APPENDIX #3: Methodology for review of integrated modelling studies

Appendix 3 outlines the steps of the formal review of integrated modelling studies for Europe and Central Asia. The formal review was conducted using the Scopus database (https://www.scopus.com) and focused on studies published in peer-reviewed research journals before May 2017. The formal review was supported by an informal review of peer-reviewed and grey literature using the knowledge of the author team and the suggestions of external reviewers during the IPBES review process.

Step 1: The initial search applied combinations of keywords as listed in Table A3.1. We used the boolean operator 'AND' to combine the different queries. The search was repeated changing the query by the names of the regions and countries considered in the Europe and Central Asia Regional assessment (see Appendix #1).

Step 2: In addition, several targeted searches were conducted to identify further integrated modelling studies to fill the data gaps which became obvious after the initial search. The targeted searches particularly focused on Central Asia and marine ecosystems, but also examined studies cited in the bibliographies of studies identified in Step 1.

Step 3: The studies obtained by the systematic and targeted searches were limited according to the following criteria:

- Included projections of future impacts considering uncertainty (i.e. considering two or more future scenarios);
- Included multiple drivers of change;
- Evaluated multiple components of biodiversity and ecosystem services (i.e. assessed multiple indicators);
- Included quantified trends in impacts (qualitative or semi-quantitative impact narratives excluded).

Step 4: Only 37 articles were found from both the formal and informal reviews that met the review criteria. From each article we extracted the information detailed in Table A3.2. This led to a total of 3,151 entries in the review database representing different combinations of integrated approaches, scenarios, regions and modelled system indicators for biodiversity, ecosystem services and human well-being.

Table A3.1: Search terms used for the literature review.

Query	Field	Keywords	Motivation
1	Topic	(Scenario* OR model* OR Impact* OR Future*)	Captures modelling studies addressing predictions into the future
2	Topic	(biodiversity OR 'ecosystem service*' OR 'human wellbeing' OR 'human well-being')	Identifies studies evaluating indicators of biodiversity, ecosystem services or human well-being
3	Topic	(system* OR holistic* OR integrat* OR interaction* OR cross-scale OR cross-sector* OR trade-offs* OR treshold* OR tipping point* OR driver*)	Captures multi-driver, multi-scale studies evaluating multiple indicators
4	Topic	(Europe OR Asia)	Sets the geographic context: Europe and Central Asia (see Appendix #1 for country names)

Table A3.2: Information extracted from the selected articles. The right-hand column lists in detail the different categories into which we classified each study within each information field.

Database field	Details
Modelling approach (from Kelly et al. 2013)	*System dynamics models* are particularly good for modelling feedbacks, delays and non-linear effects, and are more commonly found in climate change-related impact assessments. *Bayesian network models* fit probabilistic relationships between system variables, and are therefore often found in modelling assessments where uncertainty needs to be properly quantified, such as for supporting decision-making and management. *Coupled component models* combine models from different disciplines or sectors to derive an integrated outcome. They can incorporate or handle complex representation of system components and their interlinkages *Agent-based models* define interactions between autonomous entities in a system, often humans (individuals or groups), but also other species or biophysical entities (e.g. water). Some entities (usually humans) are agents that share the same resources, can communicate or compete and react to changes in their environment through individual and social learning. *Knowledge-based approaches* encode knowledge elicited from experts using a logic system to infer conclusions. They can be used to encapsulate a wide range of complex feedbacks which are difficult to incorporate explicitly in quantitative methods, but care should be taken in using such approaches where knowledge about the system is uncertain or incomplete. Such approaches are often associated with a larger representation of impact indicators including nature, its contributions to people, and a good quality of life (or a combination of all three), which is possible due to the simplified way in which system relationships are represented.
Scenario archetype	Business-as-usual Economic optimism Regional competition Regional sustainability Global sustainable development Inequality
Country	Country name and corresponding Europe and Central Asia subregion (see Appendix #1)

Database field	Details
Scale/s	Global/EU/Central Asia Regional (e.g. Mediterranean basin) National (e.g. France) Sub-national (e.g. Provence-Alpes-Côte d'Azur in France) Local (e.g. National Park)
Direct Drivers	Climate change Land use change Pollution Change in resource use Change in market value of the ecosystem service Invasive species
Indirect drivers	Indirect drivers explicitly stated in the scenario description
Feedbacks among drivers	Was any feedback among drivers explicitly indicated in the scenario description; how was the feedback included
Economic sectors	Agriculture Forestry Water management Fisheries and aquaculture Tourism Conservation All
Nature (biodiversity) indicator	Biophysical assemblages Biophysical process Biodiversity Maintenance of options Habitat creation and maintenance
Nature's contributions to people (ecosystem services) indicators (NCP)	Classified in one of the following categories: *Regulating NCP:* Pollination and dispersal of seeds and other propagles Regulation of air quality Regulation of climate Regulation of freshwater quantity, flow and timing Regulation of freshwater and coastal water quality Formation, protection and decontamination of soils and sediments Regulation of hazards and extreme events Regulation of organisms detrimental to humans

Database field	Details
	Material NCP: Energy Food and feed Materials Timber and forest products Water provisioning *Non-Material NCP:* Learning and inspiration Physical and psychological experiences Supporting identities
Good quality of life (human well-being) indicators	Education and knowledge Governance and justice (equity) Free choice Good social relations Health and wellbeing Security and livelihoods
Indicator trend	Increase (change > +5% during the period assessed) Stable (change ± 5 %) Decrease (change > -5%)
Synergies and trade-offs	Were synergies and/or tradeoffs among indicators explicitly assessed and discussed in the article