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Farmers in NE Viet Nam rank values of ecosystems from seven land uses

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ABSTRACT

Despite being promoted as an integral part of natural resource management and Payments for Ecosystem Services (PES) community participation is often considered restricted by 'lack of (local) knowledge'. Contrasting evidence suggest that farmers' more holistic understanding of ecosystems may challenge scientific studies and payment schemes typically focussing on a fraction of ecosystem services, e.g. Viet Nam's PES-policy which covers forest carbon, water and landscape beauty. Against this backdrop we explored how farmer groups in two villages (one with PES and one without) in northeast Viet Nam rated and justified fifteen ecosystem services from seven land-uses, including non-PES functions and non-forest land uses. The villagers gave overall analogous ranking and reasoning. For overall ecosystem services natural forests and forest plantations rated highest and paddy rice lowest, however for economic values natural forests rated lowest and rice-fish cultivation highest. With regards to the PES-policy, farmers failed to see the logic of excluding agricultural land and agrochemical pollution from water services. We recommend that research and capacity building aiming to prepare for PES-schemes embrace a wider range of local knowledge and understandings of ecosystem functions than those immediately considered for payment schemes. We present a participatory matrix ranking tool to support such purposes.

1. Introduction

Of the 24 ecosystem services identified in the Millennium Ecosystem Assessment report, only a handful typically generate payments for ecosystem services (PES): water, carbon, biodiversity, cultural heritage and landscape beauty (eco-tourism) (MEA, 2005; Pascual et al., 2010). This is because they are comparatively easier to monitor and have clearer financial benefits to the payer (Scherr et al., 2006). Furthermore, a review of 457 articles on PES highlighted that (1) industrialised countries tend to focus on ecosystem services generated from agriculture while developing countries focus on forestry, and (2) most reviewed PES-schemes were government-initiated, conducted at national or large scale (notably in China, EU and the US) with variable degrees of voluntariness, which contrasted with the comparatively fewer market-initiated, typically small scale and more voluntary schemes (Schomers and Matzdorf, 2013).

The dominance of top-down PES-schemes raises questions over the degree and roles of community participation (Kosoy et al., 2008). In developing countries inclusion of the poor is adamant because PES is often combined with rural development or poverty alleviation interventions. Participation is encouraged to ensure the longevity of projects, avoid myths and misunderstandings (Cremaschi et al., 2013) but may be restricted by institutional, legal or biophysical factors, income and knowledge levels (Bremer et al., 2014; Kwayu et al., 2014). In contrast to the free, prior, informed consent aspect of Reduced Emissions from Deforestation and forest Degradation (REDD), PES-schemes do not stipulate minimum levels of awareness raising before implementation. One concern is that PES suppliers, in particular smallholders would be in an inferior position for negotiation compared to (presumably better educated) intermediaries, such as government officials or buyers (To et al., 2012). For example, the need for mock auctions to ensure that farmers understand the reverse auction process as a means to identify payment levels, reflects their vulnerability if they had but one chance (Jindal et al., 2013). Furthermore, government officials themselves perceive PES as overly technical and complicated, possibly reflecting why they think PES is too difficult for farmers to understand (Simelton et al., 2013). These examples highlight, firstly that knowledge gaps should be addressed before PES implementation, in particular between local and scientific knowledge of ecosystem functions

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and their values (Petheram and Campbell, 2010; Danielsen et al., 2013), secondly that participatory tools for facilitating such co-learning are sparse. Against this background, we investigated how farmers rate and qualitatively justify the values of the ecosystems in their own landscape, including non-forest land uses, and whether there were differences between a village with PES schemes and one without. For this purpose, we developed a participatory matrix ranking tool that was tested in two villages in northern Viet Nam.

2. Methods

2.1. PES in Viet Nam

Viet Nam's national PES-policy Decree 99-2010-CP (Viet Nam Government, 2010) notes five services provided by forestland: clean water, watershed protection, water for spawning grounds, carbon and landscape beauty and specifies the payment rates for some. Challenges regarding the implementation and degrees of participation have been documented in several studies (To et al., 2012; Pham et al., 2013; Suhardiman et al., 2013).

While the there is a scholarly debate on the use of the terms "ecosystem" and "environmental" services (Derissen and Latacz-Lohmann, 2013), Viet Nam's PES policy (Decree 99) is officially translated as payment for forest "environmental" rather than "ecosystem" services. This resembles the description of environmental services as "ecosystem service(s) minus the provisioning services for which markets can be expected to balance supply and demand" (van Noordwijk et al., 2012 p. 392). The varying definitions have little bearing on discussions in Vietnamese, especially with farmers. We adapted a list of ecosystem services from MEA (2005) paying particular attention to farmers' understanding of the goods and services provided naturally (albeit in man-made agro-ecosystems) contrasted with how provisioning goods (such as food, fiber, wood) translated into economic values. Hence, the term "ecosystem" (e.g. MEA, 2005; Braat and de Groot, 2012), is used except when quoting Decree 99.

2.2. Study sites

Focus-group discussions were conducted in two villages in Bac Kan province, northeastern Viet Nam. Both villages have similar land uses, representative for the mid-altitudes of the uplands in continental southeast Asia. To Dooc village in Na Ri district had 24 households and Na Ca village in Ha Vi district 60 households (Aug 2013) out of whom over 90% cultivate both agriculture and forest land. To Dooc village participated in an ongoing forest-PES pilot scheme in operation since 2009 and some farmers had attended training (Simelton et al., 2013) while Na Ca villagers had never heard of PES.

2.3. Participatory ranking tool

Seven land-uses were identified on the valley floors and foothills—monoculture paddy rice, rice-fish cultivation and home gardens—and on adjacent sloping land: monoculture cassava or maize, taungya agroforestry system intercropping cassava with fast-growing timber trees, forest plantation and naturally regenerated forest (see Table 1). Fourteen ecosystem services were selected and some descriptions modified (MEA, 2005) by the facilitator to fit with local contexts. In addition, the "economic" value was rated, referring to the current monetary importance of respective land use to the households. Two focus groups with eight participants each (mixed gender and age) deliberated and ranked each ecosystem service associated by land-use type while one rapporteur took notes of the discussions. The ranking was relative with '6' representing the highest through to '0' for the lowest value, using maize seeds that easily could be altered.

3. Results

Table 1 gives the land uses and justifications for the ranking as given by the focus groups. Table 2 shows the ranking for the ecosystem services for lowland (plains) and upland (sloping land), respectively. Both groups rated natural forest the highest followed by tree plantation and intercropped taungya systems while paddy rice cultivation rated the lowest. The sequence only differed in that To Dooc village rated garden > upland crop > rice-fish while Na Ca village rated rice-fish > upland crop > garden. This may be a consequence of the former village having comparatively larger and more diverse home gardens and fewer households with rice-fish.

Among "provisioning" services there was a dichotomy between land uses providing food versus fuel and clean water. The "supporting" and "regulating" services were overall ranked highest for natural forests and lowest for paddy rice. The 'cultural' values included only aesthetical values (i.e. landscape beauty) as neither group said they had any sacred or spiritual values associated with any land use or plants. In the views of the villagers the naturally regenerated forest was most beautiful, followed by plantation forest, intercropping (taungya) and home garden, rice-fish, upland crop and paddy fields. One argument for rating rice-fish higher than paddy rice was that "first you see the rice field, when you come closer you see the fish" (Na Ca). Furthermore, both groups stressed that the positive ecosystem and health effects of rice-fish outweighed those associated with mono-cultivated rice. Pesticides and inorganic fertilisers were particularly seen as polluting waters and killing fish.

The "economic" values (monetary) were rated diametrically opposite those of ecosystems. Rice-fish cultivation ranked highest, followed by paddy rice, upland crops and garden. As most production was for home consumption this ranking highlights not the importance of being able to sell the produce but the ability to secure a food supply (subsistence). Moreover, farmers distringuished between monetary and ecosystem values saying that natural forests had no economic value as they were "not allowed to take out anything from these forests" (To Dooc). This highlighted a misperception of Decree 178/2001-QT-TTg on the rights and obligations of households allocated, and contracted to, forest and forestland for sharing benefits, which states the rights to benefits that households can reap from timber and non-timber forest products (Viet Nam Government, 2001), although at the time of writing the policy content is under discussion.

Contrary to our initial assumptions, the presence of PES had yet little influence on farmers' aspirations of their land use. Farmers in the PES village To Dooc anticipated they may receive carbon funds (not yet realized) while Na Ca villagers expected to maintain forest-protection funds, which in 2013 reached about the same amount (USD 10/ha/year) and had not (yet) resulted in differing land uses. Moreover, both villages were remarkably unanimous in ranking and explaining ecosystem services. Although the benefits of carbon storage are primarily global, farmers understood some basic links between climate-change information on TV and the locally visible 'carbon' in wood, leaves and roots. To Dooc-farmers are likely to have benefitted from a module in the PES-training on participatory carbon measurement, a practical skill that in contrast to more theoretical lectures had remained in vivid memory months after the training event (Simelton et al., 2013). Na Ca farmers said they gained awareness by making their own observations of the landscape and watching TV, but had many unanswered questions.

Table 1
Seven typical land-use types in Bac Kan province and associated ecosystem services as identified by farmers.
Source: Authors' fieldwork 2013.

Land-use system	**Lowland (valley floor, foot of hill)**			**Upland**			
	Paddy rice	**Rice integrated with fish**	**Home garden**	**Upland crop:** Maize or cassava	**Inter-cropping:** Taungya Years 1–3	**Forest plantation** Years 4–7	**Natural forest:** Regenerated
Description	1–2 seasons monoculture paddy rice	1–2 seasons fish (tilapia and/or carp) with paddy rice	Mixes of vegetables, fruit trees, ponds (size varies with household and village)	Mono culture cassava or maize	Reforestation stage 1 with crop and tree seedlings years 1–3: maize and *Mangletia*, *Acacia* or *Melia*	Mono-reforestation stage 2, years 4–7 with *Mangletia*, *Acacia* or *Melia*	Mixed (sub-) tropical forest species Protection forest (indigenous species encouraged)
Provisioning							
Provide food (feed)	Rice: up to 7.5 t/ha/ season 1, up to 3 t/ha season 2	Fish: up to 150 kg /1000 m^3 Rice: same as monoculture	Vegetables, fruit. Livestock (poultry, pig, cow, buffalo) Fish pond: up to 200 kg/ 1000 m^3	Cassava: 3–5 t/ha Maize: 1–2 t/ha	Maize yield year 1: 100% Year 2: 60–70% Year 3: 0–40%	Understorey plants are possible, e.g. ginger, yams, bamboo shoots	Bamboo shoots (1), there is nothing to eat (0)
Economic value	Rice for household consumption	Rice and fish Rice-fish sells at 20% higher price than pond fish	Increase stock (fish, poultry, pig) for low-risk and fast returns	~USD25–75/t		USD35/ha/year if split over 7 years	Not allowed to extract*
Provide wood, fuel	Straw (fuel/fodder/mulch)	Straw (fuel/fodder/mulch)	Twigs (fuel)	Stalks (fuel/fodder/mulch)	Stalks sprouts (fuel)	Timber and fuel	Wood and undergrowth
Produce clean water	No Use pesti-/herbicide	Yes Pesti-/herbicides are not used	Yes No chemicals used.	No High soil erosion, use chemicals		Little soil erosion, no chemicals	Yes. No soil erosion
Regulating							
Provide shade	No	Yes Rice plants shade fish, cooler water	Yes Fruit trees give shade	No Mono culture	Yes When canopy closes shade tolerant species are planted, e.g. ginger		Yes Multi-storey
Provide wind break	No Monoculture	Yes Rice plants protect fish	Yes Fruit trees give shelter	No Monoculture	Yes Trees protect crops. Bamboo "fences" reduce wind speed	Yes Woodlots and forests reduce wind speeds	Yes Multistorey shield under-storey and neighbour fields
Natural pest control	Poor Traditional varieties more pest resistant than hybrid seeds. Only with IPM	High Fewer rats, fish eat insects: plant hoppers and sheath blight	Variable Guava is biological pest control for greening disease affecting orange	Poor Maize more sensitive than cassava. Tubers affected by rats	Variable Less densely planted crops may reduce the spread of pests	Intermediate Trees are more resistant to pests than crops	High Snakes eat rats. *See biodiversity*
Resilient to extreme weather	Variable Seedlings die from cold spell, young plants sensitive to drought, rainstorm	Intermediate to low As rice; fish flee during flooding, tilapia die from cold spell	Variable Some fruit trees sensitive to storm, temperature and water stress	Intermediate to high storm fell and cold rain (rotten tubers and cobs)	Intermediate to high Acacia die from cold spell	Intermediate to high Monoplantations more prone to storm than mixed	High Multi-storey trees little affected
Supporting							
Prevent soil erosion (vary with slope, soil type, rainfall)	Yes Absorbs soil eroded from slopes	Yes same as monorice or less due to higher water levels	Variable Most have annual crops and vegetables, few permanent trees	No	Intermediate Soil loss reduce as number of annual crops reduce	Yes	Yes Soil is never left bare
Enhance soil water content (vary with soil type and mulch)	Yes Water levels allowed to vary	Yes Requires a minimum water level for the fish	Variable Fish ponds collect water that can be used for irrigation	No	Intermediate Acacia is the most water demanding species	Yes / No Plantations consume water from fields below	Yes forest micro-climate "produces water"
Enhance soil fertility	No Risk for over-fertilisation (which "pollutes the water")	Yes Fish produce excreta, reduced needs for inorganic fertilisers	Yes Small size and close to animals (manure)	Declining Burn, crop for 2–3 years, fallow 1 year, then forestry	Yes with nitrogen-fixing acacia		Yes

Table 1 (*continued*)

Land-use system	Lowland (valley floor, foot of hill)			Upland			
	Paddy rice	**Rice integrated with fish**	**Home garden**	**Upland crop:** Maize or cassava	**Inter-cropping:** Taungya Years 1–3	**Forest plantation** Years 4–7	**Natural forest:** Regenerated
Carbon stock	No Only rice stalk	No Only rice stalk	Low Mainly vegetables (0)	No Only stalks, no trees	Increasing Trees are growing but still small	High Trees are nearly fully grown (5), more wood (6)	High Most trees, dead wood and bushes (6). Poor quality, thin (5)
Biodiversity (*was explained as the number of species of plants and animals appearing in soil, air, water*)	Low Monoculture (any insects killed with herbi-/pesticides)	Low to average (value of insects and microbes: confused with pests)	Average More species but count as food (not biodiversity), some butterflies, insects.	Low (birds and insects are seen as pests if they eat seeds) few worms	Low to average (higher compared to upland crop)	Average to high (higher than taungya) more weeds and understorey vegetation, pollinators prefer *Acacia*	High Natural habitat including bees and birds
Cultural							
Landscape beauty *Potential for tourism*		"First you see the rice, when you come closer you see the fish"			"The natural forest is most beautiful if more wild species" "The more trees the more beautiful"		
Spiritual value	Discarded following long discussions to ensure sufficient clarification. In these villages ancestors were no longer buried in the paddy fields. Holy days such as the Kitchen God Day when carp are released into ponds and lakes, was considered "for fun" rather than having a religious or spiritual value.						

Note: For ranking of values see Table 2; some differing values are in parentheses.

* See comment in the text on Decision no. 178/2001/QD-TTg.

The longest discussions took place over whether agrochemical pollutants and soil counted as "clean water" and if upland soil erosion would end up as sediments in paddy fields or in streams (To Dooc). Farmers saw no economic incentives with selective cutting or more permanent farming systems such as agroforestry. As such practices are not explicitly encouraged in the reforestation or national PES-policies, few demonstration models were established. In view of this, short-rotation reforestation cycles on slopes for 'clean water production' make little sense as soil cover is easily lost during clear-felling (Mai et al., 2013). Furthermore, toxic chemicals and fertilisers are added via rice and cash-crop cultivation in agricultural fields, which are more closely linked to freshwater than sloping land.

With regards to "biodiversity" and "natural pest control", rats were reduced by snakes in natural forests in rice-fish fields (due to higher water levels) compared to monoculture paddy fields. The roles of micro-fauna (insects, bugs, worms) received mixed attention. For example, in To Dooc mono-rice was ordered higher than rice-fish because "the fish eat everything" and consequently paddy fields sprayed with pesticides (that supposedly kills unwanted flora and fauna) were considered more diverse than rice-fish fields. This confirms the efficient role of fish as biological pest control since there would be no fish if they had nothing to eat (Na Ca). The diverging perceptions mark a difference between farmers' pragmatic view when rice-fish is seen as effective for controlling pests (resulting in low biodiversity) versus the symbiotic view where insects are necessary to feed the fish (high diversity). The latter view may be a result of some Na Ca farmers having attended IPM training whereas the former had not.

Regarding "micro-climate regulation" services, farmers agreed that natural forests ensured soil-water conservation due to the shade trees provided compared to upland crops. Other observations included selecting *Mangletia glauca* for timber plantations over *Acacia mangium*, which was considered too water-demanding and reduced soil moisture in downhill crop plantations. Natural forests could best withstand extreme weather events, demonstrating the importance of protective boundaries surrounding villages with high exposure to wind. Their multi-storey canopies meant that "trees support each other" through wind, water and soil interaction effects.

4. Discussion

This study highlighted that by taking some time to understand farmers' perceptions of ecosystem functions beyond the few normally accounted for the PES-schemes, and letting them rate how ecosystem services were valuable to them, we could document wealths of knowledge and misperceptions. First, the mismatch between agriculture and forest water ecosystem services puzzled farmers. Underestimated values of water quality, in particular the contradicting exclusion of agricultural land uses and agrochemical pollutants from 'clean water' has been noted before and called for a 'landscape approach' (Keeler et al., 2012; Sayer et al., 2013; Simelton et al., 2013). In contrast, traditional integrated farming systems such as rice-fish cultivation, which often are seen as risk-averse strategies for household food security have resulted from farmers' abilities to recognise multi-functional landscapes. However, from some farmers' point of view a productive landscape may be more beautiful than a recreational one, therefore they may have different ideas of makes a "beautiful" landscape than tourists do.

The focus group discussions reflected the notion that ecosystem services result from complex and context-specific processes that often are hard to demonstrate (Pascual et al., 2010). However, reducing to four-five ecosystem services that are associated with either agriculture or forest land risks limiting the understanding of

Table 2
Ecosystem services ranked by land-use type by farmer focus groups in To Dooc (TD) and Na Ca (NC) villages from lowest (0) to highest (6).
Source: Authors' fieldwork 2013.

Relative topography	**Lowland (valley floor)**						**Upland, sloping land**							
Ecosystem Service	**Paddy rice**		**Rice integrated with fish**		**Home garden**		**Upland crop:** Maize or cassava		**Inter-cropping:** Taungya Year 1–3		**Forest plantation** Years 4–7		**Natural forest:** Regenerated	
Location (Village)	*TD*	*NC*	*TD*	*NC*	*TD*	*NC*	*TD*	*NC*	*TD*	*NC*	*TD*	*NC*	*TD*	*NC*
Provisioning														
Provide food	5	5	6	6	2	2	4	4	3	3	0	0	1	0
Provide wood, fuel	1	0	0	2	2	1	4	3	3	4	5	5	6	6
*Produce clean water**	0	0	1	3	2	2	3	1	4	4	5	5	6	6
Regulating														
Provide shade	0	0	1	2	4	1	2	3	3	4	5	5	6	6
Provide wind break	0	0	0	0	4	2	2	3	3	4	5	5	6	6
Natural pest control	0	0	4	3	2	1	1	2	3	4	5	5	6	6
Resilient to extreme weather	1	1	0	0	4	3	2	2	3	4	5	5	6	6
Supporting														
*Prevent soil erosion**	2	0	2	0	3	2	0	3	4	4	5	5	6	6
Enhance soil water content	0	0	1	1	4	3	2	2	3	4	5	5	6	6
Enhance soil fertility	0	1	1	3	2	2	3	0	4	4	5	5	6	6
*Carbon-stock**	1	1	0	2	2	0	3	3	4	4	5	6	6	5
*Biodiversity**	1	0	0	4	3	2	2	1	4	3	5	5	6	6
Cultural														
*Landscape beauty**	0	1	1	2	3	3	2	0	4	4	5	5	6	6
Spiritual value	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
***Economic value* (2012)**	5	5	6	6	2	2	4	4	3	1	1	3	0	0
Average rank	*1.1*	*1.0*	*1.6*	*2.4*	*2.8*	*1.9*	*2.4*	*2.2*	*3.4*	*3.6*	*4.4*	*4.6*	*5.2*	*5.1*
Total value	*Lowest*		*Low*						*Average*		*High*		*Highest*	

Note: TD=To Dooc village, NC=Na Ca village. See Table 1 for description of land uses.
* Services eligible for PES (from forest land) according to Decree 99.

stakeholders' complex views on their environment and missing out services that are critical for farmers' livelihoods and hence gaining their acceptance and compliance (Scherr et al., 2006; Pham et al., 2013; Suhardiman et al., 2013). Poli (2013) differs between 'complicated' closed systems, where cause and effect can be addressed separately, and 'complex' open systems where multiple causes are interacting and cannot be individually distinguished. This illustrates well the mismatch between PES-policies carving out certain land-uses (for example forest land) and ecosystem services as a (theoretically) closed system and farmers who utilize a range of ecosystem services in an environment that resemble the complex system.

The results point to that differing rather than limited knowledge about the environment affects stakeholders' attitudes to policies and projects on PES. Notably, in voluntary PES-schemes such as in Ecuador, environmental attitudes were vital for enrolling (Bremer et al., 2014). Yet, in national PES-like programs such as in China and Viet Nam, the role of environmental awareness is marginal although this may improve environmental and socio-economic performance (Scherr et al., 2006; Pham et al., 2013; Suhardiman et al., 2013). Furthermore, the focus on payment levels and efficiency issues in academic studies (Pascual et al., 2010) risks missing out on factors causing limited participation which are associated with high transaction costs and equity issues (Schomers and Matzdorf, 2013). Specifically, examples in this study such as participatory carbon monitoring and farmers referring to IPM when explaining rates for biodiversity confirmed the value of linking ecosystem services to the whole landscape and other studies showing that engaging communities in environmental monitoring is both empowering and cost-effective (Danielsen et al., 2013).

We recommend that PES-implementors and scientists also pay attention to ecosystem services that not are directly targeted in PES-schemes, as this may help detect inconsistencies in the policy/scheme that could influence participation and compliance. Accordingly we presented an exercise that required about one hour and could well be included for diagnosing knowledge gaps in training-needs assessments, for monitoring changes in knowledge and aspiration over time, or simply for discussion support. Facilitators must recognise that the discussion is central, not the ranking itself. Groups should comprise maximum 8–10 individuals who trust each other and can speak openly. Therefore, depending on the purpose, differences in awareness and valuations of ecosystem services may be reflected by dividing groups by gender, stakeholder categories, or farmers versus leaders. These outputs can easily be contrasted with expert opinions and scientific assessments of ecosystem services more widely than those immediately paid for.

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References

Braat, L.C., de Groot, R.S., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. Ecosyst. Serv. **1**, 4–15.

Bremer, L., Farley, K., Lopez-Carr, D., 2014. What factors influence participation in payment for ecosystem services programs? An evaluation of Ecuador's Socio-Paramo program. Land Use Policy **36**, 122–133.

Cremaschi, D.G., Lasco, R.D., Delfino, R.J.P., 2013. Payments for watershed protection services: emerging lessons from the Philippines journal of sustainable development , **6**:10.5539/jsd.v5536n5531p5590.

Danielsen, F., Adrian, T., Brofeldt, S., van Noordwijk, M., Poulsen, M., Rahayu, S., Rutishauser, E., Theilade, I., Widayati, A., The An, N., Nguyen Bang, T., Budiman, A., Enghoff, M., Jensen, A.E., Kurniawan, Y., Li, Q., Mingxu, Z., Schmidt-Vogt, D., Prixa, S., Thoumtone, V., Warta, Z., Burgess, N., 2013. Community monitoring for REDD+: international promises and field realities. Ecology Soc. **18**, 41.

Derissen, S., Latacz-Lohmann, U., 2013. What are PES?—a review of definitions and an extension. Ecosyst. Serv. 6, 12–15.

Jindal, R., Kerr, J., Ferraro, P., Swallow, B., 2013. Social dimensions of procurement auctions for environmental service contracts: Evaluating tradeoffs between cost-effectiveness and participation by the poor in rural Tanzania. Land Use Policy 31, 71–80.

Keeler, B., Polasky, S., Brauman, K., Johnson, K., Finlay, J., O'Neill, A., Kovacs, K., Dalzell, B., 2012. Linking water quality and well-being for improved assessment and valuation of ecosystem services. Proce. Natl. Acad. Sci. USA **109**, 18619–18624.

Kosoy, N., Martinez-Tuna, M., Muradian, R., Martinez-Alier, J., 2008. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. Ecol. Econom. 61, 446–455.

Kwayu, E.J., Sallu, S., Paavola, J., 2014. Farmer participation in the equitable payments for watershed services in Morogoro,Tanzania. Ecosyst. Serv. 7, 1–9.

Mai, V.T., van Keulen, H., Hessel, R., Ritsema, C., Roetter, R., Phien, T., 2013. Influence of paddy rice terraces on soil erosion of a small watershed in a hilly area of Northern Vietnam. Paddy Water Environ. 11 (1-4), 285–298.

MEA, 2005. Millennium Ecosystem Assessment—Ecosystems and Human Well-being: Synthesis. World Resources Institute, Island Press, Washington DC.

Pascual, U., Muradian, R., Rodriguez, L., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. Ecol. Econ. 69, 1237–1244.

Petheram, L., Campbell, B.M., 2010. Listening to locals on payments for environmental services. J. Environ. Manag. 91, 1139–1149.

Pham, T.T., Bennet, K., Vu, T.P., Brunner, J., Le, N.D., Nguyen, D.T., 2013. Payments for Forest Environmental Services in Vietnam. From policy to Practice. CIFOR, Bogor, Indonesia.

Poli, R., 2013. A note on the difference between complicated and complex social systems. Cadmus **2**, 142–147.

Sayer, J., Sunderland, T., Ghazoul, J., Pfund, J.-L., Sheil, D., Meijaard, E., Venter, M., Boedhihartono, A.K., Day, M., Garcia, C., van Oosten, C., Buck, L.E., 2013. Ten principles for a landscape approach to reconciling agriculture, conservation, and other competing land uses. Proce. Natl. Acad. Sci. USA 110 (21), 8349–8356.

Scherr, S.J., Bennett, M.T., Loughney, M., Canby, K., 2006. Developing Future Ecosystem Service Payments in China: Lessons Learned from International Experience. Forest Trends, Washington, DC.

Schomers, S., Matzdorf, B., 2013. Payments for ecosystem services: a review and comparison of developing and industrialized countries. Ecosyst. Serv. 6, 16–30.

Simelton, E., Dam, V.B., Catacutan, D., Do, T.H., Nguyen, T.H., Traldi, R., 2013. Local Capacity for Implementing Payments for Environmental Services Schemes: Lessons from the RUPES Project in Northeastern Viet Nam. World Agroforestry Centre (ICRAF), Southeast Asia Regional Program, Hanoi, Vietnam.

Suhardiman, D., Wichelns, D., Lestrelin, G., Hoanh, C., 2013. Payments for ecosystem services in Vietnam: Market-based incentives or state control of resources? Ecosyst. Serv. 5, e94–e101.

To, P.X., Dressler, W.H., Mahanty, S., Pham, T.T., Zingerli, C., 2012. The prospects for payment for ecosystem services (PES) in vietnam: a look at three payment schemes. Hum. Ecol. 40, 237–249.

van Noordwijk, M., Leimona, B., Jindal, R., Villamor, G.B., Vardhan, M., Namirembe, S., Catacutan, D., Kerr, J., Minang, P.A., Tomich, T.P., 2012. Payments for environmental services: evolution toward efficient and fair incentives for multifunctional landscapes. Ann. Rev. Environ. Resour. 37, 389–420.

Viet Nam Government, 2001. Decision No. 178/2001/QD-TTg dated 12 November 2001 by the Prime Ministoer issuing Regulation on the benefit right, responsibilities of the households. individual who are allocated, leased, and contracted forest land.

Viet Nam Government, 2010. Decree 99/2010/ND-CP: Decree on the Policy for Payment for Forest Environmental Services.. Ha Noi, Viet Nam.