Evaluating Nature Based Solutions

Draft Final Report

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Executive Summary

To come.

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1 Introduction

In 2020, the IUCN released a global standard for nature-based solutions (IUCN, 2020) with eight criteria for "the verification, design and scaling up of NBS". Criterion 4 states that NBS should be "economically viable." Otherwise, "NBS run the risk of being short-term projects, where, after closing, the solution and benefits provided cease to exist, potentially leaving the landscape and communities worse off than before" (ibid.) According to the IUCN standard, consideration must be given to both the short-term costs of NBS and to their long-term benefits, some of which may stretch over generations. The standard calls not just for assessment of the overall return on investment, efficiency and effectiveness of NBS, but also of the equity in distribution of benefits and costs. It includes three guidelines (what it calls "indicators") to use in assessing the economic viability of NBS:

- the direct and indirect benefits and costs associated with the NBS, including who pays and who benefits, should be identified and documented, taking account of any associated externalities
- cost-effectiveness studies should be provided to support the choice of NBS, and
- the cost effectiveness of NBS should be compared with that of other solutions (other NBS, combined NBS/conventional solutions or pure conventional solutions).

This paper is divided into two parts. In Part A, we explore various approaches to evaluating economic viability. We consider both standard and emerging evaluation frameworks and how these might apply to NBS of various types (Table 1). We discuss ways in which standard evaluation frameworks may be biased against NBS and whether these biases might be overcome through use of an emerging framework, comprehensive wealth, that has received a recent and thorough exposition in the Dasgupta Review on the Economics of biodiversity (Dasgupta, 2021). Part A concludes with a discussion of how the evaluation of NBS might be advanced by building upon the discussion in the Dasgupta Review.

In Part B of the paper, we consider what can be said about the economic viability of NBS relative to traditional solutions based on data taken from the academic and grey literatures. NBS studies have expanded greatly in number in recent years, so this literature is already large and it continues to grow. Thus, the review here is not intended as exhaustive but, rather, indicative of the how NBS compare to traditional solutions from an economic perspective.

Table 1 - Categories of NBS

Category of NbS approaches	Examples
Ecosystem restoration approaches	Ecological restoration Ecological engineering Forest landscape restoration
Issue-specific ecosystem-related approaches	Ecosystem-based adaptation Ecosystem-based mitigation Climate adaptation services Ecosystem-based disaster risk reduction
Infrastructure-related approaches	Natural infrastructure Green infrastructure
Ecosystem-based management approaches	Integrated coastal zone management Integrated water resources management
Ecosystem protection approaches	Area-based conservation approaches including protected area management

Source: IUCN, 2016

Part A

Frameworks for evaluation of the economic viability of nature-based solutions

1 The origins of economic evaluation

It is important to note at the outset that there is no single definition of economic viability nor any single approach to its evaluation. What defines economic viability and how it is evaluated will vary depending upon:

- what is being evaluated
    - a single purchase (should a homeowner plant roses or tulips in my garden?)
    - a project (should a company build a new factory or refurbish an old one?)
    - a policy (should a government extend health-care benefits to all citizens?)
- who is doing the evaluation
    - a private individual
    - a company
    - a national public body
    - an international public body
    - a combination of the above

Generally speaking, the complexity of defining and evaluating economic viability increases as one moves down the above lists. A private individual's assessment of the viability of a single purchase is relatively straightforward (though by no means always easy, as evidenced by the poor economic decisions all of us make from time to time). Assessing the viability of a major policy implemented by a national government acting in collaboration with an international agency will be comparatively much more complex.

Humans are naturally adept at viewing decisions in terms of the short-term costs and benefits to them as individuals and for those they care about closely. How much will it cost me now (in time, money, energy, mental effort or something else) to do X and what will X provide me (and those I care about) in the foreseeable future by way of enhanced enjoyment of life? Is that extra well-being worth the cost? Should I, in fact, spend my time doing Y instead of X?

Most people are quite good at making such decisions. Children learn the technique early on without anyone teaching them it and we all apply it, consciously or unconsciously, in many decisions in our daily lives. Without it, we would find ourselves regularly frozen by indecision. Evaluation of costs and benefits as a social skill is thus quite important. It is a rather remarkable skill as well, considering that the costs and benefits people compare are often measured in incommensurable units. Is my families' enjoyment of a pleasant garden during the summer worth eight hours of my hard work planting flowers in the spring? Or would those eight hours bring greater benefit to us if I used them to repaint the house? Humans continually make such short-term assessments, doing so without any kind of formal analytical framework.

Of course, the day-to-day decisions of individuals often have only minor and fleeting consequences if they turn out badly (the garden can be changed next year if the flowers turn out to be the wrong colour and the house can always be repainted), so use of a formal framework for such decisions is generally unnecessary. Daily life would be cumbersome if it were.

This is not so in all decision-making however. Those responsible for "bigger" decisions – that is, decisions involving long-term consequences and major investments of resources

(time, effort, money, etc.) – have much more is at stake. This is particularly true when the costs and benefits of the decision extend beyond the person(s) making the decision to include impacts on other people and their resources (for example, impacts on the time, effort and money of employees, citizens or shareholders). Individuals responsible for such far-reaching decisions may face serious consequences if they "get it wrong". Lives and livelihoods can, quite literally, be at stake. The need for these people to "get it right" has led to development of decision-making as a formal discipline employing sophisticated analytical frameworks that are highly structured in terms of concepts, methods and data requirements.

Given that comparison of costs and benefits comes naturally to most of us as individuals, it is not surprising that formal decision-making frameworks make such comparisons central to their methods. Indeed, the main formal decision-making framework is simply called "cost-benefit analysis". The broad outlines of cost-benefit analysis (CBA) and its principal variants are outlined further below. First, though, it is useful to consider the context in which CBA emerged as a formal decision-making framework and how that context has shaped the way formal decision-making is undertaken in modern society.

1.1 Cost-benefit analysis and the rise of the growth paradigm

The fact that humans are innately good at a comparing short-term costs and benefits has already been mentioned. Comparing long-term costs and benefits is, of course, harder simply because it is more difficult to define and measure things that are going to happen in the future. We know pretty well how many hours it will take us to plant spring flowers and we can be pretty certain that those spring flowers will turn into an attractive summer garden with a bit of care. It is much harder to evaluate how much effort is required to become a highly skilled IT specialist and to predict whether a lifetime of work as an IT specialist will be rewarding and lucrative. This is why longer-term decisions in people's personal lives – like what kind of profession to pursue – are often made on the basis of considerations other than measured costs and benefits. Tradition, culture, circumstance and risk-tolerance all play more important roles in people's larger life decisions than any kind of CBA, whether informal or formalized.

There are other reasons why individuals tend to apply cost-benefit analysis only to short-term decisions. One is the well-established human preference for benefits today over benefits in the future. The second is the unpredictability of the future. Since the future can never be known with certainty, people are less likely to take future costs or benefits into consideration the further into the future they are likely to emerge. Indeed, it is possible (even likely) that costs and benefits will emerge in the future that weren't even imaginable at the time a decision was made. All of this tends to constrain the time period over which individuals are naturally inclined to consider costs and benefits. This natural inclination to focus on the short-term spills inevitably into the thinking of individuals when they are engaged in formalized decision-making using CBA and other tools. This is an important contextual feature of the development of CBA and, as we will see, one with consequences for the suitability of CBA as a decision-making framework for NBS.

A second contextual feature to note is that CBA emerged as a technique largely in the western world during the 20th century, a time during which the prevailing economic

doctrine was one in which expansion of the market economy was the commonly accepted goal of governments, businesses and households. This fact influenced the development of formalized CBA in two ways. First, it led those developing CBA as a formalized decision-making tool to focus on costs and benefits related to the market and to ignore (or, at least, pay much less attention to) benefits and costs arising outside the market. Second, the dominance of growth doctrine and the statistics that emerged to support it (see next section) meant that the developers of CBA had at hand a small set of widely accepted economic variables around which to shape their framework. At the level of the economy as a whole, the core variable was gross domestic product (GDP), which measures national income. At the level of individual businesses, profit (the excess of revenues over expenses) was the key measure. For households, the key measure was labour income. Other important variables associated with growth doctrine were employment, prices, trade and investment.

1.2 Cost-benefit analysis and the development of national statistics

At the same time that growth doctrine was rising to prominence, national statistical systems were also expanding and improving the quality of their outputs. Prior to the 1930s, economic statistics were far less complete and organized than they are today. The emergence of the System of National Accounts – the system from which GDP is derived – in the 1940s brought order to these statistics, allowing statisticians to improve their quality in terms of timeliness, completeness and coherence. The success of growth doctrine in post-WWII efforts to rebuild and expand western economies reinforced the importance of the core suite of macroeconomic variables mentioned above (GDP, profits, wages, employment, prices, trade and investment). Around these core variables grew sophisticated statistical systems offering regular, reliable and ever-expanding databases describing the market economy. The natural world, it must be noted, was entirely absent from these systems.

Some argue it was unavoidable in the post-war period "to focus on the accumulation of produced capital (roads, machines, buildings, factories, and ports) and what we today call human capital (health and education). To introduce Nature, or natural capital, into economic models [and their underpinning statistics] would have been to add unnecessary luggage to the exercise." (Dasgupta, 2021). Whether nature was excluded from consideration because of a compelling need to focus on improving human welfare at a time of widespread misery – or whether this exclusion had something deeper to do with humans and their relationship with nature – is an open question. The fact is, nature did not begin to make its way into national statistical systems until the 1970s and not seriously until the 1990s. The world's first environmental statistical standard, the *System of Environmental-economic Accounting: Central Framework* (UN et al., 2014) appeared only in 2012. Even then, it excluded treatment of ecosystems and their related goods and services. It took nine more years for the United Nations to agree to a standard for statistical treatment of ecosystems and that standard, agreed to just in March 2021, covers only the measurement of ecosystems in biophysical terms. Valuation of ecosystems and their associated goods and services is considered to remain too ill-

developed to receive global imprimatur as a statistical standard, relegating work on these values to the backburner of statistical offices' efforts for years to come yet. This, of course, has negative consequences for those wishing to evaluate the economic viability of NBS.

Given the prevailing market doctrine and the statistical system that arose around it in the latter half of the 20th century, it was natural that CBA should evolve into a framework in which costs and benefits were measured in terms of a small suite of core market economic variables. Costs in CBA tend to be considered in terms of purchases of the market goods and services required to undertake an activity and benefits tend to be considered in terms of the market outcomes (GDP, profits, employment, investment, trade) the activity will generate. This is not to say that other types of costs and benefits are not considered in CBA (as explained below, they are). Rather, the point is that the starting point for CBA is market costs and benefits and that information on these costs and benefits is readily available to decision-makers. Both these things provide strong incentives for decision-makers restrict their focus to what happens in the market. To the extent that other costs and benefits – such as degradation or improvement of the environment – or are considered, they tend to be seen as ancillary and considered only once the core market costs and benefits are fully considered. The fact that data on non-market costs and benefits are much less readily available (thanks, in part, to the fact that environmental statistics have only recently developed as a domain of official national statistics) serves as a disincentive to broadening the scope of CBA. Assessing non-market costs and benefits can substantially add to the time and effort required for the analysis. In addition, the accuracy with which non-market costs and benefits can be measured is generally lower than (or perceived to be lower than) that of market costs and benefits. This is particularly so when non-market costs and benefits must be measured in terms of their equivalent market values. Users of CBA analyses may therefore be less willing to stake decisions on the results of analyses in which non-market costs and benefits figure prominently, such as decisions regarding NBS versus traditional solutions – as they may see those results as lacking credibility.

2 Economic evaluation frameworks

In the preceding section, we argued that the origins of formal decision-making as a discipline in western countries have led the main framework – cost-benefit analysis – to have a number of built-in biases that render its suitability for use in evaluating NBS questionable. Formal CBA emerged out of the innate – but anthropocentric – human capacity for comparison of short-term costs and benefits. It emerged, furthermore, in a prevailing socio-economic context in which the market economy and its growth were seen as central by governments, businesses and households alike, leading to a focus of decision-makers on market costs and benefits over all others. This bias was reinforced by the emergence of modern statistical systems with elaborate and high quality sets of economic data to feed CBA models but far less to offer in terms of data on nature.

In this section, we explore the CBA and its main variants in more detail, discussing some of the central features of the approach and how they relate to the use of CBA as a tool for

economic evaluation of NBS. We also discuss some of the other main frameworks used by formal decision-making practitioners, including economic impact analysis.

2.1 Cost-benefit analysis and variants

Cost-benefit analysis (CBA) is a standard economic evaluation approach for large projects. In simple terms, CBA evaluates the economic costs of implementing a project and compares these against the economic benefits the project will realise. If the benefits outweigh the costs, then the project is deemed worthwhile. Cost-benefit analysis can be used to evaluate the worth of an individual project or to compare several different project options for achieving a given set of benefits. In the former case, CBA offers decision-makers a single, clear decision criterion: if estimated project benefits outweigh estimated costs, the project is worthy of implementation, other things being equal. In the case where more than one project is being compared, there are two decision criteria. Benefits must still outweigh costs but additional consideration is given to which project option has the greatest ratio of benefits to costs. Where two projects are evaluated and one is found to have benefits equal to twice costs and the other to have benefits equal to three times costs, the latter project would be the one chosen for implementation. If neither option had a ratio of benefits to costs greater than unity, neither option would be considered economically viable.

In the context of their suitability for evaluating NBS, a few additional features of CBA are worth noting. First, in standard CBA, all costs and benefits are expressed in monetary terms. Those that cannot be measured using the yardstick of money are excluded from analysis. This can be problematic in instances where benefits are not readily expressed in monetary terms. CBA may not be well suited, for example, to evaluation of projects where a significant share of the costs or (more likely) the benefits are realised outside of the market and, therefore, difficult to express in monetary terms. This would include projects with non-market environmental benefits, such as many NBS.

Second, project costs and benefits that arise in the future are discounted to their present values for comparison purposes in CBA. This requires choice of a discount rate[1] and this choice can significantly impact the assessment of project costs and benefits. Upfront costs and benefits are not discounted at all, or very little, while those in the more distant future will be discounted quite a lot. The higher the discount rate, the lower will be the present value of future costs or benefits; for example, a $1 million cost/benefit incurred 10 years in the future will have a present value of about $744,000 using a 3% discount rate but a present value of only $508,000 using a discount rate of 7%. Since many NBS yield benefits that flow over long periods of time (for example, flood protection benefits of forests), discounting is particularly germane to them. NBS may be at a disadvantage to traditional solutions in CBA if their costs are mostly upfront but their benefits are back-loaded; that is, if the full benefits of the project take time to emerge and, therefore, flow more toward the end of the evaluation period. For example, the benefits of a forest restoration project are unlikely to emerge immediately, since forests take time to grow to

[1] The discount rate is similar to a rate of interest. It reflects the “time-preference of money”; that is, the fact that most individuals value a certain quantity of money more highly today than they do the same quantity of money in the future.

sufficient maturity to provide significant flows of the ecological goods and services on which NBS are based.

Third, determining the scope of costs and benefits to consider in CBA is not straightforward. As already noted, the scope of analysis is restricted to costs and benefits that can be expressed in monetary terms. This may mean that only costs and benefits that flow within the context of market transactions will be considered in CBA. Non-market costs/benefits are considered only where methods exist to measure them in market equivalent monetary values. While methods exist to value some non-market costs/benefits in monetary terms (for example, the costs of air pollution on human health), others remain challenging and/or controversial to value (for example, the spiritual value of preserving pristine wilderness). Even where values for non-market costs/benefits can be determined, their accuracy and precision may be less than that for market costs/benefits. Their inclusion in CBA may render interpretation of the results more difficult as a result. For example, if a large non-market benefit has an accuracy of just +/- 20%, its inclusion may render the overall CBA inconclusive. A project with total costs of $1.2 million and total benefits $1.3 million may appear to be justified based on CBA, since benefits outweigh costs. But if $1 million of the benefits are related to a single non-market benefit estimated with an accuracy of +/- 20%, the uncertainty in that estimate would be greater than the margin of benefits over costs, making the results of the analysis inconclusive. Analysts may, for this reason, be reluctant to include highly uncertain non-market costs and benefits in CBA. The costs and benefits of NBS could well fit into that category.

Another issue related to the scope of analysis is whether to include indirect costs/benefits in the analysis or to restrict it to just direct costs/benefits. Direct costs/benefits are those that may be attributed to the project itself; for example, the cost of concrete and steel in the construction of a new luxury apartment building and the benefits of the building in terms of rental income it might earn for the owner. Indirect costs/benefits are those that are related not to the project itself but to related ancillary activities; for example, the costs of producing the cement, sand and gravel that go into concrete used in the building or the benefits of the new building in terms of increased property values for owners of other residential buildings in the neighbourhood. Typically, the focus is on direct costs and benefits, as these are most readily measured. Addition of indirect costs and benefits adds several complications. First, estimating indirect costs/benefits is not easy, as they are not always readily observed. Modelling may therefore be required to estimate them. Second, there is the question of how far beyond direct costs/benefits to measure. Should the costs of producing the electricity used to produce the cement used to produce the concrete be included? What about the costs of producing the coal used to produce electricity? On the benefit side, should the benefits of the additional spending by the building owners whose property values have suddenly increased be included? It can be seen that the estimation of indirect costs/benefits can quickly become complex. For this reason, analysts may prefer to restrict CBA to only direct costs/benefits.

2.1.1 Cost effectiveness analysis

To deal with the difficulty expressing non-market benefits in monetary terms, a variant of CBA known as cost-effectiveness analysis (CEA) has been developed. In CEA, costs

remain measured in monetary terms but benefits are expressed in their "natural" units, which may or may not be monetary. For example, the benefits of construction of a new hospital might include reducing patient treatment costs by a certain amount (a benefit that readily lends itself to monetary measurement) plus the saving of a certain number of additional lives (a benefit that is not easily expressed in monetary terms). The decision criteria in CEA is not whether costs outweigh benefits (since this cannot be readily assessed when costs and benefits are measured in different units) but, rather, which of two options for delivering a given set of outcomes is the least expensive. Related evaluation frameworks in include cost-utility analysis and cost-minimization analysis.

2.2 Economic impact analysis

CBA and its variants are far from the only frameworks available for economic evaluation. Another major category is economic impact analysis (EIA). EIA is an evaluation approach that considers the effects an investment project will have on the broader economy. For example, an EIA might be used to determine how a $100 million project to build a bridge connecting two parts of a city divided by a river will impact the economy of the city, the region or the country. The analysis will consider the details of the $100 million in terms of major categories of spending; say, $25 million on labour, $25 million for land acquisition costs and $50 million for materials (concrete, steel, rubber, etc.) and supplies (fuel, electricity, water, etc.). This spending then gets translated through modelling into changes (impacts) in core macro-economic variables, such as GDP, employment, trade and tax revenues.

Economic impact analysis typically considers three categories of impacts. **Direct** impacts are those that result from the project itself. Direct impacts include, for example, the number of person hours of employment that will result from the construction activities or their value added (GDP). **Indirect** impacts are those associated with the activities required to support the construction project. For example, the employment and GDP associated with the production of the cement and steel purchased to build the bridge. Finally, **induced** impacts are those associated with spending elsewhere in the economy by workers employed in bridge construction. The sum of the three impact categories is the **total economic impact** of the project.

It is common in EIA to speak of impact "multipliers"; for example, the number of indirect and induced jobs created by a project for every direct job. Or the value of indirect and induced GDP created for every unit of direct GDP. Projects with higher multipliers are generally preferred over those with lower.

EIA is generally carried out using specialized macroeconomic models, either input-output models or computable general equilibrium (CGE) models. Here we focus on the nature of input-output EIA models but many of the comments below apply to CGE models as well.

Input-output (I-O) models are detailed representations of the economy showing the interrelationships among industries in terms of the production and consumption of goods and services. The models reflect the technological structure of the economy, showing what goods and services are used by a given industry and what goods and services that same industry produces from those inputs. Because the models trace the input-output

relationships of all industries to one another, they are ideally suited to EIA. For a given set of spending on goods and services (say, those required to for the bridge mentioned earlier), the models permit estimation of the direct impacts plus all indirect and induced impacts across the full supply chain of the economy. In this way, they solve one of the problems of cost-benefit analysis, the challenge of determining how far upstream to estimate benefits.

Because EIA relies on complex models (whether I-O or CGE), it is usually applied only to large investment projects. This is because the economic impacts of a project have to be large enough to be meaningfully estimated with the margins of error of the models. I-O models are exceptionally data intensive to build, especially if they are to be used for impact analysis. They may have more than 100 different industries represented, requiring detailed data on the inputs and outputs of each of them. Though 100 industries may sound like a lot, it is not in comparison to an actual economy. The models are, thus, at best gross simplifications the technological structure of the economy. They have to be in order to make the statistical exercise tractable. As a result, the models can claim neither a high degree of accuracy nor great precision in their estimates. Impacts may be accurate only to within several percentage points and precise only to the nearest million dollars. With such margins of error, use of the models to estimate the impacts of small projects would be indefensible; the impacts of such projects would likely be smaller than the models' margins of error.

I-O models also face challenges in producing sub-national estimates, especially in countries with relatively small and/or geographically concentrated economies. The data requirements to produce sub-national I-O models for such economies may be prohibitive, not least because of concerns around the confidentiality of business statistics. A company that operates the only coal mine in a remote region of a country would not permit its data to be used to construct a regional I-O model, since doing so would reveal its technological structure to other coal mining companies. This is not to say that sub-national I-O models do not exist, for they certainly. The accuracy of such models diminishes, however, as the size of the economy they represent declines.

Given their substantial data requirements, I-O models are usually produced only by national statistical offices (which have the data collection capacity and mandate required) or by specialized research organizations, often associated with universities. Organizations requiring an impact analysis for a project are obliged to contract with either an NSO or a research organization to have it done. Costs for this kind of analysis can be prohibitive.

Given the above, the applicability of EIA to evaluation of NBS projects may be limited. Many such projects are small and local, meaning that their economic impacts may fall below what is necessary for EIA models to be applied. One significant advantage of EIA, however, as an economic evaluation framework is that it is applicable to evaluation of things other than projects. For example, EIA can be used to evaluation the economic viability of a government policy or program, which is something CBA cannot offer. We pursue this point further in the next section where we talk in greater detail about the economic evaluation of NBS.

3 Evaluation of NBS

The preceding two sections have dealt with the origins of economic evaluation frameworks and some of the ways in which these origins bias the frameworks against NBS and about some of the details of the application of these frameworks. In this section we delve more deeply into the use of CBA and EIA for the economic evaluation of NBS. We start by considering the criterion in the IUCN global standard for NBS that economic viability be assessed using cost-effectiveness analysis.

3.1 Evaluation according to the IUCN global standard – Cost effectiveness analysis

The IUCN global standard for NBS calls explicitly for the use of cost-effectiveness analysis (CEA) to evaluate the economic viability of NBS. As noted in the previous section, CEA and the other variants of cost-benefit analysis were designed specifically as tools for the evaluation of projects. Projects generally have clearly defined costs and benefits and, so, lend themselves well to comparison of the two. Not all NBS can be characterized as projects however. The IUCN's own definition describes NBS broadly as "*actions* to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits" (emphasis added). Such "actions" could include a wide range of undertakings, from developing policy frameworks (such as coastal zone land management policies) to running programs (such as financial support programs to assist NGOs in educating coastal communities on the importance of mangrove protection) to implementing specific projects (such as a regional mangrove forest expansion project). Referring back to the categories of NBS in Table 1, the first three categories would mostly involve projects and the last two categories would mostly involve either programs or policies. Of these categories, then, CEA is well suited only to the first three.

Policies and programs are less amenable to evaluation using CEA because the notion of costs and benefits is less readily applied to them. For example, policies may have little in the way of direct costs but may yield all sorts of benefits. Some of the benefits may be unpredictable or even invisible, since by their nature policies touch upon a wide range of actors in often unexpected ways. Programs, for their part, may have relatively clearly defined costs but, like policies, their benefits may be wide-ranging, unpredictable and, therefore, hard to measure precisely. Only projects are likely to have both clearly defined costs and benefits. For now, we will leave aside the challenge of applying CEA to policies and programs and look only at its suitability as a framework for assessing the economic viability of NBS projects. We come back to the evaluation of NBS policies and programs later.

As discussed earlier, CEA requires that a project's costs be measured in monetary units while its benefits may be expressed in whatever units are most suitable (so-called "natural units"). For example, a CEA for a project involving expansion of a mangrove forest for coastal flood protection would measure the costs of expanding the forest

(labour, land acquisition, coastal rehabilitation, etc.) in monetary terms, while the benefits might be measured in terms of number of people, area of land or number of buildings protected from flood risk.

Unlike standard CBA, CEA is not a tool that may be used to make a yes/no decision about a specific project. CEA lacks the simple single-project decision criterion of CBA (positive net present value of benefits), since costs and benefits are not measured commensurably. Thus, CEA is of no help in deciding whether to proceed or not with an NBS project in isolation from other possible solutions. It can only be used to compare NBS solutions against others and choose which one provides benefits at the lowest cost. This presumes that two or more projects with comparable sets of benefits are available for comparison, a presumption that will often not hold in reality.

Imagine, for example, comparison of a coastal flood-risk reduction project using expansion of mangrove forests with a project based on traditional built infrastructure (say, an artificial breakwater). There are several reasons why direct comparison of the benefits of these projects may be difficult. First, it may not be possible to design the two projects in such a way that their benefits will be identical. The physical features of the coastline involved might be such that the mangrove forest and the breakwater will provide protection to slightly different land areas, for example. One project might prevent flooding on 200 hectares of land containing a school and a portion of a residential neighborhood with 100 homes. The other might protect a partially overlapping 150 hectares of land that excludes the school but includes a nearby hospital and protects only 80 homes. How are these disparate sets of benefits to be compared? Is protecting 200 hectares of land, a school and 100 homes better or worse than protecting 150 hectares of land, 80 homes and a hospital? There is no obvious way to answer this question.

Another difficulty in comparing projects may be differing timing of benefits. Design and construction of a breakwater will not occur at the same pace as design and growth of a mangrove forest. A breakwater might be constructed relatively quickly and begin offering full flood protection benefits immediately. Mangrove forests, on the other hand, take time to grow and will may not offer full flooding protection benefits for a number of years. Again, how are benefits with such divergent temporal patterns to be compared?

A third difficulty may be that the two solutions offer different sets of ancillary benefits (or co-benefits). The mangrove forest might provide carbon sequestration and wildlife habitat co-benefits, while the breakwater might provide safe moorage for boats and protection for swimmers. Again, no obvious way of comparing these co-benefits exists.

Possibilities do exist to overcome some of these challenges, at least in part. In particular, normalization of benefits can help. Flood-protection projects that protect the greatest number of houses per unit of cost might be preferred, other things being equal. Normalization works best when the range of benefits is narrow – or when one benefit dominates all the others. In such instances, it may be possible to focus on just one benefit in comparing solutions; for example, in climate change mitigation projects, a sole focus on cost per unit of CO_2 emission reductions leaving aside other benefits may be reasonable. Normalization works best when benefits do not vary across space much; for example, in projects where sequestration of CO_2 from the atmosphere is a benefit, normalization of benefits in terms of cost per tonne of CO_2 sequestered can be quite helpful in choosing among solutions. Normalization works less well where benefits are

spatially heterogeneous. Continuing with our earlier example, it is not much help in assessing the trade-off between protection of the school and the hospital (a trade-off that emerges because of spatial variation in the benefits offered by two projects). Addressing this trade-off would require information about the social benefits of schools versus hospitals that goes beyond what CEA is designed to answer.

On the cost side of the analysis, challenges exist as well. As noted, CEA requires that all project costs be expressed in monetary units. This includes direct costs (labour, materials, capital services, land acquisition and so on), plus indirect costs (negative impacts on third parties, for example). Direct costs will normally be readily measured in monetary terms but this is not necessarily the case for indirect costs. Consider the expansion of the mangrove forest again. Perhaps expanding the forest will increase local mosquito populations, leading to an increase in vector-borne illness among members of a coastal community. How is the negative impact of increased mortality/morbidity due to mosquito-borne disease to be valued? Economists have means of doing so using the so-called "value of a statistical life", but such values are far from uncontroversial. The alternative to the mangrove expansion (the artificial breakwater) might also come with indirect costs that are difficult to value; say, the cost lost seascape views for people living in the area.

Another challenge on the cost side of CEA is the asymmetry in the way spending on NBS is viewed in comparison to spending on traditional solutions from a standard economic accounting perspective. Spending to build an artificial breakwater is considered investment in fixed capital by accountants, both the national accountants who measure GDP and the business accountants who compile corporate and government balance sheets. Thus, when a breakwater is built for flood protection, an investment flow is recorded in the national accounts, which adds to GDP, and in the balance sheets of whoever built it, adding to their net worth[2]. Both entries are seen as desirable by decision-makers, whether public or private. Increasing GDP is something that every government and business hopes to do, as it is generally a winning political and economic strategy. Increasing the value of net worth is also desirable, not least because net worth is used by bond rating agencies to evaluate the credit worthiness of governments and businesses.

In contrast, when a flood control project focuses on expansion of a mangrove forest, the entity undertaking the project it does not have the same opportunity to capitalize the spending. Neither national accountants nor business accountants recognize mangrove forests as capital assets, so any spending on them is simply treated as a current expense and not as investment. Thus, unlike in the case of the artificial breakwater, no investment flow is recorded on any balance sheet. It is as though the spending simply evaporates rather than resulting in the expansion of a physical structure (the forest). Similarly, the spending will not contribute to GDP; at least, not if the spending is undertaken by a private enterprise. Rather, it will be treated as an intermediate expense of the enterprise and, other things equal, it will reduce GDP (not to mention corporate profits). The

[2] The net worth of an entity is equal to the value of its fixed assets plus its net financial assets.

spending would, however increase GDP if undertaken by a government or not-for-profit agency.[3]

These asymmetries matter quite a lot. Decision-makers pay close attention to their accounts (be they national or corporate accounts), as those accounts are closely scrutinized by third parties (journalists, shareholders, citizens, competitors) and used to criticize or praise their performance. Government decision-makers keep a close eye on GDP and to government net worth, while private decision-makers will pay attention to corporate profits and corporate net worth. The great importance attached by decision-makers to demonstrating good performance against these metrics means that any activity that does not improve them may be looked upon with considerable skepticism. Given the choice between two activities that will deliver the same outcome (flood protection), standard accounting practices provide decision-makers with a strong rationale for choosing the one that makes GDP/profits and net worth look better (artificial breakwater) over the one that makes them look stagnant or worse (expansion of mangrove forests).

Given the above, it seems unlikely that CEA will provide clear-cut or appropriate guidance on the economic viability of NBS projects in many cases. Only when a comparator project is available that provides an identical suite of benefits *and* when all costs of both projects can be meaningfully measured in monetary will the results of CEA point unambiguously toward one solution over another. In all other cases, additional information will be required to make the decision. The more the benefits and co-benefits of the NBS differ from those of the comparator project and the more difficult it is to value project costs in monetary terms, the less helpful CEA will be in deciding between NBS and traditional solutions. Even in cases where CEA would provide helpful guidance, standard economic accounting practices will tend to bias decision-makers in favour of traditional solutions over NBS, as their reward systems are very much geared toward improvements in metrics that NBS may do little to improve.

3.2 Cost-benefit analysis as an alternative to CEA

Standard cost-benefit analysis (CBA), in which both costs and benefits are measured in monetary terms, offers the potential of overcoming some of the limitations of CEA for evaluation NBS. In principle, CBA deals with the incommensurability of benefits by ensuring they are all measured in the same units of measure (money). To the extent that all benefits lend themselves to monetary measurement, CBA offers a useful basis for evaluation of NBS projects. Helpfully, it offers the possibility of evaluating NBS projects in isolation using the decision criterion of positive net present value of benefits. Of course, it also offers the possibility of evaluating NBS projects in comparison to other solutions.

In practice, CBA faces its own challenges when applied to NBS. First, not all NBS project benefits are necessarily measurable in monetary units. Benefits that accrue in terms of increased flows of marketed natural resources – for example, increased timber harvests

[3] This is due to differences in treatment of consumption expenditure by corporations and other entities in the national accounts. Corporate consumption is counted as intermediate expenditure and deducted from corporate revenues to estimate value added, or GDP. Government, household and non-profit institution consumption, on the other hand, is considered final expenditure and it contributes directly to GDP.

from expansion of forest areas – should be easily valued in monetary terms. Many NBS benefits are of a non-market type, however, and these are less readily valued. Some non-market benefits, like the value of CO_2 sequestration, might be measurable in monetary units in theory but not in practice due to shortcomings in data and/or methods available. Others, like the preservation of a culturally important landscape – might not be amenable to valuation at all. NBS might have more such benefits than traditional solutions. Given the challenges with valuation of non-market benefits, it is likely in many cases that not all NBS benefits may be expressed in monetary terms, limiting the relevance of standard CBA to the evaluation of NBS.

3.3 Evaluation of NBS programs and polices

As noted, CBA and its variants are project evaluation frameworks that do not lend themselves well to the evaluation of programs or policies. Both of the latter have costs and benefits that can be difficult to define and measure. For this reason, economic impact analysis (Section 2.2) is more appropriate for their evaluation, at least in theory.[4] In EIA, it is necessary only to be able to identify market spending associated with a policy or program in order to evaluate its economic viability. Spending on new battery-powered automobiles induced by a program to provide financial incentives for electric vehicle purchases is all that is needed to evaluate the economic viability of the program. Viability in EIA is assessed by the impact of the spending induced by the policy/program on a standard suite of core macroeconomic variables; often, GDP, investment, employment, taxes, trade and, less often, prices.

There is no specific decision criterion associated with EIA. Policies and programs with positive impacts are deemed worthy of implementation, other things being equal, and those with negative impacts are not. Just how big the positive impacts must be in order for a policy/program to considered worthwhile is a matter of (often political) judgement. In cases where the policy/program has an identifiable and meaningful cost (as in a program to subsidize electric vehicle purchases), it is possible to compare economic impacts with the cost of the policy/program. For example, the impacts of the electric vehicle subsidy program could be compared with the cost to the government of paying the subsidies. Comparing costs with impacts is not straightforward, however, since they measure quite different things. How, for example, is a government expenditure of $50 million on subsidies to be compared with an increase in GDP of $40 million and the creation of 2000 full-time jobs? Furthermore, not all policies/programs have significant implementation costs. A policy imposing a tax on CO_2 emissions, for example, may have only minor administrative costs to a government. These cannot be meaningfully compared with the economic impacts of the policy, leaving the judgement as to the whether the impacts justify the policy/program to be made on other grounds. Still, EIA is a useful and widely

[4] It is worth noting that EIA can also be applied to the evaluation of projects, especially very large ones that span multiple years and involved large mobilizations of (often public) financial and human resources. The impacts of such projects are usually large enough that they can be measured meaningfully by the kinds of models used for EIA (recall the point made earlier about the relative inaccuracy and imprecision of such models).

applied framework. In the case of evaluation of policies/programs, it is often the only option available, as standard CBA is only applicable in limited instances.

As with standard CBA and its variants, EIA has a number of shortcomings for evaluating the economic viability of NBS policies/programs. Many of these shortcomings stem again from the inherent bias of EIA toward measurement of variables related to the market economy. Imagine, for example, a government wanting to compare the economic impacts of a policy directed at forestland conservation for climate change mitigation versus one directed at paying consumers and businesses for building retrofits. While both policies might be effective at lowering CO_2 emissions, they will have quite different market economic impacts. Forest conservation does not generally result in a great deal of market activity, with the possible exceptions silviculture operations and eco-tourism. Indeed, conservation may reduce market activity if alternative uses of the forestland for agriculture, mining, timber harvesting or urbanization are prohibited. Building retrofits, on the other hand, involve substantial spending in the market economy for labour, materials and services, which will, in turn, lead to substantial increases in GDP, investment, employment and so on. When compared using EIA, then, NBS policies are almost certain to lose out to traditional solutions; the analytical framework is structured in such a way as to make this almost a foregone conclusion. Most of the benefits of forest conservation that might tip a government decision-maker in favour of it over a building retrofit policy will not show up in EIA because it the models used for EIA aren't designed to measure them. This includes all non-market benefits of forest conservation, including increased wildlife habitat, enhanced flood control, indigenous community well-being and non-market recreational activities. This is obviously a problem for NBS. The fact is that even if leaving a forest untouched may not look much like investment from a market perspective, it is investment nevertheless and we must begin to see it – and record it – as such (Dasgupta, 2021). The problem, then, is really that our frame of reference for thinking about costs and benefits in economic valuation is blinkered by the biases inherent in the standard evaluation frameworks. In the next section we consider how we might improve on this situation by moving beyond the standard frameworks.

4 Comprehensive wealth as the framework for evaluating NBS

A case has been made in the foregoing that standard frameworks for evaluating economic viability are biased against NBS. These frameworks emerged out of an anthropocentric conception of costs and benefits and were codified during a period when short-term economic growth was the dominant development paradigm. As a result, the frameworks are biased toward measurement of **short-term costs and benefits** for **humans** in the **context of market activities**, making them better suited to analysis of traditional solutions than to NBS. Additionally, standard economic accounting practices, with their **failure to recognize ecosystems** as legitimate targets for investment, provide an extra layer of bias in favour of traditional solutions. As a result, use of standard evaluation frameworks to assess economic viability places NBS unavoidably at a disadvantage vis-à-vis traditional solutions. That is not to say that no evaluation would ever come out in favour of NBS. But the hard truth is that NBS face hurdles in evaluation

processes that have nothing to do with the desirability of the solutions themselves but, rather, with the suitability of the evaluation frameworks for judging between them and traditional solutions. Given this, developing alternatives to the standard evaluation frameworks seem necessary if NBS are to be given a fair chance.

As outlined above, standard frameworks suffer from flaws in three areas:

- **Anthropocentrism:** standard frameworks focus on costs and benefits that matter specifically to humans
- **Market orientation:** standard frameworks make use mainly of variables measuring the market economy
- **Short-termism:** standard frameworks favour the present over the future

On top of this, standard evaluation frameworks are complemented by standard economic accounting rules that **fail to recognize natural assets**.

In this final section of Part 1 of this paper, we explore an emerging framework – comprehensive wealth – as an alternative to standard economic evaluation frameworks, assessing its potential to overcome their shortcomings. We start with a brief description of comprehensive wealth and then discuss in turn how it performs against each of the shortcomings listed above.

4.1 What is comprehensive wealth?

Evidence is mounting that the current, short-term focus on economic growth is no longer adequate. Indeed, the point has come where the sustainability of the well-being many (but not all) people across the globe have gained the last 70 years is threatened by more short-term growth. Excessive air pollution, shortages of clean water, climate change, mounting levels of household and public debt, rapid and unpredictable evolution of global markets, population aging and worries over social cohesion are just some of the reasons for concern about the sustainability of well-being. The recently released Dasgupta Review on the Economics of Biodiversity (Dasgupta, 2021; "Dasgupta Review" from here on) makes a persuasive case that judging whether the path of economic development countries choose to follow is sustainable must not rely on GDP. Rather, what is required is measurement of comprehensive wealth.[5]

According to the Dasgupta Review, the use of GDP to evaluate economic performance is based on a faulty application of economics. GDP, the report notes, is "indispensable in short-run macroeconomic analysis and management, but it is *wholly unsuitable for appraising investment projects* and identifying sustainable development" (Dasgupta Review, p. 5, emphasis added). This is because "an economy could record a high rate of growth of GDP by depreciating its [natural] assets" without any decision maker being aware of what was going on from looking at national statistics. Depreciating natural assets is, the review continues, precisely "the means the world economy has deployed

[5] In fact, the Dasgputa Review refers to "inclusive" rather than "comprehensive" wealth. Both terms are in use in the literature on the topic and the difference between the two is largely semantic. We use "comprehensive wealth" here as that is the term used by the International Institute for Sustainable development in its two major reports on the topic for Canada (IISD, 2016 and IISD, 2018)

for enjoying what is routinely celebrated as 'economic growth'" in recent decades (ibid). Thus, Adam Smith was quite right to emphasize not the "GDP of nations" in his seminal 18th century works on economics but, rather, the "wealth of nations". In doing so, Smith – without possibly knowing it – was presaging what would come to be called sustainability more than two centuries later. What Smith grasped – and what modern economists including Sir Partha Dasgupta and others have formalized – is that wealth is the basis of future well-being. If wealth is growing, development is almost certainly sustainable, and well-being will increase over time. If wealth is declining, well-being will eventually follow suit.

For most of the nearly two and half centuries since Smith's work was published in 1776, wealth was thought of by economists in rather narrow terms. It has predominantly been understood and studied in terms of **produced capital**, or fixed assets, such as buildings, machinery and infrastructure and **financial capital**, such as stock and bonds. Only in recent decades have economists begun to expand the concept of wealth to include other types of capital that provide essential inputs into socio-economic activity. The notion that individual capabilities and knowledge can be construed as **human capital** emerged in the 1960s and came to full maturity in the 1980s (Schultz, 1960; Kendrick, 1976; Jorgenson and Fraumeni, 1989 and 1992). Recognition of ecosystems and natural resources as **natural capital** came a bit later, especially following the work of Daly (1989) and Pearce and Turner (1990)[6]. The idea that the quality of relationships between individuals constitutes **social capital** emerged around that time as well (Coleman, 1988; Putnam, 1995). Text Box XXX provides further details.

The notion that these five types of capital constitute a nation's comprehensive wealth portfolio and that trends in the size of this portfolio were key to understanding the sustainability of development took somewhat longer. But by the late 1990s a number of researchers were beginning to think of wealth in this broader conception and to identify it as a theoretically (nearly) ideal measure of sustainability (Hamilton & Clemens, 1999; Dasgupta & Mäler, 2000; World Bank, 2011 and 2018; Arrow et al., 2012; UNU–IHDP & UNEP, 2012; Managi & Kumar, 2018; Stiglitz et al., 2009; Dasgupta, 2014; Polasky *et al*., 2015). In recent years, a number of major research efforts have been undertaken to measure comprehensive wealth nationally and globally (World Bank, 2006, 2011 and 2018; UNU–IHDP & UNEP, 2012, 2014; Managi & Kumar, 2018; IISD, 2016 and 2018).

The Dasgupta Review is the latest major work to make the point that investment decisions (that is, economic development decisions) need to be made with the goal of maximizing the value of a nation's the comprehensive wealth portfolio rather than its short-term GDP growth if the world is to follow a path of sustainable development. Results from the various efforts at measuring comprehensive wealth suggest that many countries are not currently on sustainable development paths and that natural capital is facing grave threats in essentially every country, even where other elements of the portfolio are, seemingly, doing well. As the Dasgupta Review puts it:

> *A growing body of evidence [shows] that in recent decades humanity has been degrading our most precious asset, Nature, at rates far greater than ever before.*

[6] It is worth noting that the University of British Columbia economist, Anthony Scott, was writing eloquently and empirically on natural capital some four decades before the concept became widely discussed (Scott, 1956).

Simultaneously, the material standard of living of the average person in the world has become far higher today than it has ever been; indeed, we have never had it so good. In the process of getting to where we are, though, we have degraded the biosphere to the point where the demands we make of its goods and services far exceed its ability to meet them on a sustainable basis. That is ominous for our descendants and suggests we have been living at both the best and worst of times. (Dasgupta Review, p. 5).

Text Box 1 - The elements of the comprehensive wealth portfolio

Comprehensive wealth measures the assets a nation has at its disposal. It starts with assets that would be familiar to most people: *produced capital* like buildings and equipment and *financial capital* like stocks and bonds.

It then expands the definition to make room for less familiar, but equally important, assets:

- the *natural capital* found in forests, lakes, minerals, land and the other elements of the natural environment
- the *human capital* bound up in the skills and knowledge of the people that make up the workforce
- the *social capital* resulting from civic engagement, trust and cooperation of the population

Together, these five capital stocks—produced, financial, natural, human and social—make up the comprehensive wealth portfolio.

Most people are familiar with *produced capital* and *financial capital*.They are what normally come to mind when thinking of the nation's assets: roads, railways, ports, houses, machinery and the wide variety of other manufactured assets found in the economy, in addition to stocks, bonds and other forms of financial assets. Investments by governments, businesses and households are often aimed at building up stocks of produced and financial capital.

Natural capital includes market natural resources such as timber, minerals, oil and gas. It also includes ecosystems of all kinds; for example, wetlands that help create clean drinking water and forests that act as carbon storehouses. Ecosystems are not only important for supporting life—they are also economically valuable, though their value is rarely realized through the market.

The collective knowledge, skills and capabilities of the labour force make up *human capital*—the result of lifelong learning in both formal and informal settings. Formal education is an important source of human capital but on-the-job learning and what we learn from our families and peers are equally important. Education helps make individuals more productive, which in turn can increase the productivity of their coworkers. Education also helps people contribute more fully to society as a whole. Human capital is the largest source of wealth in most countries and in developed countries in particular.

Social capital—the norms and behaviours that define interactions between members of society—is another broad component of the comprehensive wealth portfolio. Systems of laws and governance shape society and the economy. Cultural norms play an important role at home and in the workplace. Social ties and networks provide support for people trying to get ahead or overcome hard times.The norms and behaviours that define social capital dictate the use, distribution and value of the other capital assets and therefore play an important role in creating wealth. Some nonetheless consider social capital to be an enabling factor that contributes to the value of the other forms of capital rather than a distinct form of capital itself (UNU–IHDP & UNEP, 2012).

4.2 Comprehensive wealth as the framework for economic evaluation

The Dasgupta Review runs to over 600 pages and much of it is technical enough to be accessible only to those trained in university-level economics. There is no possibility that all of what the review has to say of relevance to the evaluation of economic viability, including the viability of NBS projects/programs/policies, could be covered here. The central arguments of the review in this regard are dealt with in a single chapter (Chapter 13), however, and we summarize the main points of this chapter and their relevance to the evaluation of NBS in the remainder of this section.

In Chapter 13, Dasgupta lists six questions that he contends any "social evaluator" would typically want to ask about the economy she is interested in:

1. How is the economy doing today?
2. How has it been doing in recent years?
3. What would be the forecast for the economy if policies and institutions evolve in the way we believe they might?
4. How is the economy likely to perform under alternative policies?
5. Which policies should governments support?
6. What would be an ideal set of policies?

Dasgupta calls the first three of these "sustainability assessment" questions and the last three "policy analysis" questions. We are mainly interested in what Dasgupta has to say about the latter, which comes in sections 13.11 through 13.16 of the review. Without going into technical detail, the essence of Dasgupta's argument (Box 13.8 in the review) is that analysis of a project's (or program's or policy's) contribution to comprehensive wealth, when properly measured, is the correct basis for evaluating its economic viability. This is a rather revolutionary conclusion. It means that 75 years and more of economic viability evaluation has been predicated on analysis of the wrong variables. Rather than assessing viability in terms of the net present value of market costs and benefits, as in CBA and its variants, or in terms of its impacts on GDP, employment, investment, etc., as in EIA, Dasgupta argues that it is contribution to growth in the size of a country's produced, human and natural capital that should be considered in assessing the viability of projects/programs/policies.[7] For simplicity, we will refer to projects/programs/policies from here forward using Dasgupta's term "investments".

It is important to note that Dasgupta's argument about evaluation of investments rests on a carefully set out argument that 1) wealth must be measured comprehensively (that is, it must be defined to include produced, human and natural capital); and 2) the value of the comprehensive wealth portfolio must be measured using "accounting" (or shadow) prices that reflect the contribution of different assets to social well-being rather than using

[7] Dasgupta discusses social and financial capital as well but calls these "enabling assets" and does not consider part of the comprehensive wealth portfolio. Rather, he sees them as assets that contribute to the worth of produced, human and natural capital by allowing humans to combine elements of them together in production processes (both market and non-market) to generated well-being. Dasgupta's treatment of social and financial capital in this manner stands out somewhat from other major works in this area but is consistent with his work on the global reviews of comprehensive wealth published in recent years by the UN Environment Programme.

market prices. Since the concept of accounting prices will be novel to many, it is worth quoting Dasgupta at length on their definition:

> *As this Review studies reasons for the growing disparity between private incentives and public aspirations, we pay particular attention to the wedge between market prices of capital goods, especially natural capital, and what we may call their social scarcity values, known as accounting prices or 'shadow prices'. By a capital good's accounting price, we mean the contribution an additional unit of it would make to the flow of social benefits. Accounting prices reflect an accommodation between the socially desirable and the socio-ecologically possible. There are cases where market prices approximate accounting prices, but many kinds of natural capital simply do not have markets. They are free to the user. So special methods have to be devised for estimating accounting prices. [Though there a myriad problems in doing so] it is far better to work with rough and ready figures than to ignore whole swathes of capital goods by pretending they do not exist. Unfortunately, the macroeconomic growth and development theories that have shaped our beliefs about economic possibilities and our understanding of the progress and regress of nations do not recognise humanity's dependence on Nature.* (Dasgupta review, p. 36)

Accounting prices are, of course, not observable. As Dasgupta notes, there may be cases where market prices might approximate them but there are many cases where they do not (or cannot because they do not exist). This is an obvious problem for anyone wishing to follow Dasgupta's argument to evaluate the economic viability of an NBS (or any other) investment by measuring its contribution to comprehensive wealth. The contention that this contribution is the proper means of assessing the worth of projects rests theoretically on the use of accounting prices and accounting prices are neither easily found nor approximated in many cases. Setting aside this problem, which is well beyond the scope of this paper to address, it is worth considering how NBS would fare if Dasgupta's suggestion to use comprehensive wealth as the evaluation framework for investments were the norm.

First is clear that using comprehensive wealth to evaluate investments would go a long way toward addressing the concern that ecosystems are not acknowledged as assets in standard accounting practices. One assumes that if investments were routinely evaluated by their contribution to comprehensive wealth, which includes ecosystems as assets by definition, then national and business accountants would also come to recognize ecosystems as assets. The fact that the neither the standard economic evaluation frameworks common today (CBA, EIA) nor standard accounting systems see ecosystems as assets is not a coincidence, as they derive from the same anthropocentric, market-focused paradigm. Evaluation *via* comprehensive wealth, if it were the norm, would change the nature of that paradigm fundamentally.

Regarding the anthropocentrism inherent in standard evaluation frameworks, evaluation via comprehensive wealth would not fundamentally change this, as comprehensive wealth is also a framework with human well-being at is centre. It differs from standard evaluation frameworks in two ways however. First, by explicitly acknowledging that natural capital is a source of human well-being, comprehensive wealth provides both a moral and practical basis for conservation of ecosystems. While some might find the

argument that conservation of ecosystems to preserve their contribution to human well-being and not to preserve them for them for sake of their inherent worth is morally questionable, a pragmatic view would suggest that it is far superior to leaving them out of the evaluation framework altogether.

Regarding the market bias of the standard frameworks, Dasgupta rejects this entirely with his argument that accounting prices and not market prices ought to be the basis of valuation in evaluating investments. Accounting prices, as outlined above, do not reflect private value as market prices do but, rather, social value. So, in this regard, evaluation *via* comprehensive wealth is entirely superior to standard evaluation, at least in theory. In practice, much of the work done to date to compile measures of comprehensive wealth has relied – for lack of observable accounting prices – on market prices as proxies. Will this always be the case? Or will economic concepts and methods be improved to the point where credible accounting prices for all assets will one day be routinely available for use in investment evaluation? This is an open question. But it is worth noting that the global cadre of researchers working in this field is tiny in comparison to the numbers working on improvements in the concepts and methods used to observe market prices. Until such time as more governments embrace comprehensive wealth measures, not just as the basis for investment evaluation, but also as the basis for assessment of national progress, this is not likely to change and accounting prices will remain more of a desire than a reality.

Finally, regarding the short-termism inherent in standard evaluation frameworks, again this is rejected entirely in evaluation *via* comprehensive wealth. To quote the review again:

> *As accounting prices measure the social worth of goods and services, the inclusive wealth of a nation is the social worth of its capital goods. As noted previously, by 'social worth' we mean not only the worth to people who are alive at that date,* but also to future people (Dasgupta Review, p. 326, emphasis added).

From this passage it is clear that comprehensive wealth, when measured properly using accounting prices, is a strictly intergenerational concept. In this regard, it is entirely superior to standard evaluation frameworks as the basis for assessing investment in NBS, which, as noted earlier, often exhibit slowly emerging and long-lived benefits that are discounted out of importance in the standard frameworks.

In conclusion, comprehensive wealth seems to offer considerable promise as a framework for evaluation of economic viability of NBS. The approach provides a relatively simple and conceptually sound basis for evaluating NBS (or any other investment) that is free from most of the biases that limit the suitability of standard frameworks for this purpose. By insisting that all variables be measured in the same units (accounting price weighted asset values), comprehensive wealth also deals with the problems of incommensurability that can plague some standard approaches, most notably cost-effectiveness analysis. Finally, by avoiding the need to estimate flows of costs and benefits in the future, the approach also deals with concerns around discounting of the future.

5 Discussion and future work

As noted at the end of the preceding section, comprehensive wealth – a relatively new area of research in the domain of economics – offers considerable promise as framework for the economic evaluation of NBS, not to mention other types of investments. Comprehensive wealth is free from a number of the biases that limited the suitability of standard cost-benefit analysis and economic impact analysis for evaluation of NBS. It also overcomes some of the methodological shortcomings of the standard approaches, such as incommensurability of measures and discounting of the future.

Given this, an appropriate next step for those wanting to promote evaluation of the economic viability of NBS as a key basis for comparing NBS with traditional solutions would be to join forces with the group of scholars and practicing economists working to further develop the comprehensive wealth approach. There is much to be done in this regard. For one, in spite of the exceptionally thorough theoretical treatment given to comprehensive wealth in the recent Dasgupta Review on the Economics of Biodiversity, there remain conceptual issues to be sorted out. For one, not all those working in this domain agree with Dasgupta's contention that social capital and financial capital are best viewed as enabling assets for produced, human and natural capital.

Methods for the estimation of accounting prices of capital assets also require further development, testing and implementation. Since accounting prices are key to the theoretical argument for comprehensive wealth as the basis for investment evaluation, it is essential that those implementing comprehensive wealth approaches have accounting prices available to them to work with. Falling back on market prices as proxies is liable to send inappropriate signals about the contribution of investments to social welfare, especially in instances where natural capital is a large component of the investment. This would, obviously, be the case in every instance of an NBS.

Yet another area where additional effort to develop the comprehensive wealth approach is needed is engagement with senior government official to explain this new framework to them and show them why it – and not GDP – ought to be the central basis upon which the progress of nations should be based. Standard economic evaluation frameworks like CBA and EIA are what they are because they emerged during a time with GDP and growth-oriented doctrine reigned supreme. They are biased in favour of short-term market outcomes with humans squarely in the centre (and not much around them) as a result. Until the short-term growth paradigm is replaced with another one in which the long-term sustainability of all the assets (produced, human and natural) that form the basis of human and non-human well-being is central, it is unlikely that NBS will be given a fair assessment vis à vis traditional solutions. Convincing more governments to adopt comprehensive wealth as the basis for assessing national progress is key to moving away from GDP-centric short-termism and toward a more sustainable future.

One simple move the global community of NBS supporters could do would be to encourage the IUCN to consider rethinking the recommendation to use CEA as the basis for assessing the economic viability of NBS in Criterion 4 of its global standard. The idea of the global standard is excellent and the IUCN has a great deal of credibility in the NBS community. Still, its recommendation to use CEA for assessing economic viability is

problematic in a number of ways. The IUCN could, instead, choose to recommend that comprehensive wealth be the basis for this assessment, building upon the exceptional theoretical treatment of the subject in the Dasgupta Review.

Part B – Empirical evidence of the value of NBS versus traditional solutions

To come.

References

To come