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An analytical approach in accounting for social values of ecosystem services in a Ramsar site: A case study in the Mekong Delta, Vietnam

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ABSTRACT

Within the existing literature body, the evaluation exercises predominantly adopt expert disciplined assessments to explore the biophysical conditions and economic values of ecosystem services (ES) and ecosystem disservices (EDS). This preference largely emerges from the relative convenience in data collection and quantification of these approaches, collectively accrue to practitioners' beliefs that unless explicitly quantified and monetized, these benefits will be negligible. Social aspects of ecosystems contributions to human well-being, on the other hand, are comparatively harder to grasp, thus predominantly overlooked in the general assessment of ES and EDS. To alleviate this imbalance, we presented a case study in exploring relevant ES and EDS within the context of a protected area using non-monetary methods with the aid of the local community. In particular, through deliberative mapping approach, the manuscript strived to locate, quantify, and assess a full range of relevant ES and EDS as perceived by local inhabitants across the landscape of U Minh Thuong National Park (UMTNP), Vietnam. Within the scope of this paper, we also delved into how socio-cultural perceptions and preferences towards these natural resources diverge among groups of respondents. Through the presented research, we strived to consolidate the baseline understanding regarding the ES profile of the research area with relevant social insights, paving the way for the design and implementation of sustainable management strategies. Finally, this manuscript also sought to present a practical measure to account for social dimensions and their relevance to the general assessment of ES.

1. Introduction

The concept of ES has contributed an essential step to recognize the dependence of human societies on natural ecosystems by connecting anthropogenic benefits with biophysical aspects (Häyhä et al., 2015). With the publications of landmark studies such as Costanza et al. (1997), The Millennium Ecosystem Assessment (MA) (2005), or The Economics of Ecosystems and Biodiversity (TEEB) (2010), ES has made its way into academia and policy circles, representing a sustainable growing number of scientific literature and associated policies (Christie et al., 2012; Rall et al., 2015). The concept has been drawing considerable attention as it could facilitate a platform to integrate different worldviews including scientists from multiple disciplines: ecologists, economists, socialists, *etc.*, to policy planners, and relevant non-professionals (Schröter et al., 2015). Throughout the evolution history of ES, several valuation methods have been developed to account for the biophysical, economic, and social aspects of the human benefits contributed by ecosystems, which accrue to the multidisciplinary characteristic of the concept (MA, 2005, TEEB, 2010, Christie et al., 2012).

The merits of economical approach firstly relate to the simplicity of data collection and computation, hence the mainstream focus of ES evaluation studies on the biophysical and economic accounts, while overlooking socio-cultural information (Plieninger et al., 2013). Also, this imbalance emerges from the vagueness of the terminologies associated with social aspects, such as human needs, wants or satisfaction, which makes it more challenging to establish relationships with ecological processes (Daniel et al., 2012). In other words, it is less explicit to represent the social aspects of ES in a quantitative manner, yet their economic valuations lack robustness, and thus are predominantly neglected (Plieninger et al., 2013).

However, scholars such as Schaich et al. (2010) have raised their opposing voices that the incorporation of socio-cultural features is essentially indispensable for a comprehensive assessment of the

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ecosystems contributions to avoid biased management and unwanted tradeoffs. Likewise, Chan et al. (2012) took note of the ability of social based ES studies to reveal cultural variances among residents groups, which are crucial for sustainable management of natural resources. Even more vigorously, Martín-López et al. (2012) argued that studies, through addressing relevant social variables: perceptions, attitudes, and beliefs are more likely to shed useful lights to human-nature relationships themselves than purely biophysical assessments.

The gap is particularly relevant to the evaluation of Forest associated ES. Being the most important terrestrial ecosystem on Earth, forests supply a wide range of services from the provisioning of clean water, food and timber to the regulating of climate, and hydrological regime, constituting the crucial conditions for human well being (Raymond et al., 2009). How to quantify and evaluate the values of these services, henceforth have drawn considerable attention (see for instance Ninan and Inoue, 2013; Ninan and Kontoleon, 2016; Sutherland et al., 2016; Guimarães et al., 2017). Being able to factor in these values in decision making processes could lead to better conservation outcomes via strengthening the arguments for justifying the conservation. In so doing, not only knowing the ecosystem capacity in terms of quantified ES, but also understanding the interactions (both synergies and trade-offs) among them are meaningful information required by forest managers (Alamgir et al., 2016). The need is even more critical in developing country contexts with the immense pressure of having to divert forests resources for meeting pressing development targets (Ninan and Kontoleon, 2016).

Keeping the above in view, this study aims to contribute an analytical framework to account for the values of forest ES via social accounts, using the case of a biosphere reserve area of Vietnam. There is a substantial number of publications associated with the study site, including peer-reviewed papers, having explored the ecological characteristics given its significance as one of the world's Ramsar sites. The social importance of the site, however, has never been investigated. This pilot study henceforth sought to contribute bridging these gaps with an exploratory evaluation of significant (dis) services across the site landscape, as perceived by the residents.

2. Descriptions of the research area

The research was performed at UMTNP, which contributes significantly to biodiversity preservation of Kien Giang biosphere reserve (BR) and Vietnam's Mekong Delta, in the broader sense. The Park sits on the southeast of U Minh Thuong district, Kien Giang province (Fig. 1), covering the total area of 8038 ha between Minh Thuan (MT) and An Minh Bac (AMB) communes, and supporting one of the largest peat-swamp forests remaining in the country. The National Park houses an extensive collection of terrestrial and aquatic fauna ecosystems, including 32 mammal species, 187 bird species, 37 fish species, and 203 insect species. To accommodate such rich biodiversity, notable ES include the provision of water and nutrients; the regulation of hydrology and climate regime; and the protection from natural hazards. Regarding cultural values, UMTNP also offers nature observation and ecotourism, educational activities, and cultural heritage. In fact, UMTNP is one of the most popular water bird viewing sites of the Mekong Delta, having received 44,000 visitors (97.5% domestic and 2.5% foreigners) and generated the revenue of USD 1 million in 2013 (Tran Ngoc Cuong, 2015).

Since February 22nd, 2015, UMTNP has been registered as the 8th Ramsar site of Vietnam, and the 2228th worldwide. Ramsar is one of the oldest of the modern global environmental agreements, which was negotiated through the 1960s by countries and non-governmental organizations about the increasing degradation of wetlands habitats. The term Ramsar was taken after the name of the Iranian city where the convention was adopted in 1971 and later came into force in 1975. The ultimate mission of the Ramsar convention is to provide the frameworks for national actions and international collaborations for the conservation and wise use of wetlands and their resources. The term *Ramsar site* was used to refer to the important wetlands in the world concerning the representativeness, rare species, abundance, and significance of water birds and aquatic fauna, etc. Up to date, there have been 2242 Ramsar sites with the total area of 215,253,716 ha successfully identified in 169 contracting countries. Vietnam joined the convention in January 20th, 1989 and has contributed eight RAMSAR sites, in which UMTNP being the latest recognized (From http://www.ramsar.org/about/history-of-the-ramsar-convention).

3. Research design

3.1. Assessment framework

This study seeks to propose and apply an analytical framework to quantify and evaluate the social values of the multiple benefits derived from UMTNP. Fig. 2 schematized the overall framework, clarifying the data to be collected, analysis tools and the generation of relevant insights through numerical indicators, including *Richness, Quality*, and *Diversity* of the associated ES across the landscape. The quantification of these indicators is further explained in the following Section.

3.2. Data collection

3.2.1. Secondary data

Among the associated literature reviewed, the Ramsar Information Sheet (RIS) is of particular importance as it provides fundamental information regarding natural attributes (*e.g.* area, hydrological regime) and ecological descriptions (*e.g.* abundance, representativeness and rarity of species). The RIS of UMTNP was prepared by the Biodiversity Conservation Agency, Environment Protection Administration, Ministry of Natural Resources and Environment, Vietnam. Other notable literature include the relevant scientific publications and annual reports prepared by the management board, *e.g.* BirdLife International and MARD (2004), Hoa (2005), Nguyen Van De (2002), Sage et al. (2004), Institute of Tropical Biology (2002), Tran Triet (2002), and UMTNP (2013). Collectively, the analysis of the relevant literature body has provided a general picture of the research area, paving the way for the identification of ecosystem services (ES) and Dis-services (EDS) to be evaluated as summarized in Table 1.

3.2.2. Field survey

In addition to reviewing the existing literature, data collection also includes a public participatory survey. The targeted populations for this survey were randomly selected from the local settlements of approximately 4000 households inhabiting along the 38 km boundary of UMTNP. Following the suggestions of Whittington (1998) who underlined the low response rates of self-administered methods in developing countries, we opted for a face-to-face interview approach. More specifically, we used deliberative mapping technique to collect the participants' responses regarding the abundance and quality of ES/EDS across the study site landscapes. This method is well-known in social science disciplines and has been widely applied in ES assessment studies (see for instance Fagerholm and Käyhkö, 2009; Plieninger et al., 2013; Loc et al., in press).

Each interview typically started with an introduction about the purposes of our research. Our facilitators then explained briefly the importance of ecosystems and their benefits. Subsequently, we discussed respondents' judgments about the ES and EDS of UMTNP using a matrix comprised of the four different LCS in the columns and the list ES and EDS in the rows. Table 2 provides an example of the matrix used in our deliberative mapping exercise.

Alongside the questionnaire, the facilitator also presented the photographs of each LC (Fig. 3) to support the verbal explanations. Co-author Ho Huu Loc took these photos himself shortly before the surveys to effectively describe the current situation of each LC given the

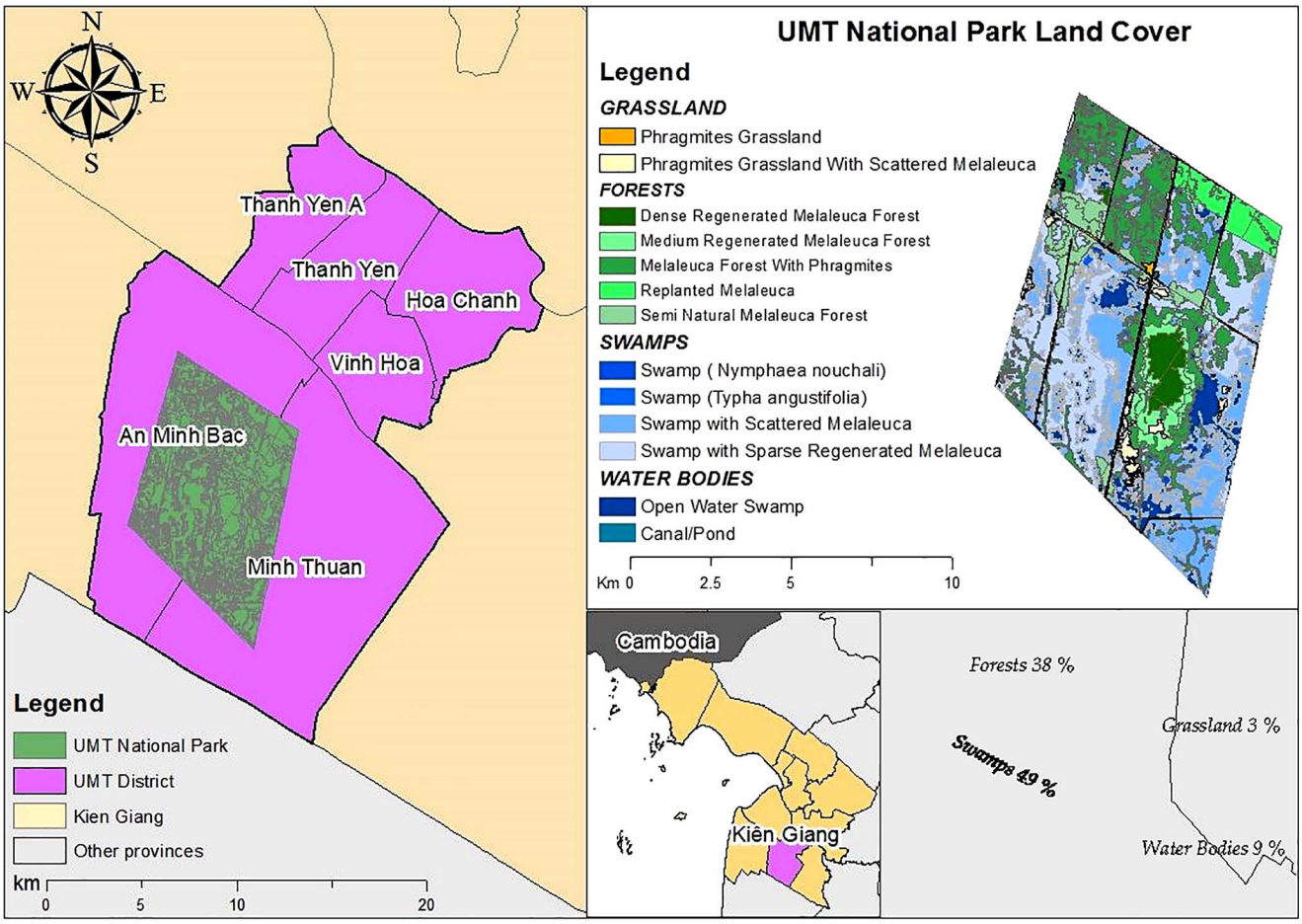

Fig. 1. U Minh Thuong National Park, Vietnam.

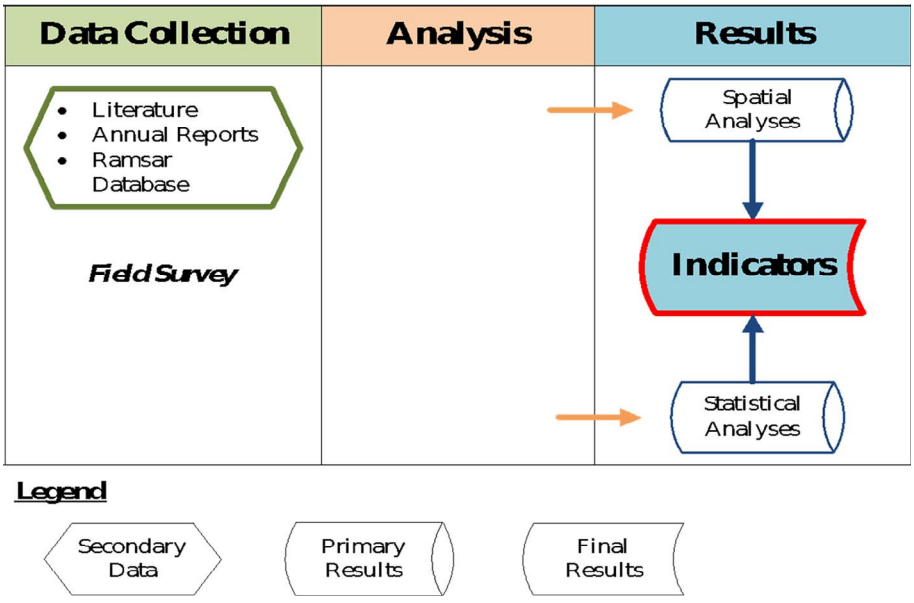

Fig. 2. Analytical framework.

constantly changing looks of the landscapes.

Participants were asked to mark on every ES and EDS that they consider relevant to each LC (Columns B.1–B.4 of Table 2). Upon finishing, the facilitators would ask them how would they *score* the quality/severity of each entry that they had previously marked on the matrix (Columns C.1–C.4 of Table 2), based on a 10-level Likert Scale. The scale from 1 to 10 signifies of the adopted Likert Scale signifies the ascendance of quality and severity of ES and EDS, respectively as illustrated in Fig. 4. Within the adopted scale, only the major tiers were explicitly described. The minor ones were to accommodate intermediate judgments. At the end of each interview, we collected respondents' social background information, i.e. gender, age group, and

Table 1
Classifications of ES and EDS.

Services & Dis-services		Definitions
Provisioning	Water	The supply of fresh water for multiple purposes
	Fishing	The provision of edible fish, shrimp, crab, *etc*
	Timber	The supply of wood
	Grazing	The provision of grass for grazing purpose
	NTFP	The supply of non-timber consumable goods from forests *e.g.* beehives, herbs, wood chips, *etc.*
Regulating and Supporting	Soil conservation	The ability to keep the soil from erosion
	Nutrients Cycling	Capacity to make the soil fertile
	Air purification	The ability to supply fresh air and cool atmosphere
	Habitat	The appearance of a wild variety of animals, birds, fish, *etc.*
Cultural	Recreation	Respondents' relaxations
	Tourism	The appearance of outside visitors
Dis-services	Fire	Fire emerged from natural or anthropogenic reasons
	Disease	Fever, malaria, dengue, *etc.*
	Animal attacks	Disturbances and threats from wild animals, birds, *etc*
	Others	Other disturbances or threats

occupations. Each interview took approximately 40–50 min. The field survey was completed in three weeks from August 6th to 30th 2016

3.2.3. Indicators

From the field survey, three numerical indicators for assessment were quantified. More specifically, the total amount of ES entries associated with the LC columns constitutes the *Richness*, whereas the respective averaged Likert Scaled points constitute the *Quality* Indicator. Finally, the diversity of the ES entries was calculated using Shannon's Diversity Index(*).

3.3. Data analysis

The thrust of this research is to understand where and how residents intuitively recognize the presence of ES and EDS across their living environment. Accordingly, we performed three statistical analyses, *i.e.* Correspondence Analysis (CA) and Principal Components Analysis (PCA), and Hierarchy Cluster Analysis (HCA) using data collected from 94 individual questionnaires. Albeit relatively small compared to 4000 households of the entire population, this sample size is comparable to the current ES evaluation and mapping research using community-scale interviews *e.g.* Plieninger et al. (2013); Raymond et al. (2009); Loc et al. (2017) or Loc et al. (in press)

Initially, the sample verification of data was conducted using Bartlett's Test for Homogeneity of Variances (Bartlett, 1937) and the Kaiser-Meyer-Okin Measure of Sampling Adequacy (Tabachnick and Fidell, 2001). To confirm the adequacy of the principal components generated, we followed the Kaiser Criterion (Hair et al., 1998). After these quality-control tests, we applied CA for the count data regarding the number of ES entries related to each LC. Subsequently, how the ES/EDS quality diversify were analyzed through PCA. Within the second analysis, the active variables are the points allocated for each ES/EDS, accumulated from different LCs while the socio-demographic information of respondents were included as supplementary variables. Finally, HCA was employed to group individuals of similar characteristics. All of the analyses above were completed with the aid of FactomineR (Le et al., 2008; Husson et al., 2015; R Core Team, 2015).

4. Results

4.1. Characteristics of respondents

Among the participants, the male is predominant with 74%, expressing their leading roles in families' matters in the local communities. Regarding the age groups, only 6% of the respondents were over 60 years old while 47% were between 40 and 60, and 42% were under 40. Regarding occupations, 72% of the interviewees have agriculture-related professions while the others either have their own business, or are self-employed labors, all of which were typified as *Others* given their minor individual accounts. Native respondents account for 65% of the entire population, while the rest considered themselves as *Immigrants*. Regarding education attributes, only eleven respondents have finished high school while the majority dropped out from secondary or primary classes (43% and 45%, respectively). There were 45 respondents who considered their livelihoods to be dependent on the provisioning of natural resources, among which, 15% is *essentially dependent*.

4.2. Services and disservices

Service with the most entries (n = 205) was Habitat, followed by Soil Conservation, Water supply, Fishing, Air purification, Nutrients cycling, NTFP, Timber, Recreation, Tourism, and Grazing. Categories wise, Regulating and Supporting services are the most widely identified services (n = 582), followed by Provisioning services (n = 507) and Cultural services (148). Disservices, in general, were recognized to a far lesser extent. More specifically, the most identified EDS was Disease (n = 70), followed by Fire (n = 67), and Animal attacks (n = 48). The "*Others*" category of EDS had only four entries, hence neglected for further analyses (Fig. 5).

Table 2
Sampled Matrix used for deliberative mapping.

A	B.1	C.1	B.2	C.2	B.3	C.3	B.4	C.4
Land Covers	Forests		Grassland		Water Bodies		Swamp	
ES/EDS	Yes/No	Marks	Yes/No	Marks	Yes/No	Marks	Yes/No	Marks
Timber								
Water								
…								

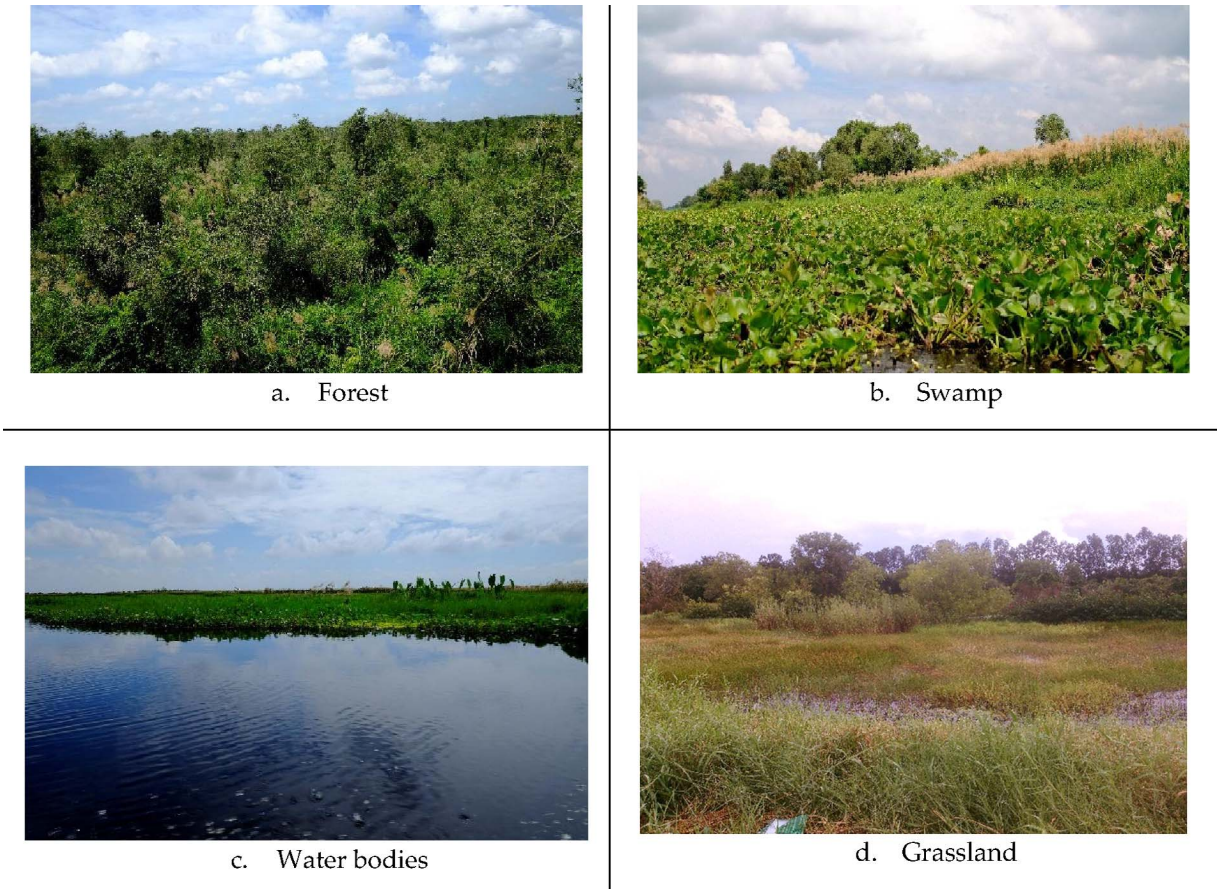

Fig. 3. Typical land covers of UMTNP. Photo credit. Co-author Ho Huu Loc.

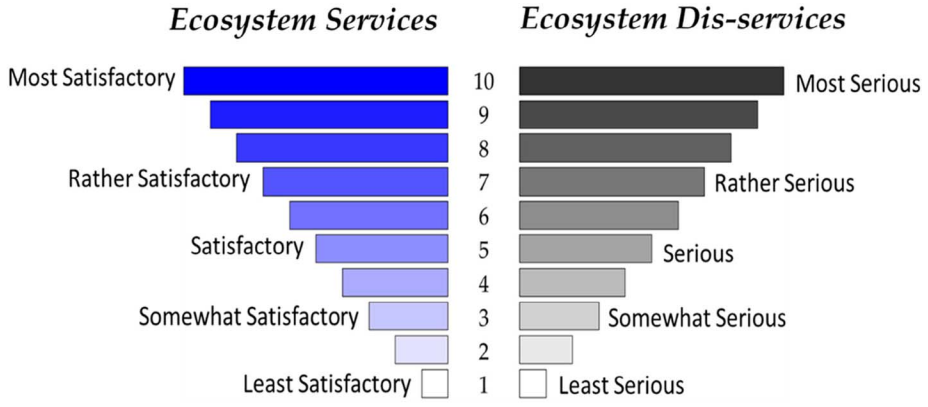

Fig. 4. The Likert Scale adopted in the field survey.

4.3. Relationship to the landscape

Within the study site, Swamps and Forests are the predominant landscapes, covering 49% and 38% of the total area, respectively, while Water bodies and Grassland respectively account for 9% and 3%. Among these four LC classes, Forests has the highest intensities of associated ES, with 649 out of 1237 entries. Water bodies, Grassland, and Swamps account for 279, 222, and 87 entries of ES, respectively. EDS, representing the negative aspects are exclusively associated with Forests through 150 out of 189 entries. The distribution of (dis-) services are of great diversity across the landscapes, regarding both abundances and categories. In particular, Regulating and Supporting services are the most perceived benefits of Forests, Swamps, and Grassland whereas Water bodies are the most associated with Provisioning services (Fig. 6).

Regarding diversity differences, while Forests, Swamps and Water bodies all feature 11 different types of services, their Shannon indexes(*) nonetheless differ, which equal 2.290, 1.804, and 1.85, respectively. Grassland, on the other hand index equals 1.986 despite featuring only 10 different ES. Fig. 7 depicts the spatial distribution of the total ES intensity, EDS intensity and ES diversity.

We further investigated the bundles of ES on the LCS via CA method. These relationships were proved significant via the Chi-squared p value of 2.2×10^{-16}. The first two axes of the CA accounted for 90% of the inertia (Fig. 8). The first axis (57.85% of inertia) differentiates between terrestrial related services: NFTP, Nutrients Cycling, Soil Conservation with aquatic related ones: Water supply and Fishing. Within the figure, the ellipses represent the statistically

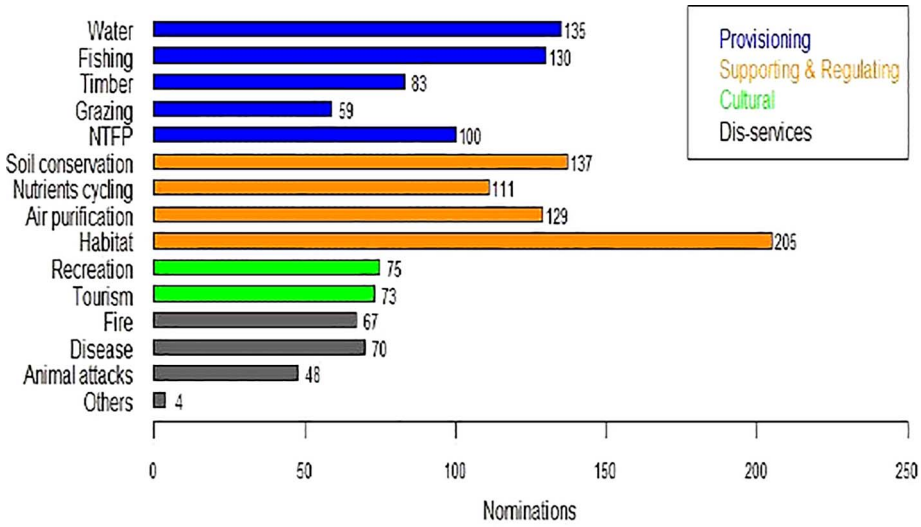

Fig. 5. ES and EDS total entries.

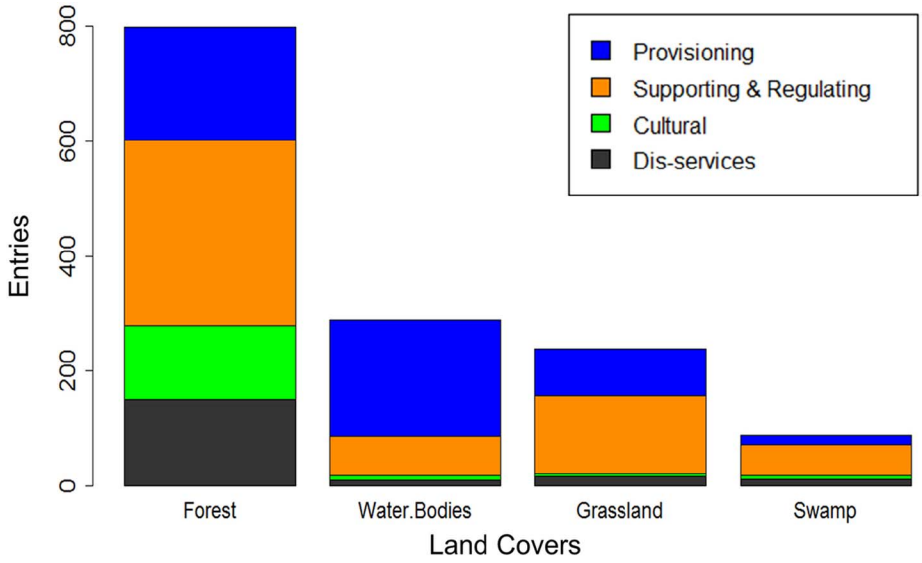

Fig. 6. ES and EDS associated with different land covers.

significant differences among LCs with respect to the abundance of (dis) services based on the confidence level of 95% (Husson et al., 2010). In principle, the closer the (dis) services (blue and gray dots) are to a given LC (red triangle), the more connected they become. For instance, the most significant ES of Swamp is Habitat, whereas Timber, Recreation, Tourism are the most connected to Forest. On the contrary, the regulating and supporting ES, *i.e.* The Provisioning and Regulating ES, *i.e.* Nutrients cycling, Air purification, and Soil conservation are relatively close to the origin, representing their *Neutral* status because the entry amount of these indirect ES are not significantly different across different LCs. Differently put, the respondents could essentially acknowledge the important attributes of different ES: some are connected to certain landscapes, while others are more widely distributed. Finally, the gray dots representing EDS are exclusively associated with Forests.

Each ES richness indicators were then integrated into the digital LC maps of UMTNP to visualize their spatial distributions (Fig. 9). In general, the majority of ES and EDS are the most associated with Forests, except for Water Supply, Fishing and Grazing. The first two exceptions are the highest in Water bodies, while the last one is the most related to Grassland. These differences are substantially relevant to the different characteristics of each LC, implying the relevance of place-based knowledge in identifying and quantifying multiple benefits derived from the landscapes.

4.4. Relationships to social attributes of respondents

4.4.1. General evaluations of ES and EDS

Fig. 10 describes the averaged points allocated to each type of ES and EDS, accumulated from four different LCs. Respondents' evaluations were substantially diverse across the list of ES (EDS) and are mostly associated with the biosphere reserve function of the research area. Being a National Park, the extractions of natural resources are limited, hence the comparatively lower points of Provisioning services. Within this category, only Water (11.14) and Fishing (9.07) are comparable to Regulating and Supporting ES because the utilization of these two resources are relatively less restricted. Similar to the general trend of Fig. 3, Habitat is the most highly graded benefits of the area (16.07), followed by Supporting services: Air purification (11.91), Soil Conservation (11.09), and Nutrients cycling (9.01). The fauna population, which contributes the highly regarded Habitat ES, is simultaneously relevant to Animal attacks (10.18). Finally, the associated ecotours services are currently provided by the management board of

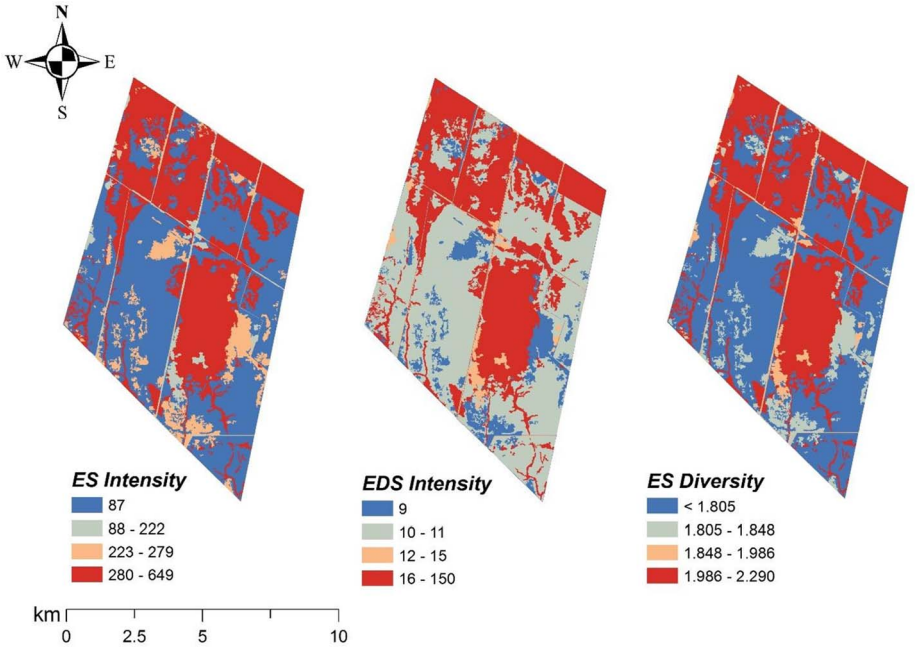

Fig. 7. Aggregated patterns of (dis) services.

UMTNP with limited participation of the residents, hence the relatively underrated values of Recreation and Tourism.

4.4.2. Multivariate analyses

Bartlett's Test of Sphericity results in the p value of 2.2×10^{-16} and the Kaiser-Meyer-Okin statistic that equals to 0.62 (> 0.5) verified the applicability of PCA method for the collected data. Findings from PCA are summarized in Fig. 11, in which the first three principal components (axes) together accounted for 55.88% of the total inertia. Among which, the first axis (25.38% of inertia) was significantly and positively related to NTFP, Tourism, Nutrients Cycling, and Fishing; the second axis (19.20% of inertia) was positively related to Water Supply, Habitat and negatively related to Recreation; the third axis (11.30% of inertia) was positively related to Air purification and negatively related to Timber. Concerning the associations between ES, two revealed bundles are (1): Water supply, Soil conservation, and Habitat; and (2): Nutrients cycling, Tourism, and NTFP, signifying positive relations among these services. In consideration of effective representation, we only plot variables contributing the most to the explaining power of each principal components, which contribute 60% of the total inertia.

The results from HCA, which helps to explore the bundles of social preferences towards relevant ES within the sampled population are visualized in Fig. 12. Also, Table 3 describes the characteristics of each cluster regarding the evaluating variables, in comparison with the Population via hypothesis tests with 95% confidence level. For instance, Tourism is significantly underrated by Cluster 1 given its averaged points being only 0.64 compared to 5.92 of the Population ($p = 1.15 \times 10^{-13}$). On the contrary, some differences are not statistically significant ($p > .05$), hence denoted by NAs in the table.

In principle, Cluster 1 represents the group with the most pessimistic evaluations of the natural resources of UMTNP, having underrated Fishing, Timber, Gazing, NTFP, Nutrients Cycling, Recreation,

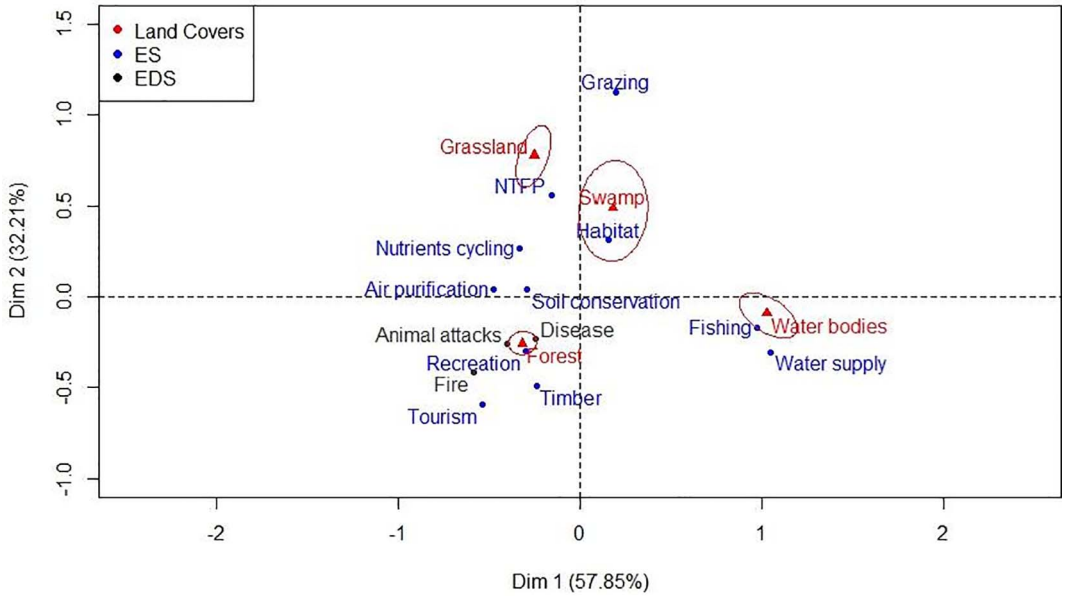

Fig. 8. Scatter plot of the first two axes of the correspondence analysis (CA).

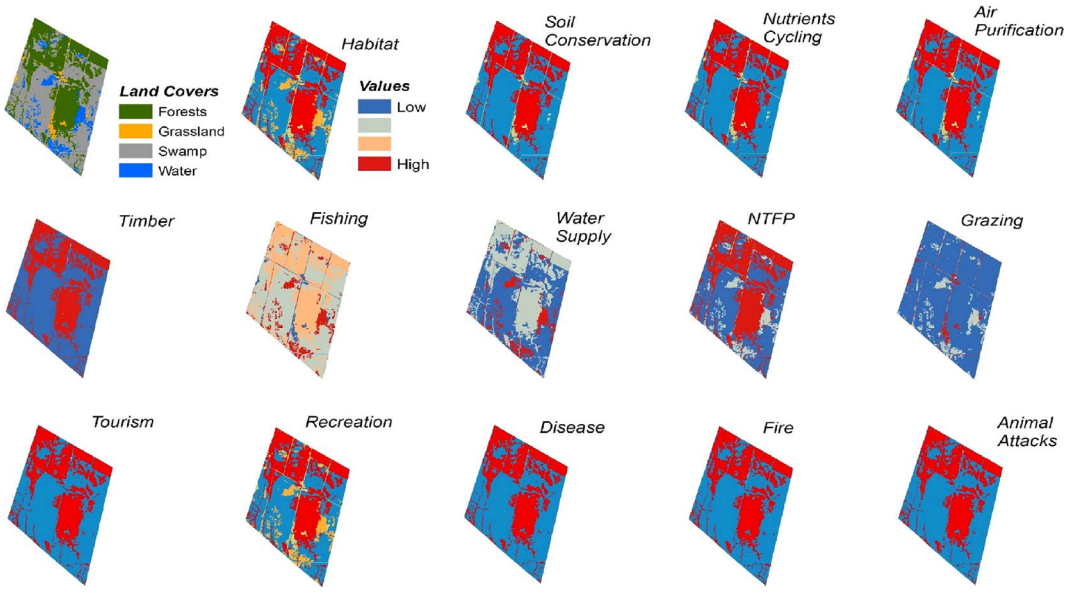

Fig. 9. Spatial distributions of ES and EDS.

and Tourism. Conversely, the assessments from Cluster 3 are better than the average of the population, except for Tourism. This optimistic attitude is also applicable to EDS, demonstrated through the relatively low points for Disease. However, Cluster 3 is quite concerned about Animal attacks. Standing in between are Cluster 2's individuals, who have underrated Water Fishing, Soil Conservation, Air purification, and Habitat while overrated Grazing, Recreation, and Tourism. Also, with the supplementary variables, Clusters are also distinguished by social attributes of contributing individuals. These variances, although not treated as primary variables within PCA, proved significant with hypothesis tests. More specifically, the differences among the clusters concerning the Communities, Age groups and Perceived Dependencies on Natural Resources are considerable with the p values equal 1.17×10^{-17}, 1.48×10^{-4} and 2.86×10^{-2}, respectively. In particular, Cluster 1 is built up mostly by the young to middle-aged respondents from MT commune; while Cluster 2 consists of AMB residents, who claimed to be independent of natural resources, and mostly did not drop out until high schools. Finally, those self-perceived nature dependent residents from AMB commune constitute the cloud of Cluster 3, who have the highest regard for ES.

5. Discussions

5.1. Methodological implications

5.1.1. Deliberative mapping

The presented method in this research was adopted from the renowned deliberative mapping technique for assessing landscape values through the aid of the local communities (Fagerholm and Käyhkö, 2009; Kingston et al., 2000; Voss et al., 2004; Plieninger et al., 2013). This research sought to propose a slightly different approach, using contingency tables to collect the spatial distribution and values local people attach to different (dis) services across the research area. One important benefit of this technique lies in the simplification of participants' mapping tasks compared to the uses of sticker dots, point markers to delineate zones (*e.g.* McIntyre et al., 2004; Brown, 2005). Besides, another unique advantage of this method relates to the alleviated workload in data processing, as the primarily collected data were

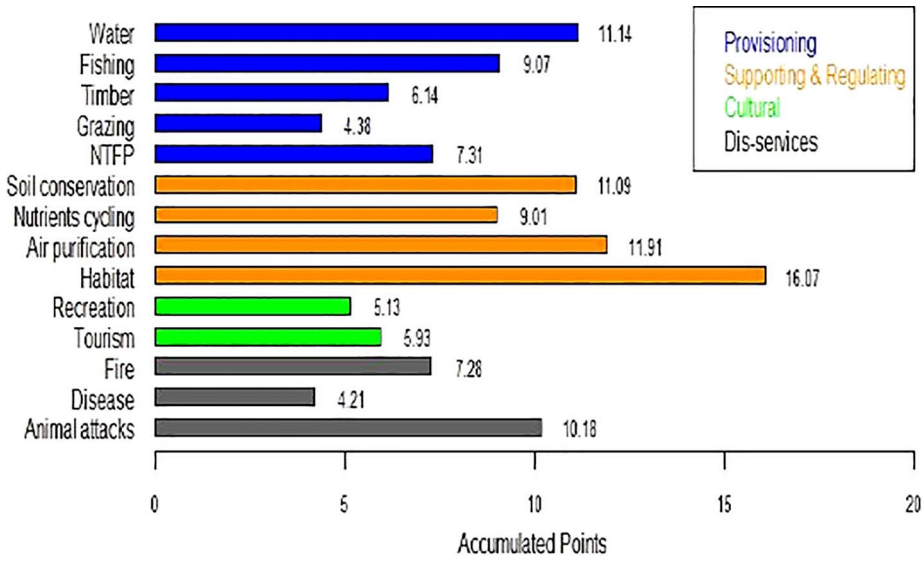

Fig. 10. Stakeholders' perceptions towards ES and EDS.

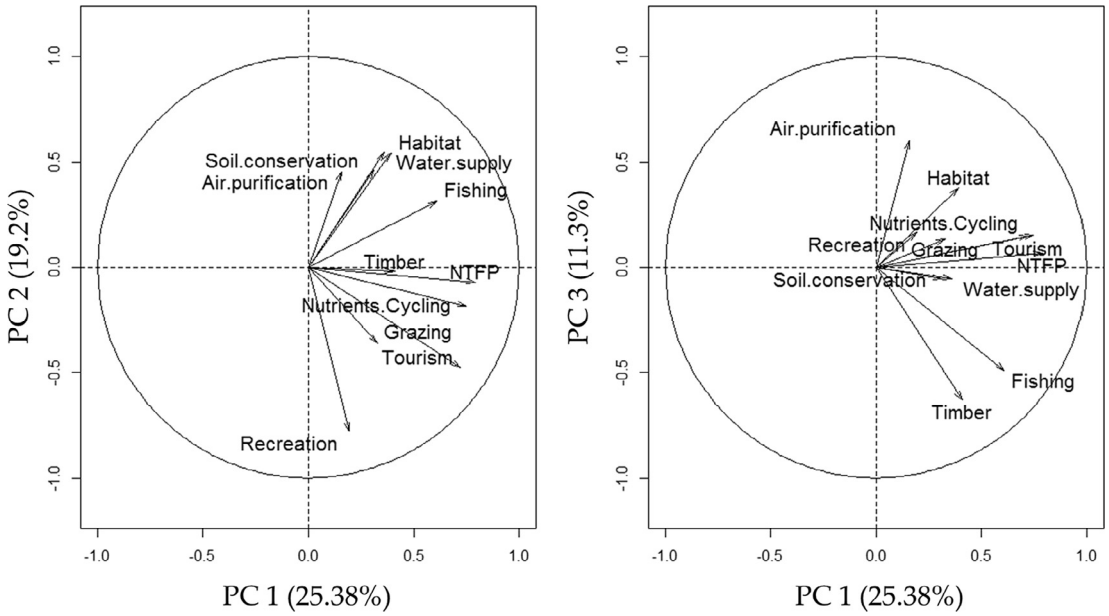

Fig. 11. Plots of associated variables of the first three axes of the principal component analysis (PCA).

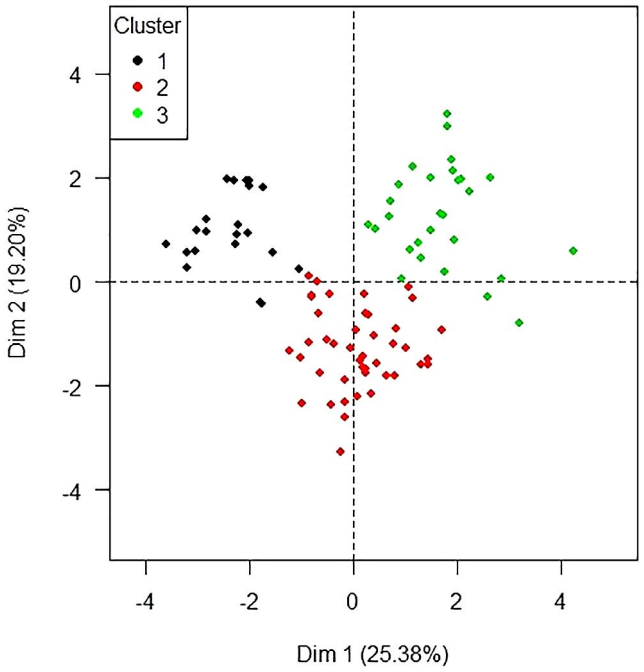

Fig. 12. Individuals factor map from HCA.

already in preferable forms for statistical analyses.

5.1.2. Supportive materials

Within the presented case study, the use of photographs also contributes an important methodological implication. In fact, UMTNP related images were readily available on the Internet given the popularity of the site, however, were not useful due to their low resolutions. Moreover, the constantly changing looks of the landscapes within a year easily confuse viewers, for instance, between Swamps and Grasslands. Therefore, we decided to take the photographs shortly before the surveys to support the verbal explanation of the interviewers. These additional efforts were well worth it, as participants appeared to be more comfortable with the photographs provided than they had been during the pretest survey.

5.1.3. Language of participation

A significant observation obtained from the interviews relates to the language barriers *i.e.* the different perceptions for the same (dis) services between ES trained personnel and the local nonprofessionals. By "*language barriers*," we referred to the way local stakeholders intuitively perceive ecosystems contributions emerging from their daily activities without having to refer to any ES textbooks. Realizing ways to overcome these barriers are therefore necessary to capture relevant social insights from non-professional respondents (Greenhalgh and Hart, 2015; Verburg et al., 2016). As a contribution to these regards, this case study sought to present a more participant oriented approach. Our field surveys essentially centralized the roles of respondents by encouraging them to express their understanding, experience through mapping exercises. This method facilitated informal interviews by not trying to *teach* highly technical terminologies thus essentially reduce the risks of information loss or distortions from confusions or misunderstandings.

5.2. Challenges

5.2.1. Acknowledgement of research outcomes

The first and utmost caveat of this study is the interpretation of research outcomes. To facilitate the discussions with participants, the LC abstract map was essentially simplified, which overlooks the biological heterogeneity of the study site. For example, swamp areas with different vegetation coverage: Nymphaea Nouchali, Typha Angustifolia, or scattered Melaleuca were uniformly labeled, regardless of their diverse flora and fauna systems. Therefore, our findings could not be *directly translated* into ecological measurement signals *e.g.* resources stocks, biodiversity richness or associated risks across the landscapes. Accordingly, the association of Habitat with Swamp (Fig. 8) implies the participants' frequent encounters with wild animals during their daily activities at some specific swamp sites, rather than the *ecological biodiversity richness* as a general term. As such, these findings nevertheless revealed social judgments towards the biological characteristics of the areas. Based on these preliminary observations, future investigations that are more robust could be achieved through finer mapping exercises (Norton et al., 2012), having respondents to delineate ES zones (Fagerholm and Käyhkö, 2009), or adopting more comprehensive participatory methods such as In-depth Interviews, Rapid Rural Appraisal, Q-methodology, *etc.* (Christie et al., 2012).

Table 3
Characteristics of Clusters.

(Dis) services	Population	Cluster 1	Cluster 2	Cluster 3
Water	11.14	NA	8.75	15.36
Fishing	9.07	5.82	7.66	13.86
Timber	6.14	3.77	NA	7.64
Grazing	4.38	1.50	6.11	NA
NTFP	7.31	1.0	NA	10.93
Soil conservation	11.09	NA	9.48	13.71
Nutrients cycling	9.01	0.4	NA	13.61
Air purification	11.91	NA	10.45	14.07
Habitat	16.07	NA	11.41	24.04
Recreation	5.13	2.45	8.14	2.5
Tourism	5.93	0.64	7.57	7.5
Fire	7.28	NA	NA	NA
Disease	4.21	NA	NA	2.54
Animal attacks	10.18	NA	NA	11.64

Notes: Green and Red shades depict higher and lower points compared to the Population, respectively.

5.2.2. The population

The second challenge is associated with the participating population formed only by the residents while the research area also serves a significant amount of outside visitors. Especially, the famous bird-viewing sites within the UMTNP have attracted thousands of wildlife photographers as well as ornithologists, both domestic and international (Bird Life International and MARD, 2004). The preferences of these visitors regarding the ecological significance of UMTNP, however, are essentially outside the scope of this case study. It would be of particular importance to explore the perceptual differences between these outside visitors and local people regarding their judgments to ES, needs, and expectations. For example, residents, given the threat of potential attacks could negatively perceive wild animals, which conversely are the main attractions to tourists. Alternatively, the utility functions of outside visitors' are likely to be connected to the site's natural capital, which is largely different from the residents who attached cultural values or use values to their living environments (Plieninger et al., 2013).

5.3. The relevance of local expertise

This research sought to capture the real knowledge of the local community living along the boundary of UMTNP. From our findings, these local inhabitants have demonstrated solid understanding about the natural resources of the area, which cumulatively evolve from their daily experiences. This source of knowledge, however, is currently missing from the associated literature body. This research hence strived to contribute an exploratory assessment of these aspects using participatory data collection method combined with three multivariate analyses techniques. More specifically, the comparatively greater amount of entries attached to non-consumable values, and their comparatively highly regarded statuses essentially ratified respondents' awareness about the importance of these natural processes. Alternatively, the less significant entries of Tourism and Recreation services indicate the limited participation of the local community in the eco-tours currently operated by the management board of UMTNP. The bundles of ES in CA essentially confirm respondents' ability to identify relevant benefits and disturbances of specific LCs. In other words, findings from this case study have underscored the relevance of local expertise to consolidating the baseline understanding of ES stocks and flows.

5.4. Contributions to landscape management strategies of the area

As previously mentioned, the motivation behind this manuscript is to provide social-based assessments for relevant ES and EDS within UMTNP, which are essentially missing from the existing body of literature. Using the Deliberative-mapping technique, we sought to shed useful lights into the spatial distributions of ES and EDS across the research area as perceived by participants and the divergences between participants groups. Raising public awareness, recognizing potential conflicts associated with different communities, and identifying risks of harmful actions emerging from inappropriate perceptions are among typical examples where our findings can contribute to the sustainable landscape management strategies. The mismatch between the underrated Tourism and Recreation values from respondents and the substantial annual revenue from eco-tours essentially implies the need for public awareness improvement. In addition to enforcing regulations or implementing educational campaigns, it might be as important to involve local inhabitants into the operation of the eco-tours, hence nurture the protective behaviors. Secondly, bundles of ES evaluations identified in HCA could have implied the essential imbalances among the local inhabitant's perceptions. While some demonstrate high regards for the ecosystems benefits, others are not as likely to, which potentially leads to conflicts about the utilization and reservation of shared resources. The depreciating attitudes of specific individuals, on the other hand, resonate deeply with illegal animal trapping, water polluting, fires, *etc.* that have been underscored as standing threats to the National Park (Tran Triet, 2002; Tran Ngoc Cuong, 2015).

6. Conclusions

The pilot study presented indicates that the integration of the deliberative mapping approach with multivariate analyses is an effective approach in assessing the local people's perceptions towards the landscape services. Various findings from this research could be useful for landscape management strategies *e.g.* the bundling of ES perceived on different landscapes, the geographic patterns of the perceived values across the research area, or the relationships between ES appreciation and participants' social backgrounds, *etc*. Based on these observations, relevant recommendations have been drawn including involving the local community to raise awareness and encourage protective behaviors, recognizing potential conflicts emerged from imbalanced perceptions of residents. Through these findings, we sought to take useful notes on the values of social expertise, or more broadly social dimensions in strengthening ES evaluation frameworks to deliver socially applicable and policy relevant research outputs.

As a contribution to methodological improvements, the presented approach has proved to be applicable in developing community contexts with solid outputs. The major benefits of this method lie in the simplified data collection method and the reduced workload in data

processing. Besides, the acknowledged difficulties are relevant to shaping future research needs. Finally, yet importantly, we would like to underscore that both public participatory and disciplined-based are both capable in producing meaningful findings to landscape management (Stephenson, 2008). These two can be inter-related components, complementing each other to form the holistic understanding of the "landscape values as a whole." Essentially, practical management strategies of landscapes cannot compromise either of the ecological chemical, economic, or sociocultural considerations, because the imbalanced representations among these key factors could not guarantee any integrated and sustainable management strategies.

7. Notes

(∗) Shannon diversity index is a popular quantitative measure used to reflect how many different classes (in this case ES) there are in a data set, simultaneously taking into account how evenly the core entities (in this case nominations) are distributed among those types of services. The Shannon index is calculated using the following equation:

$$H' = -\sum_{i=1}^{R} p_i \times lnp_i \quad (1)$$

where p_i is the proportion of nominations belonging to the *i*th type of services. In the literature, Shannon index is the most widely used indicator to account for diversity; others include the Rényi entropy, and the Simpson index (Shannon, 1948; Simpson, 1949, Renyi, 1961).

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ecolind.2017.12.066.

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