

Make nature count; a typology of approaches to economic modelling of natural capital & ecosystem services and an explorative application of the Gross Ecosystem Product (GEP).

Subtitle: *It's the economy (and ecosystems), stupid*

Willem-Jan van Zeist, Wageningen Social & Economic Research

Heleen Bartelings, Adam N. Walker, Hans van Meijl, Marijke Kuiper

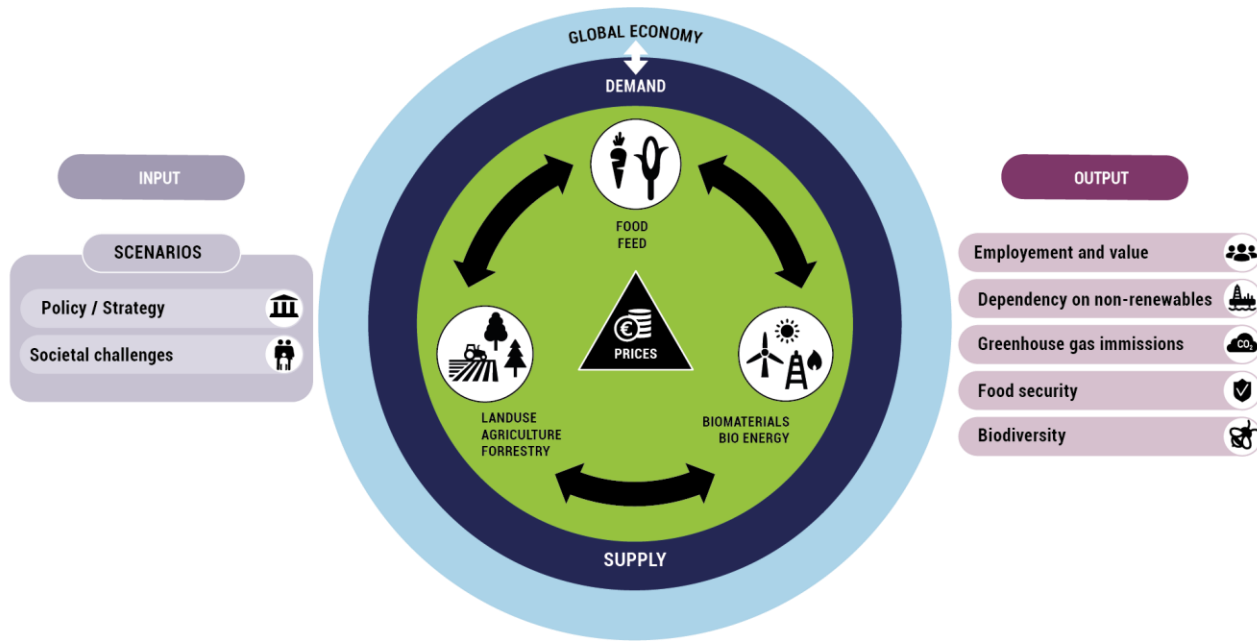
GTAP Conference 2025



Contents – Making MAGNET Nature-aware

- MAGNET
- 1. “Exploring pathways for world development within planetary boundaries”. Detlef P. van Vuuren et al. Nature volume 641, 910–916 (2025).
- 2. “A typology of approaches to economic modelling of natural capital and ecosystem services to support policy design” Marijke Kuiper et al.
- 3. “Make nature count: an explorative application of Gross Ecosystem Product and the Ecosystem Stress Index for nature inclusive policymaking”. Willem-Jan van Zeist, Heleen Bartelings, Adam N. Walker

MAGNET: a global CGE model with bioeconomy focus



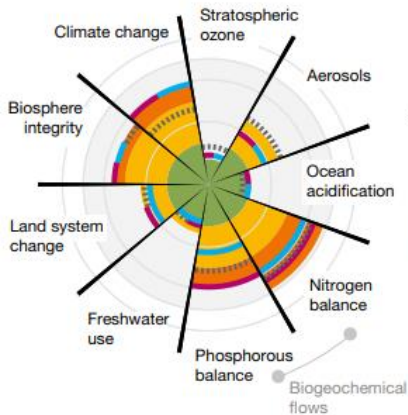
MAGNET aims at global to national cross cutting and economywide policy assessments.

Based on the GTAP - shared international starting point for global CGE models.

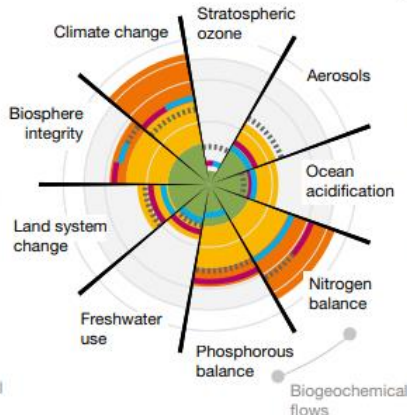
Adds details on land supply, agriculture, bioeconomy, circularity and welfare assessments.

MAGNET applied: Economy impacting Nature

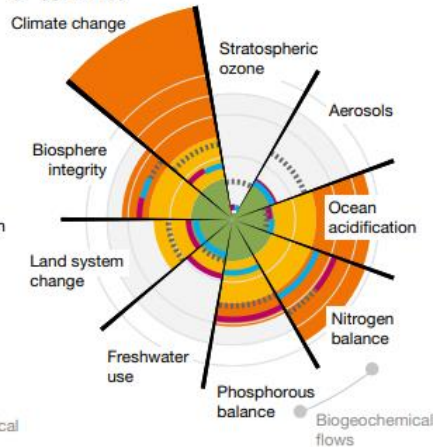
a SSP2: 2030



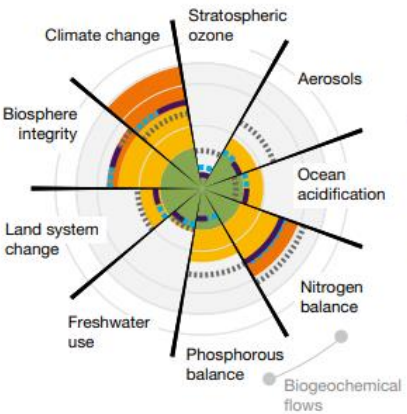
b SSP2: 2050



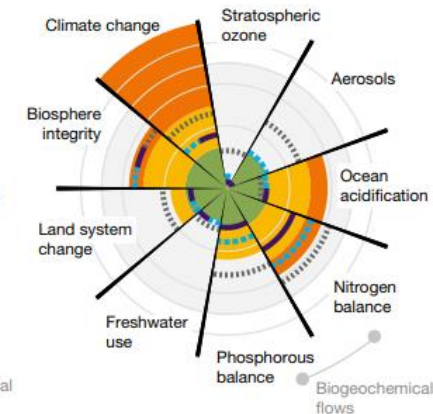
c SSP2: 2100



d SSP1: 2050



e SSP1: 2100



Main scenario:
(Top row: SSP2, bottom row: SSP1)

Below boundary (safe)
In zone of uncertainty (increasing risk)
Beyond zone of uncertainty (high risk)

Comparison:
Climate mitigation (SSP2)
Sustainability (SSP2)
Sustainability (SSP1)

..... 2015

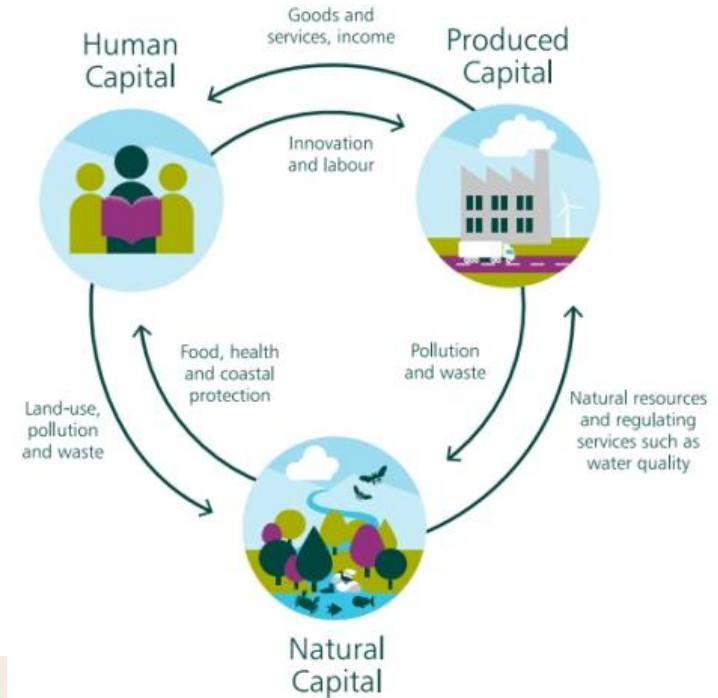
MAGNET serves as input for the agricultural economy in the IMAGE integrated assessment model with detailed biophysical & gridded representation.

Various scenarios explored to stay within planetary boundaries.

Alas, for many planetary boundaries feedback onto the economic system is missing.

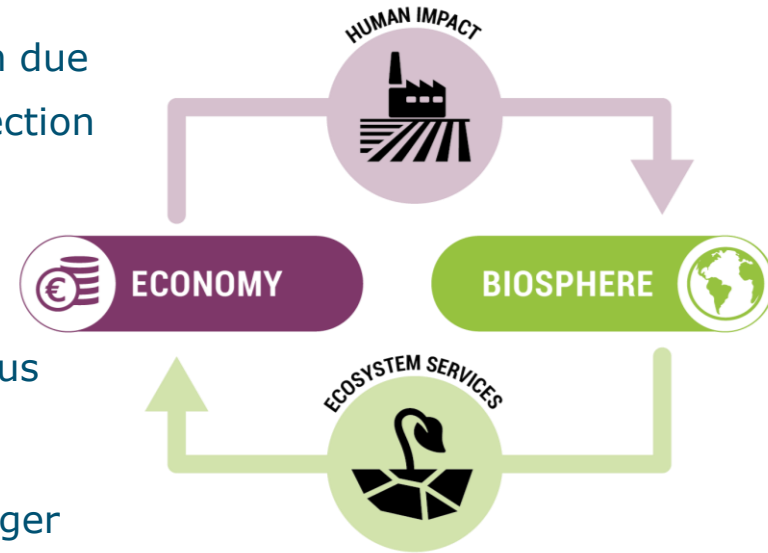
The Challenge

- For a holistic approach and to integrate nature into policy support analyses we need to include natural capital and ecosystem services into our economic models.
- Our work in progress (WIP) and thoughts in progress (TIP) firstly inspired from the Dasgupta review.
- Important first practical GTAP-based implementation in the economic case for nature report.



The Challenge – Ecosystem Services vs Economy

- Every Ecosystem Service requires unique approach due to differences in biophysical appearance and connection to economic actors.
- Key challenges are:
 - Ecosystems are spatially more heterogeneous than economic models.
 - Environmental changes happened on a longer time horizon and economic agents are myopic.
 - Substitutability between ES and regular commodities/endowments difficult to quantify.



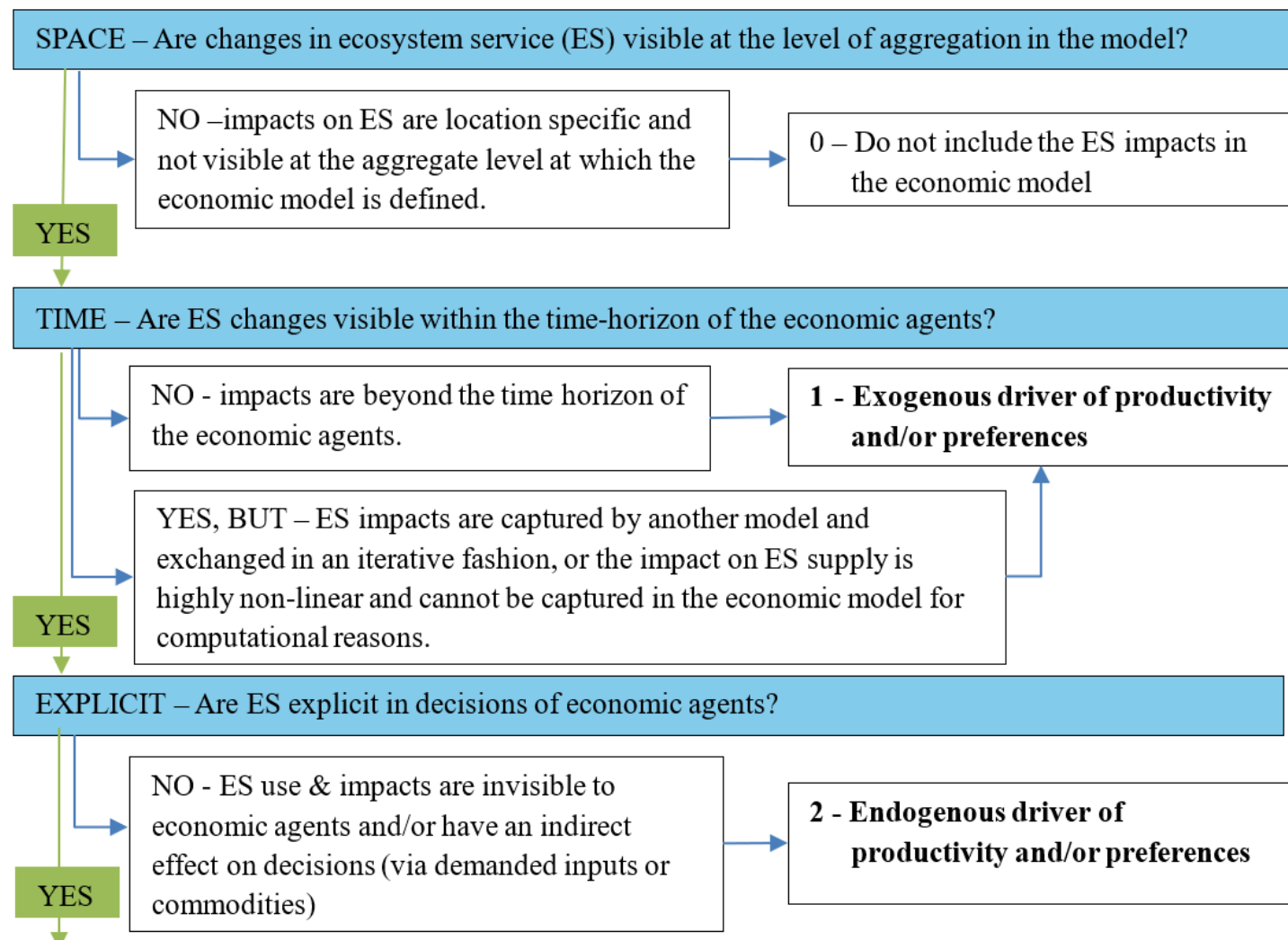
The Solution?

A systematic approach to determine how to include Ecosystem Services into CGE or PE models.

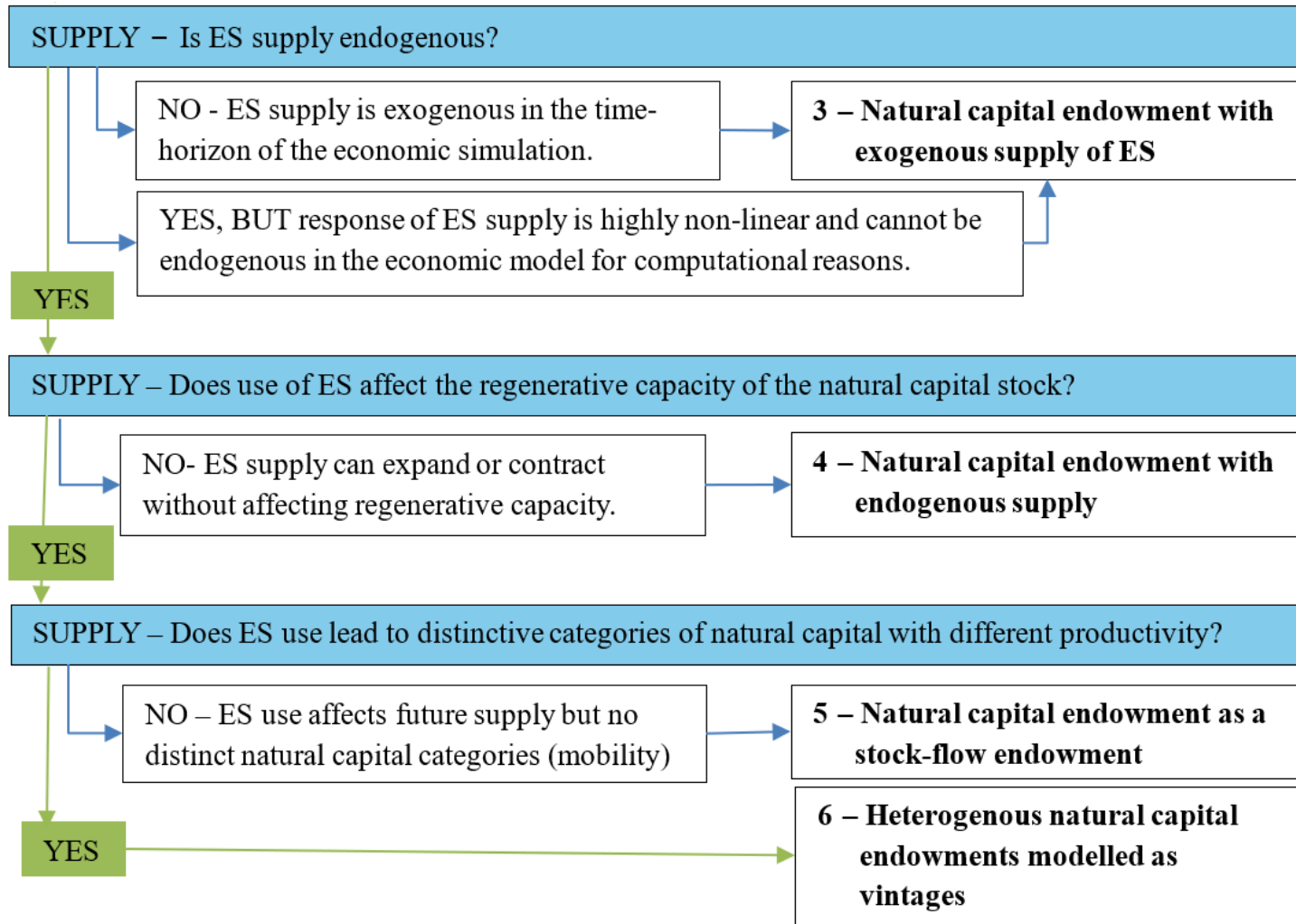
Feedback is welcome, keep your favorite Ecosystem Service in mind when going through our decision tree starting on the next slide!

Typically, three main categories are recognized.

- Cultural services: non-material benefits provided by nature (e.g. recreation, tourism)
- Regulating & maintenance services (e.g. flood control, pollination, coastal protection)
- Provisioning services: provision of material and energy (e.g. wood, crop provisioning)



Decision time!



Summarizing: 6 types of approaches

Type 1: Exogenous Driver of Productivity or Preferences

A popular example is pollination affecting output productivity or reduction of land productivity from soil degradation.

Type 2: Endogenous Driver of Productivity or Preferences

For example, endogenous climate damage function affecting e.g. productivity or tourism preference.

Type 3: Natural Capital Endowment with Exogenous Supply of ES

For example, exogenous land supply or fish stocks.

Type 4: Natural Capital Endowment with Endogenous Supply of ES

Fore example the endogenous land supply, a MAGNET favorite.

Type 5: Natural Capital Endowment as a Stock-Flow Endowment:

Wild fish stocks fish caught depends on existing stock, regenerative growth rate and harvested amount

Type 6: Heterogeneous Natural Capital Modeled as Vintages: Forestry through separate sectors for planting, investing and harvesting.

Next steps

- Mapping existing approaches, potential examples and sanity checking.
- Explore applications in existing projects for Dutch ministry of agriculture as well as projects with financial institutes on the economic impact of ecosystem service loss (e.g. BiROFin: birofin.org).
- Inspired by the framework, we are currently working on improving our climate damage function in MAGNET, improving the endogenous response of the carbon sequestration ES.
- Explore possibilities of connecting MAGNET within simulation periods through downscaling to spatial ES models and incorporate feedback mechanisms.
- Establishing link with ecosystem service *valuations* (i.e. GEP) data.

Gross Ecosystem Product (GEP)

- The GEP indicator summarizes the value ecosystem services provide to the economy in a single monetary metric. Can be used alongside GDP indicator but The GEP as separate indicator avoids worry about overlapping definitions.
- GEP module development in MAGNET based on earlier work with JRC and the Dutch ministry of agriculture.



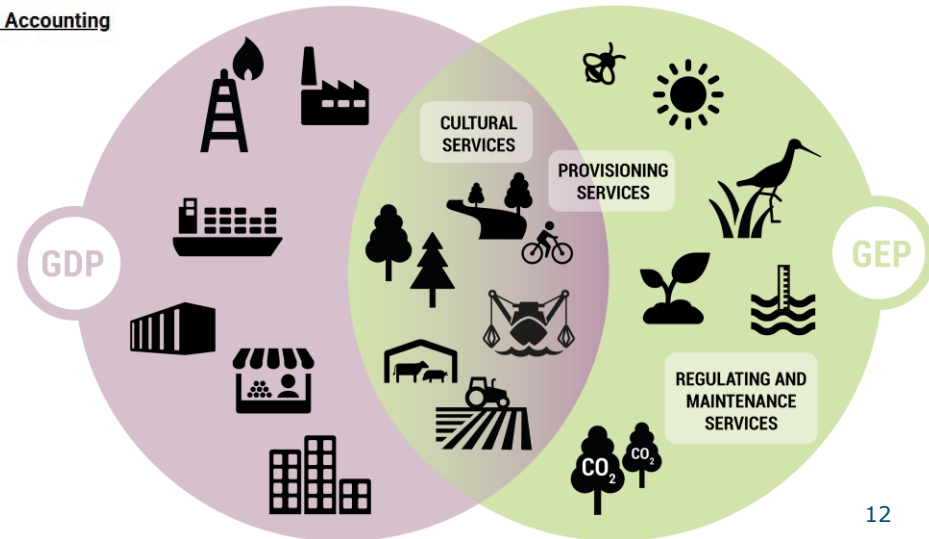
Gross Ecosystem Product in macroeconomic modelling

Rokicki, B., M'barek, R., Grammatikopoulou, I., La Notte, A., Van Alphen, M., Van Zeist, W., Bartelings, H., Polman, N.



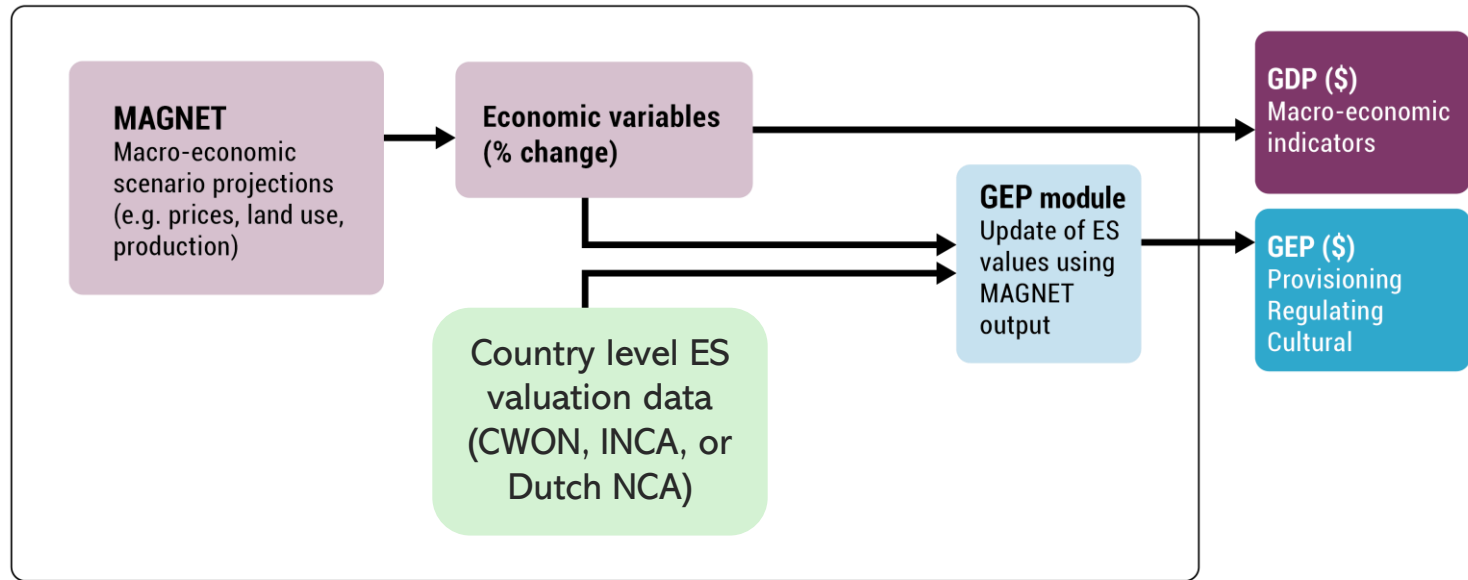
SEEA Ecosystem Accounting
(SEEA EA)

Integrated
system for
Natural
Capital
Accounting



GEP module in MAGNET – Updating ES values

- Uses a basic approach of taking an existing ecosystem service valuation database and update using appropriate MAGNET output variable.



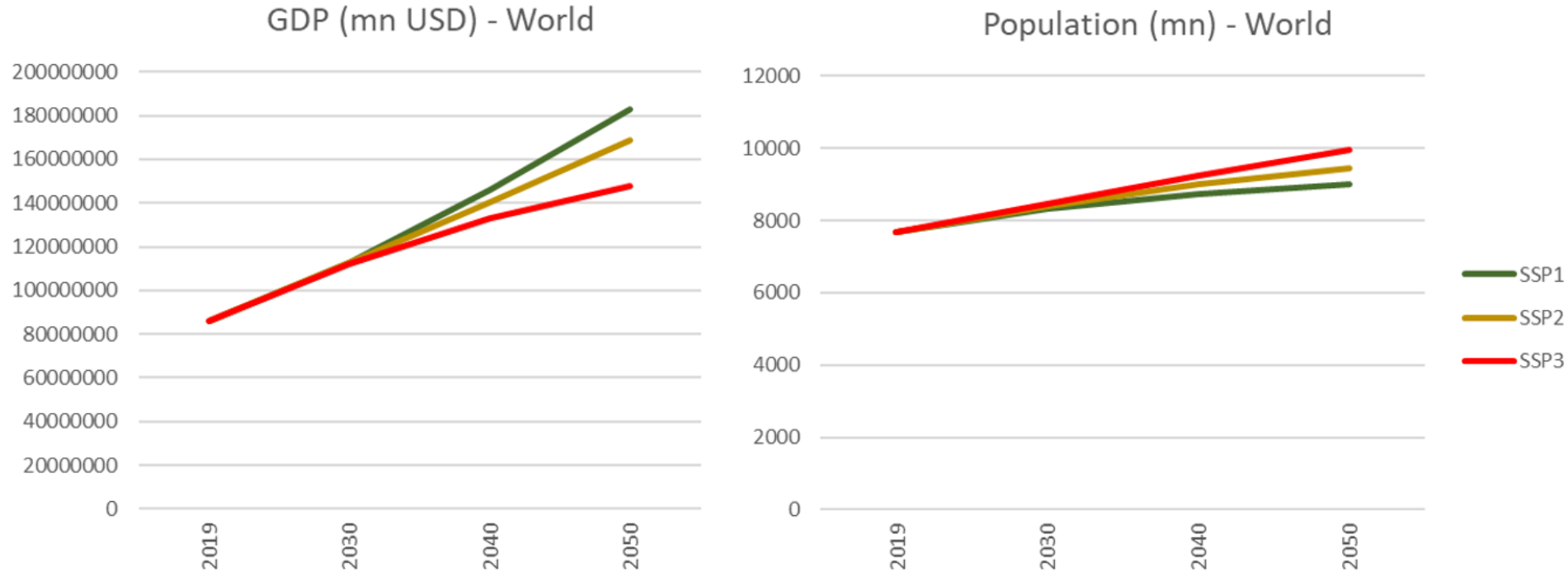
CWON 2024 country data and update methods

ES	Supply side update	Demand side update
Wood provision	Manage forest land supply	Non-economic contribution to production
Recreation	Forest land cover changes	Growth of the recreational sector
Flood control/water retention	Forest land cover changes	GDP changes (as proxy for assets at risk)

Additional derived indicator:

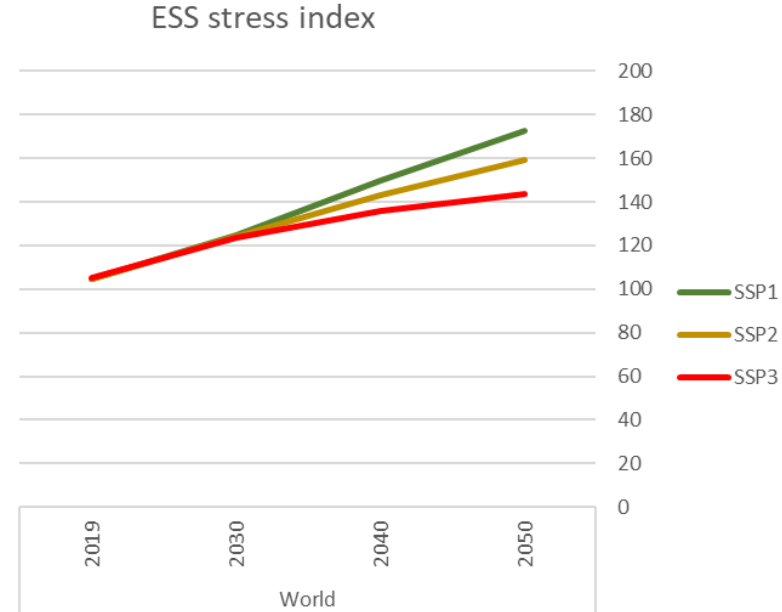
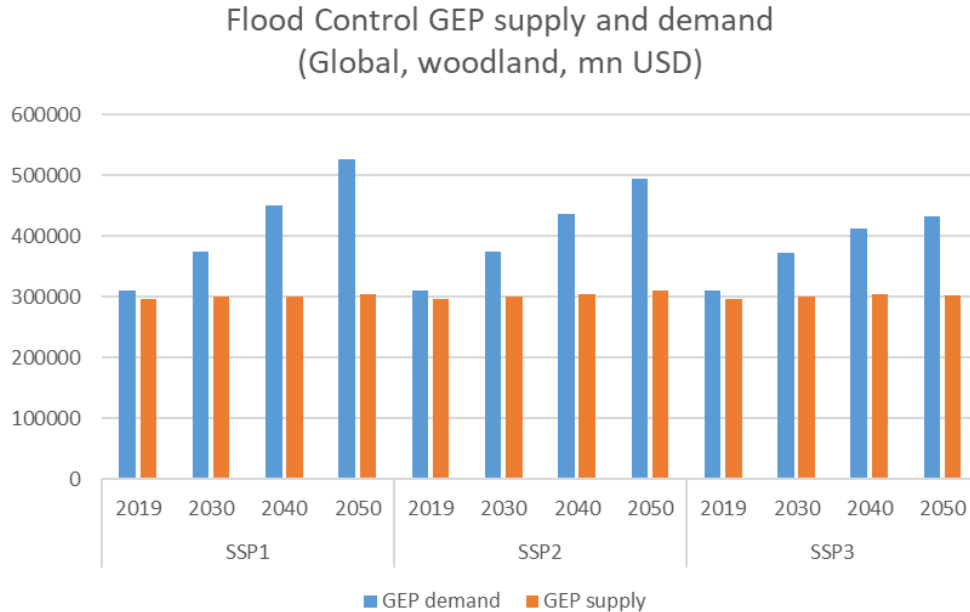
$$ESS \text{ stress index} = 100 * ESS \text{ Demand} / ESS \text{ Supply}$$

Applied in typical SSP scenario setup in MAGNET



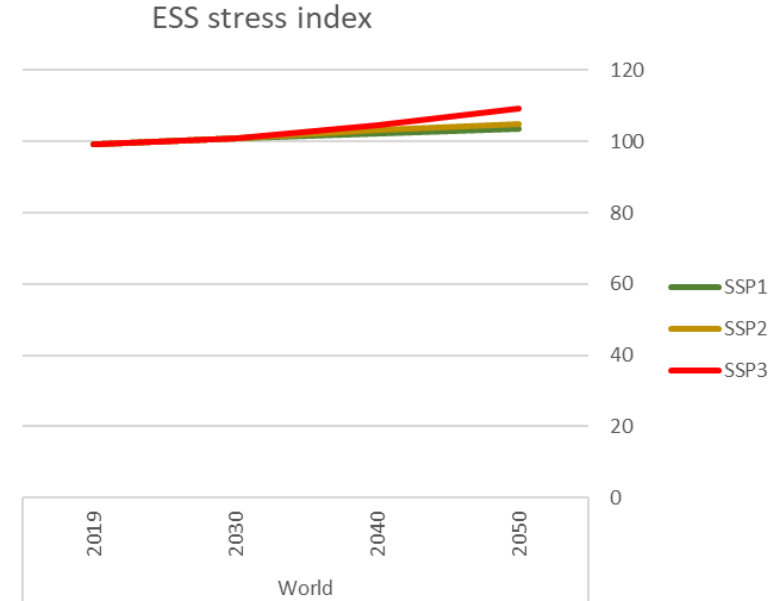
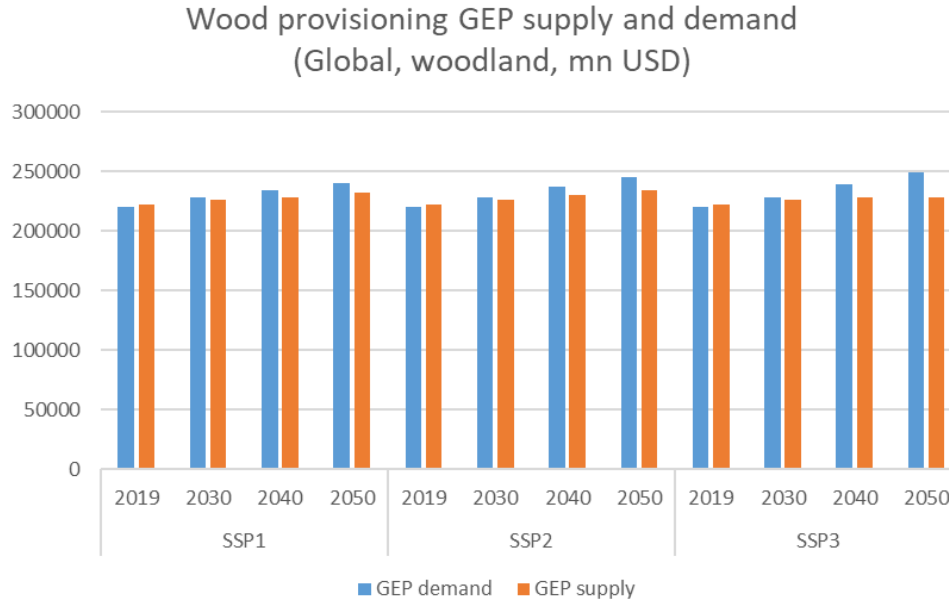
MAGNET model setup with 28 regions, 90 activities and 104 commodities. SSPv3.0 GDP and population projections.

Preliminary results: Flood control



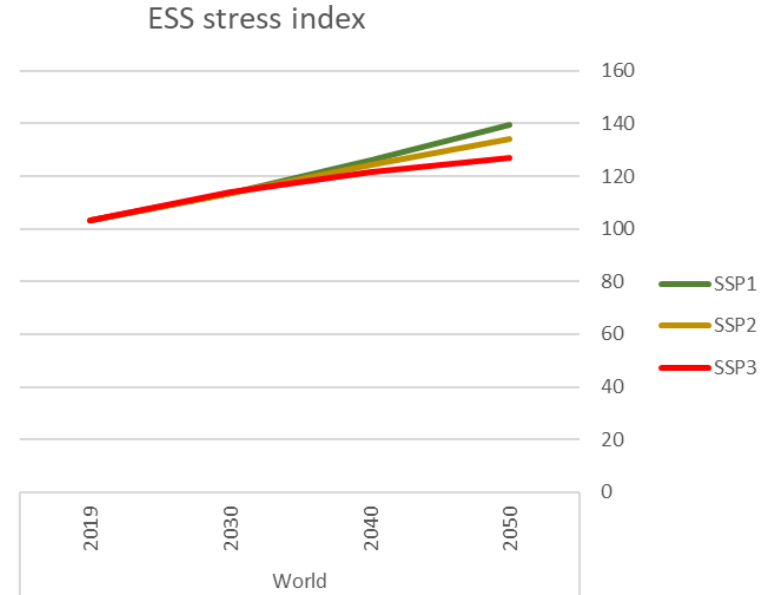
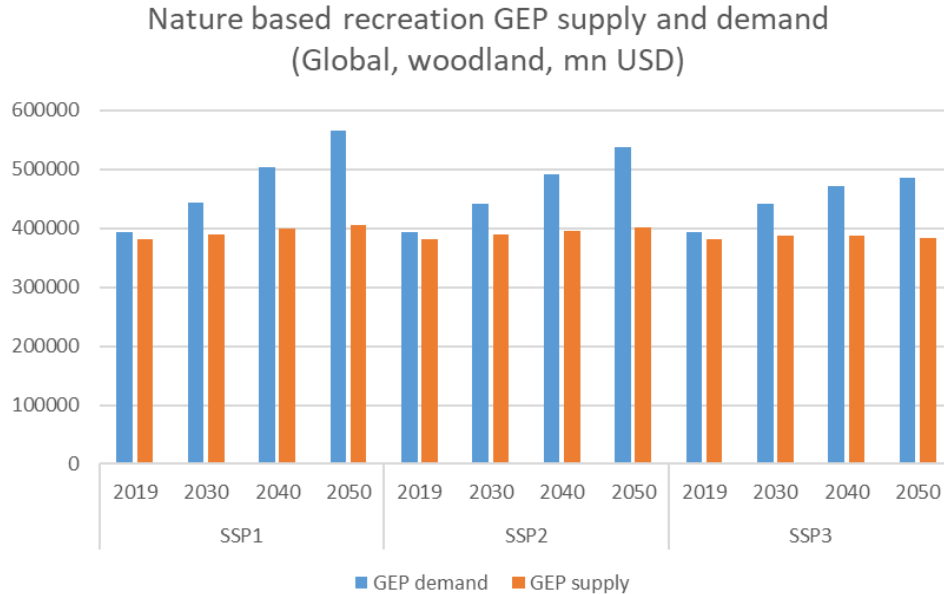
Higher GDP in SSP1 leads to higher demand for flood control.
Supply is stable as total forest area not hugely affected.

Preliminary results: Wood provisioning



Higher demand through more intensification, forestry land supply relatively low in SSP3.

Preliminary results: Nature based recreation



High demand for tourism outpaces increasing forest land cover in SSP1.

Conclusion

A useful new indicator for MAGNET!

Next steps:

- ❖ Refinement of update methods – including supply vs demand and ES prices
- ❖ Connection with the Dutch bureau of statistics and their Natural Capital Accounts for the Netherlands (publication this year)
- ❖ Connect and re-evaluation in context of the typology framework.
- ❖ Include data from rest of the world in the GEP module through ESVD database and value transfer functions (WIP & TIP)

Thank you!

Questions? E-mail: willem-jan.vanzeist@wur.nl



Acknowledgements: Funding from Dutch Ministry of Agriculture