

## Extracts from:

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“As we enter an era of unprecedented turbulence at the planetary level, we argue that ample responses to this new reality — that is, response diversity — can no longer be taken for granted and must be actively designed and managed. We describe here what response diversity is, how it is expressed and how it can be enhanced and lost.”

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“In this paper, we suggest that, if we wish to build general resilience to disruptions that cannot be exactly determined in advance, society needs to strengthen its response diversity. Response diversity is a system’s variety of responses to disruptions of all kinds. While this term originates from ecology<sup>23</sup>, we argue that it is critical to improving the resilience of any complex system. It suggests keeping options open for unexpected situations, which is consistent with theories about optimal decision-making under uncertainty and irreversibility.”

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“As we work through the various facets of response diversity, an important point to bear in mind is that, like resilience, it is a property of a system and is neither ‘good’ nor ‘bad’ per se. It can help maintain the current state of a system no matter whether it is deemed desirable or undesirable. If the state of a system and its trajectory are clearly undesirable, the appropriate focus of response diversity should be on alternative transformational pathways. Because our reason for writing this paper is the serious loss of response diversity, the focus here is on when, where and how it is playing a positive role.

Despite the critical role that response diversity plays in nature and in society at large, insights that extend beyond single sectors and disciplines are currently lacking. In this paper, we aim to fill this gap by integrating the different ways in which the concept is used and applied and highlighting the interconnectivity between different types of responses across sectors and scales. In particular, we explore just what response diversity means, how it is expressed in all kinds of systems, how it can be built and lost, its costs and benefits, and its implications for policy and governance. We conclude with some suggestions for strategies and policies to maintain or enhance response diversity. Importantly, our aim is not to scrutinize individual strategies for implementing response diversity in particular sectors but rather to provide general guidelines relevant across disciplines, which can be explored in more detail within different specific contexts.”

### **Response diversity**

“Living systems, from individual organisms to the global system, depend on having a set of processes (for example, in ecosystems, photosynthesis, decomposition and predation; or in an economy, production and exchange of goods and services, waste management and transport) that enable that system to function. To ensure that these processes can persist in the long term, agents in a system must have multiple ways by which they can respond to changes and disruptions. In other words, response diversity provides the raw material for adaptive behaviour (Fig. 2).”

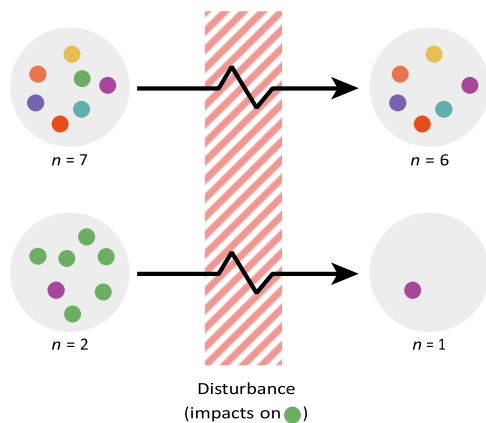


Fig. 2 | A conceptual illustration of response diversity. A high-diversity system (top) (for example, an agroecosystem) is more likely to maintain system functions and processes when facing a disturbance, whereas a low-diversity system (bottom) (for example, a monoculture) is highly vulnerable to a specific disturbance. Symbols of different colours represent the diversity ( $n$ ) of agents/ structures in a system (for example, species, traits, reserves or strategies).

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“We argue here that we need to identify different sources of response diversity, assess trends in those sources and understand the implications of responding differently. In many systems, response diversity is largely organizational and perhaps hierarchical, as discussed in Levin et al.29. In this paper, to help further unpack response diversity and make it more operational, we complement Levin et al.29 by focusing on spatial and temporal dimensions of response diversity, in addition to population and community responses (natural and human).”

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### Strategies to enhance response diversity

To address these challenges to building and maintaining response diversity, we suggest that a critical first step is to create widespread awareness of the meaning of response diversity and its crucial role in responding to unexpected change and sustaining long-run well-being. An appropriate second step would be to search for win–wins, where response diversity is enhanced as a by-product of other well-being-enhancing investments, accompanied by direct investments in response diversity, and we propose strategies to nurture it. While these strategies may be quite straightforward, they require some societal awareness about the role of response diversity and accompanying collective action, which may be more difficult to achieve. It is also important to notice that responding to multiple and compounded crises requires a combination of responses at both local and larger scales. Although many crises are local in nature, in a globalized and interconnected world, local communities are often deeply embedded within larger-scale dynamics. The fostering of strategies to enhance response diversity across multiple scales is therefore crucial.”

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“To further explore how these principles will translate in different contexts and how they could be implemented across local and regional policies, we foresee that the co-production of knowledge — that is, collaborative processes that convene academic and non-academic actors around problem framing and trust building, through knowledge generation<sup>67</sup> — can play an important role.”