WORKING PAPER

This review is associated with the Evidence-Based Forestry initiative, a collaboration between CIFOR and partner institutions supporting systematic reviews of evidence to enable better-informed decisions about forests and landscapes.

Examining how long fallow swidden systems impact upon livelihood and ecosystem services outcomes compared with alternative land-uses in the uplands of Southeast Asia

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Photo by Luke Preece/CIFOR
Forest and village landscape in Laos.

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1 Background

Upland agriculture and forest uses in Southeast Asia account for perhaps 2 million square kilometres and support between 100 and 500 million people (Cramb 2007; Mertz et al. 2009). Swidden agriculture (or shifting cultivation) has for centuries formed the basis of land uses, livelihoods and customs in the uplands. As traditionally practised, swidden involves the intermittent clearing of small patches of forest for subsistence food crop production, followed by longer periods of fallow in which forest regrowth restores productivity to the land. Long-fallow swiddens can yield complex assemblages of forest and other vegetation in unique mosaics comprised of open-canopy tree associations to mature closed-canopy forest systems best understood at the landscape scale (Fox, Castella, and Ziegler 2013, 9). As a complex system of agriculture and forestry, integrating production from cultivated fields and diverse secondary forests (Cairns 2007; Conklin 1961), swidden farming may yield a wide range of ecosystem services and resources integral to livelihoods and forest environments in Southeast Asia's uplands.

Swidden fallow systems have been described as 'living landscapes', where the linkages between forest, farm and land support human well-being and a range of ecosystem services (Fox, Castella, and Ziegler 2013). International policy debates, for example in the FAO or the UN-FCCC related to REDD[1], have discussed the role of mixed forest landscapes providing ecosystem services among a mosaic of smallholder land uses, including swidden and agroforestry systems (ibid). Despite this, global forest governance initiatives (for example REDD+) and national governments continue to press for the replacement of swidden with other land uses, considering it as destructive to forests and resulting in higher greenhouse gas emissions than other land uses (Ziegler et al. 2012), with monocrops of rubber, palm oil and teak considered to be better for carbon and livelihood outcomes (Fox, Castella, and Ziegler 2013). As these major land-use transitions continue in Southeast Asia, there is considerable uncertainty about the impacts alternative land uses (particularly intensified systems, cropping rotations and protected forests) have on livelihood security and ecosystem services compared to swidden systems. As yet few studies have comprehensively examined the evidence over longer periods of time.

1.1 Previous studies

Since the 1940s, anthropological and geographical studies have elaborated on the socially complex and ecologically integrated nature of swidden systems among uplanders throughout Southeast Asia. These studies examined how integral swiddens could support a diverse variety of starchy staples, leguminous vegetables and tree crop farming in different fallow stages (Pelzer 1948; Spencer 1966; Condominas 1977; Kundstadter, Chapman, and Sabhasri 1978) and how long-fallow systems often approximated the complexity of natural forest systems (Geertz 1963). Moreover, their successors showed that, contrary to forest and agricultural policies which considered swidden as inherently destructive and so outlawed, swiddening was a complex adaptive system based on socio-economic and ecological processes well-suited to capital poor farmers (Conklin 1957; Dove 1983; Fox 1982; Olofson 1981). In contrast to commercially oriented monocultures, they argued, mixed swidden systems benefited uplanders by offering a variety of timber and non-timber harvests for subsistence and commercial sales to diversify production and spread risks, thus avoiding the ecological and economic shocks associated with relying on one product too heavily (Bryceson 2002).

In the last two decades, scholars have examined in greater detail the potential role of swidden farming in facilitating in situ biodiversity conservation and forest management, with renewed emphasis on indigenous knowledge and traditional practices. Brookfield and Padoch (1994), Cramb (1993), Zimmerer (1996), Brookfield and Stocking (1999), among others, established the empirical links between the complexity of swidden fallows and potential for conserving in situ agro-ecological and genetic diversity, often through diversification. These scholars showed that diverse swidden fallows and gardens can support the conservation of agro-biodiversity and relatively high yields to labour. Overall, however, these studies were locally ethnographic in nature and often neglected the broader causal relationships of agricultural policies, economic interventions and population dynamics on swidden long-fallow systems. Many also failed to build upon (implicitly or explicitly) the results and conclusions of previous analyses, neglecting the value of longitudinal studies of swidden change.

1 REDD stands for reduced emissions from deforestation and forest degradation.

Since then Mertz et al. (2009, 2013), Cramb et al. (2009) and van Vliet et al. (2012) have conducted comprehensive reviews of how regional to local drivers of agrarian change (including rubber, oil palm and teak production), infrastructure development and market penetration affect the viability of swidden practices in Southeast Asia. In describing swidden decline, these scholars suggest that swidden remains vilified despite intensified land uses potentially having even greater negative impact on livelihoods and ecosystem services (see Hett et al. 2012; Padoch and Sunderland 2013). In doing so, Padoch and Sunderland (2013), among others, reinforce that under the right conditions, long-fallow systems can still sustain a range of social and ecological services, from enhancing forest cover to livelihood security amidst agrarian change and market expansion. They argue that swidden practice reflects a model of 'land sharing' in complex landscape mosaics, wherein smallholder farming and conservation efforts can be integrated across a wider upland landscape (Padoch and Sunderland 2013). They and others continue to support the assertion that the integration of diverse, complementary farming and forest systems enhances the socio-ecological resilience of people and landscapes while securing biodiversity and livelihood benefits (Tscharntke et al. 2012; Wangpakapattanawong et al. 2010; Kull et al. 2013).

The research above contrasts significantly with that of scholars who argue agricultural intensification will yield surplus food and cash crop production that reduces the amount of land needed for similar volumes of crop output, thereby curbing deforestation and 'sparing' land for forest protection (Phalan et al. 2011). Increasingly, governments, practitioners and scientists draw on a 'land sparing' rationale as national policy justification for eradicating swidden and intensifying production (as well as zoning forests) in the uplands to impede forest encroachment and deforestation. They extend this rationale to promote and subsidise 'food, fibre and fuel crops' as the basis for replacing swidden with more lucrative, intensive monocrops (see Hall, Hirsch, and Li 2011). In terms of forest governance policies, then, such intensive agriculture may spare land to free up mature forests for more effective conservation of forest cover and ecosystem services than swidden fallows or other extensive land uses allow (Fox, Castella, and Ziegler 2013).

Those advocating for a mix of long-fallow swiddens in multifunctional landscapes have suggested that variegated forest environments can maintain and or enhance forest cover and ecosystem services (to support livelihoods and biodiversity) across a landscape just as a 'land-sparing' approach might. Various studies show how swidden long fallows can be carbon neutral or positive when compared to monocropped tree-based plantations (Bruun et al. 2009; Yuen et al. 2013; Ziegler et al. 2012; Bonner, Schmidt, and Shoo 2013; Lasco, Evangelista, and Pulhin 2010; Huon et al. 2013); maintain positive hydrological properties (Ziegler et al. 2009) across landscape mosaics over time compared to intensified land uses; reduce surface soil erosion in ways similar to intact forest in the fallow period and often lower than oil palm plantations (Valentin et al. 2008; Ziegler et al. 2007; Bruijnzeel 2004; Sidle et al. 2006); enhance floral diversity over time (McNamara et al. 2012; Sodhi et al. 2010; Rerkasem et al. 2009); and support efficient soil nutrient cycling with available nitrogen and phosphorus levels (Bruun, Mertz, and Elberling 2006). Still, greater clarity is needed to understand the influence fallow length has on ecosystem services and to what extent these benefits are evident across scale (from farm plot to landscape level).

The potential role of long-fallow swidden in supporting livelihoods, forest cover and ecosystem services therefore remains stuck in a sustained, polemical debate between supporting mixed livelihoods with variegated forest cover and monocropped, intensified production with strongly opposing views on the trade-offs and 'optimal' levels of ecosystem service provisions. Our proposed systematic review is an attempt to move beyond this impasse by offering a more definitive understanding of how changes in long-fallow systems impact livelihoods and ecosystem services over time and space.

1.2 Building on and going beyond previous research

Despite the breadth of research and awareness of the relative importance of long-fallow swidden in multifunctional landscapes, there is little systematic evidence to suggest that such land-use systems are more or less suitable to maintaining livelihoods or ecosystem services compared to intensified land uses. The potential of long-fallow swidden to support livelihood security and forest conservation in the region thus needs further analysis, in terms of the political economic pressures that limit it,

the potential of farmers to manage and enhance long fallow, and how such management supports livelihood security and forest cover in mixed landscapes. Even greater uncertainty exists as to whether such multifunctional landscapes have more, less or the same degree of ecosystem service potential as more intensively used landscapes (and adjacently conserved forest).

Through a detailed analysis of each major period of research since 1945, this review aims to systematically assess studies on swidden and alternative land uses in the uplands of Southeast Asia. In doing so, our review examines the possible outcomes swidden and alternative land-use changes have on associated livelihood and ecosystem services in the region over time. In this way, the review will provide a much needed synthesis of the available data to provide policy-makers and practitioners with an evidence base in order to make informed decisions when it comes to land and forest policies and activities for the uplands of Southeast Asia.

1.3 Shaping the topic with stakeholders

The main topic under review emerged through sustained dialogue between authors at the University of Melbourne (Dressler, Keenan), the World Agroforestry Centre (ICRAF), Philippines (Wilson, Lasco) and the Center for International Forestry Research (CIFOR) (Clendenning) in autumn 2013. Supported by CIFOR's Evidence-based Forestry Initiative, the initial review topic was developed and scrutinised under a competitive process. Experts in the field assisted in determining the validity and relevance of the question as well as the scope of the proposed review during its initial stages.

While some studies have considered the impacts of transitions from swidden cultivation on livelihoods and ecosystem services (Bruun et al. 2009; Ziegler et al. 2009, 2012; van Vliet et al. 2012), none have followed a systematic review methodology, none have been exhaustive in a historical or geographical sense for Southeast Asia, and none have explicitly engaged the emerging debates concerning 'land sharing' and 'land sparing' in the context of regional policy and economic drivers of change (for example REDD+ and monoculture biofuels).

In further developing the original systematic review proposal, authors and key stakeholders attended a three-day workshop between 3 and 5 March 2014 in the Philippines. Participants included representatives from central government agencies of the Philippines (the Department of Environment and Natural Resources), non-governmental sector (Fauna and Flora International, Forest Trends Vietnam and Philippines Tropical Forest Conservation Foundation), civil society organisations (Foundation for Philippines Environment and NTFP – Exchange Programme for South and Southeast Asia), as well as academic and research institutes (University of the Philippines Los Baños and Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development). At the workshop, participants discussed and refined the central question, defined key terms, determined the breadth of analysis, identified sources of literature (especially unpublished studies) and proposed a dissemination strategy in a participatory manner, with the aim of connecting the review to national and regional policy concerns. Additional workshop outputs included the disaggregation of the main question components, a list of search terms, study inclusion and exclusion criteria, and a framework for data extraction.

2 Objective of the review

Long-fallow swidden systems in the uplands of Southeast Asia have undergone profound changes in extent, practice and configuration since the Second World War with subsequent influences on livelihood outcomes and ecosystem services (van Vliet et al. 2012). As such, the review's main objective is to examine the evidence relating to the positive or negative impacts of changes in long-fallow swidden on livelihood and ecosystem services outcomes compared to alternative land uses. During the stakeholder workshop, it was decided to examine this objective in line with the following main question:

> How do long fallow swidden systems impact upon livelihood security and vulnerability compared with alternative land uses in the uplands of Southeast Asia?

Table 1. Elements of the systematic review question.

Population	Exposure	Comparator	Outcomes
Southeast Asian uplands	Upland (swidden) farming systems	Alternative land-use systems replacing long-fallow swidden	Changes in: (1) livelihood status (secure to vulnerable or vice versa) and (2) ecosystem service indicators (positive to negative or vice versa)

A secondary question was designed to focus on how the changes in long-fallow swidden systems in Southeast Asia impact upon ecosystem services:

> How do changes in long fallow swidden systems impact upon associated ecosystem services (that is, water, soil and carbon)?

This second question was initially discussed only in terms of the carbon stocks associated with different types of land use and management. However, in consultation with authors and subject specialists, the question was expanded to include other ecosystem services relating to soil and water. These questions were disaggregated into the PECO components (Table 1).

Our definition of upland swidden farming systems (the exposure) is deliberately broad so as to encompass the range of upland agriculture that can be considered as 'swidden' and 'swidden-related': any upland swidden farming that involves the clearing and burning of fields and or forest for cultivation of food and/or cash crops for short (1–3 years) periods followed by a long-fallow (5–20 years) period in which woody vegetation is (re) established. This definition thus covers swidden practised by smallholders in the sloping uplands of Southeast Asia.

Our comparator, alternative land uses, will include but is not limited to: smallholder tree crops or farms; monocrop cultivation; forest protected areas; timber harvesting or plantation management (for example rubber); cessation of swidden systems and associated land clearing or abandonment; intensive/extensive livestock grazing; paddy rice; other agroforestry systems and ecotourism.

We consider two groups of outcomes in this review: changes in livelihood and changes in ecosystem services. Changes in livelihood status from secure to vulnerable (or vice versa) as a result of the exposure (long-fallow swidden systems) or a comparator (alternate land uses) will be measured using an adapted *Sustainable Livelihoods Framework* (Scoones 1998). Our study assesses changes in livelihood outcomes in terms of security and vulnerability by using the 'capitals' approach in the framework – involving social, human, financial, physical, natural capital as well as an additional capital relating to cultural components. These are considered strong proxy indicators of relative changes in the security or vulnerability of a livelihood at the household and community level. We consider vulnerability as involving an overall 'reduction' in the quality and quantity of the capitals that reflects a farmer's inability to withstand shocks and stress for a given period of time, and security as the overall 'enhancement' in the quality and quantity of the capitals with the ability to withstand shocks and stresses for a given period of time (Scoones 1998; Ellis 1999). Ecosystem service outcomes relate to changes in water (discharge, quality), soil (soil organic matter, bulk density, sediment yield and soil chemistry) and carbon (above and below ground carbon and soil organic carbon) metrics, and the effect of long-fallow swidden systems or alternate land uses upon these.

3 Methods

3.1 Search strategy

Authors agreed after the workshop (in March 2014) that the original question and overall scope of the systematic review needed further refining. A scoping exercise was therefore conducted to determine the size of the body of literature (and the scale of the task and resources required) and also to understand how select literature discusses livelihood security and ecosystem services in long-fallow swidden systems.

Two reviewers tested 86 different search terms and string combinations across four different databases (Web of Science, Science Direct, CAB Abstracts and Scopus) and one search engine (Google Scholar). The original search terms identified at the workshop were checked for duplications, truncated using search

operators where appropriate, and combined using the Boolean operator OR between each. These were then grouped by population, exposure and outcome and linked together using the 'AND' operator between each. This preliminary scoping study trialled the search terms and strings which were agreed upon at the workshop and were refined to arrive at the following search strings:

3.1.1 Population

(1) (Thailand OR Vietnam OR 'Viet Nam' OR Cambodia* OR Laos OR 'Lao PDR' OR Philippines OR Myanmar OR Burma OR Malaysia* OR 'Papua New Guinea' OR 'Southeast Asia' OR 'Greater Mekong' OR Zomia OR Borneo OR 'Indonesia* archipelago' OR 'Indo-China' OR Malaya OR Kampuchea OR Sarawak OR 'British North Borneo' OR 'insular south east Asia' OR 'Netherlands East Indies' OR Siam OR 'peninsular Malaysia' OR Pacific)

(1.a). (uplands OR montane OR slop* OR elevat* OR highland* OR tableland* OR mountain* OR hill* OR undulating OR escarpment OR range)

AND

3.1.2 Exposure

(2) (Swidden* OR 'Slash and burn' OR 'shifting cultivation' OR 'forest fallow*' OR fallow* OR 'upland farm*' OR rotation* OR farm* OR barbarian OR 'ethnic minorit*' OR indigenous OR custom* OR pioneer* OR 'forest eaters' OR montane OR imperata OR 'enriched fallow' OR 'long fallow' OR 'forest-fallow' OR 'rural poor' OR peasant OR 'forest farm*' OR agriculture* OR regrowth OR 'hill tribe' OR tradition* OR integral OR mixed)

AND

3.1.3 Outcome

(3) (Livelihood* OR income OR crop OR production OR yield OR portfolio OR wealth OR surplus OR risk OR vulnerability OR inequality OR diversif* OR speciali$ation OR needs OR capital OR education OR remit* OR migration OR relocat* OR dependency OR subsisten* OR cash OR market OR credit OR debt OR loan* OR land OR rich OR poor OR disparity OR secur* OR mortality OR nutrition OR death OR morbidity OR sufficien* OR asset* OR access OR food OR staple OR trade OR 'non- timber forest product*' OR 'non-wood forest product*' OR 'minor forest product*' OR NTFP OR wildlife OR game OR bushmeat OR 'bush meat' OR fish OR hunt* OR bird*)

AND

(3.a.) (ecosystem* OR 'Environmental service' OR 'natural resource*' OR soil OR carbon)

Each database search required a slight change in search term combination or strings. Some databases (Science Direct for example) only permit shorter search term combinations. Therefore, different combinations of the strings listed above, or components thereof, will be used for different online databases and search engines (Appendix 1). When conducting the full review, the specific search terms entered into each of the databases will be documented and included as an appendix for transparency and repeatability.

In addition to specialist publication databases, a search will be conducted using search engines which are likely to return a greater number of irrelevant hits than the specialist databases. The first 100 returned hits will be checked for relevance.

The web-based search will be conducted primarily in English. Non-English returns will not be discounted, but checked at title level, either using an online translation tool or drawing on the multicountry background of authors and stakeholders and included if relevant. Whether it will be included at full text level will depend on the translation resources available.

3.2 Search comprehensiveness

During the scoping study, a total of 8,868 hits were returned by Web of Science (v5.13.2) using the combination of strings detailed above. This search strategy is considered to be highly sensitive but to have low specificity, which means we are less likely to miss relevant literature, but the task of screening the returned hits will be greater. The number of hits returned and those included in the review and the date the search was conducted will be recorded.

3.2.1 Online searches

The following specialist online databases and search engines will be used to search for relevant literature:

- Agricola: USDA National Agricultural Library
- AGRIS: International Information System of the Agricultural Science and Technology (FAO)

- Directory of Open Access Journals (DOAJ)
- CAB Abstracts
- JSTOR
- ProQuest
- Science Direct
- Scopus
- Springer
- Web of Science (v.5.13.2)
- Wiley Online Library

3.2.2 Web search engines.

- Google (www.google.com)
- Google Scholar (scholar.google.com)

3.2.3 Grey literature search

Possible sources of relevant grey literature were identified during the stakeholder workshop, and these organisations' websites (see Appendix 2) will be searched using keyword terms from the main search strings to find any relevant grey literature (unpublished papers, government documents, working papers or project reports). Where practical, the libraries of these organisations and others will be visited to search for and scan hardcopy publications, reports and manuscripts. The in-country stakeholders at Southeast Asian and Pacific institutes and organisations will be encouraged to share relevant literature not available online including the libraries of experts in the field, PhD and Masters Theses. Lastly, a 'call for relevant literature' will be announced through relevant email list serves and conferences in Southeast Asia to source any studies missed through the literature search.

3.2.4 Bibliographic searches

The bibliographies of highly relevant full review articles will be searched to identify any article or studies missed in the main search. Articles retrieved in this way will be highlighted in the search database to help improve future searches. If relevant, returned articles are not available, where clarifications are required or where supporting data sets may be useful, authors will be contacted directly to request such information and access.

3.3 Study inclusion criteria

Studies that meet the following criteria will be included for analysis (should they also meet the critical appraisal criteria – see section 3.6):

3.3.1 Population

Sloping uplands of Southeast Asia (Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Laos, Papua New Guinea, Vietnam) where long-fallow swidden systems have been or could be practised.

3.3.2 Exposure

Discusses a type of farming system which:

1. includes a crop rotation and a period of forest fallow (>5 years);
2. makes a primary livelihood contribution to subsistence or market sale;
3. is conducted by smallholder individuals or families (in upland sloping zones).

3.3.3 Comparator

The study compares in some way long-fallow swidden systems to alternative land-use systems in the uplands or any land-use system that has replaced or is replacing long-fallow swidden systems. Such land uses could include but are not limited to smallholder tree crops or farms; monocrop cultivation; forest protected areas; timber harvesting or plantation management (for example rubber); land clearing or abandonment; intensive/extensive livestock grazing; paddy rice; and other agroforestry systems.

3.3.4 Outcomes

Studies must relate to one of the following outcomes to be included in the review:

1. Change in the capitals component of the adapted Livelihoods Framework: involving social, human, financial, physical, natural, social and cultural capital;
2. Change in ecosystem services: increases and decreases in carbon stock, water yield, water quality and soil fertility and quality.

3.3.5 Types of studies

Both qualitative and quantitative studies from peer-reviewed and grey literature will be considered as well as unpublished data sets. Primary studies include those using experimental (intervention and randomised designs), quasi-experimental (non-random, longitudinal designs and large *n*-surveys) and observational methods. Additionally, secondary review studies (both systematic and non-systematic) will be considered but any data cited in those studies will only be included if the original source data can be accessed. We also include qualitative case studies that pass critical appraisal (3.6), but purely theoretical, editorial or conceptual studies are excluded.

3.3.6 Exclusions

Exceptions to the criteria described above include changes attributed to urbanisation or urban sprawl, large infrastructure projects (dams, mining and so

forth) and large-scale agricultural systems in lowlands including lowland rice. Ecosystem service studies that do not discuss soil, water or carbon will not be considered.

3.4 Article screening

The articles returned from the searches will undergo a four-tier screening process which is summarised in Figure 1 and discussed in detail here.

Tier one: Titles and abstracts of articles returned from the search of all databases and online sources will be downloaded to a reference management system and backed up in a database (Microsoft Excel or Access). Any available analytical data (citation number, publication and year published) will also be downloaded and saved. At this stage, any duplicates obtained from different databases will be removed.

Tier two: Any obviously irrelevant articles will be checked initially at title and abstract level by a

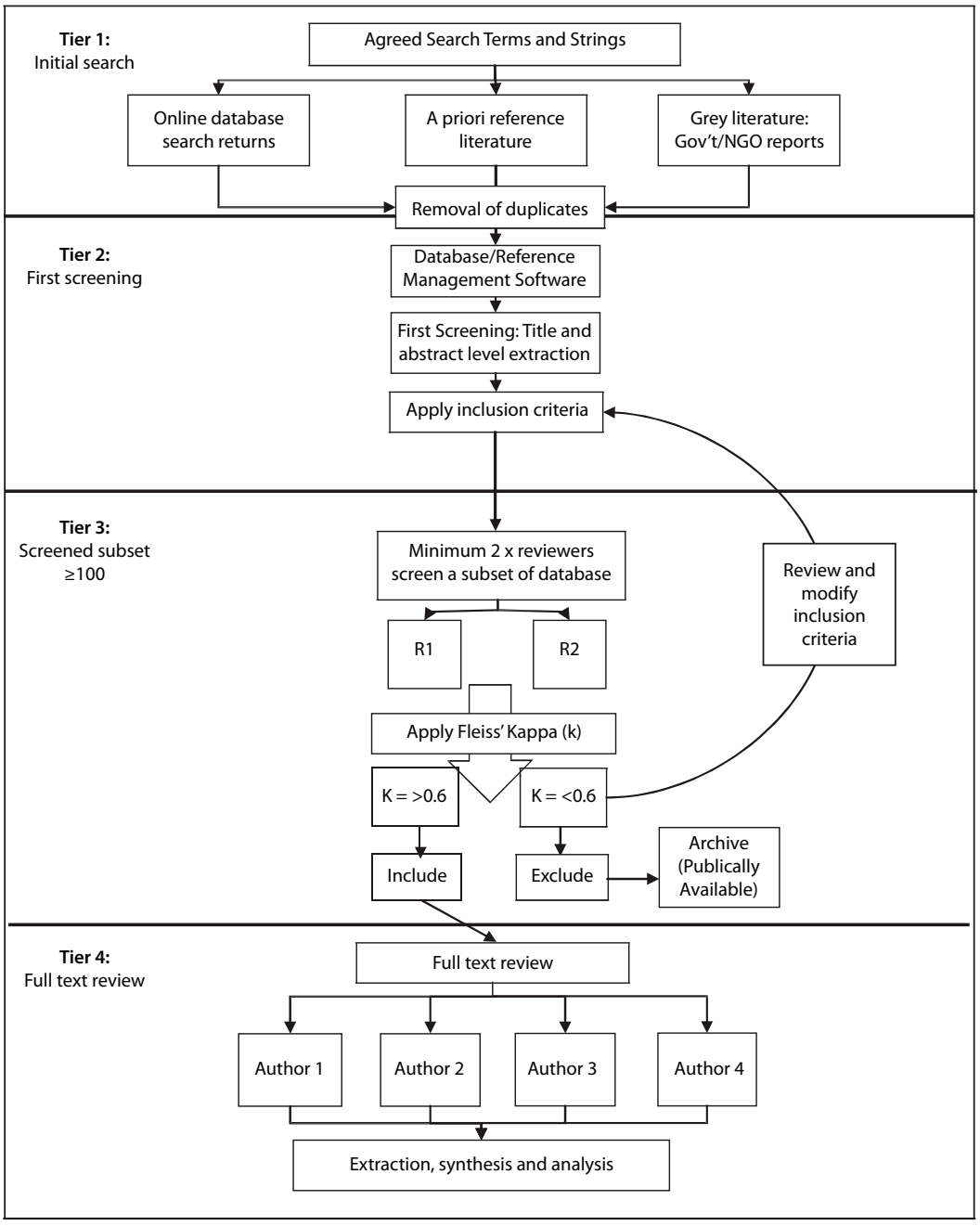

Figure 1. Search and screening procedure.

minimum of two reviewers applying the inclusion criteria. If there is uncertainty about the relevance of a particular article or if the abstract is unavailable, it will be included for full text review.

Tier three: To ensure consistent application of the inclusion criteria, before full title and abstract screening begins a sample of minimum 100 and maximum 500, randomly selected articles will first be assessed using a Fleiss' kappa statistic that compares the level of agreement between multiple reviewers. Each reviewer will screen the same subset of titles and abstracts, and the results will be recorded and treated with Fleiss' kappa (k) using R statistics' inter-rater reliability package. Kappa scores of ≥0.6 will be the threshold for proceeding with full title and abstract level screening. If this score is not achieved, the inclusion criteria will be revisited and any disagreements discussed with the review team. The kappa screening process will then be repeated on a new subset of sample articles until the necessary score is achieved. Any changes made to inclusion/exclusion criteria will be documented.

Tier four: Once the review team has agreed on a list of articles based on title and abstract screening, the remaining articles will be retrieved and assessed for final inclusion at full text review. If identified articles are unavailable online, every effort will be made to retrieve hard copies, including contacting authors directly. Articles will be divided equally among the review team authors (minimum four) for full review, critical appraisal and data extraction. Any articles or reports rejected at this stage will be archived and stored for transparency and reported in an appendix of the full review.

3.5 Potential effect modifiers

Potential effect modifiers that would influence livelihood factors and or ecosystem services include differences in socio-economic and biophysical contexts including trends in population (density); changes in access to markets; changes in the political and institutional environment, such as forest, land or agricultural policies; changes in land tenure; and biophysical changes, such as climatic extremes (drought or extreme rainfall); topography; weed and pest pressure. During data analysis, we will document the potential effect modifiers that could have influenced livelihood or ecosystem outcomes.

3.6 Critical appraisal

Studies included in the final analysis and synthesis will have to meet a minimum quality standard. Given this review is considering two sets of outcomes (livelihoods and ecosystem services) we anticipate studies will include a range of designs and methodological approaches, from quantitative studies with experimental designs through observational studies and ethnographic work. In order to accommodate this diversity, we adopt a principle-based approach to critically appraising and assessing the quality of studies, organised under different quality domains (Table 2). This approach allows us to accommodate qualitative studies and methods (including non-randomised, ethnographic and observational studies) which may not normally be considered of high quality in more conventional systematic reviews.

These principles underpin the overall critical appraisal process and ultimately determine the study quality. Each study, regardless of whether qualitative or quantitative in nature, will initially be assessed using a critical appraisal framework based on these principles with a score allocated for each of the 12 questions or principles. A score of 2 means the criteria is fully met, 1 partially met or unclear and 0 where it is unmet. Studies which score 19–24 will be considered high quality, 13–18 of moderate quality, 7–12 of low quality and 0–6 of very low quality. This will be the final assessment where studies are qualitative in nature but for quantitative studies an additional Risk of Bias (RoB) tool adapted from Bilotta, Milner, and Boyd (2014) will be used. This tool builds on the best practices examples offered by the Cochrane Collaboration and adapted for use in environmental and natural resources reviews (Appendix 3). Quantitative studies will be given a combined overall quality assessment score based on a combination of criteria (Table 3).

Studies deemed to have a final quality rating of very low will be excluded from the analysis phase and archived. Studies with a quality rating of high or moderate will be included in the final analysis and those with a rating of low will be included, subject to sensitivity analysis. Should the low-quality studies alter the effect size of moderate and high-quality studies or contradict any narrative synthesis, a subset analysis of these studies will be presented with an accompanying caveat. All components of the quality assessment will be conducted for each study by at

Table 2. Critical appraisal framework.

Quality domain	Quality criteria
Study directness	1. Does the study consider the population, exposure and comparators of interest in the review?
Conceptual framing	2. Does the study set out a theoretical or conceptual framework and hypothesis, theory or central argument which is tested?
Transparency	3. Are details of the study location and population provided?
	4. Are the aims and objectives of the research clearly stated?
Appropriateness	5. Is the research design clearly specified and appropriate for the aims and objectives of the research?
	6. Do the researchers display sufficient data to support their interpretations and conclusions?
	7. Is the duration of study adequate for the proposed design?
Validity	8. Measurement validity: Are selected indicators or measures appropriate for the stated outcome of interest given the local context?
	9. Internal validity (Credibility): Are confounding variables identified and mitigated for?
	10. External validity (Transferability): are the results or findings transferable to other contexts, locations and settings outside those in the study area?
Reliability (dependability)	11. Stability: has the study demonstrated appropriate application of stated measurement and consistency of data gathering?
Cogency	12. Is the study consistent from proposing a conceptual framework through methodology, data gathering, results and conclusion?
Risk of bias (for quantitative studies only)	Risk of Bias is assessed in quantitative studies using a separate tool which includes the following components: • Selection bias • Performance bias • Detection bias • Attrition bias • Reporting bias • Other bias

Source: DfID (2014)

least two reviewers to minimise reviewer subjectivity. Any discrepancies will be discussed among the reviewers and agreement reached on the final quality assessment.

3.7 Data extraction and synthesis

A list of potential data extraction categories was created during the stakeholder workshop and was subsequently developed into the data extraction matrix. These fields will likely require further refinement which will be achieved by conducting data extraction on a subset of relevant articles reviewed at full text level.

A relational database will be created with pre-defined categories which will guarantee consistency of data extracted. Summary data (Author, Title, Date and Publication) will be collected for each article and where multiple studies are contained therein these will be disaggregated and listed as separate studies. Basic information relating to the study including location, temporal and spatial scale, unit of analysis, land use/cropping system, type of study and any information relevant for potential effect modifiers will be extracted. Details of the study site location will be collected or determined using available information so that studies can be traced and mapped to determine any spatial patterns as part of the synthesis. Information relating to the

Table 3. Critical appraisal ratings.

Overall quality rating	Combined criteria (quantitative studies only)	Action/interpretation	Indicative methodology characteristics
High	High quality, low risk of bias (RoB)	Include in final analysis: confident about overall quality	Experimental designs (RCT); long-term ethnographic studies
Moderate	Moderate quality, low RoB High quality, unclear RoB	Include in final analysis: moderately confident about overall quality	Robust observational studies
Low	Low quality, low RoB Moderate quality, high RoB	Conduct sensitivity analysis to determine inclusion: low confidence	Robust case studies
Very Low	Very low quality, high RoB Low quality, high RoB	Exclude from final analysis	Studies with insufficient, inadequate or inappropriate designs

Source: Bilotta, Milner, and Boyd (2014)

study design and methods used will be collected to facilitate critical appraisal at full text level. Available quantitative data relating to livelihood and ecosystem outcomes will be extracted from tables and graphs and stored separately for further statistical analysis as part of the synthesis.

Where data permits, we will also attempt to draw conclusions relevant at different spatial scales from the farm or plot level through landscape to regional and even globally in the case of carbon. It is envisaged that the database will be considered as a useful output in its own right and can be made public and added to as a reference document over time.

3.7.1 Narrative synthesis

The breadth of the questions considered here and the anticipated disparate outcomes suggest that a narrative synthesis would be most appropriate for interpreting and presenting results. Summary information, descriptive statistics on the number, types and results of studies as well as study quality will be presented in tables and figures as part of a narrative synthesis. As this review considers two main questions, two syntheses will be conducted, one for ecosystem services outcomes and a second for livelihood outcomes.

Livelihood changes will be referenced as 'no change', 'security', and 'vulnerability' as indicated by changes in the six capitals (social, human, financial, physical, cultural and natural) from the adapted Sustainable Livelihoods Framework (Table 4).

A value between 0 and 2 will be assigned to each study based on the evidence relating to the six capitals which will assist with analysis:

1. No change (index 0) as indicated by retaining the same overall status in livelihood (status quo or no marked change in terms of capitals).
2. *Vulnerability* (index 1) as indicated by an overall 'reduction' in the quality and quantity of the capitals (>3 of the 6) that reflects a smallholder farmer's inability to withstand shocks and stress for a given period of time.
3. *Security* (index 2) as indicated by an overall 'enhancement' in the quality and quantity of the capitals (>3 of the 6) and reflects a smallholder farmer's ability to withstand shocks and stresses for a given period of time.

Changes in ecosystem services will be measured as increases and decreases in carbon stock, water yield, water quality and soil fertility/quality. Data relating to ecosystem services changes are likely to be quantitative in nature and reported means and standard deviations will be recorded and presented. At a minimum, descriptive and where possible analytic statistics will be applied to the quantitative data sets in an attempt to describe the significance of relative increases or decreases in ecosystem services associated with swidden systems and alternative land uses.

We apply a relative measure to ecosystem services where an increase or decrease in one (as related to water, soil and carbon) is either a positive or negative net outcome. For example, an increase in sediment

Table 4. Adapted livelihoods framework used in this review.

Capital	Indicator
Social capital	Social networks, trust, reciprocity (household, community level), reciprocal labour arrangements
Human capital	Skills, knowledge, physical health, education and labour potential
Financial capital	Cash, income, savings, debt
Physical capital	Access to and use of assets (farm and off farm), farming tools and equipment, presence of and access to infrastructure
Natural capital	Quality and quantity of land, forest, and water, and associated natural resources including yield (subsistence to surplus)
Cultural capital	Traditional (ecological) knowledge, ritual, ceremony and myth

Source: Scoones (1998).

Table 5. Common indicators of positive and negative changes in ecosystem services.

Ecosystem service group	Metric	Indicator	
		Positive	Negative
Water	Water yield: discharge [m^3 s^{-1}]	Variable	Variable
	Water quality: Sedimentation [mg kg^{-1}]	Decrease	Increase
	Nutrient or pollutant loading [mg L^{-1}]	Decrease	Increase
Carbon	Stock [Mg C ha^{-1}]	Increase	Decrease
Soil	Soil organic matter [g]	Increase	Decrease
	Bulk density [g cm^{-3}]	Decrease	Increase
	Sediment yield [Mg ha^{-1} yr^{-1}]	Variable	Variable
	Soil chemistry (N-P-K)		

yield could be considered a negative impact, whereas an increase in carbon stock may be considered a positive impact. Changes will be quantified where possible, the general direction of change (increase/decrease) and the associated impact (positive/negative) will be noted (Table 5).

3.7.2 Quantitative synthesis

It is unclear whether data from an anticipated disparate range of study types, metrics and methodologies will permit a meaningful meta-analysis to determine overall mean effect magnitude of interventions (swidden vs. alternate land uses) on outcomes (livelihoods and ecosystem services). Should the data ultimately be available to permit meta-analysis including meta-regression, an appropriate methodology will be developed in consultation with the advisory board consisting of experts in the field. This may also involve refining certain aspects of the methods discussed here. Any changes or refinements will be noted in the final review documentation.

4 Conclusion

This systematic review protocol therefore proposes a methodological approach to analyse the evidence on the range of possible outcomes such land-use changes have on swidden and associated livelihood and ecosystem services over time and space.

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Appendix 1.
Search string combinations to be used in selected online databases

Database/search engine	String combination or term*
Web of Science	(1) AND (2) AND (3)
Scopus	(1) AND (1.a.) AND (2) AND (3) AND (3.a.)
Science Direct	(Swidden OR shifting OR Rotation* OR 'slash and burn') AND (livelihood*) AND (ecosystem) AND (upland) AND (Thailand OR Vietnam OR 'Viet Nam' OR Cambodia OR Laos OR Philippines OR Indonesia OR Myanmar OR Burma OR Malaysia OR 'Papua New Guinea' OR 'Southeast Asia')
CAB	(Swidden* OR 'Slash AND burn' OR 'shifting cultivation' OR 'forest fallow*' OR fallow* OR 'upland farm*' OR rotation*) AND (Livelihood* OR income OR crop OR production OR yield OR portfolio OR wealth OR surplus OR risk OR vulnerability OR inequality OR diversif* OR speciali$ation OR needs) AND (Asia OR 'southeast Asia' OR Pacific)
Google Scholar	swidden OR shifting OR Rotation* OR 'slash and burn' AND livelihood* OR cash OR production OR yield OR income AND ecosystem OR soil OR water OR carbon AND upland AND south east asia OR Philippines OR Thailand OR Malaysia OR Indonesia OR Cambodia OR Laos OR Papua New Guinea

*Numbers refer to search strings identified in 'Search Strategy' section (3.1).

Appendix 2.
Organisations to be searched for grey literature

Organisation	Website
Asian Institute of Technology (AIT)	http://www.ait.ac.th/
SEAMEO BIOTROP	http://www.biotrop.org/
CGIAR Network, mainly:	
• CIFOR	http://www.cifor.org/
• ICRAF	http://www.worldagroforestry.org/
• Bioversity International	http://www.bioversityinternational.org/
• CIAT	http://ciat.cgiar.org/
• IFPRI	http://www.ifpri.org/
Chiang Mai University	http://www.cmu.ac.th/index_eng.php/
Conservation International Department of Agriculture (Philippines):	http://www.conservation.org/Pages/default.aspx/
• Bureau of Soils and Water Management (BSWM)	http://www.bswm.da.gov.ph/
• Bureau of Agricultural Research (BAR)	http://www.bar.gov.ph/
• Department of Environmental Natural Resources	
• Ecosystems Research and Development Bureau (ERDB)	http://erdb.denr.gov.ph/
• Forest Management Bureau (FMB)	http://forestry.denr.gov.ph/
Department of Science and Technology (DOST)	http://www.dost.gov.ph/
East West Center	http://www.eastwestcenter.org/
Flora and Fauna International	http://www.fauna-flora.org/
Forest Trends	http://www.forest-trends.org/
French Historical Resources	http://www.loc.gov/rr/european/resources/res-fr.html/
Gadjah Mada University (Indonesia)	http://www.ugm.ac.id/en/
IUCN	http://www.iucn.org/
Kasetsart University (Thailand)	http://www.ku.ac.th/english/
Multilaterals:	
• FAO	http://www.fao.org/home/en/
• AusAID	http://aid.dfat.gov.au/Pages/home.aspx/
• GIZ	http://www.giz.de/en/
• JICA	http://www.jica.go.jp/english/
• KOICA	http://www.koica.go.kr/english/main.html/
• USAID	http://www.usaid.gov/
• CIDA	http://www.acdi-cida.gc.ca/acdi-cida/acdi-cida.nsf/ eng/home/
OXFAM	http://www.oxfam.org.uk/
PAFID	http://www.pafid.org.ph/
PCAARRD Library:	http://www.pcaarrd.dost.gov.ph/home/ssentinel/
RECOFTC	http://www.recoftc.org/
SEARCA	http://searca.org/

Organisation	Website
TROPENBOS	http://www.tropenbos.org/
University of the Philippines	https://library.uplb.edu.ph/
USDA	http://agricola.nal.usda.gov/
USFS	http://www.fs.fed.us/research/
National Forestry Service, Yale	http://environment.yale.edu/gisf/programs/tropical-forestry/
World Bank	http://www.worldbank.org/
WWF	http://wwf.panda.org/
WINROCK	http://www.winrock.org/
The Nature Conservancy	http://www.nature.org/
World Resources Institute	http://www.wri.org/

Appendix 3.
Risk of bias framework

Bias domain	Risk rating* (Low, unclear, high)	Support for assessment [copy text from study and include reasons for score]
(1) SELECTION BIAS DUE TO INADEQUATE		
RANDOMISATION		
(2) PERFORMANCE BIAS		
(3) DETECTION BIAS		
(4) ATTRITION BIAS DUE TO INCOMPLETE OUTCOME DATA		
(5) REPORTING BIAS DUE TO SELECTIVE REPORTING		
(6) OTHER BIAS		

Note: *SUMMARY ASSESSMENT, Low risk = low risk in all domains, Unclear = unclear in one or more domains, High = unclear in one or more domains.

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Swidden agriculture or shifting cultivation has been practised in the uplands of Southeast Asia for centuries and is estimated to support up to 500 million people – most of whom are poor, natural resource reliant uplanders. Recently, however, dramatic land-use transformations have generated social, economic and ecological impacts that have affected the extent, practice and outcomes of swidden in the region. While certain socio-ecological trends are clear, how these broader land-use changes impact upon local livelihoods and ecosystem services remains uncertain. This systematic review protocol therefore proposes a methodological approach to analysing the evidence on the range of possible outcomes such land-use changes have on swidden and associated livelihood and ecosystem services over time and space.

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