IGES Institute for Global Environmental Strategies

S-21 Project
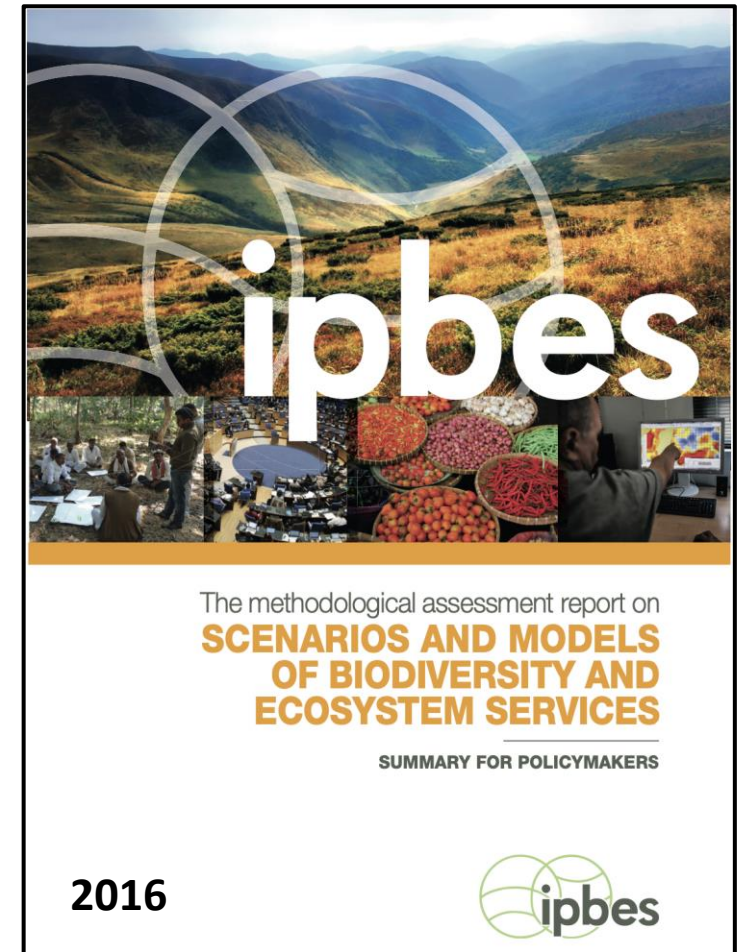**Exploring Nature Positive Futures**

Dealing with uncertainty when mobilizing scenarios for decision making:
Implications for Nature Positive Futures

27 March 2025

Paul Leadley
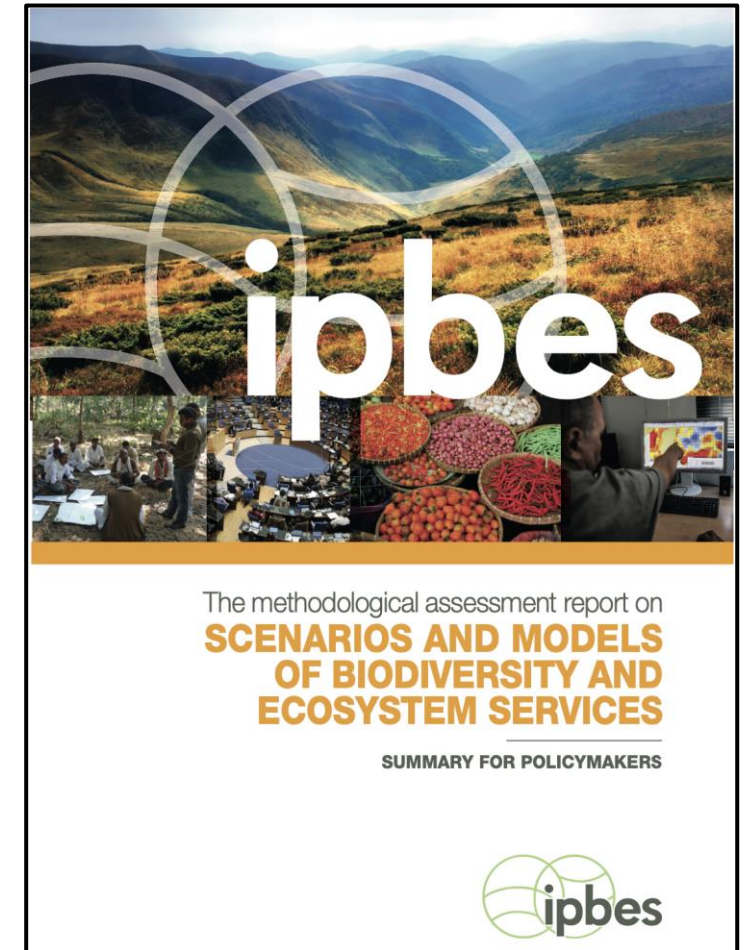Professor, Paris-Saclay University, France

HIGH-LEVEL MESSAGES

1) SCENARIOS AND MODELS CAN CONTRIBUTE SIGNIFICANTLY TO POLICY SUPPORT, EVEN THOUGH SEVERAL BARRIERS HAVE IMPEDED THEIR WIDESPREAD USE TO DATE.

2) MANY RELEVANT METHODS AND TOOLS ARE AVAILABLE, BUT THEY SHOULD BE MATCHED CAREFULLY WITH THE NEEDS OF ANY GIVEN ASSESSMENT OR DECISION-SUPPORT ACTIVITY, AND **APPLIED WITH CARE, TAKING INTO ACCOUNT UNCERTAINTIES AND UNPREDICTABILITY ASSOCIATED WITH MODEL-BASED PROJECTIONS.**

3) APPROPRIATE PLANNING, INVESTMENT AND CAPACITY-BUILDING, AMONG OTHER EFFORTS, COULD OVERCOME SIGNIFICANT REMAINING CHALLENGES IN DEVELOPING AND APPLYING SCENARIOS AND MODELS.

The methodological assessment report on
SCENARIOS AND MODELS OF BIODIVERSITY AND ECOSYSTEM SERVICES

SUMMARY FOR POLICYMAKERS

2016

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Key finding 2.5: All scenarios and models have strengths and weaknesses, and it is therefore vital that their capacities and limitations be carefully evaluated and communicated in assessment and decision processes. **Sources and levels of uncertainty should also be evaluated and communicated.**
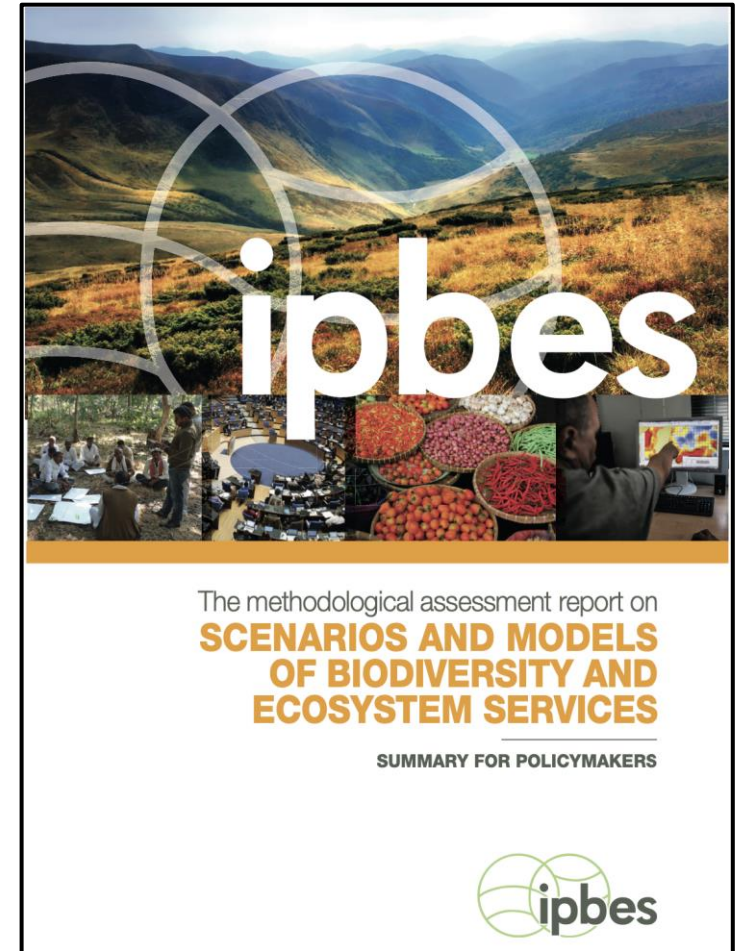
Key finding 3.4: Uncertainty associated with models is often poorly evaluated and reported in published studies, which may lead to serious misconceptions – both overly optimistic and overly pessimistic – regarding the level of confidence with which results can be employed in assessment and decision-making activities.

Guidance point 4: The scientific community may want to consider developing practical and effective approaches to evaluating and communicating levels of uncertainty associated with scenarios and models…

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"A lack of appreciation of the potential role of decision support, scenarios and models on behalf of decision makers is another impediment to uptake. This appears to be partly due to a lack of trust in modellers, models and scenarios..."

"The capacity of models to... characterise uncertainty is a key component of their credibility, indicating an important area of research and development in modelling research."

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Dealing with uncertainty when mobilizing scenarios for decision making: Implications for Nature Positive futures

Outline

- **What are the sources of uncertainty in scenarios, how can they be evaluated, and why is it so important?**

- **Examples of dealing with uncertainty in Nature Positive Scenarios**

- **Accounting for uncertainty in decision making**

What are the sources of uncertainty in scenarios, how can they be evaluated, and why is it so important?

Identifying uncertainties in scenarios and models of socio-ecological systems in support of decision-making

Rounsevell et al. (2021) One Earth
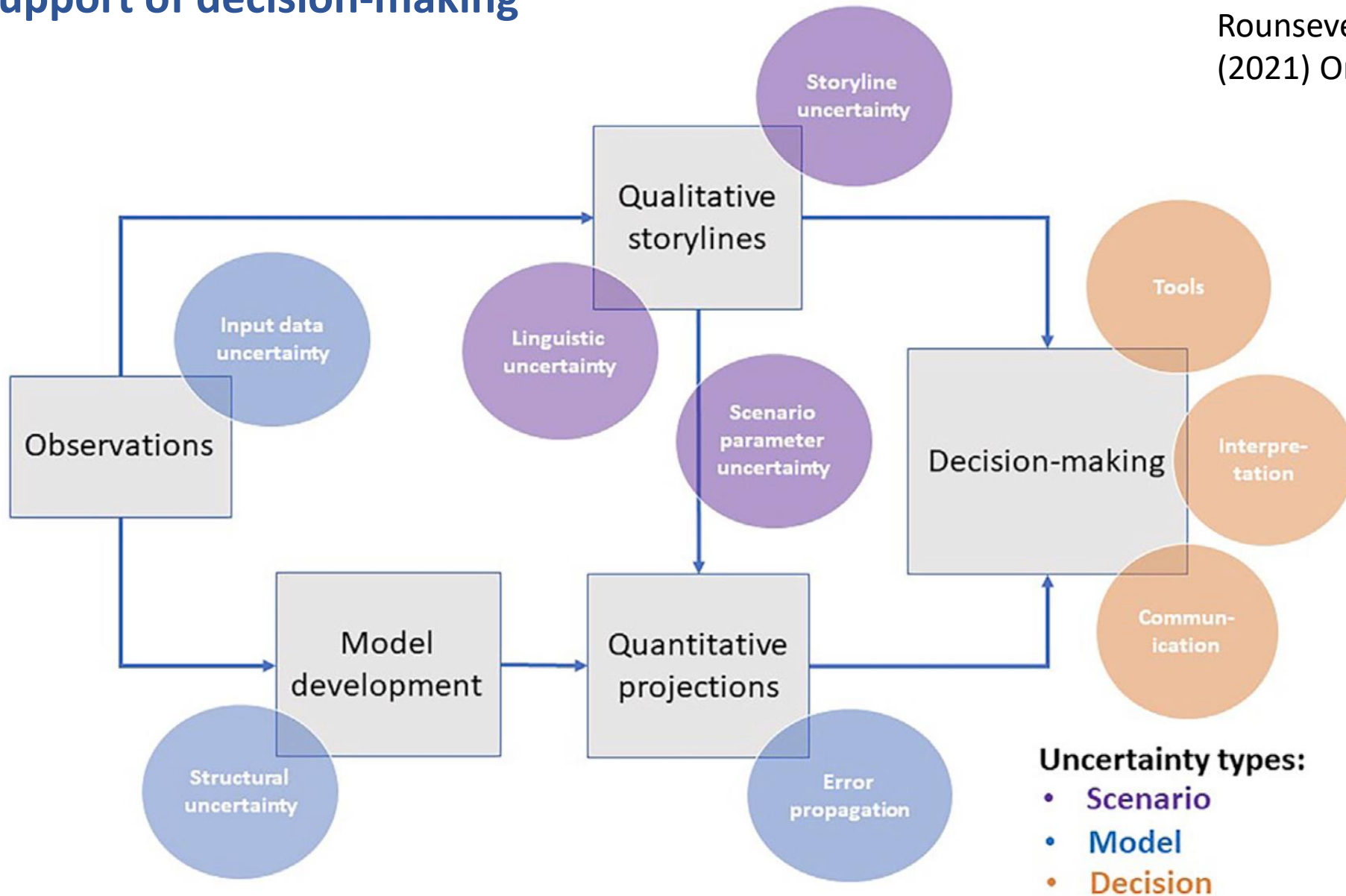
Identifying uncertainties in scenarios and models of socio-ecological systems in support of decision-making

Rounsevell et al. (2021) One Earth

Methods for evaluating uncertainty

- Benchmarking: repeated confrontation of models with a range of observations.

- Sensitivity / uncertainty analysis: testing the sensitivity of model outcomes to uncertainty in parameters and initial conditions.

- Model inter-comparaision / model ensembles: different models that address a similar question are run using a standardized simulation protocol and the same input data.

Climate change impacts on tree ranges: model intercomparison facilitates understanding and quantification of uncertainty

Cheaib et al. (2012) Ecology Letters

Common climate change projections

E.g., Simulated mean August temperatures in

10   35

+

Common maps of current tree species distributions

E.g., current distribution of *Fagus sylvatica* (Common beach)

+

Common maps of soils

+

A wide range of tree models

Niche-based
BIOMOD
NANCY-NBM
STASH

Phenology-based
PHENOFIT

DGVM
Orchidée (PFT)
IBIS (PFT)
LPJ-Guess (Species)

Mechanistic Tree growth
CASTANEA

Climate change risk evaluated for five tree species

Quercus robur

Quercus petraea

Fagus sylvatica

Pinus sylvestris

Quercus ilex

+ Plant functional groups

INSTITUT FRANÇAIS DE LA BIODIVERSITÉ

ANR

Projected climate change impacts on <u>Beech</u> for 2055

Predicted future distribution (2055)

Climate Scenario
- *Relatively high GHG emissions*
- *-200 mm precipitation*
- *+2.8°C*

for France in 2055

☐ Stable unsuitable area
🟩 Stable suitable area
🟥 Loss of suitable area
🟦 Gain of suitable area

Projected climate change impacts on <u>Beech</u> for 2055

Cheaib et al. (2012)
Ecology Letters
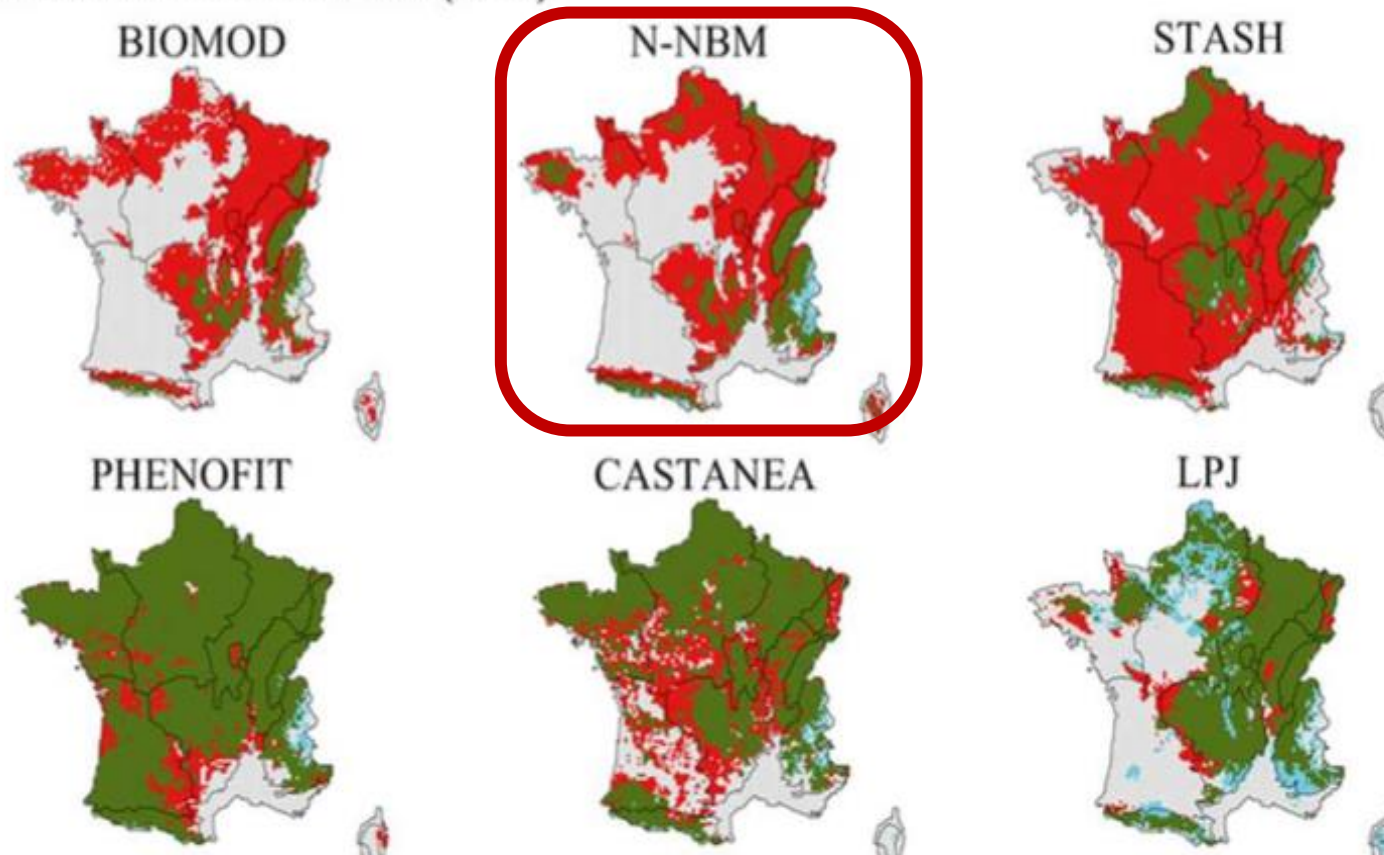
Predicted future distribution (2055)

BIOMOD   N-NBM   STASH

PHENOFIT   CASTANEA   LPJ

Climate Scenario
- *Relatively high GHG emissions*
- *-200 mm precipitation*
- *+2.8°C*

for France in 2055

Legend:
- ☐ Stable unsuitable area
- ☐ Stable suitable area (green)
- ☐ Loss of suitable area (red)
- ☐ Gain of suitable area (blue)

Projected climate change impacts on <u>Scots pine</u> for 2055

Cheaib et al. (2012) Ecology Letters
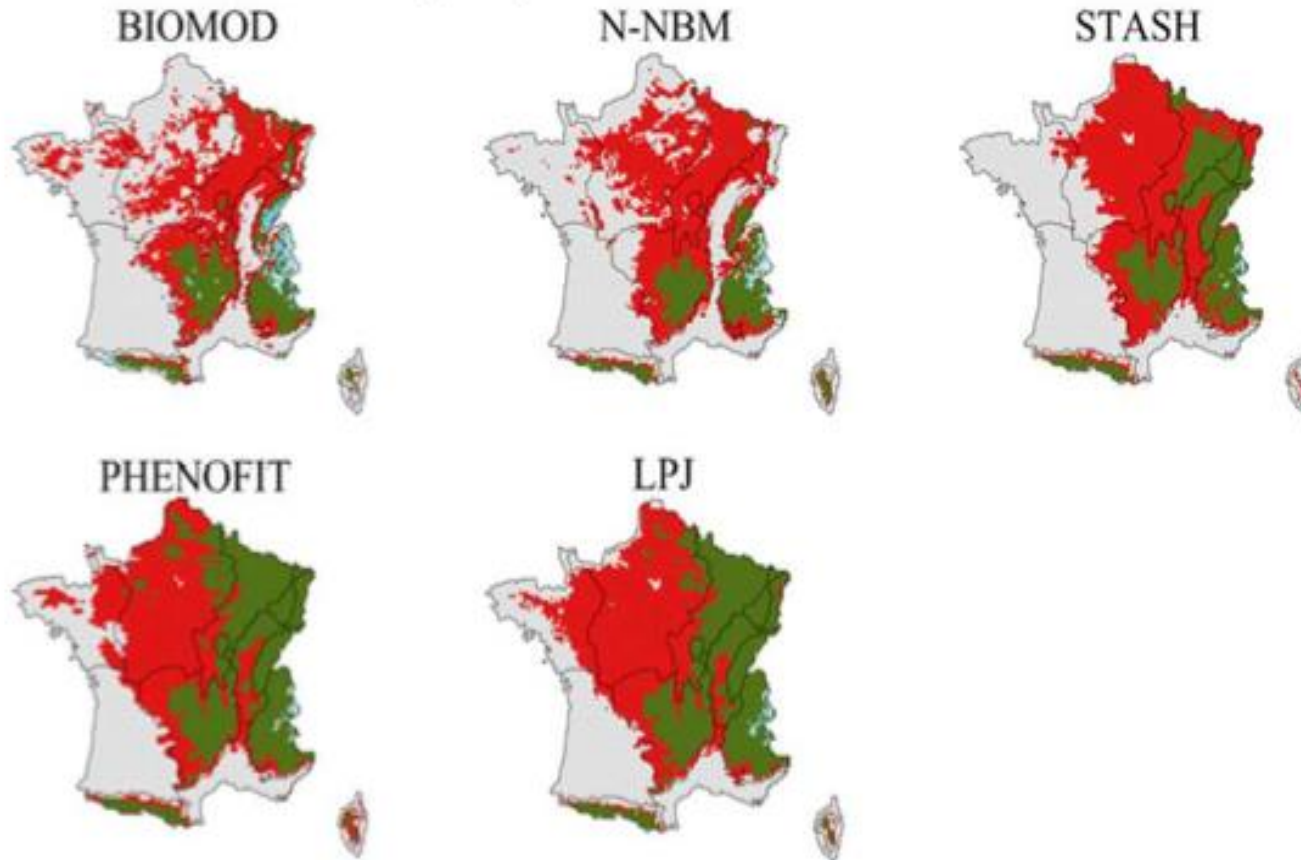
Predicted future distribution (2055)

BIOMOD   N-NBM   STASH

PHENOFIT   LPJ

Climate Scenario
- *Relatively high GHG emissions*
- *-200 mm precipitation*
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for France in 2055

☐ Stable unsuitable area
🟩 Stable suitable area
🟥 Loss of suitable area
🟦 Gain of suitable area

Scots pine mortality in Spain and Switzerland

Observational evidence of an increase in tree mortality for Scots pine in Europe

starting in the early 21st century related to climate change

Allen et al. (2010)

LETTER

Climate warming will reduce growth and survival of Scots pine except in the far north

P. B. Reich[1]* and J. Oleksyn[1,2]
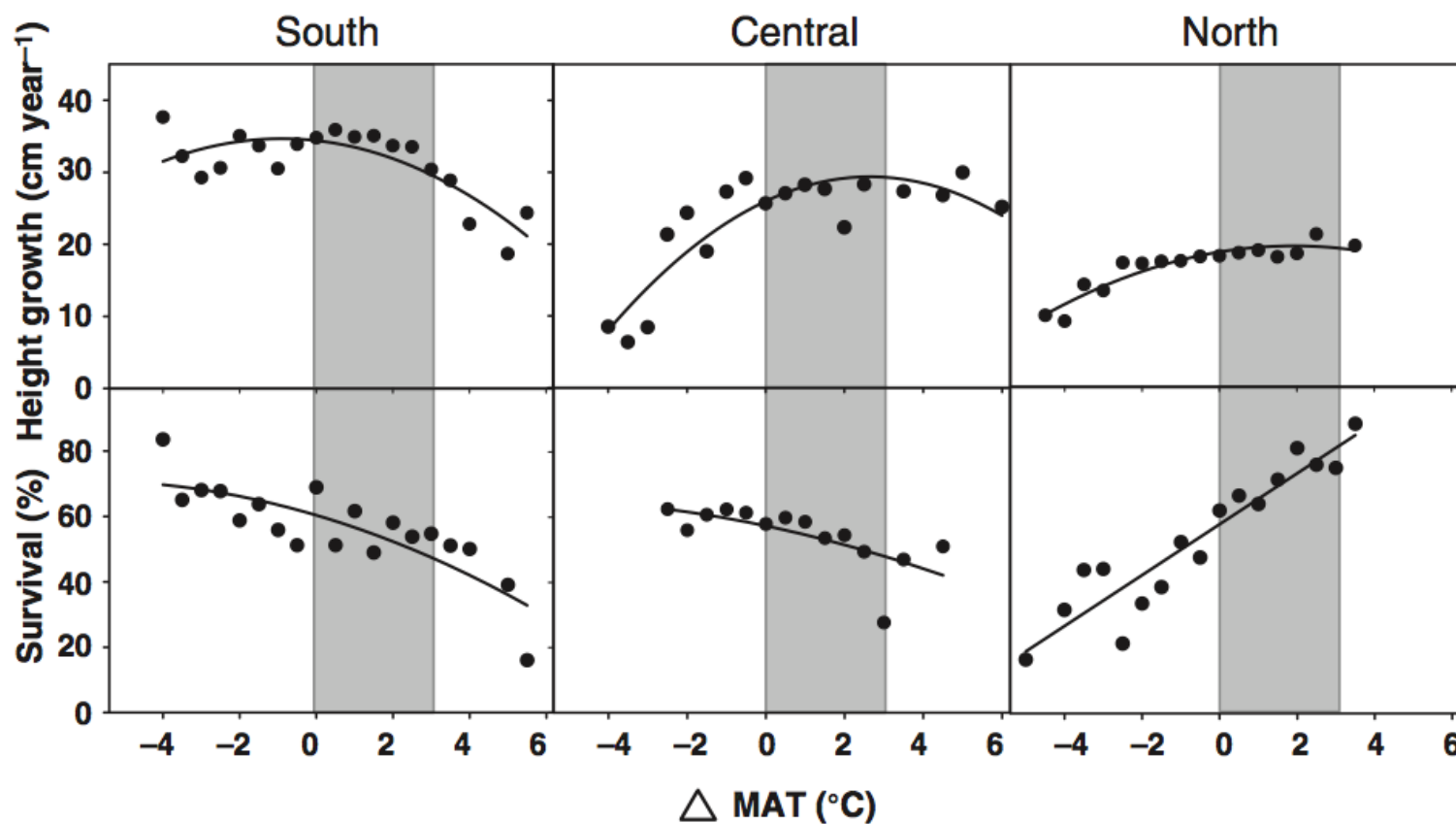
Real-world tree growth experiments in "common gardens" suggest climate warming will reduce growth and survival of Scots pine except in Northern Europe

Examples of dealing with uncertainty in Nature Positive Scenarios

Nature Positive Futures are plausible, but they require transformative change

Global Biodiversity Outlook 5 (CBD Secretariat)
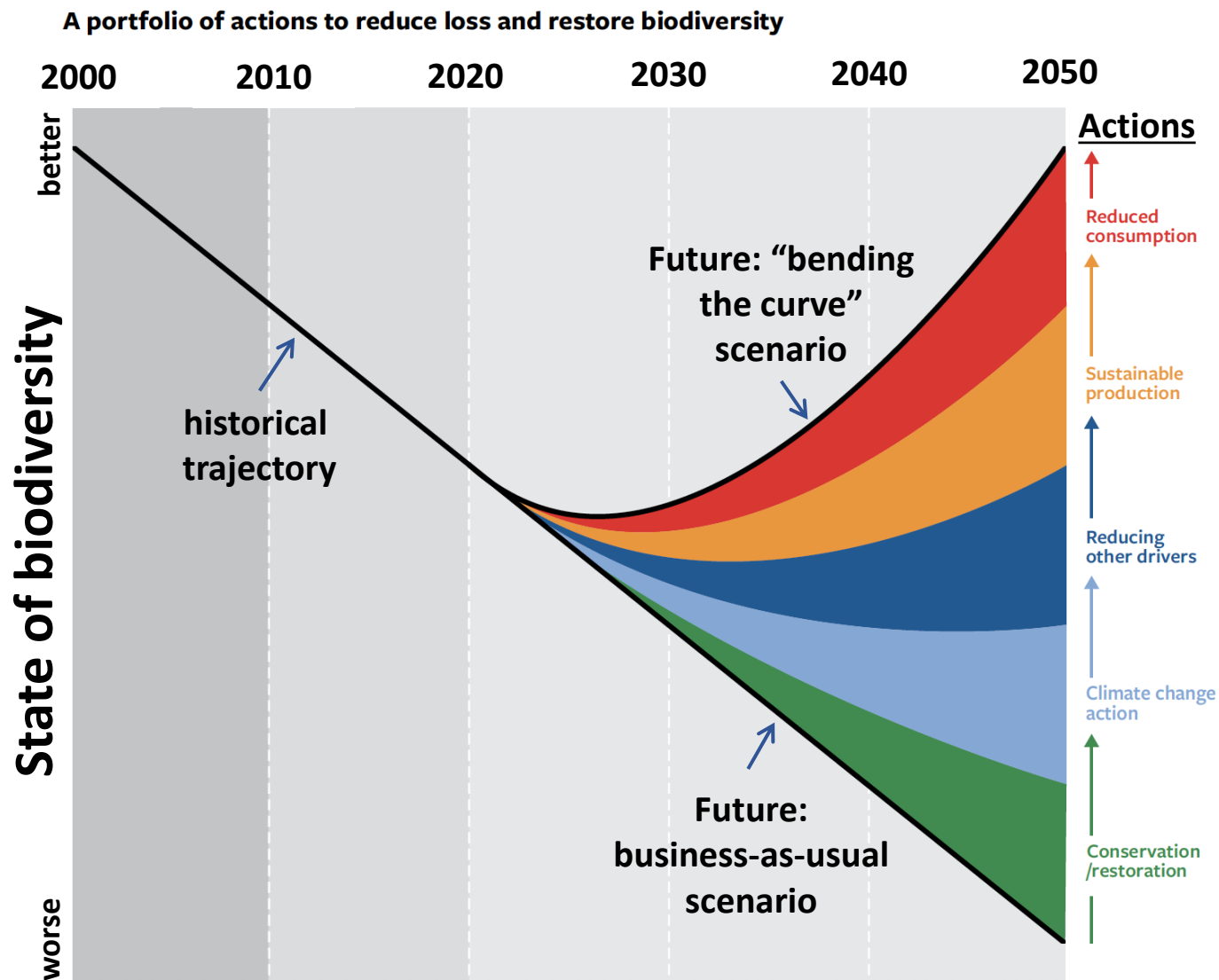
GBO5 - 8 major transitions

The "Bending the Curve Initiative": Exploring Nature Positive Futures

Supply side

Sustainably increased crop yields

Sustainably increased trade of agricultural goods

Increased restoration & landscape-level planning

Reduced waste from farm to fork

conservation

More & better managed conservation areas

Diet shift to higher share of calories from plants (low meat diet)
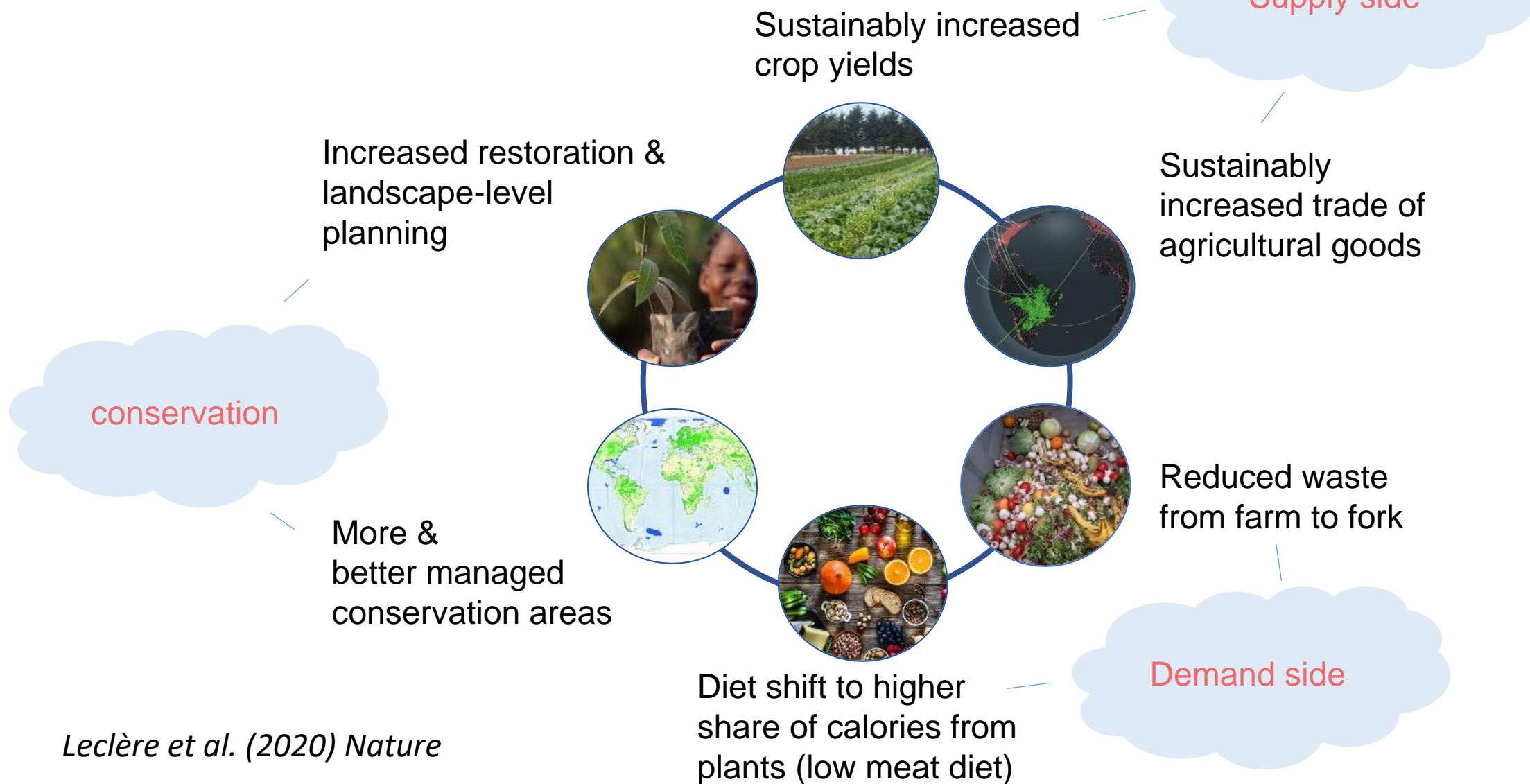
Demand side

Leclère et al. (2020) Nature

Evaluating uncertainty in the "Bending the Curve" initiative

7 Scenarios exploring the action space

Population Diets Yield, etc.

4 Land use models

Land-use change maps

7 Global biodiversity models

Habitat Intactness Population size Regional extinctions Global extinctions
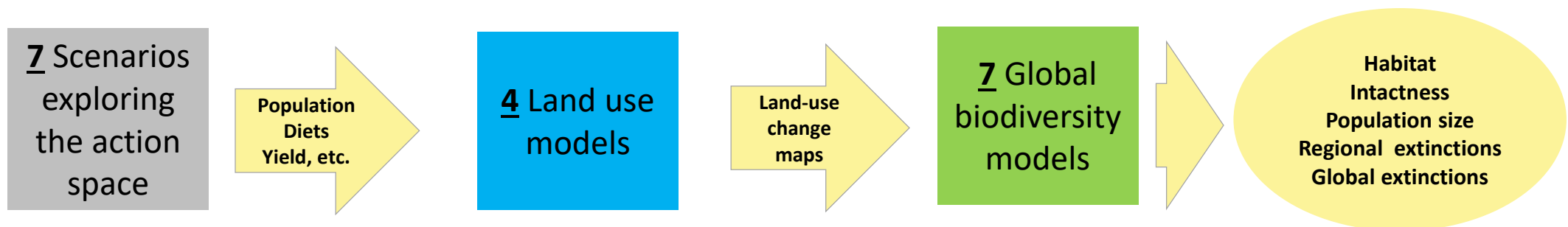
Baseline
= business as usual

+ single or combinations of **conservation, supply side**, and **demand side** actions

including the full set of measures in the **Integrated Action Portfolio**

- AIM/CGE

- MESSAGE-GLOBIOM

- IMAGE/MAGNET

- REMIND-MAgPIE

Leclère et al. (2020) Nature

Biodiversity model	Biodiversity aspect
LPI model	Population trends (birds and mammals)
INSIGHTS model	Habitat size (mammals)
AIM-biodiversity	Habitat size (vascular plants, amphibians, reptiles, birds & mammals)
PREDICTS model	Compositional intactness of ecological assemblages
GLOBIO model	Compositional intactness of ecological assemblages
cSAR models	Regional and global extinction species (vascular plants, amphibians, reptiles, birds & mammals)
BILBI model	Global extinction of vascular plants

Evaluating uncertainty in the "Bending the Curve" initiative

Biodiversity model = GLOBIO

Biodiversity model = PREDICTS

Scenarios exploring the action space

Historical Trend

Baseline scenario

Integrated action scenario

Land use models

- ● AIM
- ▲ GLOBIOM
- ■ IMAGE
- ＋ MAgPIE
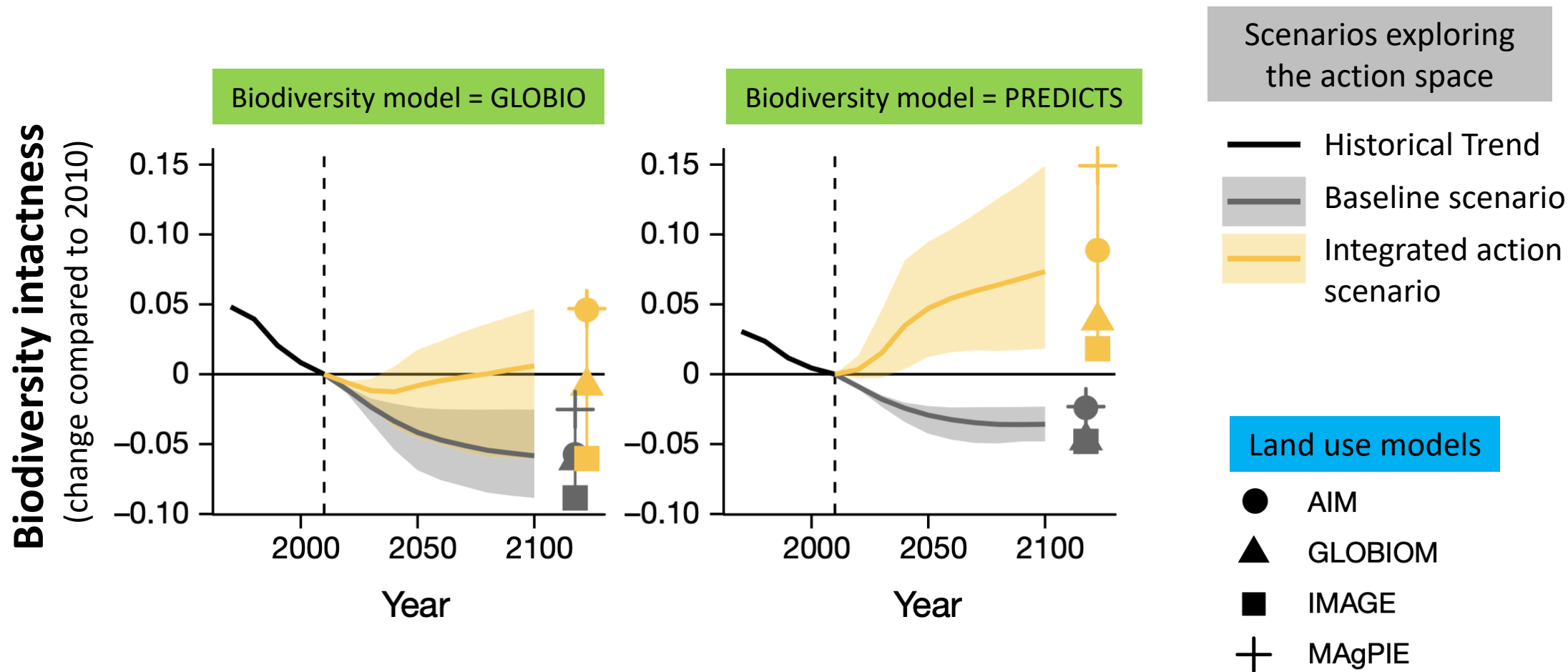
Leclère et al. (2020) Nature

The "Bending the Curve Initiative": Exploring Nature Positive Futures

Historical

1970   2010   2050   2100

Increased conservation efforts
+ more sustainable production
+ more sustainable consumption

Increased conservation efforts

Business as usual

Leclère et al. (2020) Nature, WWF
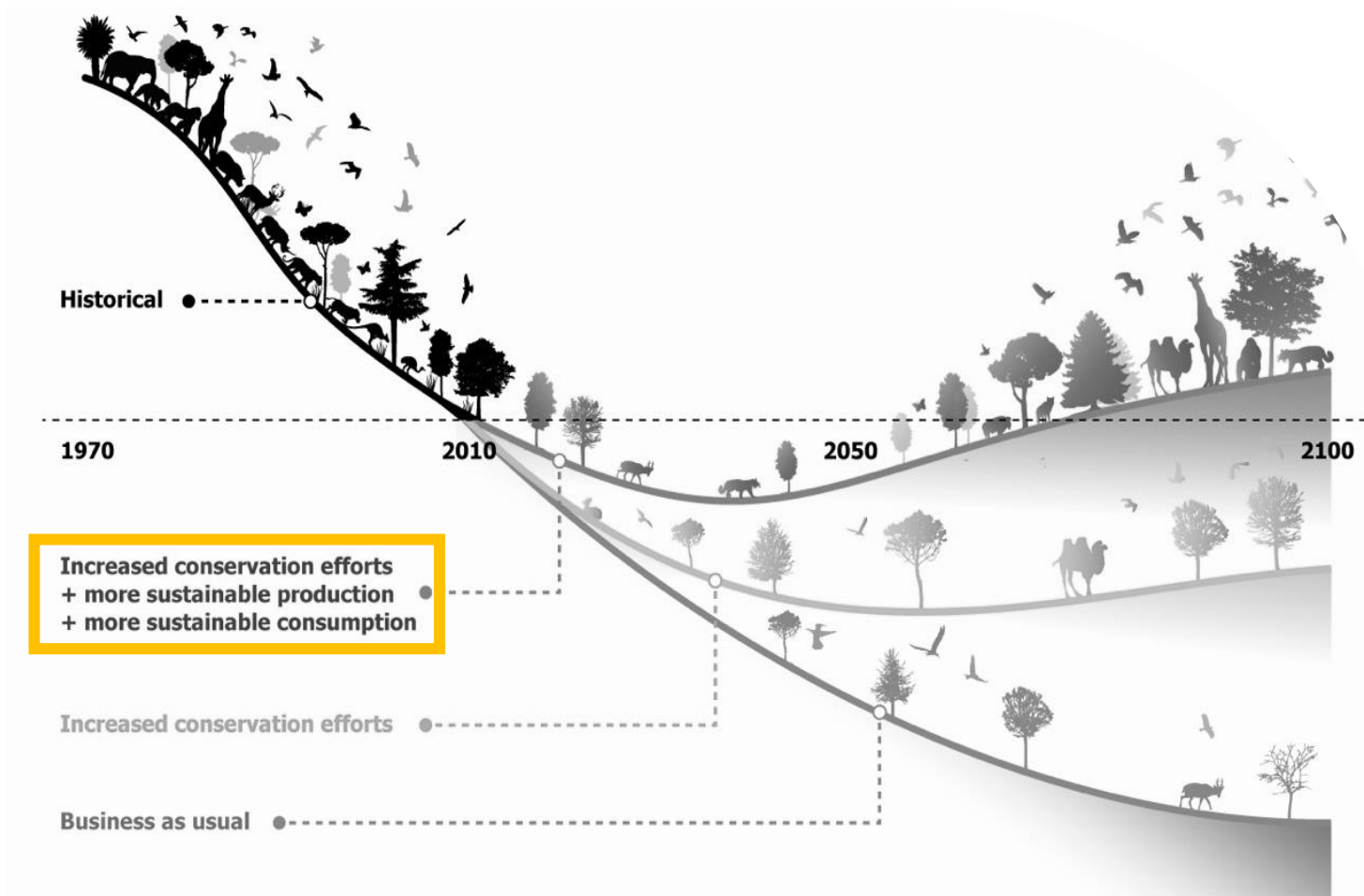
The treatment of uncertainty increases our confidence in stating:

"Bending the curve" for biodiversity over the next decades is plausible

Increased conservation efforts are key, but…

Nature positive futures (and people positive futures) only occur in these scenarios when the drivers of habitat loss are treated though integrated actions including diet shift, reduced waste, sustainable increases in trade and crop yields are transformed

Projected global trends and scenarios for terrestrial biodiversity and ecosystem services from 1900 to 2050
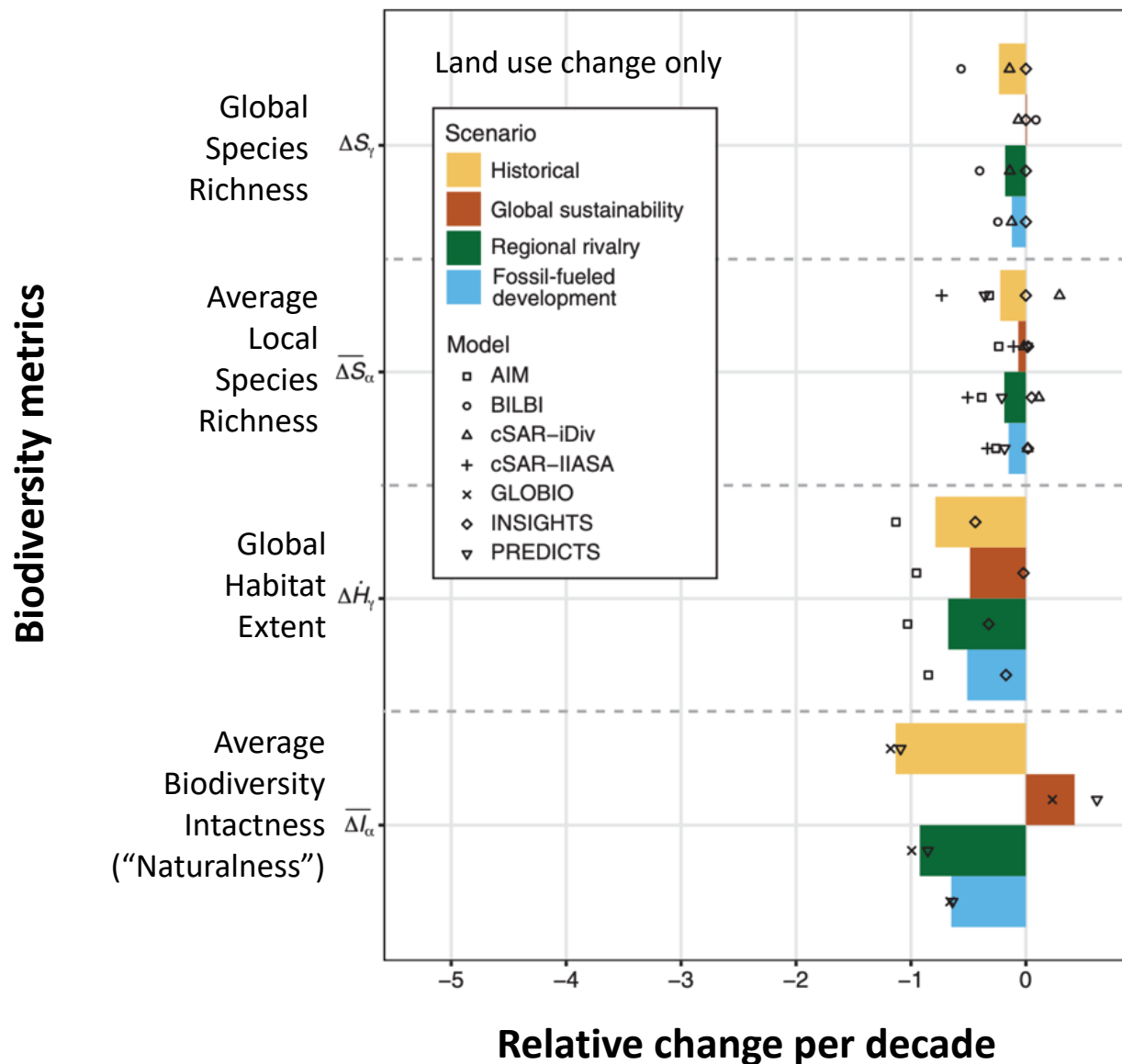
IPBES Global Assessment (2019)
Pereira et al. (2024) Science

"BES-SIM" projections for the IPBES Global Assessment (2019) based on modeling biodiversity response to SSP/RCP scenarios used in IPCC AR6 assessments

IPBES Nexus Assessment: Using scenario archetypes to synthesize outcomes from multiple Nature Positive scenarios and compare them with alternatives
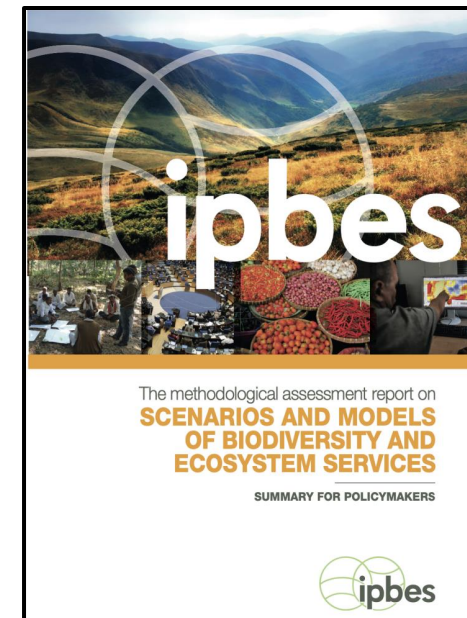
**A PROJECTED FUTURE IMPACTS ON NEXUS ELEMENTS**

IPBES (2024)

Accounting for uncertainty in decision making

• A multitude of mathematical methods exist for dealing with uncertainty … that can be useful in policy design and implementation decisions.

• However, many environmental decision problems are characterised by high social complexity… Such problems can seldom be fully characterised and analysed with mathematical approaches to uncertainty.

• Decision support methods that address subjective and intangible uncertainties are thus critical in supporting policy in most decision contexts. Such processes often require deliberation among decision makers, [scientists] and stakeholders to allow learning throughout the decision-making process.

IPBES Scenarios & Models Assessment: Chapter 2
Using scenarios and models to inform decision making in policy design and implementation

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SUMMARY FOR POLICYMAKERS

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Identifying uncertainties in scenarios and models of socio-ecological systems in support of decision-making
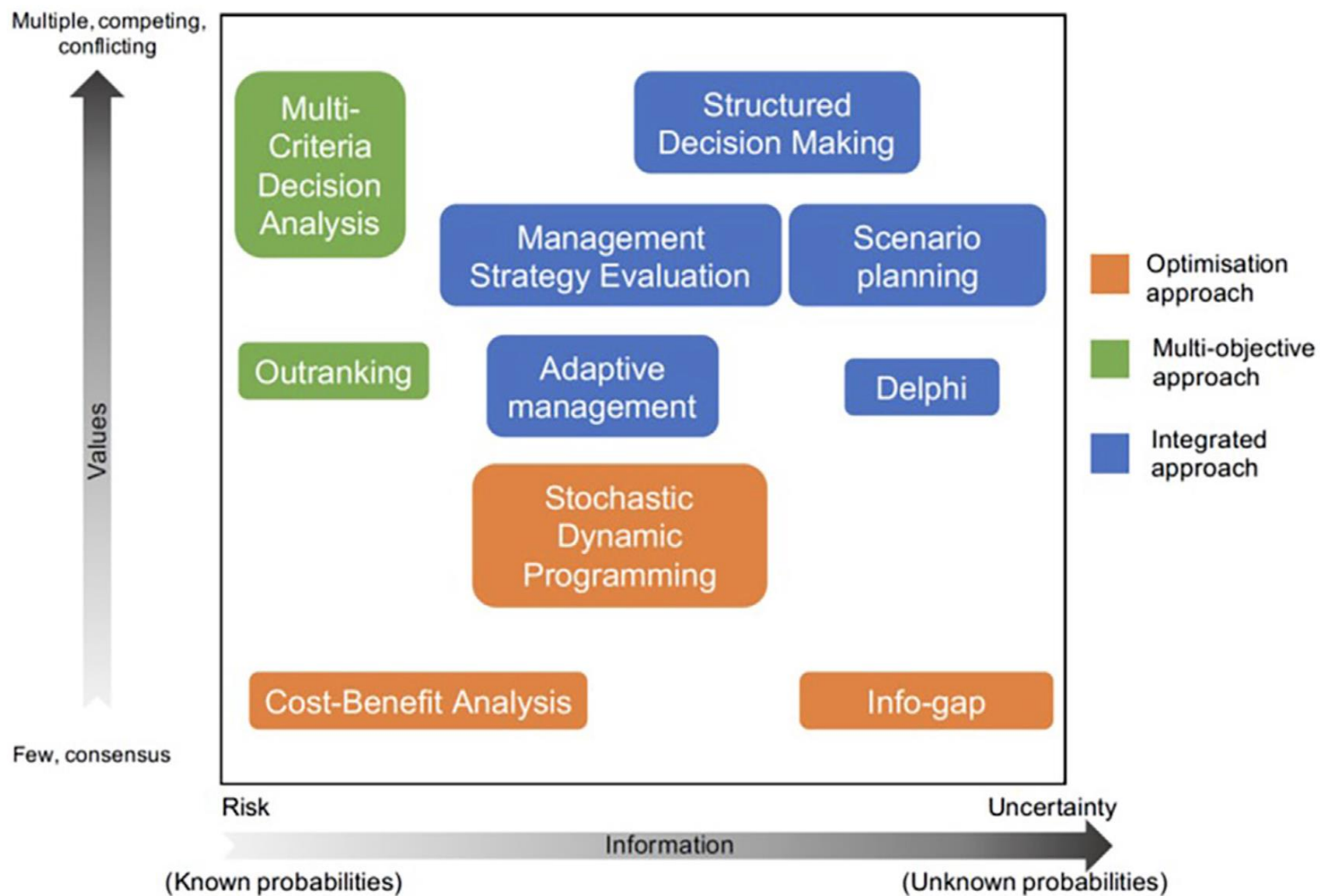
Rounsevell et al. (2021) One Earth

Key finding 2.1: Effective application and uptake of scenarios and models in policymaking and decision-making requires close involvement of policymakers, practitioners and other relevant stakeholders, including, where appropriate, holders of indigenous and local knowledge, throughout the entire process of scenario development and analysis
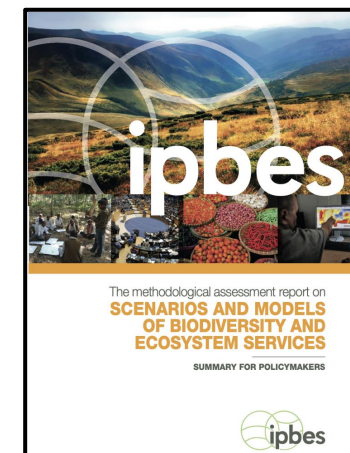
Thank you very much for your attention