecosystem services they need for wellbeing and economic growth, and *the impact* of people's activities on the environment (Fig. 2). The information from the SNA and the SEEA is arranged in a sequence of interlinked accounts (Table 2).

Having integrated and harmonised environmental and economic data in regularly updated accounts enables decision-makers to move beyond traditional siloed measures of economic success, notably GDP, which is based on obsolete economic theory and a mid-twentieth Century world-view that barely considered the environment (Stiglitz et al., 2010; Coyle, 2014; Hamilton and Hepburn, 2017; Dasgupta, 2021). With NCA, which is based on an expansion of economic theory that recognises the importance of the environment, spending packages can be designed, tested, implemented, monitored, and modified to achieve progress beyond GDP growth. NCA enables a course towards a more sustainable society to

be charted, staying within ecological thresholds (Vardon et al., 2021) through a process of developing and using the accounts that creates a dialog between different actors in society, thereby improving understanding, trust and vision (World Bank, 2021b; Farrell et al., 2022).

NCA and the SEEA is not just theory. In 2020, 89 countries reported implementing the SEEA Central Framework, and 36 reported SEEA Ecosystem Accounting (UNCEEA, 2021). The number of implementing countries reflects the substantial support provided by the international community to low- and middle-income countries channelled through programs like WAVES (Wealth Accounting and valuation of Ecosystem Services) and NCAVES (NCA and Valuation of Ecosystem Services). With growing expertise, experience, access to online data and modelling platforms (e.g., ARIES for SEEA, EO4EA, and InVEST), it is increasingly possible to rapidly produce basic accounts (Lucas and Vardon, 2021, World Bank, 2021b).

Accounting is one part of an information system that supports decision-making. The other parts include basic data, analysis, and modelling (Vardon et al., 2016). Accounting describes past trends and interactions, whereas policymaking requires looking forward and assessing present and future policy options (Bassi, 2021). Modelling draws on the information from NCA to explore possible futures and policy applications. NCA and modelling have been combined in various ways to assess future impacts of alternative development pathways (Bassi, 2021, Johnson et al., 2021). Several examples of using models with NCA make the case for investment in natural capital and ecosystem services (Collste et al., 2017, World Bank, 2021c). While the use of models for examining environmental or economic issues is not new, the availability of integrated environmental and economic data from NCA makes it

easier to feed models and analyse the interrelationships between the economy and the environment (Banerjee et al., 2020, Lucas and Vardon, 2021).

A Green Recovery through natural capital accounting

By providing integrated economic and environmental data NCA can improve decision-making for a Green Recovery. It brings together often disparate actors, supporting the alignment of multiple Green Recovery perspectives, shaping recovery packages so they build or improve natural capital, and creating incentives for actors to cooperate (World Bank, 2021b) with a compelling example from Ireland (Farrell et al., 2022). NCA also provides the impetus for improving the governance of natural capital, which too often incentivises degradation natural capital (Vardon et al., 2021).

NCA has been used by several countries for analyzing issues aligned with Green Recovery, including biodiversity conservation and restoration (Farrell et al., 2022, Coates et al., 2020, King et al., 2021), tackling climate change (Pizarro, 2020), integrated land management (Meijer et al., 2020) and SDG monitoring (Ruijs et al., 2018), with many examples from across the world (Vardon et al., 2017, Vardon et al., 2019, Vardon and Bass, 2020). Both the theoretical scope and practical examples reveal that NCA can be used in all phases of the typical policy cycle related to Green Recovery (Fig. 3; Table 3).

Illustrations of how NCA can support policy and management in the various parts of the policy cycle are presented below for: biodiversity conservation; climate action; SDG achievement; and finance and macroeconomic policy.

NCA informing biodiversity conservation

Linking biodiversity indicators with national economic accounts provides a means of mainstreaming biodiversity policy into economic planning (King et al., 2021, Vardon et al., 2019). For example, NCA has been used to integrate economic development with biodiversity conservation in Rwanda, through the means of nature-based tourism. In 2019 tourism services were by far the largest source of foreign income for Rwanda, with much of this tourism related to iconic species, such as the Gorilla (*Gorilla beringei*) (Benitez et al., 2021). Survival of this iconic species, hence the tourism industry, is reliant on conservation measures. In 2020, the COVID-19 pandemic led to a collapse of tourism in Rwanda, as it did all over Africa (African Union, 2020). NCA played a prominent role in developing Rwanda's recovery plan, providing the evidence needed to ensure the protection of ecosystems while demonstrating their role in economic development (Benitez et al., 2021). With the evidence from NCA, the Rwandan Government estimated an investment of US$3.9 billion was required to maintain the environment to ensure that nature-based tourism can return to pre-COVID-19 levels and continue to grow, while also providing ecosystem services like carbon sequestration and soil retention (Benitez et al., 2021). While the resources needed are not fully available, the accounts and the recovery plan provide a strong basis for seeking additional resources from development assistance agencies. Going forward NCA could also be used to monitor the effectiveness of expenditures in achieving environment and economic objectives, in this case the conservation of iconic species and employment and income from the tourism industry.

At a global level, the role of NCA is prominent in the first draft of the CBD Post-2020 Global Biodiversity Framework, which recognises the importance of embedding the value of biodiversity in decision-making and promotes transparency with the implementation of a natural capital accounting framework. NCA can help to achieve Goal B "*Nature's contributions to people are valued, maintained or enhanced through conservation and sustainable use supporting the global development agenda for the benefit of all*" (targets 14 - 16 and related indicators). This is also recognised in the CBD's Action Plan for the Long-term Approach to Mainstreaming Biodiversity which identifies the need to "*develop and implement nature and biodiversity reporting and implement ecosystem or natural capital accounting, using the SEEA-framework as part of national accounts to inform decision-making and implementation*." (CBD 2020, proposed activity 1.1.3)

NCA informing climate action

Natural capital investments provide benefits for climate change mitigation and adaptation (Klenert et al., 2020). For example, many ecosystems sequester and store carbon while some ecosystem types provide resilience against climate change (e.g., mangroves provide coastal protection from storm surges). The 2021 UN Climate Change Conference (COP26) in Glasgow attempted to bring the climate change and biodiversity agendas closer together. Its final outcome document, the Glasgow Climate Pact, emphasised "*the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement* …" (paragraph 38). Specific ways to bring these agendas together were not identified but, as argued in this paper, information from NCA can support the decision-making process in both agendas and adopting NCA as an information source would thus be a starting point. This

would help to identify synergies, for example where investment can create the greatest amount of benefits for least cost.

For climate action, accounts of greenhouse gas emissions and carbon can show progress towards achieving the aim of the Paris Agreement to hold the increase in the global average temperature to “well below” 2°C above pre-industrial levels. Unlike UNFCCC reporting, SEEA-based accounts directly link emissions to the SNA (Keith et al., 2021). As such, NCA provides model-ready data to help countries assess the impacts on different sectors of transitioning to a low-carbon economy.

For example, NCA informed the Government of Indonesia’s Medium Term Development Plan 2020-2024 (BAPPENAS, 2019) with a Low Carbon Development Initiative (LCDI) assessing four different development pathways using scenario modelling. The LCDI scenarios examined the impacts of the medium-term strategy up to 2024, the Nationally Determined Contributions (NDCs) of Indonesia up to 2030, as well as further policy action beyond 2030, on several indicators including GDP growth, forest loss, jobs, air quality and poverty. The GDP projections account for the impact of environmental pressures, which grow under a baseline scenario and decline when climate mitigation and adaptation interventions are implemented. The analysis showed that a low-carbon growth path could deliver an average annual GDP growth rate of 6% (Figure 4) while also unlocking an array of economic, social, and environmental benefits, including reducing extreme poverty, generating additional better-paid employment, and reducing mortality due to lower air pollution.These scenarios were updated in 2021 to support the preparation of a Green Recovery strategy (BAPPENAS, 2021). This extended the ambition for low-carbon

development to achieving Net Zero by 2060. The concept of environmental carrying capacity, embedded in the analysis with NCA, was central to the government's analysis and post-COVID-19 recovery strategy.

Investments in green space also provide benefits to climate change. Heris et al. (2021) used NCA to assess the economic benefits of urban trees in US cities for two ecosystem services: (1) cooling and mitigating climate change, and thereby reducing the need for air conditioning, and (2) rainfall interception providing improved water quality and flood mitigation. The value of these two services for 768 US cities in 2016 was estimated at US$ 539 million and US$ 425 million, respectively. In up to 11% of these cities, investing in natural capital for climate mitigation and adaptation (green infrastructure) was determined to reduce costs (51% less), and to generate additional benefits (28% more) when compared to equivalent "grey" infrastructure (produced capital) (Bassi et al., 2021). Outside of urban areas, investments to address climate change have other additional benefits. For example, the restoration or conservation of forested areas not only stores and sequesters carbon but also helps to achieve the goals of the Convention on Biological Diversity and provides other ecosystem services that support activities such as ecotourism that can help economies recover from COVID-19. Increased availability of NCA could make these types of assessment routine and guide recovery spending to those natural capital investments that lead to higher social and economic returns by working with nature.

NCA informing achievement of the Sustainable Development Goals (SDGs)

In 2015, the world committed to the 17 Sustainable Development Goals (SDGs), to achieve a prosperous, socially inclusive and environmentally sustainable future for people and the

planet. The SDGs are a universal agenda building on the Millennium Development Goals. The SDGs are "integrated and indivisible and balance the three dimensions of sustainable development: the economic, social and environmental." As NCA is an integrated information system it can inform the design, implementation, and review of evidence-based SDG policies.

Up to forty SDG indicators can be derived directly from the SEEA – notably SDG 6 (water), SDG 13 (climate), SDG 14 (life below water) and SDG 15 (life on land) (UNSD, 2019). Examples from Rwanda, Botswana, Brazil, the Netherlands and Sweden show that accounts-based data could potentially be used to derive indicators for SDG 2 (agriculture), SDG 7 (energy), SDG 8 (employment and economic growth), SDG 9 (industry, innovation and infrastructure), SDG 11 (cities) and SDG 12 (sustainable consumption and production) (Ruijs et al., 2018). NCA also provides the information necessary to target and monitor the structural reforms needed for achieving the SDGs. Implementation of NCA is itself an indicator for SDG target 17.9 on capacity building and for SDG target 17.19 on supporting statistical capacity building in developing countries. Without this support, many low- and middle-income countries will not be able to develop and apply NCA.

Other countries are using NCA to help achieve particular SDGs. For example, in Colombia water accounts and modelling were used to assess catchment management costs to provide clean water to support basic human needs and economic production (SDG 6: clean water and sanitation) (Romero et al., 2017). In Australia NCA was also used to show the relative value of water provisioning compared to timber provisioning and other economic activities,

arguing for a cessation of logging native forest (Keith et al., 2017), and a plan to phase out logging was subsequently made by government.

NCA informing finance and macro-economic policy

NCA can contribute to sustainable finance and macroeconomic policy. Alongside produced, human, and social capital, natural capital is a core component of national wealth (Managi and Kumar, 2018; Mandle et al., 2019; Zenghelis et al., 2020; World Bank, 2021a,). As is the case for any capital asset, the relevant, reliable and timely measurement of natural capital is necessary for efficient management. Understanding trends in the quantity, quality, and value of assets and the services they deliver helps identify investment priorities and aids the design of incentive mechanisms that support green and fair outcomes.

Specific policy objectives vary between countries, but governments generally focus on growth (for job creation and improving living standards) and financial stability. The "fiscal triangle" illustrates the day-to-day management of government finances, balancing taxation, borrowing, and spending. Public spending on economic recovery is funded by current taxes and debt. Debt is serviced through future taxes.

NCA relates to all parts of the fiscal triangle (Fig. 5). On the *expenditure* side, accounts record spending on environmental protection and restoration, resource management, and subsidies (or foregone income) which may harm or benefit nature. Such expenditure, by both the public and private sector, may be considered investments in natural capital. A decline in natural capital represents the accumulation of debt, much of which is borne by the public sector and future generations (Dasgupta, 2021; Vardon et al., 2021). The cost of

restoration (offsetting the depreciation in the condition of natural capital or reducing the debt) may be calculated from the expenditures and subsidies recorded. Some natural capital debts, like species extinction, cannot be repaid.

For *taxation*, the accounts provide a perspective on the reliability of different revenue streams, such as carbon taxes compared to fuel duties. For instance, the UK's natural capital accounts show that COVID-19 travel restrictions reduced fuel duty revenues by 19% from 2019 to 2020 (ONS, 2021). The accounts demonstrate that fuel duty provides more than half of all revenue from environmental taxes, and that an alternative revenue stream is needed as drivers switch to electric vehicles. Environmentally harmful subsidies are not included in the UK's accounts, but they are within scope NCA and in the past some countries have estimated the value of these for the energy and other industries (Palm and Larsson 2007). The accounts can also be used to identify links between the environment and other areas of taxation and spending. For example, natural capital investments that improve health (e.g., by improving air quality) can spur additional tax revenues due to increased labour productivity, whilst simultaneously reducing expenditure on treating respiratory illnesses. Harmful air pollutants (e.g., PM 2.5) from fossil fuels cause millions of deaths annually (Vahora et al. 2021) and removal of fossils fuel subsidies could also reduce the associated costs.

Finally, NCA can also play a role on the debt or *borrowing* side of the fiscal triangle. For example, green bonds are intended to finance environment-friendly investments in low-carbon infrastructure, flood management, ecosystem restoration, and biodiversity conservation. Green bonds are issued by sovereigns (governments) and corporations, with

more than 8,000 already listed in the Nasdaq Sustainable Bond Network. The Climate Bonds Initiative puts the value of issued green bonds in excess of USD $1.5 trillion, with the potential for more than US$1 trillion to be added in 2022. Natural capital accounts provide evidence for assessing if the investments financed by green bonds lead to the expected environmental benefits, helping reduce the risk of "greenwashing". NCA can also guide the green bond market towards sectors that yield both economic and environmental returns. NCA can reveal declines in natural capital that increase the risk of climate change, which could to lead to the downgrading of sovereign credit in many countries – or it could demonstrate net natural capital gains (Klusak et al., 2021).

Conclusions and next steps

The need for government to consider the environment in development planning and economic management has been recognised for decades (WCED, 1987). NCA provides a way for environmental information to be integrated with mainstream economic information, in turn informing the modelling and analysis that governments use for development planning and economic management.

Following the COVID-19 pandemic, government recovery stimulus has been extensive, and has increased over time, but has not fully considered the environment. Further recovery stimulus must, at least, avoid harm by taking into account the impacts of spending on the environment and, at best, provide the resources and associated structural reforms needed to enhance natural capital's role in providing future social, economic, and environmental benefits.

As the examples presented in this paper show, NCA can assist the development and implementation of policies, programs and financing needed for Green Recovery. It provides comprehensive information on natural capital and society's dependencies and impacts on it. Furthermore, it can assist monitoring the impact of spending on the economy and the environment and can foster an enabling environment for actors to cooperate and transform the way they take decisions. In doing so, NCA informs evidence-based and dynamic policies.

As such, NCA is a means for achieving a wide range of Green Recovery goals, whether they be healthy livelihoods, sustainable production and consumption, biodiversity conservation and restoration, lowering greenhouse gas emissions, or realisation of the SDGs. NCA highlights the linkages between these diverse agendas, helping to find synergies and avoid trade-offs.

Authorities in charge of recovery stimulus and reform instruments can use NCA across the policy cycle (from policy design, planning and financing to implementation and monitoring) to 'reset' the economy to deliver Green Recovery, simultaneously reinvigorating economic growth, arresting environmental decline, and achieving a more equitable society. Indeed, all parts of government have a stake in Green Recovery and NCA can provide them with consistent and regularly updated information for planning, implementation, and monitoring.

NCA will be more effective when mainstreamed in the government machinery and decision-centred in its content and delivery. The Policy Forum on Natural Capital Accounting for

Better Decision Making, established by the World Bank's WAVES Partnership in 2017, aims to share, explore and synthesize the experiences of countries that have been producing and using NCA. The Policy Forum convened five times and each time proceedings were published (World Bank 2021b). Emerging from the forum were ten principles for making NCA fit for policy (Ruijs et al., 2019), three of which relate to mainstreaming accounting: enduring NCA, continuously improving NCA, and embedding NCA in government. Having on-going accounts means that a regular and increasing amount of data are available for analysis. This allows for continuously improving accounts, taking advantage of new and evolving data sources, and assessing changes over time. Embedding NCA into government decision-making processes – and relevant private sector and civil society processes too – can improve data harmonisation, reliability and transparency as well as reduce data duplication and access costs. Over time, understanding and trust of NCA and the decisions it informs should increase.

While NCA is a potential catalyst for Green Recovery, a critical next step is to ensure purposeful action, which will require investment in information. Although accounts are proliferating and some underpinning data is improving over time, account production is still dependent on basic data collection and appropriate expertise. New data sources and online platforms can help, and the growing capacity to produce and use NCA can be better mobilised. Basic accounts can now be developed with relative ease. But support is required to continue to strengthen the capacity of all countries, and particularly low- and middle-income countries, to produce NCA and ensure that they are relevant to, and hence can influence, government decision-making and policy.

At present NCA and Green Recovery awareness is limited. Without an understanding of the fundamental features of both, uptake of either will be hindered and 'nature-negative' GDP growth will likely prevail. Better communication is needed of what Green Recovery and NCA are (Tables 1 and 2 respectively) and how they can benefit decision-making in general (Fig. 1), with specific examples, such as those presented and referred to in this paper, used to demonstrate it is more than theory. To increase awareness, the NCA and Green Recovery communities should continue collaborating, engaging with decision-makers to help them better understand, use, and trust NCA so they can be applied to Green Recovery. Such engagement will help to gain the investment in NCA, and the institutional reforms needed for Green Recovery.

The imperative now is to turn the combined adoption of the new NCA standards and the unprecedented levels of government spending for economic recovery, to move along the sustainable development pathway. Many options are available to make such a Green Recovery a reality. To achieve this a multidisciplinary effort is needed with people and institutions working together to promote NCA so that it is embedded, trusted and used in decision-making. With NCA government agencies responsible for assessing, funding and implementing recovery programs will have the information needed to plan and implement Green Recovery. Without improved information governments will not have the opportunity to fully consider the environment in decision-making. If future spending decisions continue to largely ignore the environment, then future generations will be saddled with massive debts, less ability to repay these debts as a result of reduced natural capital, and ultimately an unsustainable society.

References

1. African Union 2020. Impact of The Coronavirus (COVID 19) On The African Economy. Addis Ababa: African Union.
2. Agarwala, M. & Zenghelis, D. 2020. Natural Capital Accounting for Sustainable Macroeconomic Strategies. New York: United Nations.
3. Banerjee, O., Crossman, N., Vargas, R., Brander, L., Verburg, P., Cicowiez, M., Hauck, J. & Mckenzie, E. 2020. Global socio-economic impacts of changes in natural capital and ecosystem services: State of play and new modeling approaches. *Ecosystem Services,* 46**,** 101202.
4. Bappenas 2019. Low Carbon Development Report: A Paradigm Shift Towards a Green Economy in Indonesia. Jakarta: Ministry of National Development Planning/National Development Planning Agency (BAPPENAS).
5. Bappenas 2021. A Green Economy for a Net-Zero Future: How Indonesia can build back better after COVID-19 with the Low Carbon Development Initiative. Jakarta: Ministry of National Development Planning/National Development Planning Agency (BAPPENAS).
6. Bassi, A. M. 2021. Policy Scenario Analysis using SEEA Ecosystem Accounting. New York: United Nations.
7. Bassi, A.M., Bechauf,R., Casier,L., and Cutler, E. (2021). How Can Investment in Nature Close the Infrastructure Gap? International Institute for Sustainable Development (IISD) and United Nations Industrial Development Organization (UNIDO).

8. Bateman, I. J. & Mace, G. M. 2020. The natural capital framework for sustainably efficient and equitable decision making. *Nature Sustainability,* 3**,** 776-783.
9. Benitez, P., Blignaut, J., Kalisa, J., Katanisa, P. & Rutebuka, E. 2021. Nature-smart post-pandemic economic recovery in Rwanda: A Natural Capital Accounting approach with an emphasis on the natural resources sectors. Word Bank.
10. CBD. 2020. Action Plan for the Long-term Approach to Mainstreaming Biodiversity. UNEP. https://www.cbd.int/doc/c/cb2d/a669/83a9d4a827918b488ae8057f/sbi-03-13-add1-en.pdf
11. Coates, D., Chan, J. Y. & Hill, C. 2020. Natural Capital Accounting for Integrated Biodiversity Policies. New York: United Nations.
12. Cohen-Shacham, E., Walters, G., Janzen, C. & Maginnis, S. 2016. Nature-based Solutions to address global societal challenges. Gland: IUCN.
13. Collste, D., Pedercini, M. & Cornell, S. E. 2017. Policy coherence to achieve the SDGs: using integrated simulation models to assess effective policies. *Sustainability Science,* 12**,** 921-931.
14. Coyle, D. 2014. *GDP: A Brief but Affectionate History*, Princeton University Press.
15. Dasgupta, P. 2021. The Economics of Biodiversity: The Dasgupta Review. London: HM Treasury.
16. Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., et al. 2019. Pervasive human-driven decline of life on Earth points to the need for transformative change. *Science,* 366**,** eaax3100.
17. Dobson, A. P., Pimm, S. L., Hannah, L., Kaufman, L., Ahumada, J. A., Ando, A. W., Bernstein, A., Busch, J., et al. 2020. Ecology and economics for pandemic prevention. *Science,* 369**,** 379-381.

18. Farrell, C. A., Aronson, J., Daily, G. C., Hein, L., Obst, C., Woodworth, P. & Stout, J. C. 2022. Natural capital approaches: shifting the UN Decade on Ecosystem Restoration from aspiration to reality. Restoration Ecology, doi: 10.1111/rec.13632
19. Partners for Inclusive Green Economy. Undated. Principles, priorities and pathways for inclusive green economies: Economic transformation to deliver the SDGs https://www.greeneconomycoalition.org/assets/reports/GEC-Reports/Principles-priorities-pathways-inclusive-green-economies-web.pdf
20. Hamilton, K. & Hepburn, C. 2017. National wealth: what is missing, why it matters. Oxford University Press.
21. Hepburn, C., O'callaghan, B., Stern, N., Stiglitz, J. & Zenghelis, D. 2020. Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change? *Oxford Review of Economic Policy,* 36**,** S359-S381.
22. Heris, M., Bagstad, K. J., Rhodes, C., Troy, A., Middel, A., Hopkins, K. G. & Matuszak, J. 2021. Piloting urban ecosystem accounting for the United States. *Ecosystem Services,* 48**,** 101226.
23. Hopkins, C. & Greenfiled, O. 2021. Setting a structural agenda for a green economic recovery from COVID-19. Green Economy Coaltion. https://www.oecd.org/greengrowth/Setting a structural agenda for a green economic recovery from COVID-19-Nov2021.pdf
24. IPBES. 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services,* Bonn, Germany: IPBES secretariat.
25. Johnson, J. A., Ruta, G., Baldos, U., Cervigni, R., Chonabayashi, S., Corong, E., Gavryliuk, O., Gerber, J., et al. 2021. The Economic Case for Nature : A Global Earth-

515 Economy Model to Assess Development Policy Pathways. Washington, DC: World
516 Bank.
517 26. Keith, H., Vardon, M., Obst, C., Young, V., Houghton, R. A. & Mackey, B. 2021.
518 Evaluating nature-based solutions for climate mitigation and conservation requires
519 comprehensive carbon accounting. *Science of The Total Environment,* 769**,** 144341.
520 27. Keith, H., Vardon, M., Stein, J. A., Stein, J. L. & Lindenmayer, D. 2017. Ecosystem
521 accounts define explicit and spatial trade-offs for managing natural resources.
522 *Nature Ecology & Evolution,* 1**,** 1683-1692.
523 28. King, S., Vardon, M., Grantham, H. S., Eigenraam, M., Ferrier, S., Juhn, D., Larsen, T.,
524 Brown, C. & Turner, K. 2021. Linking biodiversity into national economic accounting.
525 *Environmental Science & Policy,* 116**,** 20-29.
526 29. Klenert, D., Funke, F., Mattauch, L. & O'callaghan, B. 2020. Five Lessons from COVID-
527 19 for Advancing Climate Change Mitigation. *Environmental and Resource*
528 *Economics,* 76**,** 751-778.
529 30. Klusak, P., Agarwala, M., Burke, M., Kraemer, M. & Mohaddes, K. 2021. Rising
530 temperatures, falling ratings: The effect of climate change on sovereign
531 creditworthiness. Canberra: Centre for Applied Macroeconomic Analysis.
532 31. Lucas, P. L. & Vardon, M. 2021. Greening the recovery to make it last: the role of
533 Natural Capital Accounting. the Hague: PBL Netherlands Environmental Assessment
534 Agency.
535 32. Maas, T. Y. & Lucas, P. L. 2021. Global green recovery: From global narrative to
536 international policy. the Hague: PBL Netherlands Environmental Assessment Agency.
537 33. Managi, S. & Kumar, P. 2018. Inclusive Wealth Report 2018: Measuring Progress
538 Towards Sustainability. London: Routledge.

34. Mandle, L., Ouyang, Z., Salzman, J. & Daily, G. C. 2019. *Green Growth that Works: Natural Capital Policy and Finance Mechanisms from Around the World,* Washington, D.C., Island Press.
35. Meijer, J., Berkhout, E., Hill, C. J. & Vardon, M. 2020. Integrated landscape management and natural capital accounting: working together for sustainable development. The Hague: PBL Netherlands Environmental Assessment Agency.
36. O'callaghan, B. J. & Murdock, E. 2021. Are we building back better? Evidence from 2020 and athways to inclusive green recovery spending. United Nations Environment Programme (UNEP).
37. OECD 2020. Making the Green Recovery work for jobs, income and growth. Paris: Organisation for Economic Co-operation and Development.
38. ONS 2021. UK Environmental Accounts: 2021. London: UK Office for National Statistics.
39. Palm, V. and Larsson, M., 2007. Economic instruments and the environmental accounts. Ecological economics, 61(4), pp.684-692.
40. Palomo, I., Locatelli, B., Otero, I., Colloff, M., Crouzat, E., Cuni-Sanchez, A., Gómez-Baggethun, E., et al. 2021. Assessing nature-based solutions for transformative change. *One Earth,* 4**,** 730-741.
41. Piaggio, M. & Siikamäki, J. 2021. COVID-19 pandemic and economy: Economic outlook, policy measures, debt distress and the role of nature. *Technical Paper No. 1, IUCN Nature-based Recovery Initiative.* Gland, Switzerland: IUCN.
42. Pizarro, R. 2020. Natural Capital Accounting for Integrated Climate Change Policies. New York: United Nations.

562 43. Romero, G., Calderon, S., Alvarez, A. & Alterio, H. 2017. Using Water Accounts and
563 Modeling to Help Set Water Prices in Colombia. *In:* Vardon, M., Bass, S., Ahlroth, S. &
564 Ruils, A. (eds.) *Forum on Natural Capital Accounting for Better Policy Decisions:*
565 *Taking Stock and Moving Forward.* Washington D.C.: World Bank WAVES.
566 44. Ruijs, A., Van Der Heide, M. & And Van Den Berg, J. 2018. Natural capital accounting
567 for the sustainable development goals. The Hague: PBL Netherlands Environmental
568 Assessment Agency.
569 45. Ruijs, A., Vardon, M., Bass, S. & Ahlroth, S. 2019. Natural capital accounting for
570 better policy. *Ambio,* 48**,** 714-725.
571 46. Rume, T., & Islam, S. 2020. Environmental effects of COVID-19 pandemic and
572 potential strategies of sustainability. Heliyon, 6(9), e04965.
573 https://doi.org/10.1016/j.heliyon.2020.e04965
574 47. Seddon, N., Sengupta, S., García-Espinosa, M., Hauler, I., Herr, D. & Rizvi, A. R. 2019.
575 Nature-based Solutions in Nationally Determined Contributions: Synthesis and
576 recommendations for enhancing climate ambition and action by 2020. Gland,
577 Switzerland and Oxford, UK: IUCN and University of Oxford.
578 48. Stahel, W. R. 2016. The circular economy. *Nature,* 531**,** 435-438.
579 49. Stiglitz, J., Sen, A. & Fitoussi, J.-P. 2010. Report by the Commission on the
580 Measurement of Economic Performance and Social Progress. Paris: The Commission
581 on the Measurement of Economic Performance and Social Progress.
582 50. UN, et al 2014. System of Environmental-Economic Accounting - Central Framework.
583 UN, New York
584 51. UN et al. 2021. System of Environmental-Economic Accounting - Ecosystem
585 Accounting. UN, New York

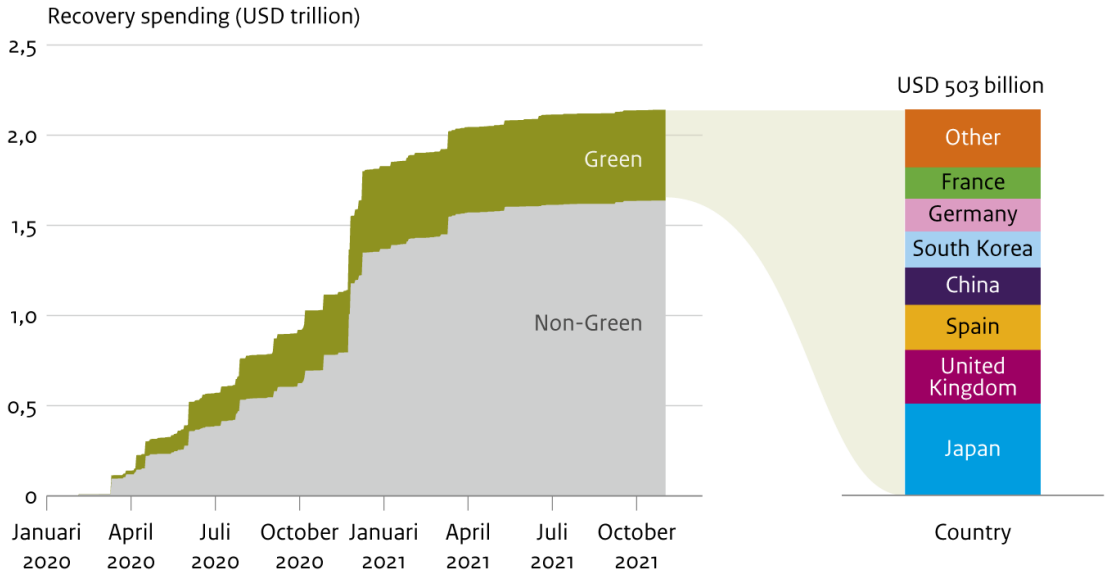
586 52. UNCEEA 2021. Global Assessment of Environmental-Economic Accounting and
587 Supporting Statistics 2020. New York: United Nations Committee of Experts on
588 Environmental-Economic Accounting.
589 53. UNEP 2021. Making peace with nature: A scientific blueprint to tackle the climate,
590 biodiversity and pollution emergencies. Nairobi: United Nations Environment
591 Program.
592 54. Vardon, M. & Bass, S. 2020. Natural Capital Accounting for Better Policy Decisions:
593 Measuring and Valuing Natural Capital to Improve Landscape Management and
594 Governance. Proceedings and Highlights of the 4th Forum on Natural Capital
595 Accounting for Better Policy Decisions. Washington D.C.: World Bank WAVES.
596 55. Vardon, M., Bass, S. & Ahlroth, S. 2019. Natural Capital Accounting for Better Policy
597 Decisions: Climate Change and Biodiversity. Proceedings and Highlights of the 3rd
598 Forum on Natural Capital Accounting for Better Policy Decisions. Washington D.C.:
599 World Bank WAVES.
600 56. Vardon, M., Bass, S., Ahlroth, S. & Ruijs, A. 2017. Forum on Natural Capital
601 Accounting for Better Policy Decisions: Taking Stock and Moving Forward.
602 Washington D.C.: the World Bank.
603 57. Vardon, M., Burnett, P. & Dovers, S. 2016. The accounting push and the policy pull:
604 balancing environment and economic decisions. *Ecological Economics,* 124**,** 145-152.
605 58. Vardon, M. J., Keith, H., Burnett, P. & Lindenmayer, D. B. 2021. From natural capital
606 accounting to natural capital banking. *Nature Sustainability*.
607 59. Vivid Economics & F4b 2021. Greenness of Stimulus Index: An assessment of COVID-
608 19 stimulus by G20 countries and other major economies in relation to climate

609 action and biodiversity goals - July 2021. Vivid Economics and Finance for Biodiersity
610 Initiative.
611 60. WCED 1987. *Our Common Future, Report of the World Commission on Environment*
612 *and Development (WCED),* New York, Oxford University Press.
613 61. World Bank 2021a. The Changing Wealth of Nations 2021: Managing Assets for the
614 Future. Washington, DC: World Bank.
615 62. World Bank 2021b. From Accounts to Policy: WAVES Closeout Report Wealth
616 Accounting and Valuation of Ecosystem Services Global Partnership (2012-2019).
617 Washington DC.: World Bank.
618 63. World Bank 2021c. Unlocking Nature-Smart Development: An Approach Paper on
619 Biodiversity and Ecosystem Services. Washington, DC.: World Bank.
620 64. WWF & ILO 2020. Nature hires: How Nature-based Solutions can power a green jobs
621 recovery. World Wide Fund For Nature (WWF) and International Labour
622 Organization (ILO).
623 65. Zenghelis, D., Agarwala, M., Coyle, D., Felici, M., Lu, S. & Wdowin, J. 2020. Valuing
624 Wealth, Building Prosperity. Wealth Economy Project first year report to LetterOne.
625 Cambridge: Bennett Institute for Public Policy, University of Cambridge.
626 66.

Figures and tables

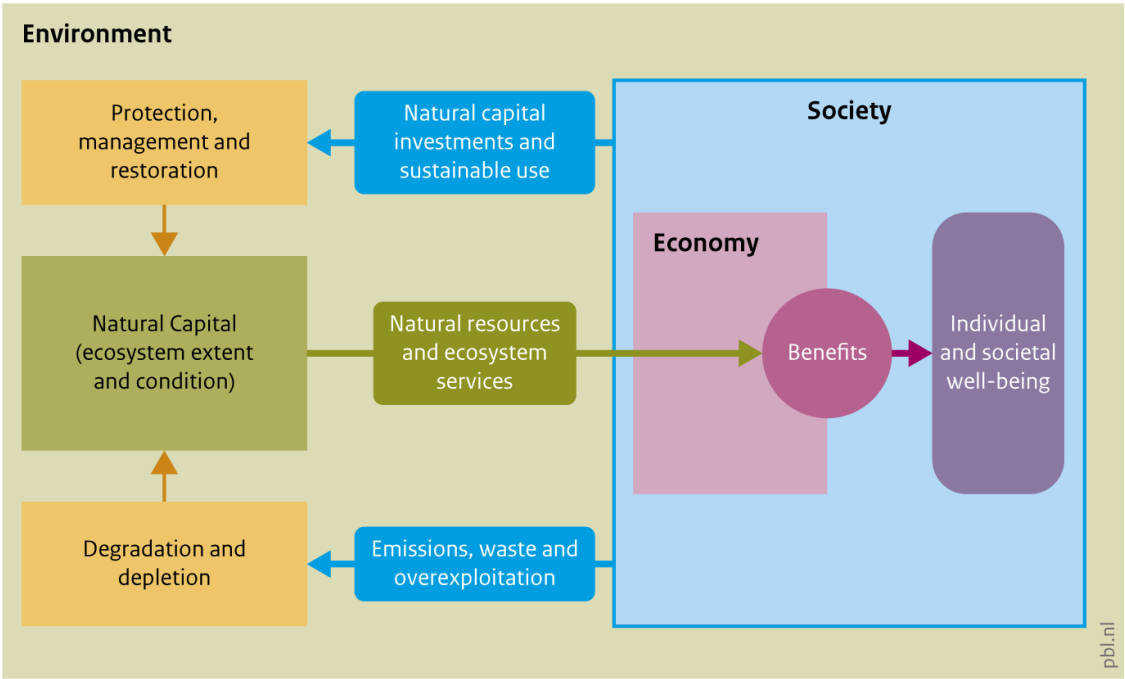
Figures

Figure 1. Green government recovery spending per November 2021. *In this analysis, a "green" policy is one which advances any of the following priorities: climate mitigation, climate adaptation, natural capital, or air pollution reduction.*



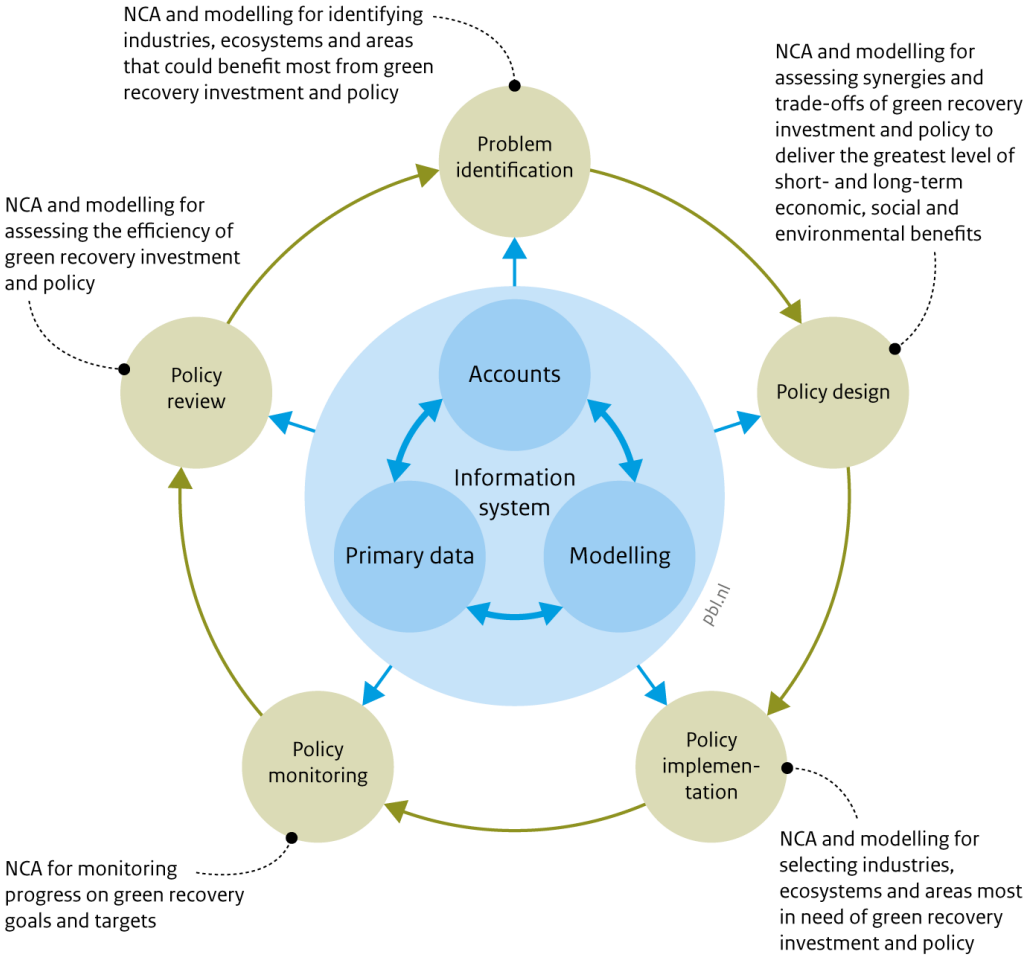
Source: Global Recovery Observatory <https://recovery.smithschool.ox.ac.uk/tracking/>

Figure 2. The interactions of the environment with society and the economy.



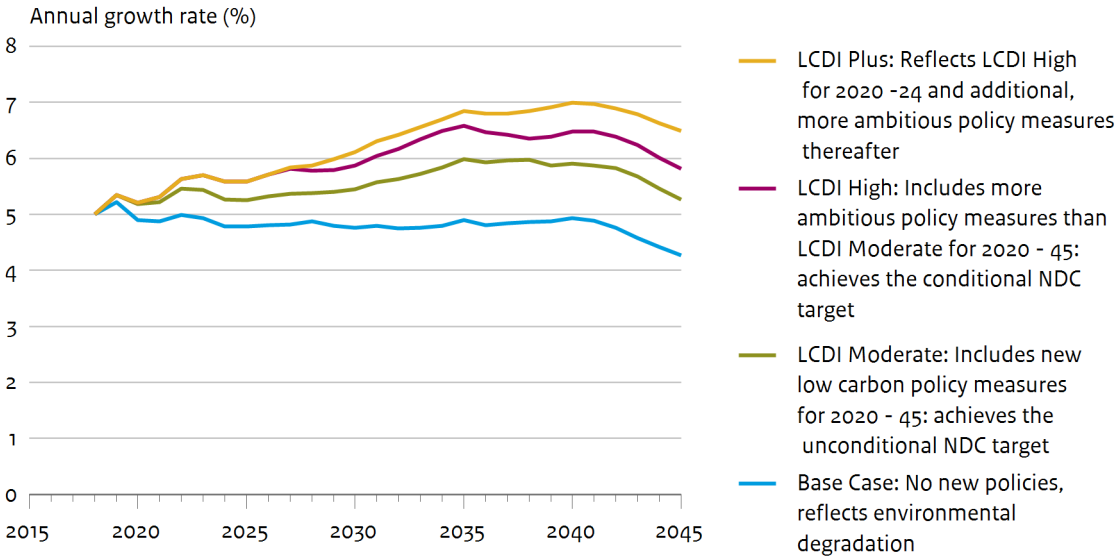
Source: After Lucas and Vardon (2021)

Figure 3. Use of NCA for Green Recovery across the policy cycle.



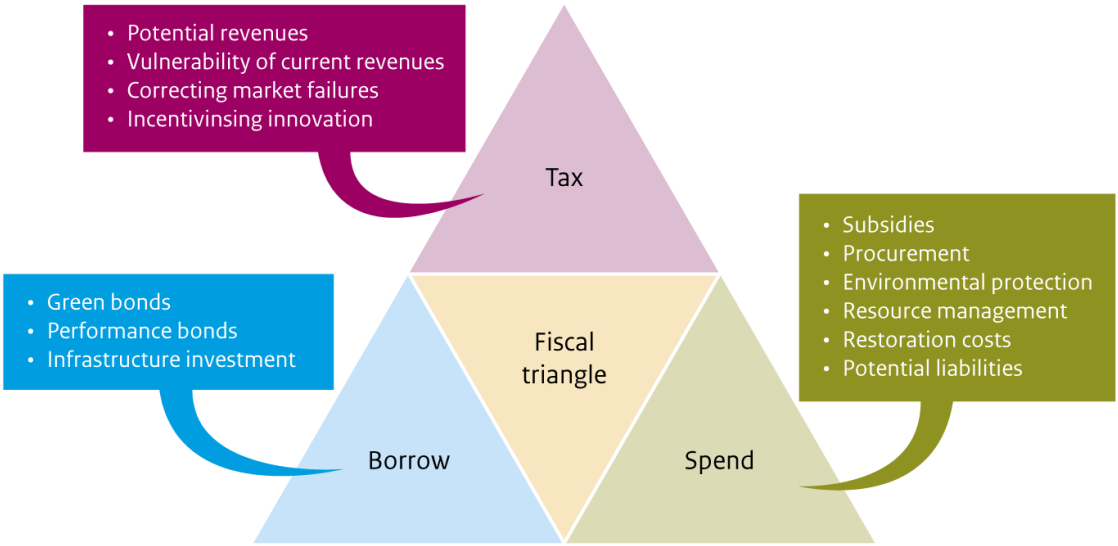
Source: After Vardon et al (2016)

Figure 4. GDP and four growth scenarios by level of CO_2 emissions in Indonesia



Source: BAPPENAS (2019)(BAPPENAS, 2019)

650 ***Figure 5. The fiscal triangle and examples of the relationship to NCA and policy***



651
652 Source: After Agarwala and Zenghelis (2020) Agar
653
654

Tables

Table 1. Three strategies for Green Recovery

	Green as a co-benefit of recovery stimulus	Green as a necessary condition of recovery stimulus	Green as an opportunity for structural reform with recovery stimulus
Strategy	Measures for economic recovery also contribute to environmental goals and/or sustainable development	Conditionalities or safeguards are put in place to avoid investments and policies that increase environmental pressure or create stranded assets. This strategy thus excludes investments in environmentally harmful infrastructure (e.g., coal fired power plants).	Recovery measures are designed to make additional progress in the field of environmental goals and/or sustainable development. Green investments and policies are combined with structural reform, such as removing environmentally harmful subsidies or phasing out unsustainable practices.
Recovery vs transition focus	Focus on socio-economic recovery. There is no direct coupling with long-term transitions	Focus on socio-economic recovery, while ensuring that this does not impede with long-term transitions.	Socio-economic recovery goes hand in hand with long-term transitions
Natural capital focus	Recovery can also improve natural capital and its services	Recovery should not result in degradation of natural capital and its services.	Recovery should improve natural capital and its services

Source: After from Maas and Lucas (2021)

Table 2. Natural capital accounts relevant to Green Recovery. From left to right, the three frameworks progressively include more aspects of the environment, mirroring the "shades of green".

	System of National Accounts (SNA) framework	System of Environmental-Economic Accounting (SEEA) Central Framework	SEEA – Ecosystem Asset Accounts
Assets accounts	**Economic Asset Accounts** Change in economic assets on balance sheet items, financial capital, produced capital and non-produced capital (natural resources).	**Environmental Asset Accounts** Changes in stocks of e.g. minerals, energy sources, land, timber, aquatic resources, soil, water and biological resources.	**Ecosystem Asset Accounts**[4] Change in ecosystem extent (size), condition (quality), and capacity (future expected flows of ecosystem services).
Flow accounts	**Economic Supply and Use tables** Transactions by residents in the National Economy and income.	**Environmental Supply and Use tables** Supply and use flows for energy, water, materials, incl. waste and emissions to soils, air and water. **Environmental Protection Activity Account** Transactions to preserve or protect the environment or to influence behavior.	**Ecosystem Supply and Use tables** Supply and use of intermediate and final ecosystem services flows (provisioning, regulating and cultural services)

Source: After Lucas and Vardon (2021)

666 **Table 3 Linking use of NCA to policy and questions of decision-makers**

Policy uses	Decision makers' questions	What information helps (data, accounts, and analytical tools)	Types of answers that NCA can provide
Problem identification	• How are we doing? What has changed, and how does that link to changes in the economy and other factors? • Given assumptions about domestic and international development, how will we fare in the future?	• Accounting data and derived indicators, simple projections, input-output analysis, environmental economic models, scenario modelling, spatial analysis, footprint analysis	• Interpretations from the data on past and present state • Scenarios for future development of economy and environment
Policy design	• If we want to change the current state or projected future state, what can we do? • Who benefits from changes in policy? • Who bears the costs of producing these benefits?	• Accounting data and derived indicators, input-output analysis, computable general equilibrium modelling, environmental economic models, scenario modelling, cost-benefit analysis, integrated assessment	• Economic and environmental effects of restrictions on scenarios to achieve policy targets • Ex ante assessment of the policies' effects on the economy and environment
Policy implementation	• How can we target the policy response to get the most improvement for the least cost? • Which activities should be done first? • What price should be put on natural resources?	• Accounting data, derived indicators, environmental economic modelling, spatial analysis, industry analysis, cost–benefit analysis, business case	• Detailed assessment of all the pros and cons of the policy interventions
Policy monitoring	• Are the policies making progress toward goals and targets?	• Accounting data and derived indicators	• Ex post assessment of policy progress and evaluation of the need to adjust policy instruments
Policy review	• How can we make the existing policy more effective to achieve the goals and targets? • Are there any unintended consequences of the policy response? • Do we need different policy responses?	• Accounting data and derived indicators, econometric modelling	• Ex post policy evaluation of effectiveness and efficiency of policy instruments

667 Source: After Lucas and Vardon (2021)
668