

# R2M rapid risk assessment to support integrated biosecurity responses from farm to global scales

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## Integrated biosecurity responses

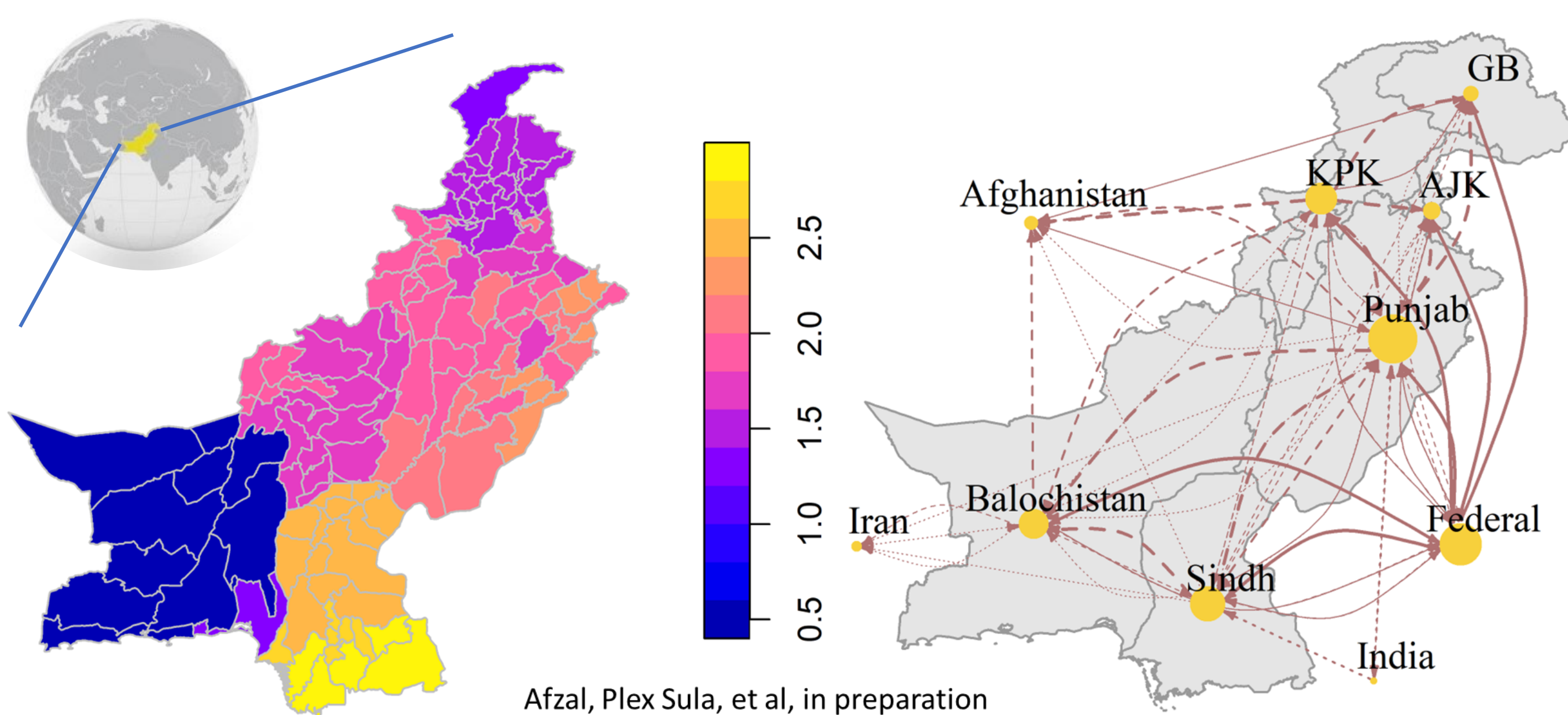
Effective biosecurity responses to emerging pests and pathogens require the coordinated efforts of national agricultural research and extension systems (NARES) and national plant protection organizations (NPPOs). The R2M tools will aid in rapid risk assessment and mitigation planning for crop pathogens and pests at the national or regional level, helping countries manage current and new invasive threats. These tools offer a flexible, scalable, and adaptable future for global biosecurity surveillance and mitigation systems.

### Current R2M Elements:

- Expert elicitation tools
- Impact Network Analysis
- Cropland connectivity
- Creating a community of practice
- More innovations to come.

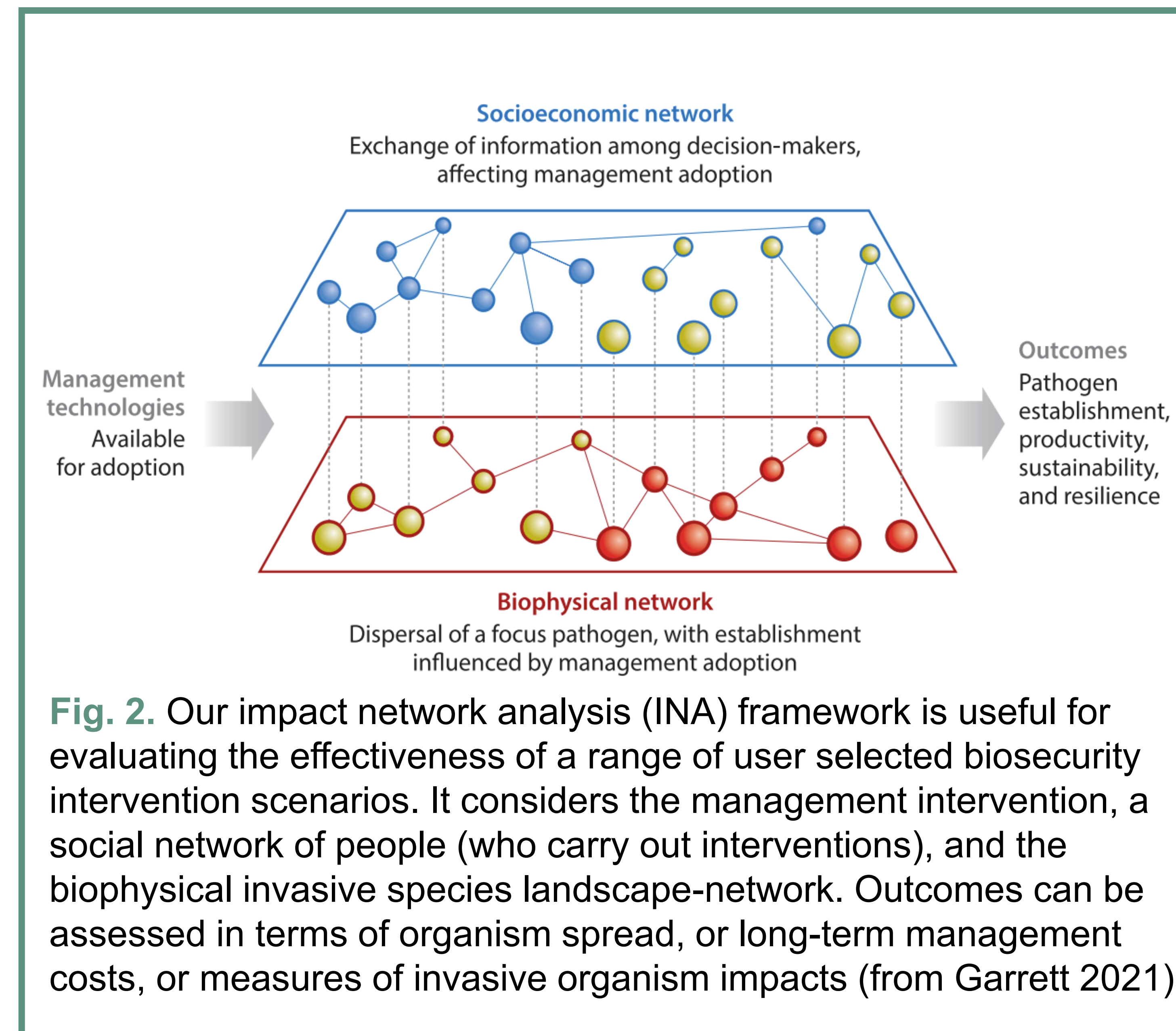


## Expert knowledge elicitation



**Fig. 1.** Expert knowledge elicitation (EKE) permits rapid parameterization of risk assessment and response models (R2M). In this example, yield losses to wheat rust in Pakistan (left) and trade connections (right) were estimated by regional experts (Afzal, Plex Sulá, et al., in prep.). In Bayesian terminology, EKE provides prior information, which can be updated with data from subsequent empirical studies (i.e. posterior information). We are developing a meta-tool to help researchers efficiently elicit and implement expert knowledge within R2M.

## Impact network analysis (INA) for management scenario comparisons



### Key questions addressed in INA scenario analysis

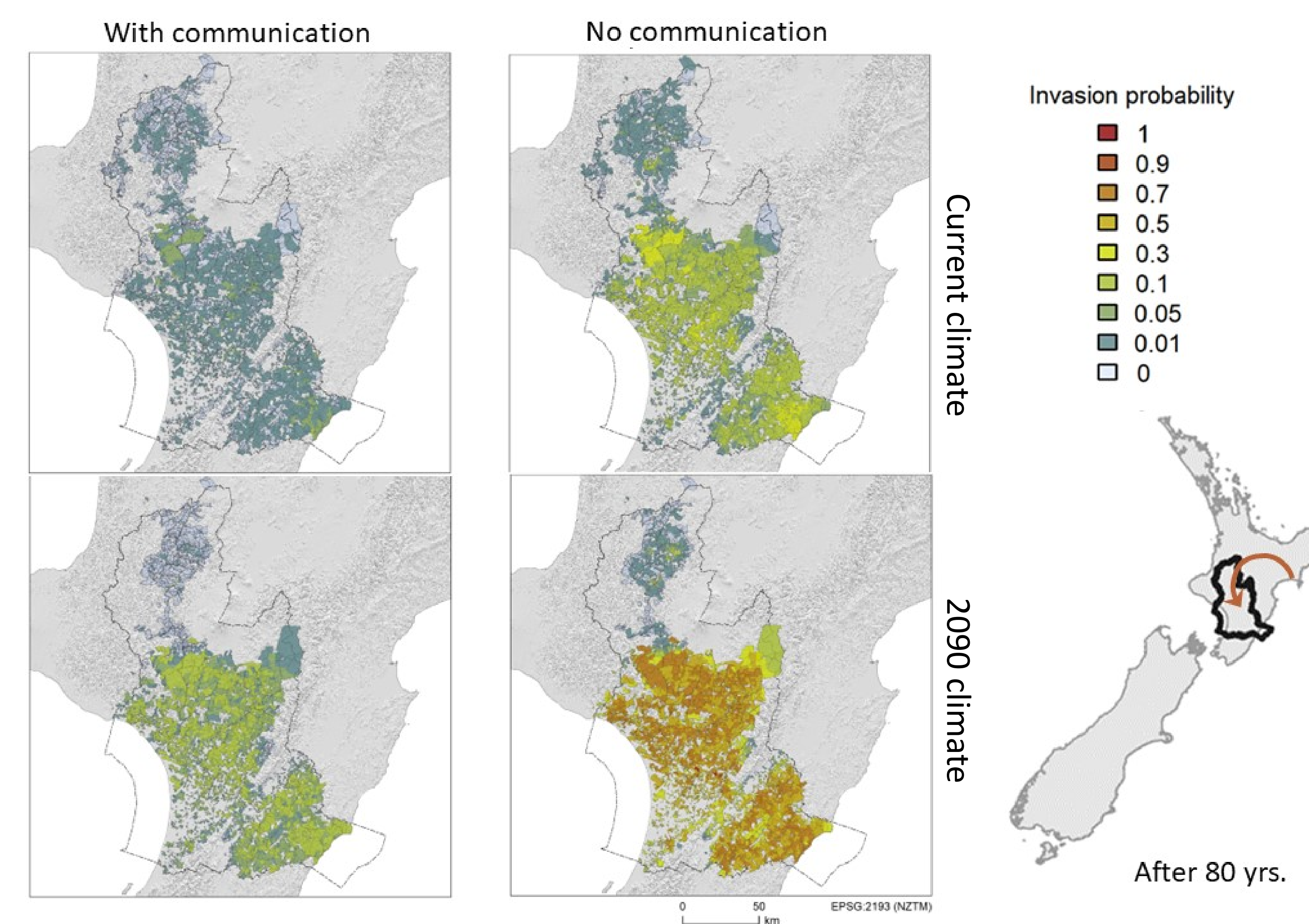
- What locations are particularly important for system management?
- How are the benefits of the system distributed by gender and age?
- How could subsidies, and policies influence system outcomes?
- Are observations over time in line with goals for project monitoring and evaluation?

#### References

- Andersen Onofre, K. F., et al. 2021. An integrated seed health strategy and phytosanitary risk assessment: potato in the Republic of Georgia. *Agricultural Systems* 191:103144.
- Etherton, B. A., et al. 2023. Are avocados toast? A framework to analyze decision-making for emerging epidemics, applied to laurel wilt. *Agricultural Systems* 206:103615.
- Garrett, K. A. 2021. Impact network analysis and the INA R package: Decision support for regional management interventions. *Methods in Ecology and Evolution* 12:1634-1647.
- Xing, Y., et al. 2020. Global cropland connectivity: A risk factor for invasion and saturation by emerging pathogens and pests. *BioScience* 70:744-758.

## Potential questions addressed with added INA functionality

- How does climate change alter our ability to eradicate or contain new incursions?
- How will management actions in source countries or regions impact local management success?
- What is the relative benefit of extension aimed at enhanced detection, local eradication, or movement restrictions?



**Fig. 3.** Invasion scenarios for the weed Chilean Needle Grass (*Nassella neesiana*) from the sheep and beef farms in currently invaded Hawkes Bay into farms in the currently uninvaded Manawatu region, models assess the benefit of communication (extension) efforts by biosecurity staff to farmers about new detected infestations, under current and future climates. This work extends the functionality of INA.

## Flexible, scalable, adaptable and open source (R packages)

**Flexible** – covers almost any imaginable management scenario  
**Scalable** – from plants, fields, farms and up to global scales  
**Adaptable** – to any pathogen, pest or weed  
**Adoptable** – open-source software with a growing community of practice