



## **Metrics to quantify resilience as a property of soil functional dynamics**

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Soils are dynamic systems that are frequently exposed to environmental disturbances. We want our soils to be “resilient” and continue to function despite these disturbances, yet it is challenging to define what resilience is, and to quantify it in a meaningful manner. To operationalise the concept we suggest that resilience can effectively be viewed as a property of the dynamic response of a soil function to perturbation. We identify four such characteristics of the response of a soil function to disturbance that can then be related to resilience:

- degree of return of the function to a reference level
- time taken to reach a new quasi-stable state
- rate (i.e. gradient) at which the function reaches the new state
- cumulative magnitude of the function (i.e. area under-the-curve) before a new state is reached

We develop metrics to quantify these characteristics based on an analogy with a mechanical spring-and-damper system, and demonstrate that these metrics effectively discriminate key features of the response of a prescribed soil function (respiration) to disturbance. Although any one of these characteristics alone could define resilience, each may lead to different insights and conclusions. The salient properties of a resilient response must thus be identified for different contexts.