Working Paper

Local knowledge on the role of trees to enhance livelihoods and ecosystem services in Ho Ho Sub-watershed, north-central Viet Nam

Bac Viet Dam, Rachmat Mulia and Delia Catacutan

World Agroforestry Centre

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Abstract

Understanding how local people view and value the role of trees in enhancing livelihoods and environmental quality is the key to increasing resilience in agricultural landscapes through tree planting. In the Ho Ho sub-watershed, north-central Viet Nam, which is highly exposed to climate change and variability, we investigated local knowledge on the role of trees that involved people upstream and downstream in the sub-watershed. The respondents were requested to identify the different roles of tree-based and annual crop systems in their landscape to livelihood and the environment, and then to rank these roles to reveal the primary function of each landuse system. We found that local knowledge on the roles of each landuse type, both in upstream and downstream communes, was influenced by the household land holding size and the actual contribution to household income as well. This, for example, explains the higher appreciation of acacia than agarwood in terms of livelihood and environmental functions. In the sub-watershed, the average land holding size per household for acacia plantation was 1.3 ha, while agarwood trees were planted in homegardens with a delayed harvesting time (15 years after planting compared to 7 years for acacia). Different responsibilities in agricultural activities between males and females in the family, contributed to contrasting responses between the male and female groups on the role of tree-based and annual crop systems in household income. Men regarded annual crops as a more important source of income than trees, whereas women asserted the opposite. In the sampled households, financial management and private consumption provision were two tasks mostly handled by women, and this likely explains the gender sensitivity. We conclude that local people in the upstream and downstream communes of the sub-watershed recognised well the important roles of trees to livelihood and environmental quality, but in actual implementation, they always prioritised livelihood over environmental issues, especially in relation to tree planting on their own land. Environmental issues were only an option considered for unallocated areas such as protection forest, or for allocated lands not suitable for planting due to physical barriers such as high elevation or steep slopes.

Keywords: Environmental services, livelihood, local knowledge, role of trees, sub-watershed

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Introduction

Forest and tree-rich landscapes can be more effective in achieving food security and climate stability than unforested ones (Chavez-Tafur 2014). Recent study by Simelton et al. (2015) reveals that trees and agroforestry have been traditionally used by farmers to cope with various climate-related hazards in Viet Nam. Farmers have reported that annual crops were generally more sensitive to weather-related events than perennials. Hoang et al. (2014) concluded that trees (including agroforests) outside forests, can help buffer and enhance the resilience of both ecosystems and local livelihoods in agricultural landscapes to climate change and variability. The Food and Agriculture Organization (FAO) (2013) includes useful information on the important roles of forests, trees on farms and agroforestry systems to food security, nutrition, livelihoods, fuel, employment and cash income. Trees can provide most of the environmental services such as regulation of the micro- and macro-climate and soil improvement, as well as water and biodiversity conservation (van Noordwijk et al. 2014). Simelton et al. (2015) and Nguyen et al. (2013) found that tree-based systems are more adaptive to climate change and variability, and households with tree-based systems had a faster economic recovery after extreme weather events compared to those without.

The Ho Ho sub-watershed and its inhabitants in north-central Viet Nam experience a high degree of exposure and sensitivity to climate change and variability, with a low adaptive capacity especially in the upstream commune (Mulia et al. 2015). Landcover analysis revealed that the most dominant landcover in the sub-watershed in 2014 was poor natural forests (logged over forest) with 72 percent and 69 percent land coverage relative to the total sub-watershed area in the upstream and downstream communes, respectively. Among different ways of improving livelihood sectors to enhance local resilience to extreme weather events including from off-/non-farm sectors, they highlight the importance of enriching the landscape through tree planting. In the sub-watershed, no agroforestry was reported outside homegardens and locals were reluctant to plant trees amid annual crops (Mulia and Dam 2015). Only when the resources in the nearby forests become depleted, climate uncertainty prevents high quality and quantity annual crops, and there is ready access to subsidies and guidance from other stakeholders, do locals re-consider tree planting in homegardens and on sloping land to increase their livelihoods and resilience to climate change and variability (Doan et al. 2016). Tree planting amid annual crops, however, is still hampered by different constraints (Mulia and Dam 2015).

Understanding how local people view and value the role of trees with regard to livelihood and environment service functions in different landuse options, and how this relates to the actual landuse distribution and change in the study landscape, is crucial in efforts to enhance both the local and environmental resilience through tree planting and the development of sustainable landscape management schemes (Pfund et al. 2011). In Viet Nam, we are still lacking studies regarding local knowledge on the role of trees with respect to livelihood and the environment (for example, Simelton and Dam 2014). In this paper, we report on how local people in the Ho Ho sub-watershed central Viet Nam have identified the roles of different landuse types including tree-based and annual crop systems with regard to livelihood and environmental qualities. We compare the local responses in upstream and downstream communes of the sub-watershed, and between male and female farmer groups. The local knowledge is used to explain the land and tree cover distribution and change during the last decade

(2005-2014) in the sub-watershed. Since the upstream and downstream communes of the Ho Ho sub-watershed have different degrees of vulnerability (Mulia et al. 2015), we hypothesise that there will be a difference in the point of view and the way locals in the two communes value the role of trees in different landuse systems. Agricultural task allocation between males and females within the family also leads to a hypothesis that there is a gender sensitivity aspect in the local knowledge on the role of trees.

Materials and methods

Site descriptions

The Ho Ho sub-watershed (Fig. 1) is located between 105°42'16.49" E and 18° 5'25.41" N within the administrative boundaries of the Huong Khe district of Ha Tinh province and the Tuyen Hoa district of Quang Binh province, north-central Viet Nam. The 2014 population was 10 000 people (equivalent to 3500 households). The average population density was 41.5 people km^{-2} in the upstream (Huong Lam and Huong Lien) commune and 30.2 people km^{-2} in the downstream (Huong Hoa) commune. The hydrology in the sub-watershed largely depends on two main rivers namely Ngan Sau and Rao Boi that flow across the sub-watershed. A dense stream system and the high upstream elevation accelerate the surface flow, especially in the rainy season between August and October.

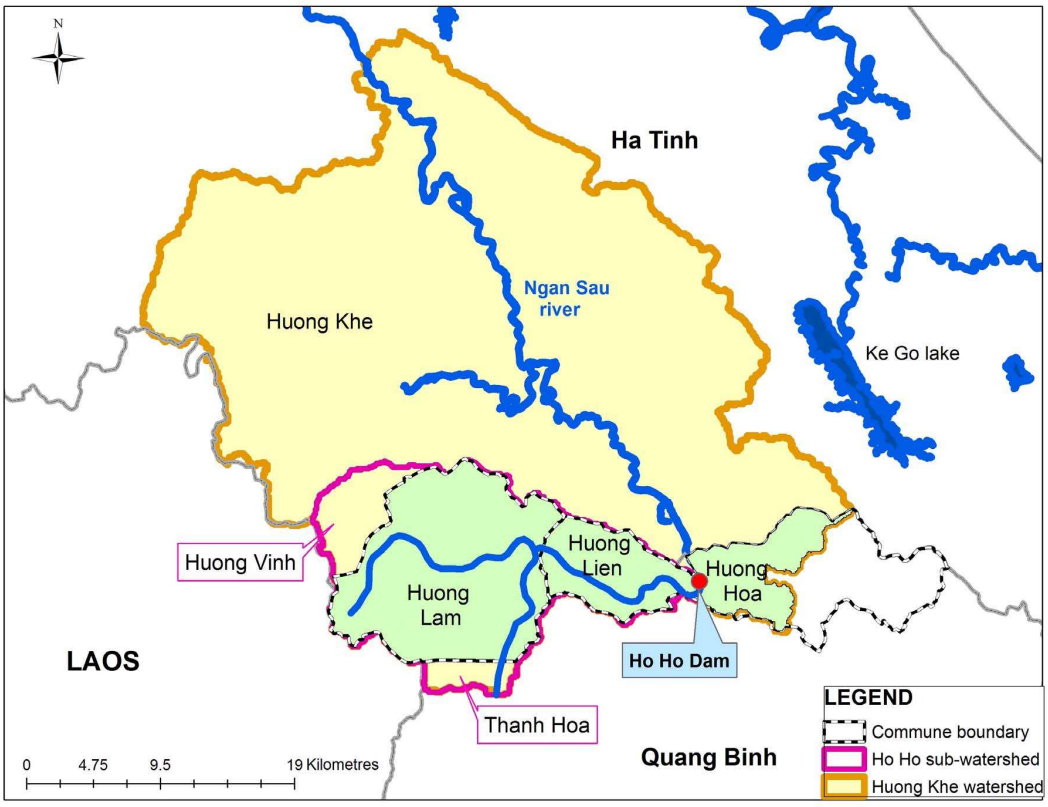

Figure 1. Location of Ho Ho sub-watershed in north-central Viet Nam

The sub-watershed is influenced by the tropical monsoon both in the summer and winter seasons. Summer generally occurs from April to August with low humidity. In particular, the area is largely affected by southwesterly winds in June and July. Winter occurs from November to March with the northeastern monsoon and rainfall. Based on the 1982-2011 weather data records for the Huong Khe district obtained from the Institute of Meteorology, Hydrology and Climate Change (IMHEN), the average temperature in the area was 25 °C with an average maximum and minimum temperature of 28.7 ° C and 21.2 ° C, respectively. The average annual rainfall is about 2500 mm. The rainy season takes place between August and September with an average total rainfall of 1425 mm, equivalent to 60 percent of the annual rainfall. January and February are the driest months with an average total monthly rainfall of only 96.6 mm. The topography of the sub-watershed is dominated by rivers and streams.

The study site includes two villages in Huong Lam (upstream commune) and three villages in Huong Hoa (downstream commune) in the Ho Ho sub-watershed. The village selection was preceded by consultations with the district and commune officials to cover spatial variation in water scarcity and the impact of weather-related extreme events such as flooding, drought, storms, cold spells and landslides. Since 2013, the Ho Ho hydropower plant located on the border between the middle and downstream communes has provided electric power and irrigation for the downstream commune. Plant construction commenced in 2004 to intercept water flow from the Ngan Sau River. The hydropower plant draws on 276 km^2 of the basin and features 2.35 km^2 of reservoir. The expected average annual flow is 19.6 $m^3 s^{-1}$ with a full capacity of 38 million m^3. The estimated average annual electricity output is 54 million kWh.

Sampling design

Local knowledge on the role of trees was captured through focus group discussions conducted in 2014 with a female-only and a male-only group in each of the upstream and downstream communes of the Ho Ho sub-watershed. Local knowledge is defined as "a collection of facts that relates to the entire system of concepts, beliefs and perceptions that people hold about the world around them. This includes the way people observe and measure their surroundings, how they solve problems and validate new information. It includes the processes whereby knowledge is generated, stored, applied and transmitted to others" (FAO, 2004). Each group consisted of nine people so that 18 female and 18 male respondents were selected from different villages in the communes and the groups were interviewed separately in the communal office to ensure independence between groups. In the group discussions, the farmers were asked to identify local landuse systems including tree-based and annual crops, the different roles of each landuse type to livelihood and the environment, and to make a pairwise ranking between landuse systems based on the Analytic Hierarchy Process (Saaty 1990).

Distribution of tree-based systems in the landscape

Spatial analysis of tree cover in the sub-watershed was carried out by combining the data from remote sensing (Landsat) in 1990, 2000 and 2014, and from the land use maps from the Ministry of Natural Resources and Environment. A detailed description and the steps of the map analysis are given in Nguyen et al. (2015).

Results

Local knowledge in upstream commune

People upstream, both males and females, mentioned two roles of the landuse system for livelihood (Fig. 2a, c) and five for environmental services (Fig. 2b, d). For the food provision function, no differentiation was made between food for humans and livestock. In the female group, these roles were assessed for each of three systems of annual crop (rice, peanuts and maize), two tree monoculture systems (acacia and agarwood), and one mixed system (agroforestry system with agarwood and taro or cassava as understorey) (Fig. 2a, b). In the male group, annual crop systems consisted of green beans as well, with pamelo, acacia and agarwood as tree monoculture systems (Fig. 2c, d). The male group did not specify any mixed systems.

The female group valued acacia as a good source of income but not so agarwood (Fig. 2a). Agarwood trees were still young and not yet in the productive stage at the time of the interview. Acacia timber is generally harvested 7 years after planting whereas resin-type agarwood products need 15 years. The female group gave a higher appreciation to the agroforestry (AF) system with agarwood. This was most likely due to the good profit from the understorey (taro or cassava). The role of trees in food provision was much lower than that of annual crops, as expected.

The female group deemed annual crops as inferior in providing environmental services, except for maize (Fig. 2b). Maize occupied a larger area than the other two crops and its root biomass was returned to the soil as mulch. For trees, acacia was valued better than agarwood and this was likely related to the land holding area. The average land holding area per household (including both upstream and downstream) in 2014 was 0.1 ha for paddy, 0.13 ha for annual crop (generally maize), 0.15 ha for homegardens and 1.3 ha for acacia plantation. Most agarwood was planted in homegardens. The females appreciated mixed systems with agarwood more than agarwood monoculture (Fig. 2b).

In contrast to the female group, the male group considered annual crops as a more important source of income than trees (Fig. 2c). This might relate to task allocation between the males and females in the family (Table 1). In 82 percent of the 200 sampled households, selling activity was handled by women (a more detail description is provided in the discussion section below). The longer time until harvesting induced a low appreciation of agarwood as a source of income generation. This low appreciation was surprisingly given to pamelo as well. For environmental service functions, except for soil improvement, the male group clearly identified trees as having a better role than annual crops (Fig. 2d).

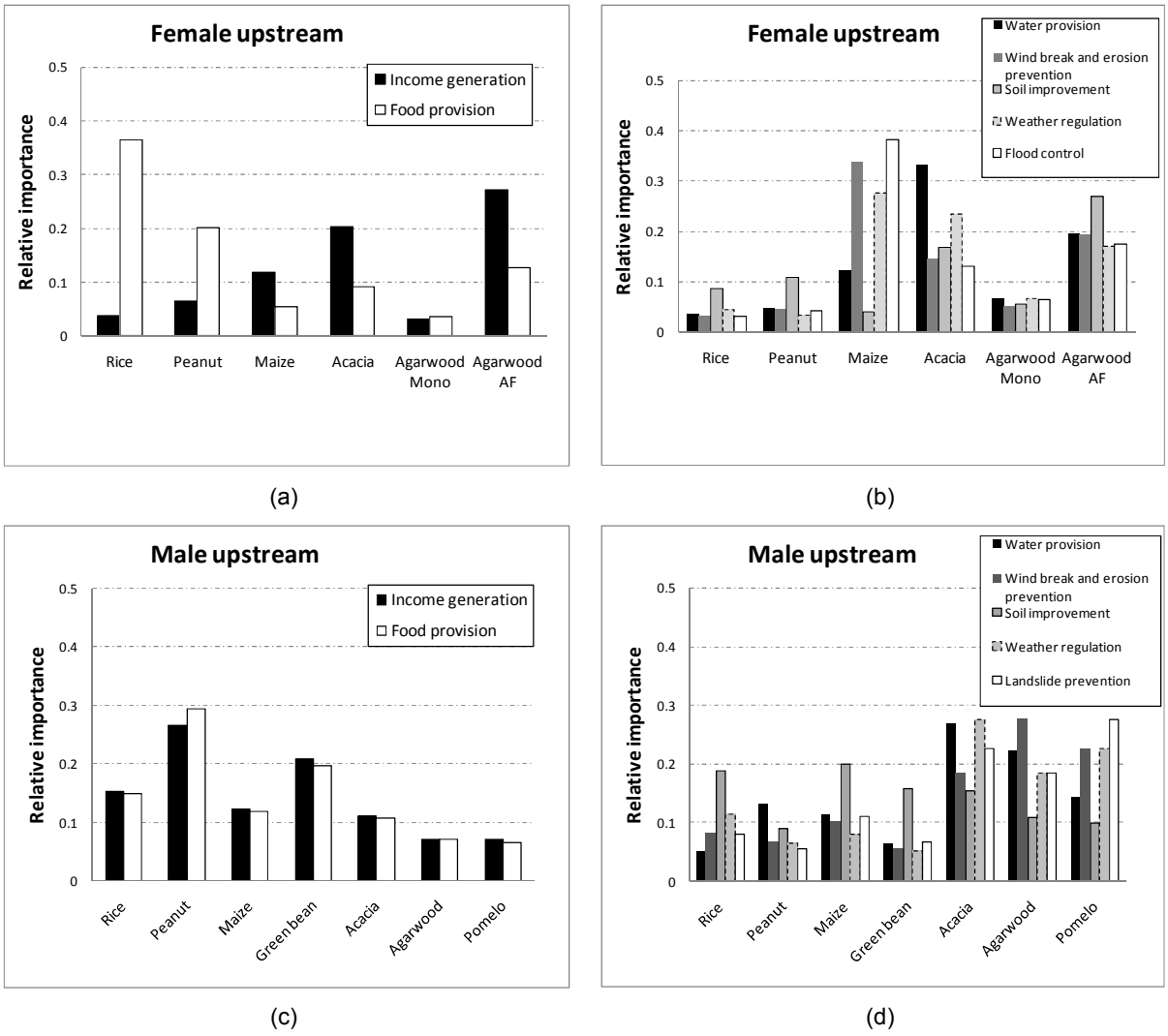

Figure 2. Role of landuse systems in livelihood and environmental services based on local knowledge of female (a, b) and male (c, d) groups in the upstream commune

Local knowledge in downstream commune

The female group downstream differentiated the food provision function between humans and livestock (Fig. 3a). However, they listed fewer environmental service functions than the male group. As for the upstream groups, the downstream female and male groups identified slightly different types of annual crop and tree-based systems, and only the female group identified the presence of mixed systems. Downstream, agarwood was usually combined with peanuts, maize or beans as an understorey crop.

The female group clearly valued tree-based systems higher than annual crops both for income generation and environmental service functions (Fig. 3a, b). Interestingly, unlike upstream, a high appreciation regarding income generation was also given to agroforestry systems with agarwood. Agarwood trees in the downstream commune were not planted earlier than upstream, which suggests that the female group probably had a better appreciation of this tree species based on potential economic benefit rather than its value for a current source of income. They knew that in the future, agarwood could provide a high income from the collected latex and wood products.

The female and male groups had different perceptions about the role of trees in income generation. As was the case upstream, the male group downstream perceived there was better income from annual crops than trees (Fig. 3c), whereas the female group saw it the other way round. From the environmental aspect, both groups generally considered trees to have better environmental services, with the exception of the soil improvement function (Fig. 3d).

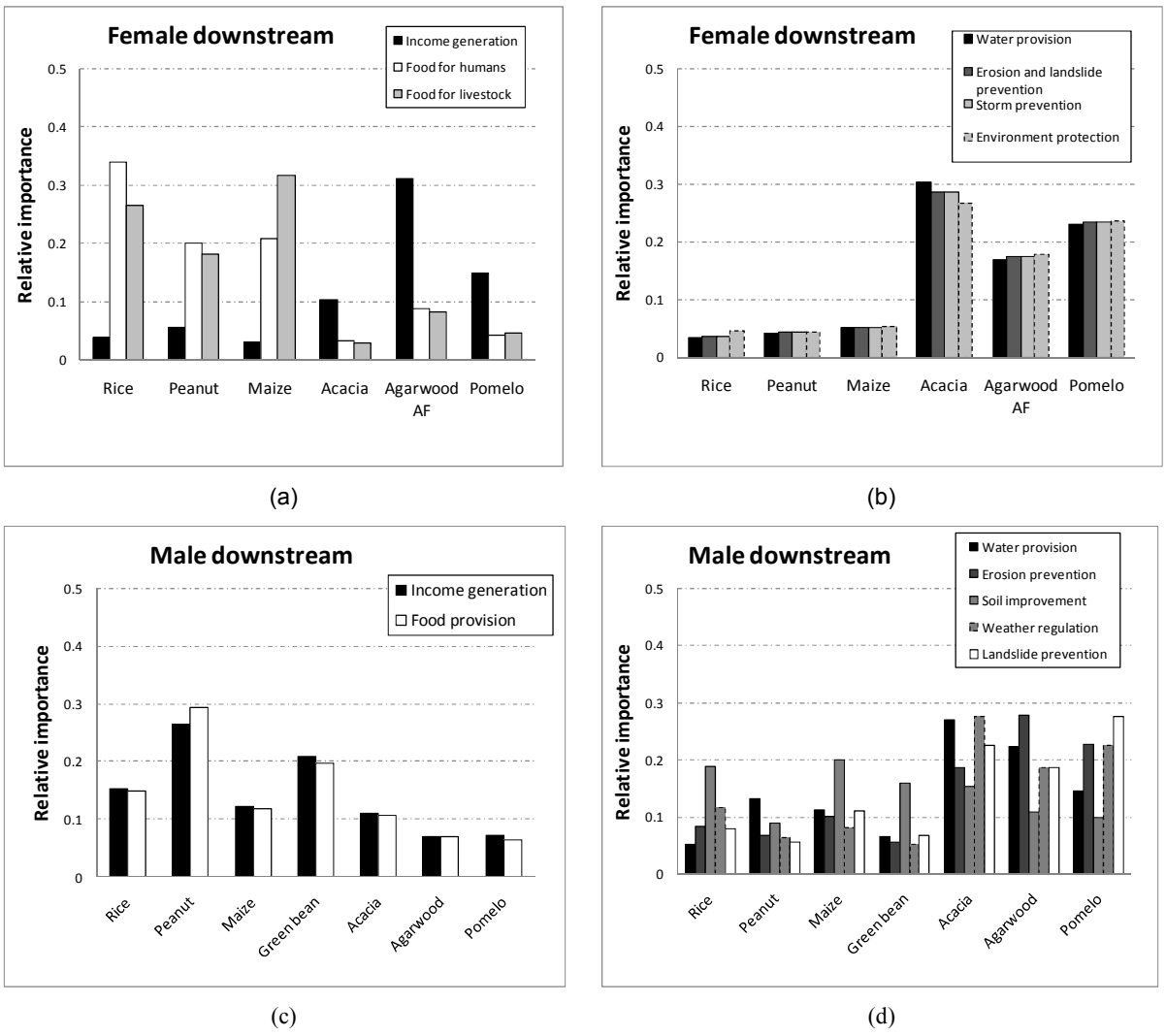

Figure 3. Role of landuse systems to livelihood and environmental services based on local knowledge of female (a, b) and male groups (c, d) in the downstream commune

Landsat tree cover analysis in the landscape

Based on the GIS analysis (Nguyen et al. 2015), undisturbed forest occupied about 15 percent of the total upstream landscape area in 1990 and 2000, and substantially decreased to 9 percent in 2014 (Fig. 4a). In contrast, pulp (acacia) plantation grew rapidly in the area to about 6 percent in 2014 from about 2.5 percent in 1990 and 2000. Other landuse types that substantially expanded in 2014 were annual crops (see Fig. 4 cropland category) and shifting cultivation.

No undisturbed forest existed downstream in 2014 (Fig. 4b). Pulp (acacia) plantation that was absent in 1990 and 2000, occupied about 8 percent of the landscape area in 2014. The area of shifting cultivation

and settlement substantially increased due to the growing population. This pattern of landuse change might indicate the gap between perception and action of local people related to tree planting and its benefits. Besides a strong awareness of the role of trees in providing environmental services, tree planting on land allocated to households will always prioritise tree species that provide more immediate and higher economic benefits rather than environmental benefits.

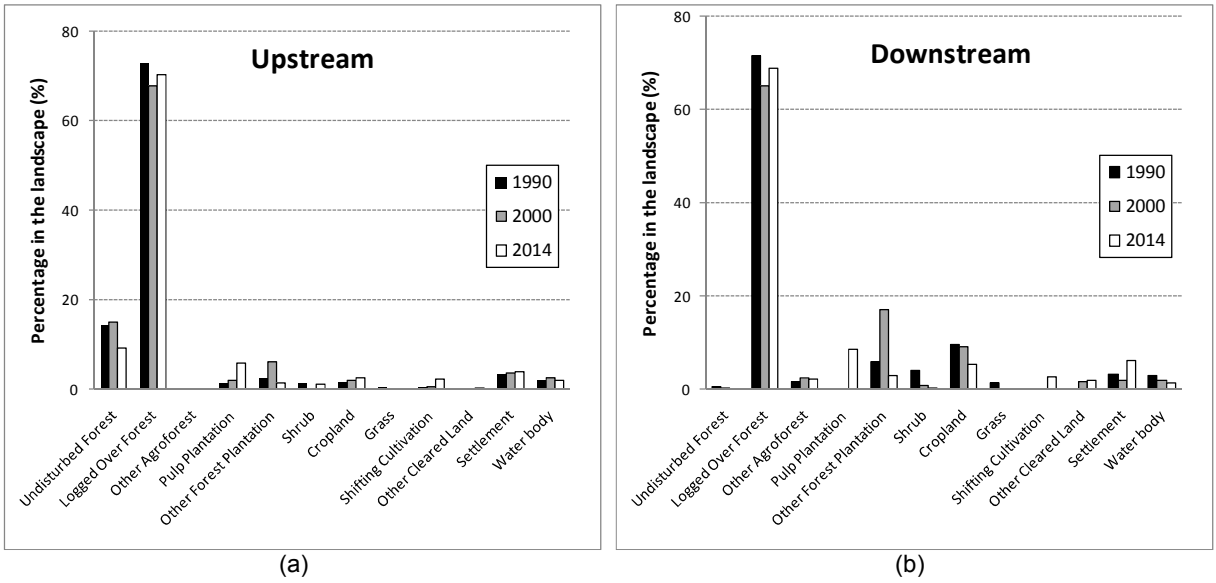

Figure 4. Landcover distribution and change in 1990, 2000, and 2014 in (a) upstream and (b) downstream communes, based on satellite images

Landcover distribution based on local knowledge

Based on local knowledge, the area of natural forest in the upstream commune was reported to have decreased dramatically between 2005 and 2014 (Fig. 5a, c). In contrast, planted forest (acacia plantation) occupied about 35 percent of the total landscape area in 2014, from nothing in 2005. This pattern also occurred in the downstream commune although not as dramatically as upstream (Fig. 5b, d). In the Landsat analysis, the natural forest category corresponds to undisturbed forest and logged over forest, while the planted forest corresponds to pulp plantation (Fig. 4a, b).

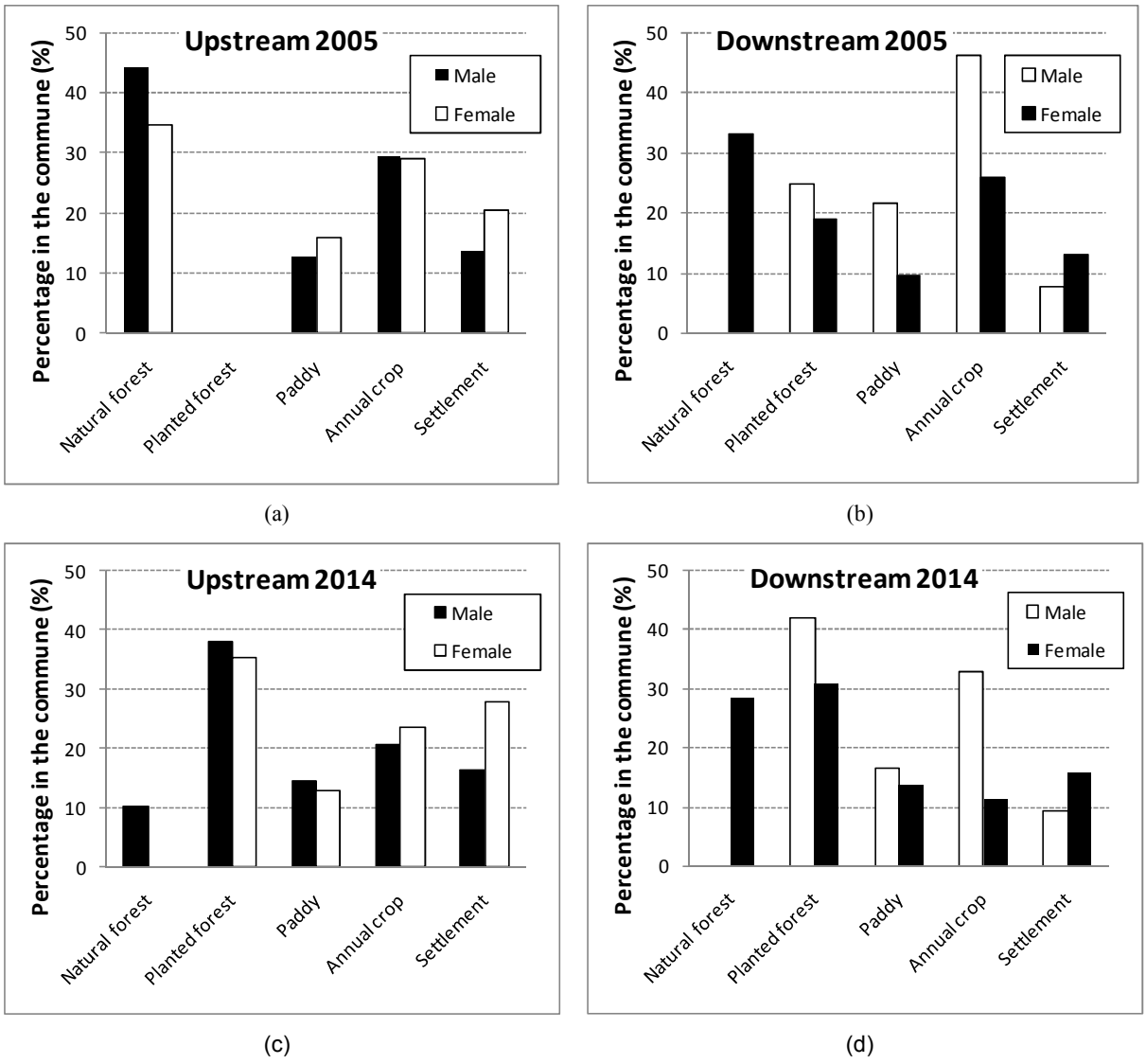

Figure 5. Percentage area of landuse types in upstream and downstream communes based on local knowledge in 2005 (a, b) and 2014 (c, d)

Discussion

Factors influencing local knowledge

The relative importance of each landuse system to livelihood and environmental services as reflected in local knowledge also depends on the area of the associated landuse system owned by the household, the total area of the associated landuse system in the communes and the actual contribution of the landuse system to household income. For example, local people upstream know that agarwood trees will generate good income 15 years after planting, but a low appreciation was given to this tree species because it did not contribute to current income. The agarwood trees in the communes were generally about 5 years old and still needed about 10 years before latex harvesting. Moreover, the average land holding area per household in 2014 was 1.3 ha for acacia while few agarwood trees were planted in homegardens. For another example, the female group upstream highly valued maize for its role in

providing environmental services such as wind breaks, erosion control, weather regulation and flooding control. This was most likely related to the large area of maize in the landscape (in the annual crop category in Fig. 5a, c) and the practice of mulching with any remaining maize biomass.

Gender sensitivity in local knowledge

Differences in local knowledge were observed between the female and male groups. Both groups considered that trees can provide better environmental services than annual crops but this was related to the livelihood aspect. Male groups appreciated annual crops more than trees in generating income whereas female groups thought the opposite, appreciating trees better than annual crops. This happened both upstream (Fig. 2a, c) and downstream (Fig. 3a, c).

The household survey that covered 100 households both upstream and downstream revealed that the husband and wife in the family have different tasks related to daily agricultural activities (Table 1). Financial management associated with buying or selling products was mostly handled by women. For example, in 73 percent of the 200 sampled households, the task of buying seeds for plantation was done by wives. The strong appreciation by the male group of the role of annual crops in generating income, might relate to the lack of the men's involvement in financial management within the family.

It is useful to investigate whether or not the task allocation as shown in Table 1 generally holds in other rural areas of Viet Nam. Such information can guide the interpretation of the results of survey or focus group discussion, or be used to design sampling for future interviews with farmers. Basically, for aspects like land preparation and tree pruning applications, it is better to ask the men. Women are more reliable in answering questions related to financial management; whereas issues related to planting and harvesting can be addressed to either men or women since in most households, this was a joint activity by men and women. Based on their study in northwest Viet Nam, Catacutan et al. (2014) also reported differences in the responses between men and women when evaluating the main function of forests. Women mentioned soil erosion prevention as the most important function of forests whereas men mentioned the forests acting as a water reservoir.

Table 1. Task allocation between husbands and wives in Ho Ho sub-watershed

Main actor (mentioned by % from 200 households)					
Task	Crop or tree?	Husband	Wife	Both	Others
Land preparation					
Ploughing for crop	Crop	63	9	24	4
Ploughing for trees	Tree	53	10	33	4
Seed preparation & Planting					
Buying seed	Crop/Tree	13	73	13	1
Buy fertilizer & pesticide	Crop	11	75	13	1
Planting/seeding	Crop/Tree	11	31	57	1
Plot management					
Fertilizing	Crop	8	66	26	1
Spraying pesticide	Crop	72	15	12	1

Main actor (mentioned by % from 200 households)					
Task	Crop or tree?	Husband	Wife	Both	Others
Taking water for irrigation	Crop	36	24	39	1
Pruning	Tree	47	14	39	1
Harvesting					
Harvesting	Crop/Tree	9	13	78	1
Post-harvest	Crop/Tree	7	15	52	27
Transporting harvested product	Crop/Tree	22	8	69	1
Selling					
Selling crop/food	Crop/Tree	5	82	11	2

Barriers to planting tree species other than acacia

The massive conversion of poor natural forest to acacia plantation has taken place in the sub-watershed since 2000 as part of the government afforestation program. A well-established market-value chain for acacia and its promotion as an N-fixing tree species to improve soil fertility, both accelerated the conversion. Seedlings were initially provided by the government and subsequently local people established their own nurseries. Local pulp industries can absorb acacia timber production in the communes. Pietrzak (2010) reported that in central Viet Nam, most rural upland villagers did not have secure land tenure, yet they grew acacia trees as part of a long-term livelihood strategy for a variety of benefits, apart from earning income.

Based on discussion with key informants (commune or village leaders), introducing other native tree species that can presumably provide better environmental service, such as better water retention, is hindered by a series of classic barriers such as difficulty in finding quality seedlings, lack of skill and knowledge in plot management, delayed harvesting time and the lack of markets for product selling. Basically, on their own land such as homegardens or allocated planted forest, local people prefer to plant trees that can grow to a useful product faster and offer a high profit such as fast-growing timber or fruit trees. Although the local people are aware of the important role of trees in providing environmental services, in the context of tree planting, land that mainly provides these functions is associated with unallocated land such as protected forest or to allocated land that has difficult topography which acts as a natural barrier for access. This in turn influences what can be cultivated, as most, if not all, of the farmers were profit-oriented and wanted a landuse that prioritised livelihood (income generation or food provision) over environmental issues.

Conclusions

From this study, we conclude:

- Local people recognise well the role of trees in livelihood and environmental service provision but tree planting on their own land will always prioritise economic rather than environmental issues. Tree planting with environmental services as the main purpose is considered to be feasible only on unallocated land such as protected forest or allocated land with natural barriers to access, for example due to difficult topography.

- Male and female groups have different responses to the role of trees in income generation. Task allocation within the family related to daily agricultural activities likely leads to the divergent perceptions.

- Massive conversion of poor natural forest into acacia plantation was supported by an established market-value chain. Any effort to introduce new tree species in the communes, presumably to provide enhanced environmental services, should be equally supported by good access to market.

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11. Bird diversity and land use on the slopes of Mt. Kilimanjaro and the adjacent plains, Tanzania
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30. Etat de la recherche agroforestière au Rwanda etude bibliographique, période 1987-2003

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32. Compensation and rewards for environmental services.
33. Latin American regional workshop report compensation.
34. Asia regional workshop on compensation ecosystem services.
35. Report of African regional workshop on compensation ecosystem services.
36. Exploring the inter-linkages among and between compensation and rewards for ecosystem services CRES and human well-being
37. Criteria and indicators for environmental service compensation and reward mechanisms: realistic, voluntary, conditional and pro-poor
38. The conditions for effective mechanisms of compensation and rewards for environmental services.
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58. Assessing the Hydrological Situation of Talau Watershed, Belu Regency, East Nusa Tenggara.
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60. Kajian Kondisi Hidrologis DAS Kapuas Hulu, Kabupaten Kapuas Hulu, Kalimantan Barat.
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77. Cooperation in Agroforestry between Ministry of Forestry of Indonesia and International Center for Research in Agroforestry
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82. Mainstreaming climate change into agricultural education: challenges and perspectives
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108. Memorias del Taller Nacional: "Iniciativas para Reducir la Deforestación en la region Andino - Amazónica", 09 de Abril del 2010. Proyecto REALU Peru
109. Percepciones sobre la Equidad y Eficiencia en la cadena de valor de REDD en Perú –Reporte de Talleres en Ucayali, San Martín y Loreto, 2009. Proyecto REALU-Perú.
110. Reducción de emisiones de todos los Usos del Suelo. Reporte del Proyecto REALU Perú Fase 1
111. Programa Alternativas a la Tumba-y-Quema (ASB) en el Perú. Informe Resumen y Síntesis de la Fase II. 2da. versión revisada

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The World Agroforestry Centre is an autonomous, non-profit research organization whose vision is a rural transformation in the developing world as smallholder households increase their use of trees in agricultural landscapes to improve food security, nutrition, income, health, shelter, social cohesion, energy resources and environmental sustainability. The Centre generates science-based knowledge about the diverse roles that trees play in agricultural landscapes, and uses its research to advance policies and practices, and their implementation that benefit the poor and the environment. It aims to ensure that all this is achieved by enhancing the quality of its science work, increasing operational efficiency, building and maintaining strong partnerships, accelerating the use and impact of its research, and promoting greater cohesion, interdependence and alignment within the organization.

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