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Agroecological initiatives in the Mekong Region: a systematic literature review and mapping reveals their implications for transitioning to sustainable food systems

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ABSTRACT

In the Mekong Region, agroecological approaches provide a niche alternative to the dominant traditional or intensive farming systems. We conducted a synthesis of current evidence on agroecological interventions by means of a systematic literature review and mapping of case studies in Cambodia, Vietnam, Laos, Thailand, and Myanmar. The majority of the 271 identified cases focussed on practical and technical support. Interventions using holistic approaches, and such that focused on improving food systems through innovative territorial governance, value chain arrangements, and policy frameworks were scarce. Most cases targeted the agroecological optimization and the modernization of traditional farming systems. A mere 18 of our cases addressed gender in relation to agroecology. To scale agroecological transitions, sectoral barriers have to be overcome. There is an urgent need to put a pronounced focus on the diversification of ecosystem services in commercial agriculture and degraded areas and on women's contributions to sustainable farming.

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Agroecology initiatives; spatial inventory; Mekong region; ecosystem services; gender relations; agroecological transitions

Introduction

The agrarian transition has tremendously transformed agricultural landscapes in the Mekong Region[1] in the past three decades: massive expansion of agricultural production landscapes, modernization, intensification, and mechanization of farming systems, and integration of production spaces in regional and global economic networks (Cole, 2022; Ingalls et al., 2018). This transition was a major trigger of deforestation (Castella & Kibler, 2015a; Estoque et al., 2019; Jamaludin et al., 2022; Namkhan et al., 2021; Zeng et al., 2018) and caused widespread land degradation by focusing on the increase of agricultural yields at the expense of other ecosystem services, e.g. carbon storage (Feng et al., 2021; Hett et al., 2012) or the regulation of soil quality (Bruun et al., 2017). The overexploitation of natural resources and the use of chemical inputs have threatened the supply of agrarian ecosystem services and caused ecosystem disservices such as soil erosion and pollution of air and water (Palomo-Campesino et al., 2018).

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The homogenization of agricultural landscapes has led to rapid and widespread biodiversity decline in a globally relevant hotspot with exceptional levels of species richness and endemism (Carrasco et al., 2016; Myers et al., 2000).

Against this background, a change of paradigm is needed to prevent irreversible tipping points leading to widespread environmental degradation and related societal impacts. Several authors call for a shift in sociotechnical regime of similar amplitude as the agrarian transition; a profound transformation of all aspects of the agrarian systems, including farming practices, territorial governance, value chain arrangements, and policy frameworks (Duru et al., 2015; Wezel et al., 2020). Alternative farming systems are needed that combine high crop productivity with a high diversity of ecosystem services and maintenance of biodiversity to reconcile food security, economic development, and environmental sustainability within multi-functional landscapes (Garcia et al., 2021; Robertson & Swinton, 2005). Beyond technical innovations in farming practices, agroecological approaches are based on fundamentally different relationships between agriculture and the environment and propose a way to protect, manage, and restore ecosystem services while providing healthy food and securing livelihoods (Altieri et al., 2015; Duru et al., 2015; Wezel et al., 2020). What's more, agroecological approaches facilitate the closing of gender gaps to enable social and environmental justice is a core principle for agroecology (Zaremba et al., 2021). Women are key stakeholders in rural family farming (Anderson et al., 2019) and their empowerment is shown to have a direct impact on agricultural productivity and household food security (Sraboni et al., 2014). Literature consistently reveals that women face limited access to resources such as land and capital, technology, training and marketing services, and unequal participation in decision-making (Akter et al., 2017; Alkire et al., 2013; Schlosberg et al., 2017).

Agroecological approaches have been promoted in different parts of the Mekong Region. However, information on successes, failures, and upscaling potential remains scattered. Various online platforms provide literature repositories on agroecological innovations, but a concise, systematic, easily accessible, practical, and spatially disaggregated overview is lacking. This makes it difficult for e.g. policymakers, rural extension services, development partners, and community-based organizations to evaluate the potential of agroecology as an alternative to intensive agriculture in different social-environmental contexts and to use this information to integrate agroecology into their development strategies. While there are a few global reviews of the relationships between agroecological or sustainable practices and ecosystem services (Duru et al., 2015, Palomo-Campesino et al., 2021; Wezel et al., 2014), to our knowledge, there is no systematic review focussing on the Mekong Region, using both scientific and grey literature, and mapping hotspots of agroecological interventions at high spatial resolution.

This study sheds light on the current state and gaps of knowledge of agroecology as an alternative pathway to the current unsustainable agrarian transition in the Mekong Region. It builds on a systematic review of scientific and grey literature that demonstrate agroecological innovations and focusses on three aspects: First, it identifies, maps, and characterizes documented agroecological initiatives, with a focus on their innovation type, the agroecological transitions they aim to achieve, and ecosystem services or biodiversity that they enhance. Second, it includes an analysis on how the identified initiatives address gender and demonstrates why this is important. Finally, it identifies knowledge gaps in the assessed body of literature and provides recommendations on priority topics to be addressed in order to scale agroecological approaches in the Mekong Region.

Materials and methods

We followed a three-step approach to identify, evaluate, and select literature sources that present agroecological innovations (see Figure 1 and the following sections).

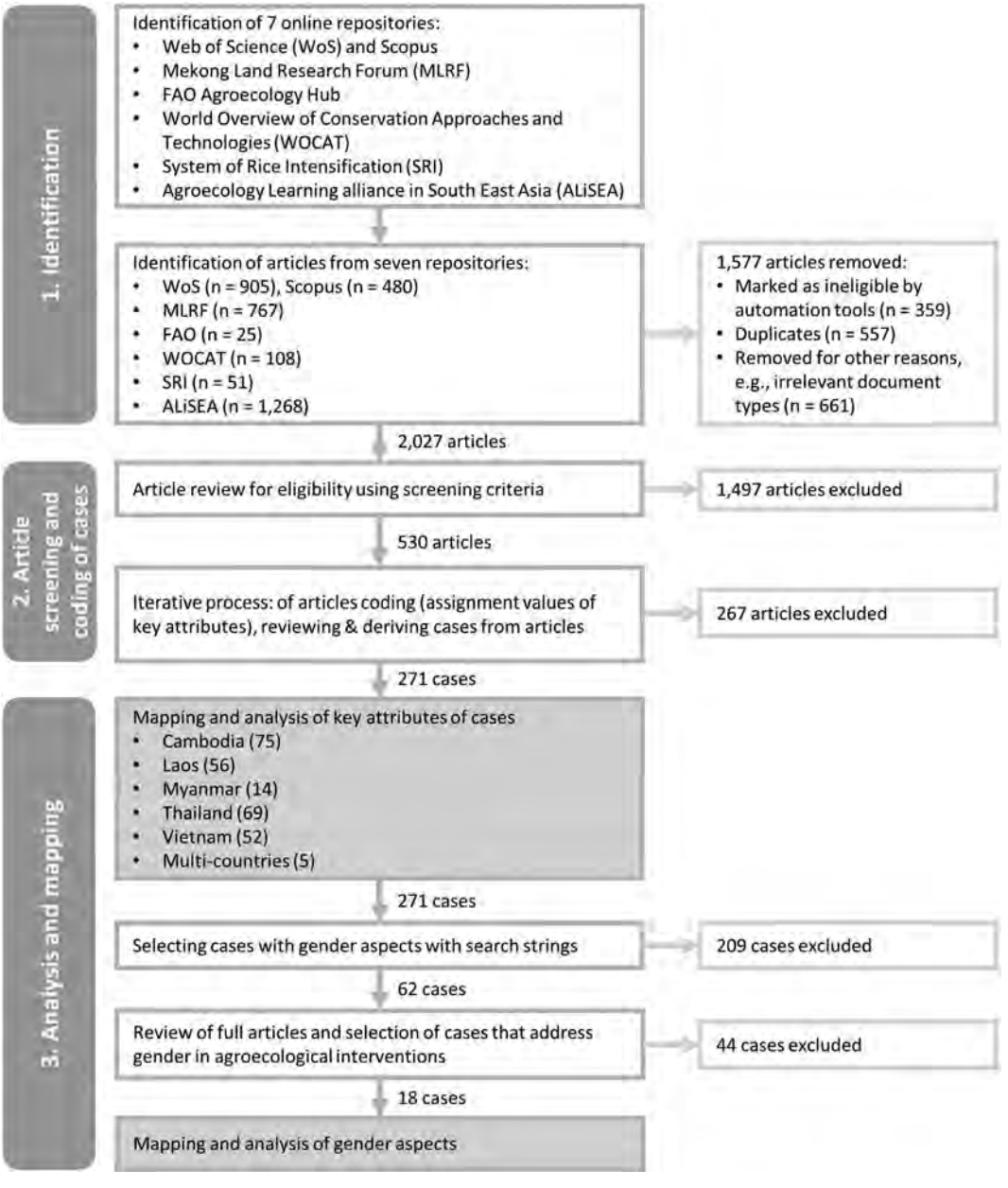

Figure 1. Workflow for identification, screening and coding of literature sources, and mapping and analysis of derived cases of agroecological innovations.

Step 1: Identification

Based on consultation with international experts from science and practice, we selected seven online literature repositories to retrieve cases:

- Scopus (www.scopus.com) and Web of Science (WoS; www.webofscience.com) repositories, which are globally leading for peer-reviewed research articles.

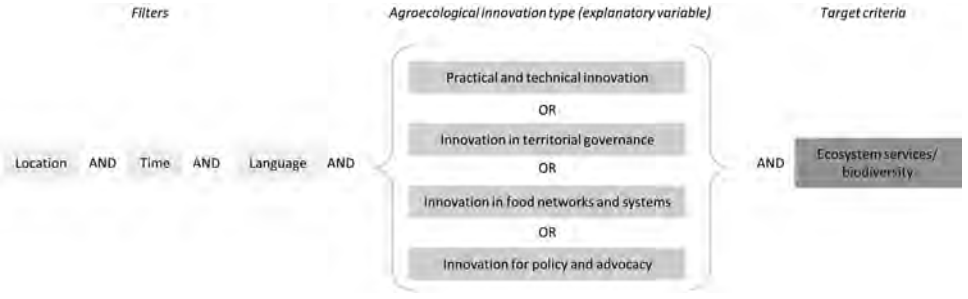

Figure 2. Elements of the search string for automated identification of articles relevant for the systematic review.

- Agroecology Learning Alliance in South East Asia (ALiSEA; https://ali-sea.org), a comprehensive regional database on agroecology.
- The FAO Agroecology Hub (FAO; www.fao.org/agroecology/database/en/), a global repository documenting efforts to further agroecology.
- The Mekong Land Research Forum (MLRF; www.mekonglandforum.org), a regional repository with articles from science and practice on land governance and food systems.
- The System of Rice Intensification International Network and Resources Centre (SRI; http://sri.ciifad.cornell.edu/), a resource for documented experiences on SRI practice with high regional relevance.
- The World Overview of Conservation Approaches and Technologies (WOCAT; www.wocat.net), a database on best practices for sustainable land management including agroecological practices.

We created search strings to automatically extract articles from these repositories (see Figure 2; complete list of keywords in Annex 1). The elements of the search strings were as follows:

Location: searched for articles from one or several countries of the Mekong Region (Cambodia, Laos, Myanmar, Thailand, Vietnam); this selection of countries is consistent with the geographical scope of the other three framing papers of this special issue;*Time*: searched for articles published between 2007 and 2021; between the inception of the agrarian transition in the Mekong Region and the most recent available sources at the time we conducted the search. Our aim was to focus on contemporary trends in agroecological literature and a consistent timeframe across the review papers of this special issue;

Agroecological innovation type: Searched for keywords referring to the level of agroecological innovation. We used the framework of Bottazzi and Boillat (2021), derived from the categories proposed by Gliessman (2016), that distinguishes four repertoires of collective action and transformation levels of agroecological innovation:

(1) practical and technical innovations: activities on-farm or in test sites, e.g. substituting synthetic with organic fertilizer, changing from conventional tillage to no-till farming
(2) landscape-level territorial governance, e.g. participatory land use planning
(3) alternative food networks and sustainable value chains, e.g. creating and strengthening bottom-up certification schemes such as participatory guarantee systems (PGS)
(4) the approval and promotion of agroecological principles in policy and through advocacy, e.g. establishing farmer field schools in the portfolio of agricultural extension services

Language: searched for articles in the English language;

Ecosystem services/biodiversity: searched for keywords referring to ecosystem services or biodiversity;

We adapted the search to deal with differences in data organization of the different repositories and removed duplicates and documents of irrelevant types such as meeting minutes, workshop reports, presentations, guidelines, handbooks, and training materials (see Annex 1 for the keywords used in the

searches and for further details on the search procedures to accommodate the different structures of the online repositories and their options to retrieve data).

Step 2: Article screening and coding of cases

Seven researchers evaluated the articles manually for eligibility based on three inclusion/exclusion criteria: (1) explicit link to a clearly identifiable geographic location; (2) topical match and focus on agroecological innovation (we excluded theoretical, conceptual, and purely analytical modelling studies, and studies only mentioning but not focusing on agroecological innovations); (3) description of beneficial impacts on ecosystem services or biodiversity.

In the case of scientific articles, titles and abstracts were used to perform the screening (with some full-text reviews when in doubt). In the case of grey literature without abstracts, we compiled abstracts using excerpts from the manuscript. The coding of articles included a review of key attributes used for the initial screening and of additional key attributes (Table 1). We used an adapted version of the concept of states and transitions in (agro-)ecosystems by Tittonell (2020) to categorize the articles (Figure 3). We distinguished between (a) articles describing transitions from traditional, industrial, and degraded states to agroecological states (T1 to T3 in Figure 3), and (b) articles describing the optimization (Pretty et al., 2018; Tittonell, 2020) or out-scaling of agroecological states (T4 and T5 in Figure 3). Articles describing more than one agroecological innovation were divided into a corresponding number of cases. Inversely, several sources describing the same agroecological innovation were merged into one 'case' in an iterative process, in which coders reviewed one-another's coding of sources.

Step 3: Analysis and mapping

We extracted the geographical location(s) of cases as accurately as possible by reviewing the full documents. Studies targeting entire administrative units (e.g. district, province, or country) were geo-tagged to the centroid of these units. We also assigned the unique code of each case to the smallest available administrative units overlapping with the case's presumed extent. Depending on the country, these administrative units were townships, wards, or village areas. For example, if a case described an agroecological innovation in a protected area, the case's code was assigned to the polygons of all administrative units overlapping with that protected area.

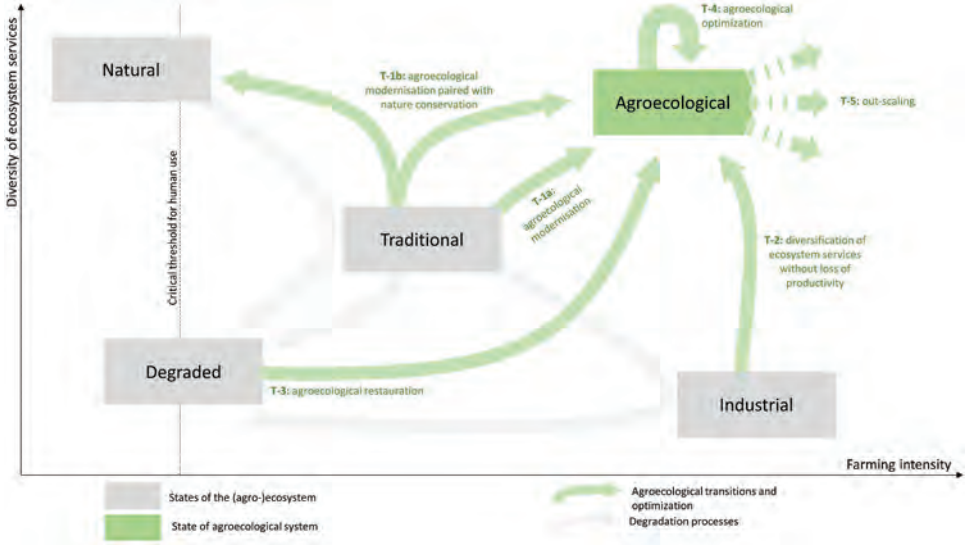

Figure 3. Framework of states and agroecological transitions used as evaluation criteria for case selection of the systematic review further developed by the authors based on Tittonell (2020).

Table 1. Key attributes for cases of the systematic review used during evaluation and manual coding of articles.

Key attributes	Description
Country	The study must be conducted in one or several countries of the Mekong Region
Geographical scale	Geographical scale at which the study was conducted (from local to global)
Study type	Type of knowledge created in the study ('experimental/applied', 'purely conceptual', or 'purely analytical'). Only 'experimental/applied' articles were included in the analysis.
Innovation type	Four categories of social movements for agroecology of Bottazzi and Boillat (2021)
Agroecological state or transition	Agroecological states and/or transitions based on Tittonell (2020) described in the article
Literature type	Distinction between research article and practical report
Ecosystem services (ES) and ES categories	Ecosystem services to be improved or ecosystem dis-service(s) to be mitigated. The causality check between agroecological intervention and positive effects on ecosystem services or biodiversity was done by the coders. Cases were coded based on which ES categories were addressed using the Common International Classification of Ecosystem Services (CICES; https://cices.eu/).
Biodiversity	The biodiversity aspect to be improved or preserved through the agroecological innovation(s) described in the article.

Table 2. An overview of identified articles for the systematic review from seven literature repositories.

Order of inclusion	Repository	Initial candidates	Candidates after running the search string and removing duplicates within the repository	Candidates after removal of duplicates with previous repositories	Duplicates found with preceding repositories
1	WoS & Scopus	n.a	1,103	1,103	0
2	MLRF	767	408	388	20
3	FAO	25	25*	24	1
4	ALiSEA	1,268	368	355	13
5	WOCAT	108	108*	108	0
6	SRI	51	50*	49	1
				2,027	

Note: *search string not run; articles were directly included in the next step.

We analysed the set of cases regarding their key attributes (Table 2). We also analysed their emphasis on gender aspects by means of two automated search strings on the full articles to detect cases mentioning gender: the first focused on gender-explicit terms (gender, feminine, femininity, feminist, masculine, masculinity) and the second on more general terms (women, men, female*, male*). Through manual review, we then categorized the cases that included gender keywords into one of the three groups, depending on whether (i) the intervention had no women/gender focus, (ii) the intervention targeted women specifically, or (iii) the intervention was gender-focused (i.e. targeted gendered power relations).

Results

General findings

Our initial search string returned 3,604 articles. After removal of unsuitable document types and duplicates, we obtained a set of 2,027 articles, which we took into screening and coding (Table 2). WoS&Scopus contributed more than half of all articles, followed by MLRF and ALiSEA. Only 20 duplicates were found and removed when we joined articles from the MLRF to the set of articles from WoS&Scopus. There were no overlaps between WOCAT and the other repositories. After manual screening, we were left with a sample of 271 sources matching our inclusion criteria (located in the Mekong Region, written after 2007, describing an agroecological innovation, of experimental/applied type, targeting the improvement of ecosystem services or biodiversity).

Table 3. Location and scale of cases of agroecological innovation.

	Country of implementation						
Scale of implementation	Cambodia	Laos	Myanmar	Thailand	Vietnam	Multi-countries	Total
Local – one location	48	31	6	31	7		123 (45%)
Local – several locations	6	7	3	18	4	2	40 (15%)
Sub-national	17	17	5	18	39	3	99 (37%)
National	4			2	1		7 (3%)
Multiple scales		1			1		2 (1%)
Total	75 (28%)	56 (21%)	14 (5%)	69 (25%)	52 (19%)	5 (2%)	271 (100%)

Geographic characteristics of cases

Cambodia and Thailand feature the largest number of cases (75 and 69, respectively), followed by Laos and Vietnam, with 57 and 53 cases, respectively (Table 3), and only 14 cases (5%) are located in Myanmar. The remaining three cases are located in several countries. Sixty per cent of the cases (163) are conducted at a local scale, out of which 75% are limited to a single target location, typically a village, village cluster, or small catchment, and 25% target multiple locations. Ninety-nine cases (37%) focus on the sub-national scale (watersheds, protected areas, or sub-national administrative entities). Only seven cases (3%) target the national scale and only two explicitly address multiple scales.

Hotspots of agroecological interventions

There are five hotspots in the Mekong Region with a high density of documented agroecological initiatives (Figure 4): (1) the Central North of Cambodia around Preah Vihear, (2) the Central South of Cambodia between Kampong Thom and Takéo, (3) the north-western uplands, (4) the greater Sa Pa area in Vietnam, and (5) the upland area between the Provincial capitals of Xiengkhuang and Luang Prabang in Laos. The Cambodia hotspots are located in the lowlands and floodplains with irrigation, whereas those in Vietnam and Laos are located in highlands with rugged terrain. In Thailand, agroecological initiatives are spread across the entire country, with a slight concentration in the north-west around Khon Kaen and north of Chiang Rai. The map shows that only very few cases have been documented in Myanmar during the assessed period (2007 – 2021).

Targeted online repositories cater to specific sectors

Academic publications, including peer-reviewed and non-peer reviewed articles, master and doctoral theses, or book chapters with a scientific structure and methodology, account for 48% of the sources of our cases, while technical reports, posters, or factsheets reporting on innovations tested in development projects or led by the private sector account for 52%. The different online repositories focus either on the researchers' or practitioners' communities, but rarely on both. WoS&Scopus only feature research articles. Scientific documents also strongly dominate in SRI (89% of all included sources), while the WOCAT and ALiSEA repositories target practitioners (Figure 5). Each repository has a distinct geographical focus, and there is a difference in the spatial targeting of researchers and practitioners. A wealth of scientific evidence stems from Vietnam and Thailand (WoS&Scopus and SRI repositories), and to a smaller extent from Cambodia (MLRF and SRI), while ALiSEA (a network with more than 150 members in the Mekong Region having a broad range of disciplinary backgrounds and focusing on various approaches to agroecology) rendered mainly cases for Laos. WOCAT, also a repository for practitioners but with a rigid science-like peer-review process, focuses on Cambodia, Thailand, and Laos with 38, 29, and 21 cases, respectively.

Agroecological innovation levels

Dominance of technical approaches

Our analysis reveals a strong dominance of practical and technical initiatives across the Mekong Region (Figures 6 and 7). Seventy-two per cent of all cases focus on this innovation level, either exclusively (145 cases) or in combination with others (50 cases). Twenty-two per cent or 61 cases

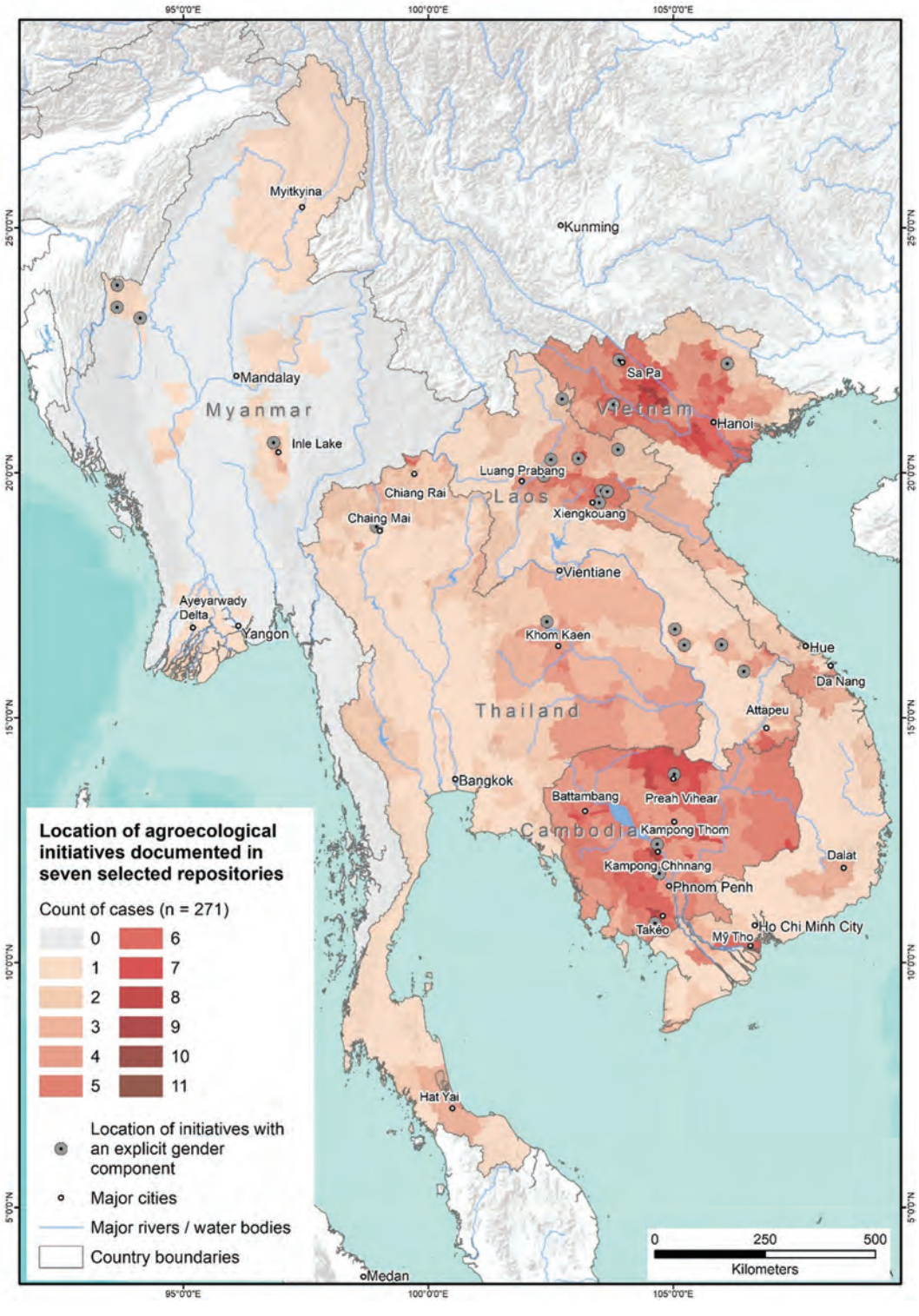

Figure 4. Spatial distribution and number of occurrences of case of the systematic review that present innovations across Cambodia, Laos, Myanmar, Thailand and Vietnam.

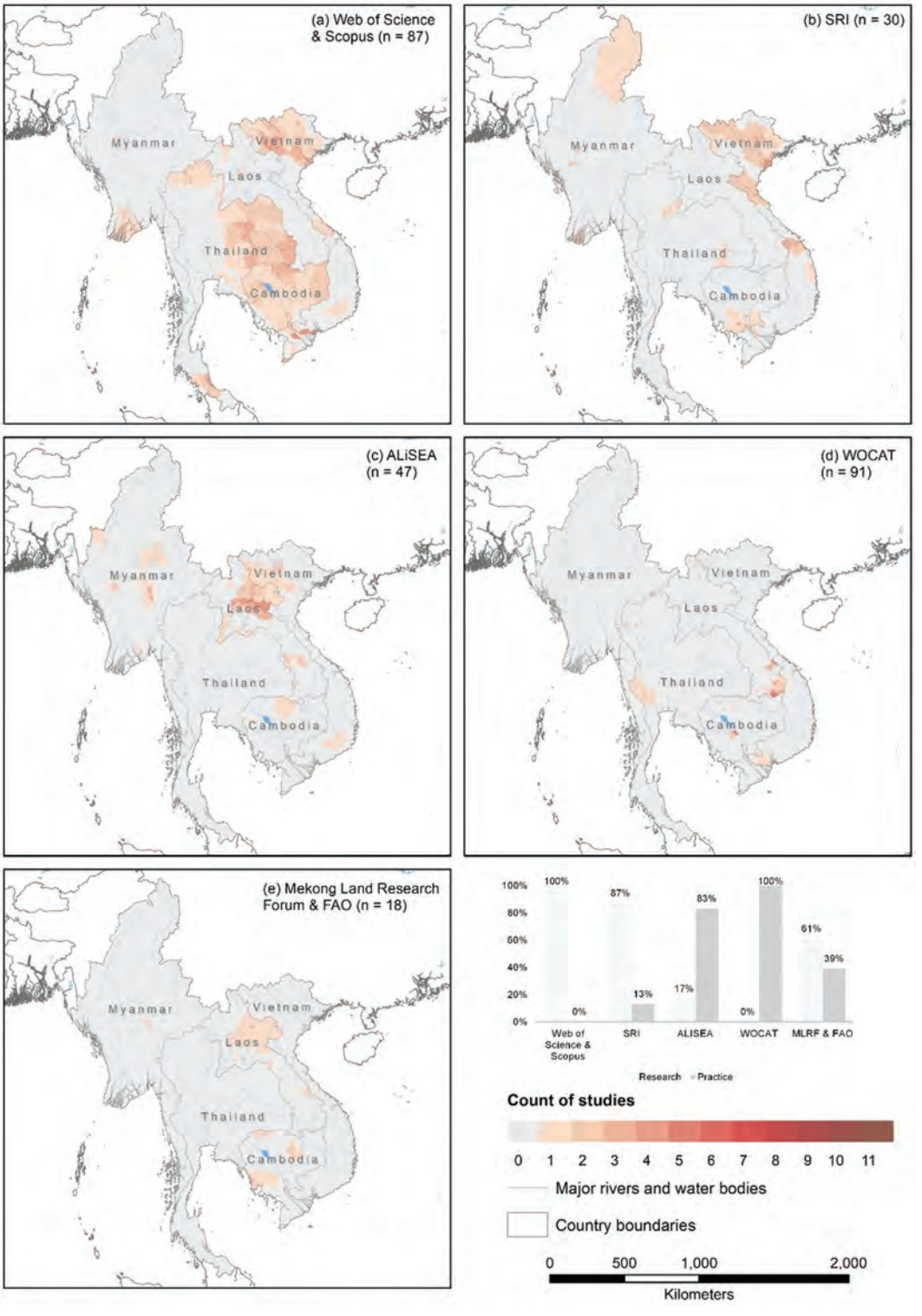

Figure 5. Hotspots of sub-national scale agroecological innovations per literature repository. Cases retreated from several repositories are featured in all the respective maps.

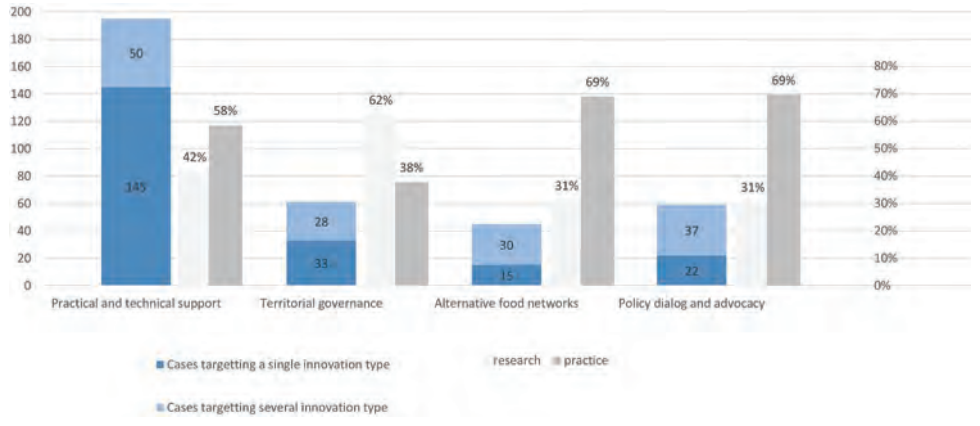

Figure 6. Agroecological initiatives categorized by innovation types (left axis) and their relative percentages of article types (research versus practice, right axis).

describe 'territorial governance' initiatives, mainly land use planning; 54% of them focus exclusively on territorial governance, while 46% combine it with other innovation levels. Only 45 cases (17%) deal with 'alternative food networks' and 59 (22%) with 'policy dialog and advocacy'.[2] Both are predominantly conducted in combination with other innovation levels and thus present a more holistic approach to agroecology.

In total, 215 cases in our set (79%) focus on a single innovation level. This concerns particularly cases reporting on practical and technical solutions. Initiatives presented in these cases usually conduct practical tests at plot or farm level without integrating the results into a broader agroecological approach. On the contrary, roughly two-thirds of cases dealing with 'alternative food networks' and 'policy dialogue and advocacy' are integrating different innovation levels. Whereas territorial governance is more often reported about in research articles (62%), publications from practice are dominant at all other innovation levels.

Interestingly, innovation levels reported in the assessed cases are not distributed evenly in the region (Figure 7). Practical and technical support appears in all countries with a dominance in Northern Laos, Northern Vietnam, Cambodia, and north-eastern Thailand. Interventions that focus on alternative food networks are rather found in Laos and Cambodia, while territorial governance innovations are concentrated in Vietnam and northern Cambodia.

Agroecological transitions

Transforming non-agroecological systems

Our analysis shows that 196 cases (62%) focus on transforming traditional, industrial, or degraded states into agroecological states (transition types: *T*-1a, *T*-1b, *T*-2, and *T*-3 in Figure 3). Out of these, nearly two-thirds (106 cases) focus on modernizing traditional agricultural systems, either as a sole objective (*T*-1a) or in combination with a nature conservation objective (*T*-1b), see Figure 8. *T*-1a and T1-b are distributed over the entire Mekong Region but are less present in Thailand. Only 34 cases (12%) focus on diversifying the ecosystem functions of industrial agricultural systems (*T*-2). They are found in strongly industrialized agricultural areas in Thailand, northern and central Vietnam, the Mekong Delta, around Tonle Sap Lake, and in south-western Cambodia. We also found *T*-2 cases in the south of Laos, where large-scale land investments have been booming in the past two decades (Hett et al., 2020). Only 12 cases focus on converting degraded states into agroecological states (*T*-3). They are located in north-eastern Thailand and in isolated areas in Cambodia, Vietnam, and Laos. Finally, the descriptions of 17 cases mention a transition from a 'conventional' to an agroecological

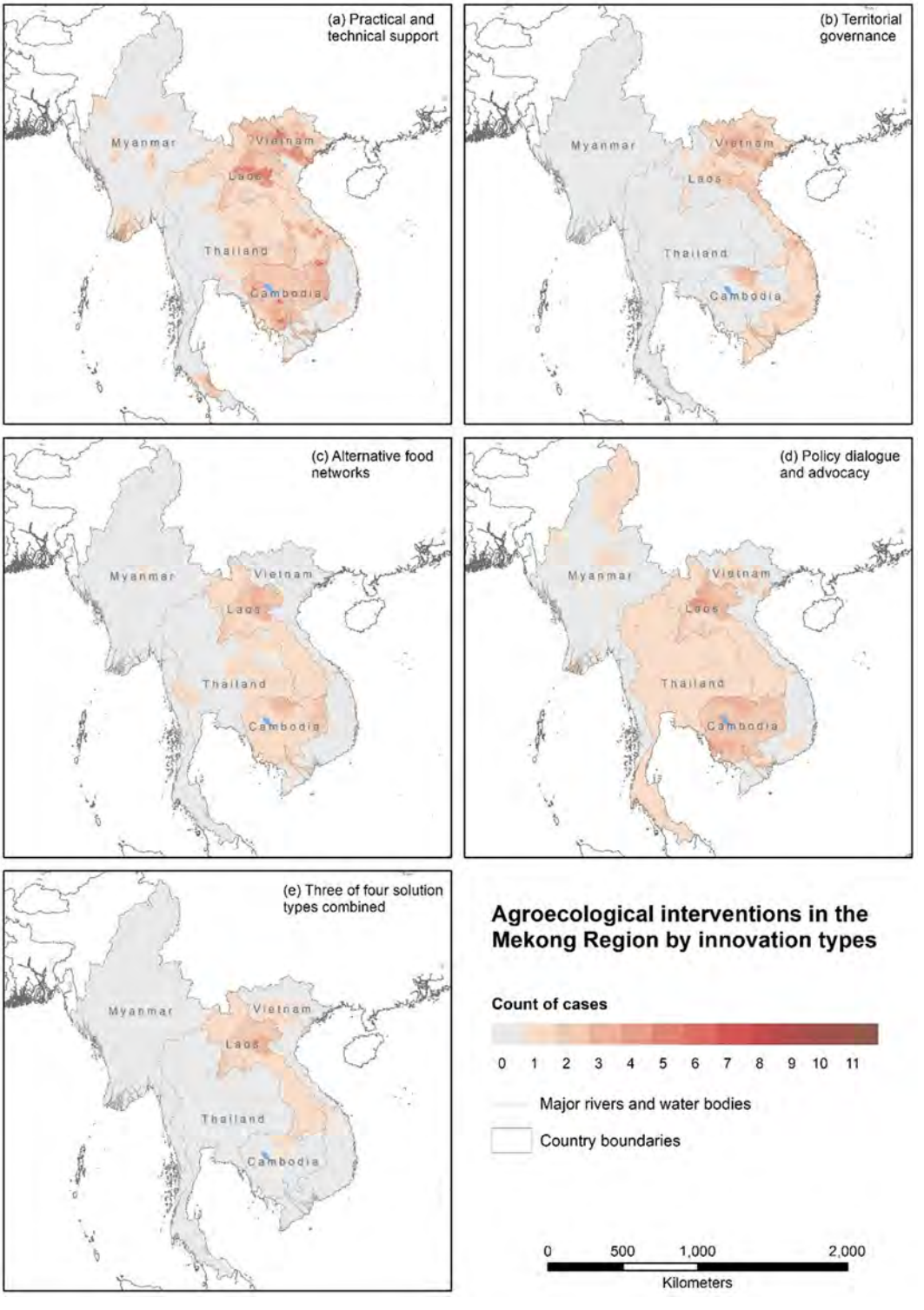

Figure 7. Hotspots of the innovation types (a) practical and technical support, (b) territorial governance, (c) alternative food networks, and (d) policy dialogue and advocacy as well as agroecologcial interventions that employ holistic approaches (e) in the Mekong Region.

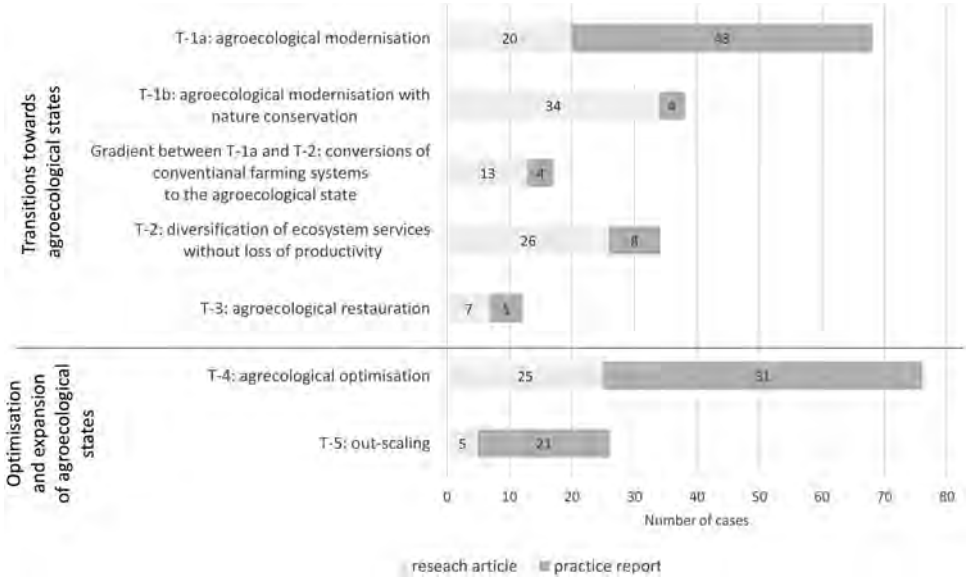

Figure 8. Number of cases of the systematic review per agroecological transition.

state. As this is too vague for an unequivocal classification, we assumed that such cases are somewhere on a gradient between *T*-1a and *T*-2.

Optimizing and out-scaling agroecological systems

The biggest category in our sample consists of cases that optimize agroecological systems (*T*-4 in Figures 3 and 8). It is however possible, that some of these reported interventions led to an agroecological transition in the longer term or that the information on a transition triggered by an intervention was not mentioned in its literature source. We might have classified some of these interventions as *T*-1a, *T*-1b, *T*-2, or *T*-3 if such information had been provided by the authors. Most cases reporting on the optimization of agroecological systems are in north-eastern Thailand, Cambodia, northern Vietnam, and in isolated patches in Laos. Two-thirds of the 'agroecological optimization' cases are WOCAT factsheets on sustainable land management practices. Only 10% of the assessed articles (26 cases) focus on out-scaling agroecological innovations (*T*-5, see in Figures 3 and 8). For example, a case initiated in 2003 by the Centre d'Etude et de Développement Agricole Cambodgien (CEDAC) out-scaled agroecological innovations to 50,000 farmers across Cambodia and used a combination of multi-purpose farm models, farmer learning events, and collaboration with a farmer association for out-scaling (Wijeratna, 2012).

Innovation levels and transition types

A cross-tabulation between innovation types and agroecological state/transition shows that practical and technical support is the dominant approach in all transition types except for modernization with nature conservation (*T*-1b), which is more often found in sources that focus on territorial governance or a combination of innovation types and agroecological out-scaling (*T*-5), where most cases focus on policy dialogue and advocacy, or again a combination of innovation types. The strongest dominance of practical and technical support is found in cases classified as *T*-4 (agroecological optimization), with 61 out of 76 cases. *T*-4 cases are also – together with cases classified as *T*-2 (diversification of ecosystem services without loss of productivity) – the ones having the lowest shares of mixed approaches (6.6% and 5.9% respectively).

Ecosystem services and biodiversity enhanced through agroecological innovation

We categorized terms referring to ecosystem services in our cases into provisioning, regulating and maintaining,[3] and cultural ecosystem services (Haines-Young & Potschin-Young, 2018) and found that 52% (142 cases) assess the positive effects of agroecology on a combination of provisioning and regulating services (Figure 9). Some cases propose to improve or diversify the production of a specific agricultural good and point to the co-benefits of the agroecological intervention on regulating services. Provisioning services are addressed in 245 cases, either in combination with other services or exclusively (51 cases). The dominant provisioning services are the production of cultivated terrestrial plants, particularly the increase or maintenance of paddy rice production in lowlands using agroecological practices (79 cases, Table 4). Many of these cases originate from the SRI repository. Agroecological innovations are also proposed for a variety of other crops, such as vegetables, fruits, cassava, cashew nuts, and even some tree plantations, including five rubber plantations. Only 17 cases focus on sustainable forest management for the provision of wild plants, non-timber forest products, and wood. Twelve cases mention products from agroforestry systems and upland farming in more general terms.

Table 4. Overview of provisioning (left) and regulation and maintenance (right) ecosystem services targeted by the case studies.

Provisioning ecosystem services(CICES V 5.1 section)		Cases	Regulating ecosystem services (CICES V 5.1 section)		Cases
Cultivated terrestrial plants and animals (unspecific)		72	Land & forest regulation & maintenance (unspecific)		62
Agricultural production	25		Environmental benefits (general)	26	
Crop production	17		Land degradation prevention (general)	9	
Crop production (industrial, monoculture)	2		Natural hazard protection (general)	6	
Food production	2		Forest regulation services (general)	8	
Food production, smallholder	14		Watershed regulation services (general)	13	
Food production, smallholder upland	4		Regulation & maintenance (specific) in forests		13
Agroforestry production	8		Deforestation/forest degradation prevention	13	
Cultivated terrestrial plants and animals (specific)		147	Regulation & maintenance (specific) in agricultural landscapes		51
Rice		79	Environmental contamination prevention (general)	32	
Rice only	60		Weed control	5	
Rice and other production	12		Pest control	14	
Rice and fish production	7		Soil quality maintenance or increase	47	
Other		68	Soil fertility improvement	20	
Vegetable (possibly other secondary crops)	21		Soil erosion protection or prevention	25	
Specific crop	13		Regulation of chemical composition of atmosphere		30
Fruit (possibly other secondary crops)	12		Vegetation carbon sequestration	12	
Coffee (possibly other secondary crops)	5		Soil carbon sequestration	7	
Tea (possibly other secondary crops)	3		Emissions-reduction in agricultural systems	11	
Tree plantation (possibly other secondary crops)	10		Regulation & maintenance of water		14
Livestock	4				
Wild plants (forest environment)		17			
Medical plants	1				
NTFP	8				
Spices	2				
Wood	6				
Reared aquatic products (fish or shrimp)		6			
Water Provision		21			
Irrigation water provision and management	19				
Water provision (general)	2				

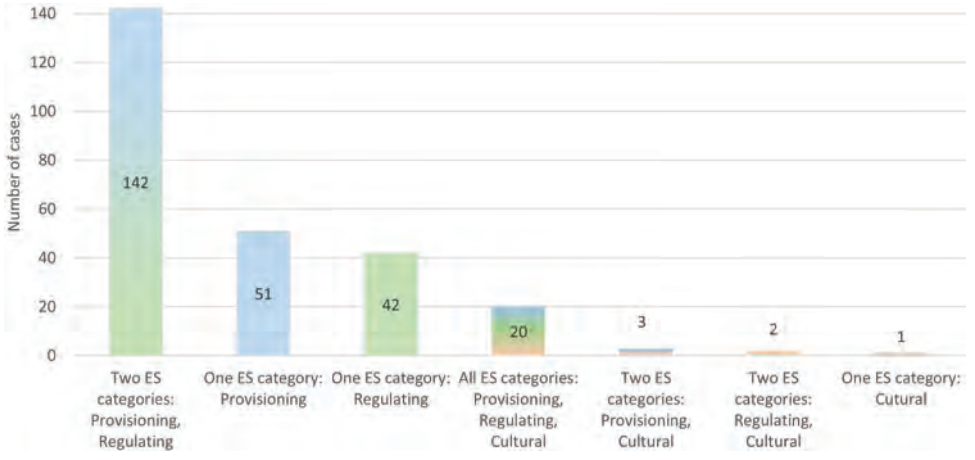

Figure 9. Frequency of reported ecosystem service (ES) categories targeted by cases of the systematic review.

Regulating services are targeted in 262 cases, particularly the improvement of soil quality and the prevention of soil erosion on agricultural land (Table 4). Pest and weed control using agroecological innovations is another priority explicitly mentioned in 14 and five cases, respectively. Thirty cases focus on climate regulation services, mainly through carbon sequestration in vegetation (12 cases) and soils (7 cases), through emission reduction (11 cases), or the prevention of deforestation and forest degradation (13 cases). Mostly, these studies propose territorial governance innovations through payments for ES, such as the Vietnamese 'Payments for Forest Ecosystem Services' (PFES) scheme, or through 'Reduction of Deforestation and Forest Degradation' (REDD+) mechanisms.

Only 26 cases (less than 10%) give attention to cultural ecosystem services, which are mostly mentioned as part of holistic agroecological approaches that should benefit provisioning, regulating, and cultural ecosystem services. Nineteen cases deal with traditional agroecological knowledge and seven highlight the importance of combining cultural and nature conservation objectives to facilitate sustainable management of natural resources. For example, Phungpracha et al. (2016) focue on cultural ecosystem services and demonstrate the importance of protecting traditional ecological knowledge to increase smallholders' food security.

Positive impacts on biodiversity are mentioned in 69 cases, mostly in reference to the inherent linkage of agroecological practices with biodiversity conservation and sustainable use. Selected studies however give detailed accounts of specific biodiversity aspects, e.g. benefits for soil microbial communities and microorganisms (Lesueur et al., 2018) or for insect diversity (Name & Bumroongsook, 2018). The sustainable management and conservation of biodiversity using agroecological innovations is the explicit focus of only 10 cases of our sample.

Agroecological innovations and gender

Our analysis reveals that 62 cases include gender keywords, but only 18 of them address gender-related issues. Sixteen articles segregate data and analysis by gender, including five that analyse specific results of/for women and provide comparisons between men and women. Eleven articles approach gender as a relational construct, i.e. considering the power relations between and among women and men and the norms that condition their respective roles and responsibilities. For example, the TABI project in Laos ensured that women and men from different backgrounds partook in a variety of activities, e.g. mapping sessions, interviews, and transect walks; the initiative developed an understanding of women's and men's challenges and priorities, and engaged both in agroecological interventions, with particular attention to

activities in which women play an integral role, such as mushroom production, benzoin, and river weed collection (Rodericks, 2020).

Positive outcomes of gender-sensitive agroecological initiatives

The reviewed cases provide evidence that gender-sensitive agroecological innovations can enable positive ecological and socioeconomic outcomes. Some initiatives explicitly seek to empower women, such as a project-building climate change resilience by promoting agroecology initiatives in Shan State, Myanmar, which focuses on empowering women by engaging female farmers to provide training in the making of organic fertilizer and compost, the growing of diverse crops, and the preparation of seedbeds (Myanmar Institute for Integrated Development MIID, 2017). The initiative had positive outcomes: women took up the techniques, biodiversity increased, and the yields of subsistence and marketed crops improved.

Are women more likely to implement agroecology?

We did not find evidence that women are more likely to implement agroecology than men, but women are more likely to engage when initiatives are seen to be complementary to, or an extension of their gendered roles. For example, an eco-tourism initiative in upland Vietnam (Hoang et al., 2020) did not explicitly target women but found that women made up 80% of villagers engaged in the project because their established roles in hospitality and handicrafts enabled them to move into tourism roles. Other studies find that women are more prone to implement initiatives that provide diverse foods, e.g. vegetable and agroforestry gardens, because it is often their responsibility to feed the family (Clarke et al., 2016; Kelly, 2014). Gender differences are also noticeable in relation to concern about risk, e.g. in the use of herbicides in Laos. Tivet et al. (2005) report that women, who expressed more concerns about the risks of men becoming poisoned, were more favourable to agroecological initiatives.

Engaging women may help to scale-out agroecological innovations to a broader audience through their networks. In this regard, Pay (2018) found that many farmers were initially resistant to trying SRI methods because of concerns about crop quality and labour requirements. However, when women were employed as trainers to spread advice, they were able to reach more farmers as they knew how to communicate with other women and had established trusted community networks.

Discussion and outlook

Our systematic review shows a contrasted landscape of agroecological initiatives in the Mekong Region: (a) agroecological initiatives are mainly sectoral and focus mostly on technical aspects of innovation; (b) agroecology researchers and practitioners operate mainly at the local – plot, field, farm, and village – level; (c) agroecological innovations take place predominantly in traditional smallholder settings, where they seek to optimize already existing agroecological systems by introducing new techniques and practices. Further, we found that (d) agricultural research and extension activities often have different geographic and topical priorities and that (e) gender dimensions are mostly ignored in this literature on agroecological innovations in the Mekong Region.

These findings point to several gaps in the areas of research, knowledge production and sharing, and implementation, which deserve more attention to support a shift from the ongoing agrarian to an agroecological transition in the Mekong Region.

Missing research–practice interfaces and holistic approaches

We found that researchers and practitioners have different geographic and topical foci: there is a concentration of research on agroecological innovations in Thailand and Vietnam, while practitioners' publications are more often found in Laos and Cambodia. This compartmentation of regions and topics makes it more difficult for both communities to jointly set up integrated agroecological initiatives.

In part, the spatial patterns of agroecological initiatives might reflect 'traditions' among various groups of researchers and practitioners, who return to areas where other members of their community have worked before. For example, WOCAT and ALiSEA have invested a lot to support the documentation of success stories of sustainable land management and agroecology in Laos and Cambodia, which partly explains the strong representation of these two countries in practitioners' publications. We also found that agroecological innovations tend to take place in sectoral silos, while holistic approaches that integrate different disciplines and engage with a variety of actors are still scarce in the Mekong Region (Gilard et al. 2015).

Unfortunately, less efforts were spent on documenting failures or difficulties in implementing agroecology approaches that would have brought up useful lessons to document the enabling conditions for successful agroecological initiatives.

Low priority on out-scaling

Our study identified a lack of documented cases focussing on the out-scaling of agroecological innovations (only 10% of cases), particularly among scientific publications (only 5 cases). Possible causes include the facts that (1) out-scaling innovations are more difficult (and probably also less attractive in terms of scientific prestige) than testing innovation in a limited area; (2) most projects start with the testing of technical innovations but usually run out of funds or time before reaching an out-scaling phase; (3) there is a lack of accompanying research in practitioners' projects aiming to out-scale agroecological innovations; and (4) there is a lack of uptake by government agencies and policymakers of findings presented by both the research and practitioners' communities. This last point could be due to a mismatch between the priorities of researchers and practitioners and the expectations of governments. For instance, while research findings highlight positive impacts of agroecological innovations on soil fertility and conservation, governments prefer findings demonstrating the increase of smallholders' income.

Blind spot 'industrial agriculture'

The trend towards large-scale commercial agriculture in the Mekong Region calls for a broadening of the agroecological perspective. Yet, our results show that industrial agricultural systems are a blind spot of agroecological research and practice. This may reflect the focus of donors and development agencies on poverty alleviation, food security and family farming, and their perception of industrial agriculture and land concessions as a competitor rather than a component of the agrarian system.

Even though sustainability challenges in traditional smallholder systems are numerous and deserve the attention of research and practice, it is not sufficient any longer to advise smallholders on what they should or should not do on their farms. Rather, there is a need for integrating various types of agricultural systems into more comprehensive agroecological landscapes. The need for agroecological territorial approaches has been widely recognized by scholars (e.g. Gliessman, 2019; Wezel et al., 2016), and case studies at the landscape level have been reported in other regions (e.g. IPES-Food, 2018; Padró et al., 2020). However, documentation of territorial agroecological approaches in the Mekong Region is still lacking, even if newer initiatives have acknowledged this gap: the project 'Agroecological and Safe Food System Transitions'[4] launched in 2019 promises to provide innovations at territorial level in flagship sites located in Laos, Vietnam, and Cambodia.

'Cultivated plants' bias in food systems

Our systematic review was limited to cases that address improvements in ecosystem services or biodiversity. Within this sample, we noticed that agroecological research and practice tend to focus on provisioning services related to cultivated plants (particularly rice) and frequently focus on the aspects of yield, income, and labour intensity, while wild plants and livestock are almost absent, and

water-related ecosystem services are poorly represented. Possibly, this reflects a predominance of classical field agronomy among the professional backgrounds in the concerned communities of researchers and practitioners. Keeping in mind the change in diets and a growing concern about nutritional aspects of food production, a stronger inclusion of livestock and wild plants into agroecological approaches is timely. A broader perspective of agroecology that includes a food system dimension has emerged recently (Wezel et al., 2020) but is not yet largely represented in our review.

Gender gap

A substantial share of the assessed sources deals with on-farm technical support and with improving productivity of cultivated plants. This indicates that our sample is strongly populated by representatives of various agronomic disciplines, who might be less used or inclined to integrate social and gender aspects into their studies. The fact that only 18 out of the 271 assessed sources explicitly address gender issues in relation to agroecology is probably a reflection of this bias.

Literature suggests that one cause of failure in agroecological innovations is the insufficient attention paid to internal differentiation by gender and the specific constraints but also capabilities of women. When women are not involved in project design, they are less likely to implement innovations, which results in poorer project outcomes. On the contrary, engaging women in agroecological initiatives as trainers and leaders allows a better dissemination of women farmers. Gender sensitive agroecological initiatives can have positive impacts on the environment and result in income and knowledge gains for women. However, they may also overload women and unintentionally reinforce gender inequalities if they do not pay attention to gender dynamics. Due to patriarchal power dynamics in many Mekong communities, innovations may benefit mostly men, thus further entrenching patriarchal power, unless innovations are specifically designed with gender-equity in mind (Neef, 2019).

Data limitations

We are aware that our sample does not cover the entirety of research and implementation efforts related to agroecological innovation in the Mekong Region between 2007 and 2021. Some publications that are of great theoretical, conceptual, or analytical value for the agroecological transition might have been excluded – even though they address aspects that we identified as gaps – because they are purely analytical or conceptual, or because they lack an explicit reference to the improvement of ecosystem services or biodiversity (which were both requirements for them to be considered in the systematic review). Further, we limited our review to articles in English and selected literature repositories with a regional or global coverage, thus missing out on national repositories such as LaoFAB.[5] This may have caused a distortion in the spatial distribution of agroecological interventions since international NGOs have been active for a long time in Laos and in Cambodia in the field of agroecology.

Another limitation is the selected time frame from 2007 to 2021 (see justification for this above) which made us disregard earlier waves of agroecological interventions, particularly the many research and development programs, which were conducted in the 1980s and 1990s, and which may have had lasting effects on farming systems in the region.

Furthermore, we may have underestimated the policy dimension of the agroecological transition as the initiatives reviewed here are mostly implemented through projects with bounded time, space, and scale, and therefore with limited capacity to support the emergence of a broad-based agroecological movement. The 59 cases addressing policy dialogue and advocacy in our sample are mainly directed towards national and sub-national authorities, extension services, and NGOs. Furthermore, they focus on food production (including farming practice such as pest control) and regulating services (mainly biodiversity conservation, soil quality/land degradation, climate change, and water management). We did not find any cases that focus on policy implications at the level of entire food systems. This is not surprising as food system policies as such are rare, and this being the case, policy implications from agroecological interventions rather to feed into the existing sectoral policies of

agricultural and environmental. Hence, more attention should be paid to the way policy issues are 'technicized and projectized', i.e. handed over to experts by policymakers (Castella et al., 2018).

To a large extent, getting researchers and practitioners to synergize their efforts toward the agroecological transition requires profound changes in the way projects are designed and governed. For example, initiatives led by the private sector have been largely ignored by development projects. We did not find any such cases as this knowledge is typically not found in the online repositories of publicly funded research. Also, the private sector, particularly those actors involved in commercial large-scale production, rather talks about regenerative agriculture instead of agroecology and does not engage much with the communities of researchers and practitioners mentioned above. They do not report on their achievements via public literature repositories on agroecology such as the ones used in our analysis, which made their possible contribution to agroecology invisible to us.

Finally, farmers and their organizations are mostly missing from the literature and reports studied. The reviewed initiatives focus mostly on researchers, policymakers, NGOs, and private sectors, with farmers and farming communities considered often as project beneficiaries. This may give the impression that the agroecological transition is mainly led by researchers and practitioners with the backing from governments and donors. The relative invisibility of farmers in leading agricultural transformations highlights the needs to better address and empower farmers' organizations so that they become actors of their own development rather than passive project beneficiaries. This also highlights that farmers are seldom involved in documenting their own practices. One way to better include the farming community in leading the agroecology transition would be to open 'people university campuses' to foster experience and knowledge sharing between academia, students, and farmers along the MASIPAG model in the Philippines, therefore enabling a real co-creation of knowledge and research agenda addressing the real needs of farming communities (Bachmann et al., 2009).

Conclusions and recommendations

We conducted a systematic review of literature presented in online repositories to identify and characterize the current knowledge on agroecological innovations coming both from research and practice with demonstrated benefits for ecosystem services and biodiversity in the Mekong Region. Within the set of case studies, we analysed whether and how gender was addressed. In summary, our review shows that there is a wealth of case studies reporting particularly on practical and technical solutions and territorial governance approaches. Currently, there is only little focus on food system transformation and innovation through advocacy and policy changes. Innovations are frequently created in sectoral silos, while cross-sectoral approaches, scale integration, and collaboration between research and practice are largely missing. Based on our findings, a logical recommendation would be to ask researchers, practitioners, and farmers to bridge the identified gaps and maybe to suggest an order of priority depending on the targeted context. While this would certainly be correct, we believe that a more systemic perspective is preferable to a piecemeal approach that targets these gaps individually.

The need for science–policy–society interfaces

A key precondition for getting agroecological initiatives out of the niche and fostering a broad-based agroecological transition in the Mekong Region should be the establishment of interfaces between farmers, researchers, policymakers, practitioners from NGOs, civil society, and investors. Such interfaces should support the exchange, co-evolution, and joint construction of knowledge and workable solutions with the aim of enriching decision-making and/or research (De Bremond et al., 2019; Van den Hove, 2007). Our findings have shown that there is little permeability between the evidence and experience accumulated by researchers and practitioners, and even less so between these two categories of actors and the private sector who may be better able than the public sector or civil society to raise capital or target investments, and thus catalyse change towards sustainable agricultural development (Van Westen et al., 2019). Interfaces between these communities would therefore

need to facilitate the flow of information, the exchange of experience and a broad-based collaboration around common sustainability targets. We believe such interfaces represent much-needed process-oriented innovation and should focus their actions on three major topics as outlined below.

Building sustainable food systems

Science–policy–society interfaces could be designed to support a shift from the disciplinary perspective identified in our results, towards embedding agroecological innovations into the shaping of sustainable food systems (including on-farm technologies, land use planning and land governance reform, sustainable value chains, etc.). Technological innovation, which is dominant in the assessed publications, is an important tool at the farm level, but it needs to be accompanied by changes at higher levels in governance, behaviour, and economic incentives to achieve agroecological transformation of entire food systems (Gilard et al. 2015; Wezel et al., 2020). As integrative approaches necessarily concern different and sometimes competing sustainable development claims, science–policy–society interfaces should be set up as knowledge arenas. Agroecological living labs are an example of such arenas and have already flourished in various, recent projects in other regions (McPhee et al., 2021).

Tackling land-based investments

Our results have shown that agroecological initiatives mostly target traditional smallholder systems or smallholder-led commercial systems. While such a focus is important to support and modernize traditional systems with the aim of securing rural livelihoods and improving food security, it neglects what arguably constitutes the segment of agricultural systems with the fastest dynamic (and therewith the strongest potential impacts) in the region: large-scale commercial agriculture. Therefore, interfaces that bring together farmers, researchers, practitioners, policymakers, and the private sector are probably the most promising way of negotiating trade-offs and co-benefits among various stakeholders and reach consensus on the design of sustainable agricultural landscapes. For example, using such interfaces, participating stakeholders could work towards a reform of national strategies on the out-scaling of sustainable agricultural practices (both large and small scale), and push for the formulation and pursuance of voluntary sustainability objectives such as land degradation neutrality to be adhered to particularly by land-based investments. They could also serve as a platform for co-designing innovative projects and governance mechanisms that are better aligned with the principles of agroecology (i.e. promoting biological, social, and institutional diversity, knowledge co-production, responsible governance, etc.).

Promoting gender-sensitive approaches

Finally, science–policy–society interfaces have the potential to foster the integration of women in the above-mentioned negotiation processes and to engage them right from the design stage in the planning, training, implementing, and managing of agroecological solutions. Participatory approaches should be more than sensitive to gender, i.e. women must be active throughout the entire projects, to make sure local norms and power relations are understood and considered, and to build trust among women and men of diverse ethnicities, occupations, and income levels. Schemes designed specifically for women and gender differentiated design are important not only for the success of agroecological initiatives, but also to avoid reproducing patriarchal power dynamics.

Notes

1. *In this paper, we use the term Mekong Region for the geographical area that includes the five countries Cambodia, Laos, Myanmar, Thailand, and Vietnam.*
2. The sum of indicated percentage exceeds 100% as individual cases can belong to several types.

3. For simplicity, we hereafter use «regulating» to mean the 'regulating and maintaining' ecosystem service category.
4. https://www.asset-project.org/
5. An online forum for sharing information about farmers and agri-business in Laos, see https://laofab.org/

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