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Advancing past socio-environmental systems science

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We dedicate this special issue of *Past Global Changes Magazine* to our dear colleague Daniele Colombaroli, who passed away on 11 August 2022. Daniele was a passionate scientist and a compassionate human being with a deep commitment towards innovating paleoscience research through building communities. He was known for his openness, generosity, and ever-readiness in supporting students and colleagues.

Daniele greatly contributed to PAGES' mission in advancing paleoscience research since his PhD days at the University of Bern. He was instrumental in steering PAGES Global Paleofire Working Group (WG) 2 (pastglobalchanges.org/gpwg2), and establishing the Global Paleofire Database (paleofire.org) as the first open-access archive of fire records across the world. Daniele was an avid advocate of bridging science-policy gaps, thus, creating the PAGES DiverseK WG (pastglobalchanges.org/diversek) which merges paleoecology and local knowledge for better decision-making on environmental and social justice issues.

Daniele utilized paleoecological tools to explore past socio-environmental systems (SES), defined as groups of humans, social elements, and processes that interact with each other and the environment through time (Biggs et al. 2021) and he excelled in his work on the legacy of human impact on present landscapes (Colombaroli et al. 2007, 2014). This need for interdisciplinarity that was key to Daniele's work on understanding feedbacks and interactions between past natural and human systems is the highlight of this special issue (Fig. 1). Whereas theoretical and practical implications in studying past SES have been a central topic for PAGES over the last decades (Dearing et al. 2007; Gillson et al. 2017; Latorre et al. 2016), recent perspectives on effective collaboration open new avenues. Crabtree (p. 4) introduces the emerging field of archaeoecology that uses tools and approaches from ecology combined with the archaeological record. Recovering past human perceptions in the face of natural hazards, such as volcanic eruptions, can be achieved by merging paleoecology and art (González p. 6). The application of environmental proxies affected by different spatiotemporal processes (diatoms, ichthyofauna) enables nuanced reconstructions of past human–environmental trajectories in archaeological sites (Zarza et al. p. 8).

The study of past socio-environmental systems also requires developing new methods to disentangle multivariate Quaternary records. Connor (p. 10) reviews recent techniques on landscape reconstruction coupled with the study of ancient DNA in sediments. New approaches in karstic lakes can complement archaeology in understanding the role of the environment in cultural and religious manifestations of the Maya (Rodriguez-Abaunza and Correa-Metrio p. 12). In tropical savannas, determining the role of fire in shaping human–environmental dynamics can be better appraised by analysing pyrogenic compounds from stalagmites (Argiriadis et al. p. 14).

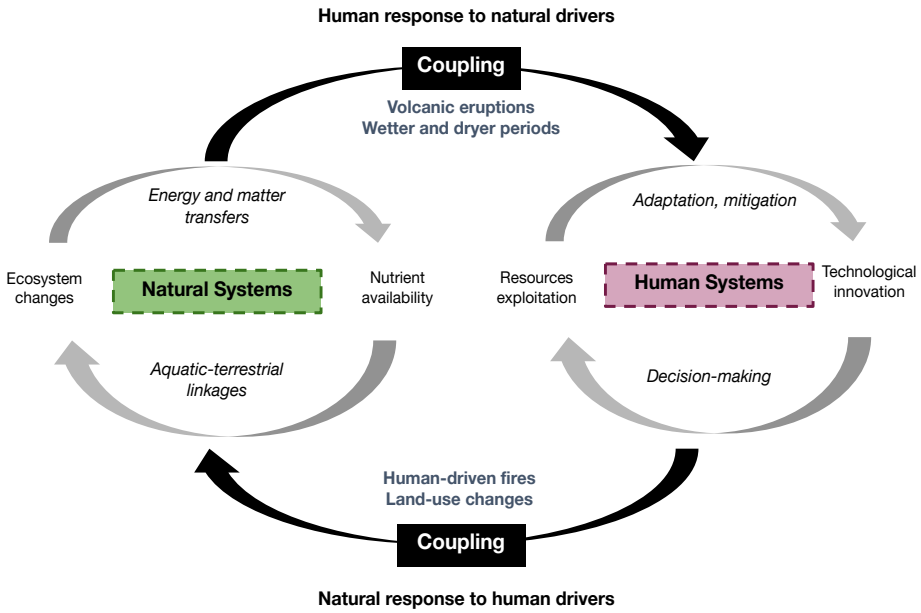

Figure 1: Diagram showing between and within-systems coupling (natural and human systems), which is the main topic of the current issue. Black arrows represent human (natural) responses to natural (human) drivers. Contributions are placed in the coupled socio-environmental systems framework, adapted from Zimmerer and Vanek as cited in serc.carleton.edu/integrate/teaching_materials/food_supply/student_materials/1059.

Some studies attest to the importance of regional perspectives for the application of paleoenvironmental and paleoclimatic reconstructions in archaeological sites. Understanding past landscape transformations by Indigenous communities in tropical floodplains is fundamental to present-day management (Lombardo p. 16). Regardless of past precipitation regimes, water availability has shaped cultural innovations to adapt to extreme climatic fluctuations in the central Altiplano (Delaere et al. p. 18), northern Chile (Maldonado et al. p. 20), and western India (Bhattacharya et al. p. 22). Yet, interactions among components of past SES are often asynchronous and nonlinear, with context-dependencies in natural and social processes (Orijemie et al. p. 24). The scaling-up of paleoenvironmental and archaeological records represents an opportunity to hypothesize causes of change across larger spatial and temporal scales, supported by strong locally-rooted inferences, while acknowledging sampling limitations, especially incomplete fossil records. This is particularly the case of environmental drivers in hominin evolution (Kinyanjui et al. p. 26), and cultural responses to global climatic events such as the one at 4.2 ka (Mehrotra and Shah p. 28).

This special issue on past socio-environmental systems speaks to Daniele's dedication for generating, disseminating, and applying new knowledge. It advocates for mobilization and collaboration as a cornerstone for advancing paleoscience research in underrepresented regions of the globe (Kulkarni et al. p. 30). Therefore, this collection of articles represents Daniele's view on transcending disciplines, merging diverse evidence, and establishing networks.

AFFILIATIONS

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