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Predicting effects on aquatic community endpoints in rice fields of southern Europe – A Bayesian network approach

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- **We developed a probabilistic approach to risk characterization for pesticides, incorporating spatial variability in exposure.**
- **A Bayesian network (BN) was used as a meta-model to link scenarios, a process-based exposure model and a probabilistic effect model.**
- **The BN was also used to calculate the joint probability of effects from individual biological endpoints to endpoint groups and to community level.**

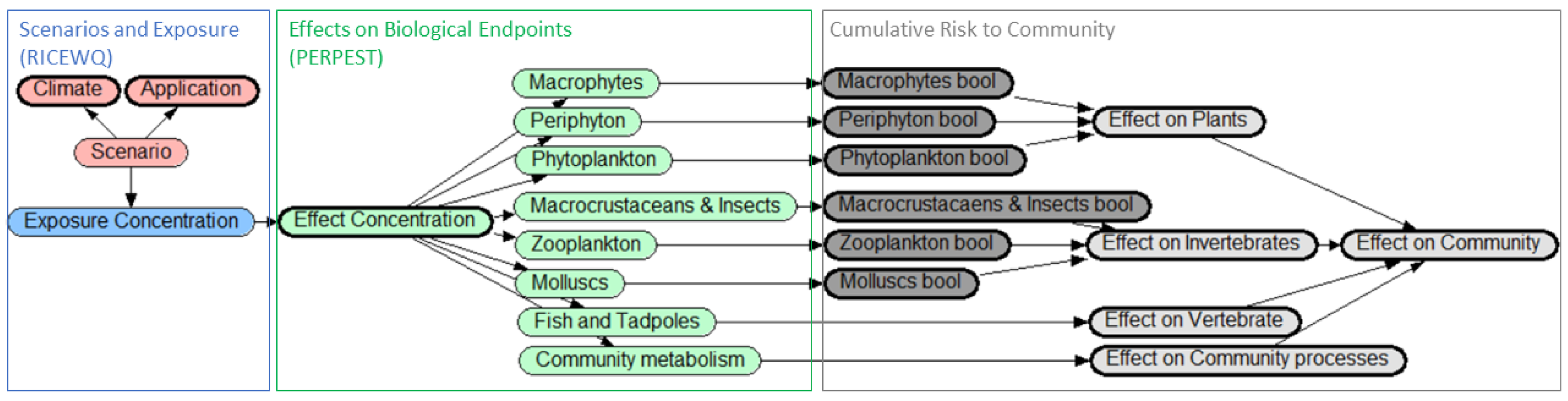

Figure 1 Conceptual model version the Bayesian network with three main modules: Scenario and exposure, Effects on biological endpoints and Cumulative risk to the aquatic community.

2 Approach

- Case study area: "Albufera national park" near Valencia (Spain)
- We developed the Bayesian network (BN) as a meta-model using outputs from two prediction models (Fig.1):
  - **RICEWQ -** simulates chemical mass balance and aquatic exposure in rice paddies (Karpouzas & Capri 2006)
  - **PERPEST –** predicts the probability of pesticide effects to various endpoints using a database of micro/mesocosm studies (Van den Brink et al. 2002)
- **Scenarios**:
  - Pesticide dosage applied: baseline & baseline+50%
  - Climate projections affecting pesticide exposure: for years 2008, 2050, 2100
- Three different **pesticide types** commonly used in the study area: **fungicide** (azoxystrobin), **herbicide** (MCPA), & **insecticide** (acetamiprid).
- RICEWQ was run for all 552 spatial units and 6 scenarios to derive probability distributions of pesticide **exposure concentration**
- The **joint probability of effect** to endpoint groups (cumulative risk) were calculated by "OR" expressions in the BN

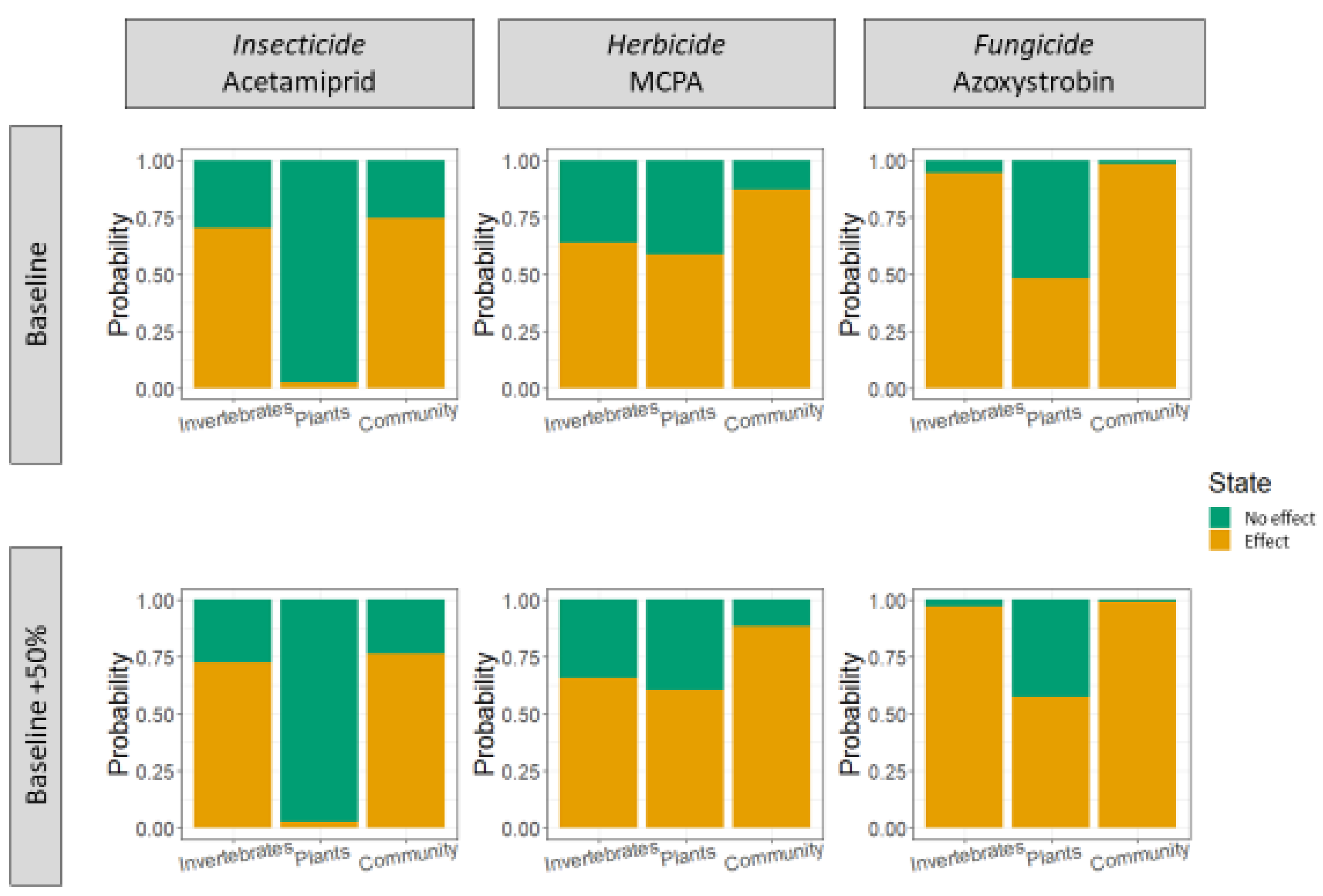

Figure 3 Examples of the predicted effect on the endpoint groups invertebrates and plants for the three selected pesticides (azoxystrobin, acetamiprid and MCPA), for climate conditions in 2050 and two pesticide application scenarios (baseline and baseline+50)

1 Background

- Climate change (CC) may affect the fate, transport and distribution of pesticides in aquatic environment in the Mediterranean (Noyes et al. 2009).
- **Probabilistic** approaches such as Bayesian networks (BN) are recommended for risk assessment to account for **uncertainty** in pesticide exposure under future scenarios (Carriger & Newman 2012; Mentzel et al. 2022a).
- The goal of this study was to develop a BN model for transparent prediction of effects on aquatic biological endpoints, as well as to endpoint groups and to the community level (Mentzel et al. 2022b).

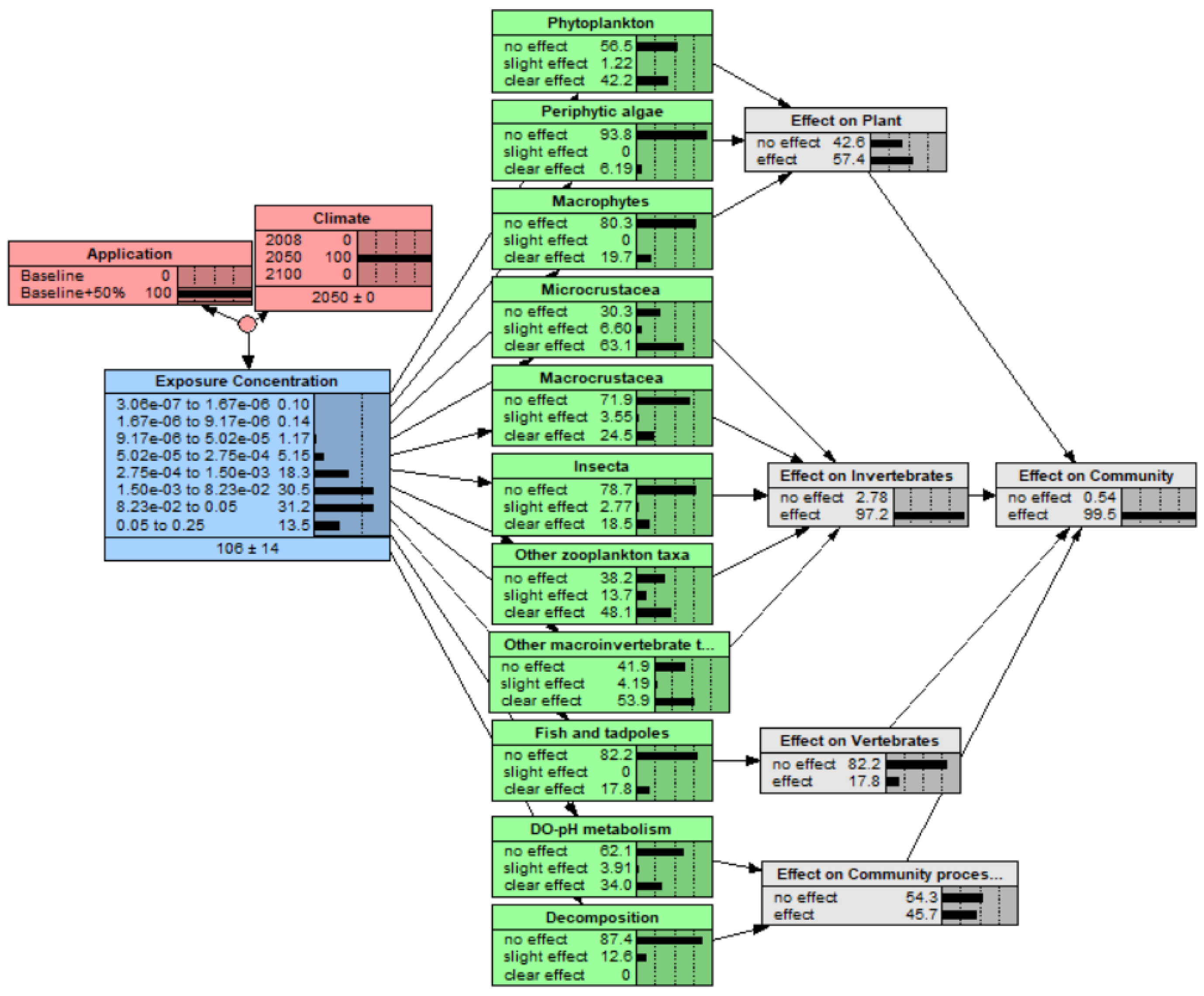

Figure 2 Example of the parameterized BN for the fungicide azoxystrobin: probability of effect on the taxonomic and functional groups, for climate conditions in 2050 and pesticide application scenario "baseline+50%".

3 Results

A parameterized BN example for the fungicide azoxystrobin (Fig. 2) shows:

- For individual endpoints, the predicted probability of clear effect ranges 0 - 63%
- The highest probability of clear effect (63%) is for microcrustaceans

The aggregated results for endpoint groups (invertebrates, plants Fig. 3) shows:

- The probability of any individual plant endpoint being affected was highest for the herbicide (MCPA, 60%) and lowest for the insecticide (2%).
- Invertebrates, however, had higher probability of being affected by the fungicide (azoxystrobin) than by the insecticide (acetamiprid).

Considering the cumulative risk to the community level (Fig. 3);

- Azoxystrobin has the highest probability (98%) affecting any of the individual endpoints in the aquatic community, and acetamiprid had the lowest (75%).
- The type of pesticide had more influence on the probability of community-level effects than the pesticide dosage level.

4 Future perspectives

- Future research efforts can incorporate more realistic scenarios, e.g., crop types, pesticide application patterns, and an ensemble of climate models.
- To advance from single-compound assessments, we aim to carry out a risk assessment of the intentional mixtures applied in the Albufera national park.

For more information on RICEWQ exposure prediction using BNs: see 2.08.P-Mo130
For more information on use of PERPEST effect model: see 3.04.P-Mo160

References

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