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HOW MONITORING CAN SUPPORT THE IMPLEMENTATION OF VALUATION TOOLS AND POSITIVE INCENTIVE MEASURES

THE INTERNATIONAL DIMENSION

Note by the Executive Secretary

I. INTRODUCTION

1. In decision IX/6, on incentive measures, Conference of the Parties at its ninth meeting requested the Executive Secretary, *"in cooperation with relevant organizations and initiatives, to examine the international dimension of how monitoring can support the implementation of valuation tools and positive incentive measures"* (paragraph 11). This examination was to draw on earlier work undertaken; namely, the terms of reference for a study on how monitoring can support the implementation of valuation tools and positive incentive measures, prepared by the Executive Secretary for consideration by the Conference of the Parties at its ninth meeting (UNEP/CBD/COP/9/INF/9), further to a request by the Conference of the Parties expressed in decision VIII/25 (paragraph 10 (d)). [1]

2. Pursuant to this request, the Executive Secretary continued cooperation with the World Conservation Monitoring Center of the United Nations Environment Programmel (UNEP-WCMC), which had already contributed to the earlier work, contained in document UNEP/CBD/COP/9/INF/9. The present note is based on a report prepared by UNEP-WCMC, and the work of its authors (Ms. Francine Kershaw, Ms. Susan Walker, Ms. Silvia Silvestri, and Mr. Jörn Scharlemann) is gratefully acknowledged. The input provided by the Natural Capital Project's Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) software tool team as well as by the University of British Columbia's Sea Around Us Project (SAUP) is also gratefully acknowledged.

3. As explained in the earlier note, biophysical monitoring data plays an important role in valuation and the subsequent design and implementation of positive incentive measures, by providing the necessary bio-physical information for valuation exercises as well as targeted and well-calibrated incentive measures, for instance by providing appropriate baselines. Monitoring data is also needed to ensure

* UNEP/CBD/COP/10/1.

[1] For ease of reference, the terms of reference are reproduced in the annex of the present note.

compliance and when evaluating the effectiveness of incentive measures, including scenario assessments of different types of measures to achieve specified objectives. [2]

4. There are however two major challenges in discharging these requirements effectively:

(a) First, the present state of monitoring iniatives and associated datasets suffers for specific deficiencies and in particular from fragmentation and a subsequent lack of standardization and exchangeability of data. This challenge need to be addressed in order to enhance the support that monitoring initiatives could provide to the application of valuation tools and positive incentices measures.

(b) Second, even when assuming that this particular challenge is effectively overcome, the fact remains that comprehensive monitoring across all biodiversity components, and all spatial scales and sectors, is, due to time and resource constraints, simply not feasible. The interpolation of existing monitoring data by modelling is therefore required in order to fill these gaps. Many of these models, developed in recent years, operate at international or global level.

5. The present note briefly reviews positive incentive measures and their relationship with economic valuation as well as a number of economic valuation approaches, including by discussing the merits of spatially-explicity approaches (section II). Section III addresses the second bullet point above by providing a concise overview of existing modeling work and by presenting, for illustrative puroposes, two model toolboxes in more detail, including their methodologies and monitoring requirements, applicable spatial scales, outputs, and links to economic valuation approaches. [3] Section IV addresses the first bullet point above and identifies a number of activities which could address these deficiencies. Section V concludes and presents recommendations for collaborative activities which could strengthen the contribution of monitoring initiatives in particular at international level.

6. The note draws heavily on previous work, further referenced below. It is hoped that the present note, in providing a succinct synthesis of some existing relevant monitoring and modelling tools operating at international level, and in pointing out opportunities for collaborative activities to address existing challenges in monitoring, contributes to efforts in developing a practical framework which could eventually facilitate in-country valuation studies and incentive measures, in accordance with national priorities and key policy goals, which is the ultimate goal of this strand of work. [4]

II. POSITIVE INCENTIVE MEASURES AND VALUATION

A. Positive incentive measures

7. Under the Convention, positive incentive measures are conceptualized as an enducement to encourage the achievement of biodiversity-friendly outcomes or support activities that promote the conservation and sustainable use of biodiversity. In many countries, such incentives are also generated through the use of breaks on governmental levies such as taxes, fees or tariffs that grant advantages or exemptions for activities that are beneficial for conservation and/or sustainable use. The Conference of the Parties recognized that positive incentive measures can influence decision making by recognizing and rewarding positive activities, and are important in achieving the objectives of the Convention and the 2010 biodiversity target, when they are targeted, flexible, transparent, appropriately monitored, and adapted to local conditions. [5]

8. Positive incentive measures can be further differentiated into direct and indirect approaches. Direct approaches provide incentives which seek to emulate market prices – they generally involve ‘paying’ relevant actors to achieve biodiversity-friendly outcomes or, conversely, to not achieve biodiversity-harmful outcomes. Examples include long-term retirement (or set aside) schemes;

[2] See UNEP/CBD/COP/9/INF/9.

[3] It is hoped that this overview can assist in implementing item 4 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

[4] See decision VIII/25, paragraph 10 (d).

[5] Decision VIII/26.

conservation leases, covenants or easements; and schemes providing payments for ecosystem services. Indirect approaches seek to support activities or projects that are not designed exclusively to conserve or promote the sustainable use of biodiversity, but also have the effect of contributing to these objectives, for instance, in the context of the generation of markets for biodiversity-related goods and services, including through certification and eco-labelling schemes, or of community-based natural resource management programmes. [6]

9. The economic rationale of these schemes is that many components of biodiversity, and the associated ecosystem services, bear characteristics of public goods, for which markets cannot develop spontaneously for those components, which then remain unpriced. The absence of an assigned value prevents existing market prices for signalling their scarcity, and hence to operate as adequate incentives for their conservation and sustainable use. This market failure can be remedied, at least partly, by eliciting the value of these biodiversity components through the application of appropriate valuation tools, and by ensuring that this value is incorporated in resource-use decision-making, including through the calibration of adequate positive incentive measures, and in particular of direct positive incentive measures. [7]

B. Valuation of ecosystem services

10. A sound valuation framework is critical to the development of many positive incentive measures. [8] Economic valuation facilitates the translation of ecosystem services into comparable human values and offers a way to compare the diverse benefits and costs associated with ecosystems by attempting to measure them in terms of a common denominator, thus providing, if only partially, the context within which policy decisions must be made. By raising awareness, valuation can thus act as an incentive measures in its own right and, as mentioned above, can also provide useful information for the right calibration of certain incentive measures.

11. A 'true' appreciation of value, i.e. "*the worth, usefulness, or importance of something*," would ideally enable all aspects of biodiversity and ecosystem services, whether directly marketed or not, to be compared on a level playing field. Methodological challenges and context-dependencies (e.g. societal preferences) related to the method of valuation, pose challenges to achieving this goal. Frequently, however, economic valuation of ecosystem services provides the only non-zero estimate of the value of biodiversity against which other goods and services, whose total value is well reflected by the marketplace, can be reasonably compared.

12. The main framework used is the Total Economic Valuation (TEV) approach that reflects the need for valuation methods to address both direct and indirect use values, as well as their non-use value – reflecting the fact that many people hold non-use or passive use values over biodiversity components that they may never experience or use directly". TEV is calculated as the sum of direct, indirect, option, and existence values, while avoiding double-counting. [9]

13. There is a broad range of ecosystem valuation tools currently in use, some of which are broadly applicable, some are applicable to specific issues, and some are tailored to specific data sources. Each different technique that is employed in ecosystem valuation will feature different bio-physical data and

[6] See UNEP/CBD/COP/10/24 for further recent information, including lessons learnt and good practice cases, in the application of positive incentive measures.

[7] Some policies providing incentives can be designed without explicit valuation, in particular those assigning physical caps. For instance, the assignment of total allowable catch (TAC) in fisheries management, and the release of individual transferable quota (ITQs) would lead to an indirect correction of market prices. In this case, monitoring data will be relevant in order to determine the appropriate stringency of the cap. These caps need to be oriented towards not exceeding the maximum sustainable yield, and associated monitoring data could provide the necessary bio-physical information. See item 7 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

[8] For a detailed explanation of tools and methodologies for the valuation of biodiversity and biodiversity resources and functions, see SCBD 2007, Silvestri & Kershaw 2010, or De Groot et al. 2006.

[9] Double counting can be an issue in particular between direct and indirect use values (Pearce D & Moran D, 1994).

information requirements.[10] Valuation approaches that have been used extensively in recent years, in a wide range of policy relevant contexts, consist of three procedures:

(a) **Revealed preference approaches**: based on actual observed behaviour data, including some methods that deduce values indirectly from behaviour in surrogate markets and price signals in these markets, which are hypothesized to have a direct relationship with the ecosystem service of interest;

(b) **Stated preference approaches**: based on hypothetical rather than actual behaviour data, where willingness to pay estimates are derived from questionnaires describing hypothetical markets or situations;

(c) **Benefits Transfer**: the process of "borrowing" existing monetary estimates and transferring them to other similar situations. Benefits transfer provides a potential solution for estimating environmental costs and benefits in situations where primary studies would be prohibitively expensive.

14. The Benefits Transfer approach is a potentially important valuation technique whenever data deficiencies or time and resource constraints prevent the preparation of costly primary studies. Caution is needed in employing this technique since intervening factors including distance to a population centre, ecosystem fragmentation, differential purchasing power, and the spatial scale at which the ecosystem service is measured, will influence estimated values even sites look 'similar'.[11]

15. Economic valuation under revealed preference approaches, and in particular under the so-called change in productivity approach, is a two step process, requiring firstly the identification, understanding and quantification of the biophysical processes underpinning the components of biodiversity and/or ecosystem services being valued, and secondly, an estimation of the value of impacts in monetary terms. Depending on the outputs sought, the data required for undertaking ecosystem service valuation may be either non-spatial or spatially-explicit. Some valuation exercises may only require non-spatial data, for example, the results of a species census within a given area, or carbon monitoring data recorded at the national level. The incorporation of spatially-explicit data into ecosystem valuation is useful whenever a spatial aspect is involved, for example, measuring the loss or change in value of ecosystem services due to land-use change or resource extraction. Incorporating a spatial dimension to the valuation process can also provide insight into the influence of different scales and assist in the spatial allocation of incentive measures.

16. Ecosystem service mapping (ESM) is a spatially explicit approach mapping areas of service provision, trajectories of flow, and areas of benefit for both the primary ecosystem services defined and all connected ecosystem services of relevance to the decision making framework at hand. Such mapping is particularly important for assessing the impact of land-use change or resource extraction on the functional response of an ecosystem; for targeting incentive measures in accordance with the spatial characteristics of ES; and for managing a landscape for the ecosystem services provision across different scales.[12] In light of the need for the quantification of both the biophysical and socio-economic aspects of ecosystem services and incentive measures, including a possible appreciation of distributional impacts (which could be spatially explicit), the design framework for positive incentive measures overlaps considerably with that for ecosystem services mapping. However, it should be noted that ecosystem valuation is not necessarily included in the ESM framework.

17. Foremost to ESM is an appreciation of the configuration of production areas (P) and benefit areas (B) (see figure 1). While there might be a tight overlap between production and benefit areas for a service such a soil formation (Figure 1, tile 1), the benefits associated with a service such a water regulation may be far removed from the provision area (Figure 1, tile 3). In other cases, as for example is the case for

[10] See UNEP/CBD/COP/9/INF/9 for details.

[11] Konarska, Sutton, & Castellon, 2002.

[12] It could thus contribute to items 1 to 3 as well as 6, 11 and 21 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9. See ibid., page 12.

services such as carbon sequestration, benefits may be realized omni-directionally from the production area (Figure 1, tile 2).

18. The ecosystem services framework of Turner and Daily (2008) captures the importance of considering the environmental change process in relation to both the ecosystemservices it impacts and the governance setting. Issues of scale (geographic and temporal), scope (specifically the number of services considered and the potential for them to interact), and governance, are fundamental in determining the actual extent to which ESM may actively inform policy. In-depth consideration of these issues is provided in section IV below.

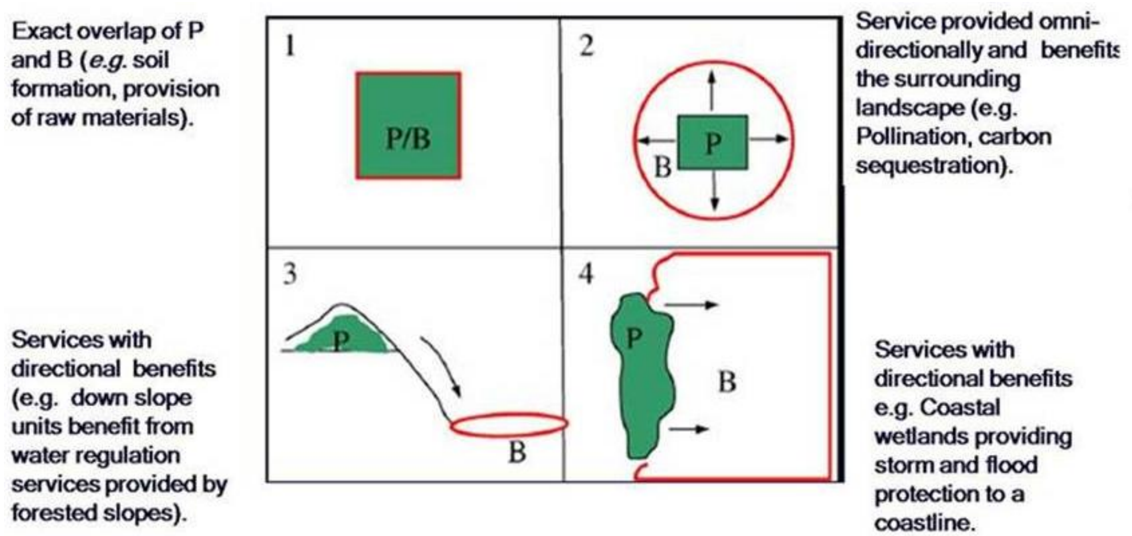

Figure 1: Spatial relationships between service production (P) and service benefit (B) areas (source: Fisher et al. 2009).

III. RECENT MODELLING INITIATIVES

19. While monitoring is a crucial prerequisite in developing valuation tools, comprehensive monitoring across all biodiversity components, and at all spatial scales, is not feasible due to time and resource constraints. Instead, the interpolation of monitoring data by modelling is required. Lessons learned from the development of valuation tools can then positively feedback into the monitoring process, informing methodological design and improving approaches through an iterative cycle (see Figure 2).

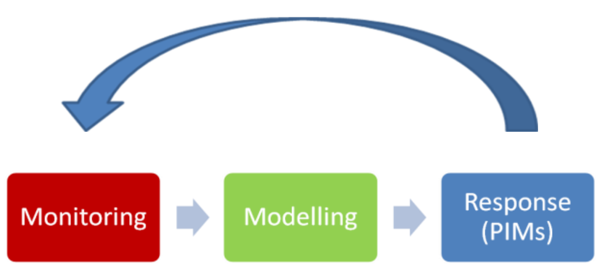

Figure 2: The link between monitoring and modelling in the development of ecosystem valuation tools and positive incentive measures and the feedback loop enabling iterative design.

20. A broad spectrum of models [13] build on monitoring data and information as described above and contribute towards the quantification and valuation of those aspects of biodiversity and ecosystem services that are relevant to the development of positive incentive measures. Models range from non-spatial and spatially-explicit biophysical models (e.g. climate, hydrological, and biogeochemical which inform the provision of potential ecosystem services), to socio-economic models (e.g. general economic, partial economic, and demographic models), to fully integrated models.

21. Integrated assessment models are characterized by having endogenous biophysical and socio-economic components. Responding to the challenges of developing fully integrated models with outputs that can be assimilated by decision-makers, several toolkits have been developed which combine the use of outputs from several different models. Examples of such toolkits are ARIES, (Artificial Intelligence for Ecosystem Services http://esd.uvm.edu/) (Villa, Ceroni, Bagstad, Johnson, & Krivov, 2009), a toolkit in development; InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs, http://www.naturalcapitalproject.org/InVEST.html) (Tallis & Polasky, 2009), and as well as the Ecopath with Ecosim (EwE) suite of models in relation to fisheries management incentives.

22. A number of technical assessments of various models and toolkits of potential relevance are available, including:

- The study ‘Scenarios and models for exploring future trends of biodiversity and ecosystem services changes’ (IEEP, Alterra, Ecologic, PBL, & UNEP-WCMC, 2009).
- The Scoping the Science review on ‘The Economics of Biodiversity Loss’ (Balmford et al., 2008). In the light of data needs, this review considers the potential for the quantification and mapping of ecosystem services at the global level.
- Reports for corporate enterprises on the strengths, weaknesses and applications of different ecosystem services tools; for instance the BSR-IPIECA (2008) report ‘*Business for Social Responsibility's Assessment of Emerging Environmental Services Tools for the International Petroleum Industry Environmental Conservation Association*’; and the BSR (2010) report ‘*Future Expectations of Corporate Environmental Performance. Emerging Ecosystem Services Tools and Applications’*.
- The Ecosystem Based Management (EBM) Tools Network [14] – a network aimed at promoting the use and development of tools for EBM in coastal and marine environments and the terrestrial environments that affect them (watersheds). The network provides an extensive searchable database of EBM tools. [15]

23. The IEEP et al (2009) report features, amongst others, MIMES (Multiscale Integrated Model of Ecosystem Services), a spatially explicit Integrated Assessment Model which links physical changes to economic values is. MIMES is based on physical ecosystem models and considers the dynamics and tradeoffs among natural, human, built and social capital, together with joint economic and social valuation of ecosystem services. The report provides details on different marine integrated models, such as the EwE model; the Cumulative Threat Model, developed at the University of California, Santa Barbara (Halpern et al. 2008), and the Reefs at Risk approach, developed by the World Resources Institute (WRI), the International Center for Aquatic Living Resources Management (ICLARM), the UNEP World Conservation Monitoring Centre (WCMC), and the United Nations Environment Programme (UNEP).

[13] IEEP et al. 2009, referenced in paragraph 22 below, provides an overview of the available models.

[14] http://www.ebmtools.org/

[15] http://www.smartgrowthtools.org/ebmtools/index.php .

24. In assessing the relative suitability of different models and toolkits to specific decision-making scenarios,[16] it is important to consider the following characteristics: (i) focus (i.e. marine, terrestrial or both); (ii) geographic coverage (i.e. global, national, local, landscape, site); (iii) theme of output (e.g. flood regulation or managed timber production); (v) required inputs, the spatial and temporal resolution of these inputs and whether or not they are user- or developer-specified; (vi) intended use (e.g., for valuation purposes); (vii) methodological framework and its relation to the driver-pressure-state-impact response framework; [17] (viii) tool accessibility and ease of use; and (ix) the assemblage of scenarios which may be considered – be they implicit or explicit (e.g. land-use change, climate change, trends in service consumption, population growth, policy and management decisions). With regard to the last point, it is important to recognize that some toolkits do not themselves generate scenarios, but rather rely on the user converting the scenario into the input land cover map or spatial plan and defining the associated input parameters.

25. For illustrative purposes, the InVEST tool and the EwE suite of models are presented in more detail below.

InVEST

26. InVEST is a freely available software tool developed by the Natural Capital Project – a partnership of Stanford University's Woods Institute for the Environment, University of Minnesota's Institute on the Environment,, The Nature Conservancy (TNC) and World Wildlife Fund (WWF). It incorporates both terrestrial and marine components and has a wide range of functions, including the support of initiatives that offer incentive measures. Table 1 below captures the potential applications of the different ecosystem service model components to valuation and incentive measures, as indicated by the InVEST team.

27. With regard to carbon storage and sequestration for instance, InVEST can be a useful guidance tool for informing the design of land-based carbon offset projects that aim to provide additional 'co-benefits' – such as conservation of biodiversity, diversification of agriculture, soil and water protection, employment, and ecotourism (CCBA, 2008), in the context of both the suggested payment mechanisms for reducing emissions from deforestation and forest degradation (REDD) and the voluntary market for carbon offsets. By adding a multiple ecosystem service perspective to carbon accounting, InVEST can help support land-based carbon offset projects by identifying how and where these co-benefits from carbon investments can be maximised. Such information can be used to guide the selection of projects for investment, improve the efficiency of chosen projects and estimate the likely level of co-benefits, possibly allowing entry into a niche market for environmentally-friendly carbon offsets. An illustration of the policy steps underpinning carbon offsets that InVEST can contribute towards is illustrated in Figure 3 and described in detail in *Using InVEST to Establish Land-based Carbon Offsets*. 18/

28. **Ecosystems included:** In particular, InVEST can model avoided reservoir sedimentation, hydropower production, open-access harvest (includes many non-timber forest products), timber production, water purification and crop pollination. Future releases will include models for flood control, irrigation water for agriculture, and agricultural production. InVEST also has a simple module for biological diversity at species level that estimates habitat integrity and rarity as a proxy for biodiversity.

29. **Scale:** Many services in InVEST involve hydrological processes that are best described at the sub-basin or larger scales. If hydrological services are important co-benefits, this may make InVEST inappropriate for small scales.

30. **Relative vs. absolute values:** Without calibration, InVEST is most useful for identifying where to focus carbon offset projects, based on relative contributions of ecosystem services across the landscape.

[16] Undertaking such an assessment would contribute to items 4, 9, and 12 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9. See ibid., page 12 – 13.

[17] European Environment Agency, 2003.

[18] http://www.naturalcapitalproject.org/Policy_Briefs/Carbon_21Jan09_FINAL.pdf

However, if InVEST models are calibrated and there is good correlation between modelled results and observations, InVEST can be used for carbon offset decisions based on absolute values.

31. **Biophysical vs. economic terms:** InVEST can quantify ecosystem services in biophysical terms (e.g. cubic meters of water), which can be useful for targeting offsets across landscapes and so used to support incentive measure initiatives. It can also estimate economic values, in monetary terms, using a range of techniques such as avoided damage or treatment costs and market valuation. Valuation can only be done once the biophysical parts of the models are calibrated to time series data. Given the simplifications in the biophysical and economic models, economic value estimates should be treated as first estimates only, for example for gaining support for land-based carbon offset projects.

32. **Temporal scale:** The current InVEST hydrological models only provide estimates of ecosystem services on an annual average basis. When monthly or seasonal patterns in hydrological service provision are of interest, InVEST may not be a useful assessment tool.

Table 1: InVEST model outputs relative to potential valuation/incentive measures (source: InVEST). [19]

	Output	Potential applications to valuation/incentives measures	Unit
Ecosystem services	Carbon storage and sequestration	b, g, o, c, m, i, h, e, b, k, j	Tons C/ha or $ NPV/ha
	Avoided reservoir sedimentation	g, t, q, o, c, m, i, h, e, b, k, j	kg/ha/yr or $NPV from avoided dredge costs
	Hydropower production	g, t, q, o, c, m, i, h, e, b, k, j	Mm water depth/ha/yr, kW/ha/yr, NPV energy value
	Crop pollination	g, o, c, m, i, h, e, b, k, j	Marginal yield kg/ha/yr, marginal NPV crop value
	Water purification	g, t, q, o, c, m, i, h, e, b, k, j	Kg/ha/yr, NPV avoided treatment costs
	Timber production	a, d, g, u, o, c, i, h, e, f, b, k, j	Volume/ha/yr, NPV/ha
	Fisheries	a, d, g, u, o, c, i, h, e, f, b, k, j	Kg/yr, NPV, net revenue
	Aquaculture	a, b, c, e, f, g, k, m	Kg/yr, NPV, net revenue
	Coastal protection	g, p, o, c, i, h, , e, b, k, j, f, p	m^2/m^3/event, avoided erosion/flood costs
	Recreation	b, e, g, j, p, o, k, h, u	# sightings, visitation rates, catch/trip, # passengers, net revenue
	Wave energy generation	b, c, e, f, g, j, o	MWh/yr, NPV
	Aesthetic views	b, g, i, j, e, o	
	Marine water quality	f, g, k, m, p, e, o	Avoided treatment costs
	Habitat rarity	e, g, o, c, n, h, j	Index
	Habitat integrity	e, g, o, c, n, h, e, j	Index
	Key Biodiversity Areas	o, c, n, h, e, j	

Reference:

a) Direct use value of harvestable species
b) Application of stated or revealed preference methods
c) Allocation of property rights
d) Harvest quotas
e) Land use zoning
f) Support for sustainable use practices
g) Production function impacts
h) Information provision for sustainable management and off take
i) Indirect (production function) valuation
j) User fees
k) Identification of perverse incentives
l) Design of agri-environmental schemes
m) Grassland diversity
n) Establishment of property right
o) Value of flood control
p) Value of water use-domestic and irrigation
q) Abstraction control/licensing
r) Abstraction and discharge limits or pricing
s) Water pricing
t) Close season on harvests
u) Other, please specify

[19] See items 6, 8, and 11 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

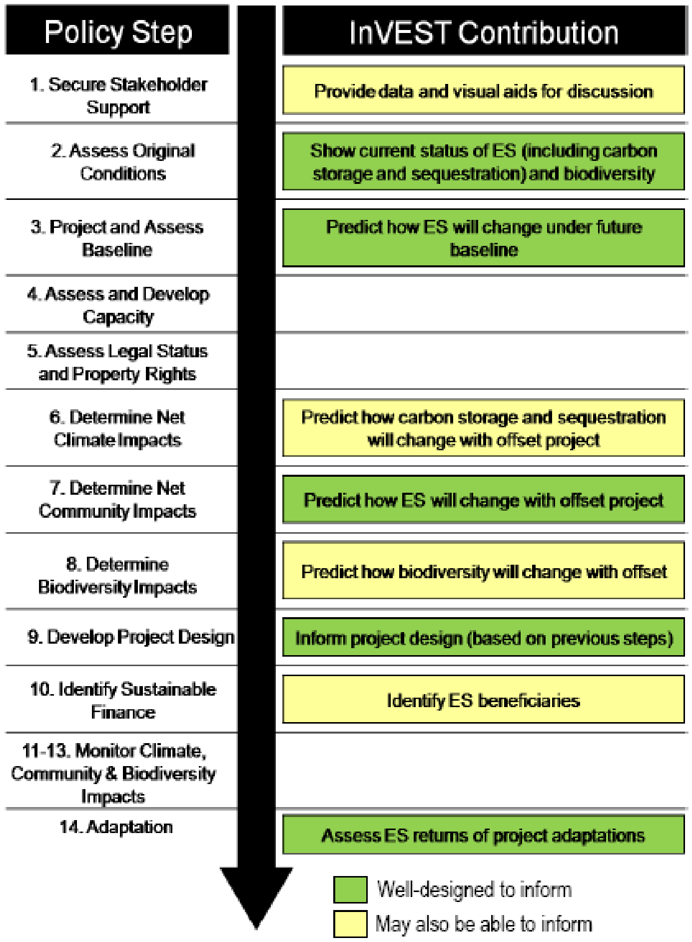

Figure 3: Contributions of InVEST to the policy steps for carbon offsets (source: Natural Capital Project).

Marine-based fisheries management using EwE

33. Over much of the world the biomass of fish targeted in fisheries (including that of both the target fish and those caught incidentally) has been reduced substantially relative to levels prior to the onset of industrial fishing. [20] In the North Atlantic, for example, current overall biomass of high-trophic level fishes is estimated to be one third of what it was in 1950. [21] Fishing pressure has reduced the biomass of some species to less than 10% of the pre-exploitation level within a few decades, particularly species with vulnerable life history traits such as large predatory fishes, including sharks and relatives, and deep sea species.

34. Important indicators have been developed which have the potential to be integrated into fisheries models and contribute toward ecosystem service valuation, such as the Ecopath with Ecosim (EwE) suite of models developed by the University of British Columbia's Sea Around Us Project (SAUP). They include the biomass diversity index; the marine trophic index; the depletion index (see details in box 1); and the ecological indicators from Annex III of the Bergen Convention.

[20] Millennium Ecosystem Assessment, 2005 and UNEP, 2006.

[21] Christensen et al., 2003.

Box 1: Indicators of Marine Biodiversity A **biomass diversity index** can be used to provide a synthesis on the number of species or functional groups that compose the biomass of the ecosystem. The biomass diversity index assumes that more stable ecosystems will tend to have a more even distribution of biomass across the functional groups and can therefore be used to evaluate model behaviour.

- The **marine trophic index (MTI)** is calculated as the average trophic level of the catch and is used to describe how the fishery and the ecosystem may interact as a result of modelled policy measures. The index is often used to evaluate the degree of "fishing down the food web" (Pauly *et al*., 1998). The MTI is one of the core indicators being used by the Convention on Biological Diversity.
- The **depletion index** (DI) has been developed to evaluate the degree of depletion of fish species by accounting for differences in their intrinsic vulnerability to fishing. It was calculated from prior knowledge of the intrinsic vulnerability and the estimated changes in functional group biomasses. Intrinsic vulnerability to fishing of the 733 species of marine fishes with catch data available from the Sea Around Us Project database (www.seaaroundus.org) was included in the analysis.

Source: adapted from Alder et al. 2007; Balmford et al. 2008

35. The Sea Around Us Project (SAUP) has developed a suite of models based upon the original Ecopath with Ecosim framework which includes Ecospace and EcoOcean. Although primarily relevant to the fisheries sector, EwE is an ecosystem model which can be broadly applied to assess the ecosystem status through the quantification of biomass at each trophic level. Model outputs are based on actual data from stock assessments, ecological studies, and the literature, and model outputs are validated by time series fitting and uncertainties assessed using the 'Ecoranger' application. [22] The models in the EwE suite are linked in the following hierarchical manner:

- Ecopath requires input of three of the following four non-spatially explicit parameters: Biomass; Production/Biomass ratio (or total mortality); Consumption/Biomass ratio; and Ecotrophic efficiency for each of the functional groups in the model. Biomass of the exploited species is the key parameter determining catches in marine fisheries, at least in the short-term. Global declines in exploited biomass are inferred from declines in catches despite increased effort.

- Ecosim inherits its initial key parameters from the base Ecopath model, and can incorporate (and benefits from) time series data, e.g. those available from single species stock assessments. This can include fishing effort or fishing mortality data.

- Ecospace also relies on the Ecopath mass-balance approach for most of its parameterisation. Additional inputs are movement rates used to compute exchanges between grid cells, estimates of the importance of trophic interactions (top-down vs. bottom-up control), and habitat preferences for each of the functional groups included in the model.

- EcoOcean was developed to quantitatively assess the future of fisheries under different scenarios and is based on a series of 19 marine ecosystem models that represent the 19 FAO fisheries management areas.

36. Positive incentive measures to address the issue of overfishing include tradable quotas, total allowable catches, and the use of gear-restrictions within management areas. In New Zealand for example, tradable fish quotas have been used to set fisheries catch at a sustainable level, protect the resource, raise revenue, increase efficiency and make fishing allocations more equitable. [23] Outputs of the EwE suite can assist in informing the development of such positive incentive measures by providing an indicator of the value of fisheries and related ecosystems, and thresholds where this value may change, and thus at what level such quotas or management actions should be set in place.

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[22] For this validation process to be robust, the user is required to carefully select input data depending on the outcome required, as EwE is highly sensitive to the input data used.

[23] AIDEnvironment, 2004; see also UNEP/CBD/COP/10/24.

37. **Scale:** EwE is a multi-scale model which can be applied to any ecosystem scale as defined by the user, and has previously been applied as a component of integrated assessments, namely the Millennium Ecosystem Assessment (MA) and the Global Environment Outlook (GEO) 3 and GEO-4. As part of the integrated assessments, EwE was linked with other models proving it can be adapted to a range of assessment applications. The use of EwE for regional scale policy exploration aiming to achieve economic, social and ecological sustainability objectives is discussed in a paper on multispecies management strategies. [24] Ecospace is the only component that provides global spatial representation using user-defined grid cells, whilst EcoOcean was developed to quantitatively assess the 19 FAO fisheries management areas and as such is limited to these.

38. **Relative vs. absolute values:** EwE has a robust validation process, however the outputs are highly sensitive to the input data and so careful consideration on what input data should be used is required prior to modelling so that the outputs are robust in relation to the questions being asked. EwE provides as realistic a representation of the state of the ecosystem as possible given the input data, and so absolute value of actual measurements will always provide a more reliable output.

39. **Biophysical vs. economic terms:** EwE can quantify ecosystem services in biophysical terms (e.g. biomass at each trophic level) which can be useful for monitoring reduced or increased fishery production – and therefore economic value - over time and consequently informing practical management actions. Modelling of trophic level provides a proxy for ecosystem value, as those ecosystems with good representation of higher trophic levels can be considered more complex and productive, and therefore economically valuable, than those degraded ecosystems with lower trophic levels.

40. **Temporal scale:** Ecopath does not have a temporal component. Ecosim provides data in monthly intervals in order to allow for seasonality and short life-spans. Ecospace time intervals are user defined, ranging from relatively short timescales (0.2 years) to longer time scales (2 years). EcoOcean is run from monthly time steps from the year 1950.

IV. CHALLENGES IN MONITORING

41. While the monitoring of biophysical processes is critical for the valuation of ecosystem services and underlying biodiversity as well as for the design and implementation of positive incentive measures, current monitoring approaches suffer in particular from challenges associated with a lack of data integration, with a subsequent need to enhance efforts to collaboratively integrate existing data with new information collected through standardized methods spanning multiple sectors.

42. The majority of these challenges stem from a general lack of available, standardized, and validated data for many ecosystems at the global, regional and sub-regional scales. Table 2 summarizes these challenges using a hierarchical framework where data availability, indicated by the arrow and associated score, declines through the list. The remainder of this section details each of these data gaps and, where possible, suggests approaches for addressing these challenges.

Geographic coverage

43. Globally, existing monitoring activities are geographically uneven, with heavy biases towards particular ecosystems. This impedes the ability to establish a comprehensive overview of the current state of biodiversity and emerging trends across regions and ecosystems.

[24] Pitcher & Cochrane, 2002.

Table 2: Hierarchical framework of data availability gaps for ecosystem monitoring

Score	Data availability gap	Description
1	Geographic coverage	The majority of data sets do not provide comprehensive global coverage, with biases in the location of research and reporting. Additionally, many reporting entities represent small-scale initiatives with no comparable data collection/reporting methodology.
2	Spatial resolution	Global data, often derived from satellite or remote sensing techniques, tends to be relatively coarse, with a higher probability of error. Data derived through small-scale activities tends to be much higher-resolution with lower probability of error, but is not conducted at the scale appropriate for regional or global assessment and international decision-making.
3	Quality/condition of ecosystem components	Component presence/absence data does not provide information on the quality or condition of the component being measured, e.g. habitat quality, which would provide a more accurate method to assess ecosystem function. Studies to assess ecosystem condition are generally conducted on a local scale and the data are not typically integrated into broad-scale, global assessments.
4	Temporal resolution	Inconsistencies and evolution in data collection methodologies as well as time lags in data reporting have resulted in time series data being almost non-existent for many ecosystem components. It is critical to establish validated baselines and develop approaches which will allow the timely compilation of data in order to measure change in habitat extent over time.

44. For an ecosystem valuation tool to accurately measure the value of an ecosystem or of a component therein, the data being used need to be comparable across the entire extent – otherwise, any trend measured could also be an artefact of different sampling techniques. With the majority of data historically being derived at the national level or via small-scale NGO-led initiatives, there has to date been little coordination and standardization of data collection and monitoring methodologies. Efforts are needed to develop and apply robust methods for integrating existing information with a view to ensure standardized data collection across scales, including the development of internationally agreed frameworks and guidelines for future data collection.

45. Remote sensing is becoming increasingly used over wide areas to generate digital maps of land-cover classes through spectral imaging. [25] Spectral imaging is useful for categorising: (i) trends in the extent of selected biomes, ecosystems and habitats; (ii) coverage of protected areas; (iii) threats to biodiversity; (iv) connectivity or fragmentation of ecosystems; (v) trends in populations of selected species; and (vi) potential human development indicators. Remote sensing can either generate maps directly using airborne or satellite sensors, or indirectly through the analysis of environmental parameters and other proxies for the actual features of interest. As remote sensing can generate maps of large areas relatively rapidly, it is potentially very useful for creating time series data sets enabling the assessment of trends over time– bearing in mind that changes in sensor technology with every satellite make comparisons across time alltooften difficult or impossible.

46. There are a number of other limitations that need to be taken into consideration when employing remote sensing techniques. Thematic maps do not adequately reflect the finer scale patterns of biodiversity, i.e. different forest types or plant and animal communities, or the more fundamental

[20] See Strand et al. 2007 or CBD Technical Series No. 32 for a comprehensive overview of the options of remote sensing, and document UNEP/CBD/COP/9/INF/9 for a brief overview.

complexity of ecosystem processes which have not yet been characterised in the field. 'Ground truthing' by other monitoring methologies is essential, but the challenges discussed in paragraph 44 above come into play again when applying such methodoogies. Remote sensing is also often of limited accessibility to the broader conservation community, and in particular developing countries, for reasons including high cost of data, the expense of storing and processing data, and the high level of expertise and facilities required for managing and analysing the data. Remote sensing techniques are also of limited utility in the marine realm as the majority of these techniques are by their nature biased toward terrestrial and tropical coastal regions (i.e. with shallow, clear waters) and exclude deep-sea habitats and also those which reside in the turbid waters of temperate regions, for which there remains no large-scale accurate mapping methodology available.

47. As explained in section III above, modelling can address such data gaps to some extent. For instance, the emerging field of predictive habitat modelling (e.g. Dawson et al. 2009; Guinan et al. 2009; Guinotte et al. 2009; Tittensor et al. 2009) seeks to improve existing habitat data sets. Under its different modelling approaches, maximum entropy modelling (Maxent; Phillips et al. 2006) has proven a particularly robust methodology. The further development and application of such modelling techniques represents an important future area of work in order to have monitoring contributing more effectively to ecosystem valuation and the application of positive incentive measures.

Spatial resolution

48. When developing ecosystem valuation models, general considerations of scale include: (a) the spatial resolution of the component datasets and adequate incorporation of the spatio-temporal relationships between service production areas and service benefits areas; (b) access (physical overlap in space and legal rights), recognizing the fact that underprivileged members of society cannot gain/loose from changes in ecosystem services if they cannot access them; and (c) the scale-dependence of valuation exercises. There is also often disparity between the scales at which international governance processes operate, which are often global in scope, and that of monitoring activities, which are often at much finer scales.

49. As discussed above, the data sets which are presently available from ecosystem monitoring activities form a disparate resource resulting from a range of methods taking place over a variety of spatial resolutions, mainly chosen as being the most appropriate for meeting the goals of a particular individual project at a particular point of time. It is a particularly complex task to consolidate this information into comparable data sets for integration into ecosystem valuation models, which, in addition to the time and resources required to undertake this consolidation, has implications for the validity and interpretation of results.

50. Related to this is the general gap in linking large-scale data resulting from remote sensing to local and regional data sets resulting derived field studies that contain specific information on habitat, communities and species. Strengthening this link would benefit both regional and site level studies, introducing an understanding of larger-scale ecosystem processes which may be influencing smaller-scale ecosystem changes, [26] and also strengthen global assessments by providing insights into finer-scale ecosystem processes, such as distribution of certain species of interest.

51. Future data collection and monitoring efforts should aim to benefit both small- and large-scale decision-making processes via a multi-scale approach. The ability to aggregate and disaggregate data over a range of hierarchical scales would provide a comprehensive information base, encouraging participation and collaboration across different sectors in its development. Increased efforts to integrate coarse-resolution remote sensing data with fine-scale field survey data will contribute towards a holistic understanding of ecosystem processes and thus provide the basis for more robust tools which can ffed into valuation exercises and inform the development of positivie incentive measures.

[26] It could thus contribute to address items 21 and 22 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

Quality/condition of ecosystem components

52. It is much more feasible to assess changes in ecosystem *extent* at large scales, such as through remote sensing techniques, than it is to assess changes in the *quality* or *condition* of an ecosystem, or component therein. For example, over a certain time period, an area of forest may appear to remain unchanged in terms of spatial extent, however the diversity of tree species within the area may be greatly reduced, meaning that the habitat's capacity for service provision may have become significantly degraded. The quantification of these qualitative changes is often impossible via indirect techniques and requires costly ground truthing by undertaking field surveys. This revisits the challenge described above of creating global data sets and indicators from small-scale studies that are not necessarily representative or comparable over larger areas. Again, the development of agreed global standards and related reporting processes would contribute significantly to overcoming these challenges, and should be positioned as a high priority activity on the international assessment agenda.

53. Additionally, the majority of past research has treated ecosystems and their services as isolated and not fully taken their interdependence and connectivity into account. For example, an increase in the extent of saltmarsh does not necessarily indicate a healthy ecosystem but may be related to a reduction in an adjacent ecosystem. This single-system paradigm is now starting to change and the need is increasingly acknowledged to take a more holistic, ecosystem approach to assessment and management that recognizes that ecosystem service provision is highly dependent on the 'flow' of these services from one ecosystem to the other.[27] Efforts need to be made to comprehensively integrate this paradigm into data collection and monitoring methodologies.

Temporal resolution

54. Time series data, that is, consistent data sets which are comparable over time, are essential to developing tools that can assess trends in environmental change, a need which corresponds directly to the international policy realm, in particular the Convention's 2010 target to reduce the rate of biodiversity loss and the emerging post-2010 targets of the Convention on Biological Diversity. The lack of such time-series data is arguably one of the most significant gaps in available ecosystem data.

55. Converse to common perceptions, there have been a number of long-running initiatives to collect ecosystem time-series data, such as the UN Food and Agriculture Organization (FAO)'s Global Forest Resources Assessment and the Living Planet Index. However, these initiatives have not been systematically funded and coordinated, and as such provide at present only a fragmented portrait of change in ecosystems globally. Historically, time series data have often been driven by individual interest and focussed on taxonomic information, with individual experts establishing long-term monitoring programmes centred upon species that were of particular interest, programmes which often ended in conjunction with the expert's career. The paradigm shift toward ecosystem-based management, expained above, corresponds to a shift toward collaboration between academic institutions, government bodies, non-governmental organizations, and the private sector, in order to consolidate individual expertise and progress towards a holistic understanding of ecosystems, to the subsequent benefit of all contributors.

56. Establishing current baselines against which to measure trends in environmental change is of high priority for the majority of global and regional initiatives, however, in doing so it is critical to build on existing data and knowledge rather than discard them in favour of a new data collection model. More effort needs to be placed on reviewing historical data and developing methodologies for their integration with present-day data collection and monitoring techniques in order to ensure that indicator development for baseline establishment, and ultimately analysis of trends, is building on previous efforts as far as possible.[28]

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[27] Silvestri & Kershaw, 2010.

[28] These activities would contribute to item 10 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

Validation

57. Finally, the validation of data and particularly of model outputs, is essential for providing sound advice for the design of positive incentive measures. As explained above, datasets derived from remote sensing often need to be validated through ground-truthing, for example by using field surveys, in order to verify that the conclusions being made from remote sensing data are in fact in line with actual occurrence or processes on the ground. Similarly, a number of organizations have compiled global data sets for specific ecosystems (for example FAO Global Forest Resources Assessment, the World Atlas of Coral Reefs, or the World Atlas of Mangroves) from multiple data sources submitted by numerous reporting entities and through integration with outputs from remote sensing. Irrespective of the challenges discussed in the previous sub-section, these datasets are considered some of the best available at the current time.

58. Unfortunately, the much-needed validation of these types of datasets along these lines is often too expensive, including because of constraints in time and available personnel. As per current practice, these data sets need to continue being subject to standard expert- and peer-review processes in order to ensure that data are being made available that are as reliable as possible. In addition, the precautionary approach should, as always, be adopted in any decision-making process.

V. SUMMARY AND CONCLUSIONS

59. Biophysical monitoring data is critical for undertaking valuation exercises and for designing and implementing positive incentive measures, including for ensuring compliance and for evaluating the effectiveness of incentive measures. The present note analyzed the two major challenges in making the potential contribution of monitoring more effective, namely: (i) the fragmentation and subsequent lack of standardization and exchangeability of existing global datasets, and (ii) the need to 'bridge' fundamental data gaps and to interpolate monitoring data by modelling. In general terms, more efforts are needed to overcome the lack of standardization and data exchangeability by enhanced cooperation among all relevant stakeholders, including the development of internationally agreed frameworks and guidelines for future data collection, as well as methodologies to effectively integrate existing datasets. Existing modelling efforts need to be supported and they need to be part of this process of enhanced international cooperation. [29]

60. As regards modelling initiatives, the note explained that a broad spectrum of models developed or under development build on monitoring data and information and contribute towards the quantification and valuation of those aspects of biodiversity and ecosystem services relevant to the development of positive incentive measures, with models ranging from: non-spatial and spatially-explicit biophysical models (e.g. climate, hydrological, and biogeochemical which inform the provision of potential ecosystem services); to socio-economic models (e.g. general economic, partial economic, and demographic models); to integrated models.

61. Given the diverse array of the biodiversity components and functions, and associated ecosystem services, it is unlikely that any single model will be able to cover *all* of the different types of value given in the concept of Total Economic Value. Different models may also be dependent on which biodiversity component is being evaluated at a particular scale, and also on the design of the incentive measure required. Integrated models are characterised by both endogenous biophysical and socio-economic components, and several toolkits exist which combine the use of and/or outputs from several different models. This type of model is more broadly applicable to a variety of ecosystem components and they could be particularly useful in developing a more holistic assessment of the value of complex ecosystems.

62. Specific recommendations, including options for further work, can be summarised as follows:

[29] These modelling efforts could also be informed by the specific gaps identified by national studies on how monitoring can support valuation and positive incentive measures, further to items 13, 19 and 23 of the terms of refererence for such studies developed in document UNEP/CBD/COP/9/INF/9.

(a) The development of integrated valuation base maps/datasets for existing benefits streams could be further encouraged, as a valuable indication of the relative value of the underlying ecosystems. This would require greater uniformity in data collection methods, data processing, and data sharing, with substantial potential for advancing knowledge. Standard protocols for sample collection and processing should be developed and adopted;

(b) Future research should target the current gaps in geographic coverage and focus on those under-researched areas, such as off-shore marine ecosystems;

(c) The development of internationally agreed frameworks and guidelines for future data collection is essential for implementing integrated assessments and should be positioned as a high priority activity on the international assessment agenda;

(d) In order to ensure that data made available is as reliable as possible, data sets should continue to be subject to standard expert- and peer-review. Datasets should be validated by ground-truthing whenever possible. The precautionary approach should, as always, be adopted in any decision-making process;

(e) Emphasis should be placed on reviewing historical data and developing methodologies for their integration with present-day data collection and management techniques in order to ensure that establishment of baselines, and ultimately analysis of trends, is building on previous efforts tyo the extent possible;

(f) Current trends towards adopting a more holistic, ecosystem-based approach to assessment and management which recognizes that ecosystem service provision is highly dependent upon the 'flow' of these services across ecosystems are welcome and should be supported by monitoring iniatives. Conversely, methodologies associated with ecosystem service mapping, including issues of governance, could be mainstreamed into the design and implementation of positive incentive measures;

(g) Future data collection and monitoring efforts should aim to benefit both small- and large-scale decision-making processes via a multi-scale approach. The ability to aggregate and disaggregate data over a range of hierarchical scales would provide a comprehensive information base for all members of the conservation community;

(h) Robust methods of integrating information from multiple, small-scale sources is needed to provide standardized assessment at the regional and global scales. This integrated approach will require cooperation between many different organizations and sectors, often fostering unprecedented partnerships. Mechanisms to facilitate these working relationships should be encouraged;

(i) Further conceptual and methodological work is needed on the linkages between marine and terrestrial ecosystems, including the development of models which accommodate the complex inter-linkages interdependencies and trade-offs between marine and terrestrial ecosystems;

(j) 'Horizon scanning' activities should be undertaken which could identify proactively what innovative positive incentive measures are likely to be employed in the future, and the underpinning monitoring activities which will be required; [30]

(k) Further conceptual work could be undertaken on 'linked' positive incentive measures which address cross-sectoral and cross-ecosystem issues and promote an appreciation of bundles of ecosystem services taking into account for instance the work of the World Resources Institute (WRI) on stacking payments for ecosystem services;

(l) Further assess the sensitivity of the choice of a particular incentive measures to the model type and data inputs, seeking for instance to clarify under what circumstances – and under what kind of measures – can datasets with a low spatial resolution be sufficient.

[30] See item 17 of the terms of reference developed in document UNEP/CBD/COP/9/INF/9.

Annex

TERMS OF REFERENCE

1. The following terms of reference for a study on how monitoring can support the implementation of valuation tools and positive incentive measures were initially identified in document UNEP/CBD/COP/9/INF/9, further to a request expressed by the Conference of the Parties in decision VIII/25, paragraph 10 (d). According to this decision, the study would propose a framework to capture the relationship between the monitoring and the valuation of biodiversity resources and functions, as a practical tool to facilitate in-country valuation studies.

2. In light of largely varying national circumstances as regards relevant biodiversity resources and functions, and associated ecosystems, as well as the variety of data sources available, the study on how monitoring can support the implementation of valuation tools and positive incentive measures would need to be undertaken on the national and/or subregional level, and would hence provide a framework to capture this relationship which would explicitly reflect the specific situation in the country of sub-region. The terms of reference provided below provide a *general* framework for analysis for undertaking such national studies. Depending on their national priorities and circumstances, countries may wish to put more emphasis on some of the elements provided below, and/or decide to de-emphasize (or delete) others.

3. Those countries that do not yet apply environmental valuation within their decision-making processes could consider using the framework to initiate a limited number of pilot valuation studies, with a view to raise awareness of biodiversity values, gain familiarity with, and build capacity on, valuation methodologies, and assess the usefulness of the framework proposed by the study.

4. The relationship between monitoring and valuation is currently poorly understood due to the limited interaction between the communities involved in these two areas (biodiversity scientists and data custodians on the monitoring side, economists and interested policy-oriented ecologists on the valuation side). One important role of the study would hence to raise awareness, for instance, about: (i) the opportunities which existing monitoring tools and associated datasets may already offer for more effectively undertaking valuation and for the design and/or improvement of positive incentive measures; and (ii) of what monitoring information is needed for valuation purposes and for the design and implementation of incentive measures. It would therefore be useful if the process of preparing the study would involve consultations of relevant stakeholders and the effective involvement of both the monitoring and the valuation communities, for instance, by convening ‘science and economics’ workshops which could assist in the delivery of the action items enumerated below.

A. Taking stock

1. Define biodiversity for the purpose of the national study and identify, in a *qualitative* manner, key biodiversity components and functions, and associated ecosystem services, of national importance.
2. Catalogue current drivers and pressures on those biodiversity components and functions, and associated ecosystem services. Identify key national policy priorities, and key policy goals.
3. Specify whether any ecosystem services are transboundary in nature, including for instance cross-border watershed services, as well as emerging information linking habitats (e.g. forests) and rain formation.
4. Take stock of relevant national and international initiatives for biodiversity monitoring, and compile an inventory of relevant national field survey data as well as remotely sensed data, and GIS maps.

This work could possibly build on existing work undertaken within NBSAP development processes and earlier biodiversity country studies.

B. Valuation

5. Based on the work above, identify prioritized valuation needs and the extent to which they can be addressed by using existing datasets and ongoing monitoring activities. Identify opportunities for 'picking low-hanging fruit': important (but not yet fulfilled) valuation needs which could be implemented with existing monitoring. Specifically, dependent on the priorities and policy goals identified above, countries may wish to assign varying degrees of emphasis to the individual sub-sections below.

a. Direct use values

6. Analyse opportunities for producing a national direct use values inventory, possibly in a GIS framework, for instance: species occurring in the wild that are used (location, price information at relevant scales, quantities harvested, and harvesting effort); overview of use (number of visitors, average time visited, annual revenues) of ecosystems of high and direct economic importance (e.g. for tourism, recreation).

7. Consider how to develop a periodic survey methodology to track quantities and prices relative to a measurable sustainable yield.

b. Indirect use values

8. As far as possible identify chains of causality or production function linkages so that the impact of changes in the condition of key ecosystems can be related to various measures of human well-being. This could include both national and international well-being endpoints.

9. Using the general analysis provided in the annex for orientation, 31/ analyze whether and to what extent existing data sets and ongoing monitoring activities could be used to specify the ecologic production functions of key ecosystem services.

10. Consider how a time series of quantities and values may be developed and represented in a GIS framework.

c. Non-use values

11. Catalogue species and/or ecosystems with potentially high non-use value, for instance, landscapes of national importance, endemic, endangered, charismatic and/or keystone species. Identify the relevant populations that hold value over these biodiversity components.

12. Using the general analysis provided in the annex for orientation, 32 analyze whether and to what extent existing data sets and ongoing monitoring activities could be used to improve the understanding of biological complexity of relevant sample groups.

13. For all sub-sections above, identify critical gaps in data availability and associated prioritized needs for new monitoring tools and activities.

14. For all sub-sections above, identify critical needs to build or enhance capacity.

C. Incentive measures

15. Identify relevant existing incentive measures for the conservation and sustainable use of relevant components of biodiversity.

16. Analyse opportunities for 'picking low-hanging fruit': whether and to what extent the design and implementation of existing incentive measures could be enhanced by better using existing datasets and ongoing monitoring activities, and subsequent valuation exercises.

17. Based on the work under B above, identify opportunities for new incentive measures based on existing datasets and monitoring activities.

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[31] See the Annex of document UNEP/CBD/COP/9/INF/9.

[32] Ibid.

18. Catalogue currently applied subsidies in relevant sectors and analyse how existing datasets and ongoing monitoring activities could be used for assessments of adverse effects on biodiversity.

19. Identify critical gaps in data availability and associated prioritized needs for new monitoring tools and activities, including for monitoring the effectiveness of incentive measures in changing behaviour over time.

20. Identify critical needs to build or enhance capacity.

D. Addressing scale

21. Identify the spatial scale of values derived in previous stages. Investigate potential to map values and the development of a GIS overlay system that can be linked to a database of location-specific values for direct, indirect and/or non use values, in accordance with national priorities and policy goals.

22. Consider options for the development of spatially referenced national accounts for relevant and prioritized biodiversity resources and functions, and associated ecosystem services, including biophysical changes and their implications for the depreciation/appreciation of the value of natural assets.

E. Conclusions and recommendations

23. Synthesize relevant conclusions and recommendations from the previous work into a national action plan on valuation, incentive measures, and monitoring, which includes:

    - Opportunities for undertaking priority valuation work by making use of existing datasets and ongoing monitoring activities.
    - Opportunities for improving existing incentive measures, including the removal of perverse incentives, by making better use of existing datasets and monitoring activities.
    - Gaps in existing datasets and ongoing monitoring activities for undertaking priority valuation work, and concrete proposals for prioritized action on how to close or narrow these gaps.
    - Gaps in existing datasets and ongoing monitoring activities for improving the application of incentive measures for conservation and sustainable use of biodiversity, including the removal of perverse incentives, and concrete proposals for prioritized action to close or narrow these these gaps.
    - With regard to all of the above: prioritized needs and opportunities for transboundary/regional/international cooperation.
    - With regard to all of the above: prioritized needs for the building or enhancement of capacity.

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