doi.org/10.22498/pages.30.1.44

Paleoscience–policy "commons": Connecting the past to a sustainable future in a human-dominated tropical biodiversity hotspot

Charuta Kulkarni[1] and Dhanya Bhaskar[2]

Building science–policy interfaces is essential for envisioning pragmatic environmental solutions. Drawing from the Western Ghats of India, we identify mutual areas of interest, or "commons", where specific environmental management issues can benefit from a long-term perspective, encouraging paleoscience–policy connections.

Achieving food security while maintaining biodiversity is a key challenge for tropical regions. Sustainable management of these regions is further threatened by global environmental changes that have serious impacts on livelihoods of billions (Gadgil and Guha 1993). Given the long histories of human occupation and the influence of past climates and land-use practices in shaping tropical landscapes, it is essential to incorporate both ecological and cultural legacies in their planning and management (Swanson et al. 2021). Conservation and restoration plans often fail to acknowledge the significance of such legacies (Gillson and Marchant 2014), resulting in conflicts between restoration targets and people's needs (Colombaroli et al. 2021). For example, management policies that are regulatory and/or restrictive (e.g. fire prevention, monoculture afforestation schemes) often contrast with traditional practices that support local livelihoods and undermine the crucial role of past ecological processes (Gadgil and Guha 1993).

With the term "commons", we refer to specific policy conservation/management issues that can benefit from a long-term perspective. Bringing examples from tropical paleoecology and environmental policy, we show how the identification of such mutual areas of interest is pertinent in establishing and expanding paleoscience–policy interfaces. We argue that identification of paleoscience-policy commons is a requisite for effective tropical landscape management where policy-relevant paleo-studies, as well as dialogs between scientific and policy circles, are rare, if not absent.

Tropical agroforestry systems: opportunities for integrating paleosciences into policy

Agroforestry, the practice of planting crops under or alongside trees, is one of the most widely used land management techniques worldwide (Fig. 1). While supporting the local livelihoods through encouraging intentional management of trees for productive agriculture, agroforestry is also recognized as a promising nature-based solution for the improvement of ecosystem functions, biodiversity conservation, and climate change adaptation (The 4th World Congress on Agroforestry, 2019). Tropical agroforestry landscapes are typical social–ecological systems that have existed for centuries or even millennia – especially those located in the biodiversity hotspots exemplify traditional practices and lessons for the future (e.g. Maezumi et al. 2018; Kulkarni et al. 2021). The Western Ghats, a 1600-km mountain range running parallel to the west coast of India, is one such biodiversity hotspot where tropical rainforests support the highest human population density. In the Western Ghats, high-resolution paleoecological data shed light on the transformation of local agroforestry systems since 4000 cal BP (Fig. 2), revealing their diverse ecological and social dimensions including ancient farming practices, their relationship with monsoonal variability, and fire as a land management strategy (e.g. Bhagwat et al. 2012; Nogué et al. 2018; Kulkarni et al. 2021). The perspectives drawn from these long-term interactions between tropical ecosystems and people offer vital clues for understanding the long-lasting benefits of agroforestry practices and their sustainable management, both of which are envisioned under India's National Agroforestry Policy for synergizing biodiversity conservation and livelihood benefits (Government of India 2014). Below, we present two commons where studies of past ecologies in the Western Ghats with a focus on local policy issues could aid in visualizing appropriate and inclusive management choices:

Figure 1: A typical tropical agroforestry landscape integrating native trees and crops (photo credit: Dhanya Bhaskar).

(1) Conservation and restoration in human-dominated tropical landscapes

India's National Agroforestry Policy focuses on ecosystem protection and resilient farming as important strategies to minimize climate risks (Government of India 2014). Land degradation in the past affected more than 30% of the country's geographical area, thus, in response, the Indian government has committed to restoring 26 Mha of degraded land by 2030 under the United Nations Convention on Combating Desertification (Press Information Bureau 2019). In this context, paleoecological studies show where conservation efforts should be focused and how these can be cognizant of local practices.

For example, pollen-based reconstructions of biodiversity in the Western Ghats highlight a high positive correlation between the canopy cover and plant diversity (Fig. 2), emphasizing the importance of maintaining tree canopies for nurturing highly diverse landscapes (Kulkarni et al. 2021). Paleodata in the Western Ghats also reveal the resilience of native evergreen trees towards

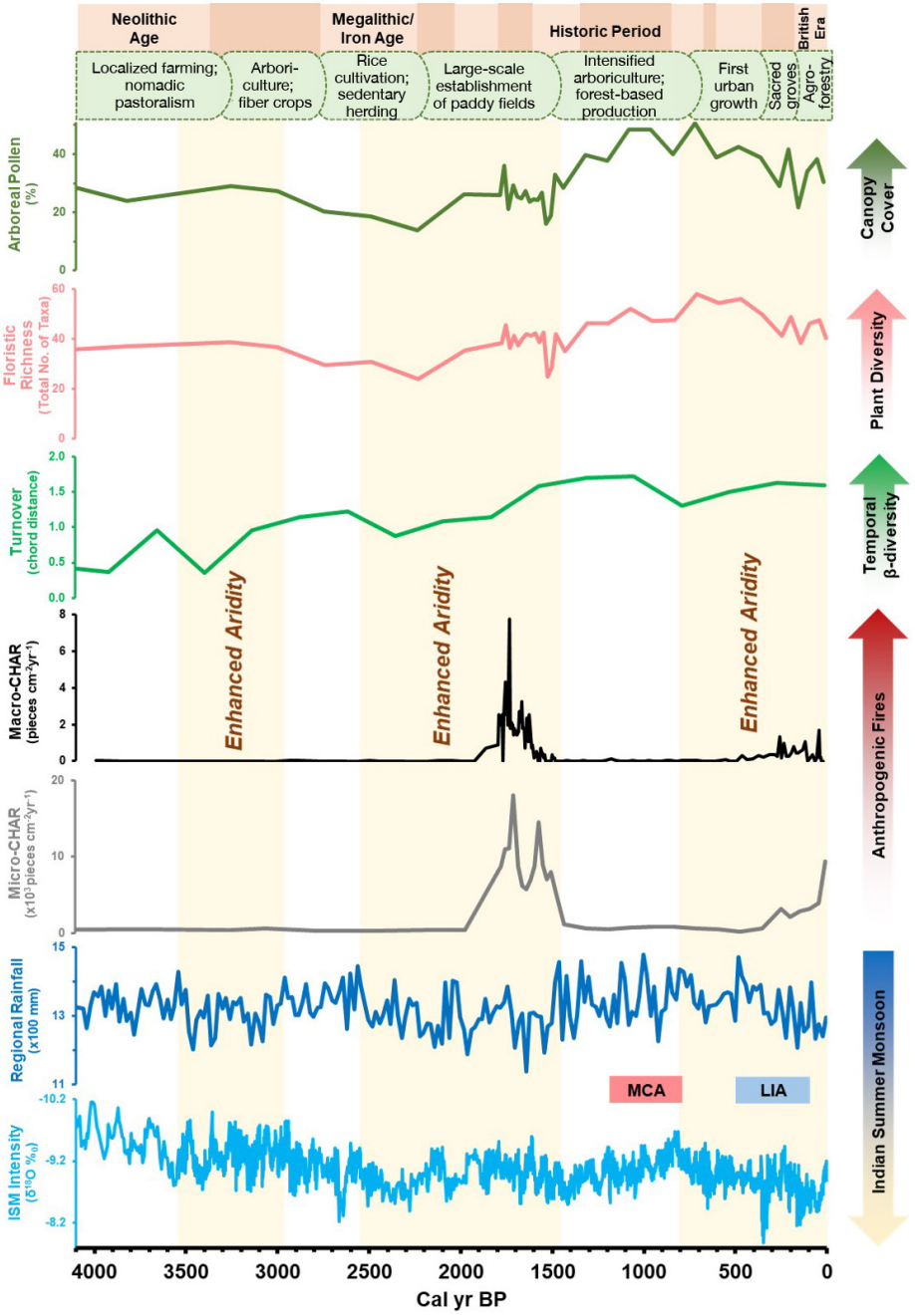

Figure 2: Transformation of the Western Ghats agroforestry landscape over the past 4000 years, showing changes in canopy cover, plant diversity, and fire in relation to the Indian Summer Monsoon variability (Modified from Kulkarni et al. 2021). Paleodata exhibit a high positive correlation between the canopy cover and plant diversity in the Western Ghats and sustained burning episodes during the periods of enhanced aridity, i.e. significant decline in the monsoon.

varying degrees of land-use change over several millennia. A few native species such as *Dipterocarpus*, *Hopea*, and *Palaquium* are already part of historic baselines and are incorporated in the current planning and restoration of the Western Ghats (Muthuramkumar et al. 2006). To this end, paleoscience imparts empirical support to the existing conservation strategies and recommends that maintaining patches of native trees on agroforestry landscapes should be a key priority for conservation and restoration efforts. This recommendation also speaks to the need for conservation beyond protected areas in human-dominated tropical landscapes, and the short-sighted rationale behind promoting exotic, fast-growing agroforestry species (e.g. *Eucalyptus*, *Casuarina*), often under government supported forestry programmes (Garcia et al. 2010).

(2) Fire in agroforested landscapes

Blanket bans on Indigenous fire practices since the colonial times has had serious repercussions on forest succession and forest-dependent livelihoods in many tropical regions (Gadgil and Guha 1993). Studies on fire management from different geographies, including those on traditional fire practices of *Soligas* in the Western Ghats (Sundaram et al. 2012) and of Pemón communities in Venezuela (Bilbao et al. 2010) unveil how outright banning of Indigenous fire practices leads to high-intensity catastrophic fires and the increased susceptibility of tropical forests towards fires.

In the Western Ghats, Kulkarni et al. (2021) show that sustained burning during dry periods (ca. 2000–1600 and 400–0 yr BP) resulted in increased canopy openings, subsequently reducing plant diversity (Fig. 2). Combined with local knowledge, they highlight how the re-introduction, or maintenance, of traditional low-intensity burns can help prevent fire-spread from peripheral agricultural lands into forest reserves, which are often in close vicinity in human-dominated tropical landscapes. This also implies that the slash-and-burn practices of tropical regions that are often portrayed as destructive, are in fact important in maintaining landscape mosaics and heterogeneity, preventing high-intensity fires and enhancing social-ecological resilience (Thekaekara et al. 2017).

Outlook

Expanding the list of paleoscience–policy commons and complementing them with historical and indigenous knowledge, can better uncover the complex drivers of tropical ecosystem transformations and the processes that maintain both natural and cultural values in landscapes. Such paleoscience–policy connections have the potential to incorporate long-term perspectives in environmental planning and can promote inclusive approaches within policymaking. This can also foster cross-sectoral and interdisciplinary collaborations at the science–policy interfaces (Swanson et al. 2021), enabling us to tackle future conservation challenges and secure livelihoods in the tropics.

AFFILIATIONS

[1]Independent researcher; London, UK
[2]Indian Institute of Forest Management, Bhopal, India

CONTACT

Charuta Kulkarni: ckulkarni@gradcenter.cuny.edu

REFERENCES

Bhagwat SA et al. (2012) Biol Conserv 153: 108-117

Bilbao BA et al. (2010) Hum Ecol 38: 663-673

Colombaroli D et al. (2021) PAGES Mag 29: 54-54

Gadgil M, Guha R (1993) This Fissured Land: An Ecological History of India. University of California Press, 312 pp

Garcia CA et al. (2010) Conserv Biol 24: 479-488

Gillson L, Marchant RA (2014) Trends Ecol Evol 29: 317-325

Government of India (2014) National Agroforestry Policy, agricoop.nic.in/sites/default/files/National Agroforestry Policy 2014.pdf

Kulkarni C et al. (2021) J Environ Manage 283: 111957

Maezumi SY et al. (2018) Nat Plants 4: 540-547

Muthuramkumar S et al. (2006) Biotropica 38: 143-160

Nogué S et al. (2018) Ecosystems 21: 45-55

Press Information Bureau (2019) India Will Restore 26 Million Hectares of Degraded Land by 2030: Prime Minister Shri Narendra Modi, pib.gov.in/Pressreleaseshare.aspx?PRID=1584542

Sundaram B et al. (2012) Hum Ecol 40: 931-942

Swanson HA et al. (2021) One Earth 4: 226-237

The 4th World Congress on Agroforestry (2019) Montpellier Declaration, agroforestry2019.cirad.fr/content/download/4744/34532/version/2/file/Montpellier_Declaration_24052019_VEng.pdf

Thekaekara T et al. (2017) Econ Polit Wkly 52: 22-25