Evaluación del riesgo de la contaminación por pesticidas en humedales costeros Mediterráneos: efectos del cambio climático global y el Pacto Verde Europeo

Claudia Martínez-Megías[1,2], Sophie Mentzel[3], Yasser Fuentes-Edfuf[4], Jannicke Moe[3], Andreu Rico[2,5]

BACKGROUND

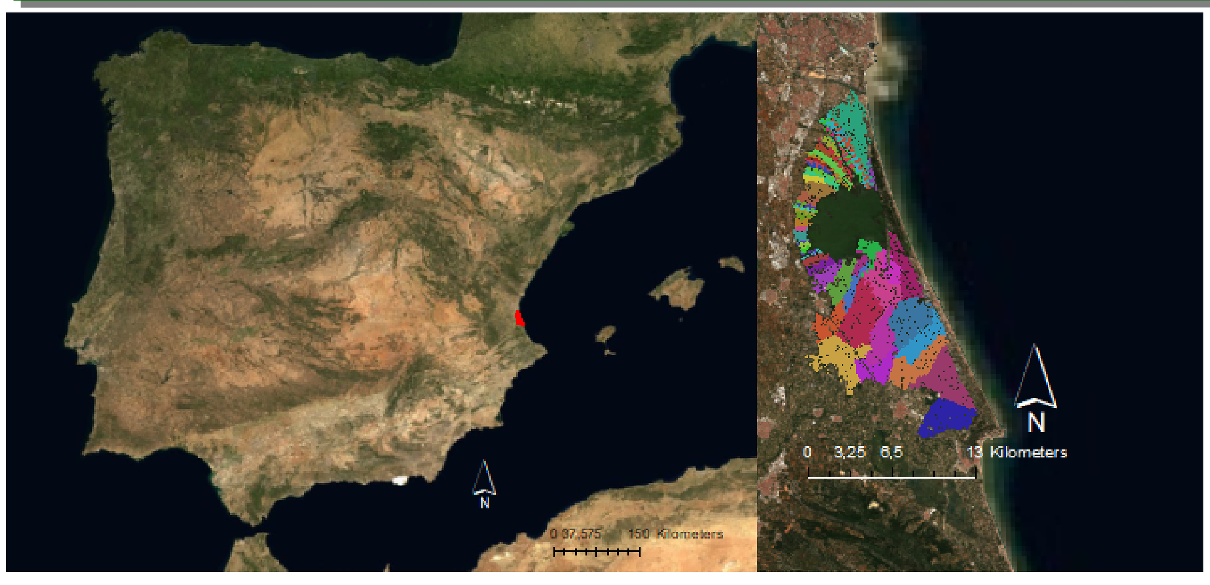

Figure 1. Location of Albufera Natural Park and division of their surrounding rice plots into hidrological clusters.

- Chemical pollution by agricultural pesticides is one of the most relevant anthropogenic stressors that affect Mediterranean wetlands [1] like Albufera Natural Park (**Fig.1**).
- Climate change could lead to both an increasing prevalence of pests and their spreading beyond their original distribution areas.
- These impacts could promote application dosages higher than reccomended ones (**Fig. 2**) by the farmers. On the other hand, policies like European Green Deal and its Farm to Fork Strategy try to mitigate the impacts by a reduction of 50% in recommended dosages.
- The use of fate and transport simulation models as well as Bayesian Networks could be a good option to pesticide management and risk assessment.

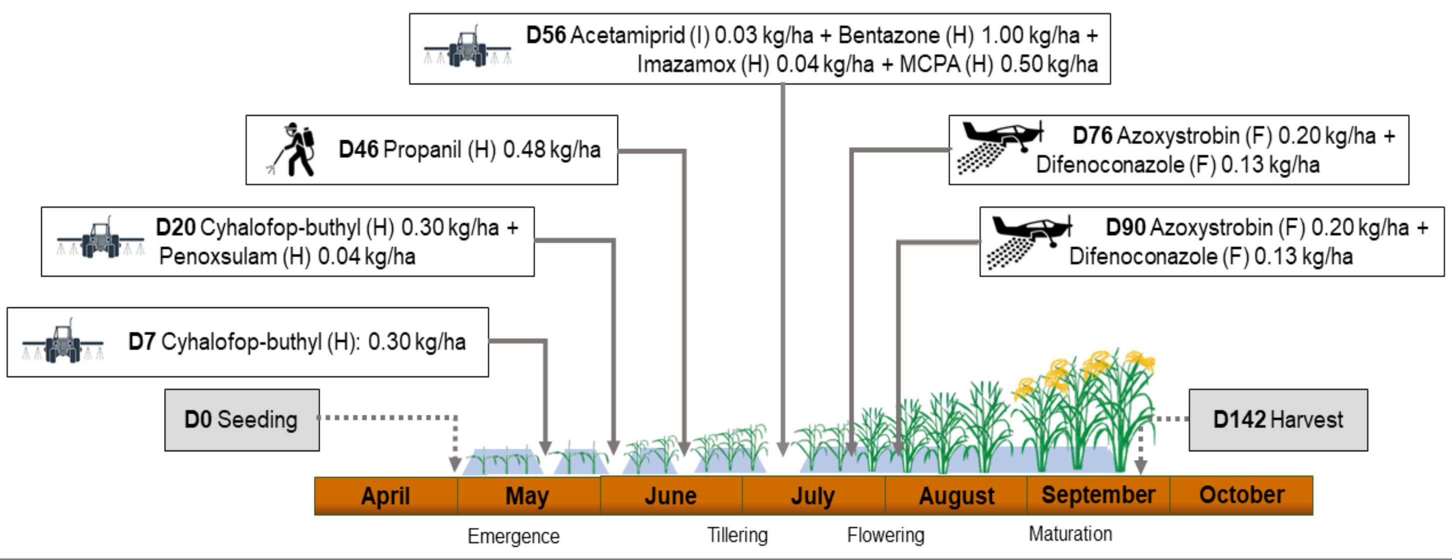

Figure 2. Crop season scheme with their corresponding pesticide applications in Albufera Natural Park. D: day of crop season; F: fungicide; H: herbicide; I: insecticide.

OBJECTIVES

- Assessment of changes in future climate and pesticides application practices, and how they can influence ecological risks of pesticides in Albufera Natural Park (ANP, Valencia, Spain).
- Understanding how future trends in temperature and precipitations in combination with varying application dosages can affect pesticide exposure, aiding to prioritize compounds regarding their risks for aquatic ecosystems.
- Assess the risks of pesticide pollution from rice production in Mediterranean areas and providing recommendations to improve monitoring and ecological risk assessments.

METHODOLOGY

Pesticide risks in 522 rice clusters were assessed using nine scenarios that described differences between current and future climate conditions and pesticide dosages (**Table 1**) during rice growing season (May-September) and considering the hidrology regime of rice plots (**Fig.1**). Climate projection MPI-ESM-LR [2] for 2050 and 2100 temperature and precipitation forecasts was obtained from AEMET (2021).

Scenarios (abbreviation)	Input data: Meteorological data	Input data: Pesticide dose
Current (2008)	2008	recommended
Mid-term projection (2050)	2050	recommended
Long-term projection (2100)	2100	recommended
Current, increasing pesticide dose (2008+)	2008	50% higher
Mid-term projection, increasing pesticide dose (2050+)	2050	50% higher
Long-term projection, increasing pesticide dose (2100+)	2100	50% higher
Current, reduced pesticide dose (2008-)	2008	50% lower
Mid-term projection, reduced pesticide dose (2050-)	2050	50% lower
Long-term projection, reduced pesticide dose (2100-)	2100	50% lower

***Table 1.** Proposed scenarios for the Ecological Risk Assessment of pesticides assessed in this study.*

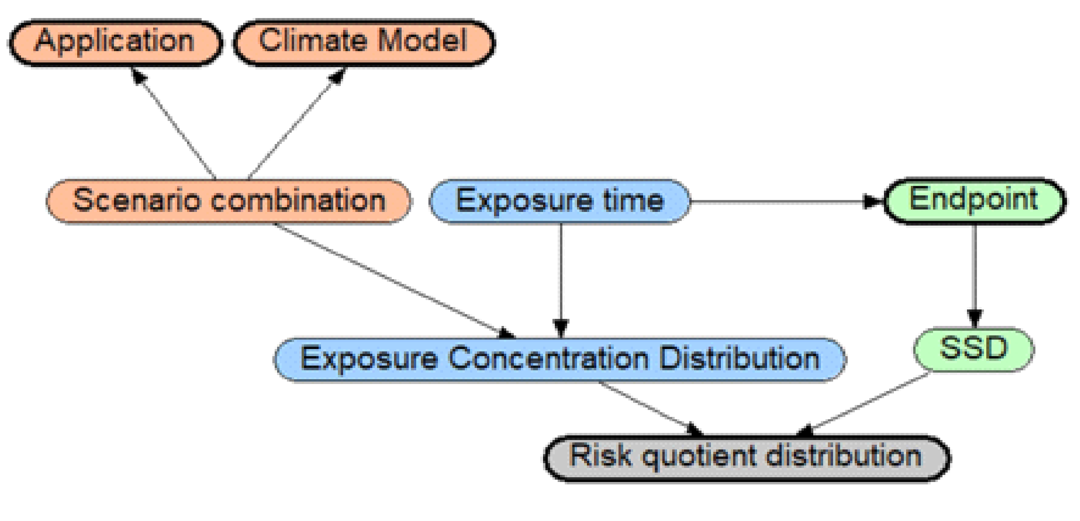

***Figure 3.** Conceptual model of the approach considered for risk assessment, including the stages from the scenarios construction to the Bayesian network design.*

Scenarios were used to simulate pesticide exposure concentrations in paddy field water for each of the nine pesticides in ANP (**Fig. 2**) using RICEWQ 1.9.2 [3]. The outputs were used together with laboratory toxicity data to build a Bayesian Network (**Fig. 3**) using Netica software [4] for the calculation of Risk quotients (RQs) for each scenario and pesticide.

RESULTS

Acetamiprid

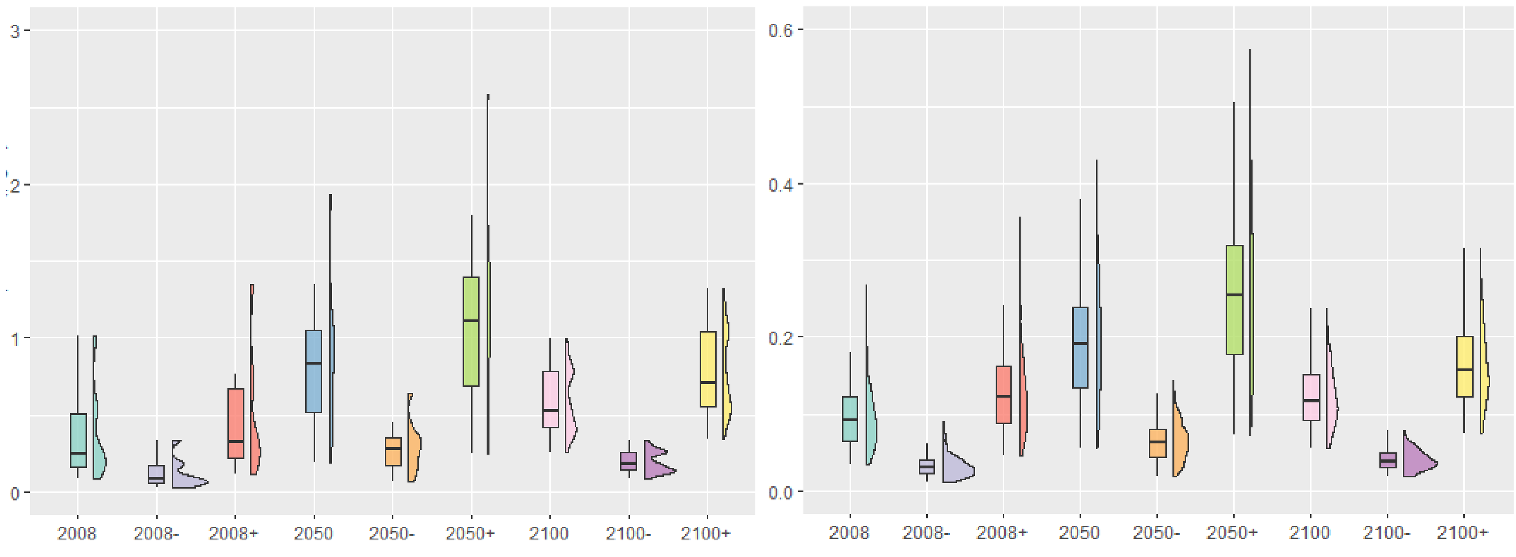

***Figure 4.** Peak exposure concentration (PEC, left) and highest Time Weighted Average Concentration (TWAC, right) for insecticide Acetamiprid. Y axis shows the concentration in µg/L.*

Exposure data shows both for PEC and TWAC similar values in 2008 and 2100 scenarios, being 2050 the ones with higher concentration values (**Fig. 4**). This suggest indirect processes ruled by rainfall events.

RQs had quite similar probabilities between scenarios (**Fig. 6**), with the exception of 2050+ that showed slightly higher probabilities of moderate and high risks (both acute and chronic).

***Figure 6.** Calculated Risk Quotients (RQs) for the Acute (left) and Chronic (right) toxicity for Acetamiprid. The colors indicate the result of RQs. Green: no risk (0-0.1); Yellow: Potential risk (0.1-1); Orange: Moderate risk (1-10); Red: High risk (10-10000). Y axis shows probabilities of each scenario's RQs.*

Azoxystrobin

***Figure 5.** Peak exposure concentration (PEC, left) and highest Time Weighted Average Concentration (TWAC, right) for fungicide Azoxystrobin. Y axis shows the concentration in µg/L.*

Different dosage scenarios seem to affect PEC and TWAC values more than climate variation (**Fig. 5**). Application by plane over flooded fields instead of emptied ones may be promoting higher concentration peaks.

RQs showed for acute toxicity lower risks probabilities for reduced dosage scenarios. For chronic toxicity RQs showed higher probabilities of moderate and high risks (**Fig. 7**).

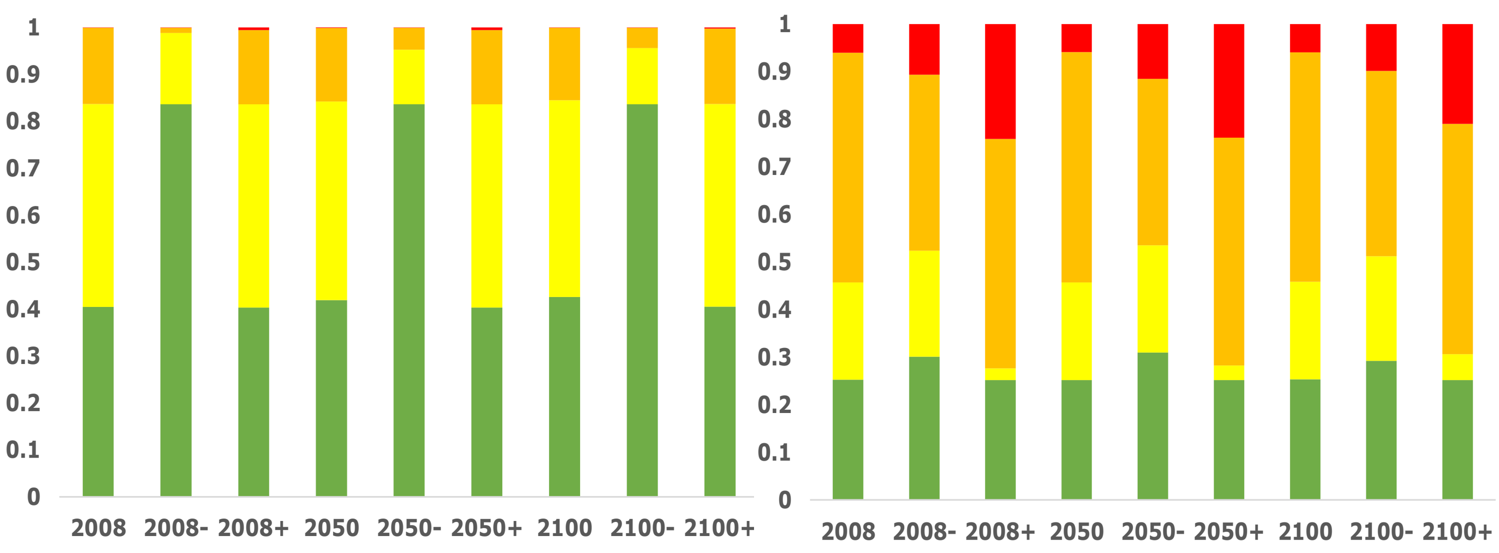

***Figure 7.** Calculated Risk Quotients (RQs) for the Acute (left) and Chronic (right) toxicity for Azoxytrobin. The colors indicate the result of RQs. Green: no risk (0-0.1); Yellow: Potential risk (0.1-1); Orange: Moderate risk (1-10); Red: High risk (10-10000). Y axis shows probabilities of each scenario's RQs.*

CONCLUSIONS

- Current pesticide application regimes are expected to affect aquatic organisms living within rice production areas of the Albufera Natural Park.
- Pesticides that showed highest probabilities of chronic risk are, in this order Azoxystrobin, MCPA and Difenoconazole, followed by the other herbicides and Acetamiprid. Similar results occur with acute risk probabilities.
- Climate change projections are not consistently increasing/decreasing pesticide exposure and risks. Exposure variation among the studied climate scenarios is intrinsically related to the meteorology (i.e., extreme precipitation events) occurring shortly before and after the application date.

References

[1] Martínez-Megías & Rico (2021). Biodiversity impacts by multiple anthropogenic stressors in Mediterranean coastal wetlands. *Science of the Total Environment.* 151712.

[2] Giorgetta, M. A., Jungclaus, J., Reick, C. H., Legutke, S., Bader, J., Böttinger, M., ... & Stevens, B. (2013). Climate and carbon cycle changes from 1850 to 2100 in MPI-ESM simulations for the Coupled Model Intercomparison Project phase 5. Journal of Advances in Modeling Earth Systems, 5(3), 572-597.

[3] Waterborne Environmental, Inc. 2021

[4] Norsys Software Corp. www.norsys.com

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[1] University of Alcalá, Alcalá de Henares, Spain
[2] IMDEA Water, Alcalá de Henares, Spain
[3] NIVA, Oslo, Norway
[4] IE Business School, Madrid, Spain
[5] ICBIBE, University of Valencia, Burjassot, Spain

Contact email: claudia.martinez@imdea.org