BIOdiversity, STAbility and sustainability in Spatial Ecological and social-ecological Systems

Rendicontazione

Informazioni relative al progetto

BIOSTASES

ID dell'accordo di sovvenzione: 666971

Sito web del progetto

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10.3030/666971

Progetto chiuso

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Questo progetto è apparso in...

Periodic Reporting for period 4 - BIOSTASES (BIOdiversity, STAbility and sustainability in Spatial Ecological and social-ecological Systems)

Periodo di rendicontazione: 2020-03-01 al 2020-08-31

Sintesi del contesto e degli obiettivi generali del progetto

Biodiversity loss is one of the greatest environmental challenges of our time. There is growing evidence that biodiversity increases the stability of ecosystem functions and services, suggesting that it may be critical to the sustainability of ecosystems and human societies in the face of environmental changes. Classical ecological theory, however, has focused on measures of stability that cannot explain and predict these stabilizing effects, especially in spatial systems.

The goal of BIOSTASES was to develop a coherent body of new theory on the stability of ecosystems and coupled social–ecological systems and its relationships with biodiversity at multiple spatial scales that can better inform empirical research. BIOSTASES sought to reach this goal through four complementary objectives. First, it aimed to propose an integrative mathematical framework that connects different concepts and measures of stability used in ecology, and to clarify the merits and properties of temporal variability as an empirically relevant measure of stability (Work Package 1, WP1). Second, it used dynamical metacommunity models to explore a wide range of novel questions related to ecosystem stability and diversity–stability relationships across scales (WP2). Third, it studied the stability of complex meta-ecosystems to provide new perspectives on the stability of food webs and on synergies and trade-offs between multiple ecosystem services across space (WP3). Fourth, it developed novel theory to study the long-term dynamics and sustainability of coupled social–ecological systems (WP4).

BIOSTASES proposed an ambitious innovative research programme that has provided new perspectives on the functioning, stability, and sustainability of ecological and coupled social–ecological systems in the face of environmental changes. It has contributed to bridging the gaps between theoretical and empirical ecology and between ecology and social sciences, and to

developing new approaches in biodiversity conservation, landscape management, and sustainable development.

Lavoro eseguito dall'inizio del progetto fino alla fine del periodo coperto dalla relazione e principali risultati finora ottenuti

All four Work Packages delivered important new scientific results.

WP1 established the bases of a new integrative mathematical framework that connects such different stability concepts as resilience, reactivity, variability, return rates, and structural stability. We developed new stability measures that can be readily applied to empirical data. A novel perspective that emerges from our work is that ecological stability is an inherently multidimensional concept, even when focusing on a single stability metric such as invariability because the various species or components that make up an ecosystem govern different stages of the recovery process after a perturbation.

WP2 led to major advances regarding the spatial scaling of ecosystem functioning and stability and its relationships with the spatial scaling of biodiversity. It developed several novel theoretical approaches to these issues: a first approach based on the concepts of alpha, beta and gamma variability across a set of discrete spatial scales; a second approach based on an invariabilityarea relationship, which links ecological stability and the area observed over a continuous range of spatial scales; and a third approach based on an extended partition of biodiversity effects to quantify the insurance effects of biodiversity on ecosystem functioning across times and places.

WP3 moved the field forward in two main directions. First, it developed a promising new approach to complex ecosystems, which considers ecosystems as disordered systems resulting from an assembly process. Many of the functional, dynamical and structural properties of the complex communities that emerge from the assembly process can be predicted analytically from a random model parameterised by only four statistical properties of the community. Second, it used simpler dynamical models to provide, for the first time, solid theoretical foundations to study multiple ecosystem functions and services in complex ecosystems.

WP4 developed novel models that include the feedback loop between biodiversity, ecosystems and human societies together with changes in human behaviour and spatial ecological dynamics to investigate the stability of coupled social-ecological systems and their ability to keep providing ecosystem services to a growing human population. Our integrative dynamical approach provided important new insights into the long-term sustainability of human societies and of their interactions with biodiversity.

Lastly, we collaborated in several international efforts to synthesise scientific knowledge on the relationships between biodiversity, ecosystem functioning and ecosystem stability across scales.

These efforts resulted in the publication of several review papers in top disciplinary and interdisciplinary journals.

Progressi oltre lo stato dell'arte e potenziale impatto previsto (incluso l'impatto socioeconomico e le implicazioni sociali più ampie del progetto fino ad ora)

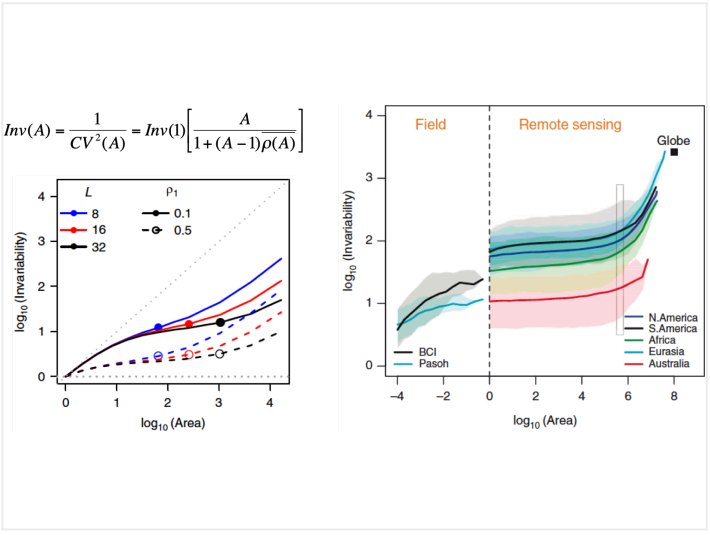
Most of the results described in the previous section represent progress beyond the state of the art. In particular:

WP1 established the bases of a new integrative mathematical framework that connects different stability concepts; it developed new stability measures that can be readily applied to empirical data; and it provided a novel perspective on ecological stability as an inherently multidimensional concept.

WP2 led to major advances regarding the spatial scaling of ecosystem functioning and stability and its relationships with the spatial scaling of biodiversity by developing several novel theoretical approaches to address these issues.

WP3 moved the field forward in two main directions: (1) it developed a promising new approach to complex ecosystems, which considers ecosystems as disordered systems resulting from an assembly process; and (2) it provided, for the first time, solid theoretical foundations to study multiple ecosystem functions and services in complex ecosystems.

WP4 developed novel models that include the feedback loop between biodiversity, ecosystems and human societies to investigate the stability of coupled social-ecological systems; these models provided important new insights into the long-term sustainability of human societies and of their interactions with biodiversity.



The Invariability-Area Relationship, as revealed by both theory and empirical data

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