Natural hazards threats to pollinators and pollination

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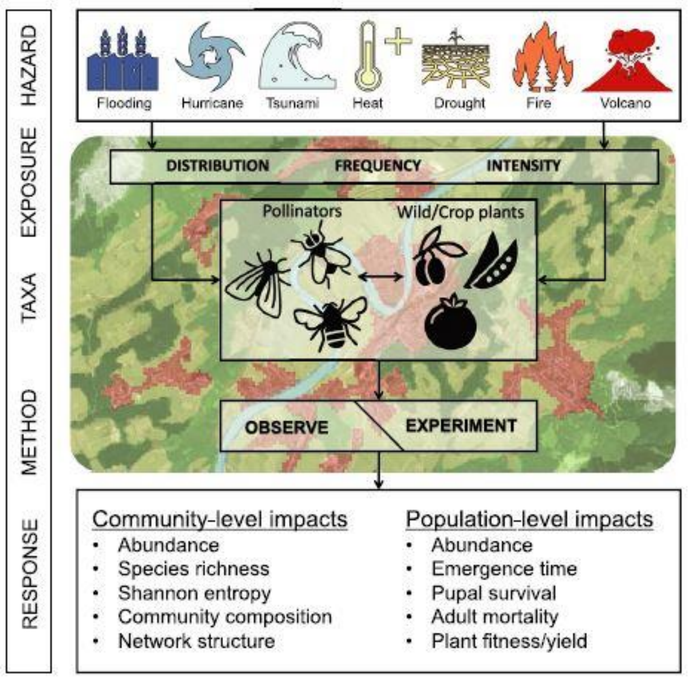
By Emmanuel Adeleke

Background



Research objectives

1. To characterize studies according to specific set of attributes
2. To score impacts of natural hazards on different types of plant and pollinator responses
3. To synthesize overall effect sizes of these responses
4. To identify research gaps and biases in the evidence base

Figure 1: Conceptual approach to the study of natural hazard impacts on pollinators and plant pollination. These impacts are measured via **observational studies** that record changes resulting from natural events or via **experimental approaches** that manipulate abiotic conditions in order to simulate natural hazard exposure.

Methods

1. Systematic literature review:

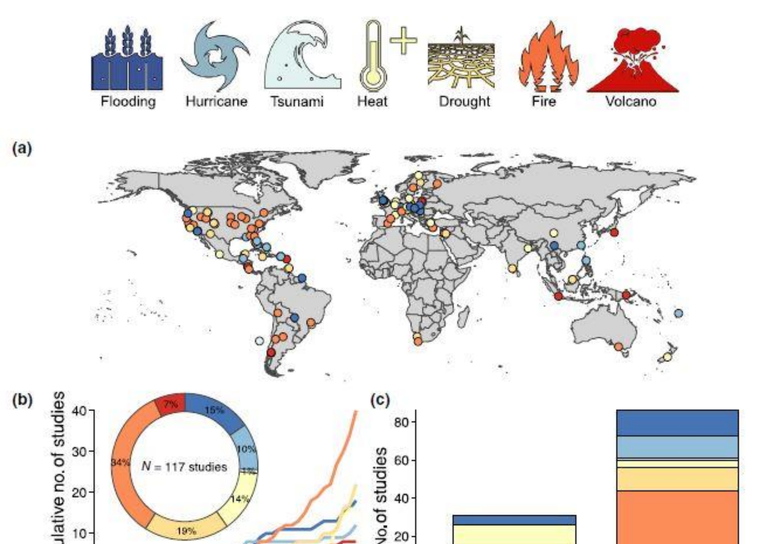


Figure 2: Systematic review yielded research on seven natural hazard types

- ✓ Article search on Google Scholar, Web of Science and review of references.
- ✓ Studies were classified based on natural hazard type, publication year, study location, methodological approach, pollinator taxa considered, level of biological organization and whether crop pollination was measured.

2. Meta-analysis: Literatures assembled from the systematic review were screened to extract all suitable studies and data. Due to a wide variety of methods and designs that often limited replication, a formal meta-analysis was not possible for many hazards. Fire was the only natural hazard for which an adequate number of studies were identified to facilitate meta-analysis.

Results & Discussions

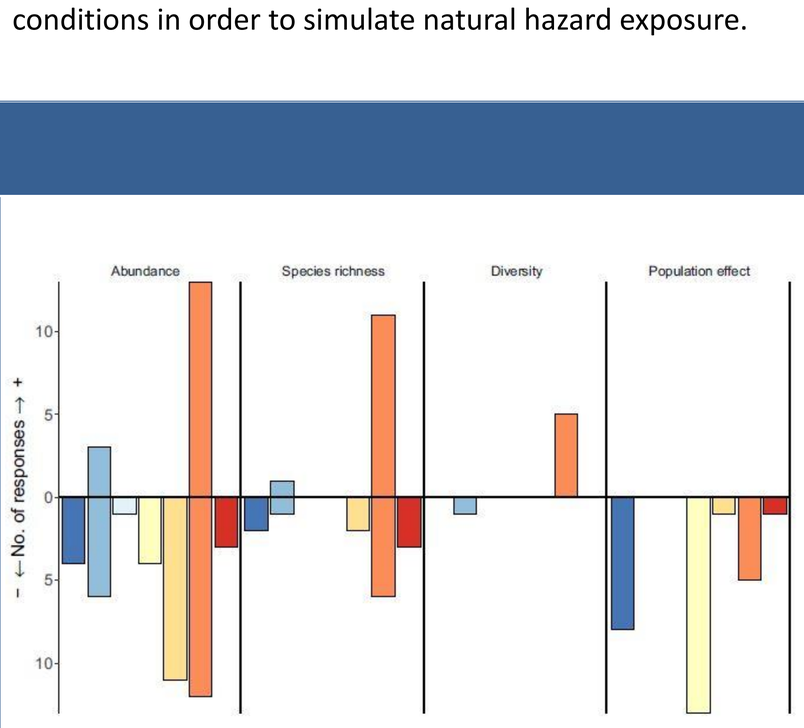


Figure 3: Natural hazard impacts on different pollinator responses. The number of statistically significant positive or negative responses according to natural hazard type.

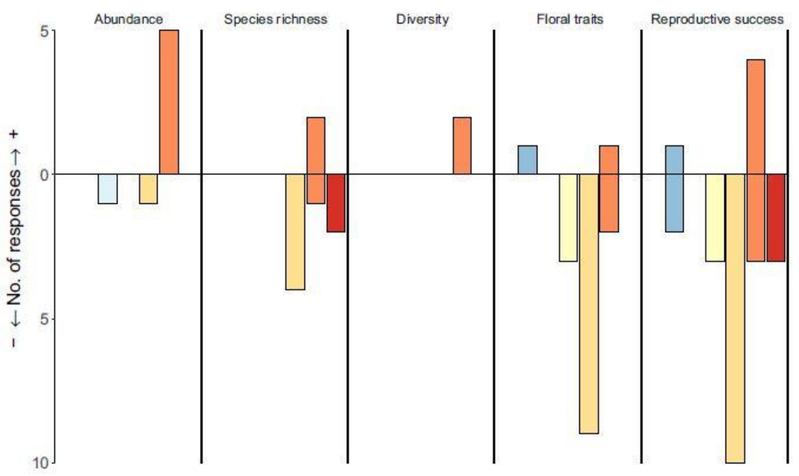


Figure 4: Natural hazard impacts on different plant responses. The number of statistically significant positive or negative responses according to natural hazard type.

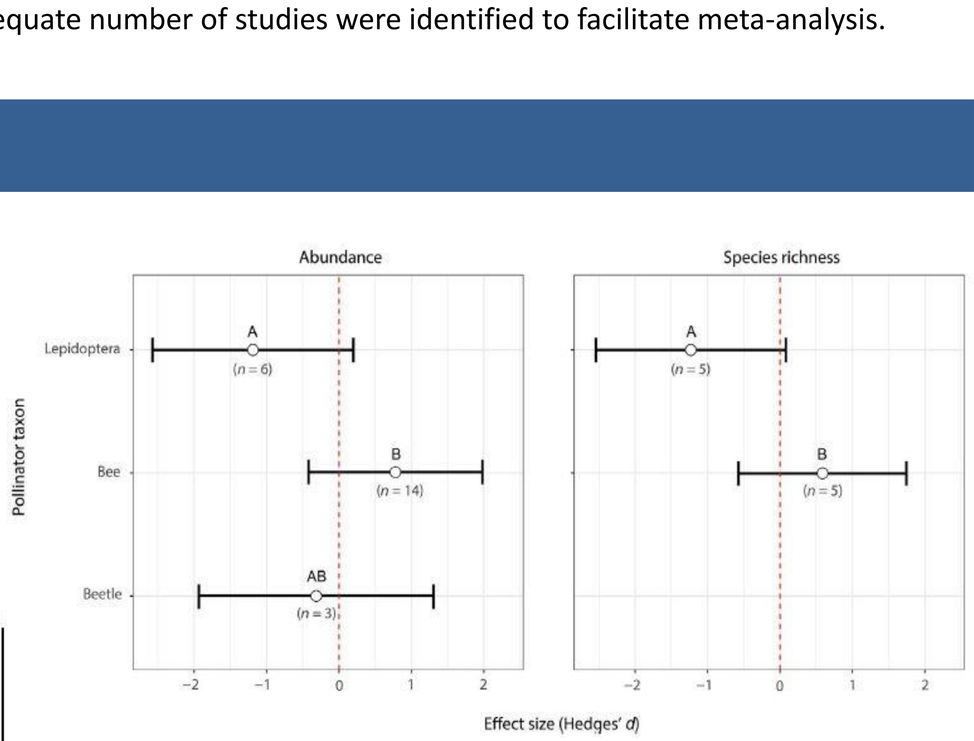


Figure 5: Meta-analysis of the effect of fire on pollinator abundance and species richness. Positive values denote an increase in abundance or species richness in burnt versus unburnt times/sites, whereas negative values denote a decrease. Pollinator taxa which do not share a letter differ significantly from each other. Beetles were not included in the analysis of species richness due to lack of available data.

Outlook and future directions

- **Critical research gap: Crop pollination services**

Too few studies (5%) of literature were identified in order to draw conclusions concerning natural hazard effects on crop pollination services. Generally, there is a categorical lack of studies examining these effects and so we have to rely on the basic literature to make inferences.

- **Therefore, as a call to expand this knowledge base, three future directions are highlighted:**

1. **Quantifying exposure:** Better quantifying hazard exposure will equip ecologists with clear information on the relationship between exposure and impacts as an aid to future predictability and evidence-based management
2. **Quantifying impacts:** Few studies examined changes to plant-pollinator interactions, co-evolutionary trajectory of plants and pollinators as well as impacts on phylogenetic diversity. Assessing these impacts should therefore be an important component of future research in this field.
3. **Connecting natual hazards, pollination and people:** Pollination services research is strongly biased toward developed regions and large-scale production systems. Impacts of climate-change driven natural hazards on the provision of key agro-ecosystem is a matter of major concern for smallholder farmers and developing regions given the disproportionate threat to food security in these areas**.** Addressing these considerable gaps in research, policy and management is vital to build strategies for disaster risk reduction and climate change adaptation

Conclusions

This study highlights the following important points as conclusions:

Given the predicted increase in the frequency and severity of extreme events with global climate change (Seneviratne et al., 2012), we need to better understand how increasing exposure affects biodiversity and human livelihoods through shifts in the supply of critical ecosystem services such as pollination.

Our understanding of natural hazard impacts on pollination is wanting, and current evidence is unable to guide conservation or climate adaptation efforts that aim to support pollinators and secure pollination for wild and crop plants.

The development of evidence-based policy and management will necessitate addressing this research gap, particularly in less developed countries where climate change is expected to hold disproportionately large effects on food security.

Building the capacity for conservation and climate adaptation will hence ultimately require knowing under what conditions ecological communities and ecosystem services are (or can be) rendered resilient to natural hazard events.