Supplementary Materials

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# **S1. Spatial scaling and resolution capabilities of ES assessments**

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|  | **Checklist**  | Y | N | NR | **Comments** |
| --- | --- | --- | --- | --- | --- |
| 1 | Is there a **process** in place for **validating** the spatial representation of ecosystem services with **stakeholders**? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 2 | Are the spatial **scale and extent** of the ecosystem services assessment **explicit**ly stated? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 3 | Does the spatial scale of the ES assessment **align** with the objectives of the **management or policy** decision it aims to inform? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 4 | Are the **spatial units** used in the assessment clearly defined and justified? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 5 | Are **spatially explicit** indicators used to assess ecosystem **services**? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 6 | Are **spatially explicit** indicators used to assess ecosystem **condition**? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 7 | Is the spatial **resolution** of the applied ecosystem condition indicators **appropriate** for the **scale** of the assessment? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 8 | Does the assessment take into account the **spatiotemporal dynamics** and potential future changes of ES? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| 9 | Is the **spatial resolution** of the applied indicators transparently stated? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| 10 | Does the assessment incorporate **local knowledge** or spatial data to enhance the relevance and accuracy of the analysis? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 11 | Is the **third spatial dimension** (e.g. elevation above sea level, relief, or slope) considered in the ES assessment? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 12 | Are the **methods** used to assess **ecosystem services appropriate** for the **complexity** of the ecosystem services evaluated? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 13 | Are **common frameworks** (e.g. CICES, Essential variables, MAES) considered in order to homogenise comparisons? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 14 | Are **maps** of the study area **recent** and do they reliably document recent land use and land cover changes at a relevant spatial scale?  | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 15 | Does the assessment include a **sensitivity analysis** to understand the effects of varying spatial resolutions? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 16 | Are the **spatial interdependencies** between different ecosystem services within the study area assessed and reported? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 17 | Have potential **trade-offs** between different **spatial scales** and their implications on ecosystem services been considered? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 18 | Is **temporal variability** in ecosystem services addressed and documented in the assessment? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 19 | Are **metadata** for spatial scales and resolutionsincluded and **following** the **INSPIRE** directive? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 20 | Are the **limitations** on the spatial scales and resolutions clearly identified and justified? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| 21 | Are **maps** of the study area used to **visualise** the assessment **results**?  | ☐ | ☐ | ☐ | Based on reviewer expertise |

**Approach to checklist compilation**

The checklist for sensibly addressing spatial scaling and resolution capabilities in a robust ecosystem services assessment has been compiled based on information that has been collected during the review process on guidance documents described in the SELINA M08 report. Insights from established proceedings and practical applications found in the guidance document were queried through closed and free text questions. Furthermore, the reviewers complemented this list based on their own expertise. All assumptions were synthesised and rephrased into 21 questions aiming to ensure a comprehensive, practical, and widely applicable checklist that increases the uptake of findings from ecosystem services assessments in decision-making processes.
One key outcome is to **be very transparent and explicit** about the spatial scale, spatial dimensions, spatial resolution, spatial dynamics, applied indicators and frameworks, uncertainties etc. in order to improve the comprehensibility of the assessment.

**Expected limitations and possible improvement**

While the checklist provides some aspects to strengthen the spatial scaling and resolution capabilities of ecosystem services assessments, it also contains some potential limitations when applied by practitioners in real world cases. In practice, it is often not the most suitable ES assessment that will be carried out, but a lack of time and resources makes it necessary to evaluate the feasibility in the respective scope. Even if practitioners have decided on the most suitable spatial scale and spatially explicit indicators with a meaningful resolution, the lack of data availability or accessibility may cause an impassable barrier. For now, no guidance on the most suitable, best-use indicators for different spatial scales and different purposes or suggestions for openly available datasets. Additionally, the background and expertise of the practitioners in case studies will most likely be very heterogeneous. Combined with the often inconsistent use and understanding of certain terms and concepts in the ecosystem services domain, we see a high risk of misunderstanding or misinterpretation of certain pieces of advice. Hence, we strongly recommend case studies to use the established Glossaries alongside as a common basis. The creation of meaningful, visually appealing maps (related i.a. to questions 12-13) requires specialised GIS knowledge. Moreover, the map users, notably decision makers, should be cautious when using ecosystem services maps for decision making and ensure they fully understand what is shown and what limitations and uncertainties come with the respective assessment. It is advisable to not only rely on a single map.

Some of the questions in this checklist should be mandatory, while some of the more specialised questions may be optional and depend for example on the purpose of the assessment or the chosen spatial scale. This could be tested by concrete use cases within case studies and adjusted in the future. Moreover, the checklists would profit from an iterative feedback mechanism to constantly refine and update them as well as from good-practice examples potentially linking the identified questions specifically to the realisation in the assessment to provide clarification.

# **S2. Ecosystem condition variables in ES assessments**

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Checklist**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Does the study aim to: |  |  |  |  |
|  | 1. **Advocate for** ensuring access to **sufficient funding** to support the implementation of new condition assessment approaches/standards, including training and incorporating new professionals?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Enhance the knowledge** and skills of policymakers and supporting scientists/technicians on agreed condition assessment approaches?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Develop standardised condition assessment methods** and accessible, interoperable databases to overcome fragmented data inventory reality faced by policymakers?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Develop user-friendly tools**, such as plugins and software, enabling policymakers and practitioners to analyse, visualise, and interpret data on ecosystem condition and services?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Encourage participation and collaboration** among stakeholders in the design and implementation of strategies like conservation, ecotourism, and monitoring of ecosystems?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Highlight priority ecosystem condition aspects**, services, and their benefits, helping policymakers focus on impactful aspects of their decisions?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. **Promote restoration targets** based on ecosystem condition needs and emphasise the importance of improving degraded ecosystems?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | 1. Establish clear indicators for ecosystem condition and services at national, regional, or local levels for monitoring and evaluation in policy development?
 | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **2** | Does the study present **well-defined methods** for assessing impacts of ecosystem condition on services? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **3** | Does the study emphasise the integration of **biodiversity conservation** within the evaluation of ecosystem conditions and services? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **4** | Does the study emphasise the integration of **well-being** assessment within the evaluation of ecosystem conditions and services? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **5** | Does the study involve the development of a **standardised framework** for integrated assessment of ecosystem condition and services to **aid policymakers** in understanding and utilising information? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **6** | Does the study recommend utilising **spatial data and maps** to visually present ecosystem condition and services data for policymakers? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **7** | Does the study provide guidelines for monitoring and evaluating the impacts of **ecosystem-based adaptation interventions**, such as nature-based solutions or green-blue networks? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **8** | Does the study present **practical case studies** and examples illustrating successful integration of ecosystem condition and services into decision-making processes? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| **9** | Does the study provide **clear definitions and explanations of terms** related to ecosystem condition and services, ensuring consistency and better understanding? | **☐** | **☐** | **☐** | Based on reviewer expertise |

**Approach for checklist compilation**

The checklist for evaluating studies incorporating ecosystem condition variables into ecosystem services models was developed through the examination of guidance documents and leveraged the expertise and experience of the reviewers in this field. The process involved synthesising insights from established methodologies and practical applications found in the guidance document. Assumptions were made based on the belief that **a robust assessment tool should encompass key dimensions important for policymakers and practitioners.** These dimensions include clarity of definitions, standardised frameworks, prioritisation of ecosystem aspects, establishment of indicators, promotion of restoration, transparent presentation of methods, integration of biodiversity and well-being, use of spatial data, stakeholder participation, enhancement of policymakers' knowledge, practical case studies, and a call for standardised methods and accessible databases. These assumptions aimed to ensure a comprehensive, practical, and widely applicable checklist, facilitating meaningful integration of ecosystem condition considerations into ecosystem services modelling and ultimately into decision-making processes.

**Expected limitations and possible steps for improvement**

While the checklist provides some criteria for evaluating studies incorporating ecosystem condition variables into ecosystem services models, there are some potential limitations when applied to real world cases. Firstly, the checklist assumes a certain level of **data availability** and accessibility, which may vary across ES assessment applications with differing resource constraints. Additionally, the checklist's emphasis on **standardisation** and clear indicators may face challenges in the context of **diverse ecosystems and regional variations**. To enhance its applicability to cases, steps for improvement could involve creating a **tiered system** that accommodates variations in data availability and resource capacities. The checklist could also benefit from **iterative feedback** from case studies to refine and tailor its criteria based on real-world experiences. Furthermore, incorporating flexibility into the checklist to allow for **project-specific adaptations** would enhance its usability across a range of ecological, socio-economic, and political contexts. Regular **updates** based on emerging best practices and technological advancements would ensure the checklist remains a dynamic and relevant tool for guiding ecosystem condition and services assessments in case studies and other applications.

# **S3. Capacity-potential, supply-demand in ES assessment**

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Checklist**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Does the study rely on the **analysis of policy needs** prior to defining **indicators** for each of the ES dimension (capacity, supply, demand)? (document #4) | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **2** | Does the study rely on the analysis of broader (not just accounting use) **policy needs** prior to defining what **input data** to and/or outputs to generate? (document #4) | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **3** | Does the study offer stepwise approaches for assessing ecosystem service capacity, potential supply, actual supply and/or, demand and **integrating them into decision-making**?  | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| **4** | Does the study rely on the **analysis of policy needs** prior to defining the ES **dimension** (capacity, supply, demand)? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **5** | Does the study **explicitly identify and define the concept**(s) (capacity, potential supply, actual supply and/or, demand)? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **6** | Does the study define the concept(s) following an **established standard terminology** (e.g., Burkhard et al. 2012; Millennium Ecosystem Assessment; CICES; IPBES)? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **7** | Does the study present **clear approaches** for assessing each dimension? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **8** | Does the study clarify **indicators** for each ES and each dimension? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **9** | Does the study link and/or **integrate** the ES **dimensions** considered in it? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **10** | Does the study address **sustainability aspects** of ES dimensions? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **11** | Does the study elucidate **uncertainties** associated with each of the assessed dimension(s) (and indicator(s))? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **12** | Does the study elucidate the **(spatial) relations** between the assessed dimensions? | **☐** | **☐** | **☐** | Based on reviewer expertise |

**Approach for checklist compilation**

The checklist has mainly been compiled by relying on the reviewers’ own experience in the design, application and communication of ecosystem services assessment, with a specific focus drawn on the concept from the **SEEA-EA framework** (concepts of capacity, potential supply, actual supply (flow), use, and/or demand). Reviewers’ own experience was combined as much as possible with guidance extracted from the reviewed literature, although it remained rather incomplete with respect to the link to policy. This diagnostic topic was addressed through twelve questions related to four topics: 1) the identification and **distinction of the concepts** of capacity, potential supply, actual supply (flow), use, and/or demand, 2) the **indicators** used to characterise those concepts in the assessments, 3) the link between the concepts and their i**ntegration in assessments**, 4) the implications of distinguishing and/or using this set of concepts in **policy making**. For each of these four topics, specific points of guidance were extracted by reviewers. These points of guidance were subsequently synthesised and reformulated into checklist questions. The review of the guidance documents and personal knowledge and experience of the experts enable them to identify further checklist questions based on their experience of how research and application of concepts of capacity, potential supply, actual supply (flow), use, and/or demand can feed into decision making.

**Expected limitations and possible improvements**

There is still some **confusion around the definition of the concepts** in the existing literature, as well as a lack of common understanding. Consequently, there is a risk that (most) concepts are still largely unclear in real world cases. Clear definitions and **examples** of the concepts should be then provided to case studies, to ensure that they are defined and applied in an appropriate and homogenous way by case studies. In addition to providing the proper documentation defining these concepts, further explanation may be needed, e.g., on how to assess them and on the **choice of indicators**, as examples of studies using modelling approaches (wrt tools, indicators) for several of these concepts are still limited. **Testing** on the ground should be conducted with case study practitioners to validate and, when needed, complement and reformulate the check-list questions.

# **S4. Economic valuation compatibility of ES assessments**

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Checklist for economic valuation compatibility**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Does the study include **time and budget** for monitoring and engaging in the **policy** development **process**? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **2** | Does the study provide **training for stakeholders** that are likely to take the results forward? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **3** | Are the **beneficiaries** of each ecosystem service **identified** and quantified (number of beneficiaries, population density, proximity to urban areas etc.) to reflect demand? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **4** | Is it possible to **expand the geographical scope** of the valuation study? If, for example, the original study was for a specific ecosystem, and there is stakeholder demand and funding for **scaling up** the analysis to the regional or national level. | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **5** | Is it possible to **expand the scope of the valuation** study? If, for example, the original study was for a limited set of ES, there might be interest and funding for extending the analysis to other relevant ES. | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **6** | Does the study discuss the **transferability** of valuation results to other contexts and regions? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **7** | Does the study use a **biophysical quantification** of ecosystem services as the basis for the economic valuation? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **8** | Do the **scales** (temporal, spatial, beneficiaries) of the **biophysical** quantification of ecosystem services **match** the economic valuation ? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **9** | Does the study describe and **distinguish** between the **total** flow of the ecosystem service and **changes** in the flow (as result of a change in management, extent, condition etc)? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **10** | Does the study provide information on **equity** implications? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **11** | Does the study assess and address **uncertainties** associated with the valuation, providing a clear indication of the confidence level in the results? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **12** | Does the study develop **recommendations on policy** responses in light of its findings?  | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **13** | Does the study develop recommendations for **appraisal** of alternative **policy options**? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **14** | Does the study organise events **open** to external **audiences** to present the results or present at events organised by others (locally, nationally and internationally)? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **15** | Does the study organise meetings at which **stakeholders** can report on progress towards improved ecosystem management? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
| **16** | Does the study publicly **report** the progress of any **further work** on ecosystem valuation and, if relevant, keep the study website up to date? | ☐ | ☐ | ☐ | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| **17** | Does the study involve **stakeholders in the scoping** and design to enhance relevance? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| **18** | Does the study assess **long-term dynamics** in ecosystem capacity, supply and demand in order to measure the **sustainability** of ES use and values. | ☐ | ☐ | ☐ | Based on reviewer expertise |
| **19** | Does the study measure the contribution of ES to **economic development indicators** (e.g. employment, growth)? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| **20** | Have the study results been added to **online valuation databases** (e.g. ESVD, EVRI)? | ☐ | ☐ | ☐ | Based on reviewer expertise |
| **21** | Have the study results been **implemented** in a **policy** or **management** tool? | ☐ | ☐ | ☐ | Based on reviewer expertise |

**Approach to checklist compilation**

The checklist has been compiled by combining guidance drawn from the review process described in Section 3. For each diagnostic question addressed in the review, specific points of guidance were recorded by reviewers as free text in the review form. These points of guidance were subsequently synthesised and reformulated into checklist questions. In addition, other points of guidance from the reviewed studies that do not directly relate to the diagnostic questions were also reformulated into checklist questions. Alongside this process, and with reflection on the points identified through the review, reviewers were invited to include additional checklist questions **based on their experience** of how economic valuation research can feed into decision making.

**Expected limitations and possible improvement**

Some checklist items delve into **technical aspects of economic valuation**, which might be challenging for practitioners in real world cases without specialised knowledge. This complexity necessitates additional explanations or expert guidance for effective comprehension and application. The checklist could also benefit from **practical testing within case studies**; real-world applications can reveal areas for refinement and enhancement. Suggested improvement steps could include: (i) further elaboration and refinement of the checklist questions, informed by practical **testing** and feedback from cases, can enhance clarity and usability; this process should aim to demystify technical aspects and make the valuation more accessible and applicable (ii) establishing a structured **feedback mechanism** to collect and analyse responses, questions, and suggestions from cases can also provide valuable insights for continuous improvement of the checklist, and (iii) providing additional resources, such as **explanatory guides** or access to expert consultation, can assist cases in navigating the more technical aspects of the checklist.

For instance, one important limitation is the potential mismatch between the generalised recommendations in the checklist and the **specific, localised needs of individual case studies**. This could lead to a lack of precision in addressing the unique economic aspects of ecosystem services in varied geographical and socio-economic settings. To improve the checklist's applicability, it would be beneficial to incorporate a mechanism for **contextual adaptation.** This could involve providing guidelines on how to modify or augment the checklist based on local economic conditions, stakeholder priorities, and specific ecosystem characteristics. Additionally, the checklist could be enhanced by integrating feedback mechanisms, where practitioners can provide insights based on their on-ground experiences. This process would allow for continuous **refinement of the checklist**, ensuring its relevance and effectiveness in diverse case applications dealing with ecosystem service economic valuation.

# **S5. Social benefit compatibility of and dimensions of justice in ES assessments**

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Checklist**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Does the study use a **participatory approach** to ensure that the assessment of ES is rooted in the needs, knowledge and values of the communities or residents relying on these services? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **2** | Does the study aim to understand the **specific social demands** for ES to inform the assessment more effectively? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **3** | Does the study identify ES beneficiaries and **assess disparities** in access and distribution of benefits? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **4** | Does the study compare/**validate** the scenarios/models/inputs/outputs with local inputs and community perspectives to enhance their credibility? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents and expanded based on reviewer expertise |
| **5** | Has a **mechanism** been established to ensure that local **stakeholders** can **respond** to the results and recommendations from the study? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| **6** | Does the study investigate the **attitudes and perceptions of communities** towards specific ES and their importance for well-being? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **7** | Does the study customise **ES classification**s to incorporate **local perspectives**? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **8** | Does the study identify the most **vulnerable or marginalised groups** within the study area, and have their needs, perspectives and values been explicitly identified and accounted for? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **9** | Does the study acknowledge who has been **positively or negatively affected** by changes in ES supply or access due to specific interventions? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **10** | Does the study account for **confounding** social, economic, cultural and environmental **factors** which mediate the relationships between ES and social benefit and justice outcomes? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **11** | Does the study evaluate the potential impacts of different **policy actions** on the distribution of ES benefits among various societal groups? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **12** | Have **indicators** been developed which are specifically **social benefit-relevant** as determined by the engagement with stakeholders? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **13** | Does the study consider the **intergenerational aspects of ES** and their implications for future well-being (e.g., impacts of policies or activities)? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **14** | Does the study explore effective **strategies for communicating** complex ES-related information to diverse audiences?  | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **15** | Does the study aim to sustain **long-term engagemen**t with residents and communities beyond initial policy development (e.g., monitoring and management)? | **☐** | **☐** | **☐** | Based on reviewer expertise |

**Approach to checklist compilation**

The checklist aims to address critical gaps identified in existing guidance documents. These gaps likely arise from limitations in understanding the intricate connections between ES and their social implications, including those related to social and environmental justice. For instance, exploring the relationships between biodiversity, ES, and social and environmental justice requires insights from disciplines such as political ecology and diverse social sciences. Moreover, existing guidelines lack information for addressing social and economic inequalities as confounding factors, which are essential when monitoring the effectiveness of models and indicators to demonstrate the connection between ES and human well-being. As a result, the presented checklist, simplified into yes/no questions, has been improved by using experts' perspectives on this topic.

**Expected limitations and possible improvement**

Despite the above information, the existing checklist has limitations. It assumes that real world cases as end users possess the necessary knowledge and resources to address the complex pathways between ES and social benefits and justice. This assumption includes conducting comprehensive stakeholder mapping and implementing transdisciplinary, cross-sectoral approaches. However, it overlooks the critical need for additional guidance in navigating the complexities of social benefits and justice linked to ES. Moreover, addressing these complexities requires a more comprehensive and inclusive approach, potentially necessitating collaboration across various disciplines and sectors that could be a challenge for some of the projects.

Finally, while the checklist is a step towards understanding and assessing the social implications of ES, it is limited in its ability to comprehensively capture the multidimensional aspects of social benefit and justice evaluation that tend to be highly context-specific, highlighting the need for a more collaborative and holistic approach in its development and implementation.

# **S6. Health benefit compatibility of ES assessments**

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| --- | --- | --- | --- | --- | --- |
|  | **Checklist**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Have the **views of local stakeholders** been incorporated into assessment design? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **2** | Have the **views** of local stakeholders been incorporated into **classifications of health-relevant ES**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **3** | Does the study design allow for **participatory approaches** to ensure that the assessment is appropriately informed and guided by local community knowledge, perspectives, needs and values? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **4** | Have distinct **pathways** between ecosystem structure / function / ecosystem services been explored or identified for those health aspects? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **5** | Does the study include an assessment of the **stocks and flows** of health relevant ES? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **6** | Does the study include an assessment of the **stocks and flows** of health relevant ES? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **7** | Has a mechanism been established to ensure that local stakeholders can **respond to the results** and recommendations from the study? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
|  | ADDITIONAL EXPERT-BASED TOPICS  |  |  |  |  |
| **8** | Have the **views of local stakeholders** been factored into the identification of health benefits? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **9** | Have key **civil society organisations** concerned with health care / health inequality / community care / specific health challenges been **engaged** in the study? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **10** | Does the study identify the most **vulnerable or marginalised groups** within the study area, and have their specific health needs, perspectives and values been explicitly identified and accounted for? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **11** | Has a **long-term role** been identified for local stakeholders, including vulnerable and marginalised groups, in **monitoring and managing** the results of policy implementation? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **12** | Does the study address both **immediate** cross-community / multi-stakeholder rights, **needs** and values (equity) as well as **longer term solutions** to securing equitable access (justice)? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **13** | Does the study identify specific health issues / outcomes relevant to the **geographic area** / **population / community** being studied? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **14** | Has the study been guided by the **principles of One Health**? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **15** | Have specific **winners and losers** in terms of health-relevant ES access and benefit sharing been identified? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **16** | Does the study include an assessment of the **wider social, economic, environmental and cultural context** within which health-relevant ES supply and demand are determined? (consider climate change, water and air quality, demography, social cohesion, social partnerships, etc.) | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **17** | Have the influences of **wider social, environmental, cultural and political issues on health** and health inequalities been accounted for? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **18** | Does the study identify **disparities in access** to / benefits from health-benefit ES and attempt to understand the **drivers** and consequences of such disparities?  | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **19** | Does the study assess the current and / or potential future **distributive impacts** of policies or activities on ecosystem management? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **20** | Does the study account for existing formal and informal **governance mechanisms** relevant to ES in the study area? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **21** | Have the study scenarios / models / inputs / outputs been v**alidated against local knowledge** or perspectives? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **22** | Have **indicators** been developed which are specifically relevant to **health benefits**, as determined by engagement with stakeholders? | **☐** | **☐** | **☐** |  Based on reviewer expertise |
| **23** | Does the study account for **confounding** social, economic, cultural and environmental **factors** which mediate the relationships between ES and health outcomes? | **☐** | **☐** | **☐** | Based on reviewer expertise |
| **24** | Has a mechanism been established to ensure the results of the assessment and related decision-making are **effectively communicated** to all stakeholders? | **☐** | **☐** | **☐** | Based on reviewer expertise |

**Approach to checklist compilation**

The checklist aims to help to address some of the major gaps identified in the guidance documents during the review; however, it is likely that those gaps reflect gaps in knowledge and expertise (on linkages between ecosystem services and health, and / or on how to assess those connections) in development of those guidance documents, and the **difficulty in synthesising fairly complex cross-cutting issues** for which much more research may be required. For example, assessing relationships between biodiversity, ES and infectious disease risk frequently **requires inputs from** eco-epidemiology and various social sciences, and often hinges on perspectives from a **diversity of disciplines or sectors** which may include agriculture, forestry, urban planning, tourism, hydrology, etc. In some cases (particularly relating to mental and physical well-being benefits from recreation) various methodologies have been tried and tested, however where these were incorporated into guidance there was (with only one exception) a lack of guidance on dealing with **confounding factors** and establishing appropriate cross-cutting and benefit-relevant indicators. There was also no guidance on understanding how **social, economic and environmental determinants of health interact,** or how these relate to issues of health inequality and justice.

**Expected limitations and possible improvement**

In order to limit the checklist to simple yes / no questions, we necessarily assume that the end users will already have the supporting knowledge and resources to identify and unpack the pathways between ES and health, carry out **appropriate stakeholder mapping**, and use that information to build the appropriate trans-disciplinary and cross-sector approaches.

Following from the above, we would expect that real world cases may **struggle to identify** the full complement of **health issues** relevant to their projects or project areas, and to explore ES and health linkages in great detail, except perhaps where there is a focus on health promotion through recreation. Improvements would come from a more detailed unpacking of ES-health pathways and paradigms and more detailed guidance on identifying appropriate stakeholders and experts for specific health issues, and further guidance on identifying and addressing related dimensions of justice.

See further narrative on compilation approach here: <https://docs.google.com/document/d/15dQQIbSi2GMK0sj_np2bdnrYbr3IzvOb/edit>

# **S7. Uncertainty assessment**

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Checklist**  | **Y** | **N** | **NR** | **Comments** |
| **1** | Does the study **validate** the ES model? (e.g. model intercomparison, external observations, sensitivity analysis) | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **2** | Does the study use **multiple models** leading to a range of outcomes? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **3** | Does the study perform **model ensembles**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **4** | Does the study **use data** of appropriate **accuracy** (temporal, spatial resolution)?  | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **5** | Does the study use **scenarios**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **6** | Does the study **monitor risks**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **7** | Does the study include contingency measures to offset risks of high uncertainty in model outcomes, e.g. risk multipliers. | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **8** | Does the study use the **precautionary principle**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **9** | Does the study communicate uncertainty in the assessment results through **levels of uncertainty**? *(e.g. Action A is 80% likely to have a certain impact.)*  | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **10** | Does the study communicate uncertainty in the assessment results by **expressing variation** in the results? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **11** | Does the study explicitly state the **simplifying** (model) **assumptions** and underlying uncertainties? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **12** | Does the study collect information during policy implementation? (allowing for **iterative** improvements of the model) | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |
| **13** | Does the study take uncertainty into account by using **adaptive planning**? | **☐** | **☐** | **☐** | Sourced from reviewed guidance documents |

# **S8 Full list of publications reviewed on ES assessment guidance**

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