Chapter 3.[1] The potential of valuation

Supplementary material

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[1] This is the final text version of the supplementary material of Chapter 3 of the IPBES methodological assessment of the diverse values and valuation of nature (https://doi.org/10.5281/zenodo.6521298).

Annex 3.1. Summary of major reviews of nature valuation methods in previous assessments.

Name of assessment	Description on valuation methods and approaches	Year
Millennium Ecosystem Assessment (MEA, 2005)	The Millennium Ecosystem Assessment considered different types of values and valuation methods (mainly economic valuation methods) to assess the consequences of ecosystem change for human well-being. This was done both in its synthesis report as well as on thematic reports.	2005
The Economics of Biodiversity and Ecosystem Services (TEEB, 2010)	The Economics of Biodiversity and Ecosystem Services assessments were heavily focused on economic valuation methods within the framework of total economic value. The focus is not on assessing the different economic valuation methods.	2010
National level assessments (UK NEA, 2011, 2014)	At the national level, some governments have assessed the state of biodiversity and ecosystem services. Notable examples include the United Kingdom's National Ecosystem Assessment in 2011 and its follow-up in 2014 (UK NEA, 2011, 2014). The follow-up described different valuation methods and specifically mentioned a need to combine monetary and non-monetary, deliberative, and interpretive methods for a comprehensive valuation of ecosystem services.	2011
The Corporate Ecosystem Services Review (Hanson et al., 2012)	In addition, the business sector has also initiated assessments of biodiversity and ecosystem services from a business perspective, such as The Corporate Ecosystem Services Review.	2012
World Ocean Assessment I (United Nations, 2017)	The World Ocean Assessment I is also known as the First Global Integrated Marine Assessment (Innis et al., 2016). The assessment provided ways for governments and policymakers to consider ocean issues, but it didn't focus on reviewing the valuation methods applied in assessing ocean values.	2015
Thematic & methodological assessments of IPBES (IPBES, 2016a, 2016b, 2018a)	The three thematic assessments of IPBES, i.e. the Assessment of Land Degradation and Restoration, Pollination, Pollinators and Food Production, and Scenarios and Models, were specific about the relationship between the individual theme and biodiversity and ecosystem services. Although different worldviews, values and knowledge systems were discussed, valuation methods and their utility and limitations were not compared.	2016, 2018
Regional assessments of IPBES (IPBES, 2018b, 2018c, 2018d, 2018e)	At regional level, IPBES has recently concluded Assessments of Biodiversity and Ecosystem Services in four of the United Nations regions: Africa, Asia-Pacific, Americas, and Europe and Central Asia. These regional specific assessments have introduced and utilised various biodiversity and ecosystem service valuation	2018

	methods, but they were not specifically assessing different valuation methods or approaches, their strengths and weaknesses based on a comparable framework or a set of criteria.	
IPBES Global Assessment (IPBES, 2019a)	While valuation methods were not the central focus of this assessment, it argues that policy reforms based on diverse values of nature's contributions have a potential to conserve nature and provide multiple benefits to society.	2019
Global Environment Outlook (UN Environment, 2019)	The Global Environment Outlook is the flagship report of United Nations Environmental Program (UNEP) and it reviews the status and trends of the environment since 1997. Diverse values of nature form a central theme throughout the assessment. The most recent Global Environmental Outlook-6 analysed the effectiveness of policy instruments and future scenarios. No review valuation methods.	2019
Global Biodiversity Outlook 5 (GBO, 2020)	This report provides the progress made, lessons learned, and best practices to achieve 20 global biodiversity targets agreed in 2010. It highlights eight transitions that recognize the value of biodiversity, the need to restore the ecosystems on which all human activity depends, and the urgency of reducing the negative impacts of such activity (GBO, 2020).	2020
UN System of Environmental-Economic Accounting—Ecosystem Accounting (United Nations, 2021a)	The System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA) is a spatially-based, integrated statistical framework for organizing biophysical information about ecosystems, measuring ecosystem services, tracking changes in ecosystem extent and condition, valuing ecosystem services and assets and linking this information to measures of economic and human activity. It complements the measurement of the relationship between the environment and the economy.	2021
World Ocean Assessment II (United Nations, 2021b)	The World Ocean Assessment II offers global reporting and assessment of the state of the marine environment, including socioeconomic aspects. The assessment provided ways for governments and policymakers to consider ocean issues, but it did not focus on reviewing the valuation methods applied in assessing ocean values.	2021
Dasgupta Review (Dasgupta, 2021)	The Dasgupta Review aims to assesses a range of scenarios for enhancing global biodiversity compared with business as usual and the relationship with economic growth, and the range of best practices for industry, communities, individuals and governments that can simultaneously achieve the goals of enhancing biodiversity and delivering sustainable economic growth (Dasgupta, 2021). It links gross domestic product with biodiversity thereby providing a basis for national accounting for biodiversity in economic terms. The review is based on the literature estimating the value of biodiversity and ecosystem services for decision-making, but it does not provide a critical assessment of different valuation methods.	2021

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Annex 3.2. Databases that include valuation studies related to biodiversity and ecosystem services.

Name of the data base	Nature or purpose of the data base	Types of values covered	Types of valuation methods covered	Geographic scope	Host institution/ organisation	No. of studies (as of 14 June 2021)	Web link	Database Access	Remarks
Environmental Valuation Reference Inventory	Economic value of environmental assets and human health effects	Non extractive use, extractive use, ecological functions, passive use, human health, built environment	Actual market pricing, revealed preference, stated preference or simulated market price	Global	Environment and Climate Change Canada	5128	http://www.evri.ca	Yes	Includes journal articles, reports, working paper, conference paper, thesis, book, book chapter, magazine
Ecosystem Service Valuation Database	Monetary values of ecosystem services across all biomes; provides explicit monetary valuation estimates (i.e. value unit/per ha)	Direct use values (extractive uses or non-extractive uses), Indirect use values	Choice modelling, contingent valuation, damage cost avoided, defensive expenditure, group valuation, hedonic pricing, input-output modelling, market prices, net factor income, opportunity cost, production function, public pricing, replacement cost, restoration cost, social cost of carbon, travel cost, value transfer	Global (with majority of data skewed to UK)	Foundation for Sustainable Development (FSD)	693	https://www.es-partnership.org/esvd/	No	updating and upgrading data base created for TEEB 2020
TEEB Valuation Database	Monetary values of ecosystem services across all biomes	Direct use values (extractive uses or non-extractive	Avoided cost, benefit transfer, choice modelling, contingent valuation, direct market pricing, factor income /	Global	Ecosystem Service Partnership	267	https://www.es-partnership.org/esvd/esvd-download/original-teeb-database/	Yes	Database of studies identified for TEEB 2010

	(i.e. value unit/per ha)	uses), Indirect use values	production function, group valuation, hedonic pricing, mitigation and restoration cost, replacement cost, total economic value, travel cost						
Envalue	Environmental valuation studies for the purpose of benefit transfer for informed decision making	Direct use values (extractive uses or non-extractive uses), Indirect use values	Benefit transfer, choice modelling, contingent valuation, conjoint analysis, demand analysis, dose-response approach, direct market pricing, household production approach, preventive expenditure, hedonic pricing, replacement cost, travel cost	Global	NSW Department of Environment & Climate Change	NA	https://www.worldcat.org/title/envalue-nsw-epa-environmental-valuation-database/oclc/222084411	Yes	A broad ranging and systematic collection of environmental valuation studies
New Zealand Non Market Valuation Database	Non-market valuation studies that have been undertaken in New Zealand	Non-marketed values	Travel cost, contingent valuation, choice based, hedonic price, benefit transfer	New Zealand	Lincoln University, New Zealand	92	https://core.ac.uk/download/pdf/29195637.pdf	Yes	It is a compilation of NMV studies in New Zealand from 1974 to 2005.
Beneficial Use Values Database	Economic values for beneficial uses of water	Direct use values (extractive uses or non-extractive uses), Indirect use values	Market valuation, contingent valuation, conjoint valuation, damage function approach, hedonic methods, adverting behaviour approaches, optimization models, opportunity cost, simulation model, travel cost method, replacement cost method	North America	University of California, Davis	131	https://www.researchgate.net/publication/266456663_THE_BENEFICIAL_USE_VALUES_DATABASE/figures?lo=1	No	

ValuebaseSWE	Environmental valuation studies carried out in Sweden	Direct use values (extractive uses or non-extractive uses), Indirect use values	Choice modelling, choice experiment, contingent valuation, discrete choice, defensive expenditure, replacement cost, restoration cost, travel cost, production function, hedonic price, stated preference, willingness to pay	Sweden	Beijer International Institute of Ecological Economics, and the Swedish EPA	224	https://www.researchgate.net/figure/VALUEBASE-SWE-spreadsheet_fig9_228425512	Yes	The database is in Swedish language.
Environmental Valuation & Cost-Benefit News	News portal related that covers legal, academic, and regulatory developments pertaining to the valuation of environmental amenities and disamenities	NA	NA	Global	Environmental Valuation & Cost-Benefit News	NA	https://www.envirovaluation.org/search/label/Ecosystem%20Valuation	No	Not a database, but a news portal that covers recent development regarding environmental valuation.
BES-Net	Contributes to the capacity building work of IPBES; accumulates knowledge base for science- policy and practice	All kinds of ecosystem services values	NA	Global	United Nations Development Programme (UNDP)	35	https://www.besnet.world/knowledge-policy-support/	Yes	76 contents with word 'valuation' in search button in resources library (as of 14 June 2021)
BlueValue	Ecosystem valuation information with actual values in numbers (related to aquatic ecosystems)	Direct use values (extractive uses or non-extractive uses), Indirect use values	Travel cost, benefit transfer, willingness to pay, market price, contingent valuation, hedonic price, replacement cost, damage cost avoided, market price, net income factor, opportunity cost, choice experiment, debt-for-nature swap, productivity	Global	Harte Research Institute for Gulf of Mexico Studies Texas A&M University–Corpus Christi	1217	https://www.bluevalue.org/search/	Yes	1217 valuation estimates available

			method, random utility method						
ValuES	Integrating ecosystem services into policy making, planning and implementation of specific projects	All kinds of ecosystem services values	Cost based valuation, market price, travel cost, contingent valuation, hedonic price, benefit transfer method, choice modelling, participatory economic valuation	Global	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)	NA	http://www.aboutvalues.net/about_values/	Yes	ValuES supports practitioners, advisors and decision makers to integrate ecosystem services into decision-making and planning
National Ocean Economics Program (NOEP)	Non-market valuation database of costal and marine ecosystems	Non marketed values	Avoided cost, benefit transfer, calibrated and conjoint analysis, choice experiments, contingent valuation, damage assessment model, discrete choice, expenditure analysis, hedonic price, random utility method, referendum method, travel cost method	United States	Middlebury Institute of International Studies at Monterey	NA	https://www.oceaneconomics.org/nonmarket/NMsearch.aspx	Yes	Focused on the US
World Resources Institute (WRI)	Provides publications related to environment, economic opportunity and human well-being	NA	NA	Global	WRI	21	https://www.wri.org/resources/type/research-65?query=valuation&sort_by=title	Yes	Research publications with word 'valuation' at WRI
EconPapers	Data provided by RePEc (Research Papers in Economics) to enhance the dissemination	All type of ecosystem services valuation studies	NA	Global	Örebro University, Business school	3,957,490 searchable working papers, articles and software items with	https://econpapers.repec.org/	Yes	Search word 'ecosystem services valuation' provided 253,633 hits

	of research in economics					3,576,411 items available on-line (as of 7 March 2022)			(as of 14 June 2021)
Ecosystem Services Assessment Portal	Provides links to tools, models, databases and other resources related to the ecosystem services assessment and valuation	All type of ecosystem services assessment and valuation	NA	Global	United States Department of Agriculture	NA	https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/climatechange/mitigation/?cid=stelprdb1048113	Yes	A collection of links to guides, databases, and online tools to value ecosystem services
Ecosystem Services and Biodiversity (ESB)	Provides publications related to assessment and valuation of ecosystem services and biodiversity	Direct use values (extractive uses or non-extractive uses), Indirect use values	NA	Global	Food and Agriculture Organization of the United Nations (FAO)	40 (with the word 'valuation' in the tab resources)	http://www.fao.org/ecosystem-services-biodiversity/resources/resources-archive/en/	Yes	Includes reports, proceedings, guidelines, methodological tools, case studies etc.

Annex 3.3. Best practice resources. Ecosystem services valuation tools

Name of valuation tool	**Nature/purpose of the tool**	**Type of values that can be mapped**	**Spatially explicit (yes/no)**	**Developed and managed by**	**Web link**	Remarks about tools
Artificial Intelligence for Ecosystem Services (ARIES)	Free and open-source ecosystem services modelling platform for ecosystem services assessment and valuation	Relative or qualitative values, biophysical units, monetary values	Yes	National Science Foundation, University of Vermont, Earth Economics and Conservation International	http://aries.integratedmodelling.org/	Requires modelling and GIS skills
Co$ting Nature	Web-based tool for spatially analysing ecosystem services and assessing the impacts of human interventions	Relative or qualitative values, monetary values	Yes	Kings College London, AmbioTEK, United Nations Environmental Program – World Conservation Monitoring Center (UNEP-WCMC)	http://www.policysupport.org/costingnature	Does not need modelling skills or GIS
Integrated Valuation of Ecosystem Services and Tradeoffs 3.4.2 (InVEST)	Computer based modelling tool for mapping and quantifying ecosystem services in biophysical or economic terms	Relative or qualitative values, biophysical units, monetary values	Yes	Stanford University, University of Minnesota, The Nature Conservancy, and the World Wildlife Fund	https://naturalcapitalproject.stanford.edu/software/invest#:~:text=InVEST%20is%20a%20suite%20of,sustain%20and%20fulfill%20human%20life.&text=The%20multi%2Dservice%2C%20modular%20design,goals%20of%20these%20diverse%20entities	Requires GIS but not modelling skills
Multiscale Integrated Models of Ecosystem Services (MIMES)	Uses ecological and economics simulation models to understand and visualise	Relative or qualitative values, biophysical units, monetary values	No	University of Vermont and AFORDable Futures LLC	http://www.afordablefutures.com/	Requires modelling and GIS skills

	ecosystem services values					
Toolkit for Ecosystem Services Site Based Assessment (TESSA)	Uses local knowledge and stakeholder engagement to assess and evaluate ecosystem services	Relative or qualitative values, biophysical units, monetary values	Yes	Developed by 14 different organizations	http://tessa.tools/	Can be used by non-experts with no technical knowledge
WaterWorld	A web-based tool for modelling hydrological services associated with specific activities under current conditions and under scenarios for land use, land management and climate change	Relative or qualitative values, biophysical units, monetary values	No	King's college London and AmbioTEK	http://www.policysupport.org/waterworld	Online training available for modelling tools
Ecosystem Services Toolkit (EST)	A .pdf document that provides stepwise guidance to carry out qualitative or quantitative ecosystem services assessments	Relative or qualitative values	Yes	Government of Canada	http://publications.gc.ca/site/eng/9.829253/publication.html	Does not require GIS or modelling skills
Social Values for Ecosystem Services (SolVES)	GIS-based application that is used for assessing, mapping and quantifying the social values of ecosystem services	Relative or qualitative values, monetary values	Yes	United States Geological Survey (USGS) and the Geosciences and Environmental Change Science	https://www.usgs.gov/centers/gecsc/science/social-values-ecosystem-services-solves?qt-science_center_objects=0#qt-science_center_objects	Requires GIS skills

Annex 3.4. Examples of tools and methods in nature-based valuation

Approach	How data are collected or generated	Examples of methods	Examples of valuation targets	Examples of tools
Direct measurements	Field observations and measurements (*in situ*/*ex situ*) Inventory /statistics	Species' lists & inventory Vegetation surveys Biophysical data collection Biodiversity monitoring	Biodiversity (Whittaker, 1972), water (Cordy, 2014), soil (Karlen et al., 1997) ecosystem processes (Nilsson et al., 1985; Tilman, 1982) ecosystem structures (Fahrig, 2003) ecosystem health (Davies et al., 2010; Shear et al., 2003)	Remote Sensing Biomass Measurement tool Biodiversity Performance Tool Canopy Assessment Tool (Public Interest Enterprises, s.f.) Water Quality Interpretation Tool (Utah State University Extension, 2020)
Stakeholder consultations	Data is collected from resource users or those are knowledgeable about the nature phenomenon	Resource use surveys Interviews Delphi Methods Expert consultation	Biodiversity (Chandler et al., 2017) Learning and inspiration (Ruppert & Duncan, 2017) Regulation of freshwater quantity (Martín-López et al., 2012a) Supporting identities (Tengberg et al., 2012)	Community based Risk Screening Tool Adaptation and Livelihoods (CRiSTAL Tool) Maptionnaire Community Engagement Platform
Spatial Analysis and Mapping	Direct ground-based mapping From satellites, aircraft, ships, drones, and other remote-sensing and on-site measurements. Normalized Difference Vegetation Index (NDVI) Enhanced Vegetation Index (EVI) Information provided by consultations with resource users, local stakeholders and experts	Species distribution & biodiversity hotspot mapping Gap Analysis Participatory mapping of different attributes of nature and ecosystems Habitat Suitability Analysis Ecological importance Forest cover estimation and forest structure analysis Vulnerability, resilience and	Forest (Chomitz & Gray, 1996) Regulation of air quality (Bagstad et al., 2013) Regulation of hazards and extreme events (Kumar et al., 2021) Maintenance of options (Reilly & Adamowski, 2017) Regulation of freshwater and coastal water (Lazzari et al., 2021)	Ecosystem services mapping at European scale (ESTIMAP) Water Evaluation And Planning system (WEAP) ARtificial Intelligence for Environment & Sustainability (ARIES) The Ecosystem Service Assessment Support Tool (ESAST)

		adaptation assessment Least Cost Corridor Analysis Unmanned aerial vehicles for monitoring of biota		
Modelling	Primary or secondary sources of data Often uses combinations of data sources collected using the methodologies mentioned above	State and transition models Phylogenetic analysis Modelling and simulation of agricultural systems or productivity Hydrological/climate modelling	Species distribution (eg.) Habitat creation and maintenance (Martín-López et al., 2012a) Regulation of freshwater water quantity and flows (Brauman et al., 2007)	The Ecosystem Services Toolkit Assisted Habitat Modeling (SAHM) The Integrated Biodiversity Assessment Tool (IBAT) Biodiversity Values Map and Threshold Tool Food Web Designer

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Annex 3.5. Overview of value stating methods including potential strengths and limitations

General approach (source of data)	How data are collected	Examples of methods	Strength of approach	Limitations of approach
Individual based Survey-based	Questionnaires and interviews administered to individuals and/or groups directly (face-to-face), electronically, by mail or by phone	Contingent valuation. Choice experiments. Ethnographic interviews/ methods. Narrative research. Happiness survey. Life satisfaction approach. Individual-based participatory assessment process. Individual- based Q-methodology. Expert elicitation. Mental mapping.	Flexible methodology which can be adapted to multiple social, cultural, and environmental contexts. Can be linked to individual social, demographic characteristics and individual experiences. Flexible choice of representation – both elicitation from a representative sample and representation of social groups.	Concerns with reliability and validity of the information [for structured methods]; Relies heavily on the accuracy of a particular description, and any errors in the description discovered after the fact cannot be changed. Concern with whether the intentions people indicate ex-ante (before the change) will accurately describe their behaviour ex-post. Ability to capture multiple/diverse values depends on sampling and inclusiveness of design
Group-based Discussions-based	Facilitator-moderated group discussions	Public good games. Deliberative valuation (including monetary). Nominal group technique (NGT). Focus groups. Scenario assessments/ visioning exercises. Photo-voice. Delphi panels	Allows preference construction through deliberation as well as learning from others. Repeated interaction can help to create trust and mutual understanding. Generates new topics. Can be used for discussion of social dilemmas. Can be used to familiarise participants with complex decision problems Can increase support for policy choice	Concerns with reliability and validity of the information. Subject to power relations effects within the group and other dynamics that might affect the assessment outcomes. Representativeness of the participants;

Annex 3.6. Summary of potentials and limitations of behaviour-based (value revealing) methods

Category	Valuation method	Description/main features	Potentials/applications	Limitations	Application - Key references
Direct observed behaviour method	Market methods (Market price)	The values of ecosystem services or nature's contributions to people are directly obtained from what people have paid for the service or good (e.g., timber harvest)	Useful for provisioning services and/or nature's contributions to people; easy to understand and apply.	Only applicable for goods and services that are traded in markets; may not be a good welfare measure rather a good revenue measure (Brander et. al., 2006)	Farber et al., 2006
	Livelihood dependence	The livelihood dependence on nature of people	Useful in the context where formal markets have limited roles and people rely on nature for subsistence.	Data is often not readily available	Adams et al., 2020; Daw et al., 2011; Yang et al., 2013.
Indirect observed behaviour method	Travel cost method	Valuations of site-based amenities are implied by the costs people incur to enjoy them (e.g., cleaner recreational lakes)	Most commonly used method; useful for direct use values and values to access to the site; based on well-established microeconomic principles; allows for including tangible costs (travel expenses); can measure consumer surplus.	Can't be used to value non-use or existence values and values associated with a change in quality of sites; specific data requirement on visitation costs; need differentiated costs to visit recreation sites to draw recreation demand curve; complicated to value multi-purpose and multi-destination trips; applies only in the valuation of use values; it is unclear and question arises on what fraction of the cost should be assigned to consecutively visited places when there are more destinations in one trip.	Bockstael & McConnell, 2007; Champ et al., 2003; Freeman et al., 2014.

	Recreational site choice method	Valuation of access to nature areas and changes in the quality of the areas based on observation of the choice between visits of different nature areas based on various attributes of the site.	Can be used to value recreational value of restoring natural areas; also, to value characteristics of nature areas for visitors in marginal terms; can account for substitution between sites; the method is more informative and can explicitly value the preferences.	Same limitations as that of travel cost method; can be used only for trips incurring costs (not areas at walkable distances); high data requirements; limited by the extent of information respondents can handle; sensitive to the study design; time consuming analysis; requires rigorous statistical analysis; challenging when the ecosystem conditions differ vastly.	Hunt, 2005; Lupi et al., 2020; Raguragavan et al., 2013.
	Time spent analysis	The value of nature, natural environment or biodiversity partly depends on how much time people spend observing or experiencing such services and how people perceive the value	This is an interpretative method; useful for cultural ecosystem services; relational values can be captured through this method.	Could be in conflict with preference-based valuation; values are not directly comparable with mainstream classification.	Capaldi et al., 2014; Stålhammar & Pedersen, 2017.
	Hedonic pricing method – amenity value	The value of a service is implied by what people will be willing to pay for the service through purchases in related or linked markets, such as housing markets for open-space or other amenity values	Useful for direct and indirect use values; marginal value of attributes can be estimated; based on actual market transactions/data and current choices; can measure consumer surplus	Can't be used for non-use values; relies on perfect competitive market assumption; assumes close association between real estate price and environmental attribute; data intensive (need to have a large database) and have statistical issues and complexity (can't up-scale marginal values to total willingness to pay in first stage hedonic, controlling for spatial correlations, not useful to forecast future values) (Banzhaf, 2010); issues in scaling up the marginal value (across markets) and can't forecast the values (not futuristic), not a rapid assessment, not always reliable data related to	Bishop et al., 2020; Palmquist, 2008; Rosen, 1974; Taylor, 2008.

				property (Kornatowska & Sienkiewicz, 2018).	
	Hedonic wage method – value of statistical life	The method estimates the risk changes associated with life-threatening events by valuing individuals' willingness-to-pay to avoid risk or estimate the wage premium/compensating wage differentials required to accept riskier jobs.	Useful for assessing trade-offs in riskier versus less-risky jobs and when labour market data is easily available.	The method is extremely data intensive; the willingness-to-pay values cannot be easily transferred for one type of risk to another; untangling premiums for non-fatal and fatal risks can be complicated.	Evans & Taylor, 2020; Viscusi, 1993
	Cost of illness method	The cost of illness method reveals individuals' behaviour for direct and indirect costs of treating an illness.	Useful for estimating the impacts on human health from loss of biodiversity or ecological degradation; very useful when the dose and response can be clearly established.	Captures only the expenditures incurred but does not measure the psychological costs of pain and suffering; there are differences in costs of treatment across countries giving an illusion that burden is different across different countries; the estimates could only be seen as lower bound.	Clabaugh & Ward, 2008
	Replacement cost method	The loss of ecosystem services or nature's contributions to people is evaluated in terms of what would it cost to replace (e.g., tertiary treatment values of wetlands if the cost of replacement is less than the value society places on tertiary treatment)	Independent of individual perception of value opportunity of using robust market data (Kornatowska & Sienkiewicz, 2018).	Is a measure of supply cost not a good welfare measure; not a true measure of economic value as the value estimates are not based on individual preferences and do not measure individual's willingness-to-pay for the benefit (Browne et al., 2018); may overestimate actual values; assumes equivalency in exchange of natural resources for an infrastructure.	Heal, 2005
	Avoided damage cost method	The biodiversity and ecosystem services or nature's contributions to	Independent of individual perception of value; useful for indirect use values; often	Can be a measure of avoiding the damage cost, not a good welfare measure; not a true measure of	Barbier, 2007

		people is valued on the basis of costs avoided, or of the extent to which it allows the avoidance of costly averting behaviours, including mitigation (e.g., clean water reduces costly incidents of diarrhoea)	used in practical decision-making (Eshet et al., 2005).	economic value as the value estimates are not based on individual preferences.	
	Defensive expenditure method	The incurred expenditures on supply of environmental services are used to infer the implicit value of benefit from consumption of the services	Independent of individual perception of value	Not a true measure of economic value as the value estimates are not based on individual preferences. They capture only a portion of individual's willingness-to-pay and thus provide minimum value of the benefit.	Freeman et al., 2014; Sinden et al., 2011
	Opportunity cost method	Value of foregone benefits/the next best alternative use of resources (e.g., agricultural use of water and land). The method also calculates the cost of preserving biodiversity	Uses standard economic analysis and is consistent with market prices; very simple and best applied when the values of the resource under consideration are difficult to measure.	Can be a measure of total revenue for the next best alternative; only direct values can be established, and indirect values cannot be measured.	Batie & Mabbs-Zeno, 1985; Ruijs et al., 2017
Other methods	Participant Observation	This method directly observes human behaviour (participant observation) that reveals peoples' preferences	Related to ground observation (structured, unstructured, participant), consideration of the contexts and details of valuation object, and in some cases free and easily accessible data.	Interpretation and analysis is difficult for participant observations, limited availability of data.	Jerneck & Olsson, 2013
	Document analysis	This method involves analysis of text documents (texts or images) including historical documents that indicates peoples'	Related to ground observation (structured, unstructured, participant), consideration of the contexts and details of valuation object.	Reliability and validity issues for documents; limited availability of data.	Ostwald et al., 2013

		preferences or the importance they give to nature.			
	Photo series analysis method	This method involves analysis of social media-based data (photos) to reveal peoples' preferences. Particularly relevant to cultural ecosystem services.	Related to ground observation, consideration of the contexts and details of valuation object, and in some cases free and easily accessible data.	Could be limited to specific services (cultural), sites (protected areas) and species (charismatic ones).	Keeler et al., 2015; Richards & Friess, 2015; Willemen et al., 2015
	Citizen Science method/Participatory action research	A tool to understand citizen's understanding. Communities and individuals are involved in designing a research question and perform scientific experiments with minimum involvement of professional scientists	Has potential to involve communities in assessments for conservation, forest management, livelihood; handles quantitative and qualitative description of information and also their ground level implementability of idea; allows respondents to think and reflect on the issue.	Scaling up is an issue. Requires thorough understanding of the issue.	(Kaartinen et al., 2013; Schröter et al., 2017)

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Annex 3.7. Behaviour-based methods – Good practice guidelines

Valuation approach	Guidelines/ manuals (name and source link)	Remarks
Economic method- direct		
Market price approach	Guidelines for the rapid economic valuation of biodiversity and ecosystem services https://www.climatelinks.org/sites/default/files/asset/document/2014_USAID-PREPARED_Guidelines-for-Rapid-Economic-Valuation-Biodiversity-Ecosystems.pdf	Provides an overview and application of market price approach together with other economic valuation methods
Economic method – indirect		
Multiple valuation methods	Guidelines for the rapid economic valuation of biodiversity and ecosystem services https://www.climatelinks.org/sites/default/files/asset/document/2014_USAID-PREPARED_Guidelines-for-Rapid-Economic-Valuation-Biodiversity-Ecosystems.pdf	Provides overview and application of different direct and indirect economic methods
	Methodological guide: Factsheet and tools. Socio-economic assessment of goods and services provided by Mediterranean forest ecosystems https://planbleu.org/wp-content/uploads/2020/04/forest_factsheets_methods.pdf	Briefly provides general description, goods and services valued, main steps of application – strengths, weaknesses, and example application with further reading on various economic valuation methods
	Training manual economic valuation and environmental assessment https://www.researchgate.net/publication/263685863_TRAINING_MANUAL_ECONOMIC_VALUATION_AND_ENVIRONMENTAL_ASSESSMENT	Provides theory and practical applications of the all revealed preference and stated preference methods of valuation
	Valuing forest ecosystem services: A training manual for planners and project developers http://www.fao.org/documents/card/en/c/CA2886EN/	Provides brief overview and application of market value and demand-curve approaches
	Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States (SIDS) https://www.cbd.int/financial/monterreytradetech/unep-valuation-sids.pdf	Provides step- wise guide on valuation techniques for Small Island Developing States, with case studies

	Economic valuation of marine and coastal ecosystem services in the Pacific Guidance manual. http://macbio-pacific.info/wp-content/uploads/2017/07/MACBIO_MESV_Guidance-Manual_Web.pdf	Provides methods with examples for valuing coastal and marine ecosystem services
	Valuation of ecosystem Services from Tiger & Snow leopard landscapes: A manual on economic valuation approaches for practitioners https://globaltigerforum.org/wp-content/uploads/2017/07/Economic-valuation-guidelines.pdf	Provides an overview of economic valuation methods and step wise guidance to field level practitioners of Tiger and Snow leopard range countries on the valuation of ecosystem services
	Valuing ecosystem services: toward better environmental decision–making https://www.nap.edu/read/11139/chapter/6	Provides details description about non-market valuation methods
	OECD (2002), Handbook of Biodiversity Valuation: A Guide for Policy Makers, OECD Publishing, Paris, https://doi.org/10.1787/9789264175792-en	Provides an overview on biodiversity values and review various methods used in valuing biodiversity.
	An introductory guide to valuing ecosystem services. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69192/pb12852-eco-valuing-071205.pdf	Provides an overview of ecosystem service valuation with specific reference to the United Kingdom.
Travel cost method	Champ, P. A., Boyle, K., & Brown, T. C. (2017). *A Primer on Nonmarket Valuation* [George R Parsons, Chapter 6: Travel Cost Methods, pp: 269-329) (2nd ed.). Dordrecht: Springer. Hanley, N., & Barbier, E. (2009). *Pricing Nature: Cost-Benefit Analysis and Environmental Policy* (Chapter 4), Cheltenham, UK: Edward Elgar Publishing. Openness Method Factsheet (Travel Cost Method) https://www.guidetoes.eu/networks/factsheets/Method_Factsheet_travel%20cost.pdf	Provides details on single site and random utility model with model, steps in estimation and applications. Provides the theoretical foundation and empirical case studies of travel cost method. Provides an introduction, strengths and weaknesses of the method, requirements and steps to apply the method.

Recreational site choice method	Lupi, F., Phaneuf, D. J., & von Haefen, R. H. (2020). Best Practices for Implementing Recreation Demand Models. *Review of Environmental Economics and Policy, 14*(2), 302-323. doi:10.1093/reep/reaa007 *Day, B. H., and G. Smith (2018). Outdoor Recreation Valuation (ORVal) User Guide: Version 2.0, Land, Environment, Economics and Policy (LEEP) Institute, Business School, University of Exeter*. https://www.leep.exeter.ac.uk/orval/	Provides best practice guidelines to implement recreation demand models based on individual-level data in measuring the value of changes in recreation site access or quality. A map-based web application that allows users to explore the distribution of greenspace across England and Wales, plotting out the locations of recreation sites. It also allows to explore the visitation and welfare values that are generated by currently accessible greenspaces. The estimates of visitation and welfare values are derived from a statistical model of recreational demand.
Hedonic pricing method – Amenity value	Bishop, K. C., Kuminoff, N. V., Banzhaf, H. S., Boyle, K. J., von Gravenitz, K., Pope, J. C., Smith, V.K., Timmins, C. D. (2020). Best Practices for Using Hedonic Property Value Models to Measure Willingness to Pay for Environmental Quality. *Review of Environmental Economics and Policy, 14*(2), 260-281. doi:10.1093/reep/reaa001 Evans, M. F., & Taylor, L. O. (2020). Using Revealed Preference Methods to Estimate the Value of Reduced Mortality Risk: Best Practice Recommendations for the Hedonic Wage Model. *Review of Environmental Economics and Policy, 14*(2), 282-301. doi:10.1093/reep/reaa006 Champ, P. A., Boyle, K., & Brown, T. C. (2017). *A Primer on Nonmarket Valuation* [Laura O Taylor, Chapter 7: The Hedonic Method, pp: 331-393) (2nd ed.). Dordrecht: Springer.	Presents best practices for hedonic property-value modeling when the goal is to measure households' willingness to pay (WTP) for a change in a spatially varying amenity. It summarizes the best practices for credible research design and interpretation based on the collective evidence from literature. Provides a best practice guidelines to implement hedonic wage model to measure value of statistical life. Provides details on theory, sampling, estimation, applications and other considerations. Provides the theoretical foundation and empirical case studies of hedonic pricing method

	Hanley, N., & Barbier, E. (2009). *Pricing Nature: Cost-Benefit Analysis and Environmental Policy* (Chapter 5), Cheltenham, UK: Edward Elgar Publishing. Openness Method Factsheet (Hedonic Property Pricing) https://www.guidetoes.eu/networks/factsheets/MethodFactsheet_hedonic-property-pricing.pdf	Provides an introduction, strengths and weaknesses of the method, requirements and steps to apply the method.
Cost based methods	Champ, P. A., Boyle, K., & Brown, T. C. (2017). *A Primer on Nonmarket Valuation* [Mark Dickie, Chapter 8: Defensive Behaviour and Damage Cost Methods. pp: 395-444) (2nd ed.). Dordrecht: Springer. Openness Method Factsheet (Cost based methods) https://www.guidetoes.eu/networks/factsheets/Method_Factsheet_cost-based%20methods.pdf	Provides theoretical framework, models and guidelines on steps to conduct defensive behaviour and damage cost studies. Provides an introduction, strengths and weaknesses of the method, requirements and steps to apply the method.
Avoided damage and replacement cost	ELD Initiative (2019). Module: Valuation of ecosystem services. ELD Campus. https://www.eld-initiative.org/fileadmin/user_upload/Modul_08_Valuation_of_ecosystem_services_191011_www.pdf ValueES (2021).Method Profile: Cost-based methods https://citieswithnature.org/wp-content/uploads/2019/02/ValuES%20Methods%20for%20integrating%20ecosystem%20services_Cost-base.pdf	Provides an overview of methods, brief guide on steps, examples, and limitations of the methods. Provide overview, methods, requirements, strength and challenges.
Non-economic method		
Participant observation	WIOSAP (2019). Guidelines on Methodologies for the Valuation of Coastal & Marine Ecosystems. Western Indian Ocean Strategic Action Programme https://www.nairobiconvention.org/CHM%20Documents/WIOSAP/WIOSAP%20docs%20for%20website/Third%20WIOSAP%20PSC/	Includes brief overview of social valuation methods, including observation.

	Guidelines%20on%20Methodologies%20for%20Valuation%20Draft%201.pdf	
Photoseries analysis	Openness Method Factsheet (Photoseries analysis for ES supply) https://www.guidetoes.eu/networks/factsheets/MethodFactsheet_Photoseries.pdf	Provides a brief introduction and a review on the advantages and limitations of the method, and a short guidance on the steps and requirements to apply it.

Annex 3.8. Overview of integrated valuation methods, including integrative methods and decision support tools, with references on strengths and limitations

Type	Integrated Valuation methods	Description/main features	Strengths	Limitations	Application areas and example references
Integrative methods– bringing information together	Participatory mapping	Spatial identification of nature's contributions to people according to stakeholder knowledge (Brown & Fagerholm, 2015).	Assess both natural and social values for landscape planning (Raymond et al., 2009). Enhance social learning (García-Nieto et al., 2019) Map nature's contributions to people in data-poor regions (Paudyal et al., 2015).	Mainly useful for informative purposes	Map the different nature's contributions to people (ecosystem services) typologies, material, regulating and non-material, as well as their supply and demand (Palomo et al., 2013).
	Production function approaches	Indirect valuation method where nature is valued as an input into the production of a good or reduction in damages (e.g., Barbier, 2000, 2016; Custódio et al., 2020). The production function approach is essentially an example of a combination of	Allows valuation of regulation services and valuation of how nature underpins provisioning services.	Restrictive scope as it rests on input-output relationships which can be difficult to establish (Hanley & Barbier, 2009b). Possibility of double counting and complexity of relationships between ecological inputs and derived benefits or outputs, non-linearity and threshold effects (Barbier, 2007).	Fishery (Barbier & Strand (1998). Pollination (Hanley et al., 2015).

		nature-based and behaviour-based valuation.			
	Integrated modelling	Linking different models for a given purpose, without necessarily considering the sharing and reuse of the contained models (Granell et al., 2013). Fundamentally, the purpose of model integration is to expand the complexity of the representation of a system (Haacker et al., 2019). Consequently, an integrated model can be defined as a system consisting of sequentially connected models of natural and/or social systems (Haacker et al., 2019).	Explicit accounting of interactions and feedbacks in the modelling process (Bach et al., 2014). Modelling the coevolution of societies with natural resources systems in a transdisciplinary way (Elshall et al., 2020). Exploratory modelling, theory building, scenario testing for participatory planning, and information provision for strategic planning and management (Bach et al., 2014). Linkage of models allows modelers to include representation of processes from different disciplines, providing more complete information to decision-makers	Difficulties in linking models built with different objectives, scales, computer languages, data requirements, parameters (Haacker et al. 2019, Bach et al. 2014). Missing knowledge (Barthel & Banzhaf, 2016), also regarding links between social and biophysical processes (Haacker et al., 2019), resulting in low level of model reuse (Granell et al. 2013). Difficulties in dealing with unexpected events (e.g., extreme climate events; McNeill et al., 2017). Propagation of uncertainties (Bach et al., 2014; Elshall et al., 2020; Sohl & Claggett, 2013). Communication and participation gaps between scientists from different disciplines and between	Provision and use of (ground and/or surface) water resources (Elshall et al., 2020). Modelling land use and land cover change, accounting for the complexity in the land use/land cover system (Sohl & Claggett, 2013), Food and water security (McNeill et al., 2017 Linking various environmental cycles (e.g., water, energy, nutrients; Bach et al., 2014). System dynamics investigate the behaviour of complex systems over time, converting the system into interconnected series of stocks and flows affecting each other through feedback loops (Zomorodian et al., 2018). Bayesian belief networks can integrate both quantitative

			(Sohl & Claggett, 2013).	science and practice (Elshall et al., 2020, Bach et al., 2014; Barthel & Banzhaf, 2016; Sohl & Claggett, 2013). Lack of validation (e.g., Phan et al., 2016; Sohl & Claggett 2013,Zomorodian et al., 2018).	and qualitative data, and accommodate data-limited conditions (Phan et al., 2016).
Decision support tools	Cost-benefit analysis CBA	Cost-benefit analysis is an economic framework to account for environmental impacts where the benefits and costs of different alternatives are measured and aggregated in monetary terms and compared to assess the alternatives (Atkinson & Mourato, 2008; Dong et al., 2016). The aim is to account for positive and negative consequences of alternatives by converting them into monetary flow,	Relatively easy way to determine social desirability and feasibility of alternatives and, thus, to screen inefficient alternatives and increase transparency and accountability in decision-making (Dong et al., 2016; Markanday et al., 2019). By following procedures that are used in other policy fields, cost-benefit analysis offers the potential to include values of nature in decision-making	Requirement to monetize all impacts (Atkinson & Mourato, 2008; Gowdy, 2004). Application of a defendable discount rate (Robbins & Daniels, 2012). Limited potential for scaling-up due to contextual preferences (Vatn & Bromley, 1994; Stevens et al., 1991). Uncertainty associated with calculating benefits and costs where market prices are not known (Kolosz & Grant-Muller, 2015; Langemeyer et al., 2016a; Massiani, 2015; Söderqvist et al., 2015; Victor, 2020).	Cost-benefit analysis has been widely applied to assess the feasibility of projects, plans, and policies of public and private sectors in relation to nature (Box 3.4). Brownfield redevelopment (Ameller et al., 2020). Urban forest projects (Song et al., 2018). Climate change adaptation measures in cities (Markanday et al., 2019). Water resource management using hydro-economic models (Momblanch et al., 2016).

		Identification of all impacts over the lifetime of alternatives in monetary units, calculation of net present values by discounting the results to base year, conduct of sensitivity analysis, and recommendation of the best alternative based on the results of net present values and sensitivity analysis and to select the alternative which maximizes social welfare (Boardman et al., 2018; Choy, 2018; Saarikoski et al., 2016; Choy, 2018; Cimon-Morin et al., 2013; Duke et al., 2013). In particular, cost-benefit analysis formalizes the procedure of how to convert benefits and costs of alternatives that occur at	where they might otherwise be ignored.	Addressing extreme or irreversible climate events (Duke et al., 2013; Markanday et al., 2019). Inadequacy in dealing with equity and environmental justice, social and ethical concerns and interdisciplinary aspects (Langemeyer et al., 2016a; Victor, 2020, Häyhä & Franzese, 2014; Hoogmartens et al., 2014; Iftekhar et al., 2017; Momblanch et al., 2016; Dong et al., 2016; Ameller et al., 2020).	

		different points in time.			
	Multi-criteria decision analysis MCDA	Multi-criteria decision analysis (MCDA) or multi criteria decision-making (MCDM) is a general framework for supporting complex decision-making situations with multiple and often conflicting objectives that stakeholder groups and/or decision-makers value differently (Belton & Stewart, 2002). Multi-criteria decision analyiss is also a set of methods to perform sustainability evaluations as a result of its flexibility and the possibility of facilitating dialogue between stakeholders, analysts, and	Prioritizing environmental attributes and functions (Leung & Cao, 2001; Linkov & Moberg, 2011; Munda, 1993; Saaty, 2001). Broad applicability for diverse user-defined goals and scenarios (Cegan et al., 2017). Ability to account for multiple dimensions of well-being and facilitating open and transparent public debates on the pros and cons of the alternatives (Chan et al., 2012; Gómez-Baggethun & Martín-López, 2015; Kenter et al., 2015). Integration of quantitative, qualitative and discordant information	Sensitivity to uncertainties (Achillas et al., 2013), which are generally not fully accounted for (Mosadeghi et al., 2013). Lacking justification for choosing one multi-criteria decision analysis method or tool over another (Cinelli et al., 2014, Huang et al., 2011). Specific advantages and limitations of tools bind the use to certain contexts (Cinelli et al., 2014). Other challenges relate to stakeholder inclusion, quantifying uncertainty, and overcoming the difficulty in negotiation when a large number of stakeholders (groups) are involved in decision-making (Andalecio, 2010).	Ecosystem services, water, forest, natural hazards, renewable energies, electricity infrastructure, waste management, fisheries management, sustainable rangeland management and urban sustainability (Scolobig & Lilliestam, 2016, Achillas et al 2013, Andalecio 2010, Khedrigharibvand et al., 2019). Multi-criteria decision analysis has been increasingly used over the last decades (Cegan et al., 2017; Huang et al., 2011). This growth can also be attributed to both increased decision complexity, information availability, and stakeholders' push for transparency in decision-making processes (Huang et al., 2011). Most multi-criteria decision analysis cases have been applied in Europe and Asia (Huang et al., 2011).

		scientists (Cinelli et al., 2014). In all of these, the basic idea is to evaluate alternatives with the multiple criteria that capture the key decision-making contexts. Stakeholders and decision-makers outline a set of criteria by which to compare alternatives, score the performance of each alternative against each criterion, and weigh the criteria based on their relative importance (Cegan et al., 2017). Multi-criteria decision analyis techniques can be used to identify either the single most preferred alternative, to short-list alternatives for subsequent analysis,	and stakeholder input and preferences into a decision-making process (Cegan et al., 2017). Capacity to integrate different value dimensions, preferences of different stakeholder groups, and different spatial and temporal dynamics (Langemeyer et al., 2016b). Evaluation of social, political, environmental considerations that are not amenable to monetization (Cegan et al., 2017).		The most commonly used multi-criteria decision anlaysis methods are multi-attribute utility theory and multi-attribute value theory, analytic hierarchy process (AHP) and analytic network process (ANP), rank based methods, and outranking methods (Cegan et al., 2017; Saaty, 2004, 2005). Analytic hierarchy process/ analytic network process and Multi-Attribute Utility Theory /Multi-Attribute Value Theory are by far the most frequently used multi-criteria decision analysis methods (Cegan et al., 2017).

		to rank alternatives or to distinguish acceptable from unacceptable possibilities (Achillas et al., 2013).			
	Participatory Rural Appraisal PRA	Participatory or rapid rural appraisal with the help of local people uses various tools like maps, seasonal calendars, matrices, rankings, grouping, scoring, transect walks, analysis of trends and changes, institutional diagrams, and analytical diagrams. Participatory or rapid rural appraisal has been widely used in natural resources management (for soil and water conservation, forestry, fisheries, wildlife, community planning, etc.), programs for women	Ability to integrate the social and ecological analyses using a bottom-up approach. Participatory or rapid rural appraisal engages participants and facilitates mediation of participants knowledge and preferences.	Divergence of practices adopted in carrying out the participatory or rapid rural appraisal, Extent of time to carry out the exercise. The results cannot be easily scaled up for policy.	One of the most popular techniques used to capture different worldviews is the participatory or rapid rural appraisal method, which had its origins in late 1980s. examples include: assessing the social and ecological aspects of conservation of giant tortoises and the associated conflict (Benitez-Capistros et al., 2018); impact of Asian elephant on the rural agricultural economy (Zhang & Wang, 2003); Links between well-being and ecosystem services in mountain communities (Pereira et al 2005, Kandel et al., 2018); Traditional indigenous production methods (Tsegaye & Struik, 2002); Indigenous knowledge in yak breeding and management (Singh, 2009).

		and the poor, agriculture, health and food security (Chambers, 1994).			
	Deliberative decision-making processes	In deliberation, participants undergo a prolonged period of discussion and reflection on their own values and viewpoints and those of other participants. Some deliberative methods aim to identify group-level consensus opinions for decision support, providing an alternative to the simple aggregation of individual preferences (Murphy et al., 2017; Palomo et al., 2011a). Including a deliberative element in the valuation activities can lead to more informed (Lienhoop & MacMillan, 2007) and *better* decision-	Deliberation helps forming preferences beyond self-interest (Dietz et al., 2009b). Provide mutual understanding and trust, raise issues that individual respondents may not have stated, and can increase social support for policy decisions (Bunse et al., 2015; Parks & Gowdy, 2013). Increase the validity of the resulting data (MacMillan et al., 2006; Szabó, 2011), reduce the number of protest answers (Lienhoop & MacMillan, 2007). Consider social equity and fairness (Sagoff, 1988; Wilson & Howarth, 2002) and	Time requirements and stricter conditions on the quality of communication (Schaafsma et al., 2018, Flynn et al., 2018). Trade-offs must usually be accommodated, new risks can be introduced when amplifying inclusivity, e.g., concerns regarding the actual representativeness of participants (Boeraeve et al., 2018) or power dynamics between participants (Berbés-Blázquez, 2012).	Deliberative valuation methodologies sometimes combine deliberative group processes with monetary valuation methods, primarily stated preference methods (i.e. deliberative monetary valuation) (Niemeyer & Spash, 2001), or with other methods providing non-monetary value indicators (see Kenter et al., 2016).

		making (Kenter et al., 2016). This information provision and preference formation objective underlies many of the deliberative monetary valuation studies (e.g., Alvarez-Farizo & Hanley, 2006; Philip & MacMillan, 2005).	raise the prospect of a transformative and moralising experience (Sagoff, 1988; Spash, 2007). Adaptable to several applications and combinable (Lynam et al., 2007).		

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Annex 3.9. Health valuation

Box SM 3.1 Health Valuation

Many pathways link expressions of biodiversity to human health and well-being and so provide bases for assigning value to biodiversity. Some pathways have been described in scientific and professional literatures, including grey literature. They are well understood at least in some major respects, and they may already serve as the basis for policies and decision-making, for example in recommendations regarding which kinds of trees to plant (or not to plant) in an urban area with particular climatic and other characteristics (e.g., Yang et al., 2015). Other pathways may have been described in oral traditions, for example, but not yet received scientific attention that could serve systematic valuation efforts.

Known and potentially knowable pathways can be organized into four domains defined with regard to their relevance for adaptation and survival (*Figure SM 3.1*). One includes pathways that work to cause harm, as when trees release pollen that triggers allergic reactions (e.g., Asam et al., 2015). A second includes pathways that work to reduce harm, as when tree foliage filters particulate air pollution (e.g., Yang et al., 2015). A third includes pathways through which people build adaptive capacities, as when an infant's interactions with household pets reduces the risk of developing allergies (e.g., Ownby et al., 2002). A fourth domain includes pathways that work to restore depleted adaptive capacities, as when settings rich in plant species attract people for outdoor activities that support effortless attention and renewal of effortful cognitive capabilities (e.g., Fuller et al., 2007).

By organizing pathways into these four domains, *Figure SM 3.1* consolidates a great deal of complexity; however, as a means to identifying bases for valuation, it requires some explanation. To begin with, a given expression of biodiversity may give rise to multiple pathways, within the same domain and/or in multiple domains. For example, a plant may bear poisonous fruit, and people may sicken or die after eating it (e.g., *Atropa belladonna*; Lee, 2007); however, that same poisonous fruit may be the source of useful medicine (e.g., atropine, used to slow the development of myopia; Yam et al., 2020).

Additional complexity has to do with the role of direct exposure and experience. Some pathways may involve mediation by direct exposure to the given expression of biodiversity, and possibly also experience that accompanies exposure. For example, adaptive capacity may grow over time with the feelings people have regarding certain animals, plants and landscapes, as when familiar trees help people develop and maintain a sense of security and attachment to place (e.g., Riley, 1992). Other pathways may not involve mediation by subjective awareness or direct exposure; however, people may nonetheless be affected by the activity or the products of the activity of some expression of biodiversity, as when a fungal species produces some mycotoxin that, dispersed in air, comes to harm health (e.g., Douwes et al., 2008).

Furthermore, a pathway in one domain may intertwine with one or more pathways in some other domain(s). For ease of presentation, only the relationships between adjacent domains are shown in *Figure SM 3.1*, with two-headed arrows indicating that relations may be reciprocal. One example of such intertwining has been indicated in the broader field of nature-and-health studies: people may be attracted out doors for recreational activities such as bird watching that serve their physical activity and the development of friendly relations with other bird watchers (both examples of capacity building) while also supporting recovery from stress and other forms of restorative experience (e.g., Hartig, 2021; Mitchell, 2013).

Finally, *Figure SM 3.1* acknowledges that how a given pathway works depends on features of the environmental and socio-cultural context and/or individual characteristics. A person who sees a wolf in a zoo may have an experience of that animal quite different from the one they would have when encountering it in the wild (Johansson et al., 2021). An arachnophobe will experience a large spider differently from a non-phobic person.

The framework shown in *Figure SM 3.1* aids biodiversity valuation in important ways. It implies that when trying to assess the value of some expression of biodiversity for human health and well-being, it is necessary to consider not only how it can serve adaptation but also how it can harm health and well-being. It also suggests ways to integrate knowledge from different sources, so that methods for assessing the natural environment (nature-based valuation) directly can be joined with methods for understanding how people are exposed to the natural environment (behaviour-based valuation), how they experience it (statement-based valuation), and how they are affected (behaviour- and statement-based valuation) in terms amenable to valuation.

Figure SM 3.1 is however silent on several important considerations that must inform use of the framework. For one, insofar as any of the four domains includes as-yet-to-be-discovered pathways, it encompasses uncertainties as well as complexity.

Second, knowledge of specific pathways may be localized in specific sources, and it may be necessary to turn to multiple sources for knowledge of the different pathways emanating from a given expression of biodiversity and to understand how they may work together.

Third, the figure does not represent ways in which human health and well-being may feedback through pathways relevant for adaptation and survival of a given expression of biodiversity. For example, the feelings a person has in the presence of some forms of animal and plant life may figure importantly in their development and attachment to place, and this may in turn feed back into their efforts to protect those expressions of biodiversity, thereby maintaining the possibility of those experiences and avoidance of the extinction of experience (e.g., Pyle, 1993).

Finally, *Figure SM 3.1* does not specify a temporal scale (e.g., brief encounters to cross-generational effects) or level of analysis (e.g., individual persons through families and communities to entire populations) at which the pathways are seen to work.

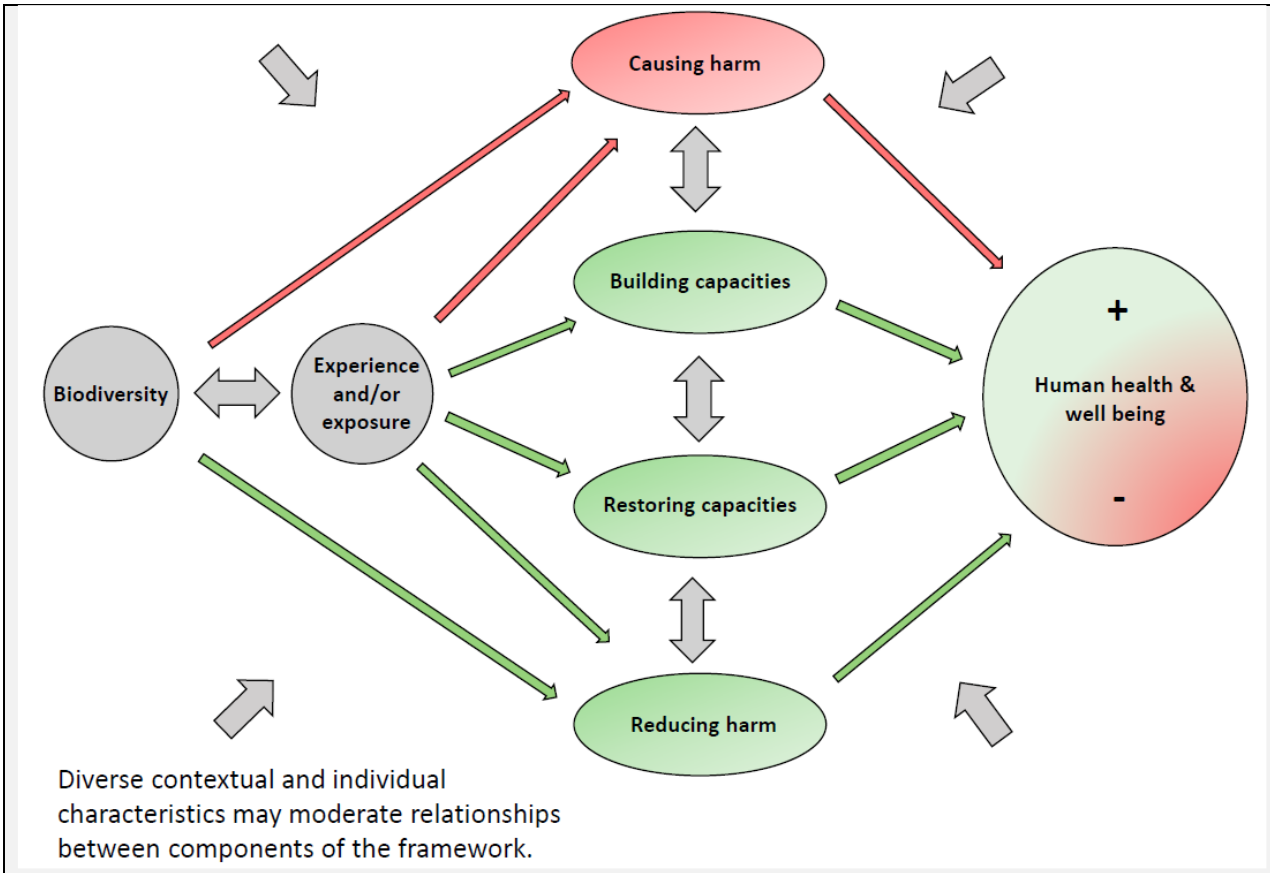

Figure SM 3.1. Pathways linking biodiversity to human health can be organized into domains defined with regard to their relevance for adaptation. A pathway in one domain may intertwine with one or more pathways in some other domain(s). Some pathways involve mediation by direct exposure to the given expression of biodiversity, and possibly the subjective experience that accompanies that exposure. Other pathways may work outside of exposure to and experience of an expression of biodiversity by individuals and groups. How a pathway works may be subject to modification by the environmental and socio-cultural context or individual characteristics. The figure is adapted from Marselle et al. (2021), Johansson et al. (2021), Markevych et al. (2017), and Hartig et al. (2014).

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Annex 3.10. How values are manifested in IPLC contexts (i.e., valuing processes subject to valuation)

Ways in which values are formed and manifested	Description	Examples from the essays	Implications for valuation
Expressions of appreciation of the world and its elements (Value expression)	This can be in actual statements people say or which are expressed in ceremonies, song, poems, dance.	*'Afars do not only value nature for its utilitarian and sometimes it's artistic and natural appeal, but also because of the understanding of the value of nature, do mourn its demise and destruction. In the Gāli Sāré poems, for instance, there are poems that paint account of loss and local extinction of animals. Herders who compose such poems passionately mourn and regret the loss of biodiversity, culture, and ancestral water (Balehegn, 2015)'* (Contribution 22).	What people say can be assessed to deduce the dimensions and elements of nature that are valued (or not), including relations with nature and the values that are expressed. Songs can be analysed; ceremonies can be evaluated to obtain information about values.
Daily decisions, actions and practices	How people spend their time and where they spend their time relative to other options.	'*For the local agro-pastoralists, local farming landscapes are crucially vital not only for their subsistence agricultural activities but also for domestic livestock production. With this integrated crop/livestock farming practice, the local agro-pastoralists usually have their farmlands not extremely far from homes. In some cases, they cultivate farms which are quite far from their homes.'* (Contribution 8).	The decisions, actions and practices can be observed in the community, in the landscape. The decisions and their outcomes can be monitored over time and space. Decisions and actions can be assessed to determine if they meet expected traditional standards.
How goods and services are exchanged in markets or other spaces	The types of items or services exchanged and their relative worth.	*'Every day before the Potato Park farmers can start work, a ceremony called Quintu is conducted which involves asking mountain gods and other elements for their blessing and for Mother Earth to 'teach us well'.'* (Contribution 13).	The worth of goods and services can be observed and compared over seasons. The nature of the goods themselves (which goods, their quality and quantity) can be monitored and related to their worth.
How knowledge	Reflected in what is taught about nature	*'Walker et al. (2019) describe some of the relational responsibilities and practices*	Which values of nature are reproduced and fostered in the

is generated and shared	and one's connections to nature, what new knowledge is developed or improved, which knowledge must be protected.	*that underpin the learning and transmission of mātauranga. They show the importance of tribal narratives as a means of imparting mātauranga, and thus how connection to place is a vital thread in kaitiakitanga'.* (Contribution 4).	educational system can be assessed. Which knowledges are considered sacred and which systems for accessing such knowledge can be analysed.
Specific norms and regulations	Rules that specify what can and cannot be done, when, where how and by whom. They bound all other ways of valuing including valuation.	*'For instance, by not sharing food, especially meat, properly among all present a hunter's ekila will be ruined so that he is unsuccessful in future. A hunter who is too often successful may stop hunting for a while for fear that his successes will attract envy and ruin his ekila'.* (Contribution 12).	Respect and disrespect of rules can assess to understand values upheld versus those that have been broken. Infraction and obedience of rules can be observed to determine who observes and doesn't, which rules are respected or not, and the circumstances that contribute to higher or lower adherence of rules. Assessments for whether rules need to be changed to accommodate changing circumstances and conditions (valuation of value systems).
Ethical principles that define what 'ought' to be	The guiding sets of values that, together, enable distinguishing between the appropriate from inappropriate, and wrong from right.	*'Life is viewed as the most precious gift and" life is equated with land" being their main source of well-being. And as land is of divine origin, "the Igorot has this indigenous concept that "no man can own any land, but the land owns every man to which "he returns when he dies".'* (Contribution 2).	Principles can be assessed to determine if they are still strong or have weakened and why.
Belief systems	Nature is addressed and consulted as a Deity. Sacred places that facilitate connecting with Nature are	*'Values are expressed through specific beliefs which denote nature and its components as a Mother (Djoty's wife gave birth to humans), a protector (the Oak tree), a nurturing space, as our family, as a forest guardian, or as a shelter (ihlathi shelter), ihlathi lokusimela (forest for hiding)*	Consultations with nature can be assessed, including their vigour and meaning for decision making. Conditions of sacred places can be assessed to stipulate quality of human nature relations.

	identified and respect.	*uThixo ulihlathi lam (God is my forest)'* (Contribution 6).	

Annex 3.11. Values as principles that position human relations with nature and guide interactions with nature

IPBES Region	Principle	Description of the principle
Africa (BaYaka communities)	**Joy**	*'It is maintaining this abundance of joy, food and multi-species companionship that is their highest value. Many of their key cultural institutions are geared explicitly to producing joy among themselves and the other species they share the forest space with. They say the forest likes this, and if camps are joyful the forest provides all they need'* (Contribution 12).
Africa (BaYaka communities)	**Ekila**	*'Ekila is a theory for maintaining abundance. Adherence to these rules, and their explanation, has established a relationship with resources that has assured BaYaka people have experienced the forest as a place of abundance for the entirety of their cultural memory: they have no word for famine. Ekila teaches that by not sharing properly resources become scarce. By sharing properly resources will always be experienced as abundant. This is as important for modern economies as it is for them'* (Contribution 12).
America (Jöti communities)	**Jnamodï**	*'Jnamodï (intangible components of human beings that insufflate intelligence, volition, knowledge, and sensibility, are the seat of health with good dispositions to hunt for the newborn)'* (Contribution 6).
America (Quechua communities)	**Ayni**	*'Ayni"*means "*sacred reciprocity'* (Contribution 13).
America (Quechua communities)	**Yanantin**	*'Yanantin (duality)'* (Contribution 13).
America (Quechua communities)	**Chaninchay**	*'Chaninchay (solidarity)'* (Contribution 13).
America (Quechua communities)	**Ayllu**	*'Ayllu (collectiveness)'* (Contribution 13).

America (Cofán communities)	**Tsampini canjensundeccu & Tsampima coirasundeccu**	*'Cofán people refer to themselves as tsampini canjensundeccu (dwellers of the tsampi) and tsampima coirasundeccu (caretakers of the tsampi). In everyday speech and political declarations, Cofán people repeatedly stress the mutual enmeshment of the tsampi (forest) and a way of life they deem deeply desirable'* (Contribution 11).
Asia Pacific (Maori communities)	**Manaakitanga**	*'Literally meaning hospitality, it also refers to ideas such a considering people's needs, caring for them or showing kindness. Care for people can equate with caring for land where foods grown or sustainably harvested (such as fish, eels or to a lesser extent these days, foods of the forest) are then shared amongst communities. Manaakitanga may also be applied by Māori land trusts who operate farming or forestry enterprises (preferably through sustainable practices) and where the profits of those businesses are then distributed to the owners/shareholders directly through dividends or through education grants or other support. Manaakitanga is a people-focused practice while its values also apply in environmental contexts especially in terms of kaitiakitanga'* (Contribution 4).
Asia Pacific (Maori communities)	**Whakapapa**	*'Whakapapa meaning to place in layers, and indicating connection and genealogy between people, ecosystems, and all flora and fauna as well as other natural forms (see for example Hikuroa, 2017; Wehi et al., 2020). Whakapapa is the foundation of Māori philosophy, encompassing social, cultural, environmental, and ecological knowledge, the systems used to generate knowledge, and the basic assumptions that ground it'* (Contribution 19).
Asia Pacific (Maori communities)	**Kaitiakitanga**	*'On kaitiakitanga, Ngāti Whātua describe, "Kaitiakitanga requires a reciprocal and balanced relationship with our natural world and resources, and with each other. Everything is inter-related and mutually dependent. If the land and sea is polluted then the health of the people will be affected as will the mana of the iwi (Ngāti Whātua Ōrākei, 2018)"'* (Contribution 19).
Asia Pacific (Maori communities)	**Mana**	*'Mana, meaning authority, power, status or position, mana is about rights. Māori community representative organisations, land trusts, community leaders and elders all promote the mana, status or rights of their communities on issues of concern'* (Contribution 19).
Asia Pacific (Maori communities)	**Whenua**	*'Whenua has two meanings – the first recognizes the life-giving aspects of lands and nature hence mana whenua meaning "customary authority of lands". The second meaning refers to*

		the customary authority of communities who seek protection of their ancestral lands irrespective of whether they legally own the lands in question' (Contribution 19).
Asia Pacific (Igorots communities)	**Adiwan**	*'Adiwan is caring for the earth. The elders teach the young the importance of keeping the land clean and safe and continuing to nurture it and guard it from harm. In return the land takes care of the people and provides their needs'* (Contribution 2).
Asia Pacific (Igorots communities)	**Inayan**	*'"inayan" embodies all virtues and morals of tribal members – humility, truthfulness, fidelity, honesty, and commitment, among others'* (Contribution 2).

Annex 3.12. Examples of methodologies, frameworks and methods developed by non-western science knowledge systems.

These knowledge systems and their approaches could inform the development of new valuation methods that take into account diverse worldviews and knowledge systems.

Research methodologies, frameworks, methods	**Brief description of what it offers**	**Examples**	**Regions**	**Authors**
Post-colonial interview methods	Focusing on relational ways of knowing; values the respect for relations people have with other humans and nature. Favours using the names of everyone participating in the meeting if they permit it. The researcher is accountable to the participants and participants are accountable to their communities.	The Pagtatanung-Tanong Interview Method	The Philippines	Drawson et al., 2017.
		Dingaka interview Method	Southern Africa	Dube, 2002.
		Focused Life-Story Interview Method	New Zealand	Edwards et al., 2005.
Kaupapa Māori theory and research methodology	Research approaches for structuring assumptions, values concepts orientations and priorities in research in Maori communities.	Kaupapa Māori	Aotearoa, New Zealand	Bishop, 2008; Smith, 2012a.
The Talanoa research methodology	Research methods derived from Samoa peoples' cultural knowledge and traditions.	The Talanoa and Faafel research methods	Samoa (Pacific peoples)	Suaalii-Sauni & Fulu-Aiolupotea, 2014.
The Khipu Model, an indigenous knowledge-based research framework	A culturally sensitive model. The Kiphu Model is conceptualised from Quechua and Māori epistemologies, ontologies and axiologies. Ultimately, informs an Indigenous research approach for selecting culturally sensitive and ethical research methods, data analysis and reporting of findings.	The Khipu Model	Peru and Aotearoa New Zealand	Huambachano, 2018a.

Relational indigenous methodologies	Methods that help maintain respectful and mutually beneficial relationships between the researcher and the Indigenous communities. Where the principles of integrity and relational accountability shape the acquisition, analysis, and use of knowledge.	Becoming a Muntu	Southern Africa	Muwanga-Zake, 2009.
		Talking circles	Southern Africa	Chilisa & Tsheko, 2014.
		The Yarn method (Yarning)	Canada	Kovach, 2009.
Deliberative and consensus seeking approaches	Methods and tools for promoting reflexivity, reducing power differentials and promoting knowledge integrations.	The Circle methodology	First Nation people in North America	Graveline, 2000. Cardinal, 2001. Martin, 2017.
		Kgotla	Botswana	Moumakwa, 2010.
		The Talking Stick tradition Anishinaabek Symbol-Based	Canada	Lavallée, 2009.
		Reflection Bidirectional Emic-Etic tool (BEE)	Central America (Mayan medical specialists and western biomedical physicians)	Berger-González et al., 2016.
Ethnophilosophy based methods	Methods that analyze the collective worldviews that are embedded in cultural expressions such as Language, proverbs and metaphors.	Language, Proverbs and Metaphors	Africa and Australia	Chilisa, 2020. Easton, 2012.

Indigenous evaluation	A process, method and paradigm for the design and framing of evaluation that is informed by indigenous philosophies, worldview and theoretical frameworks.	Made in Africa Evaluation (MEA) Approach	Africa	Chilisa, 2017b.
		Context First Approach	Global	Chilisa, 2017b.
		The Value Added Approach	Hawaii and New Zealand	Chilisa, 2017b.
		Culturally Responsive Evaluation Mode	North America	LaFrance et al., 2010.
			Hawaii and New Zealand	Kawakami et al., 2007.
Indigenous methods and practices for understanding nature	Methods and practices based on traditional ecological knowledge.	Living lists	South America	Miller, 2016.
		Inuit Ocean Observation	Northwest Atlantic Ocean	Proulx et al., 2021.
		BaYaka holistic valuation of the forest	Central Africa	Kisliuk, 2010; Lewis, 2019.
		San people resource assessment	Southern Africa	Silberbauer, 1981; Tanaka & Tanaka, 1980.
Community-based feminist participatory research approaches	Research strategies used to make evident and understand women's care for nature.	History research, individual interviews, and photovoice projects.	Australia	Sewell & Harris, 2016.
		Separate gender	Ethiopia	UNU-IAS, Bioversity

		workshops, interviews and participatory mapping		International, IGES and UNDP, 2014.
		Participatory Rural Appraisal, historical timelines	Mali	Djoudi & Brockhaus, 2011.
		Gender Analysis Guide	Global	IUCN, 2021.
Integration of Local & Citizen Knowledge	Methods that promote the uptake of local knowledge for resources management.	Patrol records and focus group discussions in the community	Artic	Danielsen et al., 2014.
		Citizen science	Global	Jørgensen & Jørgensen, 2021; Silvertown, 2009.

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Annex 3.13. Coding for Table 3.10.

Relevance:

0: Highly specific to few types of values and limited range of contexts
1a,b: Few value types (a); few contexts (b)
2a,b: Many types or values but largely within value types (e.g,. all instrumental) (a); has been applied in many different contexts but mainly the same kind of policy or environmental context (b).
3a,b: Many types of values across value types (a); and applied in many contexts across policy/environmental context (b).

Robustness:

0: Robustness not been documented for reliability or representation.
1a,b: Reliability (a) and representation (b) for selected policy uses tested in research applications (largely untested)
2a,b: Well developed to ensure reliable (a) and fair representation (b) for selected decision-making purposes
3a,b: Developed to ensure reliable (a) and fair representation (b) for multiple decision-making purposes

Resources:

0: Very specialized and requires lots of resources for every application.
1a,b: Very specialized, requires high skills level and large initial investments, i.e., high initial capacity needs (a); highly resource intensive to conduct valuation, i.e. high implementation costs (b).
2a,b: Moderate resource needs, implementable from scratch for new projects or policy evaluations within relatively short project durations: moderate initial investments, i.e., moderate initial capacity needs (a); moderate implementation costs (b).
3: Low resource needs – can be implemented in resource poor contexts (low initial investment, low initial capacity needs) (a); low implementation costs (b).

Method	**Relevance (R1)**		**Robustness (R2)**		**Resources (R3)**	
	Values	**Context**	**Reliability**	**Fair Representa-tion**	**Capacity**	**Conducting valuation**
Ecosystem service mapping	2	3	2	1	1	3
	R1: only NCPs but widely applied R2: Reliability tested in selected decision-making purposes R3: Needs high level initial investment (dependent on quality needed for the valuation)					
Biodiversity hotspots	1	2	2	1	1	2

	R1: Very specific value types but applied across the globe. R2: Reliability tested in selected decision-making purposes R3: Needs high level initial investment (dependent on quality)					
Stated Preference (SP)	2	3	2	2	2	2
	R1: Many types of values and applied in many contexts R2: Developed to ensure reliable and fair representative for multiple decision-making purposes (but the evidence is contested) R3: Moderate resource needs but does not require existing infrastructure					
Q-method (Q-sorting)	3	2	1	1	1	2
	R1: Both broad and specific values in diverse contexts R2: Design for scoping not reliable for an elicitation of values fairly for a community or society as a whole. R3: Requires a lot of preparation and planning, but can be implemented without prior existing data.					
Livelihood assessment	2	2	2	2	3	2
	R1: Range of values and context – but not very diverse R2: Recall biases but able to represent diverse social groups R3: Does not require large investment but time consuming to conduct.					
Participatory mapping	3	3	1	3	3	2
	R1: Many types of values and applied in many contexts R2: Mainly been explored in research for informative purposes but allows representation of multiple stakeholders R3: Moderate resource but can be adapted to existing data sources					
Revealed preference (RP)	1	2	3	2	1	2
	R1: Applied to a few types of values R2: Reliable for specific informative, decisive and technical purposes. Tend to include a sub-group of people. R3: Highly specialized requirements					
Integrated ecological/economic modelling	1	1	2	1	1	2
	R1: Applied to a few types of values R2: Reliable for specific informative, decisive and technical purposes but requires vary specific validation. R3: Highly specialized requirements to develop moderate costs to run.					
CBA	1	3	2	2	2	2
	R1: Applicable for values amenable to economic valuation, has been applied to a wide range of contexts and many policy questions. R2: Reliable but sensitive to aggregation choices. In principle representative but only suited to limited engagement R3: Modest data requirements and requirements for new evaluations.					
Multi-Criteria Decision Aid (MCDA)	3	3	2	2	2	2

	R1: Many types of values and has been widely applied R2: Developed to ensure fair representation for informative and decisive decision-making purposes R3: Moderate resource needs but can also be applied without valuation infrastructure.					
Deliberative decision processes	3	2	1	3	2	2
	R1: Many types of values but has not been widely applied (systematic review) R2: Developed to ensure fair representation for informative and decisive decision-making purposes R3: Moderate resource needs but can be applied without valuation infrastructure.					
Benefit Transfer (BT)	1	2	1	1	3	3
	R1: Restricted to existing databases both of values and of contexts. R2: Reliability highly dependent on approach and quality of existing data relatively low compared to other methods. R3: Low resource needs if values data bases exist					

Annex 3.14. Coding for Table 3.11 (Economic initiatives)

Relevance:

0: Highly specific to few types of values and limited range of contexts
1a,b: Few value types (a); few contexts (b)
2a,b: Many types or values but largely within value types (a); can been applied in many different contexts but mainly the same kind of policy or environmental context (b).
3a,b: Many types of values across value types (a); and has already been applied in many contexts across policy/environmental context (b).

Robustness:

0: Robustness not been documented for reliability or representation.
1a,b: Reliability (a) and representation (b) for selected policy uses tested in research applications (largely untested)
2a,b: Well developed to ensure reliable (a) and fair representation (b) for selected decision-making purposes
3a,b: Developed to ensure reliable (a) and fair representation (b) for multiple decision-making purposes

Resources:

0: Very specialized and requires lots of resources for every application.
1a,b: Very specialized and requires high skills level and initial investments, i.e., high initial capacity needs (a); requires high maintenance costs and effort to use the tools, i.e., high implementation costs (b)
2a,b: Moderate resource needs, implementable from scratch for new projects or policy evaluations within relatively short project durations, i.e., moderate initial investment or moderate initial capacity needs (a); requires moderate maintenance costs and effort to use the tools (b).
3: Low resource needs – can be implemented in resource poor contexts: low initial investment, i.e., low initial capacity needs (a); requires low maintenance costs and effort to use the tools (b).

Initiative	**Relevance (R1)**		**Robustness (R2)**		**Resources (R3)**	
	Values	**Context**	**Reliability**	**Representation**	**Capacity**	**Conducting Valuation**
TEEB	3	3	2	3	3	1
	R1: Many types of economic values R2: Reliability tested for many decision-making purposes. Some inconsistency between uses R3: Does not need high level initial investment in infrastructure; relatively high costs for each time a new policy/project is being evaluated					
UNSEEA	2	3	3	2	1	2
	R1: Both instrumental (narrowly defined) and intrinsic values; Data use at different scales R2: Highly standardized definitions to allow consistent use over time; High specificity of economic data; but limited representation of other aspects. R3: High level of investment to develop the approach in a country. Continuous costs to update data annually.					

DR	1	2	3	2	1	3
	R1: Instrumental values; socio demographic & health variables R2: Consistent economic framework, high specificity of economic data; but limited representation of other aspects. R3: High level of investment to develop the approach in a country. Modest cost one the system is in place.					

Annex 3.15. Non-Exhaustive list of guidelines for conducting research in indigenous and local communities

Guidelines	Organization that developed the guidelines	Country or Region guidelines apply to	Principles proposed in the guidelines	Link to document
Guidelines for ethical responsible research with Quechua communities of Peru. The Potato Park Biocultural Protocol.	The Association for Nature and Sustainable Development (ANDES) and International Institute for Environment and Development.	Peru	Reciprocity (Ayninakuy); duality (Yanantin); equilibrium (Rakinakuy).	Argumedo, 2011. https://pubs.iied.org/g03402
Biocultural Community Protocol of the Embera people, Cabildo Indígena Mayor de Chigorodó.	Civil Society and Organizations.	Colombia	Indigenous identity and history (Embera origin story); indigenous governance and justice; territory and sacred sites; ancestral wisdom and knowledge; education and language; health and medicinal plant knowledge; duty to consult and prior informed consent; cultural practices and expressions, including traditional housing (tambo), traditional songs (truambis), and other music, dances, handicrafts, weaving.	Gabriel Ricardo Nemogá Soto Nataly Domicó Murillo, 2018. https://winnspace.uwinnipeg.ca/bitstream/handle/10680/1549/Designing%20Biocultural%20Protocols%20with%20the%20Embera%20People%20of%20Colombia.pdf?sequence=1&isAllowed=y
Framework for Research Engagement with First Nation, Metis, and Inuit Peoples.	Canadian Institutes of Health Research followed by the 2013 Tri-council Guidelines.	Canada's First Nations, Metis and Inuits.	Authentic engagement; recognition; shared respect, trust, and commitment to mutually empowered long-term relationships; acknowledgement of rights, treaties and diversity and distinct identities; shared authority, accountability and responsibility; commitment to address the research-related priorities and needs of first nation, metis, and inuit peoples, and the university.	University of Manitoba - https://umanitoba.ca/faculties/health_sciences/medicine/media/UofM_Framework_Report_web.pdf

Guidelines for research involving indigenous peoples in Canada.	Research Ethics Board Ryerson University.	Canada	Respect; concern for the collective and individual welfare of indigenous peoples; collaboration.	https://www.ryerson.ca/content/dam/research/documents/ethics/guidelines-for-research-involving-indigenous-peoples-in-canada.pdf
General principles for ethical conduct in human research (NHMRC et al. 2007a).	National Health and Medical Research Council Act 1992. Australian Government.	Australia	Honesty and integrity, respect for participants, good stewardship of public resources, appropriate acknowledgement of the role of others, responsible communication of results.	National Statement (2007)
Values and principles for ethical conduct in Aboriginal and Torres Strait Islander health research (NHMRC 2003).	National Health and Medical Research Council Act 1992. Australian Government.	Australia	Reciprocity, respect, equality, responsibility, survival and protection, spirit integrity.	https://www.nhmrc.gov.au/about-us/publications/values-and-ethics-guidelines-ethical-conduct-aboriginal-and-torres-strait-islander-health-research
Principles of good practice social policy research and evaluation (NZ) (SPEaR).	Social Policy Evaluation and Research Committee and Aoteroa New Zealand Evaluation Association.	Aotearoa, New Zealand.	Respect, integrity, responsiveness, competency, reciprocity.	SPEaR, 2007.https://thehub.swa.govt.nz/assets/documents/43066_spear-bpg-maori-final-report-anzea_0.pdf
Generating collective knowledge on the conservation, management and sustainable use of socio-ecological production landscapes and seascapes.	United Nations University Institute for the Advanced Study of Sustainability, Tokyo & Global Environmental Strategies.	Global	Need for dynamic interaction between traditional knowledge and other information and knowledge systems; knowledge modification and translation to put into other contexts; allowing meaningful participation for decision-making and implementation; ensure or improve interest representation and organizational responsibility; ownership over decisions to solve and remain responsible at the local level; institutional coordination of different interests; strengthening indigenous governance; respect rights; promote	Received through the call for contributions. Access here.

			customary sustainable use of biological resources; related to local well-being and sustainable livelihoods are food security, health, additional or alternative income generation, livelihood security and risk reduction; revitalization of traditional knowledge and innovations on production methods.	
San Code of Research Ethics (Code San de l'éthique de la recherche).	South African San Institute (SASI).	Southern Africa (South Africa Namibia and Bostwana).	Respect, honesty, justice and equity, concern for others and for their needs, collectivism.	http://trust-project.eu/wp-content/uploads/2016/03/San-Code-of-RESEARCH-Ethics-Booklet-French.pdf
Transboundary Diagnostic Analysis (TDA) of the Botswana Portion of the Okavango River Basin: Stakeholder involvement in the Okavango Delta Management Plan (ODMP) and its relevance to the Transboundary diagnostic analysis process.	Harry Oppenheimer Okavango Research Centre.	Botswana	Creation and strengthening of ownership, participation, consultation, communication, responsibility, accountability, co-learning, interest, support, engagement, networking.	Received through the call for contributions. Access here.
Alaskan Inuit food security conceptual framework: how to assess the arctic from an inuit perspective.	Inuit Circumpolar Council-Alaska.	United States (Alaska)	Recognition, involvement, co-production, ethical use, ensure that intellectual and cultural property rights are maintained, networking, respect, equitable distribution of monetary resources, community driven, accessibility (t information), self-identity, support to cultural and self-identity practices, all activities/conditions should be attained “to the satisfaction of Inuit in a given area”.	Received through the call for contributions. Access here.

Working together: Indigenous Involvement in Caribou Stewardship A Discussion Paper drafted by the Indigenous Statement Working Group.	Indigenous Talking Circle - 17th North American Caribou Workshop 2018.	Canada	Mutual respect, support indigenous-led conservation and stewardship initiatives, recognition and making room for full expression of indigenous worldviews (including spiritual connections to the land and profound responsibility and respect to caribou), holistic definition of well-being, diversifying educational approaches and programs by supporting indigenous language revitalization and the intergenerational transfer of knowledge; non-invasive research and monitoring techniques; partnerships; equality.	Received through the call for contributions. Access here.
International Union of Conservation of Nature (IUCN) Guidelines: Gathering of Fishers' Knowledge for Policy Development and Applied Use.	Environment Agency - Abu Dhabi; Species Survival Commission; International Union of Conservation of Nature (IUCN); Commission on Environmental, Economic and Social Policy (CEESP); Sustainable Use and Livelihoods Specialist Group (SULi); World Forum of Fisher Peoples; Snapper, Seabream, Grunt Specialist Group - International Union of Conservation of Nature (IUCN) - Species Survival Commission (SSC).	Global	Fair and equitable share of benefits; obtain prior and informed approval; mutually agreed terms.	Abstract and key messages were sent through the Call for Contributions. Access here. Full guidelines can be accessed here: https://portals.iucn.org/library/sites/library/files/documents/2020-032-En.pdf

Incorporate Indigenous perspectives for impactful research and effective management.	Comment article published in Nature Ecology & Evolution Autors: Natalie C. Ban, Alejandro Frid, Mike Reid, Barry Edgar, Danielle Shaw and Peter Siwallace.	Global (based on research within Canada).	Cooperation; collaboration; free, prior and informed consent; complementarity; recognition of interconnection of all living and physical entities; openness to learn about indigenous perspectives, knowledge and practices; ability to recognize indigenous knowledge as its own source of insights; build relationships; follow indigenous protocols for developing research partnerships; co-create; foster a deeper sense of connection with the places, cultures and individuals inherent to the work; recognize that hypothesis generation involves subjectivity, which consequently reflects interests and therefore, biases and worldviews of the individual scientist who generates them.	Received through the call for contributions. Access here.
Iskenisk Declaration on the Access, Use, and Fair and Equitable Sharing of Benefits Arising Out of the Utilization of Genetic Resources and Associated Traditional Knowledge in Canada.	Signed by First Nations and Aboriginal Elders, Youth, Representatives, Members of Councils and of organizations.	Canada.	Respect to mother earth; do not violate the interconnection and interdependence with mother earth; responsibility; fairness, equitability, participation, involvement, negotiation, transparency, representativeness.	Received through the call for contributions. Access here.
TCPS 2 (2018) – Chapter 9: Research Involving the First Nations, Inuit and Métis Peoples of Canada.	Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council; Government of Canada.	Canada.	Respect for persons; concern for welfare (collective welfare as a complement to individual well-being); justice; representation in planning and decision-making; free, informed, and ongoing consent; interconnections between humans and the natural world; intergenerationality; establishing a relationship; engagement; recognition of diverse interests; mutual benefits; privacy and confidentiality.	https://ethics.gc.ca/eng/tcps2-eptc2_2018_chapter9-chapitre9.html?wbdisable=true

Engaging Gypsy, Roma, and Traveller Communities in Research: Maximizing Opportunities and Overcoming Challenges.	Research article in Qualitative Health Research. Authors: Louise Condon, Helen Bedford, Lana Ireland, Susan Kerr, Julie Mytton, Zoe Richardson, and Cath Jackson.	United Kingdom (although participants also lived and had migrated from Continental Europe).	Sensitivity to the opinions and allegiances of gatekeepers; responsivity to political and social factors; flexibility within the inclusion criteria specified; comprehensive and well-conducted public involvement; community partnership to build confidence, capacity, and a sense of entitlement; maximize involvement representation; concurrent translation and bilingual group facilitation; use appropriate venues for data collection (avoid embarrassment of exposing illiteracy); mutual respect.	https://journals.sagepub.com/doi/pdf/10.1177/1049732318813558
Guidelines regarding research with indigenous women.	Quebec Native Women Inc.	Quebec.	Include women in first contacts with communities; have a deep consultation processes that include women; include women in all the stages of the research; research should be based on local needs, which should be identified by women; respect indigenous knowledge at the same level as scientific knowledge; choose a method that respects the conditions of the community, as well as the values and knowledge of women; give voice to indigenous women; respect the holistic view of the people; establish reciprocal relationships and give something back for the knowledge women share; report back results to women involved in the research and to the community; respect fundamental values such as respect, trust, knowledge, balance, equality, and power for decision-making; sustain continuous dialogue.	https://www.faq-qnw.org/wp-content/uploads/2016/11/FAQ-2012-Lignes_directrices_recherche.pdf
The ethical principles of research with human participants and ethical review in the human sciences in Finland.	The Finnish National Board on Research Integrity TENK guidelines 2019.	Finland.	Respect for dignity and autonomy, and for all the rights held in the Finnish constitution; respect for material and immaterial cultural heritage and biodiversity, including maintaining and developing language and culture; research should be conducted in such a way that it does not cause significant risks,	https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf

			damage or harm to research participants, communities, or other subjects of research.	
Ethical code for research, action-research, and ethnoscientific collaboration in Latin America. First version.	Ethnobiology Latin-American Society (SOLAE).	Latin America.	Solidarity; respect; mutual support; recognition of collective legal norms and rules; transparency; get consent or authorization of the people; establish agreements regarding sharing the results and any commercial use of them; indigenous peoples have the right to keep privacy and secrets about their history, cosmovision and resources policies; guarantee that the research and its results will not be used to damage or discriminate the community; right of authorship and co-authorship; confidentiality; respect and maintain local agreements, norms, conducts and restrictions regarding the recognition, respect and relationships with intangible cultural heritage aspects; research should not risk or damage the tangible and intangible territory; avoid discrimination and violence; reciprocity.	https://revistaetnobiologia.mx/index.php/etno/article/view/161
The Mataatua Declaration on Cultural and Intellectual Property Rights of Indigenous Peoples.	First International Conference on the Cultural & Intellectual Property Rights of Indigenous Peoples.	Global	Recognition (of indigenous peoples as guardians of their customary knowledge and their right to protect it and to create new knowledge; of indigenous peoples' traditional guardianship over flora and fauna); accept that the cultural and intellectual property rights of indigenous people are vested with those who created them; cooperation; get consent for commercializing or experimenting with biogenetic resources; strengthen scientific environmental research by increasing indigenous communities involvement and their customary environmental knowledge.	https://www.wipo.int/export/sites/www/tk/en/databases/creative_heritage/docs/mataatua.pdf
Tkarihwaié:ri Code of Ethical Conduct to Ensure Respect for	Secretariat of the Convention on Biological Diversity.	Global.	Respect for existing settlements; intellectual property; non-discrimination; transparency/full disclosure; prior informed consent and/or approval and involvement; inter-cultural respect; safeguarding	https://www.cbd.int/traditional/code/ethicalconduct-brochure-en.pdf

the Cultural and Intellectual Heritage of Indigenous and Local Communities Relevant to the Conservation and Sustainable Use of Biological Diversity.			collective or individual ownership; fair and equitable sharing of benefits; protection and enhancement of the relationships of affected indigenous and local communities with the environment; precautionary approach; recognition of sacred sites, culturally significant sites and lands and waters traditionally occupied or used by indigenous and local communities; do not interfere with the access to traditional resources; do not cause indigenous and local communities to be removed from their lands and waters (or from those that they use); recognition of traditional guardianship/custodianship; recognition of indigenous and local community social structures; restitution and/or compensation should any adverse consequences occur; repatriation; peaceful relations; supporting research initiatives of indigenous and local communities; negotiations in good faith; respect indigenous and local community decision-making structures; partnership and cooperation: gender considerations -need for the full and effective participation of women at all levels-; full and effective participation/participatory approach; confidentiality; reciprocity.	
Steps for conducting research and evaluation in Native communities.	NACE Native American Center for Excellence Substance Abuse Prevention.	United States of America.	Establish personal and professional relationships to build rapport and credibility; appreciate history and culture; demonstrate respect; proceed in community time; recognize and value the time and contributions of community members; engage with tribal members; build capacity of the community by employing their members, training them and/or mentoring them; be aware of community readiness, and if necessary, adapt the program; be transparent; be respectful of research protocol -consider establishing an advisory board who represent key constituencies in the community-; respect privacy; employ culturally-grounded qualitative methods in data collection	https://www.samhsa.gov/sites/default/files/nace-steps-conducting-research-evaluation-native-communities.pdf Other interesting resources (found through this source): https://www.nnhrrb.navajo-nsn.gov/aboutNNHRRB.html https://irb.cherokee.org/

			protocols that include “indigenous ways of knowing”, as valuable approaches to scientific enquiry; keep the community fully informed as the study progresses; be aware of intellectual and cultural property rights; plan for sustainability (of the program) -make efforts to secure continued program support-.	
Nordic Saami Convention.	Governments of Finland, Norway and Sweden.	Finland, Norway and Sweden.	The states, in cooperation with the Saami parliaments, shall create food conditions based on the knowledge needs of the Saami society; promote recruitment of Saami researchers: research should pay attention to Saami linguistic and cultural conditions; promote cooperation between Saami and other research institutions; adapt research concerning Saami to ethical rules that the Saami’s status as an indigenous people requires.	https://www.sametinget.se/105173