Ecosystem Services in Biodiversity Conservation and Human Wellbeing: Evidence from Veun Sai-Siem Pang Conservation Area, Cambodia

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Prepared by
Abu SMG Kibria

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1. Introduction

Ecotourism is considered as the most important cultural ecosystem services. Number of studies on socio-economic effects of ecotourism has greatly emerged in past decades. But those are largely lacking of strong recognition to ecotourism as ecosystem service and observing socio-economic impacts based on a proper definition of human wellbeing (Rowat & Engelhardt, 2007). Millennium Environmental Assessment (2003) showed the linkages between ecosystem services and different components of human wellbeing. Since then research interest has grown to study the role of ecosystem on wellbeing instead of socio-economic condition. In Veun Sai-Siem Pang Conservation Area (VSSPCA) indigenous people are engaged in hunting at the forests for generations, thereby, made many species vulnerable. Conservation International implemented a Community Based Ecotourism (CBET) project for conserving the unique biodiversity especially the primate community. CBET is a strategy that uses cultural ecosystem services of forests and thus, enhances the importance of both forests and wild life. This is also potential to enhance wellbeing of the poor forest dependent people. Valuing ecosystem services and exploring its impacts on human wellbeing will generate valuable information to consider the nature as a source of diverse services in formulating policy decisions.

2. Methodology

2.1 The study area

VSSPCA is a large pristine forest in North-eastern part of Cambodia contiguous with Virachey National Park. This area is located in the Veun Sai District of Ratanakiri Province and Siem Pang District of Stung Treng Province. Ecologically, this area is located within the Indo-Burma hotspot (Myers et al., 2000).

2.2 Valuation of ESS

2.2.1 Provisioning services

Rural people in the villages adjacent to VSSPCA collect timber, resin, malva nuts, bamboos, mushrooms, wild animals from the forest. Quantitative and qualitative data of provisioning services were collected from secondary sources, key informant interview and group discussion with the local indigenous people, research assistants and village elderly people (POH-KAO, 2012, Persson et al., 2010, Ramachandra et al., 2012). Direct market valuation method was used to calculate the value of these services of the forest.

2.2.2 Carbon Storage

For estimating the value of carbon storage as ESS the following formula (Xi, 2009) was followed:

$V=Q*P*S$

Where, V = service value of carbon storage (US$), Q = carbon storage capacity of the ecosystem (t/ha), P = international carbon price (US$/t), S = area of forest (ha).

2.2.3 Water storage

One commonly adopted valuation method is the rainfall storage method was used for this valuation (Biao et al., 2010). The equation is:

$V=Q*C_{yt}$ [Here $Q=S*J*R$ (where $J=J_O*K$ and $R=R_O-R_g$)]

Where: V = Annual economic value of forest ecosystems in watershed protection; Q = Increase in water preserved in forest (meadow) ecosystems, compared to bare land (or non-forested area) (m^3); C_{yt} = Investment cost of reservoir construction per m^3; S = Area of the forest (ha); J = Annual average precipitation runoff yield of the study area (mm); R = Benefit coefficient of reduced runoff in forests (meadow) compared to bare land (or non-forested area) (%); Jo = Annual average precipitation of the study area (mm): K = Ratio of precipitation runoff yield to total precipitation of the study area; R_0 = Precipitation runoff rate under precipitation runoff condition in bare land (or non-forested area) (%); R_g= Precipitation runoff rate under precipitation runoff condition in forests (%)

2.2.4 Soil erosion prevention

The formula for calculating the value of soil erosion prevention by forests is as follows (Xi, 2009):

$Vsc=K*G*\sum Si*D$ [here, D=di-do]

Where: Vsc= Economic value of soil conservation; K= Cost of 1 ton of sediment removal; Si= Area of all types of forest (ha); D= Erosion reduction in forest land; G= Ratio of amount of sediments entering rivers or reservoirs to total soil lost; di= Rate of erosion of broad leaved forest (t/ha); do= Rate of erosion of non-forest land (t/ha)

2.2.5 Soil fertility improvement

The forest also helps to maintain fertility since soil erosion may result in losses of N, P, K and organic substance which can be regarded as proxy for nutrient cycling function. Thus, the nutrient cycling valuing formula is as follows (Xi, 2009):

$$V_f = D * S \sum P_{1i} * P_{2i} * P_{3i}$$

Where: D= Erosion reduction in forest land compared to non-forest land; P_{1i}= Content of N,P,K in forest soil (%); P_{2i}= Ratio of pure N,P,K to their fertility counterparts. The ratio of N, P, K to their fertilizer counterparts are 60/28,406/62,74.5/39 respectively (common fertilizers used are urea for N, Calcium Superphosphate for P and Potassium Chloride for K); P_{3i}= Price of fertilizers (i.e. Price of urea, Calcium Superphosphate and Potassium Chloride)

2.2.6 Recreation

We have measured the value of the recreation of the forest by multiplying the willingness to pay (WTP) with number of tourists (Baral et al., 2008). The average number of tourists was 60/yr and 20 tourists were interviewed, thus, 33% of the total population was covered.

2.2.7 Environmental purification

The method commonly adopted involves area absorption (Xi, 2009). The formula is:

$$V_e = \sum_{i=1}^{n} S\ Q_i C_i$$

Here, S= Area of broadleaf forest (ha); Q_i= Absorption or adsorption of the i^{th} pollutant per unit area (kg/ha); C_i= Treatment cost of the i^{th} pollutant (US$/kg); V_e= Value of air purification by forest (US$/yr).

2.2.8 Educational and scientific value

It is worldwide recognised that forests are great sources of knowledge (Costanza et al., 1997, MEA, 2003, Fisher et al., 2013). VSSPCA received great attention from the local and international intellectuals. We explored scientific and educational values of the forests from the data of: a) How many schools/institute visited the area as study tour, b) People from how many countries visited, c) Number of researchers were involved, d) Number of thesis (MSc, PhD) was performed, d) Number of articles and report has been published on VSSPCA area and what are the contributions to the existing knowledge of natural resource management (deGroot et al., 2010)

3. Results and discussion of Objective-(1)

3.1 Monetized value

3.1.1 Forest goods

Forest is a vital supplier of myriad wood and non-wood products to local people. These have the potential for increasing income and diversifying livelihoods of some of the poorest part of the human society (Bawa et al., 2007). It was found that indigenous people harvested 15 different goods from the forest. Firewood was collected by all of the villagers and about 80% families are engaged in cutting saplings for fencing, collecting cane and malva nuts. More than half of the families extracted resin from *Dipterocarpus spp* and that was considered as vital source of household income. Timber harvesting for house building was performed by 42% families in an average of $4m^3yr^{-1}$. Watersheds in forest area were vital sources

various fishes for the villagers (80%). People also caught different wild animals for self-consumption and sometimes selling to the market. Thus, in total the forest was supplying provisioning services worth US$370008/year. Apparently this contribution seems quite big, but in compare to the total value of the services receiving form the forest this value accounts only 0.19%.

3.1.2 Carbon storage

We estimated the conservation forest of Veun Sai stored carbon worth US$102.10 million/yr in a rate of US$1834/yr/ha. Carbon storage accounts 40% of total measured benefits of the forest. Curving down the current rate of deforestation and degradation of forest would assist world in reducing the dangerous effects of climate change in a cheaper way (Clements, 2010).

3.1.3 Water storage services

Human society relays heavily on accessible freshwater resources. Forest can ensure the availability of enormous volume of fresh water which would cost millions to manage by other means (Biao et al., 2010). Water storage benefit of the forest is worth US$39.5 mill/yr. The forest is estimated to storing amount of water per hectare that would cost US$710 /yr. This benefit accounts for 13% of the total value offered by the forest.

3.1.4 Soil erosion prevention

In our study we found that total value of soil erosion prevention provided by VSSPCA was US$22.21 million each year (399US$/yr/ha) and that was 7% of the total benefits provided by the forest. Failure to protect forest would not only increase the water management cost, it also could affect the society in many different ways.

3.1.5 Soil fertility improvement

The forest of VSSPCA was playing important role in nutrient cycling that equals to US$62.07 million annually. The value of nutrient cycling in unit area (ha) of forest is US$ 1116/yr/ha which was a significant portion (20%) of the total measured value of the services. A decline in forest soil quality would affect growth of trees and biomass, game potential, aesthetic etc. The quality of land and tree cover, gaming potential etc. may led to 17% rise in property price (Snyder et al., 2008).

3.1.6 Environmental purification

People have known that trees can help to reduce air pollutants for a long time. Trees can reduce air pollutants in two ways: (1) by direct reduction from the air, and (2) by indirect reduction by avoiding the emission of air pollutants. In direct reduction, trees absorb gaseous pollutants like sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) through leaf stomata and also can dissolve water-soluble pollutants onto moist leaf surfaces (Nowak, 1994).The value of environmental purification by the forest was estimated US$56.58 each year in a rate of 1001 US$/yr/ha. This accounts 19% of the in relation to the total benefit of the ESS.

3.1.7 Recreational

Recreational opportunities and amenities have been identified as important human-use services generated by green spaces (Lorenzo et al., 2000). Recreational activities provide the major recognition to the nature and supports protection of ecosystems. Recreational value of the forest includes the value generated by the forest itself and

gibbons. By applying contingent valuation method the recreational value of the ecosystem was found US$11542/yr in which forest itself contributed US$5412/yr and the gibbons accounted US$6129/yr. This clearly entails the attempt to save the forest only based on the recreational benefits e.g. Community Based Ecotourism (CBET) would not be feasible if the activities run in current pace. However, primate in that forest had attracted tourists from around the world and thereby, increased the recreational value of the forest as a whole. Many tourists reported that if there was not gibbon they would not visit VSSPCA i.e. the recreational value of the forest would be nearly zero. However, along with CBET program immediate attempt is required to include other ESS values of the forests in the management plan in order to conserve the unique biodiversity of VSSPCA.

3.2 Non-monetized value

3.2.1 Educational and scientific

Forest ecosystem is a great source of knowledge and destination for diverse research efforts. Scientific articles, reports, popular articles and visits on forest ecosystem communicate with wider societies and grow interest and awareness on ecological relationship (Farmer et al., 2008, Costanza et al., 1997). VSSPCA has produced valuable research results, and created networks among the researchers and organizations.

Ramachandra et al. (2012) analysed the methodological limitations of spatial and non-spatial models for predicting future deforestation. This valuable output would assist scientist to find out improved method for predicting deforestation rate worldwide.

Rawson and Bach (2011) discovered that geophagy is a common behaviour of douc langurs and silvered langurs who are predominantly arboreal. This result opened a scope to research on the function of geophagy for colobines in VSSPCA. Moreover, this provided guidelines to determine the conservation measures for conserving these two taxa.

Jackson (2014a) explored the effects of species-specific seed dispersal patterns on seedling recruitment of *Microcos paniculata.* He found that the main dispersers were bulbuls (three species) and gibbons. These results also suggest that the microclimate associated with adult *M. Paniculata* trees improved seedling recruitment and with the increased dispersal distance the ability of seedling recruitment was reduced. Jackson (2014b) conducted research at VSSPCA to develop method to assess the presence of animals and estimate their population size. Traditional means of estimating animal abundances are extremely time consuming and costly especially when they are rare and cryptic. In combination with the batch extraction and amplification techniques this would be a robust method for biodiversity monitoring in remote locations.

Hill (2011) conducted survey to understand the local knowledge and uses of primates in the villages around VSSPCA. Distance of the village from the forest and the level of knowledge on primates had a reverse relationship. She also explained the local wild life trading channel as: indigenous people→ traders in Chinese village→ Vietnamese in Ban Lung. These results would guide us in designing the program for primate and their habitat conservation.

Geissler et al. (2012) discovered *Lygosoma veunsaiensis* in VSSPCA which is considered to be a new species of lizard. This is the third new species in the last two years to be discovered in the area. In 2011 a new bat species *M. walstoni* was described by Csorba et al. (2011) and Thinh et al. (2010) identified a new gibbon species (*Nomascus annamensis)* in VSSPCA. Naven et al. (2010) explored the food and habitat of 'Asian small-clawed otter' in North-eastern Cambodia that includes VSSPCA. This research is by far the first scientific study on this otter species and considered the only source of reliable information about the species.

Australian National University runs a field school at VSSPCA to teach both honours and postgraduate students the effective and precise methods of data collection and build the capacity to utilize these data in biodiversity conservation plans and strategies.

This forest has offered research opportunities and connected 19 different academic and non-academic organizations in conducting research. This is a great example of how a patch of forest can establish such enormous research network and familiarize a country worldwide in a new dimension.

3.2.2 Ethno-cultural

Animism is the dominant religion of ethnic communities that is apparently the influence of forest. Indigenous people especially Lao and Kavet people believe that the spirit (locally called Arachs) of their ancestors lives inside the forest. Arachs is believed to guide villagers for their livelihoods. In village ceremony every family prepare traditional Jai Wine and offer to the spirits. They also practice offering chicken, pig, and a jar of wine to the spirits before commencing any major event such as shifting cultivation, logging for building house, weeding etc. If someone gets sick they believe their ancestors became angry with the person or villagers due to cutting trees and wild life hunting from the sacred places or someone did something wrong that dissatisfy the spirits. All the beliefs were found weakened because timer traders offer capitals to some villagers to convince for logging. Eventually, the marginalised villagers started to ignore their cultural resources to earn money. Continuous deforestation has eliminated many of the cultural elements of local indigenous people.

4. Activities underway

The field work was enormously challenging due to the remoteness of the area. The road condition was very poor and vehicles were not regularly available. The only research station near the research site had no electricity supply, mobile phone network and internet facilities. Hence, data collection and data analysis were difficult to finish according to the plan. We are currently working for the household survey to find out the effects of ESS on human wellbeing.

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