4. Reconciling multiple ecological knowledge for rewarding watershed services in the uplands of Indonesia

Environmental management in the uplands affects water flows. Environmental policies to secure watershed services for downstream stakeholders have traditionally been based on command and control approaches. In the past decade, participatory approaches, economic incentives and negotiation schemes involving many stakeholders have enriched such policies, with variable degrees of success. Although watershed functions are generally negatively influenced by financially profitable land use practices, the general argument for economic incentives and rewards to modify the decisions of land users is not sufficiently strong to lead to effective downstream-upstream reward schemes. Payments for quantifiable watershed services, use rights conditional on the maintenance of environmental quality, and respect for the identity and sovereignty of upland people all have a role in watershed management, but their interaction is poorly understood. We analyzed four case studies in Indonesia of emerging schemes to reward land managers for the watershed services that they actually provide. Our hypothesis is that reducing discrepancies and improving synergies of ecological knowledge of local people, that of public opinion and policy makers, and that of hydrologists and modellers in PES increases effectiveness of a PES scheme. Early diagnoses of differences and synergies among these knowledge systems will clarify expectations from all relevant actors, avoid unrealistic targets for quality of watershed services, help define conditionality of RWS and offer appropriate monitoring procedures. Experience with strategic use of information and vested interests of intermediaries and donors imply that credibility, salience and legitimacy of knowledge for any RWS need to be secured before it can be used in actual negotiations. The case studies showed considerable discrepancies between the three main knowledge systems on quantitative aspects of water flows in relation to forest and tree cover, but showed agreement on factors affecting the quality of surface water and slope stability.

This chapter is adapted from Leimona, B., Lusiana, B., Van Noordwijk, M., Ekadinata, A., Mulyoutami, E. 2011. Reconciling multiple ecological knowledge for rewarding watershed services in the uplands of Indonesia. World Agroforestry Centre.

4.1. Introduction

Degradation of watersheds reduces human well-being by affecting the supply and quality of fresh water and increasing the frequency of water-caused disasters. Increased intensity of land use in uplands, however, also provides livelihood options for a growing population. The trade-off between economic demands and watershed conservation is a chronic problem in maintaining healthy watersheds (Barbier and Burgess 1997; MA 2005), with the risk of overshoot of the carrying capacity of watersheds and a downward spiral of land degradation.

Managing this trade-off and shifting the decisions of land managers towards conservation are expected to be supported by policy instruments, such as public investment and market based instruments (Tomich, Thomas, and Van Noordwijk 2004; Asquith and Wunder 2009; Smith et al. 2006). Public investment in restoration efforts seems unavoidable, and as prevention is better than cure, a direct public role in preventing degradation is logical. Market-based instruments for watershed services to internalize the negative externalities of watershed problems are expressed in monetary units and speak the same language as the direct economic benefits of land use.

Inspired by the way Costa Rica changed its forest subsidy scheme into a "Payment to Ecosystem Services" (PES) in the 1990's (Chomitz, Brenes, and Constantino 1999), the last decade has seen wider experimentation with payments to markets for watershed services as policy and institutional options in managing watersheds. Costa Rica made substantial progress in (involuntarily) charging the captive audience of water users, and more limited progress in charging beneficiaries of the biodiversity and carbon sequestration users as the basis of their payments (Pagiola 2008). Strong path dependency in the way payments to service providers originated in previous forest subsidy schemes; however, imply considerable room for improvement in the efficiency with which the schemes generate environmental services (Ferraro and Simpson 2002; Ferraro 2004). Lessons from other public incentive schemes (Jack, Kousky, and Sims 2008) suggest how the environmental, socioeconomic, political, and dynamic context of a PES policy is likely to interact with policy design to produce policy outcomes, including environmental effectiveness, cost-effectiveness, and poverty alleviation.

While the initial success and visibility of the Costa Rica program has encouraged experimentation elsewhere, including in Asia and Africa (FAO 2007; Smith et al. 2006; Van Noordwijk and Leimona 2010; Swallow et al. 2010), a more critical literature is now emerging that suggests approaches supporting collective action at the local community level and address issues of fairness for all involved actors are now seen as essential to achieve success. This shift suggests a need to blend different perspectives and knowledge of various relevant actors during the planning and implementation of any PES schemes in enhancing watershed services.

However, key actors in setting watershed policy often develop plans based on perceptions rather than scientific realities and traditional ecological knowledge. The watershed rehabilitation efforts, including the ones under an rewards for environmental service (RWS)[15] scheme, mostly neglect farmers' local practices {Joshi, 2004 #42} and concentrate on large-scale tree planting as a "one-size-fits-all" solution. The trend from the late 1980's onward shows that participation, inclusion of a social dimension, dialogue, and the concept of "farmer first" have become the central tenets of

[15] In the rest of the text, rather than "payment", we will use the broader term "reward for watershed services" (RWS), for any policy instruments that enable land managers (in this case, communities that are managing their lands in the upper part of a watershed) to receive benefits from downstream beneficiaries for the services provided by a well-managed watershed.

environmental management, acknowledging the importance of local ecological knowledge[16] (Chapman 2002; Schalenbourg 2004). Therefore, in designing and implementing an RWS scheme, it is important to obtain and understand the knowledge and perceptions of different stakeholders on the hydrological issues and watershed management in a particular area (Pelz and Gannon 1979; Rhoads et al. 1999).

This paper reviews and synthesizes the multiple ecological knowledge systems in hydrological scoping study for rewarding watershed services schemes in Indonesia. Although the recognition of multiple knowledge system has been common in watershed management (Olsson and Folke 2001; Olsson, Folke, and Berkes 2004; Rhoads et al. 1999), analysis of such knowledge for negotiated rewards for environmental services has not yet become common practice and described in literature. Our hypothesis is that reducing discrepancies and improving synergies of ecological knowledge of all actors in PES increases efficiency and fairness in negotiating a PES scheme. Section 2 clarifies the research methodology of assessing multiple knowledge systems. Section 3 describes four case of the knowledge scoping in Indonesia: Singkarak –West Sumatra, Sumberjaya – Lampung, Kapuas Hulu – West Kalimantan and Talau –East Nusa Tenggara. These watersheds are the target for testing and implementing RWS schemes located in different landscape and climatic zones across Indonesia. In Section 4, we present our findings based on the knowledge of the local stakeholders and public/policy makers and the ecological knowledge of the hydrologists, and a review of the rewards for watershed services in Indonesia. Finally, the last two sections discuss the interaction of the three knowledge systems and analyze the uptake on the watershed services scoping study results by the ES intermediaries in designing and implementing the RWS, and present our conclusion.

4.2. Theoretical framework

Stakeholder negotiation is a key stage in establishing a conservation agreement among RWS stakeholders that can lead to an established RWS scheme. It requires optimal and symmetric information among the providers, beneficiaries, and intermediaries of the RWS schemes as a minimal necessity to guarantee a relatively conflict-free agreement and to avoid a tedious process of negotiation (Ferraro 2008; Van Noordwijk, Tomich, and Verbist 2002). During the negotiation process, the flows of knowledge can be upwards from land managers as ES providers and intermediaries to downstream stakeholders as ES beneficiaries, as well as downwards from downstream stakeholders to upstream communities, and the interaction can potentially enrich both (as knowledge is a non-consumable good, not reduced by its use).

Van Noordwijk et al. (2001) proposed the concept of a "negotiation support system" (NSS) in integrated watershed management that provided a solution that "optimizes the way in which multiple objectives could be achieved, and then would make decisions to be imposed on the various actors and stakeholders". The integrated natural resource tools used with the NSS concept were to respond to the fact that any multi-stakeholder process will engage a large number of individual decisions coming from different perspectives and accessing different sources of knowledge and information. Further, these individuals communicate through different technical means to organize exploitation, and with different objectives, constraints, priorities, and strategies (Van Noordwijk, Tomich, and Verbist 2002; Dixit and Olson 2000; Olsson, Folke, and Berkes 2004).

[16] We define ecological knowledge as experience acquired of direct human contact with the environment

The generic term *watershed function* means different things to different stakeholders in different situations and it may be constrained by gaps in understanding of the watershed functions and service provisions. The watershed functions are derived from human-induced landscape through land-cover types and spatial patterns driven by mostly external policy and planning of watershed management (Figure 4.1). The combination of upstream dynamic of land use change and external drivers will provide both positive and negative consequences for downstream community. To close the feedback loop (Figure 4.1), external stakeholders, such as policy makers and downstream users utilize decisive (i.e. regulations), incentive (i.e. payment for environmental services) and facilitating (i.e. moral persuasion) environmental policy tools to modify upstream land use practices in producing positive externalities. Ideally, such policy tools will allow positive impacts in managing negative environmental externalities in countries with strong institutions and good governance, the reality in many developing countries is otherwise (Van Noordwijk, Tomich, and Verbist 2001; Tomich, Thomas, and Van Noordwijk 2004). Therefore, at least four aspects have to be considered in enhancing the likelihood of negotiated policy tools, including RWS schemes: (1) shared perceptions of way identifiable watershed functions are influenced by upland land use and affect downstream interests; (2) existence of trade-offs between the local utility of upland land-use decisions and these identifiable watershed functions; (3) presence of community scale institutions that effectively facilitate collective land-use decisions and that can secure compliance with agreements; (4) presence of trust among all relevant actors as a basic condition for negotiation and compliance by all partners to agreements (Van Noordwijk 2005{; Jeanes et al. 2006).

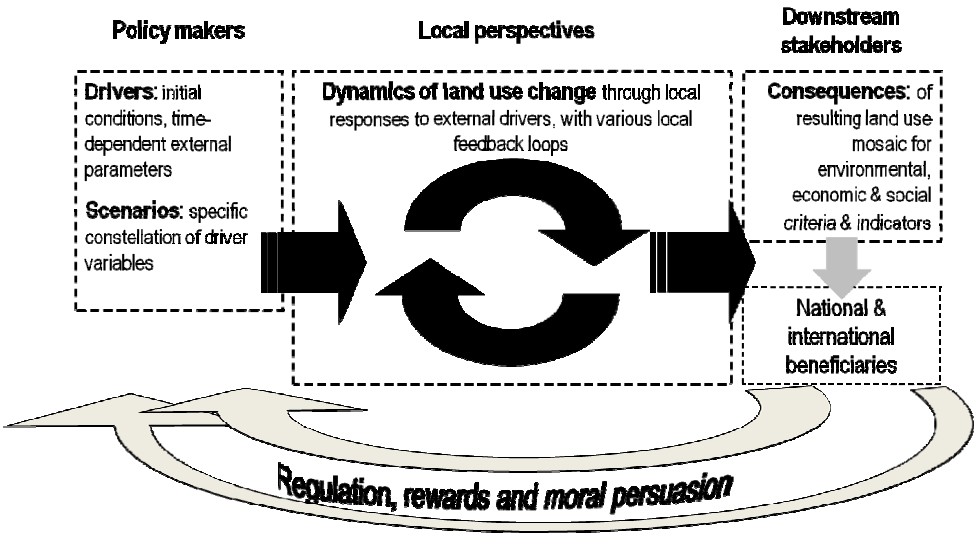


Figure 4.1 Feedback loop influencing real drivers of behavioural and land practice changes (adapted from Jeanes et al. (2006))

In practice, efforts to link scientific and empirical knowledge and action on the ground are a complicated and difficult endeavour. Analysis of *boundaries* in a knowledge-action system or *boundary work* is defined as "the process through which the research community organizes its

relations with the worlds of action and policy making" (Cash et al. 2002; Clark et al. 2010). The exploration on the interaction of the three knowledge systems needs to appreciate the knowledge and its explanatory systems in its local context and against its empirical basis, before it can be compared with generic, de-contextualized science. The boundary work studies in developing countries indicated that articulation of users' demand for technical information is one of the essential contributions of boundary work and the extreme politicization of formal knowledge is not uncommon in rural development situations (Clark et al., 2010).

Clark et al. (2011) recently explored how the knowledge generated by A) a single discipline or B) by multiple disciplines and knowledge systems can be used for 1) general enlightenment, 2) decision support for key stakeholders and 3) negotiations among multiple stakeholders who tend to have and selectively use multiple knowledge claims. Conflicts over the use of uplands in active forest margins and efforts to turn round a current lose-lose situation for local and external situations have been the archetypical case where negotiation support needs to balance multi-stakeholder process of trust building as well as knowledge requirements (van Noordwijk et al., 2001).

4.3. Materials and Methods

This study employed a combined qualitative and quantitative research methodology, encompassing both primary and secondary analysis of empirical evidences from Indonesian cases (Table 4.1). The four case studies were based on hydrological assessment gathering information and synthesizing the three knowledge systems: local, public/policy maker and modeler/hydrologist ecological knowledge (Jeanes et al. 2006).

The local's and public/policy maker's knowledge acquisition method was modified from the knowledge based system approach (Dixon et al. 2001). It was started with stakeholder analysis to comprehend the actors in watershed management and their roles by conducting stakeholder identification. The next step was knowledge articulation through capturing the perceptions of the stakeholders who were local stakeholders and policy makers on hydrological functions, water movement and the consequences of land use options on the landscape. Local people are the actual land managers who work and interact with the watershed landscape on a day-to-day basis. Policy makers at the regency and provincial level are people who have been given a mandate to control and manage the watershed areas assuming that the policies they create will have a strong influence on the future condition of a watershed.

The hydrological modelling uses the existing data available in the public domain and refers to the generic characteristics of the hydrological modelling, ensuring the ability of the approach to be repeatable across sites within different climatic zones. Based on this premise, the following are the activities of hydrological modelling (Jeanes et al. 2006):

1. Gathering and reviewing existing relevant information on climatic and hydrological data of the watershed, including rainfall, river flow data and land cover maps;
2. Analyzing land cover/land use change and its consequences to water balance, including the river flow of the watershed;
3. Modeling the water balance of the watershed, including scenario analysis of plausible land cover changes and their likely impacts on watershed functions.

Table 4.1 Research components of local, public/policy makers, and hydrologist ecological knowledge

Local ecological knowledge	
Goal	Local-specific analysis of problem, its cause and effect.
Source of information	Key informants, village members
Documents needed	Base map as a foundation for participatory mapping
Questions asked and topics explored	Where are hot-spots within watershed causing degradation?
	What are existing patterns of land use in such watershed?
	Who contribute to the current land use pattern?
	Why do these land-use patterns developed?
	What are the examples of areas that decrease or buffer degradation of watershed?
	Do good practices in solving such watershed problems exist? What are those practices?
Public or Policy Maker Ecological Knowledge	
Goal	Analysis of perceptions about problems of environment and water resource at watershed level, and their root causes and effects.
Source of information	Government officers, community leaders, general public including downstream stakeholders
Documents needed	Base and thematic maps Reports on environmental and watershed profiles
Questions asked and topics explored	What and where do watershed problems occur? Who caused the watershed problems and what are the reasons?
	What are past and current pattern of: (1) land use, (2) forest cover, (3) river flow, (3) water quality and use, (4) lake, (5) river?
	Are any developmental projects planned within the watershed? Will these projects cause environmental degradation?
Modeller or hydrologist ecological knowledge	
Goal	Plausible land use change scenarios with analysis of drivers and impacts to watershed of such scenarios
Source of information	Land use modeller and hydrologist
Documents needed	*Spatial data*: topographic, landform, geology, soil, natural vegetation, land use time series and administrative maps. *Climatic* data: daily rainfall *Hydrological* data: daily water level of water body
Questions asked and topics explored	What changes occurred in watershed? What are the drivers of such land use changes?
	How do land use change influence water balance and use within the watershed?
	What are main indicators in influencing water quantity and water quality of the watershed?
	What are impacts of land cover on water balance and river flow of the watershed?

The hydrological modelling recognizes multiple scales (Ranieri et al. 2004; De Groot et al. 2010) ranging from the plot level, where infiltration is influenced by the condition of the topsoil, via the stream level that generally involves multiple farms, to the river level that is influenced by domestic water use and waste management as well as land use, and finally to the catchment level that may include industrial and (semi) urban use as well. To model the influence of current and future land use change to a watershed's hydrological function, we applied the GenRiver 2.0 computer software modelling (van Noordwijk 2002; van Noordwijk et al 2010) with the minimum 20 year-time-series climatic and hydrological data. GenRiver is a simple water balance model that simulates river flow. It was developed for data-scarce situations and is based on empirical equations. The model can be used to explore the basic changes in river flow characteristics across spatial scales, from the patch level, through the sub-catchment to the catchment level. Appendix 1 shows the equations for measuring watershed indicators used in the hydrological models.

To analyze the landscape configuration and land use dynamics of a watershed, we acquired spatial data from satellite imagery for land cover mapping, a digital elevation model for watershed characterization, and from thematic maps for the analysis of the landscape configuration. The next step was to conduct terrain processing for watershed delineation and analysis of land use/cover changes and their trajectories.

Complete studies at each site have been coordinated by the World Agroforestry Centre (ICRAF) in Aceh (Khasanah et al. 2010), Singkarak (Farida et al. 2005), Kapuas Hulu (Lusiana et al. 2008) and Talau (Lusiana et. al., 2008). For the Sumberjaya case, studies of the three knowledge systems were conducted separately, that is hydrological ecological knowledge (Verbist et al. 2005), and local and public ecological knowledge (Agus, Gintings, and Van Noordwijk 2002; Chapman 2002; Schalenbourg 2004).

In addition, we organized a series of interviews with key stakeholders, mostly the project managers, who were involved in the implementation of RWS schemes. The interviews aimed to gain some information on: the progress of the RWS schemes, the types of scenarios that had resulted from the scoping study applied to establish conservation contracts between ES providers and buyers, and information on the strengths and weaknesses of the application of multiple knowledge in designing and planning an RWS scheme. Three of the sites were coordinated by the World Wildlife Fund (WWF) Indonesia in collaboration with the consortium of "Equitable Payment for Watershed Services" of CARE International, and the International Institute for Environment and Development (IIED) (Kapuas Hulu –West Kalimantan and Talau –East Nusa Tenggara). The other two sites (Singkarak – West Sumatra and Sumberjaya – Lampung) were action research sites of the Rewarding Upland Poor for Environmental Services (RUPES Phase 2) project coordinated by ICRAF in collaboration with local NGOs and government.

4.4. Case studies from watersheds in Indonesia: setting the scene

Figure 4.2 shows the location of the four case studies on scoping study in Indonesia: Singkarak –West Sumatra, Sumberjaya – Lampung, Kapuas Hulu –West Kalimantan and Talau –East Nusa Tenggara. The sites represent substantially different human and landscape characteristics across Indonesia. Kapuas Hulu is dominated by a tropical forest landscape with very low human density, while the remaining sites have medium to high population density and are dominated by agricultural landscapes ranging through complex tree crops and horticulture to paddy field. Being in the driest part of

Indonesia, grassland for forage is the most common land cover in Talau. The main characteristics of the sites are summarized in Table 4.2.

Figure 4.2 Location of watershed scoping study sites in Indonesia

Table 4.2 Main characteristics of study sites

	Singkarak	**Sumberjaya**	**Kapuas Hulu**	**Talau**
Province	West Sumatra	Lampung	West Kalimantan	East Nusa Tenggara
Regency and Population density (person.km^{-2})	Upper: Solok (62) Down: Tanah Datar (245)	West Lampung (150)	Kapuas Hulu (7)	Belu (145)
Catchment area (hectares)	10,780	54,190	980,000	72,000
Main land use/cover	Agriculture	Complex mixed tree crop	Forest	Grassland
% Forest cover[c] (year)	16 (2002)	15 (2002)	90 (2004)	6 (2004)
Climatic condition/ No. of wet months	Humid tropics/ 5	Humid tropics/ 7	Humid tropics/ 10–12	Dry/ 4
Total annual rainfall mm year^{-1}	2760	2500	4100	1605

[a] Based on population density of regency in 2004 (BPS, 2005). The average population density for Indonesia in 2004 was 121.7.
[b] Forest cover refers to the time when the study was conducted; the year is that of the Landsat-TM acquisition that became the basis for the "current" land cover map.

4.4.1 Singkarak –West Sumatra

Singkarak Basin is a watershed forming part of Bukit Barisan consisting primarily of volcanoes with Lake Singkarak situated in the middle of the basin with. A hydroelectric project located in the downstream section of the watershed has diverted most of the lake outflow from its natural outlet (the Ombilin River) to the Anai River that flows westward into the Indian Ocean near Padang. The

Minangkabau is the dominant ethnic group in Singkarak with a matrilineal culture governing and enforcing its ethnic norms and conventions. Dryland agriculture and fisheries provide the main income sources for the majority of people around Singkarak Lake, while 10% of the people still practice swidden agriculture or shifting cultivation.

4.4.2 Sumberjaya – Lampung

Sumberjaya watershed as the main contributor of the Way Besai River is located around the Bukit Rigis covering the West Lampung district. Downstream of the Way Besai River, a HEP company produces about 480–2042 MWh of electricity daily that is distributed to three provinces in Sumatra. Multi ethnicity characterizes the Sumberjaya communities consisting Semendo ethnic group and migrants from Java (Sundanese and Javanese). The Semendo people mostly practice slash and burn agriculture, while the migrants practice permanent coffee-based plantations on the hilly slopes and paddy field along riparian strips. In general, there are two types of Robusta coffee garden in Sumberjaya: monoculture and a multi-strata system. The multi-strata system refers to agroforestry coffee systems that have been practiced since the late 1980s, where farmers plant various timber and fruit trees in their coffee gardens.

4.4.3 Kapuas Hulu – West Kalimantan

Kapuas Hulu Basin located in the northern part of West Kalimatan is the source of most of Kalimantan's rivers flowing to Central Kalimantan province and Sarawak. Malaysia. In the upstream part of Kapuas Hulu lies the Betung Karihun National Park, a hotspot biodiversity area and one of the last frontiers of natural habitat in Kalimantan (Curran, 2004). Forest is the dominant land cover in Kapuas Hulu covering 90% of the total watershed. The Kapuas Hulu Basin is the home of several indigenous Dayak tribes: Iban, Kantu', Tamanbaloh, Kayan, Bukat, and Punan. The Iban and Kantu' people are mostly farmers with the egalitarian characteristics of being more open and democratic. The Tamanbaloh and Kaya people are also farmers with a more complex leadership structure. The Bukat and Punan people are forest gatherers and hunters who live in small groups; their leadership structure is based on seniority and skill. Farmers cultivated their horticulture lands more intensively in Sibau catchment, while in Kapuas, the main livelihoods of the local stakeholders were gathering forest products and extensive local agroforestry practices (*tembawang*).

4.4.4 Talau – East Nusa Tenggara

The Talau watershed is a cross-country watershed encompassing Indonesia and Timor Leste. Rivers from the Talau watershed drain to the Ombai Strait in Timor Leste. Water springs are the main source of water for people in the area. Two important sub-catchments in Talau are Lahurus and Motabuik, representing respectively, 2 and15% of the total watershed area. The Lahurus sub-catchment provides water to the domestic users and the Public Water Service of Atambua (PDAM Atambua). The Motabuik sub-catchment is the upper most in the upper catchment for which data on river flow are available. Grassland is the most dominant land cover in this area (66%) and forest constitutes only 1% of the area.

The dominant ethnic groups in the Belu Regency are the Tetun (Belu), Dawan (Attoin Metto), Bunak (Marae) and Kemak with strong cultural traditions still influencing their daily life. Customary law exists and influences their management and use of natural resources. The Belu ethnic group recognizes three strata of law: (i) *Kneter/ Neter* - way of life, (ii) *Ktaek/Taek* – norms, and (iii) Ukun badu –the taboos and restrictions. The last stratum sets the rules for natural resource management

stating that natural resources (soil, water, big rocks, big trees, mountain, etc) are considered sacred and have owners. Sacred lands are usually owned communally and are governed by all ethnic group members.

4.5. Results

This section describes the findings from four case studies on the ecological knowledge of each actor: local communities as ES providers, public-policy makers as ES beneficiaries and regulators, and ecological modelers as neutral actors providing scientific facts. We also present the implementation of current RWS schemes at each site. This information is to analyze how the scoping study applying the multiple ecological knowledge influences the PES practices.

4.5.1 Singkarak – West Sumatra

Local and public-policy makers' viewpoints

In Singkarak, communities observed that the overall water availability is rather good in the Paninggahan area (one of the upstream *nagari*) and water becomes slightly scarce only in the dry season. They also observed that the problem of flooding around the lake has increased since the construction of the hydroelectric dam by HEP at the exit point. Floods enter the paddy fields around the lake. People surrounding the lake also have water quality problems caused by domestic pollution in addition to over consumption that can decrease their fishing harvest from the lake. They perceived that the hydroelectric power (HEP) company was not able to provide as much electricity as was expected because of high fluctuations in the level of the lake.

The type of tree (pine versus broadleaf) is perceived to have an effect on the amount of evapotranspiration from their foliage with a subsequent influence on the total availability of water in the soil and water flowing downstream. The local people claim that soils have "dried up" after pines were planted in previously forested areas. In recent years, pine has been used extensively in reforestation programs in the area. As a solution to the negative influence of pines tree on water availability, local stakeholders mentioned mahogany and teak as examples of species that do not need much water.

In 2003, under the leadership of their elected local leader i.e. *wali nagari*, villagers developed a village regulation on river protection. The purpose of this regulation was to protect the existence of a native fish species (*ikan bilih*) by allowing fish of a certain size to be harvested. The district government bought these fish and released them into the lake. Local communities were only allowed to catch the fish in the lake.

The government officials also mentioned season, land coverage, soil type, and tree type as factors influencing water availability. Reforestation is seen as increasing land coverage that can decrease evaporation. An informal government group also agreed that trees help to hold water in the ground, reducing runoff and soil erosion. Government officials said that forest clearing to the south of Singkarak Lake is causing most problems with flooding mainly because there is less forest area that can hold water and reduce flooding. Farmers have a similar opinion about the factors influencing flooding and the subsequent effect mainly on rice crops and also damaging fields and irrigation channels.

Hydrological modelling findings

The water balance model suggests that the overall shortfall of water for electricity generation is a problem of timing or lack of effective storage capacity; the storage capacity of the lake at the peak of the rainy season is insufficient to retain the water, so it is allowed to overflow into the Ombilin River. The main issue is whether the upstream watershed could retain enough water to provide stable flows during the dry season for around 2–3 months. Figure 4.3 shows the modelling results[17] of different land use scenarios of the watershed: (1) all degraded lands are converted to natural forest; (2) business as usual: current mixed land use; (3) all lands are severely degraded. The hydrological modelling revealed that the presumed positive relationship between reforestation efforts and water availability for HEP was not likely to exist. Climatic variation influences the performance of the hydroelectric power company more than the land use changes in the basin.

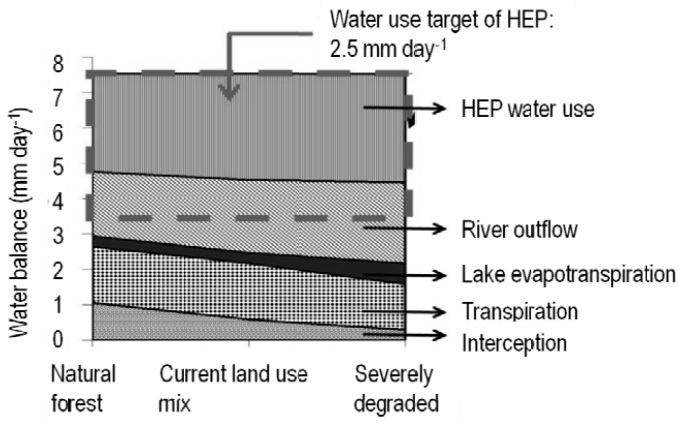


Figure 4.3 Water balance of Singkarak basin with different land use scenarios (Farida et al. 2005)

In addition to that, decreasing water quality will trigger eutrophication in the lake. Although this condition will not affect the overall debit of the lake, it will in the end reduce the efficiency of HEP to produce hydroelectricity. Therefore, maintaining water quality in the lake is important for all stakeholders. Priority actions would have to focus on the rivers and streams that currently carry the highest sediment, nutrient, and organic pollutant loads, most noticeably the Sumani River that drains the largest area of intensive horticulture and passes by a medium-sized town. Pollution control at the point source level will have to complement efforts based on land cover.

Current RWS scheme

The existing local government regulation states that the surface and ground water tax is allocated 30% to the province, 35% to the district producing the water, and 35% to other districts in West Sumatra. Similar to the water tax, the hydropower royalties stopped its distribution at the district level. In the beginning of the scheme, the local intermediary negotiated the redistribution of the water tax and

[17] This paper will only show important and relevant results of the hydrological study. Complete results can be obtained from working papers of Rapid Hydrological Appraisal of Singkarak

hydropower royalty to local communities through *nagari*s as rewards for watershed service schemes. This was under the assumption that land rehabilitation through reforestation would increase the amount of water in the lake resulting in a better water supply for commercial water uses.

Starting in 2010, at the nagari level, farmers managed 49-hectares degraded lands are involving in a voluntary carbon market (VCM) scheme with a private company from the Netherlands. This scheme applied participatory tree-selection with the farmers in rehabilitating their degraded land considering their local knowledge on tree species and market potential. In the same year, a proposal to Ministry of Environment was submitted by 12 nagari leaders surrounding the Lake Singakarak proposing various lake management techniques adjusted to the needs of each nagari.

4.5.2 Sumberjaya

Local and public-policy makers' viewpoints

In Sumberjaya, farmers cultivated coffee on steeper erosion-prone land and paddy field along the riparian area face flooding problems and river bank abrasion. They converted primary and secondary forest to monoculture and multistrata or agroforestry coffee gardens. Farmers have been prepared to invest heavily in artificial fertilisers to increase productivity and also applied a range of erosion restraint measures in their coffee gardens, such as terraces, trenches, ridges, and pits. They selected certain tree species, such as *Gliricidia* and positioned them and manipulated the plant components on the basis of soil management issues. Farmers are well aware of the consequences of an over enthusiastic regime of soil cultivation on steep ground, and identified the risk of soil loss if other conservation measures are not put in place.

In 1998, the local government and its Forestry Department depicted that uncontrolled deforestation and conversion to coffee on the slopes have led to a tremendous increase of erosion and reduction of discharge of the Way Besai River. This negatively impacts operation of the newly constructed Way Besai hydro-power dam. Water availability for irrigated paddy rice downstream was reduced. The enforcement of forest boundaries led to the eviction of thousands of farmers between 1991 and 1996. Evicted farmers were resettled on the infertile acid lowland peneplain or converted swamp forest of northeast Lampung. After the political change of 1998, farmers needing a living returned to the area, often under silent approval of the local government that needed income and was interested in economic development.

Hydrological modelling findings

A time series of daily rainfall and discharge (water flow) data showed that although on average rainfall remained constant over the years, the average discharge had increased, with the likely cause being the conversion of forest to coffee gardens reducing evapotranspiration. A real decrease in the low flows in the Way Besai in the dry season did occur; however, the number of years with a prolonged dry season also decreased. An increase of El Niño years (1976 versus 1991, 1994, and 1997) induced the perception that dry season flows had been reduced by the local land use change rather than by global climate change.

In Sumberjaya, the ICRAF scientists tested the rate of erosion under various land use types (forest, bare soil, multi strata and monoculture coffee systems) in two plots during 2001–2005. The research revealed that soil properties have a greater influence on the rate of erosion compared to the intensity of tree cover (Figure 4.4). The first plot showed that the rate of erosion was between 4 tonne/ha/year for forest and 30 tonne/ha/year for bare soil, while the second plot showed that the rate of erosion

ranged between 0.1 (forest) and 4 tonne ha-1 year-1 (bare soil) under the same treatments (Verbist et al., 2005). The rate of erosion of coffee gardens was in between the rates for bare soil and forest. The highest rate of erosion occurred in 3-year-old coffee garden then gradually declined as litter layers established the soil cover. The Sumberjaya watershed has an old crater landscape with a high diversity of geological substrates. Even under dense forest cover some pristine headwaters can turn quite turbid. Further, the research show that land use plays a less important role in river sedimentation compared to the geological characteristics (Verbist 2008). The overall sediment yield at the watershed level was caused by landslides, river bank collapse, and contribution of dirt footpaths. The research showed that catchments with relatively high forest cover (more than 30 % coverage) are also the ones with the highest sediment yield.

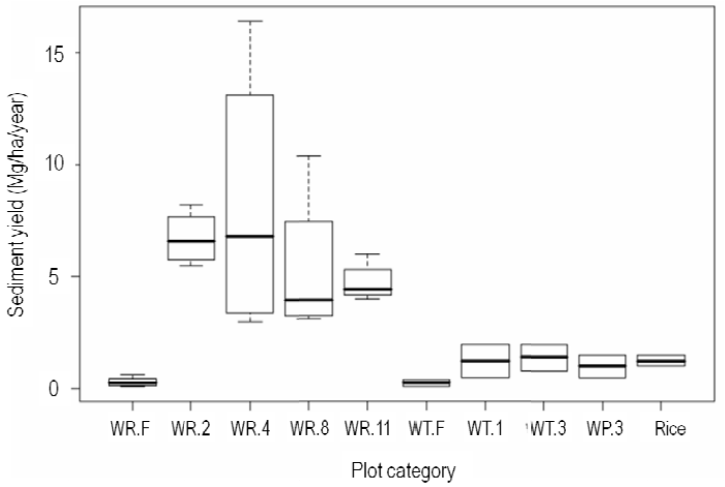


Figure 4.4 Average of plot level erosion in Sumberjaya for monoculture coffee and forest in three sub-catchments (Verbist 2008)

Note: WR = Way Ringkih sub-catchment; WT = Way Tebu sub-catchment; WP = Way Petai sub-catchment; F= forest; the numbers 1, 2, 3, 4, 8, 11 referring to the age of monoculture coffee gardens in the year 2 of the measurement

Current RWS scheme

In 2001, the Ministry of Forestry promulgated decree 31/2001 on community forestry. The decree provided guidelines for community forestry (HKm) contracts requiring farmers to form farmers' organizations, and follow management guidelines approved by local forestry officials. The HKm permit in a protection forest area could be considered as a reward for watershed services since a condition for farmers joining the voluntary program was to plant a minimum 400 trees per hectare. Conditional tenure security to utilize forest land has a probationary period of five years and can be extended to a maximum of 25 years if the farmers' HKm group accomplishes all its criteria and indicators.

The River Care scheme coordinated by ICRAF was a collective action program organized by communities living along the riparian strip who undertook the responsibility for producing clean water by reducing soil sedimentation. The payment was made in cash (USD 2,222 in Gunung Sari) or as a micro hydroelectric power plant with a capacity of 5000 watt (in Buluh Kapur) with a similar monetary value to Gunung Sari if the community could reduce the sediment by 30% or more. There was a reducing level of rewards of USD 833, USD 555, and USD 278 for sediment reductions of 21–29, 10–20, and less than 10%, respectively. Every three months, the scheme was monitored by an external stakeholder, such as the local Forestry Service.

4.5.3 Kapuas Hulu

Local and public-policy makers' viewpoints

In Kapuas Hulu, different tribes and livelihood options strongly influence the land use pattern along the river. People in the upstream tend to have less permanent dwellings, use subsistence practices and less technology. They are mostly hunters and subsistence food-gatherers with high income uncertainty. They perceived erosion and landslides caused by logging activities in the upstream areas and riparian zones as leading to high economic loss. In Sibau and Mendalam, people blamed the establishment of shortcuts across river banks to speed up water transportation as a cause of sedimentation. The Mendalam people were also concerned about the recent establishment of a forest concession company in the area. In Kapuas, mining and small-scale logging were considered to be the main factors.

The Dayak people in Kapuas Hulu use their own customary law in managing the forest. The ethnic law limits the provisioning service of the forest solely to domestic uses with permission granted by the *adat* leaders, for activities such as timber and animal harvesting. They also defined protected areas including forest and Sadong Lake and had some rules on fishing practices, such as banning fishing using electric shocks and poisons. The Melayu Sambus community agreed to avoid the use of pesticides and insecticides when opening up new lands and did not allow outsiders to open up and exploit lands in their area. In Mendalam, they were planning to establish an *adat* forum on watershed management.

The Public Water Service (PDAM) of Putusibau in the capital of Kapuas Hulu indicated that turbidity was problematic and had resulted in a decrease in the water quality for domestic uses. Furthermore, gold mining activities had the potential to increase water pollution due to toxic mercury use. Local community and policy makers mentioned that the environmental problems in this area were forest degradation, river siltation, lack of fresh water, and high water pollution. The high threat of forest loss and fragmentation caused by fire, logging, and mining activities was perceived to be decreasing the hydrological function of the watershed. River siltation leading to river shallowness could disturb river transportation as boats were the main vehicle in this area.

Hydrological modelling findings

Between 2001 and 2004, the forest area in the Kapuas Hulu basin decreased by about 130 km^2 and the total area managed by farmers increased by around 42 km^2. This change was insignificant in the context of the total basin area, but it represented a substantial relative increase in the agricultural land. In addition, settlement had more than doubled within this period. These changes mostly occurred in the provincial land area designated as "dry agricultural" zone. Most of the land changes occurred along the river outside the National Park area.

Exploration on the effect of forest conversion on the landscape water balance revealed that reducing the forest cover in the area would increase the surface run-off and reduce the soil-quick flow. Thus, this has to be anticipated by healthy riparian zones to avoid an increase in sedimentation of the river. The landscape water balance analysis also showed that up until 2004, the run-off fraction in the Kapuas Hulu Basin was low, revealing the ability of the Kapuas Hulu basin to maintain its watershed function, particularly related to maintaining river flow (Figure 4.5). However, there were already signs of degradation at a smaller catchment scale. Estimation of landscape water balance at the smaller catchment level of the Mendalam sub-catchment indicated the run-off fraction was six times that of the overall basin (Lusiana et al. 2008).

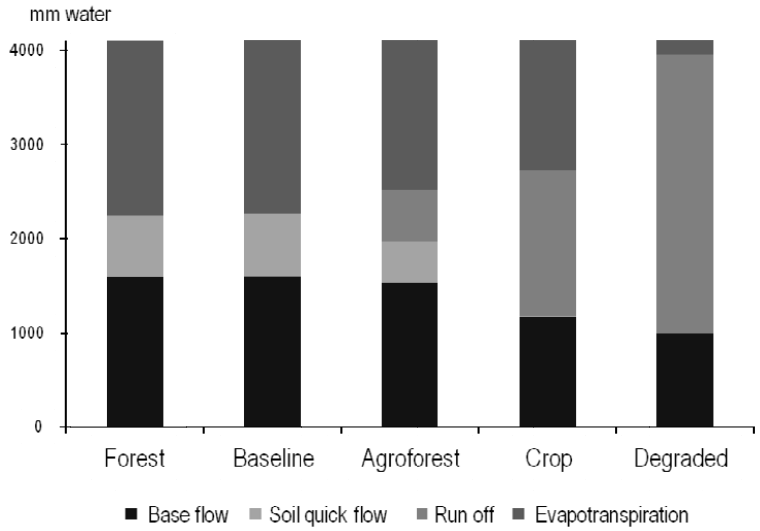


Figure 4.5 Water balance of Kapuas Hulu basin at different land use scenarios (Lusiana et al. 2008)

Current RWS scheme

Current progress showed that the facilitators were focusing on rehabilitation along the riparian zone and the establishment of a local agroforestry system or *tembawang* to reduce sedimentation in five villages in the Mendalam sub-watershed. The facilitators chose to focus on the Mendalam sub-catchment due to the development of intensified systems in the area (vegetable plots, coffee systems) and also the threat of a forest concession being opened up in the area. The district government allocated about USD 20,000 annually to each village through their village budget. The fund was available for allocation to both individual participants of the PES program and to village revenue. The percentages of both allocations have not been decided yet. The land rehabilitation was organized on private lands owned by the local stakeholders since the district government represented their target buyer, that is, the local public water service (PDAM)

4.5.4 Talau

Local and public-policy makers' viewpoints

Local knowledge on the seasons and climate is tightly linked to knowledge of the planting calendar because of the long dry season (8 months) and the short rainy season (3–4 months). The severe dry season influences the selection of plants grown by the local people. Local people believe that the forest has an important role as a ground water provider, regulator, and also as a source of livelihood. Local people also have a well-articulated understanding of the relationship between vegetation, soil, and water availability. According to them, plants that are suitable in the water spring area are species that have deep roots that can hold water in the ground, such as betel nut, mahogany and candlenut. Local people said that teak is not a good plant to plant close to water springs, as it takes a lot of water but does not keep water in its roots or stem and instead releases water into the air. The forest is associated with the existence of water springs. Tree density and tree species are significantly linked with ground water availability. Trees function as rainwater holders, groundwater keepers and prevent erosion.

The local stakeholders have institutionalized the protection of water sources, access to water, and water allocation. Sub-ethnic groups or clans treated springs as sacred groves. They controlled and regulated springs and their use. The *mamar* or forest surrounding water springs ((Sumu 2003)) is protected from livestock and loggers. People who belong to the clan are allowed to use some economic plants such as *sirih* (*Piper betle*) and pinang (*Areca catechu*). In the past, only people of the clan were allowed to use water from springs. People from other clans need to ask permission and would be penalized if they refused to comply. However, recently, customary law no longer has such a stronghold. This has triggered conflicts over water use in some parts of the area, mainly due to the distribution of water to other areas outside the surrounding village.

Hydrological modelling findings

From the limited information available on river flow, the overall pattern of the Talau river flow can be described in three phases: the early part of the rainy season, when the soil and landscape storage capacity for water is recharged; the second part of the rainy season, when a larger proportion of the current rainfall is transmitted to the river; and the dry season, when the river (and spring) flow depends on the gradual release of stored water underground. The buffering capacity of the Talau watershed is less in years with high rainfall and consequently high total water discharge. River flow in the Talau watershed is strongly seasonal; the risk of flash floods is especially high in the second part of the rainy season, when the storage capacity of the landscape is saturated and strong rainfall is passed on to the river without much buffering. The landscape water balance both in the Talau watershed and the Lahurus sub-catchment shows strong seasonal differences (Figure 4.6). Actual evapotranspiration is much lower than the potential evapotranspiration, due to the strong seasonality of rainfall and the limited storage capacity of water in the soils.

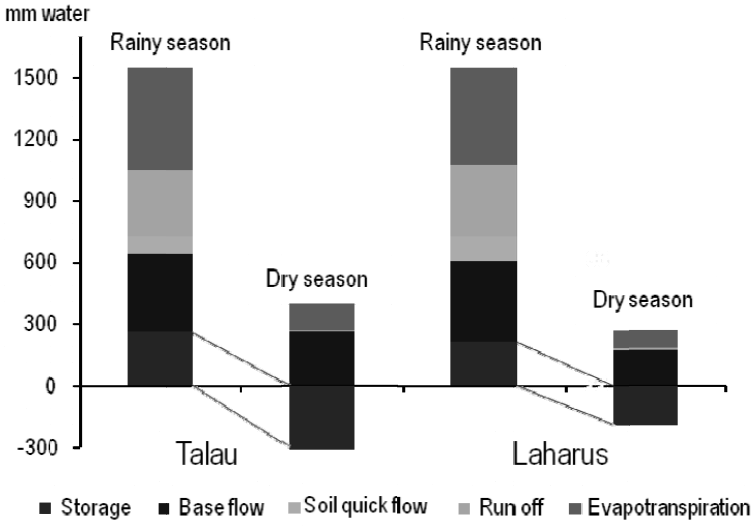


Figure 4.6 Estimated annual water balance of Talau watershed and Lahurus sub-catchment during rainy season and dry season

From an eco-hydrological perspective, it is likely that planting more trees in the area, as currently suggested by local people and policy makers, will not substantially increase low flows and there is a risk of even lowering the current baseflow (Figure 4.7). Estimation using models showed converting non-productive land (defined as grassland and bush/shrub land) into agroforestry systems or forest does not change the annual low flow. Nevertheless, adding trees into the landscape reduced surface runoff and increased soil-quick flow. This result implied that rainfall will not reach the river as soon as it occurs, increasing the watershed buffering capacity and consequently flash flooding can be avoided. Assuming that runoff is highly correlated with soil erosion, a reduction in surface runoff also suggests a reduction in soil erosion and therefore improved water quality.

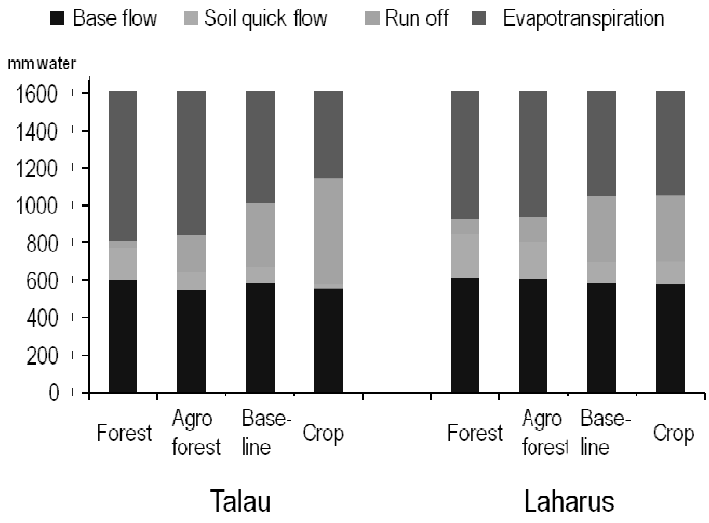


Figure 4.7 Water balance of Talau watershed and Lahurus sub-catchment at different land use scenarios (Lusiana et al. 2008)

Current RWS scheme

In 2007, a Memorandum of Understanding (MoU) was signed between the Belu district government and the community group of Lasiolat representing seven villages in the Lasiolat sub-district, Belu as a response to the facilitation of the RWS scheme by CARE/WWF. The MoU stated the general role and the responsibility of both parties so that the community would be actively involved in the watershed conservation program, while the local government actively supported and implemented jointly the program. As a result, the local government allocated some funds through the relevant district service, that is, the Forestry and Plantation Services of the Belu district, for watershed conservation as part of their annual budget. In 2008, they allocated about USD 48,000 and estimated a similar amount annually up to 2011.

4.6. Discussion

4.6.1 Gaps among the three knowledge systems

Most of the upstream communities in the study sites use water for domestic consumption and smallholder agriculture, such as paddy fields, fishponds, and plantations. They recognized the importance of the services of their ecosystems, such as the importance of forests and rivers, and connected these services to benefit their livelihood including cultural rituals. Therefore, their perceptions of the hydrological problems are mostly through processes that influence their daily activities and income. Furthermore, communities perceived that they could suffer from watershed problems caused by the presence of external stakeholders, such as the construction of hydroelectric power schemes worsening flooding, the presence of a municipal water company reducing water

supplies for local uses, or the presence of a concession company carrying out extensive logging upstream.

Farmers at all sites mostly were able to describe in detail the different elements within their landscape, the interactions among them and their cause-effect relationships. Local communities tended to focus on solutions at the plot level and had limited ability to formulate larger scale ecological processes. They were aware of and applied a variety of techniques to solve their watershed problems. The solutions applied were somewhat consistent among sites even though the sites are geographically dispersed. For example, people at all sites consistently mentioned mahogany as an example of a tree species that retained water but they had different opinions about teak.

In finding solutions, local community members sought location-specific solutions while general public and policy stakeholders referred to generic solutions in the form of forest protection and rehabilitation through reforestation as important actions in responding to floods, soil erosion, and riverbank abrasion. Policy makers, however, gave more attention to the role of the forest in providing beneficial watershed services (Verbist, 2005, Schalenbourg, 2004). For example, the Singkarak case showed that solutions preferred by policy makers (mass reforestation by planting pines) to solve watershed problems could cause problems to other stakeholders (drying up water resources due to the high evapotranspiration rate of the pines). In Kapuas Hulu, solutions to the watershed problems focused more on the removal of perverse policies, such as the granting of permits to logging companies, rather than changing land use practices at the local level. Gouyon (2002) and van Noordwijk et. al. (2004) proposed the removal of the current negative impacts on the environment and the rural poor before designing and implementing an RWS scheme.

Cross-site analysis showed that the reality check provided by knowledge integration approach presented rich information on causes of watershed problems and solutions (Table 4.3). In some cases, imbalance in supply and demand for ES (for example, water allocation in Talau and overfishing in Singkarak) and human-induced activities with no direct relations to land use change (for examples, cutting the river bank in Kapuas Hulu) caused more watershed problems than local (upstream) land use practices. In the Sumberjaya case, coffee plantation under multistrata-systems could produce litter layers that prevented soil erosion. This was different from the previous perception that generalized all coffee plantations as the main cause of river sedimentation.

Further, the results from the simulation model helped to ascertain whether stakeholders' perceptions and understanding of the hydrological situation and their solutions to tackle emerging problems actually represent what is currently happening or what could happen in the future. For example, analysis of the landscape water balance of Kapuas Hulu showed that the condition of the basin under the "business as usual" scenario was similar to the forested condition, reflecting that this scenario can still maintain its hydrological function since the tree cover in the area is still "pristine" with almost 100% tree cover.

Table 4.3 Analysis of multiple ecological knowledge and its management implication for RWS

	Singkarak	**Sumberjaya**	**Kapuas Hulu**	**Talau**
Initial perceived problem	Deforestation at the upstream of watershed caused floods and decrease of the water level of the lake, thus disturbing the operational of hydroelectric power company (HEP).	Forest conversion to coffee agroforestry gardens caused increase of sediment yield, thus clogging the HEP electricity generator and causing low electricity production.	Forest conversion to agriculture and illegal logging causing increased of sediment yield, thus decreasing the water quality for drinking water company.	Deforestation surrounding the water spring decreased water supply from the spring.
Results from hydrological analysis	Decrease of water level was caused by ineffective watershed buffering in retaining water during rainy season. Downstream water quality was influenced by high domestic and agricultural pollutants. Floods were mostly caused by river stream diversion by HEP.	Sedimentation mostly was caused by instable geological characteristics of the watershed. Coffee plantation less than 3 years, landslides (occurred in forested area), river bank collapse, and dirt footpaths were sources of sediment yield.	Low run-off showed that watershed was still well-functioning with the current land practices and changes. Intensive use along riparian causing river bank collapse and river edge cutting for boat transportation were sources of sediment yield.	Lack of water from water springs dominantly was caused by climatic changes and ineffective watershed in buffering water. Overconsumption and unwise use of water from the spring worsened water management and caused conflicts.
Management implication from local perspectives	Reforestation uses trees with low evapotranspiration. Local wisdom maintains clean water stream in the upstream and conserving native *ikan bilih*.	Simple sediment retention construction and planting deep root trees, including compaction of dirt path were useful to reduce surface erosion.	*Tembawang* traditional agroforestry system along riparian zone helps reducing pressures to soil erosion.	Reviving local wisdom of spring water management can help solving internal conflicts.
Management implication for watershed management and RWS	Upstream village level: maintaining current intact environment, i.e. biodiversity conservation such as organic coffee, bundled VCM and watershed services. Villages surrounding the Lake: improving water quality of the	Collective action to conserve riparian zone involving village members along the river. Individual and collective action to manage coffee garden by applying simple construction and multistrata tree-	Collective action to conserve riparian zone involving village members along the river. Collective action to maintain intact forest in the upper watershed as a potential for REDD+ type	Collective and individual action to promote tree-planting to increase watershed buffering. Spring water management with wise consumption and regulated extraction of PDAM.

	Lake and connecting river.	planting.	schemes. Law enforcement on illegal logging and logging permits.

4.6.2 Constraints in the application of multiple knowledge in RWS implementation

Our case studies showed that the availability of information is a prerequisite for increasing the quality and sustainability of RWS programs. The review found that the factors influencing the design and implementation of RWS programs are varied and beyond the availability of multi-perception ecological knowledge and scientific data.

Strategic use of information

Ecosystem services intermediaries have an important role in determining the strategic use of environmental information. As mentioned earlier, many conservation actions are only based on general beliefs, such as that planting trees in the upper watershed can increase the volume of the stored water in a lake downstream, or even more extreme, many believe indisputably that planting trees can solve all environmental problems. Potential ES buyers or ES consumers may have intrinsic motivations based on this common myth and assume that certain conservation practices are able to enhance ES provision to their benefit. Revelation of the scientific fact that planting trees, conversely, can actually reduce the base flow due to an increase in evapotranspiration, as shown in the Singkarak case study (Van Noordwijk, Leimona et al. 2007), may reduce investors' motivation to participate in any RWS scheme, when the buyers' interest is water quantity increment. Moreover, an incomplete understanding of forest versus watershed problems can produce undesired results—namely, a misconception that reforestation is not important. Intermediaries as benevolent environmental agencies might deter the disclosure of these "contradictory" facts and will carefully consider the strategic use of scientific-based information and avoid creating reduced moral motivation in buyers engaging in the scheme. Asheim (2010) presented empirical support for this effect.

Vested interest of donors and implementing agencies

Van Noordwijk et al. (2004) hypothesized that both ES buyers and sellers would have to strategically consider options and threats to accomplish both their and others' benefits (and losses). Applying SWOT analysis (the abbreviation for strengths, weakness, opportunities and threats) they explained that stakeholders tendentiously preferred "starting with easy wins rather than most urgent issues". This tendency also seems to apply in our case studies where implementing agencies selected pilots with complete historical data or strategically interposed other agendas rather than establishing an RWS scheme per se. In addition, donors' obligations have a great influence on determining hotspots or a targeted pilot area, in which case the selection of the defined ES has been made not based fully on scientific facts but purposively chosen as the option that best matches with project design documents or that is the nearest to the locations of potential buyers. This is not uncommon, since often a donor's indicator for a successful RWS scheme is skewed towards having a successful transaction between sellers and buyers with a contract, clear business case, or memorandum of understanding signed by both parties. In the domain of public policies, there is a long history of the selective use of science (Galudra and Sirait, 2009), where forests and watershed functions are part of the considerations as well.

4.6.3 Applying nested and multiple prototypes in RWS

Our case studies and other global experiences indicated that the PES schemes currently practiced were still at the relatively small scale and pilot level (villages or sub-watershed levels). Most of the schemes were donor-driven with a limited budget, time frame, and high transaction cost since this approach is relatively new and needs a huge investment to mature (Grieg-Gran, Porras, and Wunder 2005; Leimona, Joshi, and Van Noordwijk 2009). This discrepancy between the spatial and temporal scale in providing ES and investment in case studies implies that most of the cases cannot be used to prove the strict PES concept, where an environmental service becomes a tangible commodity transacted between its sellers and buyers. Therefore, we recommend that PES project managers might adopt a negotiated situation by applying nested and multiple prototypes in establishing RWS (Table 16). Van Noordwijk and Leimona (2010) identified three paradigms in the PES domain: commoditization, compensation, and co-investment. The applicability of these paradigms differs in relation to the clarity with which the concept of ES is understood in a local context, and the type of conditionality, efficiency, and degree of focus on fairness and equity.

The salience, credibility and legitimacy – aspects of knowledge in the way it is communicated among multiple stakeholders (Clark et al., 2010) – not only applies to scientific knowledge, but also to the local and public policy makers components of ecological knowledge. Any RWS scheme can be interpreted as having an ***efficiency*** dimension, that can be analyzed as the objectively measurable enhancement of specified watershed functions in relation to the financial inputs required, and a perceived ***fairness*** dimension, which is only partially captured by an objectively measurable degree of equity (Pascual et al. 2010).

Across the multiple scales that most watershed management issues entail, we can envisage the use of multiple incentive paradigms –commoditization environmental services (CES), compensation for any opportunities skipped (COS), and co-investment in landscape stewardship (CIS), as introduced by van Noordwijk and Leimona, 2010), and achieve a balance between fairness and efficiency at each scale (Figure 4.8). We presume that the applicability of the CIS, COS and CES paradigms of van Noordwijk and Leimona (2010) varies with scale.

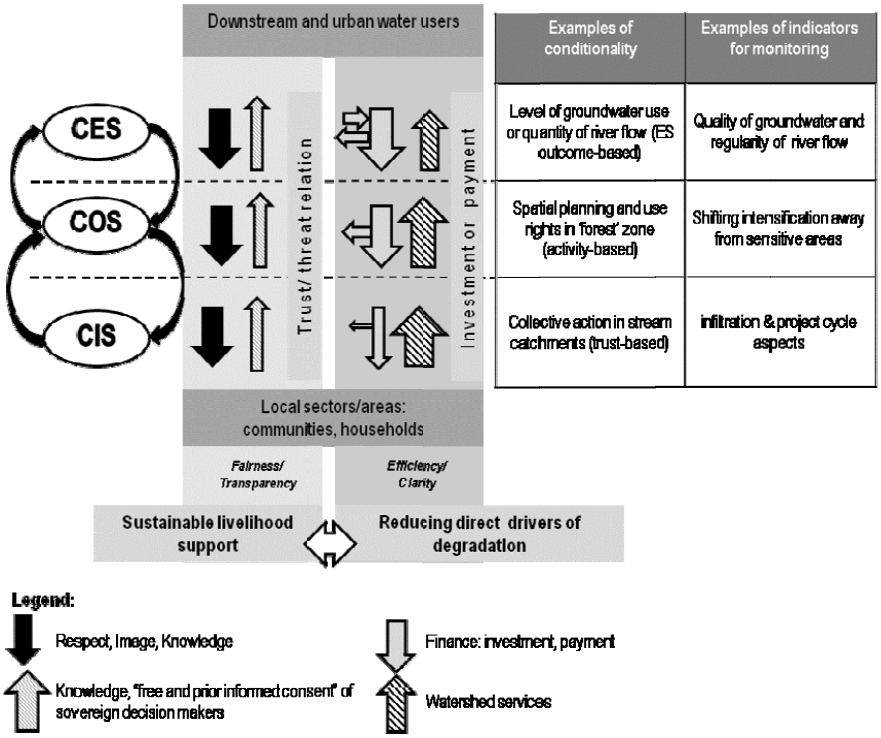


Figure 4.8 Conceptualization of the cross-scale exchanges in the "fairness" and "efficiency" domains of rewards for watershed services.

4.7. Conclusion

Integration of stakeholders' knowledge and perceptions on hydrological issues prior to Rewarding Watershed Services (RWS) scheme development could help to clarify how the watershed service is provided, who could be responsible for providing this service, and how the watershed service is being impacted upon at present. This leads to a better understanding of how rewards can be channelled to effectively enhance or at least maintain the underlying hydrological functions. The case studies showed that integration of multiple knowledge systems has helped to clarify the level of conditionality between the potential seller and the environmental service that the potential buyer is seeking.

Early and thorough analysis of the multiple knowledge systems involved in planning, designing and negotiating incentives for enhancing watershed services could help in increasing the quality and sustainability of the emerging policies and schemes by acknowledge the common hydrological issues among local stakeholder, enhancing the social capital between stakeholders, increasing the perceived fairness dimension of any resulting RWS and provide objective forecasts on how ecosystem services will respond to watershed management. However, the five case studies differ in the stage of development of RWS and the long-term sustainability of the emerging schemes cannot be empirically

judged yet. Nevertheless, results showed that the recognition, appreciation, and use of multiple knowledge systems in the early stages of planning and designing an RWS scheme has provided a "no-regrets" option, allowing for effective communication strategies and also allowing intermediaries and project managers to facilitate negotiations between ES providers and ES beneficiaries towards operational and sustainable reward systems.

Appendix 1. Quantitative watershed function indicators (Van Noordwijk et al. 2011)

Criteria	Indicator
1. Transmit water	Total water yield (discharge) per unit rainfall(TWY) $TWY = \Sigma Q/(A * \Sigma P)=1-(\Sigma E/\Sigma P)$ Q = river discharge P = rainfall A = area E = evapotranspiration
2. Buffer peak rain event	a).Buffering indicator for peak flows given peak rain events (BI) $BI = (P_{abAvg}–(Q_{abAvg}/A))/ P_{abAvg}$ $= 1 – Q_{abAvg} / (A P_{abAvg})$ with $P_{abAvg} = \Sigma \max(P-P_{mean},0)$ $Q_{abAvg} = \Sigma \max(Q-Q_{mean},0)$ b). Relative buffering indicator, adjusted for relative water yield (RBI) $RBI = 1 – (P_{mean} / Q_{mean})*(Q_{abAvg} / P_{abAvg})$ c). Buffering peak event (BPE) $BPE = 1-Max(daily\_Q-Q_{mean}) /(A*Max(daily\_P–Pmean))$ d). Highest of monthly river discharge totals relative to mean monthly rainfall e). Fraction of total river discharge derived from Surface quick flow (same day as rain event) f). Fraction of total river discharge derived from Soil quick flow (one day after rain event)
3. Realease gradually	a). Lowest of monthly river discharge totals relative to mean monthly rainfall b). Fraction of discharge derived from slow flow (> 1 day after rain event) $\Sigma Q_{slow}/(\Sigma Q) = (\Sigma P_{infiltr} – \Sigma E_{S+V})/ \Sigma Q$ with $P_{infiltr}$ = amount of rainfall infiltrated into the soil ES+V = evaporation from soil surface an d transpiration by plants

Note:
Q (mm/day) = [Q(m^3/sec) x24 hourx3600 sec/hour]/[A(km^2) x10^6 m^2/km^2)]x10^3 (mm/m)
P_{mean} = average rainfall
Q_{mean} = average debit
P_{abAvg} = rainfall above average
Q_{abAvg} = debit above average

5. Designing a field experiment of an environmental service procurement auction for watershed services in the Sumberjaya watershed, Indonesia

Payment for environmental services (PES) is a market-based, conditional and voluntary policy option that, in this study, provides incentives for maintaining watershed services. The setting of this study is a watershed area in Lampung, Indonesia, where soil erosion has broad implications for both on-site and off-site environmental damage. A key condition of PES is transparency regarding the conditions under which incentives or rewards can be granted. Balanced information and the power of transaction are the basis for any environmental service (ES). A contract procurement auction is an alternative mechanism for extracting information from ES providers on levels of payments or incentives that will cover their costs when joining a conservation program. In this chapter we focus on designing a market-based payment for watershed services and using procurement auction method to reveal hidden information on the opportunity costs of supplying environmental services. This is an initial application of a procurement auction method in a rural setting in a developing country. Our study resulted in a set of auction rules for determining how limited watershed rehabilitation funds could be allocated. Our results show that a sealed-bid, multiple round, second-price Vickrey auction with a uniform price can be applied where most of the auction participants have a low education level, low asset endowment, small plot size, and where market-based competitiveness is not common. The rate of contract accomplishment was moderate and this may be influenced by many other factors such as the farmer groups' leadership and their institutional arrangements for conducting conservation activities. The implication of these findings is that designing a proper conservation auction method and estimating the 'right' value for contracts form only minimal requirements for the success of any conservation contract.

This chapter is modified from Leimona, B., Jack, B.K., Lusiana, B., Pasha, R., 2009. Designing a procurement auction for reducing sedimentation: a field experiment in Indonesia. Research paper. Economy and Environment Program for Southeast Asia (EEPSEA) and Leimona, B., Jack, B.K., 2010. Indonesia: a pilot PES auction in the Sumberjaya watershed. In: OECD (Ed.), Paying for biodiversity: enhancing the cost-effectiveness of payments for ecosystem services. OECD Publishing, Paris, France, pp. 161-178.

Elements of this case study have been previously published in Jack, B.K., Leimona, B., Ferraro, P.J., 2008. A revealed preference approach to estimating supply curves for ecosystem services: use of auctions to set payments for soil control in Indonesia. Conservation Biology 23, 359-367.

5.1. Introduction

A payment for environmental services (PES) is one example of a conservation approach that provides incentives for maintaining the functions of a watershed by considering the supply and demand of environmental services. The central principles of this approach are that those who provide environmental services (ES) or the ES providers should be rewarded for doing so, and that those who receive the services should pay for their provision based on the performance in enhancing ES (Ferraro 2001; Ferraro and Kiss, 2002; Pagiola and Platais, 2002). Compared to previous conservation approaches, the approach's main innovation is the conditionality or the transparency of conditions wherein incentives or rewards can be granted (Wunder, 2005; van Noordwijk et al 2008). As a consequence of this conditionality, PES requires voluntary contractual relationships between ES providers or farmers as land managers[18] and ES buyers.

The conditionality of the PES requires transparent information and a balanced power of transaction as the basis of any ES contracts to ensure fairness and effectiveness. Information asymmetry exists when one actor has more or better information than the other on their benefits in being involved in the PES scheme. Two important information asymmetries in the design of PES contracts are *hidden information* or lack of information while negotiating a contract and *hidden action* or lack of information about the performance of the agreed contract or lack of ability to retaliate for a breach of an agreement (Latacz-Lohmann and Schilizzi 2005; Ferraro 2004).

Hidden information (adverse selection) that often occurs in designing and negotiating a PES scheme is the lack of information on the opportunity costs of supplying environmental services (Ferraro 2008). The amount of incentive required by farmers to change their behaviours to enhance environmental services is private information. If the incentive is too low, it will not motivate ES providers to improve their land-use practices and provision of ES. If the incentive is too high, the PES will fail to provide environmental services effectively from a given budget.

A PES contract procurement auction is an alternative policy mechanism to extract from ES providers the information on level of payments or incentives that at least cover all their costs in joining a conservation program (Latacz-Lohmann and Schilizzi 2005; Ferraro 2004). It is defined as "a process through which a buyer of environmental services invites bids (tenders) from suppliers of environmental services for a specified contract and then buys the contracts with the lowest bids" (Ferraro 2008).

Procurement auctions on conservation contracts have been successfully implemented in the United States, Australia and Europe (Stoneham et al., 2003). The award of contracts on the basis of competitive bidding is a method frequently used in procuring commodities for which there are no well-established markets (Latacz-Lohmann and van der Hamsvoort, 1997; Ferraro, 2008), such as in markets for environmental services.

While inverse auctions for PES have been applied in a number of developed countries, they have to date not been widely adopted in developing countries. This chapter examines one of the few applications of inverse auctions in a rural setting of a developing country, namely in Lampung, Indonesia. A pilot PES scheme was implemented in 2006-2008 to induce farmers to reduce sedimentation in two sites in the Sumberjaya Watershed: Way Ringkih (Site 1) and Way Lirikan (Site

[18] In our context, we denote farmers as environmental service suppliers since they have a role in maintaining the environmental benefits from the watershed. Their decisions on land use practices influence the provision of environmental services (ES) from this landscape, including clean water, high biodiversity and the beauty of the landscape.

2). Site 1 consists of two villages Talang Kuningan and Talang Harapan, and Site 2 consists of Wanasari I and Talang Anyar. This study resulted in a set of auction rules to determine how the limited budget of the watershed rehabilitation fund, financed by the parastatal hydropower company, would be allocated. Additionally, the aim of this pilot was to obtain an understanding of the drivers of farmers' willingness to accept (WTA) compensation for a conservation contract and to assess the feasibility of using auctions in a developing country context.

In this chapter, we focus on designing a procurement auction method to reveal hidden information on the opportunity costs of supplying environmental services. This is the first application of procurement auction method in a rural setting of a developing country, where most of the auction participants have a low education level (less than seven years of education), low asset endowment, small plot size (most owned land of less than 0.5 hectares) and where market-based competitiveness is not so common.

5.2. Theoretical Framework

5.2.1 Experimental Auction

Experimental auction methods are becoming more commonplace in non-market valuation because of their perceived benefits relative to previously used contingent valuation survey methods. The reason is that participants have more incentives to reveal their true value for a product compared to a hypothetical survey setting. In this case, real products and real money are exchanged in an experimental setting (Lusk, Feldkamp, and Schroeder 2004). The mechanism is particularly useful in low-income countries where markets are imperfect and households can behave in ways very different from profit maximization (Ferraro 2004).

Four auctions are commonly used in the literature that can theoretically reveal any private information asked for (or *incentive compatible*): the English auctions, second price (Vickrey auction), Becker-DeGroot-&-Marschak (BDM) and random n-th price auctions. The structure of each mechanism is outlined in Table 5.1 (Lusk, Feldkamp, and Schroeder 2004). The most widely recognized and straightforward method is the English auction. In an English auction, the experimenter opens the auction at a relatively high price and begins running down in fixed increments. Depending upon the setup of the auction, participants either offer descending bids or signal their willingness to stay in the auction as prices are decreased over time. The auction ends when only one participant is willing to accept the current price. This participant wins the contract, and s/he is paid.

The other three types of auctions, namely: second price, BDM and random n-th price auctions basically modify the one-shot, sealed offer auction wherein each participant independently fills out and submits an offer-submission card that specifies the per-hectare price proposed to join the program. In a second price auction, the individual with the lowest bid wins the auction and is paid the second lowest bid amount for joining the program. The BDM mechanism induces individuals to truthfully reveal certainty equivalents for lotteries. In the BDM elicitation procedures, a random number or price is drawn from a pre-specified distribution. Individuals with bids lesser than the randomly drawn price 'win' the auction and are given the contracts at the randomly drawn price. The random n-th price auction introduced by Shogren et al. (2001) combines elements of two classic demand-revealing mechanisms – the second price and the BDM mechanism. The random-n-th-price auction works as follows: each bidder submits a bid, each bid is rank-ordered from highest to lowest.

A random number uniformly-distributed between 2 and k (k bidders) is selected. Each of the (n-1) lowest bidders wins the contract at the n-th price.

The three auctions above give participants incentives to tell the truth because each auction separates what they say from what they are paid. Sincere bidding is the weakly dominant strategy. In examining the effects of varying numbers of bidders, more aggressive bidding happens in first price auction, while this treatment has essentially no impact on bidding in second-price auction and results in lower bids in third-price auctions (Kagel, 1995). Shogren et al (2001)concluded that second-price auction does a reasonable job on aggregate but falls short at the individual level. Comparison of the random n-th price auction to the second-price auction showed that the second-price auction works better on-margin, and the random n-th price auction works better off-margin.

Lusk et al. (2004) investigated the effect of several procedural issues on valuation estimates from experimental auctions. They conducted multiple bidding rounds for the second-price and the random n-th price auctions because market prices are endogenously determined and subjects could incorporate market feedback into their valuations. On the other hand, in the BDM mechanism, market prices are exogenously determined, and as such, subjects receive no meaningful feedback from additional rounds. They found that the choice of auction institution significantly (both statistically and economically) influenced bids. Results indicated that the second price auction generated higher valuations than English, BDM, and random n-th price auctions, especially in latter bidding rounds, and that the random n-th price auction yielded lower valuations than the English and BDM auctions.

Table 5.1 Incentive compatible auction[19]

	Auction Institution			
	English	**Second Price**	**BDM**	**Random n-th Price**
Participant procedure	Sequentially offer ascending bids	Simultaneously submit sealed bids	Simultaneously submit sealed bids	Simultaneously submit sealed bids
Winning bidder	Participant who offers the last bid	Participant with highest (or lowest) bid	All participants with bid greater (or lesser) than a randomly drawn price	All participants with bid greater (or lesser) than a randomly (n-th) bid
Number of winners	1	1	0 to all participants	n-1
Market feedback?	Yes, with multiple rounds	Yes, with multiple rounds	Yes	No
Market price	Last bid offered	Second highest (or lowest) bid	Randomly drawn price	n-th highest (or lowest) bid

[19] Modified from Lusk et al. (2004)

5.2.2 Designing a PES Procurement Auction in Developing Countries: Some Considerations

A sealed-bid auction maintains anonymity. In a developing country where village leaders and elders have significant roles and dominance in decision-making, a sealed-bid auction is considered more appropriate compared to an English or Dutch auction(Ferraro 2004). A second price auction is also relatively easily to explain and to be understood by participants, making the bidding process more transparent.

In procurement auctions, the reserve price is the maximum acceptable bid[20]. The announcement of a reserve price can influence the bidding decision and hide the bidders' true value. However, the bidders also can implicitly interpret the information revealed by winning bids as reserve prices in multiple round auctions (Latacz-Lohmann and Schilizzi 2005).

Two pricing mechanisms in auctions are uniform pricing and discriminatory pricing. When more than one product is available in an auction, the auction may have multiple winners with different winning bid values. With uniform pricing at a procurement auction, all winners are paid the price offered by the winner with the lowest winning bid. For discriminatory pricing, all the winners are paid their exact bid amounts.

Alix-Garcia et al (2003) showed that uniform pricing may be more equitable while discriminatory pricing is more cost-effective. A complete list of possible implications for each pricing rule is listed in Table 5.2. Latacz-Lohmann and Schilizzi (2005) showed that under uniform pricing a bidder's bid only determines the chance of winning but not the payment received. It was assumed that the bidders' dominant strategy thus is to bid their true opportunity costs.

Table 5.2. Comparison between two pricing rules: uniform and discriminative

Element	Uniform	Discriminative	Description
Bidding strategy	+	-	Under discriminatory pricing, ES seller's bid determines both chance of winning and price to be received for selected activities Under uniform pricing, ES sellers' bid only determines chance of winning, so it reveals WTA more accurately
Transaction cost	+	-	Uniform pricing requires relatively more simple administration when dealing with many ES sellers
Fairness	+	-	ES sellers in discriminative pricing earn no profits if they submit offers equal to their opportunity costs
Political interest	-	+	High opportunity cost farmers can be disappointed when uniform pricing is applied
Efficiency of ES buyer	-	+	ES buyers might achieve environmental objective at least cost (McKee and Berrens

[20] Shor, Mikhael, "Reserve Price" Dictionary of Game Theory Terms, Game Theory .net, <http://www.gametheory.net/dictionary/ *url_of_entry.html*> Web accessed: June 06, 2008

Element	Uniform	Discriminative	Description
			2001; Cason and Gangadharan 2004) For ES sellers, since conservation payment is a non-stochastic income, it would lower their income uncertainty (Riley and Samuelson 1981)
Effect of risk aversion	+ (not exist)	- (exist)	Risk-averse participants inflate their bids under discriminative pricing
Effect of over-bidding	+ (not exist)	- (exist)	Over bidding will increase expenditure under discriminative bidding

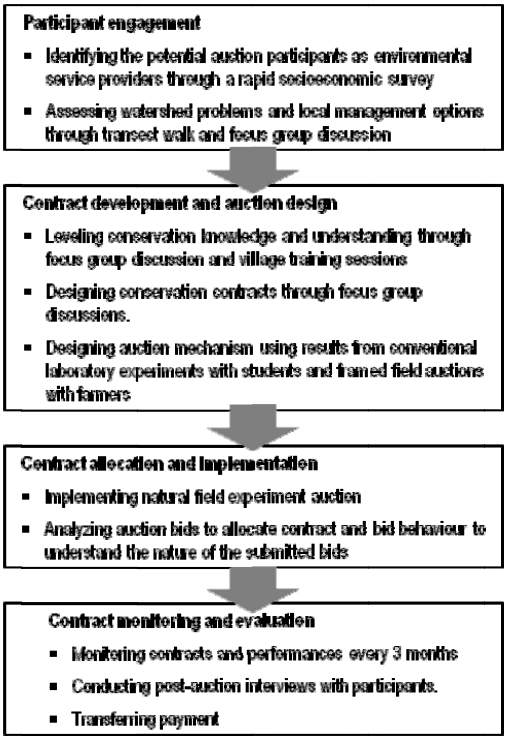
5.3. Methods

As part of a PES project on the island of Sumatra led by the RUPES Phase II (Rewards for, Use of and Pro-poor Investment of Environmental Service scheme) of the World Agroforestry Centre (ICRAF), this pilot auction was implemented to elicit private information on landholders' payments in return for soil conservation investments on private coffee farms. The farmers are environmental service suppliers as they play a role in maintaining the environmental benefits from the watershed. Their decisions on land use practices influence the provision of environmental services (ES) from this landscape, including water quality, biodiversity and scenic beauty. Information on the supply curves can be valuable for designing conservation-payment programmes; estimating these costs accurately can inform conservation planners of the financial, ecological and socioeconomic implications of future scaled-up PES programmes.

The Sumberjaya watershed is dominated by coffee crops in erosion-prone uplands. Erosion transports sediment loads to sensitive aquatic ecosystems and has serious negative effects on the resident flora and fauna. Moreover, a gradual reduction in soil organic carbon due to erosion can, depending on its deposition site, lead to a reduction in ecosystem carbon storage (van Noordwijk, Suyamto et al. 2008). Finally, soil erosion in Sumberjaya contributes to the rapid siltation of a downstream hydropower reservoir (the PLTA Way Besai reservoir, located approximately 30km downstream of the reservoir) that provides local irrigation services and electricity for three provinces in Sumatra (Sihite 2001; Ananda and Herath 2003). Erosion control is an impure public good that generates both private benefits and positive externalities. As a result, farmers tend to under-invest in soil conservation. The watershed rehabilitation fund in Indonesia is mostly obtained from the corporations' conservation funds. The legal basis of this scheme is the Letter of Ministry of Parastatal Company Affairs over Corporate Social Responsibility Partnership Programs. It was cited that 1% of net-benefit of state-owned companies should be allocated for developing environmental programmes with the communities. This scheme could be seen as potential mechanisms for rewarding transfers through a governmental public investment scheme.

Several preparatory steps were taken before the procurement auction was conducted (Figure 5.1). First, the sample population and potential auction participants were identified at the sub-watershed level. Second, the conservation contract that would be offered in the auction was designed. In designing the contract and local institution to implement it, some basic information was needed, such as: What problems would be solved by the conservation project? Do the local farmers have any knowledge in solving the watershed problems? What are these appropriate conservation techniques? What are the farmers' preferences for terms of payment? When does the contract begin? Third, some

elements of the auctions were tested and selected through two types of experiments: laboratory auction experiment with students and field framed experiments with farmers[21] (Harrison and List 2004). The final step was to conduct a natural field experiment and monitor the contract accomplishment of farmers who obtained a contract for one year.



Source: Adapted from Leimona et al. (2009)

Figure 5.1 Flow of research in designing a market-based PES

Several on farm techniques effectively reduce soil erosion from smallholder coffee farms in the watershed (Agus, Gintings, and Van Noordwijk 2002). Four focus group discussions involving 76 farmers from three villages led to the selection of three scientifically appropriate techniques: soil infiltration pits, vegetation strips and ridging between coffee trees. Farmers preferred these techniques

[21] This taxonomy of field experiments proposed by Harrison and List (2004) differentiated between field experiments from conventional lab experiments:
A *conventional lab experiment* is "one that employs a standard subject pool of students, an abstract framing, and an imposed set of rules";
A *framed field experiment* is an experiment that "employs a nonstandard subject pool with field context in either the commodity, task, or information set that the subjects can use";
A *natural field experiment* is "the same as a framed field experiment but where the environment is one where the subjects naturally undertake these tasks and where the subjects do not know that they are in an experiment"

for their suitability, familiarity and simplicity (Leimona et al. 2009). All three are scalable and verifiable, and thus appropriate for contracts that make payments conditional upon performance. Moreover, the contracted techniques reduce erosion without decreasing coffee production and incur few fixed costs, requiring primarily labour investments using tools already owned by the farmers. Components of landholders' WTA were anticipated to include both observable characteristics, such as plot slope, and unobservable characteristics, such as the opportunity cost of labour and individual discount rates. Bids in an incentive compatible auction capture all of these factors, and thus reveal the distribution of WTA within the population.

We observed the socioeconomic factors influencing the auction participants in submitting their final bids by applying a regression analysis with *Reverse Helmert* coding (or difference coding) as the additional coding systems for ordinal and categorical variables using the STATA 9.1 software. This system compares each level of non-numeric variables to the mean of the subsequent level(s). Each variable is compared to the mean of previous level(s)[22].

We analyzed the validity of applying this auction design in a rural setting in Indonesia by testing some factors. These factors were (1) technical factors, such as: farmers' understanding of auction rules, easiness of the rules, appropriateness of the bid offered during the auction, and fairness of the auction process; (2) social relationship factors, such as: impact on relationships between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange between farmers; (3) environmental perception factors, such as awareness of soil and water conservation and rate of contract accomplishment.

For analyzing the social relationship factors (impact on relationships between contracted and non-contracted farmers, general interpersonal relationships between communities, and information exchange between farmers) and environmental perception factors (awareness of soil and water conservation and the rate of contract accomplishment), we applied Fisher's exact tests between two independent categorical variables. Fisher's exact test predicted the relationship between non-contracted and contracted farmers on each social and environmental variable. The application of Fisher's exact test assumes that each cell has an expected frequency of five or less.

As suggested by Ferraro (2004), in addition to survey data collected on the observable characteristics of auction participants, the risk preferences and time preferences of participants were also considered. To date several approaches have been used to assess the importance and nature of risk aversion. Simple lottery choice tasks involving cash prizes were used to estimate the degree of risk aversion as well as specific functional forms. This experiment was based on six lottery choices from real situations (Holt and Laury 2002).

Individual discount rate can represent time preferences. Harrison et al (2002) indicated that constant discount rates for specific household types were assumed, but not the same rates across all households. Respondents will be asked a simple basic question in order to elicit an individual discount rate: for example, applying to a time horizon of six months, do you prefer Rp. 50,000 in one month or Rp. 50,000+x in seven months? This delayed option involves greater transaction costs and the revealed discount rate would include these subjective transaction costs. By having both options entail future income, individuals hold any transaction costs or concerns about experimenter default constant.

[22] Introduction to SAS. UCLA: Academic Technology Services, Statistical Consulting Group. from http://www.ats.ucla.edu/stat/Stata/webbooks/reg/chapter5/statareg5.htm#HELMERT (accessed July 10, 2009).

5.4. Result

This section discussed the results from the natural field experiments in two sub-watersheds involving 82 farmers. We presented the selection of auction design and described their implementations. The procurement auctions result in participants' bid capturing the supply curve for conservation contract. We compared the conservation costs captured from the auction and the cost estimates based on labour investment to gain some insights for efficiency gains from the auction. Finally, we analysed the rate of contract accomplishment and results from interviews with participants. The interviews revealed level of understanding of the auction, social relationship, and environmental perception after the farmers participated in the auction.

5.4.1 Auction design and implementation

The socio-economic characteristics of the farmers (*i.e.* the auction participants) are: low education level (below seven years of education), low asset endowment, small plot size (mostly less than 0.5 hectares), where familiarity with market based competitiveness is not particularly common. Several of the auction design elements were selected to respond to these characteristics and general rural situations in developing countries, where most of the participants had strong social binding among their community members, and where village leaders and elders have significant roles and dominance in decision making (Ferraro 2004). Auction elements were chosen for their simplicity, equitable payments and transparency to ensure each participant had the freedom to reveal their own bids without any external interference. A sealed bid auction was conducted to maintain anonymity. The second price auction was selected since it was relatively easy to explain and be understood by the participants, hence making the bidding process more transparent.

An effort-based payment mechanism was chosen because the time frame of this project was too short for accurate output based (*i.e.* level of sedimentation reduced) performance payments. Inaccurate measurement of environmental service outcome would bias the performance achieved by the farmers and at the end, could cause any disappointment both from providers and buyers. Table 5.3 summarises the design characteristics of the auction.

To provide an incentive for truthful cost revelation, a uniform price rule was used, where the final contract price equals the lowest rejected offer price. Under this uniform price rule, bidders who bid above their true values cannot benefit from overbidding. This is because the price is set by the lowest rejected bid, and bidders risk losing the contract at a price they would have been willing to accept. Bidders who bid below their true value increase the likelihood of winning a contract at a price below their minimum acceptable price. Thus, all bidders' best (weakly dominant) strategy is to bid their true WTA. They can do no better, and sometimes worse, by misrepresenting their WTA. In contrast, discriminative price procurement auctions, where winning bidders receive a contract price equal to their own bid (Stoneham et al. 2003), or under a uniform price rule where the price is set by the last accepted offer, bidders have strategic incentives to inflate their bids to levels above their true WTA. Furthermore, Alix-Garcia et al (2003) show that uniform pricing may be more equitable, while discriminatory pricing is more cost-effective.

In game theory, a reserve price is the maximum acceptable bid[23]. For this auction, a reserve price was preset, but was not announced since the announcement of reserve prices can influence the bidding strategy (Latacz-Lohmann and Schilizzi 2005). However, the bidders can also implicitly interpret

[23] Shor, Michael. "Reverse Price" Dictionary of Game Theory. Game Theory.net http://www.gametheory.net/dictionary/CitationInformation.html Web accessed: July 13, 2011

information in their winning bids as reserve prices in multiple round auctions. To avoid bidder learning between preparatory bidding rounds, only the winning ID numbers were announced, and the total conservation budget was not revealed.

Table 5.3 Characteristics of reverse auction design

Characteristic	Implementation
Auction type	One-sided, sealed bid procurement auction
Bidding units	Willingness to accept (WTA)
Budget limit	Predetermined, concealed
Number of rounds	7 provisional, 1 binding
Announcement of provisional winners	By ID number
Bid timing	Simultaneous
Pricing rule	Uniform, lowest rejected price
Tie-breaking rule	Random in determining tied winners
Bidder number	Known, fixed
Activities contracted	Determined in advance

Source: Jack, Leimona and Ferraro (2008), Leimona et al (2009)

The conservation auction was carried out on consecutive days in two nearby villages in a single sub watershed. The villages were selected based on hydrological studies showing their contribution to sediment loads. A random sample of participants from the sub district population would have provided results more in keeping with the purposes of this study, but the interests and preferences of ICRAF to integrate its biophysical and socioeconomic research precluded this approach.

The primary occupation in the two villages is coffee farming, most of which takes place on small, individually owned plots that are not subject to any land use regulations. The auction was limited to owners of private coffee plots, and excluded plots on state forest lands which are subject to other regulations. One village comprised 55 households, 53 of which owned private agricultural land. Of these, five rented or sharecropped their land, leaving 48 eligible households, all of which participated in the auction. In the other village, 55 of the 87 households owned private agricultural land. Of these, 20 rented or sharecropped their land. Thus 35 households were eligible, and 34 participated in the auction. To ensure that participants understood the contract requirements, all participating farmers attended field training. The theory and practice of erosion control management techniques were presented, and site visits were made to adjacent villages where erosion control management was already in place.

Farmers, each designated with an identification number, submitted sealed bids representing their per hectare price for accepting a conservation contract. They had to reveal an average willingness-to-accept per hectare, rather than a different price for each hectare of their property because we believed farmers would have found varying prices per hectare confusing and because uniform-price auctions in which bidders bid multiple units are not necessarily incentive-compatible (Ausubel, Cramton, and

University of Maryland at College Park. Dept. of 1996). Farmers were informed that payments would be made in three instalments, with the second two conditional upon verification of compliance. The multi-instalment payment plan provided incentives for compliance for the duration of the contract, which mitigated valuation problems associated with moral hazard (*i.e.* lowering bids because of the expectation of lax enforcement). In addition, the farmers expressed a preference for periodic payments during focus group discussions, likely due to a lack of access to credit markets. As the primary purpose of the auction was to accurately estimate supply curves (rather than to maximise the conservation benefits per dollar spent), plots were not ranked by their erosion mitigation potential. Farmers were aware that enrolment decisions were based solely on their bid price per hectare. Contracts were treated as discrete (*i.e.* either all or none of plot was contracted), though contracting could also have treated hectares as the discrete unit.

In each of the two villages, the auction lasted 2-3 hours, during which the participants heard the contract described, received instructions about the auction, and submitted their bids. Following Cummings *et al.*(2004), the auction was designed with several provisional rounds preceding the final allocation round. After each provisional round, the bidder identification numbers of provisional winners were announced. No price information was provided between rounds and participants were not allowed to converse. Bids were revised and re-submitted for each round, a process designed to increase familiarity with the mechanism (Cummings, Holt, and Laury 2004). Participants were informed of the number of provisional rounds in advance to ensure that final round bids were based solely on WTA and not subjective expectations about the number of rounds. Jack (2009) noted that the multiple familiarisation rounds in Sumberjaya auction resulted in reduced bid inflation, thus allowing a larger land area to be enrolled – or in other words, increases the efficiency of the auction.

The contractual arrangements between the two sites were different. At Site 1, two farmer groups (one from each *talang*) signed the contracts. The members arranged working in rotation, shifting from one plot to another until all the contracted activities were finalised. At Site 2, farmers signed individual contracts with ICRAF. In other words, there were two group contracts at Site 1, and 15 individual contracts at Site 2.

5.4.2 Auction outcomes and environmental impacts

Of the 82 auction participants bidding on 70 ha, 34 participants received contracts for soil conservation activities on a total of 25 ha at an average price of USD 171.70 (1 USD = 9000 IDR) (Table 5.4). The total budget of around USD 4 450 was combined with the uniform pricing rule to determine the contract price of USD 177.78/ha in the first village and USD 166.67/ha in the second village.

Table 5.4 Summary statistics of the reverse auction (USD per hectare)

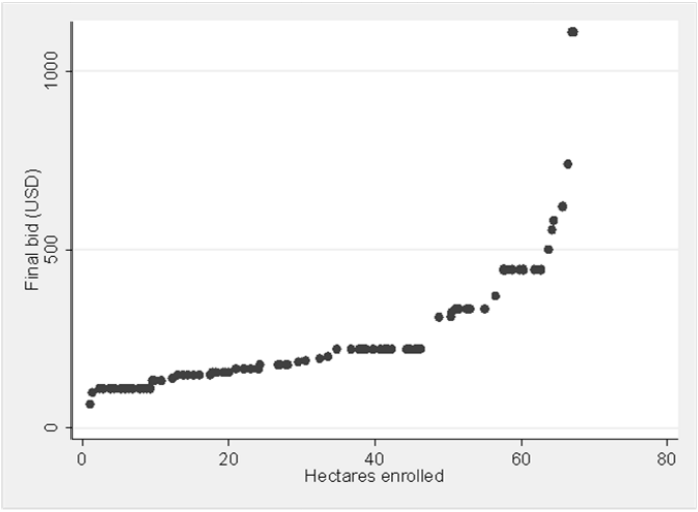
Number of participants	82
Number of contracts awarded	34
Number of hectares bid	70
Number of hectares contracted	25
Contract price per hectare	171.70
Mean bid per hectare	263.14

Median bid per hectare	181.67
Minimum bid per hectare	66.67
Maximum bid per hectare	2 777.78
Standard deviation	344.91

Source: Jack, Leimona and Ferraro (2008)

Just over one additional hectare of conservation investment would have been purchased if participants were paid their own bid (*i.e.* discriminative-price auction). However, as explained above, bid inflation under a discriminative-price rule would reduce these gains. In the following discussion, we did not consider a single high outlier bid.

Figure 5.2 presents the aggregate supply curve from the two villages, *i.e.* describing the number of hectares enrolled in the program for any given price. It follows an exponential distribution with increasing marginal costs. Note that this supply curve represents short-run costs as estimated by the participants, which may change as participants learn more about the contract or the contractor. Measuring a supply curve in terms of erosion abated would be preferred over the proxy measure of hectares under soil erosion mitigation activities. Most conservation payment initiatives, including this study, measure performance by land use activities rather than actual services supplied, because of monitoring difficulties and the risk burden for landholders (Wunder 2007).



Source: Jack, Leimona and Ferraro (2008)

Figure 5.2 Supply curve resulting from reverse auction

5.4.3 Efficiency Gains from the Auction

To assess the efficiency of the auction, alternative methods were used to estimate the costs of the contracts prior to the auction. Labour costs were expected to comprise the primary investments

needed for the contract. Labour cost information was thus elicited using two approaches. First, during focus groups, farmers were asked to estimate the labour requirements of the contract. Estimates were based on wages, number of hired workers and number of work days. The average costs approximated by the farmers were USD 300 per hectare, including forgone wages from the farmer's own labour investment. Second, cost information was collected as part of a household survey, asking about time investments for past implementation of soil conservation activities. The estimates based on retrospective calculations were slightly lower, around USD 225.

The cost estimates based on labour investments are 30 to 75% higher than the auction price of USD 171.70 per hectare, and 24 to 65% higher than the median bid. Based on estimated labour costs, 14.8 to 19.8 hectares of contracts could have been enrolled under the available budget, as opposed to the 25 hectares actually purchased under the auction (26% to 69% more). On the other hand, the mean bid price was between the two estimates based on labour costs, suggesting that these methods may have been fairly accurate in estimating mean values. This outcome does not indicate that the labour cost estimates were inaccurate, simply that they provided incomplete measures of farmers' WTA.

5.4.4 Contract monitoring

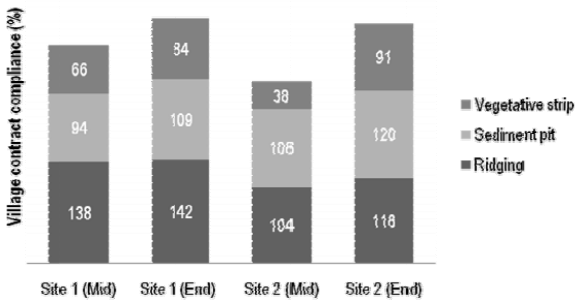
The research team conducted two qualitative (third and ninth month of contract signing) and quantitative (sixth and twelfth month of the contract signing) monitoring activities in the field. The qualitative monitoring obtained information on the contract implementation using open-ended questions. The enumerators checked the general quality of the conservation structure and asked farmers whether or not they had any difficulties in implementing their contacts. During quantitative monitoring, enumerators measured the size of sediment pits and observed the quality of the ridging and grass strips. They also surveyed social interactions among farmers and other conservation structures that were not required by the contract, such as water drainage and terracing. This monitoring involved two external evaluators from the District Forestry Service who independently gave scores to the farmers' accomplishments. The head of the village accompanied the team as a witness to fair evaluation. Farmers who were not able to accomplish at least 50% of the contracted activities had to give up and could not continue their contracts. At the final monitoring, the implementing agency paid the remaining fund to farmers who had accomplished at least 80% of the contracted activities.

The mid-term monitoring revealed that most farmers successfully completed their obligations. Figure 5.3 shows the average compliance for Site 1 and 2 at the six month quantitative assessment and at the end of the contract. Only one contract was terminated early; a farmer from Site 2 only achieved 4% of the required activities after six months. The exit interview revealed that the main reason for such performance was the higher opportunity cost for getting other side jobs than the contract value.[i]

After one-year of contract implementation, again most of the farmers showed good progress in implementing their contracts. Farmers constructed ridgings and sediment pits over and above the demands of the contract, but they lagged behind in planting the vegetative strips. Farmers also practiced other conservation techniques such as the building of terracing and drainage that could optimally support the contracted conservation efforts. All farmers constructed terracing, which could be done simultaneously with ridging and half built drainage systems.

The successful completion of planting vegetative strips was found to be influenced by other farm priorities. For example, in Talang Kuningan, Site 1, planting was successful, partly because they used it as extra fodder for their livestock (goats). However, in Talang Harapan, Site 1, the absence of

livestock removed this extra incentive and less effort was put into planting vegetative strips. This highlights how conservation measures are especially successful when they are mutually advantageous for the landholders.



Source: Leimona et al (2009)

Figure 5.3 Average village compliance within each site measured during the middle and at the end of the contract term

In summary, 19 out of 34 farmers successfully accomplished the contract requirements (*i.e.* 55% across the two sites). Fourteen farmers did not pass the final evaluation and one farmer failed during the mid-term evaluation. Most of them failed in planting the grass strips although many of them constructed both ridging and sediment pits, even exceeding the contractual agreement. We decided that for the final decision, the percentage of accomplishment would not be calculated cumulatively. We did not add up all the percentages but evaluated these individually. Thus, farmers who failed one of the contracted components were not eligible for the final payment. Although the rate of accomplishment could be categorised as low, we could not conclude that the overall conservation effort was not successful. Table 5.5 shows that the rate of accomplishment was greater than 80% for all contracted techniques: ridging (128%), sediment pits (114%), and grass strip (88%).

Table 5.5 Rate of contract accomplishment

	Total number of farmers	**Number of failed farmers**	**Rate of success (%)**
Site 1	19	10	47
Talang Kuningan	9	0	100
Talang Harapan	10	10	0
Site 2	15	6	67
Wanasari I	10	4	70
Talang Anyar	5	2	60

Source: Leimona et al (2009)

Each *talang* (sub-villages) across the two sites had different rates of success in accomplishing their contracts. At Site 1, all farmers (100%) in Talang Kuningan fulfilled their contractual agreement, while in Talang Harapan, no farmer received the final payment. The rate of success at Site 2 was higher (67%) and well distributed at each *talang* compared to Site 1, with a 47% rate of success. The different contractual arrangements and institutions are likely to have influenced the rate of success of each *talang*.

An exit interview was conducted to examine the underlying motivations for contract performance. Most of the Talang Harapan farmers, where group contracts were issued, cited the lack of leadership and poor coordination as the major reasons why their group was not motivated in performing well. The field assistant observed that the group did not choose the leader voluntarily, and the group leader was not an active community member. Farmers also cited time constraints as a factor, due to other activities, such as harvesting coffee, working in the rice field and other gardens, engaging as daily labourers, and renting motor bikes. Unsuitable weather was another factor. In reality, many other farmers could easily find grass and accomplish fully the conservation activities with the current weather. However, most of them felt that they could not accomplish the contract at the sixth month as this coincided with the coffee harvesting period. Some of the farmers also assumed that receiving a low score during the mid-term evaluation could influence the final result, hence lowering their motivation to complete the contract.

The farmers suggested some improvements to increase the conservation program's rate of success. At least six farmers proposed having individual contracts rather than group contracts because weak coordination among members could make the whole group fail. Some contract components should be more flexible, they said. Most of them agreed that there should be sanction and that the current sanction was suitable. None of the farmers had problems with the design of the auction and the contractual agreement. Subsequent analysis showed that there was no significant difference in conservation awareness level, understanding on the auction design (rules, complexity), information quality and level of satisfaction between farmers who complied fully with the contract and those who did not.

5.4.5 Design Factors: Farmers' Understanding of Auction Design and the Auction Aftermath

A post-auction interview revealed that most farmers understood the rules when implementing the conservation auction (Table 5.6). Three farmers out of 48 (4 percent) did not understand the rules and all of them lost. About 32 percent of the farmers, both winning and losing, understood the rules very well. Most farmers were satisfied with the completeness of information provided by the facilitators when implementing the auction. The participants found it relatively easy to understand the rules for implementing the auction and for deciding the winners. The wining farmers interpreted the rules more easily compared to the losing ones. Most farmers thought that the auction process and the determination of the winner had been conducted fairly (88 percent). The farmers who felt that the auction was unfair mostly lost. Most farmers (78 percent) were fully aware that competition was taking place the auction participants in order to win the contract and that the budget of auctioneer was limited.

Table 5.6 Descriptive analysis of post-auction technical factors

Variable	Frequency Non-contracted (N=48)	Frequency Contracted (N=34)	Total
Understanding of the auction rules			
Not understand at all	3 (0.06)	0 (0.00)	3
Moderately understand	16 (0.33)	8 (0.24)	24
Quite understand	11 (0.23)	12 (0.35)	23
Understand	3 (0.06)	3 (0.09)	6
Understand very well	15 (0.31)	11 (0.32)	26
Complexity of the auction rules			
Very difficult	2 (0.04)	1 (0.03)	3
Quite difficult	17 (0.35)	14 (0.41)	31
Quite easy	7 (0.15)	10 (0.29)	17
Easy	18 (0.38)	7 (0.21)	25
Very easy	4 (0.08)	2 (0.06)	6
Fairness of the auction implementation			
Not fair	7 (0.15)	3 (0.09)	10
Fair	41 (0.85)	31 (0.91)	72
Awareness of competition among participants			
Not aware	10 (0.21)	9 (0.26)	19
Aware	38 (0.79)	25 (0.74)	64
Contract value received			
Too low	19 (0.40)	5 (0.15)	24
Not too low	17 (0.35)	17 (0.50)	34
Moderate	12 (0.25)	12 (0.35)	24
High	-	-	-
Too high	-	-	-
Willingness to change the offer			
Yes	12 (0.25)	12 (0.35)	24
No	36 (0.75)	22 (0.65)	58

Note: proportion in parenthesis

As predicted, about 40 percent of the losing farmers considered the contract value per hectare to be too low. About 70 percent of all participants found that the value was either not too low or moderate. The median appropriate total amount of contract value per hectare according to interviewed farmers was USD 246 (Rp. 2,000,000) or about 12.5 percent higher than the cut-off price. Most of them would be likely to change their previous bid if they had another chance to offer a new bid. From the follow-up interview, however, we found that 32 percent of farmers wanted to change their previous bids, 28

percent of farmers would decrease their offer and the remaining 40 percent of farmers would increase their offers. A statistical test revealed that the average final bid as the result of the auction differed to the mean of the appropriate amount of contract value in the participants' opinion after the auction (Table 5.7). The overall value proposed after the auction was higher.

The bidders' (farmers') learning process is influenced by the number of wins from previous rounds as well as farmers' perceptions of auction design factors. Data from the multiple bids submitted by each individual allows insights into farmers' understanding of the auction and learning across the multiple bidding rounds. Jack (2009) provides an analysis of the learning observed in the auction using the adjustments of bids between rounds as an indicator of learning and finds that individuals are responsive to previous round outcomes and rejects a simulated null hypothesis of random bidding. The data suggests that individuals do use the trial rounds to learn how to bid, but conclusions about whether they learn about the auction structure itself or about the value of the contract remain unclear.

Table 5.7 Contract value per hectare offered by farmers after auction

Variable	Mean	Standard Deviation	Minimum	Maximum	P-value
Appropriate total amount of contract value per hectare	246	120	161	753	0.0000***

N: 80 individuals
Note: *p<.15, **p<.10, ***p<.05

We used the framework of bid adjustments during the trial as a proxy way of learning (Jack 2009) to further investigate farmer responses about understanding the auction process (Table 5.8). The independent variable was *bid adjustment for each respondent at each round* and the dependent variables were parameters representing farmers' perceptions of design factors such as *understanding of auction rules, easiness of the rules*, *fairness of the auction process* and *awareness of competition between participants*. We found that farmers who stated that they "understand" the auction rules had reliable different mean of bid adjustments compared to the average mean of bid adjustment of farmers who stated "not understand at all", "moderately understand", and "quite understand". Farmers who thought that the auction rules were quite easy adjusted their bids upward compared to those who stated that the auction rules were very difficult or difficult (level 1 and level 2). We analyzed the mean bid adjustments of famers who were aware of competition and found a significant difference compared to the means of farmers who were not aware of competition. The latter had a lower mean of bid adjustment.

Table 5.8 Farmers' understanding of auction design

Variables	Coefficient	Standard error	P-value
Understanding of the auction rules			
Not understand at all	-	--	-
Moderately understand	-0.1077	0.06	0.09**
Quite understand	-0.0262	0.05	0.57
Understand	-0.1035	0.05	0.03***
Very understand	-0.0121	0.05	0.80
Easiness of the rules			
Very difficult	-	-	-
Difficult	-0.0019	0.07	0.98
Quite easy	-0.0856	0.04	0.04***
Easy	0.0112	0.05	0.82
Very easy	0.0191	0.05	0.70
Fairness of the auction implementation			
Not fair	-	-	-
Fair	0.0054	0.04	0.90
Awareness of competition between participants			
Not aware	-	-	-
Aware	-0.0604	0.04	0.14*
Number of observation = 492			
Number of groups = 82			
Wald chi-square(12) = 49.94			
Prob > chi-square = 0.00			

Note: *p<.15, **p<.10, ***p<.05

5.4.6 Social relationship factors: impact on communities

As far as social conditions and interaction among community members was concerned, the auction participants experienced slightly significant changes (Table 5.9). There was a statistically significant 5-percent difference between the non-contracted and contracted farmers when evaluating the relationship between winners and losers. Non-contracted and contracted farmers had an almost similar perspective on interpersonal relationships among the community in the *talang* after the auction. The impact on information exchange between farmers was statistically significant at 10 percent. The contracted farmers gave better evaluation of the social impacts of the auction and of conservation contract activities compared to the non-contracted farmers.

Table 5.9 Perspective of non-contracted and contracted farmers on social impacts

Variable	**Frequency Non-contracted (N=48)**	**Frequency Contracted (N=34)**	**Fisher's exact test P-value**
Impact on relationships between winners and losers			0.143*
Very bad	0 (0.00)	0 (0.00)	
Bad	5 (0.10)	6 (0.18)	
Quite good	17 (0.35)	9 (0.26)	
Good	21 (0.44)	19 (0.56	
Very good	5 (0.10)	0 (0.00)	
Impact on general interpersonal relationships among the community			0.175
Very bad	0 (0.00)	0 (0.00)	
Bad	3 (0.06)	2 (0.06)	
Quite good	18 (0.38)	13 (0.38)	
Good	21 (0.44)	19 (0.56)	
Very good	6 (0.13)	0 (0.00)	
Impact on information exchange between farmers			0.055**
Very bad	1 (0.02)	0 (0.00)	
Bad	7 (0.15)	0 (0.00)	
Quite good	19 (0.40)	17 (0.50)	
Good	13 (0.27)	14 (0.41)	
Very good	8 (0.17)	3 (0.09)	

Note: proportion in parenthesis

5.4.7 Environmental perception factors: awareness of conservation and rate of accomplishment

There were no significant differences between contracted and non-contracted farmers of their awareness and willingness to implement soil and water conservation on their land (Table 5.10). Some farmers expressed the view (via interviews) that enthusiasm amongst farmers for conserving the environment and for land conservation practices improved after the training, meeting and auction process.

Table 5.10 Perspective on environmental impacts from non-contracted and contracted farmers

Variable	Frequency Non-contracted (N=48)	Frequency Contracted (N=34)	Fisher's exact test P-value
Awareness of soil and water conservation			0.188
Very bad	0 (0.00)	0 (0.00)	
Bad	2 (0.04)	1 (0.03)	
Quite good	30 (0.63)	16 (0.47)	
Good	7 (0.15)	12 (0.35)	
Very good	9 (0.19)	5 (0.15)	
Willingness to implement soil and water conservation			0.340 (0.509)
No	2 (0.04)	0 (0.00)	
Yes	46 (0.96)	34 (1.00)	

Note: results from 2-sided Fisher's exact test are in parenthesis. The others are calculated from 1-sided Fisher's exact test.
For the frequency column, proportion is in parenthesis

5.5. Discussion and Conclusions

Based on the outcomes from the laboratory and field experiments as well as theoretical considerations, the design of this pilot auction was a sealed bid auction with budget constraints, random tie rule, uniform pricing rule, minimised collusion, announced ID numbers of provision winners and announced number of rounds. The auction followed a fairly standard format, with a single buyer and multiple sellers submitting sealed bids representing their WTA the soil conservation contract for their plot. Bids were assessed according to a per hectare price and the cut-off price was determined by a pre-set budget constraint.

The auction for the PES programme in Indonesia was designed using a uniform price rule for fairness reasons. The literature on auction design finds that uniform pricing is more likely to reveal farmers' true opportunity cost because bidders only determine the chance of winning. However, uniform pricing is relatively less cost-effective compared to the discriminative price rule.

The auction was a multiple round consisting of eight rounds with the last binding round. The benefit of multiple rounds was that farmers learned from the rounds of the auction. However, the announced last round may introduce forms of strategic behaviour. Concealing the number of rounds will give

participants higher uncertainty because they have their own subjective probability distribution about the chance of the last round. By announcing the last round, the benefits from farmers' learning on the previous round and the advantages of a one-shot auction for the last round were combined.

The rate of accomplishment at the final monitoring was moderate. The reasons for this were various, ranging from lack of leadership and coordination among farmer group members, difficulty in finding grass seedlings to accomplish the contract, and coincidence with coffee harvesting time. In this specific case, private contract tends to be more successful compared to collective contract when leadership is lacking or "champion" among the community members does not exist. Institutional aspects and contract flexibility might influence the accomplishment of conservation efforts. Analysis showed that there were no significant differences in level of understanding, complexity, and competitiveness and conservation awareness between compliant and non-compliant farmers.

A limitation of this study is that all units of the pilot site were treated as homogeneous, with respect to their contribution to erosion and downstream sedimentation. These sites' contribution to environmental services is also heterogeneous, related to hydrological and geophysical factors that are unlikely to be correlated with cost. The emphasis of this pilot auction was to assess the feasibility of the auction approach in a developing country context and to obtain an understanding of farmers WTA and the drivers thereof. A scoring rule giving higher values to plots that contribute more to downstream problems is preferable. For instance, plots located on steeper slopes and closer to rivers and streams could be assigned higher values so as to enhance the cost effectiveness of a larger scale auction. The simplifications in this pilot auction were deemed appropriate for the research and valuation intentions of the study. For a larger scale allocation auction, modifications such as using supply curve information resulting from this procurement auction would be more appropriate. Such valuation information provides a reasonable platform for designing a scaled up fixed payment scheme, including differential rates and eligibility rules necessary for targeting participants.

The design of an experimental auction should fit the purpose of overall objectives of a conservation program. In this case, the challenge was to design and administer a fair auction for farmers with low formal education, prone to social conflicts, and influenced by power structures within their community.

6. The livelihood impacts of incentive payments for watershed management in West Java, Indonesia

The case study presented in this chapter is located in Cidanau Indonesia, a watershed for supplying domestic and industrial water needs of Banten Province, Java Island, Indonesia. This paper describes the process of initiating the PES scheme and its design, and reviews the impacts of the five year scheme on local livelihoods. We assessed these impacts through a series of focus group discussions with the participants and non-participants and interviews with implementing agencies. The Cidanau PES scheme has impacted the livelihood of PES participants and non-participants. Benefits were mostly non-financial: expanded social networks with external stakeholders; knowledge and capacity of the community; and small-scale public infrastructure investments.

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6.1. Introduction

Payment for environmental services (PES) is now quite a well-recognized approach in Asia. Interest and investment from international donors has enabled the testing of different PES mechanisms over the last decade, particularly focusing on watershed protection and carbon sequestration. With the exception of China and Vietnam, where the schemes are state-run, schemes in Asia are generally small scale community-level projects.

The case study presented in this chapter is located in Cidanau, Indonesia. The Cidanau watershed is one of the most important watersheds for supplying domestic and industrial water needs of Banten Province, Java Island, Indonesia. The watershed covers 22,260 ha located between two regencies: Serang and Padeglang and their six sub-districts. The Cidanau watershed also has a special role in biodiversity protection. In the base of the bowl-shaped Cidanau watershed lays the Rawa Danau Reserve – a 4,200 hectare nature reserve which contains the only remaining lowland swamp forest in Java with 131 endemic species. The Reserve is important in the hydrological process too, as the reservoir for Cidanau River, with its tributaries flowing into the Sunda strait.

The Cidanau project was initiated by a multi-stakeholder watershed forum – *Forum Komunikasi DAS Cidanau* (FKDC)[24] and facilitated by the Rekonvasi Bhumi and the Institute for Social and Economic Research, Education & Information (LP3ES) – both Indonesian non government organizations (NGOs). In the beginning, the aim of the PES scheme was to slow down the environmental degradation of the Rawa Danau Reserve and the watershed around it. The PES scheme in Cidanau officially started in 2004 when a state-owned water company – the Krakatau Tirta Industri and the FKDC, representing the upstream farmers, signed a contract to conserve the watershed.

This paper describes the process of initiating the PES scheme and its design, and reviews the impacts of the five year scheme on local livelihoods. We assessed these impacts through a series of focus group discussions with the participants and non-participants and interviews with implementing agencies.

6.2. Methods

We collected qualitative data from three villages in the Cidanau Watershed (Citaman, Cikumbuen and Kadu Agung). In each village, we held two focus group discussions (FGD) for participants and two FGDs for non-participants. All the PES participants joined the discussion and for the non-participants, we contacted village leaders who organized available household representatives to join the FGD. The non-participants were 30 households in each village. In total, the FGD participants involved to 113 participants and 90 non-participants (Table 6.1).

[24] The sixty-four members of this forum are upstream and downstream stakeholders. The upstream stakeholders include farmer groups, government of Serang district, the Serang legislative body, provincial agriculture services (provincial and district forestry and environment), provincial and district planning agencies (BAPPEDA), provincial human capacity and development agency, provincial human settlement and regional infrastructure services and a nongovernment organization (NGO). Downstream stakeholders include representatives of the PT Krakatau Tirta Industry (KTI) (a private water company), government and legislative body of Cilegon district, agriculture services and urban water users. This body was later to become the primary coordination mechanism for PES.

Table 6.1 The sample of FGD participants

Village	Participating household	Percentage of total participating household	Non-participant household	Percentage of total non-participating household	Total household in each village
Cikumbuen	32	100%	30	18%	203
Citaman	43	100%	30	18%	210
Kadu Agung	38	100%	30	8%	414
Total	113		90		

The facilitators guided the FGD through a series of questions on the impact of PES by comparing three time-periods: before the year 2000 (a landmark year covering the period of 1998- 2000 remembered by communities because it marked the beginning of political reforms and economic crisis), between 2000 and 2004, and after signing a PES contract (2005–present). The livelihood impacts were discussed in terms of the five asset types covered in the Sustainable Livelihood Framework: financial, human, social, physical and natural. For each asset category, we asked the participants as a group to identify relevant impacts (Table 6.2), and to collectively rank them according to their relative importance. For example, under financial assets, groups listed all sources of income during each era. The most important ten sources were then ranked, and paper dots were used by the facilitators to describe the relative percentage that each income source contributed to the overall household income. Some impacts, such as trust and social capital, required further discussion to clarify their meaning

In addition to the FGDs a one day workshop was held involving FKDC members, local government and the Krakatau Tirta Industry (KTI) company. We followed this up with some informal interviews to clarify any conflicting or unclear data from the workshop. In analysing livelihood impacts, the data are limited to the results from the FGDs and stakeholder interviews, as there has been no detailed quantitative analysis so far of household level livelihood impacts in Cidanau.

Table 6.2 The livelihood issues discussed in focus groups

Capital	Type of information discussed
Financial	Sources of income over the three periods
Human	What (if any) capacity/skills/knowledge were gained through the scheme?
Social	What was the nature and degree of trust with other stakeholders during the three periods? What norms or standards of behavior did the community set itself in connection with the scheme (e.g. sanctions etc)? What were community's networks like during the three periods?
Natural	What benefits did they gain from the watershed and its protection?
Physical	Had any investments been made as a result of the scheme (e.g. infrastructure)?

6.3. The design of PES scheme

6.3.1 The environmental problems in Cidanau

The Cidanau watershed has been experiencing rapid change in land cover for almost two decades as forest is converted for agriculture due to population increase and a high dependence on farming.[25] The number of people living and farming illegally in the upstream protected area increased from around 600 in the late 1990s to an estimated 1,500 in 2007. This period has also seen the conversion of conservation forest to rice fields and other crops. In addition, the Rawa Danau reserve has experienced intensive encroachment and associated decreases in flora and fauna diversity. In 2000, about 20 percent of the Rawa Danau natural reserve area has been encroached (Darmawan, Tsuyuki, and Prasetyo 2005).

As noted earlier, this conversion of forest to farming land combined with unsustainable farming practices degrade the environmental services (ES) provided by the Cidanau watershed. The Cidanau watershed is the only water supply for Cilegon housing and industrial area and also for approximately 100 industries that operate around it. The main problems experienced by the water consumers (the ES beneficiaries) of Cidanau watershed are shortage of water in the dry season and water quality degradation due to pollution and high sedimentation (Adi 2003; Munawir and Vermeulen 2007; Budhi, Kuswanto, and Muhammad 2008).

Fluctuating water flow and water quality are the most important problems in Cidanau. During the long dry season, the flow has been as low as 5 m^3/s, especially in 1987 and 1991. The average discharge is 12.5 m/s, fluctuating from annual minimum of 1.2 m/s in dry season (August) to an annual maximum of 44 m/s in the rainy season. In addition to the fluctuating water flow problem, intensive use of fertilizer and agricultural chemicals, and the process of burning paddy husk reduce the quality of Cidanau's water. Remote sensing observation indicates that about 71 percent of the watershed is prone to degradation with the rate of erosion above 35.22 ton/hectare/year. The sedimentation narrows water channels and swallows reservoirs and contributes to the reduction of water supply and quality from the Cidanau catchment.

6.3.2 PES as one initiative to rehabilitate the Cidanau watershed

The numerous efforts that have been made to overcome the watershed problems in the Cidanau have had limited success. These include a transmigration program for the communities living in the Rawa Danau area, reforestation and land rehabilitation activities. Key issues in the failure of past efforts include lack of consultation and joint planning between key stakeholders, and lack of attention to social outcomes.

Failures of these previous efforts at watershed management in Cidanau triggered a group of people concerned about the degradation of Rawa Danau to establish the FKDC in 1998. The forum tried to increase awareness among the public and the local government to environmental problems and integrated watershed management by conducting seminars and discussions. This forum received recognition from the newly established Banten provincial government[26] and gained legal status through a Governors Decree in 2002.

[25] The land cover of the Cidanau watershed is mostly dominated by agriculture lands (71%): mixed farming (36.7%) and rice fields (34.4%) and the remaining 18.5% and 8.4% is forest and swamp forest (Adi, 2003).
[26] Banten was a district in West Java Province before 2000 and became a new province in 2000.

The concept of payment for watershed services in Cidanau was introduced by international organizations, such as *Deutsche Gesellschaft für Technische Zusammenarbeit* (German Technical Cooperation, GTZ), the World Agroforestry Centre (ICRAF) and International Institute for Environment and Development (IIED) in 2002. A member of Rekonvasi Bhumi (a local NGO) visited Costa Rica to see the implementation of a PES program funded by GTZ. The conditionality aspect, the involvement of multiple stakeholders in watershed management and the innovative nature of the Costa Rican PES scheme stimulated their interest to trial such a scheme in Cidanau. In 2004, the FKDC invited the PT Krakatau Tirta Industry (PT KTI) to join this scheme and started facilitating negotiation between private land owners in the upper watershed and the company.

6.3.3 The stakeholders, their roles and responsibilities

The PES scheme involves many stakeholders, including farmer groups, downstream companies, government officers from district, provincial and national levels, supporting NGOs and universities (Table 6.3).

Table 6.3 The stakeholders involved in the PES scheme

Role	Stakeholders
ES Providers	Four upstream farmer Groups from Cidanau (Citaman, Cibojong, Kadu Agung villages).
ES Buyers	Current single buyer: PT KTI Potential buyers: other companies in Cilegon such as PDAM (state-owned water company), Krakatau Steel, Ronn & Hass, PT Pelindo, PT Politrima, Chandra Asri, Bakrie Group.
ES Intermediaries	Forum Komunikasi Cidanau (FKDC) – a multi stakeholder forum.
Policy makers	District government and legislative officers of Serang (upstream) and Cilegon (downstream)
	Provincial government and legislative officers of Banten
	National watershed management body coordinated by the Ministry of Forestry
Main supporting NGO	Rekonvasi Bhumi, LP3ES
Main supporting university	Bogor Agricultural University
Main supporting international agencies	ICRAF, IIED, GTZ

6.3.4 The sellers of the environmental service

In total, 142 farmers were involved in the PES scheme: 43 from Citaman, 29 from Cibojong, 38 farmers in Kadu Agung, and 32 in Cikumbuen (Table 6.4). Participating villages were selected according to the mapping of critical land by the local government (e.g. steep slopes and erosion-prone soil) and participating farmers at each village were selected by considering their involvement in farmer groups and private ownership. Aside from land ownership, no other socio-economic criteria were considered as the intermediary felt there was relatively equal wealth distribution and

landownership rates among the communities, with the typical land of each household being between 0.2–0.5 hectares.

Table 6.4 Farmers involved in the PES scheme

Village	Number of farmers	Starting year
Cikumbuen	32	2007
Citaman	43	2005
Kadu Agung	38	2007
Cibojong	29	2005 (ended after 2 years)
Total	142	

6.3.5 The buyer of the environmental service

KTI – the only authorized company managing water from the Cidanau watershed – is the only buyer in the current PES scheme. The water from upstream flows through a 28 kilometre pipe to the water treatment reservoir. KTI initially used this clean water for its steel industry operations. Recently, this company has also been supplying about 80 per cent of the water needs of 120 companies at Cilegon, such as PDAM (a state-owned company that supplies drinking water, which purchases the water at a subsidized price), and Indonesia Power Company, which supplies electricity to Java and Bali. This highlights the importance of the Cidanau watershed for industrial activities. KTI clarified that the initial source of funds for the PES scheme came from the operational budget of the company, and PES funding was drawn from corporate social responsibility funds.[27] The company's staff remarked that the motivation for engagement in PES was to support conservation efforts in the Cidanau watershed, rather than securing access to clean water for the production process. The company's staff mentioned that the government was the one responsible for the maintenance of the constant flow of water.

6.3.6 The intermediary for the environmental service

FKDC's role in the PES scheme is to manage funds, to facilitate contracts with farmer groups, and to monitor and verify rehabilitation activities. Their additional role is to raise awareness of payment for environmental services amongst other potential buyers in Cilegon industrial area. FKDC added an ad hoc team within its structure in 2005 to specifically facilitate the scheme. This ad hoc team consists of representatives of government institutions at the provincial and regency levels in Cidanau watershed area and an NGO.

This team plays an intermediary role by (1) managing the payment of PES funds from the buyer to the farmers for their rehabilitation and conservation activities; (2) supporting planting activities on private farms involved in the PES project; (3) encouraging other potential buyers to join the scheme; and (4) advocating the integration of the PES scheme in the provincial and district governments' environmental management policy.

[27] In Indonesia, a state-owned company must allocate 1% of net-benefit of state-owned companies for developing environmental programs with the communities. The legal basis of this scheme is the Letter of Ministry of State-owned Company Affairs about Corporate Social Responsibility Partnership Program (KEP-236/MBU/2003).

6.3.7 Setting the price for the environmental service

The price-setting process in Cidanau was based on negotiations between the buyer (KTI), the intermediary (FKDC) and the sellers (farmer groups). The agreed price was formalised in a Memorandum of Agreement between KTI and FKDC (represented by the Governor of Banten Province). After this agreement, the chair person of FKDC Ad Hoc team and farmers groups from Citaman and Cibojong made another agreement covering a total land area in two villages of 50 hectares. In 2007, the other two villages (Kadu Agung and Cikumbuen) joined the initiative, each with 25 hectares.

The annual rate set in the contract between the KTI and the FKDC was US$ 350[28] per hectare based on input costs, calculated according to funding levels provided in government tree-planting programs (land preparation, ground cover, seedlings, transport, fertilizers and labor) on state lands. The market value was established by referring to the cost per hectare of national forest rehabilitation program (GERHAN) coordinated by the national government. KTI made three payments within five years, and were subject to six percent tax. The total payment of the KTI to the FKDC was US$ 35,000.00 for Phase 1: 2005–2007 and US$ 40,000.00 for the following Phase 2: 2007–2009. The payment for the fifth year was to be renegotiated.

The Ad Hoc Team initially offered to farmers annual payments of US$ 75 per hectare. The annual payments were agreed at US$ 120 per hectare, provided that 500 trees per hectare were planted and plantings maintained. The FKDC scaled down the payment to farmers in order to cover all the five-year payment with the available four year fund from KTI or in other words, to provide a buffer in case KTI did not meet its obligations. They took this risk-management action because they still have to negotiate the fifth year payment in 2011. From the interview with the FKDC members, they plan either to involve new farmer groups in other villages or to extend the contract with the current farmers if the KTI disburses its third payment in 2011.

6.3.8 Payment allocation

Since it had a key role in the agreement and disbursement of payments to farmer groups, FKDC took responsibility for managing many of the transaction costs for buyers (

Table 6.5). FKDC members estimated that the transaction cost was around 14 percent of the annual payment, including the costs of capacity building activities, searching and contacting new buyers, information dissemination, and monitoring and verifying performance of agreements in the field.

Farmers used about 95 per cent of their initial payment to buy seedlings, plant and maintain the trees, and were left with around 5 per cent to spend on their own priorities, including investment in local business in their first year. Interviews indicate that the operational costs for the second year were 50 percent lower, and many farmers chose to invest the balance on their business. Figure 6.1 describes the actors involved in the scheme and their flow of payments and ES.

[28] 1 US$ = Rp. 10,000

Table 6.5 Actual allocation of revenues by the FKDC in the first four years

Payment allocation	US$	Fraction of total payment
Payment for the 100 hectare contracted farmer lands ▪ 95% for buying seedlings and planting; ▪ 5% for investing on local business.	60,000	80%
Transaction cost ▪ 40% for conducting capacity building and searching more buyers (dissemination, publication, seminars, etc.) ▪ 27% for monitoring and verifying field activities; ▪ 33% for operational cost: - 16% for paying personnel cost for five persons; - 11% for organizing meetings; - 6% for administration purposes;	10,500	14%
Tax	4,500	6%
Total	**75,000***	**100%**

Note: This amount is the payment from KTI for Phase 1 and Phase 2 (4 years). KTI still has to transfer the remaining funds for the fifth year, as much as US$100,000 contingent on current performance and will be transferred in 2010. The total commitment should be US$175,000 (100 hectares x US$350 per hectare x 5 year).

The contract between the FKDC and the farmer groups in four villages involves:

1. Yearly payment of US$120 per hectare for five years, subject to satisfactory implementation of the rehabilitation works;

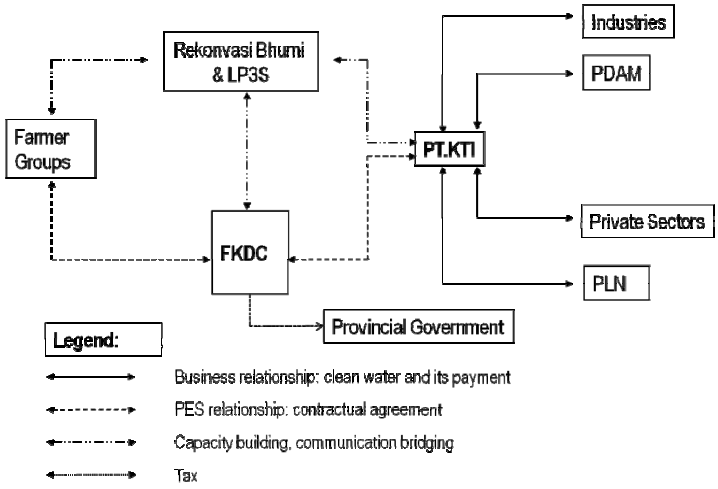
2. Implementation of rehabilitation activities, including planting and maintaining timber and fruit trees at a minimum of 500 trees per hectare and no cutting during the contract period;

3. Payment schedule distributed as follows:

    - 30 per cent on signing the contract;
    - 30 per cent after six month of implementation;
    - 40 per cent after one year of implementation.

All members of the first two farmer groups received their first payment in May 2005. Three months later, the FKDC commenced monitoring and requested records of tree planting on contracted lands. In Citaman, the Ad Hoc team found that 0.5 hectare was not being maintained as per agreement because the owner left the village for a new job. However, since the other members of the farmer group had accomplished the minimum requirement of the contract, the Ad Hoc team did not disqualify the group. The group decided to manage the 0.5 hectare land and charged the owner the operational costs of managing this land under the contract. The contract is a collective one. If a farmer breaks the rule, the Ad Hoc team will terminate the contract of all the members. The collective contract was chosen

over individual ones because they assumed that by applying the "sharing responsibility principle"[29], it can strengthen internal relationship and self-monitoring among group members.



Legend: FKDC = Forum Komunikasi DAS Cidanau (Communication Forum of Cidanau Watershed); PDAM = state-owned drinking water company; PLN = state-owned electricity company.
Source: adapted from Budhi et al. (2008)

Figure 6.1 The PES scheme relationship and flows of services

6.3.9 Implementation problems

A number of issues associated with the PES scheme were raised in focus group discussions by FKDC members.

First, the FKDC found it difficult to communicate the unique characteristics of an incentive-based mechanism to other stakeholders, such as local government and buyers, because of their relative inexperience with the operation of such mechanisms Buyers often viewed the scheme as adding another layer to their operational costs and have, in many cases, used corporate social responsibility funds to cover the ES payment (which means it is accounted for as a promotional rather than an operational cost).

Second, lengthy negotiations were unavoidable given the number of stakeholders involved and since KTI was unwilling to pay directly the farmer groups. There were at least three stages of negotiation over two years. The first stage, to establish the main design elements, was between the Rekonvasi Bhumi and the Ad Hoc team of FKDC and took a period of eight months. The second negotiation period, to draft the contract, between the KTI and the Ad Hoc team lasted about six months. The third negotiation phase, to develop contracts for payment amounts and conditionality, was between the Ad Hoc Team and farmer groups in the villages of Citaman and Cibojong.

[29] In Indonesian, the term is *tanggung renteng* literally meaning an individual failure will become collective failure.

Third, the FKDC members expected the communities to have a more active role in conserving the watershed rather than depending on the PES payment for any environmental conservation. There was confusion whether any formal regulation by provincial government could play an important role in targeting more ES buyers as well as an enabling policy environment with strong political support. They stated that such regulations were needed but did not have ideas about the contents of such regulations. Without the certainty of voluntary participation of additional buyers, FKDC was less able to encourage more sellers to engage in the scheme. Meanwhile, KTI demanded regulations obliging potential buyers to participate in the PES, having assumed that such regulations would optimize the role of additional buyers in conserving the watershed.

After 2 years of implementation, the Cibojong village did not achieve the target stipulated in the contract and the contract was terminated. A farmer cut the trees on about 0.14 ha of land, reporting that the trees had been stolen (an investigation later found out that one of his family members had cut the trees to buy a motorcycle). Procedurally, a report should have been made to the FKDC, together with a letter from the police department guaranteeing that they would not breach the contract further. However, this was not done, and the members assumed that the contract had been cancelled. Villagers continued to cut trees on the PES-contracted lands, based on their assumption that the scheme would not provide them any further payment. An interview conducted by the FKDC with the members revealed that most would have preferred to remain in the scheme. Therefore, the cancelling of the contract would likely have been avoided if the group had advised the members of the correct procedure following the initial (illegal) cutting of the trees.

6.4. The impacts of the PES scheme

6.4.1 The environment

A clear assessment of the environmental outcome of the scheme is not available yet. Although some data were presented earlier in this chapter on decreases in water quantity and quality in Cidanau, the actual link between the land use practices used to promote watershed protection and water supply are unclear. Also the scale of the current PES scheme may have been limited in its environmental impact given the size of the watershed. The monitoring system for the scheme relied on the accomplishment of contractually agreed land use practices as a proxy for environmental outcomes. FKDC members, particularly those from KTI, have visually observed that the water supply is relatively stable in 2008 but so far this has not been backed up by scientific evidence.

6.4.2 The livelihoods of the participants and non participants

Financial capital

According to focus group discussions (FGDs), the communities in Cidanau earn their income from the tree-crops – *melinjo*[30], coconut, robusta coffee, durian and clove – which represent the top six income source, and further planting of these tree crops was supported through the PES scheme. The FGDs did not indicate significant changes in income sources between the periods before 2000, 2000-2005 and after the introduction of the PES in 2005 for both participants and non-participants (Table 6.6). Tree

[30] A fruit native to Indonesia used for vegetable soup, or ground into flour and deep-fried as crackers

species were selected, on the basis of commodity prices and market demand, to enable participants to build their productive base of valuable tree crops.

Table 6.6 Household income sources (percentage)

Source of Income	After PES (2005- now)		Before PES (2000 -2005)		Before PES (before 2000)	
	P	NP	P	NP	P	NP
Melinjo	26.67	28.33	23.33	31.67	15.00	16.67
Farming labor	15.00	15.00	0.00	8.33	0.00	13.33
Coconut	11.67	8.33	10.00	8.33	15.00	10.00
Clove	10.00	6.67	18.33	6.67	11.67	10.00
Coffee	10.00	10.00	15.00	10.00	16.67	18.33
Durian	6.67	3.33	13.33	8.33	23.33	11.67
Salak	5.00	8.33	5.00	5.00	3.33	0.00
Wood	5.00	6.67	8.33	0.00	0.00	0.00
Payment for ES	3.33	0.00	0.00	0.00	0.00	0.00
Banana	1.67	1.67	3.33	3.33	3.33	11.67
Cocoa	1.67	0.00	0.00	0.00	0.00	0.00
Petai	1.67	6.67	0.00	5.00	0.00	0.00
Cotton	1.67	0.00	3.33	1.67	5.00	1.67
Jengkol	0.00	0.00	0.00	0.00	5.00	0.00
Paddy	0.00	0.00	0.00	0.00	0.00	1.67
Upland paddy	0.00	1.67	0.00	5.00	1.67	0.00
Others (clove labor, livestock labor, motorbike renting, construction labor, trader)	0.00	3.33	0.00	6.67	0.00	5.00

Note: P for participants and NP for non participants

Indications are that the PES contract in Cidanau did not have a major impact on the livelihood options pursued by communities because of their existing reliance on tree crops as a primary income source before the scheme commenced. Some participants did mention, however, that they had lost income from wood harvesting and wanted the option of continuing with tree thinning on their contracted gardens. The income from the wood harvest could be as high as US$200 annually, around 60 per cent higher than the value of the PES contract. Wood harvesting had previously contributed an estimated five to seven percent of household income for both participants and non-participants. Some forty types of commodities, including leaves, flowers, and fruits that are locally marketable.

The annual PES income of US$120 per hectare contributed only around three percent to PES participants' household income. Only one group in Citaman regarded PES as a primary source of income. The rest considered PES income to be short term and not a primary livelihood source, although during the four year operation of the scheme the total payment might have exceed their

income from selling fruits. Around half of the participants assumed that the PES contract could increase the price of their land, although most non-participants did not consider it likely that the land price would rise as a result of the PES scheme. No transaction on land allocated to the PES scheme has occurred, therefore there is no information about the impact on the value of land.

The PES scheme has stimulated local business, mostly because of additional business development support from NGOs and government agencies involved in the PES scheme. The facilitating NGO Rekonvasi Bhumi (together with the Serang Service Office of Industry, Trade and Cooperatives) has supported farmer groups with entrepreneurship and marketing training, and also gained advice on technical issues from the Environment Technology Agency (Munawir and Vermeulen 2007). Some areas of local business development have included production and marketing of vegetable oil from nilam (*Pogostemon cablin)* and *melinjo* craker production. FKDC members had observed that the PES scheme provided a locus for greater government support to the participating villages to (1) establish a nursery of fruit trees; (2) develop local business for edible mushrooms in Citaman and Kadu Agung; and (3) establish a poultry project in Cikumbuen. They felt that the reputation of these villages had been raised due to their participation in the PES scheme.

Human capital

PES participants and non-participants attended occasional training, conducted by the Agricultural Service and Forestry Service of the local government, dealing with coffee, *melinjo*, timber and fruit tree cultivation. However, the PES scheme had a particular impact on the capacity, skills and knowledge of participants (Table 6.7) because of their regular interaction with NGO staff and researchers.

PES participants were more aware of environmental issues such as the causes of erosion, landslides and downstream sedimentation, as well as management measures such as erosion prevention, prevention of illegal cutting of trees, waste management, and the role of trees in water and soil conservation. However, only about 30 percent of the participants and 17 percent of the non-participants knew about the concept of PES and how the value of the contract could be calculated. PES participants also reported improved capacity and skills in managing the farmers' organization, including networking to improve local business and to improve implementation of the PES scheme. This capacity building occurred through interaction with the FKDC members.

As noted earlier, some participants observed that they had more available time and less activity on their lands due to restrictions on activities under the PES scheme. Because of this, PES participants and non-participants focus groups identified a need for training in alternative livelihoods, such as (1) raising livestock and poultry; (2) cultivating fruit and timber trees; (3) making fruit crackers, from *melinjo*, banana, and cassava; (4) pest management; (5) establishing fresh water fish pond; (6) apiary business; (6) cultivating mushrooms. Women identified an interest in training in literacy, sewing and cooking. The FKDC members added that the communities also might need further training to strengthen their local institutions.

Interviews with the FKDC members indicated that their knowledge about PES issues increased, such as the principles of PES, how to design community-based forest management, how to strengthen local institutions, global issues such as global warming, the Clean Development Mechanism, and Reducing Emission for Degradation and Deforestation.

Table 6.7 Type of knowledge/ capacity/skills gained by participants and non-participants after the PES implementation

Type of knowledge/capacity/skills	Participant (%)	Non-participant (%)
Conservation		
Causes of erosion, landslides and downstream sedimentation	100	17
How to maintain clean water and to reduce air pollution	83	-
Roles of trees in conservation	67	-
Simple construction to prevent erosion	50	-
Understanding of PES concept	33	17
Institution and Governance		
Ability to govern an organization	67	17
Ability to solve problems within farmer groups	67	-
Administration of farmer groups	50	17
Networking to improve local business and PES implementation	50	-
Transparent financial management	33	-
How to develop local business		
Livestock	33	17
Agriculture	17	-
Fishery	-	-

Social capital

Aspects of social capital discussed in communities include behavioural norms within the community, reciprocity between community members, trust, and the existence of internal and external networks, before and after the implementation of the PES scheme.

The focus groups with PES participants in Citaman revealed that they had written rules to guide members of their farmers' group towards meeting their collective obligations under the PES contract: if one member defaulted on the agreement, this would become the responsibility of the whole group. Sanctions would be imposed on such a member in the form of expulsion from the group. In other villages, there were no written rules but people knew the rule that trees should not be cut in the contracted areas. The sanction for cutting trees involved a police report, as well as informal social sanctions at the community level. The informal sanctions included exclusion from social gathering. The participants also commented about rent seeking by local government staff in relation to PES payments, i.e. requesting part of the payment for contributing to village income.

All the participants that joined the focus groups knew about the written contract between their group and the FKDC, and that observing restrictions on cutting trees was necessary to receive payments,

while cutting trees would lead to contract termination. Some participants observed that the local NGO, Rekonvasi Bhumi, used informal warnings as the first step if contract infringements occurred[31].

The PES contract brought opportunities for participating communities to interact more with other external stakeholders, which expanded the external networks of these communities to include: (1) researchers conducting studies on PES in Cidanau; (2) local NGOs who facilitated the PES contract; (3) the KTI as the buyers; (4) the FKDC as the intermediary; (5) other government agencies besides the Agriculture and Forestry Services, such as Natural Resource Service.. In contrast, non-participants only mentioned increased interaction with the local NGO and government agencies amongst their new contacts after PES.

The focus groups discussed issues of trust within the community and between community members and external stakeholders (Table 6.8). Trust was seen as the ability to receive and give assistance from people beyond the immediate household and relatives in case of shortness of money or food. Focus groups reported that trust amongst community members (both participants and non participants) in Cidanau was relatively high, while the level of trust between community members and external stakeholders was lower. This is consistent with the observation that the four villages involved in the program have a high degree f internal homogeneity. Most of them are Moslem and their wealth strata are almost equal, which may contribute to ease of interaction and trust.[32] In Cidanau, communities usually participate in regular collective action events to produce public goods and services, such as maintaining roads, bridges, community buildings and water supply systems. These activities are an important aspect of rural social capital in Indonesia (Grootaert 1999). This also appears to be the case in Cidanau.

Some key persons, mostly group chair-persons and village elders, lead in negations with external stakeholders and gain access to more information than other participants. There were some signs of jealousy amongst non-participants regarding their exclusion from the PES scheme as a result of limited budget from the buyer. The interaction between participants and non-participants in the same village decreased as the interaction between participants and other external stakeholders increased. This condition somehow created an exclusive group of PES participants who did not socially blend with other villagers. The FKDC members also mentioned this tendency.

There was a general agreement that trust between communities and government was lower after 2000 and has become worse since the start of the PES project. The communities do not consider the government a partner from whom they can ask for assistance. The communities felt a reduced level of confidence in the government's capacity and commitment to provide public services (Table 6.8). Since 1998, Indonesia has been in a period of transition known as *Reformasi* (Reform in Indonesia). Although this period has been characterized by greater freedom of speech, many rural communities considered that they had more secure livelihoods during the earlier Suharto-dominated period, which involved unprecedented national growth and greater integration of rural areas into national development. The *Reformasi* era provided greater autonomy to village level governments. However, there have been fewer nationwide programmes, as local conditions vary greatly and severe financial constraints during 1997-1998 led to reduced government spending on rural development (Antlov 2003). The communities in Cidanau noted that the government had paid less attention to rural development after the beginning of the *Reformasi* era and felt a diminished sense of trust in the government. Rekonvasi Bhumi, the only NGO that is active in advocating the PES concept, was

[31] Farmers from Cibojong village, where the contract had been cancelled, were not participants in these focus groups
[32] Rahadian, the Director of Rekonvasi Bhumi, *pers. comm.* (2008).

established soon after the beginning of the *Reformasi* era, when greater space was created for civil society. In Cidanau, interaction between community members and this local NGO nurtured a level of trust; the same was true with FKDC, the ES buyer.

Table 6.8 Trust among internal and external stakeholders

Relationship	How trust is expressed
Amongst participants	Borrowing money and rice; Sharing information; Mortgaging (loans); Collective labor sharing
Participants and government	Making identification and family card; Paying tax; Receiving administrative information; Getting cash assistance[33]; Maintaining security
Participants and non-participants	Collective labor sharing; Sharing information; Borrowing money, rice, daily needs and construction materials
Participants and FKDC	Delivering the payments for accomplishing the contracts; Sharing information; Maintaining transparency in managing the funds of organizations.
Participants and PERHUTANI	Giving seedlings; Giving information; Giving access to manage forest and plant ally-cropping on the area of PERHUTANI.
Participants and NGO	Implementing programs; Sharing information, especially on environmental services; Conducting meetings.

Government officials shared the view that the existence of the PES scheme had increased their communication with stakeholders such as the FKDC members and the KTI, as well as a need for greater inter agency communication. They expected that PES could assist the government in conducting their conservation program and in improving the communities' livelihood.

Natural capital

Since the PES scheme only targeted individual farmers, and restrictions on land use only applied to private lands, there was no change in access to common resources. Before the scheme and after its beginning, communities in Cidanau utilized non timber products from the forest, such as water, wild

[33] The Indonesia government has a program called *Bantuan Langsung Tunai* or direct cash assistance as one of its program for buffering the poor from the financial crisis.

boar, fish, fire wood, medicinal plants, herbs, fruits, and leaves. Around half of the participants did comment, however, that the PES contract had reduced their access to timber for construction because they could not harvest the timber from the contracted land. Currently, they have to buy some wood to fulfil their own needs. The FKDC reported that at the end of the contract the farmers would be allowed to cut 40 percent of their current plantings to fulfil their needs for wood and increase their income if they are willing to continue the PES contract.

Both participants and non-participants knew the benefits of maintaining natural resources. They could explain environmental services provided by the healthy ecosystem and claimed that they had this knowledge for a long time. According to informants, the services provided by intact watershed and Rawa Danau conservation area included providing timber for construction and non timber forest products, storing water, avoiding flood, landslide and erosion, contribution to a comfortable micro climate, fertilizing soils, ecotourism, particularly for the Rawa Danau. In addition, the local government and the buyer added that the Cidanau watershed had high and strategic economic value because it supported the existence of important industries and households in the towns of Cilegon and Serang.

The communities have been involved in various rehabilitation activities (both government initiated and locally organized) before and after the PES scheme. Government programs included planting trees, such as mahogany, clove, *albizia* and *calliandra*, joining forest fire prevention activities and forest patrols for the prevention of illegal logging, and terracing steep lands. The Cidanau communities were also involved in the National Movement of Land Rehabilitation. Self-supporting activities included cleaning the river annually in Kadu Agung and planting bamboo and productive trees, such as *melinjo*, durian and stink bean. However, these actions are mostly patchy, not integrated, and short-term with uncertain success.[34] In addition, the PES project did not set up systematic monitoring for environmental services in Cidanau. The KTI claimed that the sedimentation and water quality in Cidanau improved in the last two years. However, whether this conclusion is correct, and whether the change in ES would have any connection with the PES scheme has not been scientifically demonstrated.

Physical capital

In Citaman, the group invested five percent of their PES payments to build a 100 meter pipeline for clean water to serve about 50 households. This water pipeline also served non-participants, but they were required to pay a service fee of US$ 0.30 per month or one kilogram of rice. In Kadu Agung, they planned to build a village mosque from all funds collected through the PES contract. Other villages did not report plans to invest their money in education and health improvements. Their investments on physical capital were a collective decision driven by their specific needs. Villages without any investment plans might simply not have collective needs.

Participants in focus groups complained about the poor condition of the roads, which doubled their transportation costs. This has been the case for many years and a change of government did not bring any changes to their village assets. However, the discussions with the FKDC highlighted that the community had received assistance to develop a nursery and building for community meetings in

[34] Reports on the failure of the National Movement of Land Rehabilitation are numerous (http://www.fkkm.org/Warta/index2.php?terbitan=noe&action=detail5&page=17 accessed 13 November 2009). One of the reasons for this failure is that the program is top-down with very little participation from the community. The government dominates the supply of the plant materials and determines the species that should be planted. The community acts as labors for the planting activities and mostly they are not interesting in maintaining their plantation because in some cases, they do not have access to the harvest.

Ciomas village. The budget for these activities came from the provincial government in 2005 because they noticed the existence of PES activities in the village.

The FKDC has no further plans to develop public facilities in the villages covered by the PES scheme. Nevertheless, the FKDC agreed that developing public infrastructure in the sellers' villages could multiply the positive impacts of the PES scheme. For example, better roads to the villages would increase accessibility and bring ease in communication, coordination and monitoring as well as contributing to wider economic and social development.

6.5. Conclusion

6.5.1 Livelihood impacts

The Cidanau PES scheme has impacted the livelihood of PES participants and non-participants. Benefits were mostly non-financial: expanded social networks with external stakeholders; knowledge and capacity of the community; and small-scale public infrastructure investments. Direct financial benefits were limited. So far, four villages out of five have proved successful in meeting the contract terms; however, there is a need to investigate further whether the non-financial benefits and limited financial benefits are sufficient to cover their 'total opportunity cost'. We presume these benefits combined with recognition from the governments and external stakeholders can increase farmers' commitment to the scheme. It is important to adjust the value of the new contract so the farmers can cover their true opportunity cost if the funds from the buyer allow that. This finding is in line with the conclusions in other PES sites in Asia (Leimona, Joshi, and Van Noordwijk 2009).

Although the PES scheme did not drastically change the livelihoods of participants, linkages with external stakeholders were creating options for participants to diversify or capture greater value from their income sources. The external stakeholders are largely partners in the PES scheme, such as the FKDC and a local NGO. Exposure to these partners also increased the participants' knowledge of conservation, skills to manage the farmers' organization, and helped to build networks to improve their businesses and implementation of the PES scheme.

Participants and non-participants reported that they were aware of the benefits of conservation before the PES scheme was implemented. Their understanding of the PES concept was still limited. The capacity building for PES concept at the local level has been important. However, future capacity building should also be focused on tangible aspects of the PES scheme and problems that put barriers at the local level in implementing PES such as lack of information of good planting materials and know-how on tree management.

The PES scheme has created new standards and mechanisms for managing behaviour around natural resources. It supports the establishment of new written and unwritten rules as well as sanctions related to natural resource management and land-use practices. The PES contract sets out formal rules and sanctions binding the sellers and the intermediary supplementing their existing informal rules and sanctions. These informal rules and sanctions were useful to support collective action and induce the accomplishment rate of the PES contract.

There were signs of jealousy among non-participants in Cidanau towards the participants due to their exclusion from the PES scheme. Such jealousy has not so far destroyed social relationships in communities because the amount of payments is limited and it has not created inequality. The

investment of PES income in community infrastructure, such as water supply, mosques, and meeting halls might reduce social conflict as they extend to the indirect beneficiaries of the scheme, although not the same degree in some cases. Improved government investment in PES villages, as planned but yet to be implemented, could also help to reduce and the risk of potential conflict between participants and non-participants.

Access to common pool resources, such as state forests, did not change with the implementation of the PES scheme because only non timber products were taken from the forest.[35] However, the restrictions posed by the PES scheme on landowners' access to timber on their own lands could lead to illegal logging on common lands, that is, it could result in so called leakage. Monitoring of the nearby environment should be therefore carried by the PES scheme.

6.5.2 Environmental impact

There is insufficient scientific evidence to judge the impacts of the Cidanau scheme on environmental services. Although the selection of contracted villages was based on criteria that would maximize environmental outcomes, i.e. steep slopes and erosion-prone soil, and stakeholders in the scheme believed that planting trees would solve the watershed problems in Cidanau, the cause and effect link between changing land use practices and increasing ES are unclear and indirect. For the next step, identifying and monitoring specific indicators of watershed services in Cidanau is crucial. For instance, a rapid hydrological assessment in Singkarak, West Sumatra, Indonesia (Jeanes et al. 2006; Farida et al. 2005) concluded that the raise of the water level of the lake, sought by the ES buyer to increase their hydroelectric performance, is mostly influenced by changes in mean annual rainfall and only mildly by land cover. Without understanding of watershed functions, and related indicators, PES schemes such as this may not achieve the desired environmental impact, leading to disappointment amongst sellers and buyers.

6.5.3 Design of the PES scheme

The amount of the payment per hectare set out in the PES scheme in Cidanau was based on input costs for tree planting. Information on opportunity costs is not available for Cidanau yet. Farmers might have accepted the contract without further consideration of real costs and benefits in involving in the scheme. The agreed value of the contract might not fully represent the real opportunity cost of the farmers because of the dominant position of the intermediary. The transaction cost in Cidanau was about 14% of the total payment.

In terms of lessons for REDD, the Cidanau case raises important issues regarding the need to factor in opportunity costs and co-benefit beyond financial payment when negotiating payments to ensure their long term sustainability. It also highlights the need for awareness of the social dynamic between participants and non-participants and design benefit packages to minimize community level conflict. The Cidanau case suggests that the role of the intermediary is very important and possibly dominant. An honest and trusted intermediary is one of the keys to success.

[35] Further investigation on this should be done because some literature mentioned that deforestation had been a big problem in Cidanau (Kiely 2005)

7. Discussion and Conclusions

7.1. Introduction

Asia's landscape, where most of its inhabitants depend on agriculture and natural resources for their livelihood, has an immense diversity of land-cover mosaics. This region offers many opportunities to explore interactions between environmental services (ES) and land use practices by its farmers. These farmers mostly act as land managers who have a meagre living in the upper watershed and at the forest boundary. These areas provide many valuable ES and at the same time are mostly under severe threat of degradation (MA 2005). Market imperfection and policy distortion that neglect the social and economic importance of ecosystems are claimed as root causes for environmental problems in Asia (Tomich et al. 2004; TEEB 2010)

Supported by global agreements, the solution of environmental problems in developing countries, specifically in Asia have to emphasize dual goals of poverty alleviation and environmental conservation (Tinbergen 1976; UN 1992). Payment for Environmental Services (PES) is one of the tools currently being tested and practiced globally to help achieve these goals (Muradian et al. 2010; Pascual et al. 2010; Van Noordwijk and Leimona 2010). The PES-concept was initially strictly defined as a market-based environmental policy instrument to achieve environmental protection in the most efficient way (Pagiola, Arcenas, and Platais 2005; Engel, Pagiola, and Wunder 2008). This is based on the principle "you get what you pay" for positive effects on the flow of environmental services (Wunder 2007). However, recent literature discussed that the Coasean and pure market approach dominating the conceptualization of PES cannot be easily generalized and implemented in practice (Muradian et al. 2010).

This thesis presents an analysis of practical applications of PES in Asian developing countries. It shows that in order for PES to achieve its dual goals, the emphasis to inclusion of both efficiency and fairness elements to all actors involved is essential. This chapter briefly describes the obstacles to, and conditions for, establishing PES in developing country contexts. This PhD research investigated the need for broader categorisation of PES conditionality and perspectives to meet imperfect conditions for applying strict ES market-based policies in developing countries. Observed imperfect conditions are among others: insecure property rights, high incidence of poverty, poor environmental governance, and high potential conflict in natural resource management. This thesis suggests some solutions how to design a pro-poor PES based on an analysis of circumstances where PES can contribute to income increment, observed preferred rewards and PES outcomes to ES providers. The findings also include the application of multiple ecological-knowledge to improve PES efficiency and fairness. Further, this thesis provides lessons in designing and administering a procurement auction for rural farmers in Indonesia. Table 7.1 summarizes the main finding of this thesis.

Table 7.1 Main findings of the thesis

	Hypothesis	Main findings
1	Preconditions for application of the PES concept with strict conditionality are not met in many developing countries' contexts and a wider PES interpretation is needed. (Chapter 2)	In practice, strict conditionality cannot be met among ES providers, intermediaries and beneficiaries involved in PES contracts. The analysis of the research sites in Asia suggests that broader perspectives of PES (i.e. commoditized ES, compensation for opportunities forgone and co-investment in environmental stewardship) may well become the foundation to balance efficiency and fairness of PES schemes.
2	Only under specific circumstances, will cash incentives from PES contribute substantially to increase disposable income and alleviate poverty of ES providers. (Chapter 3)	Pro-poor PES can only have a significant effect on rural income if it (1) involves upstream providers who have low population density and/or a small area relative to the beneficiaries; (2) involves downstream beneficiaries who have relatively higher income than the upstream providers; (3) provides highly critical and non-substitutable ES; (4) is efficient and has low opportunity and transaction cost, but high willingness and ability to pay of downstream beneficiaries.
3	Indirect non-financial benefits at the community scale contributes to reducing poverty through a common-goods PES design (Pascual et al. 2010). (Chapter 3)	Non-financial incentives are very often the most preferred and possible types of rewards.
4	Reducing discrepancies and improving synergies of ecological knowledge of all actors in PES balance efficiency and fairness of a PES scheme. (Chapter 4)	Integration of stakeholders' knowledge and perceptions in designing PES, specifically rewards for watershed services (RWS), can increase PES efficiency by clarifying expectations from all relevant actors, avoiding unrealistic targets for quality of watershed services, helping define conditionality of RWS and offering appropriate monitoring procedures, and PES fairness by reducing conflicts and accepting multiple perspectives. Experience with strategic use of information and vested interests of intermediaries and donors imply that credibility, salience and legitimacy of knowledge for any RWS need to be secured before it can be used in actual negotiations.
5	A PES procurement contract auction increases efficiency of PES contract allocation. Specific elements of procurement auction have to be designed and administered for fairness of farmers with low formal education, prone to social conflicts and influenced by power structures within their community (Chapter 5)	A PES procurement auction is applicable in rural communities to allocate contracts among land owners with high willingness to accept. Nevertheless, opportunity costs and co-benefits of farmers in joining PES cannot be fully captured. A sealed bid auction with budget constraints, random tie-rule, and uniform pricing rule with minimised collusion is relatively understandable by participants, considered fair and does not raise conflicts among community members, i.e. participants and non participants, contracted and non-contracted.

	Hypothesis	Main findings
6	PES schemes give local communities access to various types of capitals (Chapter 6)	PES schemes do not drastically change the livelihoods of participants. Contributions to improved welfare of participants so far are towards social and human capital with limited effects on financial, natural and physical capitals.

7.2. Discussion of main findings

The structure of this sub-chapter is based on the main findings presented in Table 7.1. Section 7.2.1 summarises and discusses PES practices in Asia and their efficiency and fairness aspects in general (Table 7.1 number 1). Section 7.2.2 combines the discussion of the results from Chapter 3 on monetary payments and its implications for the ES providers, and locally determined reward-preferences (Table 7.1 number 2 and 3). Section 7.2.3 discusses the lessons in synergizing multiple ecological knowledge among relevant PES actors (Table 7.1 number 4). Section 7.2.4 examines the application of a PES procurement auction in rural settings (Table 7.1 number 5). Finally, section 7.2.5 discusses an evaluation of an established PES scheme using a sustainable livelihood framework (Table 7.1 number 6).

Broader categorization of conditionality of PES emphasizes interdependency between fairness and efficiency as opposed to a strict and prescriptive PES definition

The current PES definition reflects the Coasean conceptualization of PES i.e. efficiency gains may be achieved independent of the allocation of property rights (Neef and Thomas 2009; Bulte et al. 2008; Zilberman, Lipper, and McCarthy 2008; Muradian et al. 2010). The concept also disregards equity issue since the aggregate gains and losses by different economic agents is more important than how they are distributed in society (Pascual et al. 2010). The ideal PES schemes based on environmental and cost efficiency principle should "integrate environmental services[36] into markets, and should be like any other market transaction" (Farley and Costanza 2010). Further, the inclusion of poverty alleviation goal might reduce economic efficiency of the scheme (Pagiola, Arcenas, and Platais 2005; Wunder, Engel, and Pagiola 2008). Practices in developing countries mostly rule out PES if this definition is strictly applied as a market-based or commoditized ES (Chapter 2).

Our case studies proved that precondition for the Coasean conceptualization of PES could not be met. The reasons, among others, were lack of data and capability to measure, map, model, value and monitor ecosystem services at multiple scales; unclear property rights; lack of sustainable funding; and close links between poverty and environmental degradation (Chapter 2, 3 and 4). In addition to that, the Asian cases mostly placed ES providers as more marginalized community group with low formal education background and lack of access to information and justice. Our result aligned with the Heredia Declaration of Payments for Ecosystem Services introduced by an article by Farley and Costanza (2010). The article concluded that payment do not require commodification, however shared responsibility is needed to provide and protect ecosystem services.

Analysis of global PES schemes as part of our study, including our case studies showed that strict conditionality of PES mostly did not exist (Chapter 2). Therefore, we recognized that in practice,

[36] In their article, Farley and Costanza (2010) used the term "ecosystem services" rather than "environmental services".

conditionality of PES contract is stratified ranging from ES contracts link tangible benefits for the ES providers by the actual enhanced delivery of ES (level I), maintenance of agro-ecosystems in a desirable state (level II), performance agreed actions to enhance ES (level III), development and implementation of management plans to enhance ES with respect for local sovereignty in conserving the environment for both local and external benefits (level IV). This stratification contributes to bringing the theory of PES conditionality closer to practice.

Based on these levels of conditionality and recognition of PES practices in Asia, we offer three distinct perspectives of PES. Those are commoditization of ES, compensation for opportunities skipped/forgone and co-investment in environmental stewardship (Chapter 2). *Commoditization of ES* operates at conditionality level I with no explicit poverty targets. *Compensation for opportunities skipped/forgone* is when land users are paid for accepting restrictions on their use of land and has conditionality at level II or III. *Co-investment in environmental stewardship* is where PES contracts between ES providers and buyers are flexible with broad sanction and monitoring requirement. Mutual trust is strong.

Our case studies also observed that there are opportunities for phased strategies. After creating, for example, a basis of respect and relationship through the *co-investment* paradigm, there may be more space for specific follow-ups in the *commoditization* paradigm for actual delivery of ES to meet conservation and ES additionality objectives, i.e. a PES scheme is additional whereas the scheme increases environmental services compared to baselines without a PES scheme.

In order to be pro-poor, a PES has to adapt to the local conditions, including in designing types, forms and expected level of rewards

The case studies of PES in Asia experienced shifting perspectives: from legitimating cost-efficient and effective natural resource management to concerns about fairness in design and benefit distribution of the scheme. Monetization and commoditization of ES through PES can create technical problems in addressing both efficiency and fairness outcomes; it also raises ethical arguments by obscuring cultural, political and social relationship in environmental service generation (Kosoy and Corbera 2010).

We analyzed the contribution of actual cash for individual ES providers from beneficiaries to poverty alleviation and proved that such design has to attentively consider some key ratios of relative numbers of service providers and beneficiaries, and their income per capita measures (Chapter 3). The analysis of income and spatial data on Indonesian agro-ecosystems indicated that a modest increased target of 5% of annual disposable income of upstream rural household may be difficult to be achieved given the population and income structure of downstream and upstream areas in Asia.

Identifying rewards that match with people's needs and expectations, is one particularly important aspect of pro-poor RES approaches. The findings from focus group discussions at the different sites suggest that there is a substantial variation among communities concerning poverty concepts and reward preferences (Chapter 3). This provides important insights into the various dimensions that well-targeted reward schemes need to address. Our analysis concluded that rewards in the forms of human capital, social capital and physical capital – or what are often referred to as non-financial incentives – are very often the most preferred and possible types of rewards. Public social investments, such as education and health services (i.e. human capital), good road conditions (i.e. physical capital), security of land tenure, recognition as environmental champion and trust from government to maintain intact environment (i.e. social capital). In industrialized country, these public

investment are part of government's responsibility, however they are lacking in our case studies. These aspects combined with high social cohesion that defies the concept of free-rider (i.e. we don't mind our neighbour enjoying our rewards from maintaining good ES and we prefer everybody is happy) support the preference of non-financial reward.

Initial investment in achieving a shared understanding of multiple ecological knowledge in providing and managing ES increases efficiency and fairness of PES scheme

One of the main problems of a PES scheme is that there are widely held assumptions between changes in land cover and environmental service (ES) provision. The proposed solutions of environmental problems, including decrease of ES provisions, are mostly based on the relative merits of reforestation emphasising that ES is provided only by natural forest but not by other land uses. Furthermore, standardized solution to natural resource management refers to narrowly defined land-rehabilitation projects by, for example, planting trees and not considering other landscape management techniques, such as constructing simple sedimentation retainer along riparian zone.

In natural resource management, different stakeholders may in fact have opposite interests in utilizing a landscape. From the policy perspective, agroforestry-mosaic landscapes as found in many Asian countries, can offer great opportunity for combining economic and environment targets. In these landscapes, farmers combine elements of the natural forest that provide environmental services with trees for productive purposes and intensive food cropping systems (Van Noordwijk, Tomich, and Verbist 2002). Yet, potential ES buyers and policy makers in general sometimes fail recognizing these agroforestry systems. As the agricultural landscapes, for example, may not meet the legal definitions of "forest" or be in conflict with the existing land-use regulation system and policies – even though the land practices can provide ES at similar level to forest ecosystems can.

The appreciation of the various quantitative environmental service indicators probably differs by stakeholder group. To ensure an established PES, we need to understand these ES indicators from the perspective of both upstream and downstream local communities, general public and policy makers, and ecological modeller or hydrologist – who involve in a PES scheme (Jeanes et al. 2006; Farida et al. 2005). The multiple ecological knowledge approach applied in this study (c.f. Chapter 4) is to clarify expectations from all relevant actors, avoid unrealistic targets for quality of watershed services, help define conditionality of RWS and offer appropriate monitoring procedures. However, our case studies also showed that the availability of information is only a prerequisite for increasing the quality and sustainability of PES schemes. Interviews with practitioners in this study found that the factors influencing the design and implementation of PES programs are varied and beyond the availability of multi-perception knowledge and scientific data. The issue of strategic use of information, a discrepancy between scale in the provision of environmental services and its investment, and the vested interests of intermediaries and donors deter the optimal use of such multiple knowledge analysis in designing and implementing rewards for watershed schemes.

A competitive market-based procurement auction enhances efficiency of contract allocation but it needs refining for capturing real opportunity costs and co-benefits of participating farmers.

Most farmers in upland Asia are smallholders and tend to be among the poorest and most marginalized groups. There has been an intensive debate on whether or not small-scale farmers take a

long-term view in their decision-making (Schultz 1980). Economists have argued that resource-poor farmers are forced to focus on short-term survival, and thus valuing future benefits of long-term investment in soil, water, and tree conservation much lower than immediate increases in productivity.

We administered a natural field experimental auction using a sealed bid auction with budget constraints, random tie-rule, and uniform pricing rule with minimised collusion. Our post-auction interviews suggested that farmers had good understanding of auction design. Another quantitative analysis of auction behaviour also concluded that farmers had gone through a learning process in submitting their bids (Jack 2009). In addition to that, our data showed that most of the participating and non-participating farmers had a good knowledge in soil and water conservation and that they showed willingness to implement the watershed conservation.

Our procurement auction experiment showed ambiguous results on whether a competitive market-based experience could increase cost-efficiency gains (c.f. Chapter 5). The auction experiment suggested that the cost estimates based on labour investments are higher than the auction price and the mean auction bid. Based on estimated labour costs, the areas of contracts that could have been enrolled under the available budget were smaller compared to the areas actually purchased under the auction. However, these auction bids did not reflect the real value of both opportunity costs and co-benefit gained by farmers by joining a conservation contract since the contract compliance rate was moderate. There were various reasons for this, ranging from a lack of leadership and coordination between members of the farmer's groups, to the difficulty of finding grass seedlings, to a conservation activity's clash with coffee harvesting time. Thus, we presumed that there were other motivations beyond the financial cost-benefit that existed among the participating farmers when they submitted relatively lower auction bids compared to their labour investment.

A sustainable livelihood framework enables broader analysis of local perspectives by encompassing various types of capitals

Poverty as simply inadequacy of income is still fairly common in the literature on human deprivation. However, this view has to capture the understanding that income influences people's live style and at the end contributes to impoverishment of live (Sen 2000). The perspectives on poverty inescapably surpass the notion of welfare utility and encompass a broader range of capabilities (Kahneman, Wakker, and Sarin 1997; Wegner and Pascual 2011; Sen 1999), including the capabilities of pursuing individual happiness (Frey and Stutzer 2002). Therefore, increasing evidence and theory of plural dimensions of human well being (Wegner and Pascual 2011) support the perspective of multidimensional of poverty in analysing local perspectives on PES outcomes.

Our study on local perspectives on PES outcomes showed that benefits were mostly non-financial, including expanded social networks with external stakeholders, knowledge and capacity of the community and small-scale public infrastructure investments. Direct financial benefits were limited. We presume the non-financial benefits combined with recognition from the governments and external stakeholders can well increase farmers' commitment to the scheme. When financial payment is given, it is important to adjust the value of new contracts so the farmers can cover their true opportunity cost if the funds from the buyer allow that. However, findings in other PES sites in Asia revealed that most of the scheme cannot cover farmers' true opportunity cost because of limited funds of buyers (c.f. Leimona et al. 2009).

Although the PES scheme did not drastically change the livelihoods of participants, linkages with external stakeholders were creating opportunities for participants to diversify or capture greater value

from their income sources. Our case study showed that exposure to these partners also increased the participants' knowledge of conservation, their skills to manage the farmers' organization, and helped to build networks to improve their businesses and implementation of the PES scheme. It also highlights the need for awareness of the social dynamics between participants and non-participants and design benefit packages to minimize community level conflict. Literature on PES mentions that conditional monetary PES forming extrinsic motivation might crowd out intrinsic motivation of people to do something right for societies (Farley and Costanza 2010). Experiences from the behavioural economics and psychology fields show that even only reminders to money made people performed independent but socially insensitive. Further, experiments showed that people might commit more efforts in exchange for no payment, such as in social market where reciprocity is expected, rather than they expend when they receive low payment, such as underpayment in a monetary market (Ariely 2009; Heyman and Ariely 2004).

7.3. Conclusions

This thesis aimed to contribute to the knowledge base on how to balance efficiency and fairness of PES schemes in Asia through analyses of several case studies. Its main conclusions are summarised below.

First, the empirical observations on emerging PES-mechanisms in the Asian case studies indicate that the performance of PES to achieve and balance efficiency and fairness is strongly influenced by complex behaviour and decision making at the individual level. These behaviours at individual levels are not only limited to ES providers as the main actors of PES but also beneficiaries, intermediaries, and supporters of PES (e.g. governments and international agents). Motivations of stakeholders, their perceptions, power relations and political interest towards PES can further shape the design and implementation of PES. A language of co-investment in environmental stewardship may be more conducive to the type of respect, mutual accountability and commitment to sustainable development.

Second, non-financial payment has to be considered as an important incentive for ES providers. Such payments have weaknesses, such as giving indirect benefits to ES providers, which reduces the effectiveness of the payment and can trigger free-riders and patronizing effects. Nevertheless, in-kind reward is often the most feasible transfer because the budget for PES from ES beneficiaries is typically small and cannot cover the full opportunity costs of the providers. Moreover, in-kind reward avoids neglecting non-participants and aligns with social cohesiveness characterizing rural communities in most developing countries.

Third, the application of multiple ecological knowledge systems, i.e. local, public and scientific ecological knowledge can support the establishment of efficient and fair PES schemes. Clarifying problems in the provision of ES and recommending solutions at each spatial scale leads to more realistic expectations of all stakeholders in implementing PES schemes. The roles of each actor are then well-recognized and solutions based on local contexts rather than standardized ones lead to mutual responsibility among PES actors.

Fourth, the ES providers' decision making process in joining and implementing a PES contract is influenced by social and institutional factors beyond monetary values. However, rural communities are open to a market-based approach, harnessing competitiveness among its participants as long as the design of the market-based instrument is transparent and does not make them worse-off.

Fifth, evaluating an established PES using the sustainable livelihood framework can provide more complete insights how PES makes actors involved better or worse-off. It also can more fairly evaluate project implementers since a broader view of impacts are captured. Our case in Indonesia suggests that the role of the intermediary is very important and possibly dominant. An honest and trusted intermediary is thus one of the key factors to success of a PES scheme. It also highlights the need for awareness of the social dynamics between participants and non-participants and design benefit packages to minimize community level conflict.

Finally, interdependency of fairness and efficiency is the main consideration in designing and implementing a PES scheme in developing countries. Neither fairness nor efficiency alone should be the primary aim but an intermediate PES that is fairly efficient and efficiently fair may bridge the gap to the practical implementations of PES on the ground.

7.4. Synthesis and recommendations: integrating PES mechanisms into a wider concept of sustainable development

As a relatively new concept, PES is facing challenges in its process of being adopted as an innovation. The initial theory of PES emphasized effectiveness of the scheme by maximizing ES provision in relation to the monetary value invested. In practice, PES often needs considering fairness aspects and respect for traditional practices of local communities. The difference between theory and implementation of PES schemes places this approach in balancing fairness and efficiency in PES designs and implementations in a critical light.

Recognition of the range of PES approaches to provide incentives for enhancement of ES is needed rather than using "PES-like" terminology for partial matches with a theoretical framework. Such terminology may not reflect an optimal solution. A positive terminology for portraying PES in practices may avoid frustrations from practitioners, who might otherwise sense to be blamed for not meeting theoretical expectations (Muradian et al. 2010; Van Noordwijk and Leimona 2010).

A broader view of efficiency can be achieved if all potential win-win exchanges across actors and capital types have been identified, negotiated and implemented. An ideal PES scheme, in the perception of the external stakeholders, can efficiently produce the desired effects or result in ES increments with a minimum expenditure of time, effort, skill or money across the negotiation and implementation phases. An ideal PES scheme from a local perspective provides substantial net benefits after all transaction and opportunity costs have been accounted for. While the minimum condition for local stakeholders is that the scheme at least does not make them worse-off socially and economically, and the minimum condition for external stakeholders is to break-even with alternative options to secure the ES they depend on. These different perceptions and expectations on distribution of costs and benefits among relevant stakeholders should be reflected at each stage of PES development. A pro-poor PES scheme is feasible under some conditions but not under other, depending on the degree of space-time association (rather than causal relationship) of poverty and environmental degradation.

This PhD study was limited to research sites that were selected from a larger set of candidates of PES implementation sites in Indonesia, the Philippines and Vietnam with the main results coming from the Indonesian case studies. Thus, these sites may not necessarily represent the broader conditions of all PES schemes in Asia. Nevertheless, methodologically, this PhD study contributes to the introduction of a nested approach and assessment of people's perspective in identifying ES, PES supply costs,

various types of ES rewards and livelihood outcomes of such schemes, and levelling expectations of all actors involved to avoid over expectations and perverse incentives. The study supports the argument to incorporate a more holistic livelihoods perspective in PES schemes and to combine efforts through moral persuasion, regulation and rewards or incentive approaches to modify local-resource-use decisions in the social, political and ecological realities of the Asian landscape.

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Summary

Payment for Environmental Service (PES) has multiple interpretations and definitions. Initially, the PES-concept was strictly defined as a market-based environmental policy instrument to achieve environmental protection in the most efficient way. The goals were to solve some of the root causes of environmental problems: market imperfection and policy distortion. However, empirical evidence showed that the prescriptive conceptualization of PES cannot be easily generalized and implemented in practice and the commodification of ecosystem services is problematic. The Coasean and pure market-based approach, which dominates the conceptualization of PES, is an important cause of the critical debate surrounding the PES concept.

The overarching hypothesis of this thesis is that without combining efficiency and fairness aspects, the PES concept will not provide sustainable solutions and its implementation may achieve neither an increase of ES provision nor improve livelihoods. This hypothesis is tested through three main research questions:

1. How do current PES designs and practices in Asia balance fairness and efficiency of the payment schemes?
2. What are the key considerations in designing and implementing a PES scheme as a multiple-goal policy instrument in the context of densely populated Asian landscapes?
3. How to integrate PES mechanisms into a wider concept of sustainable development in a developing country context and what policy recommendations can be offered?

After presenting the concept of PES and its evolution over time in Chapter 1, the preconditions for application of the PES concept with strict conditionality for developing countries in Asia is discussed in Chapter 2. The study revisits the debate on providing monetary payments and its implications for rural environmental service (ES) providers (cf. Chapter 3). Chapter 4 discusses the lessons learned in synergizing multiple ecological-knowledge systems among relevant PES actors and Chapter 5 examines the application of a PES procurement auction in rural settings. An evaluation of an established PES scheme using a sustainable livelihood framework is presented in Chapter 6.

This PhD study combines a quantitative and qualitative research approach using empirical cases in Indonesia, the Philippines and Nepal. Those research methods are combined through participatory action research in nine study sites coordinated by the World Agroforestry Centre. Participatory action research reflects a process of progressive problem solving to improve the way PES is addressed in the context of developing countries.

Results from the analysis of experiences with evolving PES practices in Asia suggest that strict conditionality cannot be met among ES providers, intermediaries and beneficiaries involved in PES contracts (Chapter 2). Lessons learned from the empirical case studies show that conditionality of PES-contracts is stratified ranging from ES contracts linking tangible benefits for the ES providers by the actual enhanced delivery of ES (level I), to maintenance of agro-ecosystems in a desirable state (level II), to performance agreed actions to enhance ES (level III), to development and implementation of management plans to enhance ES with respect for local sovereignty in conserving the environment for both local and external benefits (level IV). The analysis of the research sites in Asia also suggests that broader perspectives of PES (i.e. commoditized ES, compensation for opportunities forgone and co-investment in environmental stewardship) may well become the foundation to balance efficiency and fairness of PES schemes. These broader perspectives of PES may capture most of the current variation in PES approaches compared to a normative and prescriptive PES definition that is commonly used.

Chapter 3 reviewed some key issues associated with design and implementation of pro-poor PES by developing and exploring two propositions related to conditions required for PES to effectively contribute to poverty alleviation, and to preferred forms of pro-poor mechanisms. The analysis of income and spatial data on Indonesian agro-ecosystems indicated that a modest target of 5% of increase in annual disposable income of upstream rural household may be difficult to achieve given the population and income structure of downstream and upstream areas in Asia. The findings from focus group discussions at the different sites suggest that there is a substantial variation among communities concerning poverty concepts and reward preferences (Chapter 3). This provides important insights into the various dimensions that well-targeted reward schemes need to address.

Chapter 4 reviews and synthesizes the analysis of multiple ecological-knowledge systems, i.e. local, public/policy maker and modeller/hydrologist ecological knowledge, in four watershed cases in Indonesia. Initial investment in reconciling multiple ecological knowledge systems applied in the case studies included in this PhD study (c.f. Chapter 4) can increase PES efficiency by clarifying expectations from all relevant actors, avoiding unrealistic targets for quality of watershed services, helping define conditionality of RWS and offering appropriate monitoring procedures, and PES fairness by reducing conflicts and accepting multiple perspectives. However, these case studies also showed that the availability of information is only a prerequisite for increasing the quality and sustainability of PES schemes. Interviews with practitioners in this study showed that the factors influencing the design and implementation of PES programs are varied and beyond the availability of multi-perception knowledge and scientific data. The issue of strategic use of information, a discrepancy between scale in the provision of environmental services and its investment, and the vested interests of intermediaries and donors deter the optimal use of such multiple knowledge analysis in designing and implementing rewards for watershed schemes.

Chapter 5 presents the implementation of a reverse auction approach to elicit private information on landholders' payments in return for soil conservation investments on private coffee farms in the Sumberjaya watershed, Indonesia that is dominated by coffee crops in erosion-prone uplands. Erosion control is an impure public good that generates both private benefits and positive externalities, in this case to a downstream hydropower company. The research included selecting and testing some elements of the auctions through two types of experiments: a laboratory auction experiment with students and field framed experiments with farmers. The final step of the research was to conduct a natural field experiment and to monitor the success and completion rate of the contract by farmers who won the auction for one year. Our procurement auction experiment showed ambiguous results on whether a competitive market-based experience could increase cost-efficiency gains (c.f. Chapter 5).

The auction experiment suggested that the cost estimates based on labour investments are higher than the auction price and the mean auction bid. Based on estimated labour costs, the areas of contracts that could have been enrolled under the available budget were smaller compared to the areas actually purchased under the auction. However, these auction bids did not reflect the real value of both opportunity costs and co-benefits gained by farmers by joining a conservation contract since the contract compliance rate was moderate. There were various reasons for this, ranging from a lack of leadership and coordination between members of the farmer's groups, to the difficulty of finding grass seedlings, to a conservation activity's clash with coffee harvesting time. Thus, we presumed that there were other motivations beyond the financial cost-benefit that prevailed among the participating farmers when they submitted relatively low auction bids compared to their labour investment.

Chapter 6 describes the process of initiating the PES scheme and its design, and reviews the impacts of the five year scheme on local livelihoods. The assessment of these impacts was conducted through a series of focus group discussions with the participants and non-participants and interviews with implementing agencies. The livelihood impacts were discussed in terms of the five asset types covered in the Sustainable Livelihood Framework: financial, human, social, physical and natural. In analysing livelihood impacts, the data are limited to the results from the FGDs and stakeholder interviews, since there has been no detailed quantitative analysis so far of household level livelihood impacts in Cidanau. Although the PES scheme did not drastically change the livelihoods of participants, linkages with external stakeholders were creating opportunities for participants to diversify or capture greater value from their income sources. Our case study showed that exposure to these partners also increased the participants' knowledge of conservation, their skills to manage the farmers' organization, and helped to build networks to improve their businesses and implementation of the PES scheme. It also highlights the need for awareness of the social dynamics between participants and non-participants and design benefit packages to minimize community level conflict.

Chapter 7 summarizes the contribution of this PhD thesis to the knowledge base on how to balance efficiency and fairness of the PES schemes through several analyses.

First, the empirical observations on emerging PES-mechanisms in the Asian case studies indicate that the performance of PES to achieve and balance efficiency and fairness is strongly influenced by complex behaviour and decision making at the individual level. The behavioural differences at the individual level is not only limited to ES providers as the main actors of PES but was also found with beneficiaries, intermediaries, and supporters of PES (e.g. governments and international agents). Motivations of stakeholders, their perceptions, power relations and political interest towards PES have great influence on the design and implementation of PES. A language of co-investment in environmental stewardship may be more conducive to create respect, mutual accountability and commitment to sustainable development than PES alone.

Second, non-financial payment has to be considered as an important incentive for ES providers. Such payments have weaknesses, such as giving indirect benefits to ES providers, which reduces the effectiveness of the payment and can trigger free-riders and patronage effects. Nevertheless, in-kind reward is often the most feasible transfer because the budget for PES from ES beneficiaries is typically small and cannot cover the full opportunity costs of the providers. Moreover, in-kind reward avoids neglecting non-participants and aligns with social cohesiveness characterizing rural communities in most developing countries.

Third, the recognition and attempted reconciliation of multiple ecological knowledge systems, i.e. local, public and scientific ecological knowledge, can support the establishment of efficient and fair

PES schemes. Clarifying problems in the provision of ES and recommending solutions at each spatial scale leads to more realistic expectations of all stakeholders in implementing PES schemes. The roles of each actor are then well-recognized and solutions based on local contexts rather than standardized ones lead to mutual responsibility among PES actors.

Fourth, the ES providers' decision making process in joining and implementing a PES contract is influenced by social and institutional factors beyond monetary values. However, rural communities are open to a market-based approach, harnessing competitiveness among its participants as long as the design of the market-based instrument is transparent and does not make them worse-off.

Fifth, evaluating an established PES using the sustainable livelihood framework can provide more complete insights how PES makes actors involved better or worse-off. It also can evaluate project implementers more fair since a broader range of impacts is captured. Our case in Indonesia suggests that the role of the intermediary is very important and possibly dominant. An honest and trusted intermediary is thus one of the key factors to success of a PES scheme. It also highlights the need for awareness of the social dynamics between participants and non-participants and design benefit packages to minimize community level conflict.

Finally, interdependency of fairness and efficiency should be the main consideration in designing and implementing a PES scheme in developing countries. Neither fairness nor efficiency alone should be the primary aim but an intermediate PES that is "fairly efficient and efficiently fair" may bridge the gap between PES theory and the practical implementation of PES on the ground.

Samenvatting (summary in Dutch)

Over Payment for Environmental Services (PES) (in Nederlands: betaling voor ecosysteemdiensten) bestaan meerdere opvattingen en definities. In het begin was het PES-concept alleen bedoeld als instrument voor milieubeleid op basis van de vrije markt, om zo de meest efficiënte milieubescherming te bewerkstelligen. Het doel was om de fundamentele oorzaken van milieuproblemen te verhelpen: marktfalen en beleidsvervormingen. Empirisch bewijs liet echter zien dat het voorschrijvende concept van PES in de praktijk niet gemakkelijk te generaliseren en implementeren was en dat de commodificatie van ecosysteemdiensten problematisch is. Het *Coasiaanse en zuivere markt-principe*, dat ten grondslag ligt aan het PES-concept, is een van de belangrijkste oorzaken van de kritische discussie rond PES.

De overkoepelende hypothese van deze thesis is dat zonder het combineren van de aspecten efficiëntie en eerlijkheid of redelijkheid (fairness), het PES-concept geen duurzame oplossingen zal bieden en implementatie van betaling voor ecosysteemdiensten geen toename in ecosysteemopbrengsten of verhoging van de welvaart zal opleveren.
Deze hypothese wordt getoetst aan de hand van drie onderzoeksvragen:

1. Hoe reguleren huidige PES ontwerpen in Azië de balans tussen eerlijkheid en efficiëntie van de Payment-factor?
2. Wat zijn de belangrijkste overwegingen bij het ontwerpen en uitvoeren van een PES-schema als beleidsinstrument voor meerdere doelen in de context van het dichtbevolkte Aziatische landschap?
3. Hoe kunnen PES mechanismes geïntegreerd worden in een breder concept van duurzame ontwikkeling in de context van een ontwikkelingsland, en welke beleidsaanbevelingen kunnen gegeven worden?

Na de beschrijving van het PES-concept en de ontwikkeling hiervan in de loop der tijd in Hoofdstuk 1 worden de voorwaarden voor toepassing van PES binnen de context van Aziatische ontwikkelingslanden besproken in Hoofdstuk 2. Het onderzoek bespreekt de discussie betreffende het verlenen van geldelijke vergoedingen en de gevolgen hiervan voor landelijke ecosysteemdiensten (ES) (cf. Hoofdstuk 3).
Hoofdstuk 4 bespreekt de lessen die geleerd kunnen worden uit de synergiewerking tussen meerdere ecologische kennissystemen van relevante PES-deelnemers.
In Hoofdstuk 5 wordt de toepassing van een veiling voor PES-aanvragen in landelijke situaties onderzocht.
Een evaluatie van een gevestigd PES-systeem op basis van duurzaam levensonderhoud wordt gepresenteerd in Hoofdstuk 6.

Dit proefschrift combineert een kwantitatieve en kwalitatieve onderzoeksbenadering voor empirische casussen in Indonesië, de Filippijnen en Nepal. Die onderzoeksmethoden worden gecombineerd door participatief onderzoek op negen onderzoeksplaatsen, gecoördineerd door het World Agroforestry Centre. Participatief onderzoek biedt een progressieve aanpak bij het verhelpen van problemen met betrekking tot PES in de context van ontwikkelingslanden.

Analyse van de resultaten van ervaringen met evoluerende PES-systemen in Azië suggereert dat strikte conditionaliteit niet mogelijk is tussen ES-leveranciers, tussenpersonen en begunstigden betrokken bij PES contracten (Hoofdstuk 2). Empirisch casusonderzoek leert ons dat conditionaliteit van PES contracten varieert van ES-contracten die tastbare voordelen hebben voor de leveranciers van ES-diensten door feitelijke verhoging van de levering van ES-diensten (level I), tot het onderhouden van agro-ecosystemen op het gewenste niveau (level II), tot prestatiegerichte acties ter verbetering van ES-diensten (level III), tot de ontwikkeling en implementatie van beheerplannen ter verbetering van ES-diensten met behoud van de lokale soevereiniteit wat betreft milieubehoud voor zowel de lokale als de externe baten (level IV).

De analyse van de onderzoekslocaties in Azië wijste erop dat bredere opvattingen van PES (i.e. gecommodificeerde ES-diensten, compensatie voor gederfde kansen en investering in milieu-rentmeesterschap) kansrijk zijn als basis voor een PES-systeem dat balans brengt tussen efficiëntie en eerlijkheid. Deze bredere perspectieven van PES-programma's kunnen het grootste gedeelte van de huidige variatie tussen PES-opvattingen omvatten, in tegenstelling tot de doorgaans gebruikte 'voorschrijvende' definitie van PES.

Hoofdstuk 3 bespreekt enkele kernvragen in verband met het ontwerp en de implementatie van PES gericht op armoede bestrijding door het ontwikkelen en onderzoeken van twee proposities die gerelateerd zijn aan de vereiste voorwaarden voor PES wil dit daadwerkelijk bijdragen aan armoedevermindering, en aan geprefereerde vormen van de anti-armoede werkwijze. De analyse van inkomen en ruimtelijke informatie van Indonesische agro-ecosystemen geeft aan dat een bescheiden toename van 5% in het besteedbaar inkomen van een stroomopwaarts gelegen landelijk huishouden al zeer lastig te bereiken is, gegeven de verschillen in bevolkings- en inkomensstructuur met stroomafwaartse gebieden in Azië. De bevindingen uit de discussies van focusgroepen van verscheidene onderzoekslocaties impliceren een wezenlijke variatie tussen gemeenschappen betreffende armoedeconcepten en beloningsvoorkeur. Dit levert belangrijke inzichten op in de verschillende perspectieven die een goed afgestemd beloningsplan moet omvatten.

Hoofdstuk 4 bespreekt en synthetiseert de analyse van meerdere ecologische kennissystemen, i.e. plaatselijke, politiek/beleids vormende en modelmatige/hydrologische ecologische kennis van **stroomgebieden.** Initiële investering in het verenigen van verscheidene ecologische kennissystemen toegepast in de casusonderzoeken in dit onderzoek kan de efficiëntie van PES-systemen verhogen door het verhelderen van de verwachtingen van alle relevante spelers. Hiermee worden onrealistische doelstellingen vermeden ten aanzien van de kwaliteit van stroomgebied diensten, kan het bijdragen aan de definiëring van de voorwaarden van de PES conditionaliteit en het aanreiken van geschikte monitoringprocedures, en kan een eerlijke PES regeling bereikt worden door het verminderen van conflicten en het openstaan voor verschillende perspectieven.
Deze casusonderzoeken lieten echter ook zien dat de beschikbaarheid van informatie slechts een voorwaarde is voor een toename van kwaliteit en duurzaamheid van PES-regelingen. Uit interviews met uitvoerders van PES blijkt dat de factoren die van invloed zijn op het ontwerp en de uitvoering van PES-regelingen erg variëren en buiten bereik liggen van de huidige multi-waarnemingskennis en wetenschappelijke data. De kwestie van strategisch gebruik van informatie, een discrepantie tussen de

levering van milieudiensten en de investering daarin, en de gevestigde belangen van tussenpersonen en donatoren werken het optimale gebruik van deze multiple kennis-analyse in ontwerp en implementatie van stroomgebiedregelingen tegen.

Hoofdstuk 5 presenteert de invoering van een omgekeerd veilingsysteem om privé-informatie te onttrekken over betalingen van grondbezitters in ruil voor investering in bodembescherming op particuliere koffieplantages in het stroomgebied Sumberjaya, Indonesië, dat gedomineerd wordt door koffieplanten in erosiegevoelige hooglanden. Erosiebeheer is een onzuiver publiek goed dat zowel particuliere voordelen als positieve externe effecten genereert, in dit geval aan een stoomafwaarts gelegen waterkrachtbedrijf. Het onderzoek omvatte het selecteren en testen van een aantal elementen van de veilingen door twee verschillende soorten experimenten: een veiling in een laboratoriumomgeving met studenten en een onderzoek in het veld met daadwerkelijke boeren. De laatste stap in het onderzoek was om een natuurlijk veldonderzoek uit te voeren en toezicht te houden op het succes en de snelheid waarmee voldaan werd aan het eenjarige contract door de boeren die dit op de veiling hadden verkregen. Ons experiment met de inkoopveiling leverde dubbelzinnige resultaten op betreffende de vraag of een concurrerende markt-gebaseerde ervaring daadwerkelijk de kostenefficientie zou laten toenemen. Het veilingexperiment suggereerde dat de kostenschatting van arbeidsinvesteringen hoger was dan de veilingprijs en het gemiddelde bod. Op basis van de geschatte arbeidskosten zouden de gecontracteerde arealen die binnen het budget zouden kunnen worden aangepakt, kleiner zijn dan de arealen die op de veiling daadwerkelijk zijn verkocht. Deze biedingen reflecteren echter niet de werkelijke waarde van zowel de opportunity costs als de neven-baten verkregen door boeren die deelnemen aan een conservatiecontract, omdat de contractnaleving matig was. Hier waren verscheidene redenen voor, van gebrek aan leiderschap en coördinatie tussen leden van de boerenbonden, tot de moeilijkheden bij het vinden van gras kiemplanten, tot een conflict tussen conservatie en de koffie-oogsttijd. Zo veronderstelden wij dat er andere motieven naast de financiële kosten-baten speelden bij de deelnemende boeren, toen zij lage biedingen deden vergeleken met hun arbeidsinvestering.

Hoofdstuk 6 beschrijft het proces van het begin van een PES-regeling en het ontwerp hiervan, en bespreekt de effecten van de vijf-jaar-regeling op de lokale economie. De beoordeling van deze effecten werd uitgevoerd door een reeks focus groep discussies (FGDs) met deelnemers en niet-deelnemers en interviews met uitvoerende instanties. De invloed op het levensonderhoud werd besproken in vijf typen activa zoals gedekt in de Sustainable Livelihood Framework: financieel, menselijk, sociaal, fysiek en natuurlijk. Bij de analyse van de invloed op levensonderhoud zijn de gegevens beperkt tot de resultaten van de FGD's en interviews met belanghebbenden, daar er geen gedetailleerde kwantitatieve analyse beschikbaar is van de effecten op levensonderhoud op huishoudelijk niveau in Cidanau. Hoewel de PES-regeling het levensonderhoud van deelnemers niet drastisch beïnvloed heeft, zijn er door koppelingen met externe stakeholders mogelijkheden ontstaan voor deelnemers om te diversifiëren of grotere waarde uit hun inkomstenbronnen te verkrijgen. Ons casusonderzoek toonde aan dat contact met deze externe partners ook de kennis van de deelnemers met betrekking tot conservatie deed toenemen, hun vaardigheden voor het beheren van de boerenorganisatie versterkten, en dat dit vergrote netwerk ook hun bedrijven en de implementatie van een PES-regeling bevorderde. Het onderzoek benadrukt ook het belang van aandacht voor de sociale dynamiek tussen deelnemers en niet-deelnemers en de noodzaak om bij het ontwerp van het beloningsschema interne conflicten in de gemeenschap te minimaliseren.

Hoofdstuk 7 geeft een samenvatting van de bijdrage van dit proefschrift aan de kennisbasis over hoe een balans tussen efficiëntie en eerlijkheid te realiseren binnen de opzet van PES-ontwerpen door verschillende analyses.

Ten eerste geven de empirische observaties over opkomende PES-functionaliteit in de Aziatische casusonderzoeken aan dat de potentie van PES om balans tussen efficiëntie en eerlijkheid te bereiken sterk beïnvloed wordt door complex gedrag en besluitvorming op het niveau van het individu. De gedragsmatige verschillen op individueel niveau zijn niet beperkt tot de ES-aanbieders als hoofdspelers bij PES, maar ook bij begunstigden, tussenpersonen en voorstanders van PES (e.g. overheden en internationale agentschappen). Beweegredenen van belanghebbenden, hun opvattingen, machtsrelaties en politiek belang bij PES hebben sterke invloed op het ontwerp en implementatie van PES. Eensgezinde co-investering in milieubewustzijn kan meer bijdragen aan respect, wederzijdse verantwoording en toewijding aan duurzame ontwikkeling dan PES alleen.

Ten tweede moet niet-financiële beloning worden beschouwd als een belangrijke stimulans voor ES-aanbieders. Dergelijke beloningen hebben zwaktes, zoals het indirect voordelen geven aan ES-aanbieders waarmee de effectiviteit van de daadwerkelijke betaling vermindert en de kans op free-rider en patronage effecten verhoogd wordt. Desondanks is in natura beloning vaak de meest haalbare transactie, omdat het budget voor PES van ES-begunstigden vaak klein is en ontoereikend voor de volledige alternatieve kosten van de aanbieders. Bovendien voorkomt in natura beloning verwaarlozing van niet-deelnemers en sluit ze aan bij de sociale cohesie die prevalent is in landelijke gemeenschappen in de meeste ontwikkelingslanden.

Ten derde kan de erkenning en poging tot verzoening van meerdere ecologische kennissystemen, dat wil zeggen lokaal, publiek en wetenschappelijke ecologische kennis, het opzetten van een efficiënte en eerlijke PES-regeling ondersteunen. Het verhelderen van problemen in de levering van ES-diensten en het doen van aanbevelingen voor oplossingen op elke ruimtelijke schaal leidt tot meer realistische verwachtingen van alle belanghebbenden bij het invoeren van een PES-regeling. De rol van elke actor is dan helder en oplossingen op basis van de lokale context in tegenstelling tot gestandaardiseerde pakketten leidt tot een wederzijdse verantwoordelijkheid onder PES-actoren.

Ten vierde is het besluitvormingsproces van de ES-aanbieders in deelname aan en implementatie van een PES-contract onderhevig aan sociale en institutionele factoren die verder gaan dan de puur financiële.
Rurale gemeenschappen staan echter wel open voor een marktgerichte aanpak, inclusief de te dulden concurrentie onderling, zo lang de vorm van het marktinstrument transparant is en hen niet benadeelt.

Ten vijfde kan het evalueren van een gevestigd PES-systeem op basis van het kader van een duurzaam bestaan een beter inzicht geven in de invloed die PES heeft op de actoren, ten gunste of ten ongunste. Het kan projectontwikkelaars ook eerlijker evalueren omdat er een breder scala aan effecten wordt meegenomen in de evaluatie. Onze casus in Indonesië suggereert dat de rol van de tussenpersoon zeer belangrijk is, mogelijk zelfs dominant. Een eerlijke en vertrouwde intermediair is daarmee een van de sleutelfactoren in het bepalen van het succes van een PES-regeling. Het legt ook nadruk op de noodzaak voor bewustwording van de sociale dynamiek tussen de deelnemers en de niet-deelnemers en op het ontwerp van beloningspakketten die de sociale conflicten in de gemeenschap minimaliseert.

Ten slotte moet de onderlinge afhankelijkheid van eerlijkheid en efficiëntie de hoofdoverweging zijn bij het ontwerpen en implementeren van een PES-regeling in ontwikkelingslanden. Eerlijkheid noch efficiëntie alleen kunnen het primaire doel zijn, maar een tussenliggende PES die “redelijk efficiënt en efficiënt eerlijk” is kan de kloof tussen PES-theorie en daadwerkelijke PES-implementatie dichten.

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Beria Leimona commenced her PhD with the Environmental System Analysis Group of Wageningen Research and University (WUR), the Netherlands in 2007 under the fellowship award of WUR Sandwich PhD. Her PhD programme was organized in collaboration with the World Agroforestry Centre – the Southeast Asia Office (ICRAF SEA), where she has worked since 2002. At ICRAF SEA, she coordinates a project on Rewarding Upland Poor for Environmental Services (RUPES) Phase 2 is mainly supported by the International Fund for Agriculture and Development (IFAD). This project covers six countries in Asia: China, Indonesia, India, the Philippines, Nepal and Vietnam. As a researcher specializing in pro-poor rewards for environmental services (RES) initiatives in Asia, she also contributed to some global initiatives of RES implementation. In 2010, she joined a team to evaluate a project of Equitable Payment for Watershed Services of the consortium of WWF and CARE International in Tanzania and Kenya, and Indonesia. In 2011, she was invited by CAREC Regional Environmental Centre for Central Asia to evaluate a national initiative of RES in Kazakhstan. During her work with ICRAF, she was also involved in several collaborative publications on RES and experimental economics with international organisations such as FAO, UNESCAP, IFAD, OECD and national and international universities. At the national level, she is active in giving inputs to the development of environmental regulations and protocols. At the regional level, Leimona is a member of the Environment and Economics Programme for Southeast Asia (EEPSEA) network.

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Completed training and supervision plan

The SENSE Research School declares that Ms. Beria Leimona has successfully fulfilled all requirements of the Educational PhD Program of SENSE with a work load of 48 ECTS, including the following activities:

SENSE PhD courses

- Environmental Research in Context
- Research Context Activity: Co-organizing scientific and practicing workshops on: Payment for Environmental Services (22-26 January 2007 in Lombok, Indonesia)

Other PhD courses

- Governance for Forests, Nature and People
- Applying Game Theory and Behavioral Economics to the Environment

External training at foreign research institute

- Reviewing the Equitable Payment for Ecosystem Services project in Tanzania and Kenya, CARE and WWF International, Tanzania and Kenya

Oral Presentations

- Economy and Environment Program of Southeast Asia (EEPSEA) 28th Biannual Workshop, 14-16 November 2007, Kuala Lumpur, Malaysia
- UPLAND International Symposium, 1 – 4 April 2008, Stuttgart, Germany
- Rewarding Upland Farmers for Reducing Sedimentation: River Care Scheme, IUCN World Conservation Congress 5 – 9 October 2008, Barcelona, Spain
- Estimating Cost of Supplying Ecosystem Services A case study from experimental field auctions and soil erosion control in Indonesia, IUCN World Conservation Congress 5 – 9 October 2008, Barcelona, Spain
- A Field Experiment of Direct Incentive Scheme for Provisioning Watershed Services, EEPSEA Biannual Workshop, 19 – 20 November 2008, Nusa Dua, Indonesia
- Science, Economics and Institutions of Payments for Environmental Services Workshop, 20 – 30 April 2009, Chiang Mai, Thailand
- Incentives for Improving Economic Policy, Biodiversity Conservation, and Natural Resource Management Target Performance - UNESCAP , South-East Asia Regional Workshop on Payments for Ecosystem Services, 29 June – 2 July 2009, Bangkok, Thailand
- Linking international, national and local rules and incentives for different phases of tree cover transitions in Indonesia: emerging REDD and A/R-CDM praxis in Indonesia, International Conference “Legal Pluralist Perspectives on Development and Cultural Diversity, 31 August – 3 September 2009, Zurich, Switzerland