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**SPECIAL ISSUE – *The importance of common lands' management for sustaining ecosystem services***

**POSEBNA IZDAJA – *Pomen upravljanja skupnih zemljišč za zagotavljanje ekosistemskih storitev***



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*Front cover photography: Vezeira*, the traditional migration of livestock, from the village of Pincães (Montalegre, Portugal) to high-altitude pastures is a community event organized to revive pastoral traditions and involve younger generations (photograph: Joana Nogueira).
*Fotografija na naslovnici: Vezeira*, tradicionalna selitev živine iz vasi Pincães na Portugalskem na visokogorske pašnike, ki jo izvaja lokalna skupnost, je namenjena oživitvi pašnih tradicij in vključevanju mlajših generacij (fotografija: Joana Nogueira).

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# THE NEXUS OF COMMON LANDS AND ECOSYSTEM SERVICES: A SYSTEMATIC REVIEW AND THEMATIC INSIGHTS

Sai-Leung Ng, Nien-Ming Hong, Yin-Jen Chen

SAI-LEUNG NG

A community-managed irrigation system in a traditional Taiwanese village.

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**Sai-Leung Ng[1], Nien-Ming Hong[1], Yin-Jen Chen[1]**

# The nexus of common lands and ecosystem services: A systematic review and thematic insights

ABSTRACT: Common lands are vital for sustaining ecosystem services that support human well-being. This study systematically reviews 53 empirical articles to examine the nexus between common lands and ecosystem services. Results show that management is fundamental in determining the provision of these services. Both traditional and innovative collective approaches are essential for maintaining ecosystem services across spatial scales. These services support biodiversity conservation and generate economic opportunities. The study highlights the need for integrated strategies to enhance the resilience and sustainability of common lands.

KEYWORDS: common land management, ecosystem services, sustainable resource use, biodiversity conservation, economic opportunities

# Povezavanost skupnih zemljišč in ekosistemskih storitev: sistematični pregled in tematske ugotovitve

POVZETEK: Skupna zemljišča so ključna za ohranjanje ekosistemskih storitev, ki podpirajo blaginjo ljudi. Ta študija sistematično pregleduje 53 empiričnih člankov, da bi proučila povezavo med skupnimi zemljišči in ekosistemskimi storitvami. Rezultati kažejo, da je upravljanje ključnega pomena za zagotavljanje teh storitev. Tradicionalni in inovativni kolektivni pristopi so bistveni za ohranjanje ekosistemskih storitev na različnih prostorskih ravneh. Te storitve podpirajo ohranjanje biotske raznovrstnosti in ustvarjajo gospodarske priložnosti. Študija poudarja potrebo po celostnih strategijah za povečanje odpornosti in trajnosti skupnih zemljišč.

KLJUČNE BESEDE: skupno upravljanje zemljišč, ekosistemske storitve, trajnostna raba virov, ohranjanje biotske raznovrstnosti, gospodarske priložnosti

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# 1 Introduction

Common lands refer to shared natural resources, such as forests, pastures, wetlands, and water bodies, collectively accessed and managed by communities rather than privately or solely state-owned (Ostrom 1992). Governance may be formalized through state recognition or rooted in local customs and institutions (Urbanc et al. 2023). These lands exist globally in diverse forms, including grazing lands, community forests, water sources, fishing grounds, functioning as critical socio-ecological systems where human and ecological processes interact.

Common lands are vital providers of ecosystem services, which the Millennium Ecosystem Assessment (MEA) (2005) categorizes into four types: provisioning (e.g., fuelwood), regulating (e.g., watershed protection), cultural (e.g., recreation), and supporting ecosystem services (e.g., nutrient cycling). These services support livelihoods, ecological resilience, and human well-being. While recognizing these four types, Rodríguez-Ortega et al. (2014) grouped them into provisioning and non-provisioning ecosystem services. Recent frameworks like the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Díaz et al. 2015) and the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin 2018) moves toward a three-group typology, with supporting ecosystem services now considered integral ecological processes underlying all other services rather than a separate category. Because of conceptual clarity, historical significance, and widespread application in both empirical studies and policy communication, the four-group typology of MEA (2005) remains one of the most commonly used frameworks in ecosystem service research (Costanza et al. 2017; Mengist and Soromessa 2019).

Beyond the theoretical evolution of ecosystem service classifications, numerous studies demonstrate that land management practices critically influence the quality and provision of these services. For instance, sustainable agricultural systems and community forest governance can enhance biodiversity and water regulation, whereas intensification and monoculture reduce ecological stability (Carreño-Rocabado et al. 2016; Silva et al. 2019). These insights highlight that ecosystem service outcomes are strongly shaped by governance and management approaches. This creates an important entry point for considering the role of commons and their collective management in promoting sustainable provision of ecosystem services.

Effective management strategies are necessary to maintain the integrity of common lands so that ecosystem services can be sustained. Traditionally, management has been based on collective norms and indigenous knowledge systems aimed at ecological sustainability (Kaye-Zwiebel and King 2014; Meinzen-Dick et al. 2021; Makhubele et al. 2022; Urbanc et al. 2023). Informal or customary institutions help regulate access, distribute benefits equitably, and prevent overexploitation (Ostrom 1992). The management of common lands has become increasingly complex due to external pressures such as land conversion, climate change, and resource overexploitation that in turn threaten their long-term viability (Hristov al. 2020). More recently, hybrid models have emerged, incorporating economic instruments and regulatory frameworks, to align conservation goals with development priorities (Costanza et al. 2014; De Jong et al. 2018; Rodríguez-Ortega et al. 2014).

Despite growing research, there remains a lack of comprehensive synthesis that systematically analyzes how different management approaches impact ecosystem service outcomes across local, regional, and global scales (Bennett et al. 2015). This study addresses that gap through a systematic review of empirical literature on common land management and ecosystem services. Thematic analysis is employed to synthesize key patterns across diverse cases. The study pursues three core objectives:

1) To evaluate how management practices on common lands influence ecosystem services, both positively and negatively.
2) To examine the role of traditional and innovative collective management approaches and their contributions to ecosystem service outcomes across spatial scales.
3) To explore ecosystem services as key drivers in biodiversity conservation and economic opportunities within the context of common lands.

This paper contributes to the existing body of knowledge by offering an up-to-date synthesis of empirical research on the nexus between common land management and ecosystem services. The evidence-based insights generated can inform more effective, inclusive, and adaptive management strategies for sustaining common lands under changing environmental and socio-economic conditions.

# 2. Methods

## 2.1 Systematic review approach

This study employs a systematic review methodology following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al. 2009) to ensure transparency and replicability in identifying and analyzing literature on common lands. The data collection followed a four-stage process (Table 1).

Table 1: Results of the PRISMA procedure

| Stage | Result | Explanation |
|---|---|---|
| Identification | 176 | 176 papers are identified by keyword string searching in Scopus |
| Screening | 143 | 17 non peer-reviewed papers are excluded;<br>16 non research articles are excluded;<br>0 duplicates are excluded |
| Eligibility | 45 | 98 ineligible papers and papers published before 2014 are excluded |
| Included | 53 | 8 papers were manually identified using expert knowledge |

The data query was performed on 15 November 2024. Scopus was selected for the identification of relevant documents. While Scopus and WoS are considered the best choices for bibliometric studies, the former was more appropriate for this study because the field of common lands involves a broad coverage of social sciences and environmental studies (Pranckutė 2021). An initial scoping searching using the term »commons« alone yielded many irrelevant results (e.g., digital, urban, or knowledge commons). Because this study focuses on land- and resource-based commons, a refined keyword string, TITLE-ABS-KEY ((»common land« OR »common resource« OR »common-pool«) AND (»ecosystem service«)), was used to identify 176 documents.

In the screening phase, only peer-reviewed journal articles were retained to maintain scientific rigor and reliability, while other publication types, such as book chapters, conference papers, and reports, were excluded. Additionally, metadata checks were performed to identify and remove duplicate records. After applying these criteria, 143 articles remained.

During eligibility, full-text reviews were conducted. Only empirical studies published from 2014 onward were included in order to focus on the most recent decade of research developments, resulting in a final selection of 45 articles. To broaden global representation and increase European perspectives, nine additional empirical studies were identified outside the database search. These studies were journal articles published in the period 2014–2024, aligning with the inclusion criteria for the data querying, but they employed alternative terminology (e.g., »transhumance,« »High Nature Value farmland,« etc.) not captured by the keyword query. Their inclusion ensures that the dataset more adequately represents global contributions to the field. Incorporating such studies aligns with best practices in systematic reviews, which recommend complementing database searches with manual methods (Booth et al. 2016). The final dataset comprises 53 studies, the list of which is provided in Table 2. Of these, 15 were conducted in Europe, followed by nine in South America, seven in Africa, six in Asia, six in North America, three in Oceania, and seven with a global scope.

## 2.2 Thematic analysis

This study employed thematic analysis to extract and synthesize key insights from the selected empirical literature on common lands and ecosystem services, following Braun and Clarke's (2006) inductive method. While the overarching themes, namely, collective management practices, ecosystem services, conservation and economic opportunities, were shaped by the research objectives, the specific categories and sub-categories were derived directly from the data rather than imposed a priori.

The coding process involved two iterative steps. First, open coding assigned initial codes to recurring patterns such as management approaches, ecosystem service types, and socio-economic impacts. Specifically,

examples such as »rotational grazing« and »cooperative irrigation systems,« were identified as open codes under management practices, while »water purification« and »spiritual well-being« were identified as open codes under ecosystem services. Second, axial coding was applied, where related codes were grouped into broader themes aligned with the research objectives. Codes were grouped into broader themes when they demonstrated conceptual coherence, recurred across multiple studies, and directly reflected the study's objectives. This ensured that the resulting themes were both empirically grounded and analytically relevant to the research questions. The three themes presented in the Results section correspond directly to the categories generated through axial coding, ensuring consistency between the analytical process and the reported findings. These themes were aligned with the study's research objectives, which focused on common lands' contributions to ecosystem services, the effectiveness of collective management approaches, and the role of ecosystem services in biodiversity conservation and economic opportunities.

Each of the 53 included studies was assigned to relevant coding categories based on its core findings. The unit of analysis was the full text of each article, with coding focused on the empirical evidence presented in the Results and, where relevant, supported by insights from the Discussion and Conclusion sections. The coding scheme and results are provided in Table 2. To ensure coding consistency and minimize bias, an inter-coder reliability check was independently conducted by two researchers. Member checking was also employed to validate key interpretations with two experts in the field to reinforce the accuracy of the thematic synthesis.

# 3 Results of literature review

The results of literature review are described in subchapters (see 3.1, 3.2, 3.3) and presented in Table 2.

## 3.1 Positive and negative impacts of land management on ecosystem services (Theme 1)

Common lands offer a wide range of ecosystem services essential to both environmental integrity and human well-being (Costanza et al. 2014; Rodríguez-Ortega et al. 2014). Supporting ecosystem services sustain critical ecosystem functions such as biodiversity maintenance, nutrient cycling, and soil formation, and underpin the delivery of all other ecosystem services by maintaining ecological stability (Berman et al. 2020). Traditional community-based farmland management has been shown to support essential ecological processes like nutrient cycling and soil formation (Lomba et al. 2020). Practices such as controlled grazing and organic farming help preserve soil structure and enhance nutrient flows (Nave et al. 2019). Policy frameworks, for example the Common Agricultural Policy, have supported the integration of conservation practices with local management to improve the resilience of farmlands and grazing systems, many of which are communal farms or pastures within shared-use arrangements or managed cooperatively (Galán et al. 2022). Community forestry practices, such as protected community forests, often sustain greater species richness than unmanaged or exploited lands (Kaye-Zwiebel and King 2014), and forest conservation enhances microbial diversity, which in turn supports soil fertility and productivity (Nave et al. 2019). However, unsustainable practices within commons, such as the intensification of grazing or cultivation on shared farmlands, can disrupt ecosystem functions. For example, when common pastures are converted into intensive agricultural plots, biodiversity declines and ecological processes are disrupted (Hristov et al. 2020). Similarly, monoculture farming and excessive pesticide use on formerly diverse common lands reduce biodiversity, disrupt food chains, and impair ecosystem stability (Carreño-Rocabado et al. 2016; Silva et al. 2019).

Provisioning ecosystem services refer to the tangible resources that common lands supply resources, such as food, water, timber, and medicinal plants, that are particularly vital for rural and Indigenous communities. Traditional grazing systems illustrate how production can be balanced with ecological integrity (Nogueira et al. 2023). Agroforestry and regulated harvesting within communal or cooperative land tenure systems contribute significantly to food security and rural livelihoods (Gómez et al. 2023), and agri-environmental policy incentives often determine the viability of such practices. Watershed co-management supports water availability for both irrigation and household use (Pipan et al. 2023). Within communal grazing lands and shared agricultural landscapes, soil restoration has been shown to increase organic matter, improving crop yields and supporting carbon sequestration (González et al. 2024). Conversely, in poorly governed or open-access commons, overuse and poor management often lead to depletion of provisioning

Table 2: The coding scheme and results of 54 selected articles on common lands and ecosystem services.

| Article [a] | Coding scheme [b] | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theme 1 [c] | | | | | | | | Theme 2 [d] | | | | | | | | | | | | Theme 3 [e] | | | | | | | |
| | I | | | | II | | | | I | | | | | II | | | | | | | I | | II | | | | | |
| | i | ii | iii | iv | i | ii | iii | iv | i | ii | iii | iv | v | i | ii | iii | iv | v | vi | i | ii | i | ii | iii | iv | | |
| 1 Ban et al. (2015) | | + | | + | | | | | | | | + | + | | | + | | | | | | | | | | | | |
| 2 Barton et al. (2017) | + | + | | | | | | | | | | | | | + | | | | | | | | + | | | | | |
| 3 Berman et al. (2020) | + | | + | + | | | + | | | + | | | | | | | + | | | | | | | | | | | + |
| 4 Beye et al. (2022) | + | | + | | | | | | | | | | | | | | | | | | + | | | | | | | |
| 5 Carreño-Rocabado et al. (2016) | | | | | + | | + | | | | | | | | | | | | | | | + | | | | | | |
| 6 Cavigliasso et al. (2022) | + | | | | + | | | | | | | | | | | | | | | | | + | | | | | | |
| 7 Chai et (2021) | | | | | | | | | | | + | | | + | | | | | | | | | + | | | | | |
| 8 Costanza et al. (2014) | + | + | + | + | | | | | | | | | | + | | | | | | | | + | | | | | | + |
| 9 De Araujo Barbosa et al. (2016) | | | | | | + | + | | | | | | | | | | | | | | | + | | | | + | | |
| 10 Denham (2017) | | | | | | | | + | | + | | | | + | | | + | | | | | | + | + | | | | |
| 11 Diwediga et al. (2015) | | | | | + | + | + | | | | | | | | | | | | | | | + | | | | | | |
| 12 Galán et al. (2022) | + | | + | | | | | | + | | | + | | | | | | | | | + | | | | | | + | |
| 13 Gómez et al. (2023) | | + | | + | | | | | | + | | | | | | | + | | | | | | + | + | | | + | |
| 14 González et al. (2024) | + | | + | | | | + | | | | | | | | | | | | | | | + | | | | | + | |
| 15 Guerbois et al. (2019) | + | | + | | | | | | + | + | | | | | | | + | | + | | | | | | | | | |
| 16 Gurney et al. (2021) | | | | | | | | | | | | | + | | | + | + | | | | | | | + | | | | |
| 17 Handberg & Angelsen (2019) | | | | | | | | | | | | | | + | | | | | | | | + | + | | | | + | |
| 18 Hausner et al. (2014) | + | + | + | + | | | | | | | | | | | | | | | | | | + | | + | | | + | |
| 19 Hayes & Murtinho (2018) | | | | | | | | | + | | | | | + | | | + | | | | | + | + | | | | | |
| 20 Kauffman et al. (2014) | | | + | | | | + | | | | | | | | | | | | | | | + | | | | + | | |
| 21 Kaye-Zwiebel & King (2014) | + | + | | + | | | | | | | | + | | | | | | | | | | | + | | | | | |
| 22 Makhubele et al. (2022) | + | | | | | | | | | | | + | | | | | | | | | + | + | | | | | | |
| 23 Måren et al. (2014) | + | | + | | | | | | | + | | | | | | | | | | | + | + | | | | | | |
| 24 Meinzen-Dick et al. (2021) | | | | | | | | | + | | | | | | | + | | | | | | | | | | | | |
| 25 Mekuria et al. (2021) | + | + | + | | | | | | + | | | | | | | | | | | | | + | | | | | | |
| 26 Mirza et al. (2019) | | | | | | | + | | | | | | | | + | | | | + | | | | | | | | | + |
| 27 Nave et al. (2019) | + | | + | | + | | + | | | | | | | | | | | | | | | | | | | + | | |
| 28 Nguyen et al. (2022) | | | | | | | | + | | | | | | + | | + | + | | | | | | + | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 Nkhata et al. (2017) | + | | + | | + | | + | | + | | | | | | + | | | | | | | | | | |
| 30 Nkhwanana et al. (2022) | | | | | + | | | | | | | | | + | | | + | | | + | | | | | |
| 31 Pagot & Gatto (2024) | | | | | | | | | + | | | | | | | + | | | | | | + | | | + |
| 32 Pantshwa & Buschke (2019) | | | | | + | | + | | | | | | | | | | | | + | + | | | | | |
| 33 Plumb et al. (2018) | | | | | | | | | | | + | | + | | | | | | | | + | | | | |
| 34 Polman et al. (2016) | + | | + | | | | | | | | | | | | + | + | | | | | | + | | | + |
| 35 Pulhin et al. (2022) | + | | | | | | | | | + | | | | | + | + | | | | | + | | | | |
| 36 Ratinger et al. (2021) | | | | | | | | | | | | | | | + | + | | | | | | | | | + |
| 37 Reithe et al. (2014) | | + | + | | | | | | | | | | + | | + | | | | | | | | | + | + |
| 38 Ricart e al. (2019) | | + | + | | | | | | | | + | | | | + | | | | | | | | | | + |
| 39 Sattler et al. (2015) | | | | | | | | | | + | + | | | | | | | | | + | | | | | + |
| 40 Silva et al. (2019) | + | | + | | + | | + | | | | | | | | | | | | + | + | | | | | |
| 41 Squires & Vestergaard (2016) | | | | | | | | | | | | | + | | + | | | | | | | | | | + |
| 42 Wagner & Egerer (2022) | | | | | | | | | | | | | | | + | | | + | + | | | | | | + |
| 43 Wang & Zhang (2024) | | + | + | + | | + | + | + | | | | | | | | | | + | | | | | | | |
| 44 Wells et al. (2024) | | + | | + | | + | | + | + | | | | | | | | + | | | | | | | | |
| 45 Bogataj & Krč (2023) | | | | | | + | | + | + | | | | | | | | | | | + | + | | | + | + |
| 46 Hristov et al. (2020) | + | + | + | | | | | | | + | | | | | + | | | | + | | + | | | | + |
| 47 Lomba et al. (2020) | + | | | + | + | | | + | | | | + | | | | | + | | | + | + | | | | |
| 48 Nogueira et al. (2023) | | + | | | | | | | + | + | | | | | | | + | | | | | | | | + |
| 49 Pipan et al. (2023) | | | + | | | | + | | | + | + | | | | | + | + | | | | + | | | | + |
| 50 Renes et al. (2023) | + | + | | + | | | | | | | | + | | | | | | | | + | + | | + | | |
| 51 Rodríguez-Ortega et al. (2018) | | + | + | + | | | | | | | | + | | | | | | | | | + | | | | + |
| 52 Šumrada & Erjavec (2023) | | | | | | | | | + | | | | | | | + | + | | | + | + | + | | | |
| 53 Tucker et al. (2023) | | | | | | | | | + | + | | | | | + | + | | | | + | + | | | | + |
| Total number | 21 | 15 | 20 | 11 | 9 | 5 | 13 | 6 | 12 | 11 | 5 | 7 | 4 | 7 | 7 | 13 | 16 | 3 | 4 | 11 | 25 | 11 | 7 | 5 | 22 |

[a] Articles #1–44 were identified by automated keyword search, while articles #45–53 were manually selected based on expert judgment. Full citations for all articles are provided in the reference list of this paper.

[b] Coding scheme: Arabic numerals (e.g., 1, 2) indicate themes; capital Roman numerals (e.g., I, II) indicate categories; lowercase Roman numerals (e.g., i, ii) indicate sub-categories.

[c] Theme 1: Impacts of land management on ecosystem services, where Category I represents positive impacts (i: Supporting ecosystem services; ii: Provisioning ecosystem services; iii: Regulating ecosystem services; iv: Cultural ecosystem services) and Category II represents negative impacts (i: Supporting ecosystem services; ii: Provisioning ecosystem services; iii: Regulating ecosystem services; iv: Cultural ecosystem services).

[d] Theme 2: Collective management approaches, where Category I represents traditional approaches (i: Common-pool resource management; ii: Indigenous knowledge-based management; iii: Cooperative irrigation systems; iv: Traditional agroforestry and pastoral systems; v: Customary marine resource management) and Category II represents innovative approaches (i: Payments for ecosystem services (PES); ii: Ecosystem service auctions and market-based instruments; iii: Environmental cooperatives and multi-stakeholder partnerships; iv: Community-based conservation initiatives; v: Digital and data-driven management; vi: Technology-enabled adaptive management).

[e] Theme 3: Ecosystem services opportunities, where Category I represents Biodiversity conservation (i: Biodiversity refuges; ii: Ecosystem health) and Category II represents economic opportunities (i: Payments for ecosystem services (PES); ii: Ecotourism; iii: Carbon markets; iv: Sustainable resource management).

ecosystem services. Overexploitation of forest and water resources, intensive grazing, and vegetation loss have all contributed to reduced availability of plant-based resources (Diwediga et al. 2015; de Araujo Barbosa et al. 2016; Silva et al. 2019).

Regulating ecosystem services encompass ecosystem functions that help moderate environmental conditions, including carbon sequestration, water purification, and erosion control. Forest conservation plays a key role in climate change mitigation by capturing carbon (Berman et al. 2020), and wetlands filter pollutants while reducing the risk of floods (Guerbois et al. 2019). Healthy forests and wetlands buffer extreme weather events, stabilize water cycles, and minimize soil erosion (Mekuria et al. 2021). Effective common land management, such as rotational grazing, maintenance of forest cover, or restoration of traditional irrigation systems enhances environmental stability by maintaining vegetation cover, regulating water flows, and preventing soil erosion, which collectively reduce drought and flood risks (Galán et al. 2022). In contrast, repeatedly tillage in collectively managed farmlands increases greenhouse-gas emissions (Hristov et al. 2020). Land degradation increases exposure to droughts and floods, weakening ecosystem functionality and resilience (Nkhata et al. 2017).

Cultural ecosystem services refer to the non-material benefits derived from common lands, including cultural identity, spiritual well-being, and aesthetic and recreational values. Traditional land management, which occur under either communal or individual tenure arrangements, is often deeply embedded in cultural practices and can reinforce community identity and social cohesion (Kaye-Zwiebel and King 2014; Wells et al. 2024). Transhumance is one example, preserving both cultural heritage and ecological landscapes in Europe (Renes et al. 2023). However, cultural ecosystem services can be undermined by shifts in land governance and policy. For example, the marginalization of high-nature-value farming and cultural landscapes due to intensification and policy changes has eroded community traditions (Lomba et al. 2020). Policy constraints may restrict the expression of communal identity and limit cultural continuity (Nguyen et al. 2022), and ignoring Indigenous sovereignty can undermine longstanding cultural ties to land (Denham 2017).

## 3.2 Collective management approaches enhancing ecosystem service across spatial scales (Theme 2)

Collective management approaches, as synthesized from the reviewed studies (e.g., Meinzen-Dick et al. 2021; Gómez et al. 2023; Tucker et al. 2023), can be categorized as either traditional approaches, rooted in local customs and Indigenous knowledge systems, or innovative approaches, which incorporate new institutional designs, technological tools, or adaptive governance strategies. Regardless of form, these approaches share common features such as collective decision-making, participatory structures, and multi-stakeholder coordination. Their effectiveness varies across spatial scales, from local communities to regional or international networks, influencing ecosystem service outcomes through a variety of mechanisms.

A major strand of traditional collective management includes a range of practices that reflect deep community engagement with local ecosystems. Among the most widely documented is common-pool resource management, in which communities collectively govern access to shared forests, rangelands, or fisheries. For example, customary tenure systems in India have ensured the long-term sustainability of forest resources (Meinzen-Dick et al. 2021), while community-led conservation efforts in South Africa's Garden Route have maintained ecosystem health through cooperative governance (Guerbois et al. 2019). Forest commons governance, as seen in Slovenia, illustrates how community stewardship enhances ecological resilience (Bogataj and Krč 2023), and these systems are often influenced by national or EU-level policy frameworks. Indigenous knowledge-based practices represent another key category of collective management, as they rely on cultural rules, customary tenure, and shared norms to organize land use. In the Amazon, agroforestry systems are maintained collectively through cultural rules that promote biodiversity and ecological balance (Gómez et al. 2023). In upland Portugal, seasonal grazing and rotational systems demonstrate how traditional knowledge is embedded in community practices to support ecosystem sustainability, reinforced by agricultural policy incentives (Nogueira et al. 2023).

Another form of collective management is cooperative irrigation systems. Across Europe, cooperative networks manage water distribution for agriculture in ways that balance efficiency with local participation

(Ricart et al. 2019). In Oregon, USA, irrigation districts operate through similar principles, demonstrating the global relevance of collective water management (Plumb et al. 2018).

Traditional agroforestry and pastoral systems also contribute to sustainable land use, as access and practices are governed collectively through customary rules, rotational arrangements, and community norms that balance ecological resilience with shared livelihood benefits. Mountain grazing systems maintained under the Common Agricultural Policy illustrate how long-standing practices are adapted within policy frameworks to preserve biodiversity and resilience (Galán et al. 2022). Transhumance, a seasonal herding tradition in Europe, exemplifies a collective management approach in which communities coordinate seasonal grazing rights and herd movements, thereby maintaining habitat connectivity and cultural continuity (Renes et al. 2023).

In coastal areas, customary marine resource management illustrates the integration of local governance with ecosystem stewardship. In the Indo-Pacific, community-managed marine areas have become important for sustainable fisheries, combining cultural norms with ecological monitoring (Ban et al. 2015; Gurney et al. 2021).

Among innovative governance mechanisms are payments for ecosystem services (PES), environmental cooperatives, and market-based instruments. PES are one such mechanism, providing financial incentives for conservation. In China, PES programs have been integrated into village-level irrigation systems, blending institutional reforms with traditional collective action (Chai et al. 2021). In Vietnam, community-based PES arrangements have supported conservation goals while addressing equity concerns (Nguyen et al. 2022).

Environmental cooperatives and multi-stakeholder partnerships also exemplify innovation in governance. In Europe, environmental cooperatives have evolved from top-down interventions into collaborative networks balancing ecological and economic objectives (Ratinger et al. 2021). In marine environments, partnerships between governments and local fishing communities have enhanced the legitimacy and effectiveness of protected area management (Reithe et al. 2014).

Community-based conservation initiatives remain central to local resource management. In the Philippines, protected area co-management is supported through legal recognition of community property rights (Pulhin et al. 2022). Similar arrangements across Latin America have yielded conservation gains and empowered marginalized groups (Sattler et al. 2015; Hayes and Murtinho 2018). In Slovenia, the blending of administrative support with community norms has strengthened water commons governance (Pipan et al. 2023).

Other innovative instruments include ecosystem service auctions and market-based tools, which have been adapted to communal contexts. Studies highlight how auction systems can align with collective land tenure, influencing participation and conservation outcomes (Barton et al. 2017). Governance design remains critical for ensuring both effectiveness and equity (Squires and Vestergaard 2016).

Digital and data-driven management approaches enhance transparency and monitoring. In South Africa, community actors use Sentinel-2 satellite imagery to track ecosystem degradation and guide local interventions (Nkhwanana et al. 2022). In China's Liaohe River Delta, digital ecosystem service models inform co-management decisions across agencies and user groups (Wang and Zhang 2024).

Technology-enabled adaptive management is another frontier of collective management. In urban and rural areas, communities employ machine learning tools to assess land-use change and soil health, enabling data-driven feedback loops (Wagner and Egerer 2022). Computer models are used to simulate how policy frameworks, such as Common Agricultural Policy, affects agricultural development (Hristov et al. 2020). Broader research has emphasized the role of technological innovation in shaping environmental access and equity (Mirza et al. 2019).

Finally, cross-scale governance illustrates how collective management systems operate at multiple spatial scales, from community-level initiatives to transboundary efforts. Local projects often succeed due to participatory governance and embedded knowledge systems but face challenges such as limited funding, weak institutional support, and land-use pressures (Pagot and Gatto 2024). Improved policy coordination and data integration are also essential to advancing these innovative approaches, ensuring long-term sustainability (Nguyen et al. 2022).

At regional and international levels, common land initiatives address large-scale challenges such as watershed restoration and integrated landscape governance. These efforts frequently encounter complex institutional landscapes, overlapping jurisdictions, and diverging stakeholder interests (Pagot and Gatto 2024). Policy alignment across scales is critical for advancing effectiveness (Nguyen et al. 2022). Importantly,

cross-scale linkages enhance resilience and learning. Local initiatives can benefit from technical assistance and policy alignment, while broader programs draw on local knowledge and community-based innovations (Pagot and Gatto 2024). As Tucker et al. (2023) argue, integrating commons governance across levels fosters adaptive capacity and long-term sustainability.

## 3.3 Ecosystem services as drivers of biodiversity conservation and economic opportunities (Theme 3)

Ecosystem services serve as critical drivers of both biodiversity conservation and local economic development on common lands. Biodiversity conservation provides the ecological foundation for economic opportunities, as species-rich commons underpin provisioning ecosystem services (e.g., grazing, non-timber products) and cultural ecosystem services (e.g., tourism). The dual role underscores the significance of commons for achieving integrated environmental and socio-economic sustainability.

Biodiversity conservation is closely linked to the ecosystem services provided by common lands (Rodríguez-Ortega et al. 2014). Forests, agroforestry systems, and rangelands managed through collective practices often serve as biodiversity refuges. For instance, traditional agroforestry systems, such as those in South Africa's Vhembe Biosphere Reserve, support diverse tree species (Makhubele et al. 2022), while community-managed Himalayan forests ensure greater species richness compared to state or privately managed forests (Måren et al. 2014). In Europe, traditional collective grazing practices prevent shrub encroachment and maintain habitats for birds and insects (Galán et al. 2022). Transhumance has also been instrumental in maintaining semi-natural high-value conservation areas and contributes to rural economies through cultural tourism (Renes et al. 2023). Managed grazing in Mediterranean landscapes promotes habitat heterogeneity (Silva et al. 2019), and wetlands and riparian commons further contribute as breeding grounds for fish, amphibians, and birds (Pantshwa and Buschke 2019).

Ecosystem health is supported by services such as soil fertility, water regulation, pollination, and carbon sequestration. In the Colombian Andes, community-managed forests enhance soil quality and microbial diversity, sustaining productive and biodiverse ecosystems (González et al. 2024). Hydrological services provided by forests and wetlands are equally important. Community land tenure in Norway has improved water retention and reduced sedimentation (Hausner et al. 2014), while conservation initiatives in Ecuador and Slovenia have improved water quality and aquatic biodiversity (Hayes and Murtinho 2018; Pipan et al. 2023).

Pollination services are essential to both biodiversity and agriculture. Enriched grasslands support greater pollinator diversity (Beye et al. 2022), and wild bee populations thrive in floral-rich common lands (Cavigliasso et al. 2022). In Slovenia, collective agri-environmental incentives have enhanced pollinator habitats in high-nature-value farmland (Šumrada and Erjavec 2023). Carbon sequestration also supports biodiversity by preserving forest, grassland, and mangrove habitats that are often managed as community or village commons. In the Dominican Republic, intact mangrove ecosystems store significant amounts of carbon and support diverse aquatic and avian species, whereas their conversion to private aquaculture ponds has led to substantial carbon emissions and habitat loss (Kauffman et al. 2014). In contrast, fire-managed savannas in Tanzania show how collective land management can sustain both biodiversity and carbon stocks (Handberg and Angelsen 2019).

Ecosystem services also provide economic opportunities. PES, already introduced in Theme 2, are also important here for linking conservation with livelihood benefits. Programs in Mexican forests have improved local incomes while preserving biodiversity (Denham 2017), and communal PES schemes in Ecuador have enhanced water quality and livelihoods in Andean regions (Hayes and Murtinho 2018). In Slovenia, agri-environmental payments linked to biodiversity support farmers managing commons (Šumrada and Erjavec 2023).

Ecotourism is another important revenue stream for communities managing common lands. In Norway, ecotourism integrated with community forest management brings financial returns and supports conservation (Hausner et al. 2014). In Mexico, cloud forest ecotourism is often organized through community-based initiatives in regions under communal tenure. It has generated jobs and fostered environmental education for the local communities (Denham 2017). In Europe, transhumance contributes to cultural tourism and

supports rural economies (Renes et al. 2023). Marine commons also offer significant potential for nature-based tourism (Gurney et al. 2021).

Carbon markets monetize sequestration services through credit systems. In the Amazon, community-based carbon initiatives have improved forest conditions while generating income (de Araujo Barbosa et al. 2016). In the Dominican Republic, the conversion of formerly community-managed mangroves mangroves to private aquaculture ponds has released substantial carbon stocks. This has not only reduced competitiveness in global carbon markets but also resulted in economic and environmental losses associated with the breakdown of commons management (Kauffman et al. 2014).

Finally, sustainable resource management of commons provides long-term economic resilience. Examples include timber, non-timber forest products, and fisheries harvested under collective governance, which can balance livelihoods with ecological sustainability. In Colombia, community-based sustainable sustainable forestry has boosted both ecological and economic outcomes (González et al. 2024). In Tanzania, community-based fire management has improved biodiversity, carbon storage, and livelihoods (Handberg and Angelsen 2019). In Slovenia, forest commons support economic recovery and sustained access to natural resources following environmental disturbances (Bogataj and Krč 2023).

Taken together, these findings show that biodiversity conservation and economic opportunities on commons are often intertwined rather than separate domains. Biodiversity-supporting ecosystem services create the conditions for livelihoods, and under effective communal or collective governance, economic incentives can reinforce conservation. At the same time, pressures to generate income may lead to trade-offs that challenge ecological outcomes, highlighting the need to balance environmental and socio-economic goals.

# 4 Discussion

## 4.1 Analytical framework for common lands and ecosystem services

The thematic analysis shows that management practices, ecosystem services, and socio-economic benefits are closely interlinked. To capture these connections, an analytical framework was developed to illustrate how governance of common lands shapes ecosystem service outcomes and, in turn, broader conservation and economic benefits (Figure 1).

The framework distinguishes between two relationships. The direct relationship reflects how management structures, tenure arrangements, and day-to-day decisions affect biodiversity and livelihoods by determining

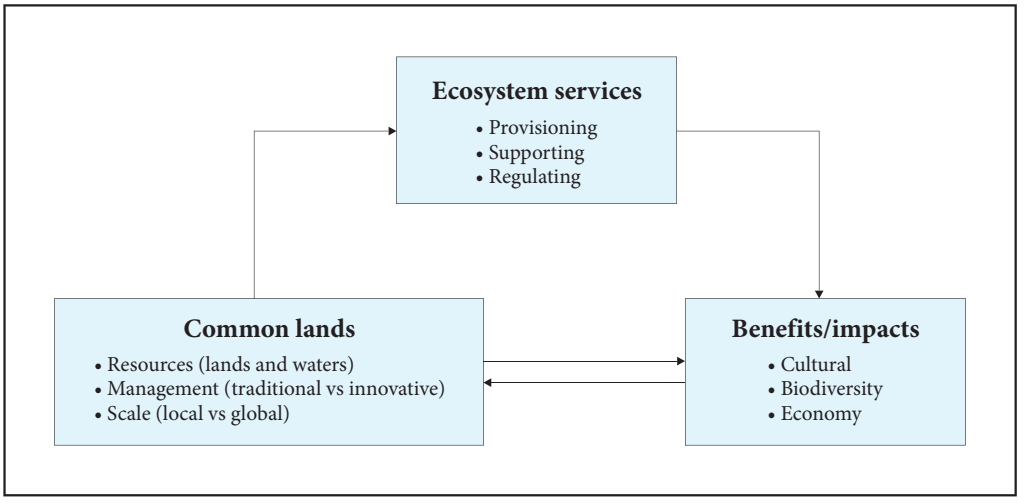


Figure 1: The analytical framework for common lands and ecosystem services.

access to and use of resources. Examples include the loss of ecological integrity through deforestation or overgrazing, and the enhancement of both biodiversity and productivity through community-based conservation when supported by strong local institutions and equitable participation (Carreño-Rocabado et al. 2016). Benefits from sustainable practices may also encourage further participation and stewardship, reinforcing positive outcomes (Urbanc et al. 2023).

The indirect relationship is understood through ecosystem services, which serve as a lens to examine how management practices connect to biodiversity and socio-economic outcomes. Ecosystem services translate governance decisions into ecological and livelihood benefits by maintaining key processes and generating both material and non-material values (Bennett et al. 2015; Berman et al. 2020). While common lands are physically shared resources, their ecological potential is largely determined by how they are governed and managed. Their sustained provision, however, relies on effective and sustainable management practices. Thus, governance and management ultimately shape whether ecosystem services can be delivered effectively, in turn influencing conservation and economic opportunities.

This dual-pathway framing highlights the novelty of the framework, since ecosystem services are recognized not only as outputs of governance but also as intermediaries that shape long-term outcomes. The framework therefore offers both a theoretical and practical tool for future research and policy, enabling comparison across cases, guiding policy design, and advancing commons scholarship by connecting ecological processes with institutional arrangements and distributive outcomes.

## 4.2 Theoretical and practical implications

Theoretically, this study clarifies the dynamics between common lands and ecosystem services. While ecosystem services are commonly framed as passive consequences of common lands, this study treats ecosystem services as the pathways through which governance of common lands translates into biodiversity conservation and socio-economic outcomes. Therefore, common land management should be embedded in broader socio-ecological systems influenced by markets, climate, and policy (Biggs et al. 2015).

Second, this study highlights the importance of multi-level management structures in achieving sustainable ecosystem service outcomes by sustaining multifunctional bundles, in contrast to individually or company-managed lands that often prioritize provisioning ecosystem services (Ostrom 1992; Tucker et al. 2023). Within these broader governance landscapes, polycentric management decentralizes decision-making and strengthens the governance of common lands (Meinzen-Dick et al. 2021). These dynamics are particularly relevant in contexts where both traditional management and modern interventions interact (De Jong et al. 2018). At the same time, multi-level and polycentric arrangements can present challenges. Coordination across levels may be difficult, transaction costs may increase, and overlapping or fragmented authority can weaken accountability. Power imbalances among stakeholders may also reduce inclusiveness, and resource-poor communities may face barriers to effective participation. Recognizing these potential downsides provides a more balanced understanding of polycentric governance in practice.

From a practical standpoint, the study suggests strengthening local institutions to improve conservation outcomes and equitable benefit-sharing (Meinzen-Dick et al. 2021). Tools such as PES and co-management can incentivize sustainable practices (Berman et al. 2020; Gómez et al. 2023), while cross-scale coordination can promote resilience, mitigate conflict, and align efforts across jurisdictions (Biggs et al. 2015). However, PES schemes may raise concerns. They can undermine trust (Chan et al. 2017), privilege landowners while excluding marginalized groups (Pascual et al. 2014), or conflict with cultural values and community agency (Muradian et al. 2010). PES may also favor short-term incentives over long-term stewardship (Hayes and Murtinho, 2018). Recognizing these limitations provides a more balanced perspective on the role of PES schemes in commons governance.

Second, the study underscores the need for management models that are flexible, participatory, and adaptive to changing environmental and socio-economic conditions (Tucker et al. 2023). In addition, policy interventions should be recognized as a cross-cutting factor shaping outcomes across all ecosystem services and governance levels. Effective policy alignment can reinforce traditional practices, enable innovative mechanisms such as PES, and support coordination across scales to strengthen the resilience of commons. Policymakers must ensure that management structures not only regulate access to common lands but also empower communities with the necessary tools and incentives to engage in sustainable resource management.

### 4.3 Limitations and recommendations for future studies

This study is limited by its reliance on keywords that explicitly link common lands with ecosystem services. While this approach was necessary to focus the dataset, it may bias the literature toward anthropocentric perspectives that frame biodiversity conservation in utilitarian terms. As a result, alternative perspectives, such as post-humanist or eco-centric approaches, or framings of economic well-being beyond land productivity, may be underrepresented. Future reviews could address this by experimenting with broader or more inclusive search strings. Second, the study relies on peer-reviewed literature, potentially excluding insights from grey literature and community-based knowledge. Future research should incorporate a broader range of sources, including policy reports and interviews. Third, language bias is another concern, as most selected articles were in English. Non-English literature is underrepresented and should be better included in future reviews. Fourth, comparability is constrained by spatial and temporal variation in management contexts. Longitudinal and cross-case studies are needed to assess the durability and scalability of different management regimes. Fifth, this study adopts the four-part typology of MEA (2005), which includes supporting ecosystem services as a distinct category. While still widely used in empirical studies, this typology differs from some recent frameworks, such as IPBES and CICES, that reclassify supporting ecosystem services as foundational ecological functions. This discrepancy may limit the comparability with some recent studies. Future reviews should consider ways to bridge these frameworks, such as mapping legacy data onto updated classifications. Finally, this study does not fully capture the influence of external drivers, such as climate change, global trade policies, or demographic shifts, which may significantly influence common land management and ecosystem service provision. Future studies should examine how such factors shape local management responses and resilience.

## 5 Conclusion

This study provides a systematic review on the management of common lands and their impact on ecosystem services. An analytical framework is proposed to clarify how management structures and ecosystem services interact to generate socio-ecological benefits. Common lands generate not only direct effects on biodiversity conservation and economic opportunities but also indirect effects mediated through ecosystem service. Adaptive and multi-level governance, aligning communal and collective local practices with broader policy mechanisms, contributes to sustainability. Such integration ensures that common lands remain resilient systems capable of supporting biodiversity and livelihoods in an era of environmental uncertainty.

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All intellectual content and interpretations were produced by the human authors. No AI tools were used for the conceptualization, writing, translation, summarization, analysis, or figure production of this study. Basic AI-powered software (e.g., grammar and citation checkers) was used solely for minor formatting or language refinement purposes.

RESEARCH DATA: For information on the availability of research data related to the study, please visit the article webpage: https://doi.org/10.3986/AGS.14327.

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