ISSN: 2423- 222X

OUR PALAWAN

THE SCIENTIFIC JOURNAL OF THE PALAWAN COUNCIL FOR SUSTAINABLE DEVELOPMENT
Onsite Management Authority of the Palawan Biosphere Reserve
VOLUME 4 ISSUE No. 1 JANUARY-DECEMBER 2018

Axis Calamianensis - Calauit Island, Palawan, Philippines

IN THIS ISSUE:

OUR PALAWAN
The Scientific Journal of the Palawan Council for Sustainable Development
Volume 4 Issue 1, *January—December 2018*

Published by
The Palawan Council for Sustainable Development (PCSD)
(Management Authority of the Palawan Biosphere Reserve)
PCSD Building, Sports Complex Road, Sta. Monica Heights, Puerto Princesa City
P.O. Box 45 PPC 5300 Palawan, Philippines

ISSN: 2423-222X
Online:
www.pkp.pcsd.gov.ph
www.pcsd.gov.ph
www.palawanbr.pcsd.gov.ph

Cover Photo

The Calamian Deer *(Axis calamianensis)* is an endemic species of Palawan. This species is found only in the Calamian Group of Islands. Aside from its captivating natural beauty, Palawan is high in endemism. It is habitat to unique flora and fauna. (Photo credit: PCSDS, 2004)

ISSN: 2423-222X

PCSD Building, Sports Complex Road, Sta. Monica Heights
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Palawan Council for Sustainable Development Staff

EXECUTIVE DIRECTOR'S MESSAGE

As the yearend of fruitful 2018 beckons, the Palawan Council for Sustainable Development Staff (PCSDS) is pleased to present to the public its 4th edition of Our Palawan Journal. This is the wrap-up of our initiatives, research papers and related activities that were completed during the last semester of the year.

We have envisioned that this journal will serve as platform for publication of the research works for student-researchers, professionals and experts who are willing to share the results and findings of their study. Looking back from our first edition in 2015, we are pleased that so far, we have published 4 volumes comprising of 28 materials for the last 3 years.

PCSDS is committed to support our would-be partners in this similar endeavor. As we desire to maximize the objectives of this initiative, we encourage researchers and students alike to share their works in this medium. We are confident that information sharing will lead to better understanding of the natural processes in our environment and the resources present therein. Inter-connectivity within our biodiversity is off hand an exciting premise that can pique interests and imagination. We must pursue learning and in doing so, there might just be some new discoveries and new potentials worthy of further exploration. We will continue to dream that one day soon, there could be a discovery of a valuable component from our flora and fauna that will cure or treat diseases or even prevent illnesses in the future. Who knows, something worthy of commercialization or an industry-based potential is just within reach from our rich environs.

Our province is endowed with a wealth of natural history. It is a living laboratory with massive opportunities for further study and discovery. Palawan is a paradise so fragile. As such, we must ensure that the processes are consistent with the provisions and issuances promulgated under the SEP for Palawan Act. Environmental research is one of the strategic approaches being espoused under the tenets of RA 7611, hence, we are trying to continuously broaden this platform for both basic and applied research.

In this issue, we are publishing four (4) researches, two of which are contributions from partner researchers while the other two are in-house studies conducted by PCSDS. We also feature articles of our staff presented during the 3rd National Conference on Sustainable Development and 4th Palawan Research Symposium. A new monitoring tool to ensure Sustainable and Responsible Mining in Palawan Biosphere Reserve (Philippines) called Sustainable Management Online Tool (SMOT) is also featured. These are among our recent initiatives which we deemed worth sharing.

In behalf of the PCSD Staff, I would like to thank our contributors for unselfishly supporting this endeavor.

NELSON P. DEVANADERA
Executive Director

About the Journal

Our Palawan is an Open Access journal. It is made freely available for researchers, students, and readers from private and government sectors that are interested in the sustainable management, protection and conservation of the natural resources of the Palawan Biosphere Reserve. It is accessible online through the websites of Palawan Council for Sustainable Development (pcsd.gov.ph) and Palawan Knowledge Platform for Biodiversity and Sustainable Development (pkp.pcsd.gov.ph). Hard copies are also available at the PCSD Library. These are also provided to our partner government agencies and academic institutions. The authors and readers can read, download, copy, distribute, print, search, or link to the full texts of published articles.

Our Palawan practices a double-blind peer review. The review process has basically three stages: (1) primary checking (the Editors make sure that the manuscript complies with the Author's Guidelines); (2) review by the external reviewers, involving an assessment of its suitability for publication (compatibility with *Our Palawan's* aims and scopes, evidence of research, sufficiency of references to the international literature, and scientific soundness); and (3) proofreading and checking whether the article is written in compliance with the Author's Guidelines.

Submission of Manuscript. For the next issue, submission of manuscripts is now open for acceptance. Manuscripts should comply with the Author's Guidelines which could be obtained by e-mail from the Editors at *research@pcsd.gov.ph* and *pcsdresearch@gmail.com.* You may visit us at PCSD Building, Sta. Monica Puerto Princesa City, Palawan.

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The Scientific Journal of the Palawan Council for Sustainable Development
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January – December 2018

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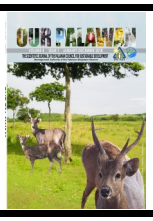

Identifying Important Habitats of Endemic and Threatened Species in Puerto Princesa, Palawan

*Palawan Council for Sustainable Development Staff

ABSTRACT

Palawan is one of the Philippine's remaining islands with the largest forest tracts left. However, despite retaining approximately 50% of its original forests, it is under threat of degradation due to anthropogenic activities; affecting many species of fauna and flora. In this study, we present the identification of important habitats for endemic and threatened species in the northern part of Victoria-Anepahan Mountain Range, in Puerto Princesa, Palawan. We identified important habitats based on vegetation in eight Barangays through supervised classification of 2017 land satellite image (Landsat 8). Classification was performed using the Semi-Automatic Land Classification plugin of Quantum GIS. To determine species highest concentration across the study region, we produced distribution models for 41 species using the maximum entropy algorithm implemented in Maxent. Finally, we assessed the Environmentally Critical Areas Network (ECAN) to determine if current zones are positioned appropriately to protect the endemic and threatened species. Our results show that the largest extent of pristine forest is found in Bacungan, Inagawan, Iwahig and Napsan, however, these areas are also facing habitat degradation as indicated by relatively large extent of secondary growth and cultivation. Species distribution modeling shows that the predicted highest species concentration has been found in pristine forests of lowland areas between 100-900 meters elevation, with the maximum species overlap of 36 species. Whereas the predicted lowest species overlap (<20) is found in mountain tops (>1000 m) and in open areas. The assessment of ECAN revealed several mismatches between the current zones and important habitats. The results of this study recommend the reevaluation and rezoning of the ECAN zones.

Keywords:

Threatened species
Endemic species
Habitat
Victoria-Anepahan Mountain Range
Puerto Princesa City
Palawan

Commissioned study by the Palawan Council for Sustainable Development Staff

INTRODUCTION

Tropical habitats are being altered extensively at an increasing rate (Sodhi et al. 2004, 2010). Changes are often attributed to anthropogenic activities, causing biodiversity loss globally (Hoffmann et al. 2010; Laurance et al. 2012; Hudson et al. 2014). Reducing the impacts of habitat modifications on biodiversity is one of the most urgent challenges in conservation. In recent years, intensive efforts have begun to address this problem. Several organizations have developed strategies to determine critical areas and habitats for biodiversity, i.e. areas which require immediate conservation action, to inform management and guide conservation spending (Mittermeier et al. 1998; Myers et al. 2000). However, this exercise is often done on global, national and regional scales, with limited information available on how important areas should be identified on a local scale. There are no standard guidelines and specific methods to identify important areas, but many countries generally utilize the measure of 'irreplaceability' and 'vulnerability' as a tool (Brooks et al. 2006). Irreplaceability includes information on the area's biological richness, diversity and endemism (Margules and Pressey 2000; Myers et al. 2000; Stattersfield et al. 2005). Vulnerability includes information on biological threats such as logging and clearing. It also includes information on threatened species, land tenures, expert opinion, and environmental and spatial variables (Margules and Pressey 2000; Brooks et al. 2006). For instance, in the Philippines, a total of 117 Important Bird Areas (IBA) (Mallari et al. 2001) and 206 Conservation Priority Areas (PBCPP 2002) were identified based on these measures.

The biodiversity of the Philippines is extremely rich and unique, with approximately 15,000 known plant species and more than 1,300 terrestrial vertebrates (Brown and Diesmos 2009). Despite the remarkable composition of fauna and flora, it is under intense pressure from direct persecution (e.g., hunting) and severe habitat loss through forest degradation and deforestation (Catibog and Heaney 2006; Posa et al. 2008). In fact, over the last decades, the country had lost around 90 % of its original forest cover (ESSC 1999; Mallari et al. 2001). Luzon and Palawan are among the last remaining islands in the country with the largest extent of forest left (FMB 2013). Palawan is hailed as the Philippine's last frontier of biodiversity because it retains about 50% of its natural habitats, which still supports viable populations of endemic and globally threatened species (Quinnell and Blamford 1988; PCSD 2010). In 1992, to avoid further degradation and to sustainably manage Palawan's remaining natural habitats, the Republic Act 7611, also known as the "Strategic Environmental Plan (SEP) for Palawan", was enacted. The SEP is a comprehensive policy framework for the sustainable development of Palawan, protecting and enhancing the natural resources and endangered environment of the province. As the main strategy of SEP, a zoning scheme called the Environmentally Critical Areas Network (ECAN) was established. ECAN is a graded system of protection and development control in which natural resources (both terrestrial and marine/coastal areas) are subject to the following management scheme and zonation: (1) a core zone with maximum protection and free of anthropogenic disturbance, (2) a buffer zone, in which regulated use of resources is permitted and which is divided in sub-zones: restricted, controlled and traditional use, and (3) a multiple use zone, in which settlements, urbanization, industrialization, agricultural activities and fisheries may be undertaken. Since 1993, ECAN maps were made and regularly updated to incorporate new data and adapt to developments in the province.

In this study we aim to identify and map out the location of locally important habitats of endemic and threatened species in Puerto Princesa, particularly the area of the Victoria-Anepahan Mountain Range (VAMR), in support to the current initiative of the Palawan Council for Sustainable Development (PCSD) and the local government units to update the ECAN zones of the city.

METHODOLOGY

Study site

Puerto Princesa is found at the center of the Palawan island with a total land area of 2,380 km^2 (Figure 1). It is the only city and highly urbanized area of the province. The city is surrounded by a mountain chain with highest peak reaching circa (ca) 1,500 meter above sea level. Natural habitat is mostly lowland and semi-evergreen rainforest, with different forest types occurring on basaltic, ultrabasic and karst limestone bedrocks (Quinnell and Blamford 1988; Mallari 2001). Puerto Princesa has an annual mean temperature and precipitation of 27.43 °C and 1,560 mm, respectively. There are three Key Biodiversity Areas (KBA) found in Puerto Princesa. These are the Puerto Princesa Subterranean River National Park (PPSRNP), Cleopatra's Needle and a part of the Victoria-Anepahan Mountain Range (VAMR) (Mallari et al. 2001; PBCPP 2002). The VAMR extends from Puerto Princesa to the municipalities of Aborlan, Narra and Quezon. It has a total land area of 164,700 hectares, with the largest area of Palawan's forest found on ultramafic rocks (Mallari et al. 2001; Fernando et al. 2008).

Vegetation analysis

In March 2018, a rapid assessment of vegetation in the northern part of VAMR in Puerto Princesa was conducted, covering the barangays of Bacungan, Simpocan, Bagong Bayan, Napsan, Montible, Iwahig and Irawan (Figure 1). During the assessment, we collected geographic coordinates of different habitat types such as cultivation, mangroves, secondary growth and pristine forests, to be used as reference points for supervised vegetation analysis (i.e., habitat types were classified based on collected samples or training points). We also utilized a drone unit (Phantom 3 Pro) to collect photographs and coordinates of inaccessible areas (e.g., steep terrains, deep forests). We performed vegetation analysis using a Land Satellite (LANDSAT 8 OLI)

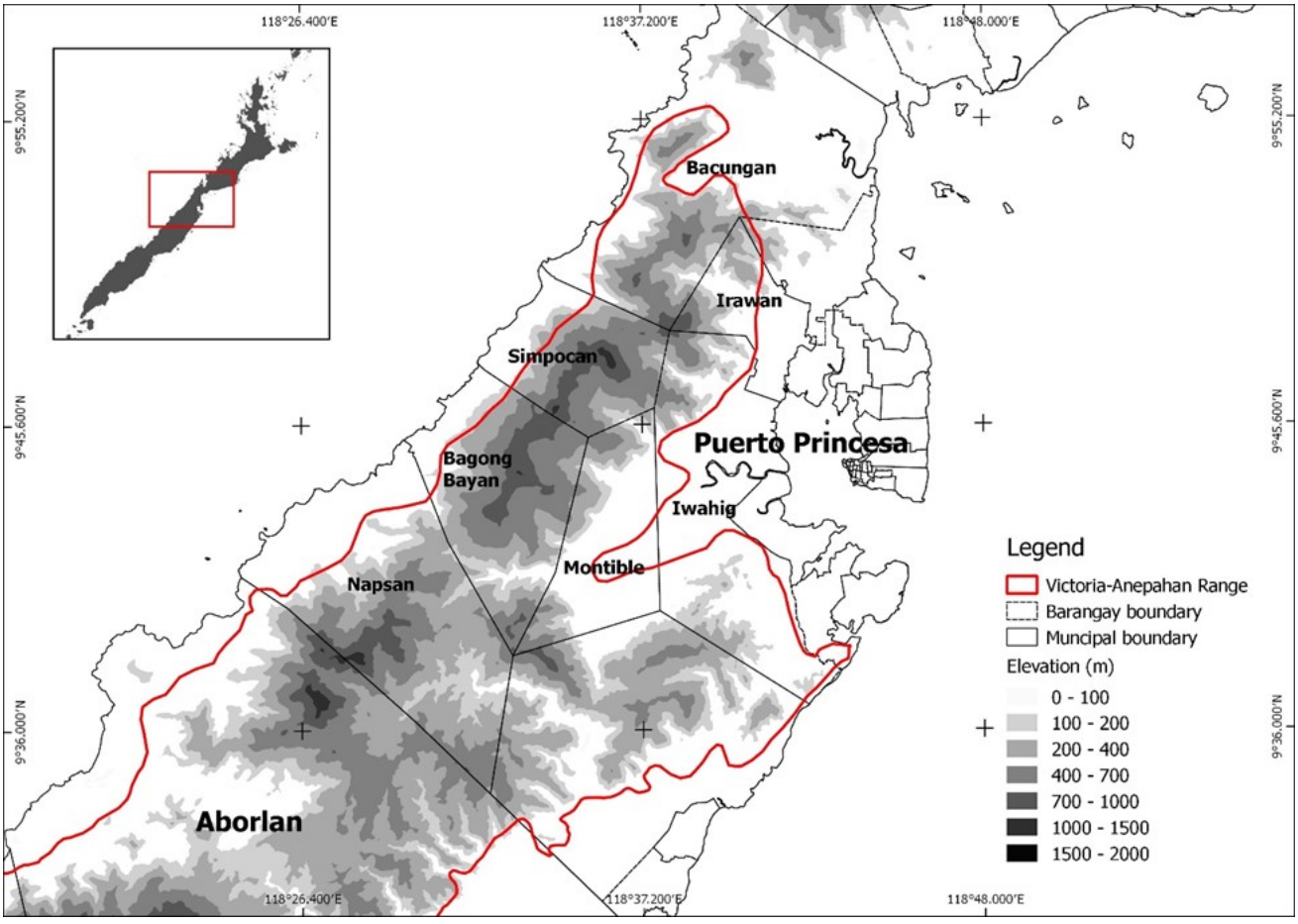

Figure 1. Map of Puerto Princesa City, showing the extent of the Victoria-Anepahan Mountain Range (in red polygon) and the Barangays, visited during the rapid assessment of vegetation.

image obtained in April 2017, courtesy of United States Geological Survey (Figure 2). The image was processed using the "Semi-Automatic Classification v. 5.3.11" plugin in Quantum GIS v. 2.18.18 (Congedo et al. 2013). We used four vegetation classes: (1) cultivation (including kaingin, coconut plantations and other forms of agricultural activities), (2) mangrove forest, (3) secondary growth (<20 years old) and (4) pristine forest (>20 years old). The estimated cover of each vegetation type was also calculated. However, the calculated area may not be the most accurate, because there were areas covered by cloud, which we had to exclude from the calculation (see Figure 2). A generated vegetation map was used to delineate the potential extent of important habitats of endemic and threatened species. All maps were produced using Quantum GIS.

Species distribution modeling

To determine the important habitats of endemic and threatened species in Puerto Princesa, we performed a predictive modeling for 13 birds, 8 mammals, 8 amphibians, and 12 plant and tree species. We utilized two datasets for the modeling: environmental variables and species occurrence records. Twenty-one environmental variables were used as predictors, composed of climatic and topographic conditions and vegetative cover (Supplemental Information Table 1). Climatic variables were obtained from WorldClim (http://www.worldclim.org), a 30 arc-second climate data designed for developing distribution models. We obtained a digital elevation model (DEM) from Shuttle Radar Topography Mission (http://srtm.csi.cgiar.org) and utilized it to construct slope and aspect variables, using the "terrain analysis" plugin of

Figure 2. LANDSAT 8 image (natural color) used in vegetation analysis. Red dots indicate the collection sites of training points used for classification. *Source: US Geological Survey. https://earthexplorer.usgs.gov*

Quantum GIS v.2.18 (QGIS; http://www.qgis.org). Vegetative cover of 2010 was obtained from the National Mapping and Resource Information Authority of the Philippines (NAMRIA). All variables were processed in QGIS as raster, with a spatial resolution or pixel size of 0.08333 (ca. 1 km^2). Species occurrence records are geographic coordinates of sites where the species have been recorded. We used species records from our field surveys, which were collected between 2014 and 2018, and supplemented them with records from the literature and data from online repositories such as the Global Biodiversity Information Facility (GBIF). The number of occurrence records used ranged from 5 to 67 (Supplemental Information- Table 2). Species with less than five records were not included in the analysis because this would give extremely poor results.

We used the maximum entropy algorithm implemented in Maxent v.3.3.3k to develop the models. Maxent is one of the most popular and best machine learning tools for predicting species distribution and habitat suitability (Elith et al. 2006; Hernandez et al. 2006; Phillips et al. 2006). Maxent is also known for its capability to handle both categorical and continuous data, small occurrence records and integrate interactions between variables. Prior to modeling, we created a sampling bias raster file, using the species occurrence records to account for sampling effort across the study area. This was done to avoid those areas which were not sampled (i.e., no records) to be automatically classified as unsuitable for the species (Supplemental Infomation Figure 1). The sampling bias raster file was constructed using the Gaussian Kernel Density Estimation of GRASS plugin in QGIS. During the modeling process, we used the linear and quadratic feature of Maxent, as recommended for small records (<100), and adjusted the regularization parameter to 0.25 (Phillips et al. 2004). To provide more space for the model to converge, the maximum iteration was set to 5000. These were the only adjustments made to Maxent with the other settings set to default. We applied a minimum training presence threshold value to Maxent's continuous output or logistic model to represent the species potential distribution. Final output for each species is represented by a binary (threshold) map, with 0 and 1 values indicating absence and presence of species, respectively.

Identification and delineation of important habitats

We identified and delineated important habitats based on species distribution model (SDM) outputs and vegetation analysis. Model outputs or binary maps for each taxonomic group were amalgamated in QGIS using the raster calculator. All areas in which species were predicted as being present (indicated by 1) were added to determine the areas with the highest species concentrations or overlap. This process was repeated for all taxa, producing a single map of species richness. Then the generated species richness map was overlaid to the vegetation map to strategically identify and delineate the extent of the important habitats. For instance, areas with the highest species concentrations (25-36) and located in pristine forest were classified as important, and therefore may be considered as areas that would require a full course of protection. Delineated important habitats were also overlaid to current ECAN zones to determine potential mismatches and derive new information on how the zones could be reclassified properly to facilitate a full extent of protection and management.

RESULTS AND DISCUSSION

Vegetation status

Vegetation status in the northern portion of the Victoria-Anepahan Mountain Range, based on the analysis of 2017 land satellite image, indicates that Bacungan, Inagawan, Iwahig and Napsan encompass the largest area of pristine forest, whereas Irawan and Simpocan encompass the smallest area. The largest extent of secondary growth forest is also found in Bacungan, Inagawan, Iwahig and Napsan, and the smallest extent in Montible, Simpocan and Bagong Bayan. The largest area of cultivation or open area is found in Bacungan, Inagawan and Iwahig. Montible, Bagong Bayan and Simpocan contained the smallest extent of open area or cultivation (Table 1 and Figure 3). These results therefore suggest the following: (a) despite that Bacungan, Inagawan, Iwahig and Napsan are covered the most with pristine forests, there has been active degradation and conversion of

Table 3. Estimated extent of vegetation types per barangay, based on the analysis of LANDSAT 8 image acquired in April 2017. Calculated areas are in hectare.

Barangay	Vegetation Types			
	Pristine Forest	Secondary Growth Forest	Open Area/ Cultivation	No data/Cloud
Bacungan	8,714.10	4,443.62	1,512.47	2,785.34
Bagong Bayan	7,402.73	751.44	172.68	1,066.13
Inagawan	12,918.44	2,243.57	2,835.34	427.33
Irawan	1,881.05	1,218.17	286.74	205.86
Iwahig	7,691.15	3,284.52	1,243.07	210.31
Montible	6,126.57	342.54	91.80	37.44
Napsan	11,480.66	2,022.39	559.85	459.18
Simpocan	4,386.99	728.63	197.76	879.78

**Note:* *The calculated area may not represent the most accurate extent because there were areas excluded in the computation due to the cloud cover (see last column).*

Figure 3. Upper photo showing the patches of recently cleared forest in Barangay Simpocan and below showing cultivated areas between Bagong Bayan and Napsan, Puerto Princesa City. Aerial photos by C. Supsup.

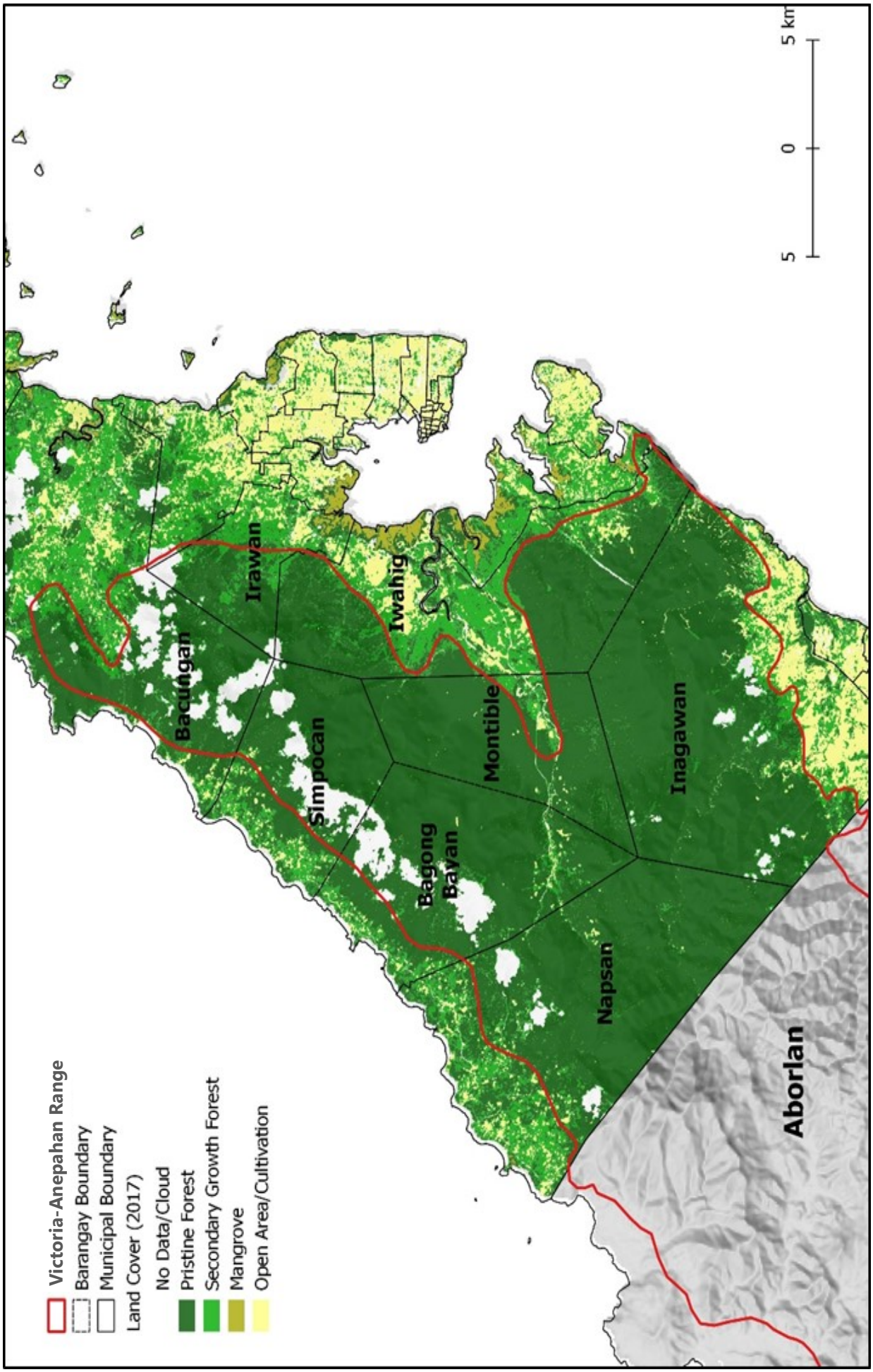

Figure 4. Map of the northern portion of VAMR in Puerto Princesa, showing the extent of different vegetation types analyzed based on LANDSAT 8 image.

natural habitats in these areas, as indicated by the relative extent of secondary growth and cultivation, and (b) the small extent of secondary growth and cultivation in Bagong Bayan, Montible and Simpocan does not necessarily mean that there is no active degradation or conversion activities, as indicated by recently cleared forests (Figure 4).

Important habitats

Our species distribution modeling predicted the highest overlap of endemic and threatened species (ca. 30–36) in the lowland areas of almost all barangays, with a noticeable extent in Bacungan, Simpocan, Bagong Bayan, Montible, Inagawan and Iwahig (Figure 5). The predicted lowest species overlap (< 20) is found mostly in mountain peaks (above 1000 meter, particularly peaks running from Irawan to Montible) and open areas. The overlay of SDMs and analyzed vegetation showed that the highest species overlap is located in pristine forest covering lowland areas between 100-900 meter elevation. These findings therefore suggest that the most suitable or important habitats for endemic and threatened species are the lowland areas with pristine forest and a few patches of secondary growth near forest edges (Amalgamated species distribution models for each taxonomic group are shown in Supporting Information Figures 2 to 5).

Tropical lowland habitats are the most important habitats for many endemic and threatened species in the Philippines (Heaney and Regalado 1998; Collar et al. 1999; Mallari et al. 2001). However, tropical lowlands are now being rapidly and heavily altered, pushing many species of fauna and flora on the verge of extinction (Heaney and Regalado 1998; Diesmos 2008). Take for example the case of the "Critically Endangered" endemic freshwater crocodile *Crocodylus mindorensis,* which was

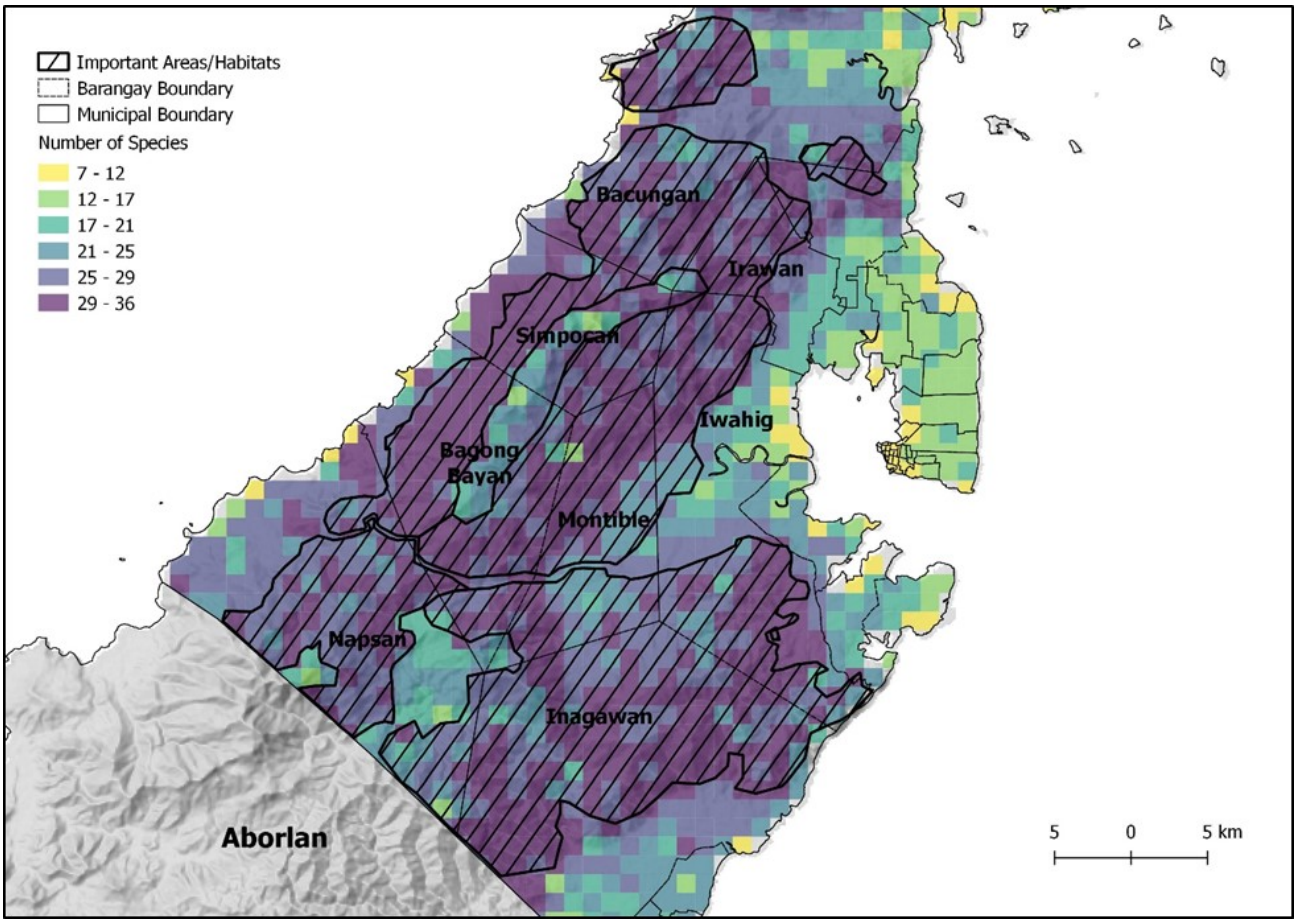

Figure 5. Map of amalgamated distribution models of 41 species. The color shading (in blue) indicates the number of species (richness) per pixel or 1 km^2, with the highest overlap of 36 species. Polygons filled with lines show the extent of high species concentrations, also identified as important areas or habitats for biodiversity conservation (delineated based on high species concentration and vegetation overlap).

previously found in almost all major islands of the Philippines. This species is known to occupy undisturbed rivers, creeks, ponds and marshes in lowland habitats from sea level up to 850 m elevation. But because of rapid changes in the lowland habitats, brought on by anthropogenic activities, their population has severely declined and their distribution is now confined to only few localities, in Ligwasan Marsh in Mindanao, Isabela and Abra in Luzon and in Dalupiri Island (van Weerd 2010). In Palawan, numerous spatially restricted species are already listed by the IUCN as "Threatened". This includes the "Endangered" *Manis culionensis*, which is hunted massively for its skin, which is used to treat asthma (Esselstyn et al. 2004). Also, *Barburoula busuangensis* and the flagship species *Polyplectron napoleonis* of Puerto Princesa, are both hunted for consumption. If these unique creatures remain to be ignored and conservation initiatives are not undertaken, they may face a similar fate as *C. mindorensis*, or worse, may become extinct. These species are especially vulnerable, considering that they occur only in Palawan and nowhere else.

Mismatches in ECAN zones

The overlay of SDMs, ECAN and vegetation revealed several mismatches in the current ECAN zonation and designated important habitats: (a) few areas in Bacungan with pristine forest and high species concentration are designated as multiple use zone, (b) edges of important habitats in Simpocan, Bagong Bayan and Napsan are designated as controlled used zones, and (c) large extents of important habitats in Inagawan, and south of Montible and Iwahig are presently designated as restricted use zone (see Figure 6). Hence, these findings suggest that the current ECAN zones are not positioned most effectively and require re-evaluation to consequently maximize the protection of important habitats for biodiversity conservation.

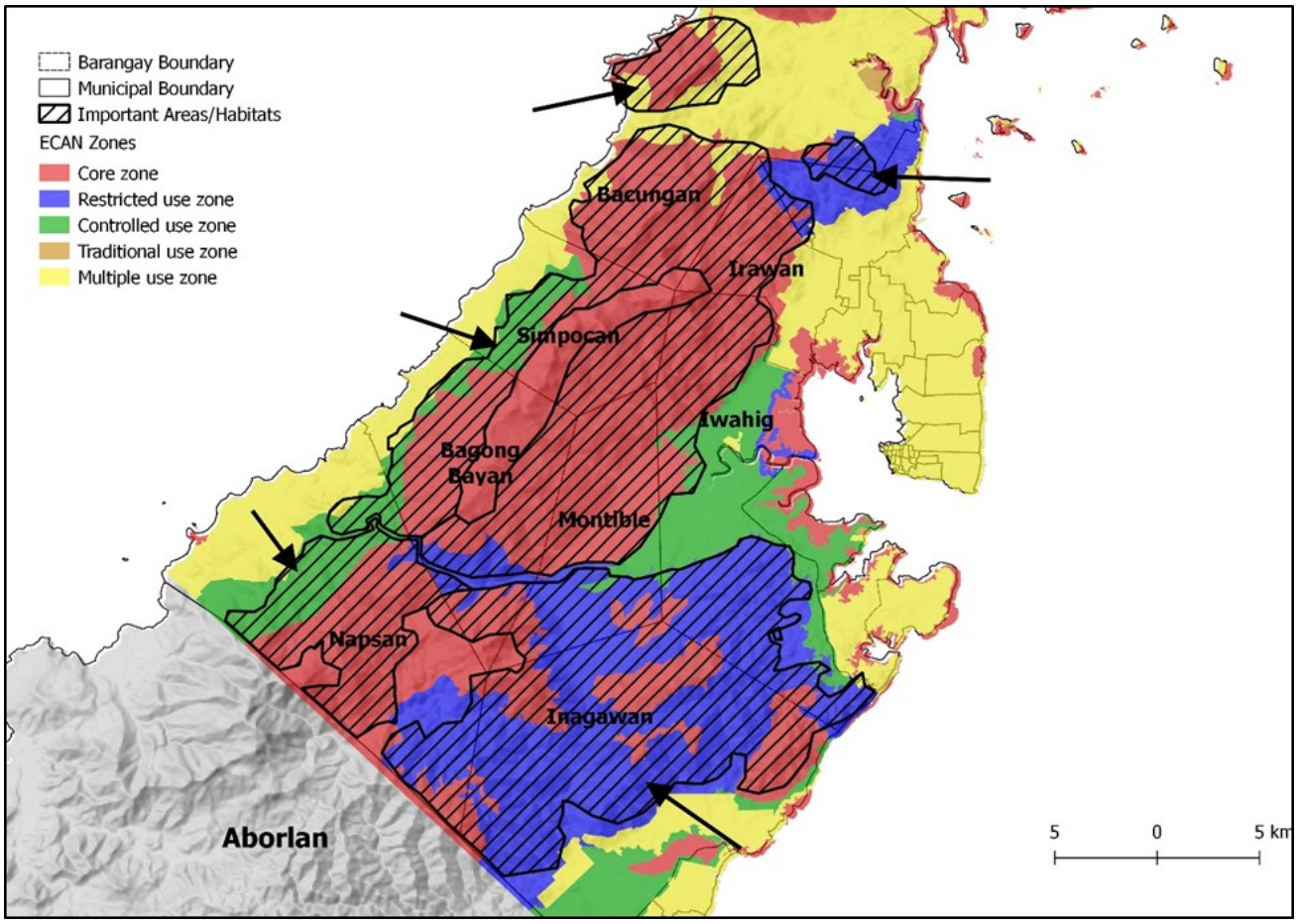

Figure 6. Map showing the ECAN zones and identified important areas/habitats. Arrows indicate the areas of mismatches between ECAN zones and important habitats.

CONCLUSION AND RECOMMENDATIONS

Our study highlights the importance of natural habitats for survival of most endemic and globally threatened species. As demonstrated in our results for species found in Palawan, especially in the northern part of Victoria-Anepahan Mountain Range, pristine forests in lowland areas between 100-900 m were predicted to hold most of the species. However, our results also showed that most lowland areas are under threat of degradation. For instance, the extent of secondary growth forest and cultivation in Bacungan, Inagawan, Iwahig and Napsan indicates that in the past years there has been active conversion and degradation of lowland areas. Based on NAMRIA's 2003 land cover data, secondary and pristine forests in Bacungan and Napsan were not markedly reduced nor converted to other land use yet. But in 2010 or possibly earlier, signs of noticeable degradation begun to appear here. In Inagawan and Iwahig, we believe that degradation of natural habitats started since 1980s or earlier (SSC 1988); and our analysis of 2017 land satellite image further shows that after nearly 18 years many areas near the coast of Bacungan, Inagawan, Iwahig and Napsan are now open and that natural habitats (<400 m) are now being cleared for plantations (e.g., coconut) and other agricultural activities. The little extent of secondary growth and open areas or cultivation in Bagong Bayan, Simpocan and Montible does not necessarily mean that there is no active degradation of habitats in these areas. We believe that spatially noticeable habitat degradation started here only recently, probably between 2010–2018. Hence, our findings clearly illustrate that disturbance is present in lowland areas, which could consequently significantly reduce the diversity of endemic and threatened species that are predicted to be found there.

The information on mismatches between ECAN zones and important habitats in Palawan is not new. Mallari (2009) already pointed this out in his study on understory bird species in Puerto Princesa Subterranean River National Park. A similar case was observed in the south of the VAMR (FFI 2014), and more recently in Mt. Bulanjao (CCI 2018). All these studies pointed out that the designated core zones are not positioned effectively to maximally protect the endemic and threatened species of Palawan. We agree with their conclusions that re-evaluation/re-zoning of the current ECAN zones is necessary. Based on our results, we suggest the following revisions of the zones:

1. Extend the core zone to all pristine forest found in the lowland areas of Bacungan, Simpocan, Bagong Bayan and Napsan. This will remove the extent of multiple use zone positioned in pristine forest of Bacungan and replace the controlled use zone in Simpocan, Bagong Bayan and Napsan.
2. Designate all lowland areas with pristine forest as core zone in the south of Montible, Iwahig and most importantly Inagawan. If regulated extraction of resource in these areas is necessary, a part of the area could be assigned as restricted use zone including some areas in Napsan, particularly those areas with < 25 species (see recommended areas for restricted use zone in Figure 6).
3. Place all secondary growth forests found near the edges of pristine forest under controlled use zone, preferably 500–1000 m from edge of pristine forest; areas beyond this zone could then be designated as multiple use zone.
4. Retain the core zone in mountain peaks running from Irawan to Montible. Despite low species concentration, these areas may contain endemic species restricted only to high elevations.

ACKNOWLEDGMENT

This research commissioned by Palawan Council for Sustainable Development Staff was conducted by Christian E. Supsup of Biology Department, De La Salle University, Manila and Augusto A. Asis of Puerto Princesa Subterranean River National Park, Puerto Princesa City, Philippines.

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SUPPLEMENTAL INFORMATION

Table 1. List of 21 environmental variables used as predictors for the species distribution modeling. All layers are in raster format with uniform projection (WGS 84) and a pixel size of 0.08333 (approx. 1 square kilometer).

Codes	Environmental Variables	Codes	Environmental Variables
LCover	Land Cover	PrecipS	Precipitation seasonality
Aspt	Aspect	PrecipCQ	Precipitation of coldest quarter
Slp	Slope	PrecipDM	Precipitation of driest month
Elev	Elevation	PrecipDQ	Precipitation of driest quarter
AMTemp	Annual mean temperature	PrecipWQ	Precipitation of warmest quarter
Aprecip	Annual precipitation	PrecipWtM	Precipitation of wettest month
Isotherm	Isothermality	PrecipWtQ	Precipitation of wettest quarter
MDR	Mean diurnal range	TempAR	Temperature Annual Range
MxTempWM	Maximum temperature of warmest month	TempS	Temperature seasonality
MnTempDQ	Mean temperature of driest quarter		
MnTempWQ	Mean temperature of warmest quarter		
MnTempWtQ	Mean temperature of wettest quarter		

Table 2. List of amphibian, bird, mammal and plant/tree species used for the species distribution modeling. Information on species conservation status, extent of occurrence, habitat and number of records are also provided.

Species name	Conservation Status	Species range	Habitat	Records
Amphibians:				
Philippine Flat-Headed Frog *Barbourula busuangensis*	VU	Philippines – restricted to Palawan	Primary and secondary lowland forests	19
Malatgan River Caecilian *Ichthyophis weberi*	DD	Philippines - restricted to Palawan	Primary forests	7
Palawan Fanged Frog *Limnonectes acanthi*	VU	Philippines - restricted to Palawan	Lower montane & primary lowland forests	27
Palawan Horned Frog *Megophrys ligayae*	EN	Philippines - restricted to Palawan	Montane & primary lowland forest	15
Palawan Toadlet *Pelophryne albotaeniata*	EN	Philippines - restricted to Palawan	Montane & primary lowland forest	6
Palawan Bush Frog *Philautus longicrus*	NT	Philippines, Indonesia, Malaysia	Montane & primary lowland forest	16
Palawan Striped Stream Frog *Pulchrana moellendorffi*	NT	Philippines - restricted to Palawan	Lower montane & primary lowland forests	29
Palawan Torrent Frog *Sanguirana sanguinea*	LC	Philippines; Indonesia	Primary & secondary lowland forests	18
Birds:				
Palawan Hornbill *Anthracoceros marchei*	VU	Philippines - restricted to Palawan	Primary & secondary lowland forests	41
Yellow-throated Leafbird *Chloropsis palawanensis*	LC	Philippines - restricted to Palawan	Primary lowland forest	67
Palawan Blue Flycatcher *Cyornis lemprieri*	NT	Philippines - restricted to Palawan	Sub-montane & lowland primary forests	40
Palawan Flycatcher *Ficedula platenae*	VU	Philippines - restricted to Palawan	Primary lowland forest	21
Melodious Babbler *Malacopteron palawanense*	NT	Philippines - restricted to Palawan	Primary lowland forest	22
Philippine Scrubfowl *Megapodius cumingii*	LC	Philippines, Indonesia, Malaysia	Primary lowland forest	11
Palawan Scops-owl *Otus fuliginosus*	NT	Philippines - restricted to Palawan	Primary lowland forest	18
Palawan Tit *Parus amabilis*	NT	Philippines - restricted to Palawan	Primary lowland forest	12
Palawan Peacock-Pheasant *Polyplectron napoleonis*	VU	Philippines - restricted to Palawan	Primary lowland forest	14
Blue-Headed Racquet-Tail *Prioniturus platenae*	VU	Philippines - restricted to Palawan	Primary & secondary lowland forests	32
Palawan Flowerpecker *Prionochilus plateni*	LC	Philippines - restricted to Palawan	Primary lowland forest	62
Blue Paradise-Flycatcher *Terpsiphone cyanescens*	LC	Philippines - restricted to Palawan	Primary lowland forest	38
Palawan Stripped-Babbler *Zosterornis hypogrammicus*	NT	Philippines - restricted to Palawan	Montane & lowland primary forests	5

Continuation of Supplemental Information Table 2.

Species name	Conservation Status	Species range	Habitat	Records
Mammals:				
Palawan Shrew *Crocidura palawanensis*	LC	Philippines - restricted to Palawan	Primary & secondary lowland forests	10
Palawan Flying Squirrel *Hylopetes nigripes*	NT	Philippines - restricted to Palawan	Primary & secondary lowland forests	13
Long-Tailed Macaque *Macaca fascicularis*	LC	Southeast Asia	Primary & secondary lowland, mangrove forest, cultivated areas	21
Palawan Pangolin *Manis culionensis*	EN	Philippines - restricted to Palawan	Primary & secondary lowland forests	44
Palawan Spiny Rat *Maxomys panglima*	LC	Philippines - restricted to Palawan	Lower montane, primary & secondary lowland forests	24
Southern Palawan Tree Squirrel *Sundasciurus steerii*	LC	Philippines - restricted to Palawan	Primary & secondary lowland forests	12
Palawan Bearded Pig *Sus ahoenobarbus*	NT	Philippines - restricted to Palawan	Montane, lowland primary & secondary forests	18
Palawan Tree Shrew *Tupaia palawanensis*	LC	Philippines - restricted to Palawan	Primary & secondary lowland forests	23
Flora:				
Antipolo *Artocarpus blancoi*	VU	Philippines	Primary lowland forest	8
Pagsahingin *Canarium asperum*	LC	Philippines, Indonesia, Malaysia, Papua New Guinea	Primary & secondary lowland forests	30
Cryptocarya palawanensis	EN	Philippines - restricted to Palawan	Primary lowland forest next to mangrove stands	5
Kamagong *Diospyros discolor*	VU	Philippines	Primary & secondary lowland forests	12
Palawan Suraga *Glyptopetalum palawanense*	VU	Philippines, Malaysia	Primary lowland forest	6
Ipil *Intsia bijuga*	VU	Southeast Asia, Japan, India, Madagascar, Australia, British Indian Ocean Territory, Tanzania, Vanuatu, Papua New Guinea	Primary lowland forest	15
Liusin *Maranthes corymbosa*	LC	Philippines, Australia, Indonesia, Malaysia, Micronesia, Panama, Singapore, Thailand, Solomon Islands	Primary & secondary lowland forests	20
Palawan Medinilla *Medinilla palawanensis*	EN	Philippines - Restricted to Palawan	Primary lowland forest (on ultrabasic rocks)	6
Duguan *Myristica philippinensis*	VU	Philippines	Primary & secondary lowland forests	6
Nato *Palaquium luzoniense*	VU	Philippines	Primary & secondary lowland forests	17
Apitong Baboi *Swintonia foxworthyi*	NA	Philippines, Indonesia, Malaysia	Primary lowland forest	18
Siamese Yellowleaf *Xanthophyllum flavescens*	NA	Southeast Asia	Primary lowland forest	13

Table 3. Drone flying locations and coordinates, utilized as reference points during the vegetation analysis.

Description	Longitude	Latitude
Cultivated	118.6518056	9.890583333
Forest	118.6327778	9.888055556
Forest	118.6133611	9.884694444
Built-up	118.6028889	9.869722222
Road	118.6132222	9.884722222
Road	118.6084722	9.880777778
Road	118.5905	9.857138889
Road	118.5845833	9.688361111
Road	118.5808333	9.849833333
Cultivated	118.5720833	9.834083333
Road	118.5777222	9.848444444
Road	118.5775278	9.848305556
Road	118.5754444	9.844833333
Road	118.56325	9.825444444
Road	118.5546667	9.8175
Road	118.552	9.810694444
Cultivated	118.5449444	9.800611111
Road	118.5165556	9.770888889
Road	118.5125278	9.762583333
Forest	118.5157778	9.704027778
Built-up	118.5061667	9.751527778
Road	118.4992222	9.743722222
Road	118.4889444	9.733305556
Built-up	118.4871111	9.730361111
Road	118.4638611	9.721833333
Forest	118.4647778	9.706638889
Road	118.457	9.719388889
Forest	118.5845833	9.688361111
Mangrove	118.684125	9.733186111
Cultivated	118.6788278	9.785847222
Forest	118.671375	9.826622222
Cultivated	118.4888111	9.729083333
Cultivated	118.5463472	9.799341667

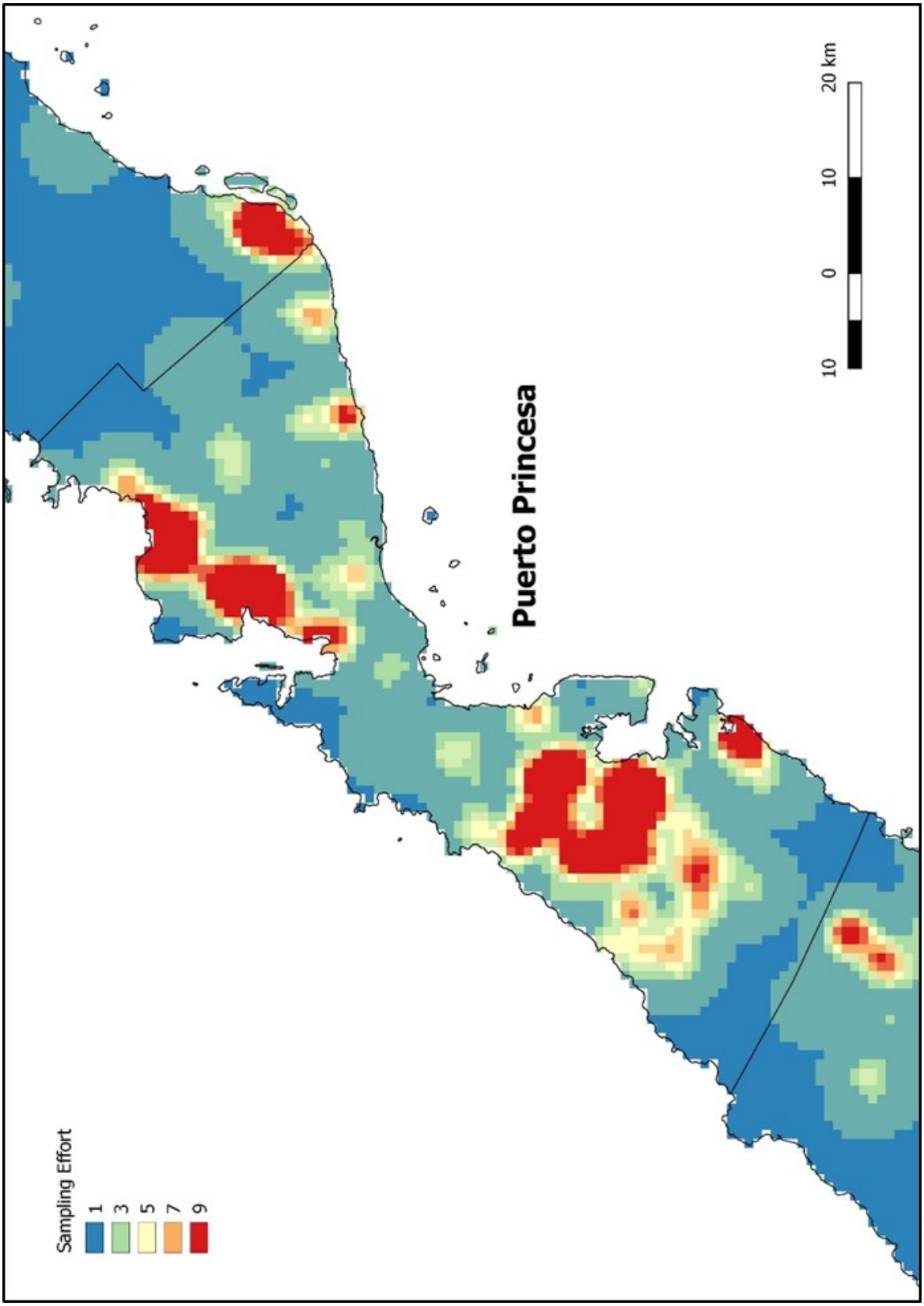

Figure 1. Sampling bias file used for the species distribution modeling. The color shading indicates the sampling effort derived through the gaussian kernel density estimate of occurrence records. Density estimate was reclassified to arbitrary values (1-9) because pixels or areas with zero values cannot be handled by Maxent.

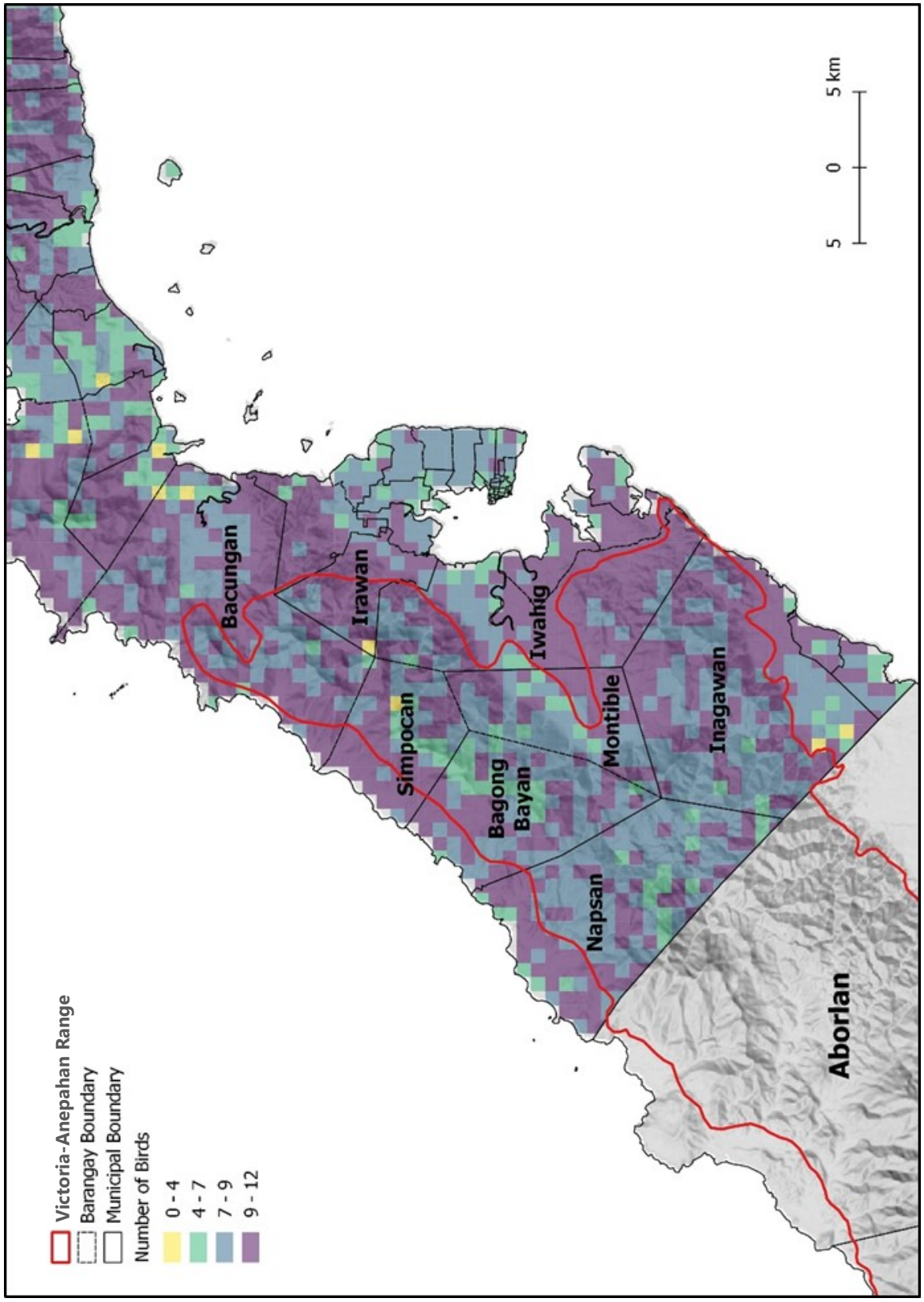

Figure 2. Map of combined distribution models of 13 bird species in the northern part of Victoria Anepahan Mountain Range in Puerto Princesa City.

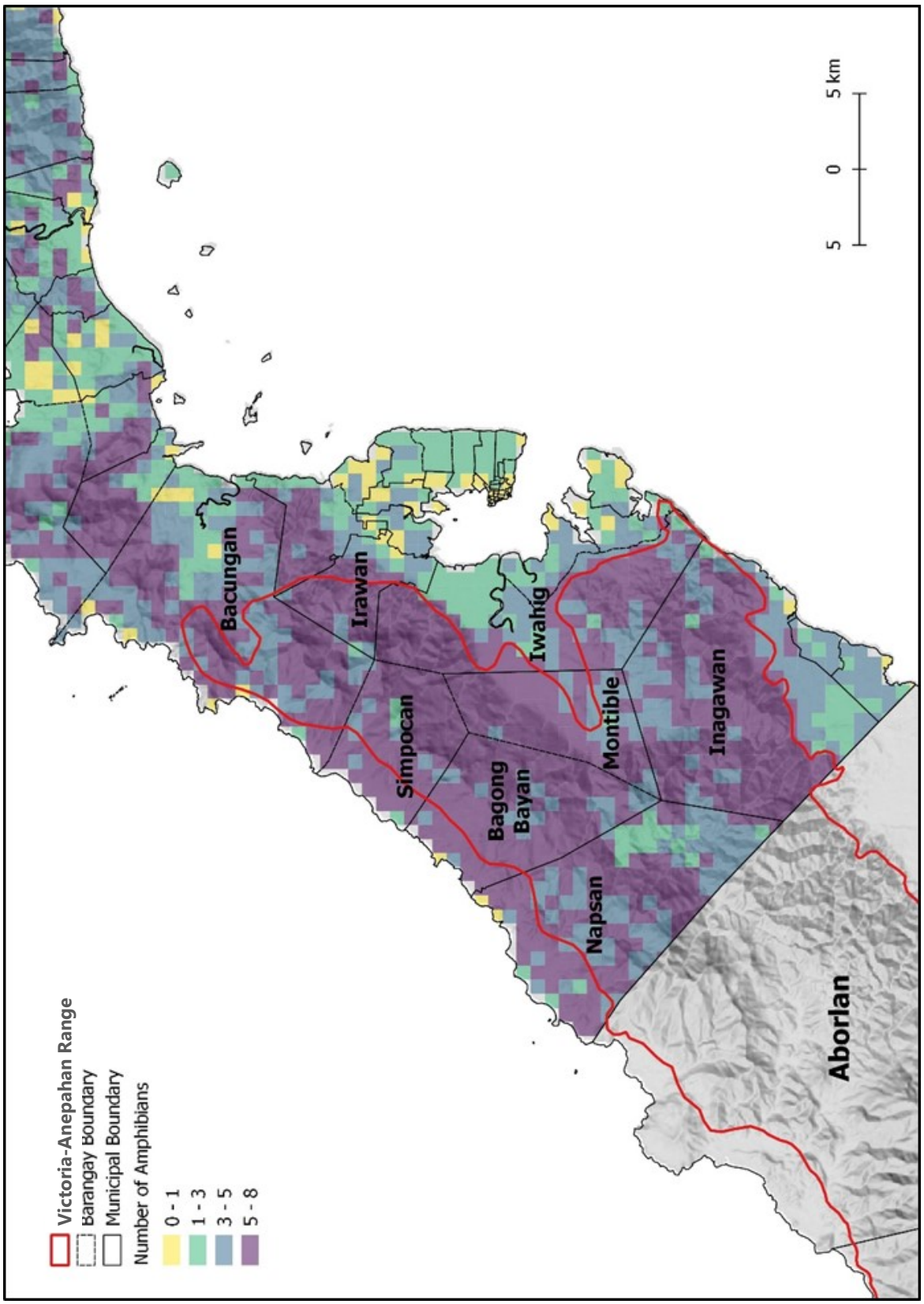

Figure 3. Map of combined distribution models of eight amphibian species in the northern part of Victoria Anepahan Mountain Range in Puerto Princesa City.

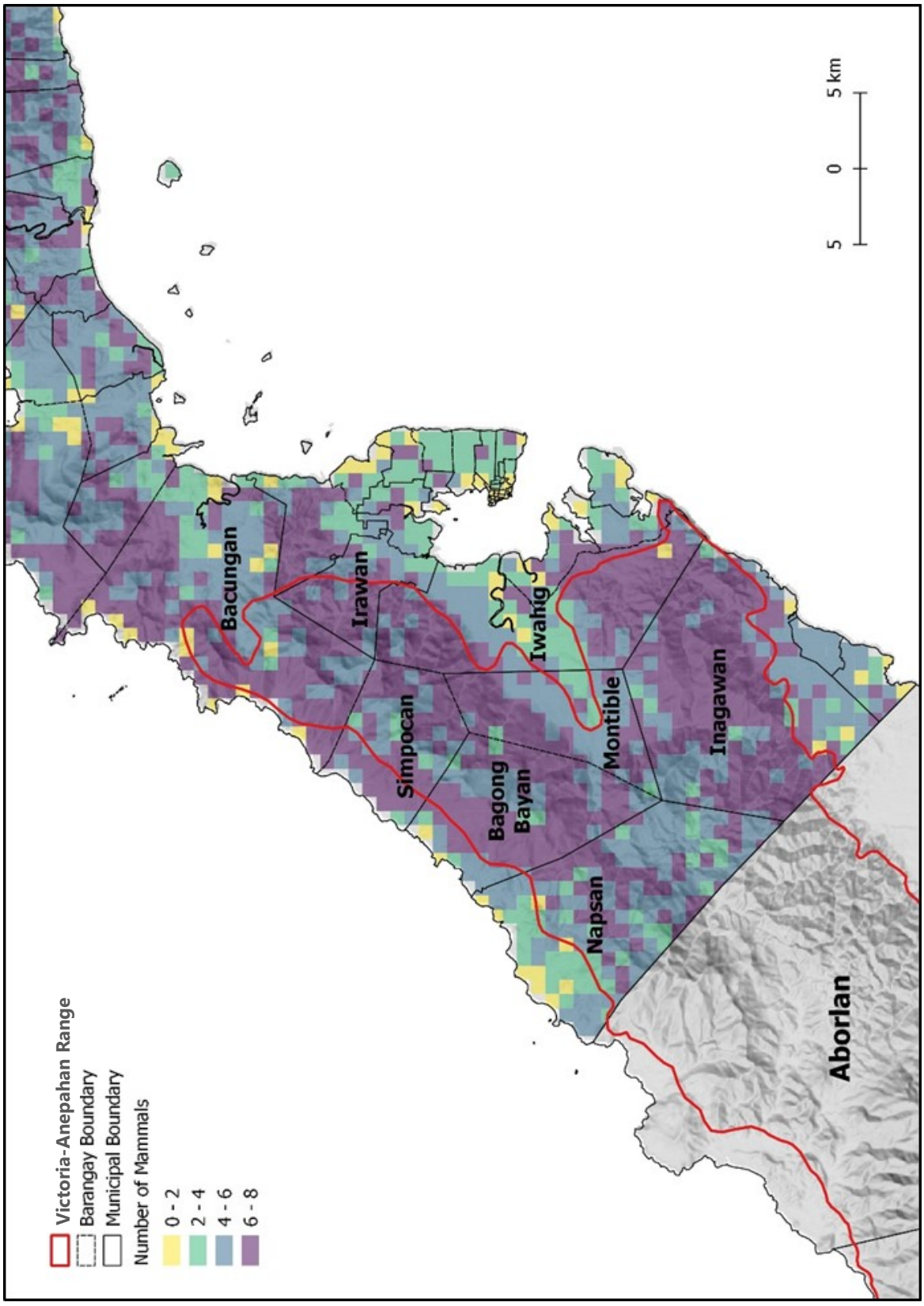

Figure 4. Map of combined distribution models of eight mammal species in the northern part of Victoria Anepahan Mountain Range in Puerto Princesa City.

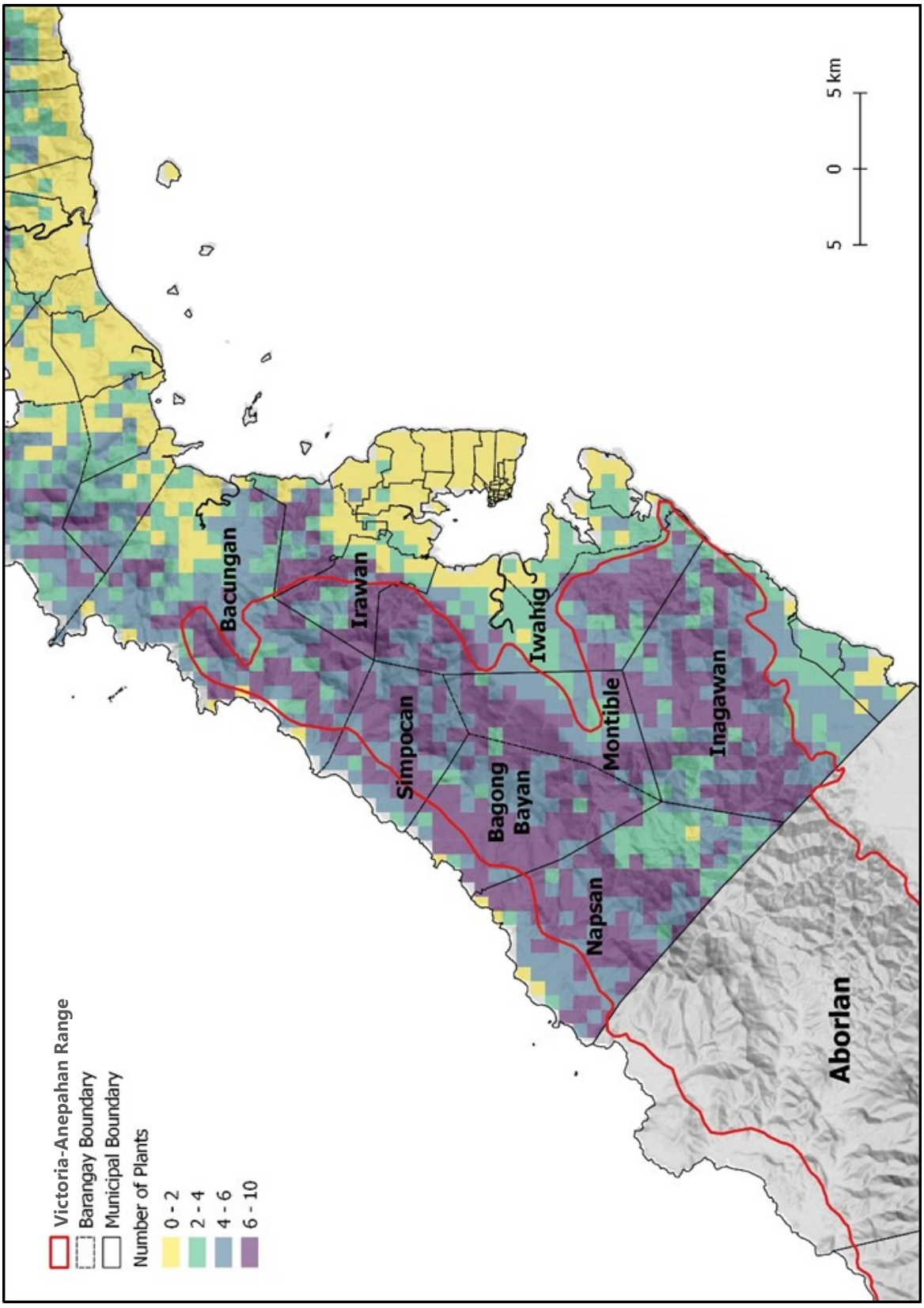

Figure 5. Map of combined distribution models of 12 plant and tree species in the northern part of Victoria Anepahan Mountain Range in Puerto Princesa City.

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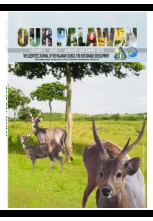

Preliminary Phytochemical Screening and Evaluation of Antiproliferative, Cytotoxic and Antituberculosis Activities of Three *Apocynaceae* Plants Endemic to Palawan, Philippines

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ABSTRACT

Alyxia linearis, *Tabernaemontana ternifolia*, and *Wrightia hanleyi* are Apocynaceae species endemic to Palawan. There are no published reports on the ethnomedicinal, biological, and phytochemical studies for these endemic plants. Thus, this study investigated the presence of secondary metabolites and the potential of these three endemic species as source of active agents in the treatment of cancer and tuberculosis, two of the leading causes of death worldwide. The crude extracts from the leaves, twigs, and roots of these three endemic species were tested for cytotoxic activity against three human cancer cell lines (HUVEC, K-562, and HeLa) using CellTiter-Blue1 assay. The antituberculosis activity of the crude extracts against *Mycobacterium tuberculosis* $H_{37}Rv$ was also assessed using MABA. Phytochemical screening showed the presence of alkaloids, phenols, tannins, flavonoids, terpenoids, higher alcohols and steroids in the crude extracts of *A. linearis*, *T. ternifolia*, and *W. hanleyi.* The dichloromethane and methanol root extracts from *T. ternifolia* displayed the strongest antiproliferative activity against HUVEC and K-562 cell lines (GI_{50} values = 0.2 to 1.0 µg/ml); while the dichloromethane twig extract from *A. linearis* (CC_{50} = 4.4 µg/ml) and hexane root extract from *W. hanleyi* (CC_{50} = 9.8 µg/ml) showed moderately strong cytotoxic activity against HeLa cell line. The dichloromethane root extract from *W. hanleyi* root (MIC = 7.4 µg/ml) showed the best activity against the virulent *M. tuberculosis* $H_{37}Rv$ followed by the dichloromethane root extract from *T. ternifolia* root (MIC 9.6 = µg/ml). These results highlight the potential of *A. linearis*, *T. ternifolia*, and *W. hanleyi* as source of active compounds, which require further studies to isolate and identify the constituents which possess antiproliferative, cytotoxic and antituberculosis activities.

Keywords:
Alyxia linearis
Tabernaemontana ternifolia
Wrightia hanleyi
Apocynaceae
Endemic plants

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INTRODUCTION

Natural products are proven to be valuable sources of pharmacological agents that can be used in biological, medical, and pharmaceutical fields. Indeed, bioactive plant constituents have been employed as a base or as a structural template for new drug development, or as a therapeutic drug for the treatment of various human ailments (Grabowski and Schneider 2007). In fact, more than 50% of all modern drugs were derived from natural products (Madhurima et al. 2012).

The Apocynaceae family comprises of 366 genera with over 5,000 species of tropical shrubs, trees, herbs and woody climbers (Endress et al. 2014; Liu et al. 2013; The Plant List 2013). In the Asia-Pacific region, Apocynaceae species are utilized in traditional medicine for the treatment of diabetes, fever, gastrointestinal problems, malaria, pain, and skin and ectoparasitic infections (Chan et al. 2016; Wong et al. 2013; Billo et al. 2005; Mohamad et al. 2011). In Indian and African traditional medicine, Apocynaceae plants are utilized in the treatment of asthma, tuberculosis and chest complaints (Pallant and Steenkamp 2008; McGaw et al. 2008; Mariita et al. 2010; Luo et al. 2011). The secondary metabolites triterpenoids, iridoids, alkaloids and cardenolides present in Apocynaceae species are known to possess anti-inflammatory, cardioprotective, hepatoprotective, hypoglycemic and neuroprotective properties (Chan et al. 2016); while alkaloids, glycosides, tannins, phenolics, xanthones, quinones, sterols, and triterpenoids are said to act as antituberculosis agents (Arya 2011).

The Apocynaceae genera including *Allamanda, Alstonia, Calotropis, Catharanthus, Cerbera, Nerium, Plumeria, Tabernaemontana* and *Vallaris* have been reported to exhibit cytotoxic or anticancer properties (Wong et al. 2013). One of the most significant medical contributions of this family is the introduction of the first commercial anticancer drugs, vinblastine and vincristine, developed from *Catharanthus roseus* (periwinkle). Vinblastine is used to treat Hodgkin's disease while vincristine is used as remedy for lymphocytic leukemia in children (Chan et al. 2016). In addition, the Apocynaceae genera such as *Catharanthus, Tabernaemontana, Voacanga*, and *Wrightia* were observed to display antituberculosis activity (Cantrell et al. 1996; Nagarajan et al. 2008; Mohamad et al. 2011; Pallant et al. 2012; Macabeo et al. 2011; Boligon et al. 2014).

Cancer continues to be a leading cause of death worldwide, with approximately 17.5 million new cases and 8.7 million cancer-related deaths in 2015 (Ogbolel et al. 2017). In the Philippines, it was predicted that the total new cases of cancer in 2015 was about 109,280 with 48,138 new cases among males and 61,142 among females, whereas the number of cancer deaths in the same year was predicted to be 66,151, with 34,391 in males and 31,760 in females (Philippine Cancer Society 2015). This high incidence of cancer deaths, in addition to the problems of poor selectivity and severe side effects of current chemotherapeutic drugs, demand for the development of safer and more effective anticancer agents (Ogbolel et al. 2017). Plants play a very significant role as source of antitumor agents since over 67% of currently available anticancer are derived from natural sources (Cragg & Newman 2012).

Tuberculosis (TB) still ranks among the top ten leading causes of morbidity and mortality around the globe (Khainar et al. 2012; Godebo et al. 2015). According to the Global Tuberculosis Report in 2015, TB remains one of the world's biggest health threats, and ranks, together with HIV, as the leading cause of death from infectious diseases globally (WHO 2015). Similarly, the Philippines saw 14,000 TB related deaths and approximately 324,000 incident TB patients in 2015 (WHO WPR, 2017). The treatment of TB is not only remarkably lengthy, but the synthetic drugs for tuberculosis, though effective and efficient, present unavoidable adverse effects to the human body. The above-mentioned facts and figures underline the need to search for and develop potent anti-TB drugs with novel mechanism of action, of lower toxicity, and limited side effects. Natural products possessing antimycobacterial activity provide a potential area for discovering new antituberculosis agents.

The Philippines is considered a biodiversity hotspot with high endemism rate of both plant and animal species (Langenberger et al. 2006). In particular, the province of Palawan is home to numerous rare and endemic plants. The province harbors an estimated 3,000 to 3,500 flowering plant species mostly known to occur

only in Palawan and exhibiting about 15-20% endemism (Madulid 2002; Sopsop and Buot 2009). The three Apocynaceae plants endemic to Palawan – *Alyxia linearis* Markgraf, *Tabernaemontana ternifolia* DJ Middleton, and *Wrightia hanleyi* Elmer – have not been studied before (Figure 1). There were no published reports found on the ethnomedicinal, biological and chemical studies for these endemic species.

A. linearis was identified to occur only in Palawan, specifically in Bacungan, Puerto Princesa, and in Bulanjao Range, Rio Tuba. It survives in forest with ultramafic soil and at low altitudes (Pelser et al. 2015). *T. ternifolia* was introduced as a new species of *Tabernaemontan*a from the Philippines in 2005. It was found growing in two mountains in mainland Palawan, Mt. Mantalingahan and Mt. Beaufort, at elevations above 800 m (Middleton 2005a). *W. hanleyi*, locally known as "*benta-os"* and "*sabat-dalan*," is endemic to Palawan with herbarium specimens collected from Puerto Princesa (Mt. Pulgar, Mt. Cleopatra, Bacungan hills, Takduan zigzag, Tagburos, St. Paul's Bay, Mt. Bloomfield), Narra (Brgy. Calategas, Bato-bato river), Quezon (Lipuun, Tawa-tawa), and Taytay (Ngan PT 1965; Middleton DJ 2005b).

As stated above, Apocynaceae species are employed in traditional medicine for the treatment of various ailments and are known to produce biologically active secondary metabolites which may possibly be utilized for drug discovery and development. In addition, limited scientific studies have been conducted and published on any endemic plants of Palawan. Hence, this present undertaking was one of the first few studies that endeavored to investigate the phytoconstituents and pharmacological potential of endemic plant species of the province. The aim of the study was to determine the presence of secondary metabolites from the crude extracts of the leaves, twigs, and roots of *A. linearis*, *T. ternifolia*, and *W. hanleyi*. It also aimed to evaluate the antiproliferative, cytotoxic, and antituberculosis activities of the crude extracts from these endemic species.

METHODOLOGY

Collection and Identification of the Plant Materials

A. linearis (leaves, twigs, and roots) was collected in Sitio Magarwak (9.868448°N, 118.724624°E, 22.3 m elevation), Brgy. Sta. Lourdes, Puerto Princesa City on March 25, 2014. *T. ternifolia* (leaves, twigs, and roots) was collected from the montane forest of Mt. Beaufort (9.813055°N, 118.642972°E, 1019.3 m elevation) in Brgy. Irawan, Puerto Princesa City, on April 7, 2014. *W. hanleyi* (leaves, twigs, and roots) was collected from the rocky limestone of Tabon Caves (9.278572°N, 117.981184°E, 59.4 m elevation) in Lipuun Pt., Quezon, on June 4, 2014. Voucher specimens for *A. linearis, T. ternifolia,* and *W. hanleyi* (Acc. No. 2021. 2022, and 2023, respectively) were deposited at the Palawan State University

(a) *Alyxia linearis* **(b)** *Tabernaemontana ternifolia* **(c)** *Wrightia hanleyi*

Figure 1. The three Apocynaceae plants endemic to Palawan used in the study.

Extraction and Phytochemical Screening

Figure 2 shows that all plant parts (150 - 200 grams each) were air-dried at room temperature for a month and then ground separately using a Wiley Mill with a fine mesh. The pulverized leaves, twigs and roots of *A. linearis T. ternifolia, and W. hanleyi* (100 g each) were then macerated separately with a succession of solvents of increasing polarity (hexane, dichloromethane, and methanol) each at room temperature for 3 days, using 100-200 ml of solvent for each extraction. The extraction was repeated thrice with 24-hour interval before each collection. The collected crude extract was concentrated in *vacuo* using a Buchi rotary evaporator at a maintained temperature (40-43°C for hexane (Hex), 39-40°C for dichloromethane (DCM), and 45°C for methanol (MeOH)). A small portion (1 mg) of each crude extract was sent to the Leibniz-Institute for Natural Product Research and Infection Biology, Hans-Knöll-Institute in Germany for antiproliferative and cytotoxicity assays against HUVEC, K-562, and HeLa cell lines. Similarly, 1 mg of each crude extract was sent to the Institute for Tuberculosis Research, College of Pharmacy, University of Illinois at Chicago for MABA screening against *M. tuberculosis* $H_{37}Rv$.

For phytochemical screening, a small amount of each crude extract (5-10mg) was dissolved in their respective solvent (i.e., hexane, dichloromethane and methanol) to form a sample solution. The solvent system for the TLC developing chamber was prepared from varying ratios (v/v) of petroleum ether and ethyl acetate. Capillary tube was used to spot a sample solution on the silica gel TLC plate at 1cm from the edge of the plate and the drop was allowed to dry. The plate was placed in TLC developing chamber allowing the sample to ascend the TLC plate by capillary action. The plate was removed and the solvent front was marked then allowed to dry. Three spray reagents were used - vanillin-sulfuric acid reagent, Potassium ferrocyanide- ferric chloride ($K_4Fe(CN)_6$-$FeCl_3$) and Dragendorff's reagent - to characterize the crude extracts. For the first two spray reagents, maximum visualization was achieved by heating and charring, and/or until an appreciable color has appeared. Dragendorff's reagent was used to screen for the presence of alkaloids, $K_4Fe(CN)_6$-$FeCl_3$ for phenols, tannins, and flavonoids, and vanillin-H_2SO_4 for higher alcohols, terpenoids, phenol derivatives, steroids and essential oils. Results of the phytochemical screening are reflected in Table 1.

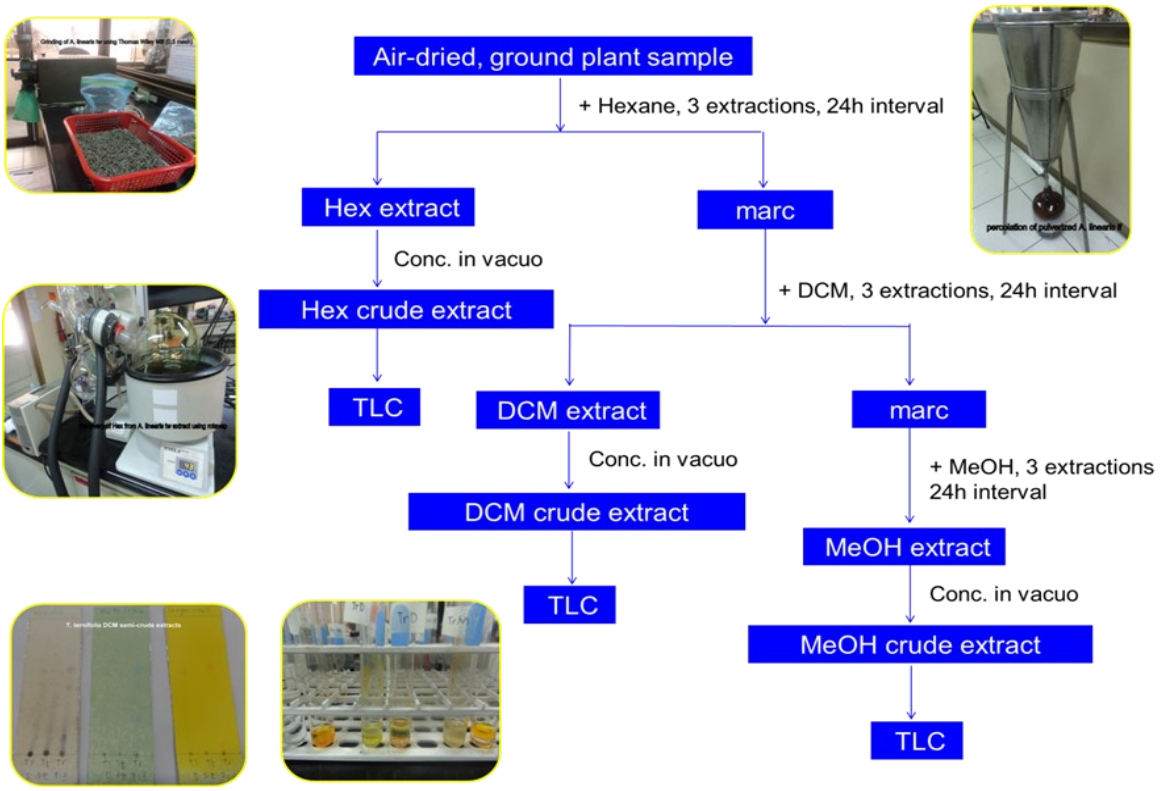

Figure 2. Schematic diagram for plant extraction and phytochemical screening.

Note: Hex = hexane; DCM = dichloromethane; MeOH = methanol; TLC = thin layer chromatography; conc = concentrated

Antiproliferative and Cytotoxicity Assays

Cell Titer-Blue1 Assay, as described by Krauth et al. (2010), was used for the determination of inhibition of cell proliferation specifically against human umbilical vein endothelial cord (HUVEC), human immortalized myelogenous leukemia (K-562), and human epithelial carcinoma (HeLa) cell lines. The GI_{50} and CC_{50} values were defined as the value at the intersection of the dose curve with the 50% line compared to untreated control. For comparison, the chemotherapeutic agents, imatinib and doxorubicin, were used as positive controls.

Antituberculosis Assay

The anti-TB assay used the virulent strain *Mycobacterium tuberculosis* $H_{37}Rv$ (ATCC 27294, American Type Culture Collection, Rockville, MD). The activity against replicating *M. tb* $H_{37}Rv$ was determined using a fluorescence readout in the Microplate Alamar Blue Assay [MABA] (Cho et al. 2015) following incubation for one week. For reference purposes, the standard TB drugs rifampin (RMP), isoniazid (INH), capreomycin (CAP) and bedaquiline (TMC207) were used as positive drug controls. The MABA MIC (mg/ml) is the lowest concentration at which the test compound exhibited an inhibition of >90% relative to the mean of replicate bacteria-only controls. Results of the antituberculosis assay are reflected in Supplemental Information-Table 2.

RESULTS AND DISCUSSION

This study initiated a preliminary survey on the major secondary metabolites present in three endemic Apocynaceae plants in Palawan. TLC analyses of the crude extracts followed by visualization with the three spray reagents showed the presence of different secondary metabolites (Table 1). Most crude extracts from the leaves, twigs, and roots of *A. linearis*, *T. ternifolia* and *W. hanleyi* showed the probable presence of alkaloids, phenols, tannins, flavonoids, terpenoids, higher alcohols and steroids. Alkaloids possess diverse biological activities such as anticancer, anti-inflammatory, antimalarial, antimicrobial, antipsychotic, antiulcer, hypoglycaemic, neuroprotective and hepatoprotective activities (Chan et al. 2016). In addition, alkaloids, tannins, phenolics, sterols, and triterpenoids exhibit antituberculosis properties (Arya 2011). Moreover, triterpenoids are known for their analgesic, anti-allergy, anticancer, antiviral, bactericidal, cardiovascular, cytotoxic, fungicidal, and spermicidal properties (Chan et al. 2016). Thus, although *A. linearis*, *T. ternifolia* and *W. hanleyi* have no known ethnomedicinal uses, the presence of alkaloids, phenols, tannins, flavonoids, terpenoids, steroids, and higher alcohols in the leaves, twigs, and roots of these endemic Apocynaceae species make them potential sources of active compounds that can be employed in drug discovery and development.

Preliminary screening of the antiproliferative and cytotoxic activities of the leaf, twig, and root extracts from the three endemic Apocynaceae species was also conducted. Results of the antiproliferative and cytotoxicity assays are shown in Supplemental Information–Table 1. Results of the Cell Titer-Blue1 assay indicated that the DCM (TrD) and MeOH (TrM) root extracts from *T. ternifolia* displayed strong antiproliferative activity against HUVEC and K-562 cancer cell lines (GI_{50} = 0.2 to 1.0 µg/ml) but weak cytotoxicity against HeLa cell line (CC_{50} = 19.6 to 39.2 µg/ml). In addition, the MeOH leaf (AlM) and DCM twig (AtD) extracts from *A. linearis* (GI_{50} = 4.8 to 9.4 µg/ml), the DCM leaf (TlD) and Hex twig (TtH) extracts from *T. ternifolia* (GI_{50} = 6.7 to 7.2 µg/ml), and the DCM twig (WtD) extract from *W. hanleyi* (GI_{50} = 8.2 to 9.7 µg/ml) exhibited moderately strong activity against HUVEC and K-562 cell lines. However, only the *A. linearis* DCM twig extract (AtD, CC_{50} = 4.4 µg/ml) and the *W. hanleyi* Hex root extract (WrH, CC_{50} = 9.8 µg/ml) showed moderately strong cytotoxic activity against HeLa cell lines. The presence of alkaloids and terpenoids in AlM, AtH, TlD, TtH, TrD, TrM, WtD, and WrH crude extracts may be responsible for the observed cytotoxicity against HUVEC, K-562, and HeLa cancer cell lines (Chan et al. 2016). Interestingly, although it showed weak cytotoxic effect against HeLa, TrM (GI_{50} = 0.2 to 0.9 µg/ml) displayed comparable activity with the anticancer drug, doxorubicin (GI_{50} = 0.1 to 1.0 µg/ml), against HUVEC and K-562 cancer cell lines. These results indicate that these endemic Apocynaceae species are potential sources of biologically active

compounds that may possess anticancer or cytotoxic properties.

A preliminary screening of antitubercular activity against *M. tuberculosis* $H_{37}Rv$ using MABA was also carried out. Results of the antituberculosis assay are shown Supplemental Information– Table 2. MABA MIC results suggested that only the DCM root extracts from *T. ternifolia* (TrD, MIC = 9.6 µg/ml) and *W. hanleyi* (WrD, MIC = 7.4 µg/ml) presented moderately strong inhibitory activity against *M. tuberculosis* $H_{37}Rv$. The rest of the crude extracts exhibited weak antitubercular activity. The presence of alkaloids, tannins, phenolics, sterols, and triterpenoids in TrD and WrD crude extract may be responsible for the observed inhibitory activity against *M. tuberculosis* H37Rv (Arya 2011). Results imply that *T. ternifolia* and *W. hanleyi* are potential sources of active compounds that may be used in the development of antituberculosis drugs.

Table 1. Phytochemical compounds present in the crude extracts.

Crude Extract	Code	Alkaloids	Phenols, Tannins, Flavonoids	Terpenoids, Steroids, Higher alcohols
A. linearis leaf hexane	**AlH**	-	-	+
A. linearis leaf dichloromethane	**AlD**	+	+	+
A. linearis leaf methanol	**AlM**	+	+	+
A. linearis twig hexane	**AtH**	+	-	+
A. linearis twig dichloromethane	**AtD**	+	+	+
A. linearis twig methanol	**AtM**	+	+	+
A. linearis root hexane	**ArH**	+	-	+
A. linearis root dichloromethane	**ArD**	+	+	+
A. linearis root methanol	**ArM**	+	+	+
T. ternifolia leaf hexane	**TlH**	+	-	+
T. ternifolia leaf dichloromethane	**TlD**	+	-	-
T. ternifolia leaf methanol	**TlM**	-	+	+
T. ternifolia twig hexane	**TtH**	+	+	+
T. ternifolia twig dichloromethane	**TtD**	+	-	+
T. ternifolia twig methanol	**TtM**	-	+	+
T. ternifolia root hexane	**TrH**	+	+	+
T. ternifolia root dichloromethane	**TrD**	+	+	+
T. ternifolia root methanol	**TrM**	+	+	+
W. hanleyi leaf hexane	**WlH**	-	+	+
W. hanleyi leaf dichloromethane	**WlD**	+	+	+
W. hanleyi leaf methanol	**WlM**	+	+	-
W. hanleyi twig hexane	**WtH**	-	-	+
W. hanleyi twig dichloromethane	**WtD**	+	+	+
W. hanleyi twig methanol	**WtM**	-	+	+
W. hanleyi root hexane	**WrH**	-	-	+
W. hanleyi root dichloromethane	**WrD**	+	+	+
W. hanleyi root methanol	**WrM**	+	+	+

Note: + presence; - absence

CONCLUSION

This study reported, for the first time, the secondary metabolites and the cytotoxic and antituberculosis activities of the endemic Apocynaceae plants *A. linearis*, *T. ternifolia*, and *W. hanleyi.* Preliminary phytochemical screening have shown the possible presence of alkaloids, phenols, tannins, flavonoids, terpenoids, higher alcohols and steroids in these endemic species. The Cell Titer-Blue1 showed that the leaf, twig, and root extracts from these three endemic species displayed cytotoxic activity against HUVEC, K-562, and HeLa cancer cell lines, with the *T. ternifolia* root extract exhibited the strongest antiproliferative activity against HUVEC and K-562 cell lines. The MABA MIC revealed that the *T. ternifolia* and *W. hanleyi* root extracts presented moderately strong inhibitory activity against *M. tuberculosis* H_{37}Rv. The results of this study demonstrated the phytomedicinal impact of these three Apocynaceae species endemic to Palawan as potential source of anticancer and antituberculosis agents. Thus, further bioassay-guided screening is necessary to isolate and identify the constituents from *A. linearis*, *T. ternifolia*, and *W. hanleyi* with cytotoxic and antituberculosis properties, which may also be useful against other diseases.

POLICY IMPLICATION

Although the province of Palawan is blessed with rich endemic flora, very limited studies have been conducted on the medicinal potential of these plants. Present and future outcomes of this study could be utilized by the PCSDS as preliminary data in the wider scale investigation of other endemic plants of the province to evaluate their biological activities. The agency could provide thesis funding for undergraduate and graduate students in the province to conduct phytochemical and biological investigations of plants endemic to Palawan. Proper monitoring, conservation, and propagation of endemic plants with medicinal potential would then be the administrative task of the agency.

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SUPPLEMENTAL INFORMATION

Table 1. Cytotoxicity of crude extracts and anti-cancer drug controls .

Crude Extract	Antiproliferative Effect		Cytotoxicity
	HUVEC GI_{50} [µg/ml]	K-562 GI_{50} [µg/ml]	HeLa CC_{50} [µg/ml]
AlH	≥50	40.4 (± 4.2)	≥50
AlD	≥50	≥50	≥50
AlM	9.4 (± 0.1)	4.8 (± 0.6)	11.3 (± 0.3)
AtH	>50	>50	>50
AtD	16.7 (± 0.4)	8.6 (± 1.3)	4.4 (± 0.4)
AtM	26.8 (± 1.5)	35.2 (± 2.8)	49.6 (± 0.7)
ArH	≥50	41.8 (± 4.3)	≥50
ArD	34.3 (± 1.1)	25.1 (± 3.8)	46.7 (± 3.4)
ArM	≥50	≥50	≥50
TlH	15.8 (± 1.0)	17.4 (± 0.4)	32.2 (± 0.5)
TlD	7.0 (± 0.5)	19.3 (± 4.2)	38.1 (± 2.8)
TlM	19.5 (± 0.6)	17.9 (± 1.3)	22.3 (± 0.2)
TtH	7.2 (± 1.6)	6.7 (± 0.5)	15.8 (± 1.1)
TtD	16.0 (± 0.7)	12.8 (± 1.6)	19.8 (± 1.6)
TtM	28.9 (± 3.0)	21.8 (± 1.4)	47.6 (± 1.9)
TrH	>50	>50	>50
TrD	0.3 (± 0.05)	1.0 (± 0.2)	19.6 (± 2.2)
TrM	0.2 (± 0.05)	0.9 (± 0.1)	39.2 (± 1.9)
WlH	>50	≥50	≥50
WlD	>50	>50	>50
WlM	>50	>50	>50
WtH	22.4 (± 0.9)	17.8 (± 0.2)	31.7 (± 0.8)
WtD	8.2 (± 0.7)	9.7 (± 0.2)	31.7 (± 1.2)
WtM	>50	>50	>50
WrH	20.4 (± 0.8)	15.3 (± 1.6)	9.8 (± 0.3)
WrD	29.3 (± 2.0)	>50	42.8 (± 0.5)
WrM	>50	>50	>50
***Imatinib**	10.9 (±1.2)	0.1 (±6.7x10^{-3})	38.8 (±1.4)
***Doxorubicin**	0.1	1.0±0.6	2.0±0.8

Table 2. Microplate Alamar Blue Assay Minimum Inhibitory Concentration (MABA MIC) values of crude extracts and TB drug controls .

Crude Extract	MABA MIC [µg/ml] vs. *M. tb.* $H_{37}Rv$
AlH	22.5
AlD	27
AlM	>64
AtH	49.8
AtD	26.6
AtM	>64
ArH	55.3
ArD	39.6
ArM	61.1
TlH	14.4
TlD	60.6
TlM	52.6
TtH	30.1
TtD	25.2
TtM	24.2
TrH	56.5
TrD	9.6
TrM	18.1
WlH	19.0
WrH	21.2
WrD	7.4
WrM	25.5
RMP	0.0242
INH	0.0151
CAP	0.923
TMC207	0.0222

** GI_{50} and CC_{50} values obtained from Macabeo et al. (2013)*

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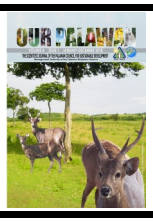

Encouraging Natural Resource Conservation through the Human Affect: The Case of Icadambanauan Island, Palawan, Philippines

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Keywords:
Sense of Place
General Ecological Behavior
Icadambanauan Island
Resource conservation

ABSTRACT

Seeking the relationship of humans to their surroundings is a key factor to understand environmental problems that we currently face. This study tried to identify how human belongingness to his environment, as measured by Sense of Place, affects attitudes towards environmental conservation, as measured through the General Ecological Behavior (GEB) using the data gathered through survey of all the households in Icadambanauan Island. Data were analyzed using two-stage least squares regression methods. Results showed that the island residents' Sense of Place have significant positive relationship to their conservation behavior. If given the proper attention, these connections already embedded in our socio-ecological systems may help enhance management plans geared towards conservation of resources or in resolving environmental problem, especially those linked with anthropogenic activities.

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INTRODUCTION

Environmental degradation is a problem that the Philippines is threatened with (ADB 2009). With the reports on deteriorating environment such as losing good coral cover (Bruno and Selig 2007) and mangrove forests (ADB 2009), anthropogenic activities have been attributed to these problems wherein some of the reasons behind these are illegal and destructive actions and even unregulated resource use (PCSDS 2015).

Since humans play a crucial role in these predicaments, encouraging resource conservation can help halt the aggravating conditions. By inculcating a more positive behavior towards the environment, recurring problems of degradation can at least be minimized. To further influence the behavioral dimension of human as associated to the environment, understanding the link and relationship between them is deemed essential.

One of the factors yet to be proven in influencing one's behavior towards the environment is man's relationship to its physical environment, properly termed as the Sense of Place (SOP). Based from Altman and Low (1992), it is the relationship that exists between the spatial-environmental setting and human beings. Once understood, SOP can be a potential key in understanding one's tendencies in showing pro-environmental behavior.

The behavior of an individual towards his environment is one of the basic but usually disregarded factors in resolving environmental problems that we encounter at present. That is even why research studies seeking to understand human behavior as an important factor for sustainability of our natural resources is a necessary field that needs attention (Gonzales et al. 1988, in Ramkisoon et al. 2012). With the complexity of understanding human behavior, it is not an easy task to untangle the bits of intermeshed factors that create or influence it. To further situate and understand behavior towards environment, a specific case scenario was used for this study. Reducing larger externalities, a small yet self-sustaining system such as Icadambanauan Island, is perfect because it will be possible to track down intrinsic variables that can influence behavior.

The Sense of Place (SOP) is usually linked to the behavior shown by the people only after a certain devastation or degradation to their environment has occurred. When a portion of their identity or emotional attachment with their physical spaces is disrupted by the change, one's SOP becomes more highlighted. SOP is usually expressed through the people's longing for the restoration of their previous environment that they used to have (Manzo and Perkins 2006; Warsini et al. 2014). In the case of Icadambanauan Island, it is of interest in this study to understand whether the SOP is already a part of the reasons behind people's behavior which led them to continuously maintain the condition of their own island to support their growing population.

By establishing the relationship between SOP and behavior, it will be easier to comprehend how people can be motivated to engage in conservation actions that will eventually lead to a more stable and resilient environment (Azizul et al. 2016). Studying such motivations coming from their attachment and behavior towards their current environment can be an important component in successfully bridging the human and environment balanced relationship.

Conservation of Natural Resources

When dealing with conservation of natural resources, it is all about wise use. As Krutilla (1987) mentioned about the early and usual definition of conservation, it revolves around optimal use of the finite resources but what problem usually arises is that people do not value the resources high enough to be considered as something that needs to be conserved. This is the same point raised by Gascon et al. (2015) regarding undervalued resources. They claimed that humans are actually overusing the natural resources but since the spectrum of resources seem to be too much at the moment, people tend to oversee the chaotic future. To resolve these misnomers, placing emphasis on pro-environmental behaviors such as resource conservation and continuous mainstreaming of these topics in basic education should be encouraged.

The Role of SOP to Pro-environmental Behavior

As popularized by researchers such as Jorgensen and Stedman (2006), SOP is understood as a human-environment attachment, dealing with one's emotions,

Figure 1. Location Map of Icadambanauan Island, Taytay, Palawan.

behaviors and beliefs on a particular geographical location. This concept, which is considered as a broad term covers the three constructs discussed by various researches namely (1) place identity, (2) place dependence and (3) place attachment. Though these terms are separately treated by a number of studies, SOP can combine the three aspects, creating a better and detailed picture of the relationship between human and the physical environment.

Mostly discussing on the component of place attachment, studies have found out that the more a person is attached to his or her physical environment, the more he or she is willing to participate in pro-environmental activities (Manzo and Perkins 2006). Whenever any threat is felt to be present in the area where one is attached, the more protective the individual becomes. This attitude was said to be greatly influenced by the possible sense of loss which may happen if the potential threat is not resolved.

In the study of Jorgensen and Stedman (2006) with lakeshore property owners, it was found that moderate to high correlation exists between the three dimensions of SOP. The people's perception of the environmental features of the place was noted to have the highest influence to the SOP of the property owners. It was also found out that the strongest predictor of the lakeshore property owners' SOP was their intent of retaining the natural vegetation of the site especially the vegetation along the lake's shoreline. The said variable was also seen to be positively correlated to the three dimensions explored by Jorgensen and Stedman (2006).

This study aimed to establish the relationship between the people's SOP with their conservation behavior, herein measured through the General Ecological Behavior (GEB) scale. With the existing literature and studies showing possible linkages of the two, it is hypothesized that SOP is positively correlated with one's GEB. Furthermore, a person's socio-economic characteristic is also considered as an important factor in determining one's SOP at the onset.

METHODOLOGY

The study was conducted in Icadambanauan Island in Taytay, Palawan, Philippines. It is a home for more or less 200 households who are highly dependent on fishing as a means of their subsistence. The island does not have a large scale electrical source, and only small solar panels mostly granted through a private organization serve as the households' source of light during night time. There is also a scarcity in freshwater. A normal routine for the community is to fetch

water and even other basic necessities, such as rice and other food item from Palawan mainland by boat.

With the interest of the study to understand the behavior of humans toward their environment, a survey design was used to capture both SOP and conservation behavior. A survey questionnaire was developed capturing the variables intended for the assessment. The SOP scale used by Jorgensen and Stedman (2006) was utilized. Meanwhile, Kaiser (1998) and Kaiser and Wilson's (2000) General Ecological Behavior Scale, which tries to measure conservation behavior, was also incorporated in the survey form. A total enumeration was done considering the manageable number of households.

To understand the relationship between SOP and General Ecological Behavior (GEB), a two-stage least square regression was employed. Two simultaneous equations were used to incorporate important predictors of SOP on the onset of the relationship establishment for the GEB.

RESULTS AND DISCUSSION

Considering that Sense of Place can be highly affected by the spatial environment itself and the people's socio-economic conditions, these factors were regressed with SOP which is the first stage of the 2SLS regression.

Stage 1: $SOP = \alpha + \beta\ SES_i + \beta\ PEC_j + \mu$.

Where:

SES_i= vector of Socio-Economic Characteristics:
- *Purok*
- *Sex dummy (1 if male; 0 otherwise)*
- *Civil Status (1 single; 0 otherwise)*
- *Education (years)*
- *Income (monthly, in Philippine peso)*
- *Place of Origin dummy (1 if native, 0 if otherwise)*
- *Length of residency (years)*

PEC_j= average score of perceived condition of the different ecosystems

μ= error term

β = coefficient

α = *constant/ intercept*

Figure 2. Interviews and one on one surveys with communities of Icadambanauan Island. *Top left:* Interview with Genelita Abique, one of the residents who have spent almost their lifetime in the island but was originally born from another municipality of Palawan. *Top right*: Interview with the President of the BFAR– assisted livelihood project on sea cucumber, officer of the Senior Citizens Association and Barangay Councilor, Kgd. Eliseo Dandal. *Lower left*: Courtesy call and key informant interview with Barangay Chairman Elfren Dandal. *Lower right*: Interview with Mr. Cristituto Aurello (82) one of the eldest native residents of Barangay Biton.

Variables identified to significantly affect SOP were the respondents' *purok,* the sub -cluster of the community under the barangay level, sex, place of origin, years of residency and their perception of their environment (Table 1). The coefficients of the significant variables were used to estimate the predicted SOP values.

Table 1. Factors affecting the SOP scores.

Variables	Coefficients	Std. Error
Intercept	2.9920***	0.1921
Purok	-0.1446***	0.0452
Sex	0.1978***	0.0645
Civil Status	-0.0455	0.0459
Education	0.0078	0.0116
Livelihood	0.0051	0.0221
Income	-0.00001435	$1.381E^{-5}$
Place of Origin	0.2274***	0.0776
Years Residency	Years Residency	0.0072***
PEC	PEC	0.2020***
R^2	0.227	
Adjusted R^2	0.190	
R	0.476	
Std. Error	0.399	
n	200	
k	9	
F	6.19	

**** Significant at 0.01 level.*

Civil status, education, livelihood and income were found to be insignificant in the case of Icadambanauan Island. As provided by the overview of the respondents' characteristics (Supplemental Information Table 1), majority of them are married with no stable livelihood. They have an average of at least secondary level in terms of education while income is below the average recommended for the Philippines. Since the respondents are more or less homogenous with these variables, nobody stands out among others making their effects negligible to their emotional bond to their environment. Overall, the regression model earned F=6.19 which signified that the effect of the variables in the model are significant (F crit = 2.72 at 0.01 level).

For the second stage of the 2SLS, the predicted SOP values or the $\widehat{SOP}$ were used:

$$\text{Stage 2: GEB} = f(\widehat{SOP})$$

This enabled the effects of the predictors of SOP to be incorporated in the analysis. Using another regression, it showed that the sense of place do have a significant effect on GEB at 0.05 level (Table 2).

Table 2. Effect of $\widehat{SOP}$ on GEB.

Variables	Coefficients	Std. Error
Intercept	3.1603***	0.4141
$\widehat{SOP}$	0.2451**	0.1052
R^2	0.027	
R	0.163	
Std. Error	0.311	
n	200	
k	1	
F	5.42	

*** Significant at 0.05 level*
**** Significant at 0.01 level*

Notice that the value of R^2 is notably low for the two regression models. This case is usually expected for the second model since only one predictor variable is included in the analysis. Considering also that the study is geared towards analyzing behavior and the social component, which is technically a real complex interplay of a number of factors, the value of R^2 does not particularly reject and delimit the results of the regression analysis. Meanwhile, F value of 5.42 shows that the regression model have significant results but at 0.05 level (F crit = 3.84).

On the review done by Azizul et al. (2016), their group formulated a new conceptual framework on reconsidering SOP with regards to the bioregional planning aimed for resource conservation. Based on their analysis, it appears that SOP is an important guiding factor that can help mobilize people in participating into plan formulation. Furthermore, being an important component of the planning process will enable them to gain motivation that translates into attitudes that are in favor of ecosystem conservation. This concept is now being reflected by the results for the Icadambanauan Island wherein SOP can help predict one's

conservation behavior.

In a recent empirical study of Davis, Le and Coy (2011), the same idea was also observed. Though the study did not directly used SOP as their main predictor of GEB, their team tried to use several variables which can also be considered as somewhat similar with what each of SOP's constructs are trying to gauge. For instance, using the model of commitment and interdependence theory as their guide, they utilized a number of components as possible predictors of GEB. The component Inclusion of Nature in Self (INS) measure which tries to gauge one's closeness and interconnectedness to his environment is more or less similar with SOP's Place Attachment. Meanwhile, the Environmental Identity Scale (EID) which measured the degree of a person's inclusion of self to his environment or to nature runs along with the concept of Place Identity. Other components such as Close Relationship Scale, the measurement for human and environment relationship, and Connectedness to Nature Scale, emotional attachment to environment, are all analogous to the idea behind SOP.

CONCLUSIONS AND POLICY IMPLICATIONS

Understanding the relationship between humans and their environment is a crucial factor if the end goal would be the sustainable management of resources. With studies on Person and Environment (P-E) linkages such as this, it can be assumed that people truly influence the state of his physical environment and vice versa.

This study tried to assess the link between the people and environment in an island by looking at the relationship between SOP and GEB. Using the people's perception on their nearby environment to represent their physical surrounding's status, including their socio-economic profile, it was found out that such predictors can influence one's SOP significantly. Variables such as sex, type of residency, years of residence in the island, and perception on environmental condition were the factors found to be significantly predicting the SOP. It was learned that the residents' SOP has a significant relationship with their pro-environmental action herein measured through the General Ecological Behavior (GEB) scale.

In understanding socio-ecological systems, the links and patterns found in Icadambanauan Island have shown possible links on how human and environment interactions are intertwined. This study shows how human emotions, which are usually disregarded in many aspects of technical assessments, have important roles and should be taken into account with objectivity.

The people of Icadambanauan Island have been showing their belongingness to the bounds of their environment, reflecting the complexity of man and environment's close relationship which is usually overlooked when understanding the dynamics of the environment. With limited resources and freshwater scarcity, the community still chooses to stay within the island despite the hardships that they encounter in it.

SOP, as a product of the influences of the environment to human and socio-economic dimensions, is an important factor on how human could be triggered to deliver desired actions such as participation in pro-environmental actions. If properly recognized, the same factor can become an essential key in attaining resolutions to our environmental problems that usually runs in conflict as always with human interests.

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Palawan Endemic

New shrew species in Palawan

Palawan Moss Shrew

Palawanosorex muscorum

This shrew is found only within 1550-1940 masl, near the peak of Mount Mantalingahan, covered by the political boundary of the Municipality of Rizal. Based from the latest published scientific article by R. Hetterer et.al., this new genus and new species is found only in Palawan, with its closest relatives found in Africa.

Source: *Journal of Mammalogy*, Volume 99, Issue 3, 1 June 2018, Pages 518–536
https://doi.org/10.1093/jmammal/gyy041
Photo credits: Danilo Balete

Our Palawan
The Scientific Journal of Palawan Council for Sustainable Development
Research and Analysis
Life on Land

Estimating Population Density and Predicting Suitable Areas of Calamian Deer *(Axis calamianensis)* to Inform Management and Conservation Initiatives in Calamian Islands, Palawan

Palawan Council for Sustainable Development Staff*

Keywords:
Calamian Deer
Calamian Island
Busuanga
Habitat Suitability
Population Density

ABSTRACT

Calamian deer (*Axis calamianensis)* is one of the endangered species endemic to Palawan. Occurring in the northern Calamian group of Islands, the study found out that majority of the population flourishes on Calauit island, Busuanga as compared with other nearby islands. But regardless of the island's suitability as habitat for Calamian deer, the analysis revealed that there is a significant drop of the population attributed to illegal hunting. On the site suitability analysis, the variables of the modeling showed that high probability of species presence are in relatively flat, lowland areas with grassland vegetation. With these, several plans are recommended for the development and conservation of the current Calamian Deer habitats.

Commissioned study by the Palawan Council for Sustainable Development Staff

INTRODUCTION

Philippine ungulates are among the most globally threatened species (Cowan and Holloway 1973; Oliver 1993, 1994). There are eight recognized endemic ungulate species in the country, three of which are known to occur only in Palawan Faunal Region (Oliver 1993; Heaney 1998). These are the Palawan Bearded Pig *Sus ahoenobarbus*, Balabac Mouse Deer *Tragulus nigricans* and Calamian Deer *Axis calamianensis*. The Palawan Bearded Pig is listed presently as "Near Threatened" by the International Union for Conservation of Nature (IUCN) while both the Balabac Mouse Deer and Calamian Dear are listed as "Endangered" (IUCN 2015). Over the last decades, these species had suffered extensively because of habitat loss and direct persecution, which have caused significant decline to their population (Oliver 1993). The Calamian Deer had suffered the most reduction in numbers, losing nearly all its population (Grimwood 1976).

The Calamian Deer, also locally known as "Calachao", is found only in Calamian Islands, which is located in the northern tip of Palawan. At present, this species occurs in three of the four major islands of Calamian (i.e., Busuanga, Culion, Calauit), and potentially on small nearby islands (IUCN 2015). It has not been recorded on Coron island despite good condition of vegetation. Its apparent absence on Coron probably is due to the island's steep limestone terrain (Rico and Oliver 2008; Widmann et al. 2017). It is also not known from anywhere else in the region, including mainland Palawan. However, recently discovered fossils indicate that this species might had occurred in mainland Palawan and got extinct at the end of Pleistocene period (Piper et al. 2008). The deer population was reportedly abundant in almost all suitable areas throughout the islands of Busuanga and Culion in the 1940s, but their number severely declined in the 1970s because of extreme hunting pressure (Grimwood 1976). Only a small population survived in south of Culion and Calauit. In 1976, the Calauit island was proclaimed as Game Preserve and Wildlife Sanctuary mainly to accommodate the eight African ungulate species which were presented to President Fernand Marcos during his visit to Kenya (Oliver 1993). A year after the proclamation, 30 individuals of Calamian Deer were released in Calauit, and their population had increased to about 550 individuals by the end of 1991 (Oliver 1993). In 1994, the deer population In the island was estimated to had reached ca. 1,123 individuals (Orig and Rosell 1994). The most recent surveys of its population indicate that the species remain widespread in Busuanga and Culion but occuring in low densities (Rico and Oliver 2008). The species occurs mostly in grasslands, open woodlands and secondary growth forest (Hoogstraal 1951). They can be observed typically grazing, resting and chewing cud almost throughout the day (Widmann et al. 2017).

In 2016, the Katala Foundation begun implementing the Palawan Deer Research and Conservation Program, which aims to determine the present population and distribution of the Calamian Deer and establish potential conservation breeding program for future reintroduction in mainland Palawan (Widmann et al. 2017). A parallel research initiative is also being conducted by the Palawan Council for Sustainable Development (PCSD) to formulate protection and conservation management plan for the species, therefore including this study. In this study, we aim to conduct a rapid assessment in Busuanga and Calauit islands to estimate the species population density and predict potential suitable areas using spatially explicit modeling tools.

METHODOLOGY

Study sites

Busuanga and Calauit islands are found at the northernmost tip of Palawan, which both are part of the Calamian Group of Island (Figure 1). The two islands are connected virtually by a small strip of land with dense mangrove forest, extending on both sides. Busuanga has a total land area of ca. 392 km^2, with steep terrains reaching about 600 m elevation. Whereas, the Calauit island has a total land area of 34 km^2, is relatively flat, having only few hilly mountains reaching ca. 200 m elevation. Natural vegetation on both islands is composed mostly of lowland forest and natural grasslands found on ultramafic rocks, and mangrove forest along the coast. In Busuanga, the continuing alteration of natural habitats (e.g., cultivation, urbanization) has increased the extent of grasslands and open

areas on the island. As a result, the remaining good extent of lowland forest is now limited to steep mountains and deep valleys. Busuanga and Calauit have similar climatic condition, having two pronounced seasons: dry from November to April, and wet during the rest of the year. Annual average temperature and precipitation on these islands is 23.14 °C and 2,318 mm, respectively (Hijmans 2005). During our visit in March 2018, the islands were relatively dry, but there were days with intermittent rain in the afternoon between (14:00–16:00 h).

Population survey and density estimate

We performed a rapid assessment of the Calamian Deer population throughout the islands of Busuanga and Calauit. We employed a combination of point count, dungs and footprints count (Sutherland 2006), opportunistic search and informal community interview. Point count stations were selected randomly on the islands (see stations in Figure 1; sample station view in Figure 2). We searched each station to determine species presence through direct contact or indirect (by counting dungs and footprints). Then, the radial distance of observed dungs and tracks from the center of established station was recorded. Opportunistic search was performed based on the results of community interview where areas of recent sightings were visited to validate the species presence. The assessment was done throughout the day, and at night between (18:00–21:00 h), particularly in Buluang, Busuanga.

We calculated the species population density using the program DISTANCE (Buckland 1993; Buckland et al 2004). We used the point count data, which derived mainly from indirect contact of the animal through observed presence of dungs and tracks (see summary of data in Table 2). The radial distance, type of

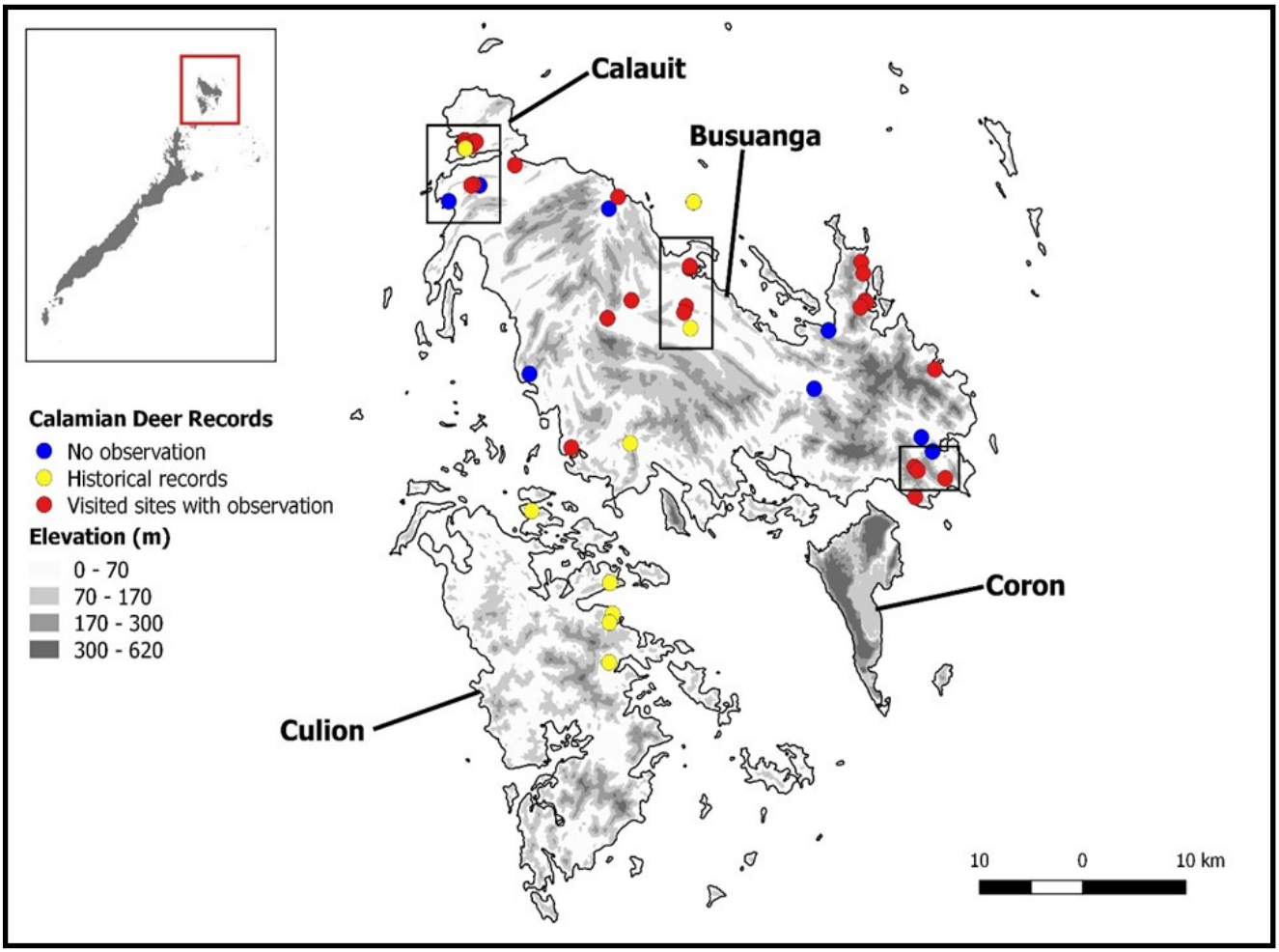

Figure 1. Map of Calamian islands, showing the sites we visited with and without deer observation and historical records obtained from museum records and published reports/articles. The small boxes (in black) indicate the location of point count stations. Geographic coordinates are presented in Supplemental Information- Table 1.

habitat and its extent were also utilized in the analysis. During the analysis, we used the program default setting. We did not truncate the observation distance; therefore, we retained all our observations regardless of distance from the center of station. The half-normal key function was used and the best model fit was selected based on lowest Akaike Information Criterion (AIC) value (see Buckland 1993). This calculation was done only for Busuanga island. The data collected from Calauit was excluded because the population from the island does not reflect the present condition in other areas. Thus, including the data will give a bias estimate. To estimate the species total population throughout Busuanga, Culion and other islands, we used the calculated animal density from DISTANCE and multiplied it to the total land area of suitable habitat generated using the species distribution modeling.

Predicting suitable areas

We predicted suitable areas for Calamian Deer using the species distribution modeling technique (Peterson et al. 2011). We used a total 51 records, obtained from our survey and supplemented with secondary data from literature and museum records though the Global Biodiversity Information Facility (https://www.gbif.org). Twenty one (21) environmental variables comprised of climatic, topographic and vegetative data were utilized as predictors. The 30 arc-second climatic data was obtained from WorldClim (https:// www.worldclim.org). Topographic data such as elevation, slope and aspect were derived from the digital elevation model of Shuttle Radar Topography Mission (https://srtm.csi.cgiar.org). Vegetation cover was obtained from the National Mapping and Resource Information Authority of the Philippines. All the variables were in raster format (i.e., images), with uniform spatial resolution of ca. 1 km^2. Data calibration was done in Quantum GIS.

To develop the model, we used the most widely known algorithm in species distribution or suitability modeling – the maximum entropy algorithm or Maxent (Phillips et al. 2004, 2006). However, before the modeling we constructed a bias file to account for our sampling effort and to avoid areas that were not visited from being classified automatically as unsuitable for the species (Supsup et al. in review). During the modeling, we used only the linear and quadratic feature of Maxent as recommended for small records (Phillips et al. 2006). Following the feature, we adjusted the regularization parameter to 0.25. The maximum iteration was set to 5000, and the rest of Maxent's setting was set to default. Ten replicates were run to determine if the model prediction is consistent. We obtained only the average logistic output from 10 replicates to represent the species suitable areas. Finally, we reclassified the logistic output to have the following outputs: below the lowest predicted value (LPV) is unsuitable (< 0.18; see Supsup et al. in review about LPV), 0.18–0.50 is suitable and 0.50–0.80 is highly suitable. Suitable areas were presented on a map.

RESULTS

Estimated density and population of Calamian Deer

In our point count station in Calauit we recorded a total of 156 individuals of Calamian Deer, this number is restricted only to major grazing area (Figure 3). We suspect that total population left on the island probably is ca. 250 –300 individuals. Whereas, our four-point count stations from Busuanga yielded an extremely low number of individuals, with highest count recorded in Barangay San Jose, Municipality of Coron (Table 2). Our result on species population density analysis using DISTANCE conforms to our observation outside of Calauit, showing the species has an estimated density of 0.15 ±71.01 (± coefficient of variation; CV) per hectare and an average cluster size of 1.09 ±8.33. Therefore, our assessment indicates that species population stronghold remains in Calauit; and the species is still occurring in selected areas of Busuanga, but their population persist at extremely low density.

Our result on species distribution modeling and calculated population revealed that Busuanga island has the largest extent of predicted suitable areas for Calamian Dear (Figure 3). Therefore, having also the highest population estimate of ca. 3,927 followed by Culion and other neighboring small islands (Table 2). Thus, our result suggests that a relatively large population may still occur on major islands of Calamian with the assumption that suitable habitats are free from any anthropogenic disturbance.

Table 1. Location of point count stations in Calauit and Busuanga island. Shown also is the habitat type per station and the number of individuals observed. Asterisk (*) denote observations which derived mainly from indirect contact of the species (i.e., presence of dungs and tracks, captured individuals by locals).

Point count stations	Habitat type	Number of individuals
Calauit Island, Municipality of Busuanga	Grassland	156 (ca. 250-300)
Buluang, Municipality of Busuanga*	Grassland	2
San Jose, Municipality of Coron*	Grassland	4
Decalachao, Municipality of Coron*	Grassland	2
Marcilla, Municipality of Coron*	Wooded Grassland	3

Suitable areas

The entire island of Calauit including several large fragmented areas on Busuanga and Culion, and small islands between these appears suitable for the deer, whereas, Coron is nearly unsuitable for the species (Figure 5). Our model revealed that a good extent of highly suitable areas are found in Busuanga, particularly the stretch of relatively flat areas in Yulo King Ranch, Brgy. Decalachao and San Jose. Thus, indicating these areas are important. They may still hold viable population of the Calamian Deer. Analysis of variables contribution shows that suitable habitat model is influenced mainly by vegetation types and topographic features (elevation, slope; see Figure 6). There is high probability of species presence in relatively flat (< 10° slope) lowland areas (< 200 m elevation) with grassland vegetation.

DISCUSSION

Our study revealed that Calamian Deer is still occurring on major islands of Calamian, but their population exists at extremely low density. The stronghold of species population remains in Calauit where we estimated that around 250-300 individuals are left. This estimate might be low compared to past reports, particularly between 2005–2009 (PCSD, unpublished data). The management of Calauit sanctuary reported about 1,000-1,500 individuals during these years. However, in nearly 10 years, if this number is accurate, the species population on the island significantly dropped to less than 500 individuals. According to the sanctuary management, this reduction is mainly because of the continued illegal hunting on the island and nearby areas. We believe that our estimate represents the present condition of the species population in Calauit because we employed a more systematic assessment to avoid biases during observation, for example, pseudo-replication or double counting of individuals which often the cause of overestimated population (Sutherland 2005).

The species condition outside of Calauit is completely different. The deer in Calauit can be observed in a large group roaming freely on the island. However, in Busuanga and presumably in Culion and other small islands, the deer is extremely rare and difficult to observe. Based from our analysis, the calculated population density of deer in Busuanga is 0.15 per hectare only, meaning that seeing an individual in one hectare of land is nearly impossible. In fact, all of our records from Busuanga were based on indirect signs (dungs, tracks, report of captured individuals). Therefore, this only indicates that deer population in Busuanga has declined drastically as reported already in many surveys and assessments (Grimwood 1976; Oliver 1993, 1993; Rico and Oliver 2008). The decline of deer population has been attributed mainly to severe illegal hunting and habitat destruction (Grimwood 1976; Oliver 1993). During our community interviews, we found that hunting is happening mostly in Calauit and nearby areas, particularly in Barangay Buluang, New Quezon – in mainland Busuanga, and potentially northern part of Cheey. Also, a few cases of recent hunting occurred in Barangay San Jose and Marcilla (east of Busuanga island) where

Table 2. The estimated total population of Calamian Deer in Busuanga, Culion and other small islands, calculated by multiplying the animal density to predicted suitable areas (values in parenthesis). Calauit island was excluded from the computation because we already provided the estimated total population, which reflects the current condition on the ground.

Sites	Estimated population in suitable areas	Estimated population in highly suitable areas	Total population
Busuanga Island	**2,773** (18,489 ha)	**1,154** (7,694 ha)	**3,927**
Culion Island	**1,564** (10,429 ha)	**173** (1,153 ha)	**1,737**
Other islands (excluding Coron)	**166** (1,110 ha)	**38** (258 ha)	**204**
TOTAL	**4,503**	**1,365**	**5,868**

locals reported that individuals were shot in 2017.

The known habitats of Calamian Deer are natural grasslands and secondary forests. However, during the assessment we observed that many of these habitats are being converted currently to agricultural plots and built-up areas. Although the deer could temporarily benefit from agricultural lands because they are often sighted in newly burned areas feeding on fresh shoots and licking on ashes, the continuing removal of vegetation cover will eventually affect the species (Rico and Oliver 2008). Extent of built-up areas is increasing now in Busuanga due to increase of human population, which often demand new infrastructures. For instance, in Yulo King's Ranch, which was known in the 1970s as one of the areas in Busuanga with viable population of deer (Grimwood 1970), is now being occupied by migrants apparently from Mindoro and an airport was recently established here (Supplemental Information- Figure 3). Road construction throughout the island is also ongoing, which eventually increases the vulnerability of natural habitats to destruction.

At present, there are no estimates or reports of the deer population on Calamian islands. To the best of our knowledge, our study is the first attempt to provide such information. Our population estimate indicates a relatively large population (estimated 5,868 individuals) of deer may still occur in major islands of Calamian, assuming that all predicted suitable areas are free from any anthropogenic disturbance. Because the predicted suitable areas are based solely on climatic, topographic and vegetative features, and therefore, it does not account for disturbance such as hunting pressure and impacts of increasing human population. Thus, if this assumption is not met, our estimate may not reflect the species' true population. For instance, a good extent of highly suitable area was predicted in Yulo King's Ranch, however, as discussed above, a large portion of this area is disturbed already. As a result, almost no deer can be observed now here compared to previous years (Grimwood 1976). The increasing disturbance in Yulo King's Ranch perhaps has forced the species population to move to other undisturbed suitable areas. This case is observed typically in Busuanga, a clear example was reported by locals in Barangay San Jose where deer are usually chased by dogs and often forced to immediately retreat to other areas to seek refuge. Some individuals will end up crossing the sea to reach other islands (see Supplemental Information- Figure 6). However, fishermen will also chase them and get killed. If deer luckily reached an island they will likely survive, but this is no longer the case because many small islands now are being converted to resorts.

Analysis of variables response and contribution to species distribution model indicate that there is high probability of species presence in relatively flat, lowland areas with grassland vegetation. This result is consistent to known habitat of Calamian Deer (Oliver 1993,

Rico and Oliver 2008). Therefore, inclusion of this type of habitat in future conservation and management plans is important.

CONCLUSION AND POLICY IMPLICATION

This study presented for the first time the estimation of population of calamian deer in Calamian Islands. It also predicted the potential suitable areas for calamian deer using the species distribution technique.

Based on the results of our assessment and analysis, we propose the following conservation and management plans:

1. The island of Calauit was declared as Game Preserve and Wildlife Sanctuary, which is supposed to be giving protection to wildlife species, however, our results indicate that illegal hunting is still occurring here. During our visit, we observed that there are no protection measures in place on the island. Therefore, we suggest that an appropriate patrolling and monitoring programs should be established here, having this will certainly reduce or halt hunting activities.
2. Calauit staff and communities from Buluang reported that deer are often seen leaving the island, and eventually will end up to hunters outside. Calauit is a relatively small island to accommodate a large population of deer and other wildlife species. We suspect that deer are leaving the island to look for more resources outside. Thus, we suggest to consider expanding the current extent of wildlife sanctuary to all suitable habitats outside of Calauit (Supplemental Information Figure 4).
3. Illegal hunting still is the major threat to Calamian Deer population. We suggest that an island-wide educational campaign should be conducted, targeting hunters and community of fishermen who often encountered the species, for example, in Barangay San Jose (see discussion above).
4. The elusive behavior of Calamian Deer often hinder biologists to determine their true status in the wildlife, particularly in Busuanga, Culion and adjacent small islands. Most information is derived from community members' observations. Therefore, we suggest developing a program where communities will be involved directly in the long-term monitoring of the species, for example, developing mobile application for recording wildlife species observation in their areas. A few applications were developed already for this purpose (e.g., WildObs, CyberTracker), and many countries including the Philippines have started utilizing some of these applications to monitor wildlife species.
5. Information about the species distribution and population provided here is far from complete. Therefore, we suggest that future surveys and assessments will be conducted in areas that were not covered by our survey, particularly areas that were predicted suitable for the species, for example, the small islands found between Busuanga and Culion.

ACKNOWLEDGMENT

This research commissioned by Palawan Council for Sustainable Development Staff was conducted by Christian E. Supsup of Biology Department, De La Salle University, Manila and Augusto A. Asis of Puerto Princesa Subterranean River National Park, Puerto Princesa City, Philippines.

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Palawan Frogmouth

(Batrachostomus chaseni)

An endemic bird of Palawan locally known as "karwang". These birds were named "frogmouth" due to their wide frog-like gape and flattened hooked bill. It inhabits the dense rainforest of Palawan and feeds into insects and some invertebrates.

Photo credits: Erickson Tabayag

SUPPLEMENTAL INFORMATION

Table 1. The specific localities we visited on Calauit and Busuanga islands, including the records obtained from secondary data. Shown also are the geographic coordinates of each locality and our observation notes.

Specific locality	Longitude	Latitude	Description	Notes
		BUSUANGA		
Brgy. Cheey	120.012286	12.229416	No observation	Area visited, but no observation
Brgy. Cheey	120.020422	12.239354	Reported present	Local testimony (1930-1970 - abundant)
Brgy. Conception	119.98106	12.02919	Reported present	Confirmed, seen by locals
Brgy. Bogtong	119.943237	12.090454	No observation	Area visited, but no observation
Brgy. New Quezon	119.92818	12.26495	Reported present	Not confirmed
Brgy. Buluang	119.896906	12.247660	No observation	Area visited, but no observation
Brgy. Buluang	119.86968	12.23399	No observation	Area visited, but no observation
Brgy. Buluang	119.89163	12.24838	Reported present	Confirmed, seen by locals
Brgy. Cheey	120.03319	12.15296	Reported present	Not confirmed
Brgy. Cheey	120.01204	12.13773	Reported present	Not confirmed
Brgy. Buluang	119.88941	12.24762	Reported present	Confirmed, seen by locals - crossing the road
Calauit Island	119.883053	12.278303	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.885646	12.281571	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.8831	12.28509	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88495	12.28258	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88329	12.28038	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88417	12.28019	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88518	12.2802	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88586	12.28021	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88471	12.27999	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88565	12.2802	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.89002	12.28178	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.8899	12.28098	Present	Calauit Game Preserve and Wildlife Sanctuary

Continuation...

Table 1. The specific localities we visited on Calauit and Busuanga islands, including the records obtained from secondary data. Shown also are the geographic coordinates of each locality and our observation notes.

Specific locality	Longitude	Latitude	Description	Notes
		BUSUANGA		
Calauit Island	119.88883	12.28004	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88374	12.28516	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.89208	12.28456	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.89323	12.28411	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88387	12.28081	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88437	12.27914	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88296	12.27967	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88348	12.28109	Present	Calauit Game Preserve and Wildlife Sanctuary
Calauit Island	119.88393	12.27825	Historical record	Grimwood 1976; Oliver 1993
		CORON		
Brgy. San Nicolas	120.19669	12.08071	No observation	Area visited, but no observation
Dimaquiat Island	120.08768	12.23582	Historical record	Rico and Oliver 2008
Brgy. Marcilla	120.28746	11.99114	Reported present	Not confirmed
Brgy. Marcilla	120.286661	12.01619	Reported Present	Confirmed, captured by locals
Brgy. Marcilla	120.28954	12.01337	Reported Present	Confirmed, captured by locals
Brgy. Marcilla	120.31418	12.006995	Reported Present	Confirmed, captured by locals
Brgy. Turda	120.30407	12.098124	Reported present	Not confirmed
Brgy. Borac	120.29248	12.041002	No observation	Area visited, but no observation
Brgy. Borac	120.302562	12.029302	No observation	Area visited, but no observation
Brgy. Decabobo	120.20895	12.12969	No observation	Area visited, but no observation
Brgy. Buenavista	120.24118	12.15482	Reported present	Local testimony (1970s - abundant)
Brgy. Buenavista	120.24248	12.1533	Reported present	Local testimony (1970s - abundant)
Brgy. Buenavista	120.237287	12.149335	Reported present	Local testimony (1970s - abundant)
Brgy. Malawig	120.23754	12.18711	Reported present	Not confirmed
Brgy. Malawig	120.239372	12.177631	Reported present	Local testimony (1970s; abundant)
Brgy. San Jose	120.08469	12.18029	Reported present	Confirmed, with dungs and tracks
Brgy. San Jose	120.08543	12.18123	Reported present	Confirmed, with dungs and tracks

Continuation...

Table 1. The specific localities we visited on Calauit and Busuanga islands, including the records obtained from secondary data. Shown also are the geographic coordinates of each locality and our observation notes.

Specific locality	Longitude	Latitude	Description	Notes
		CORON		
Brgy. San Jose	120.08481	12.18209	Reported present	Confirmed, with dungs and tracks
Brgy. Decalachao	120.08194	12.1485	Reported present	Not confirmed
Brgy. Decalachao	120.08014	12.1433	Reported present	Confirmed, captured by locals
Brgy. Bintuan	120.033402	12.0334	Historical record	Preserved specimen - FMNH 62808-11
Brgy. Yulo King Ranch	120.0861	12.13025	Historical record	Grimwood 1976
		CULION		
Brgy. Balala	120.016701	11.85	Historical record	Preserved specimen - FMNH 62815-16 (probably from Brgy. Burabod)
Brgy. Balala	120.01938	11.89056	Historical record	Preserved specimen - FMNH 62813-14
Brgy. Jardin	120.016701	11.9167	Historical record	Preserved specimen - FMNH 62817-18
Brgy. Balala	120.016667	11.883333	Historical record	Preserved specimen - RBINS 16375
Marily Island	119.94635	11.97592	Historical record	Rico and Oliver 2008

Figure 1. Aerial view of our point count station in Barangay San Jose, Coron. *Photo by C. Supsup*

Figure 2. Aerial view of the major grazing area in Calauit Game Preserve and Wildlife Sanctuary. *Photo by C. Supsup*

Figure 3. Aerial view of the Yulo King's Ranch, showing the increasing presence of communities and anthropogenic disturbances. *Photo by C. Supsup.*

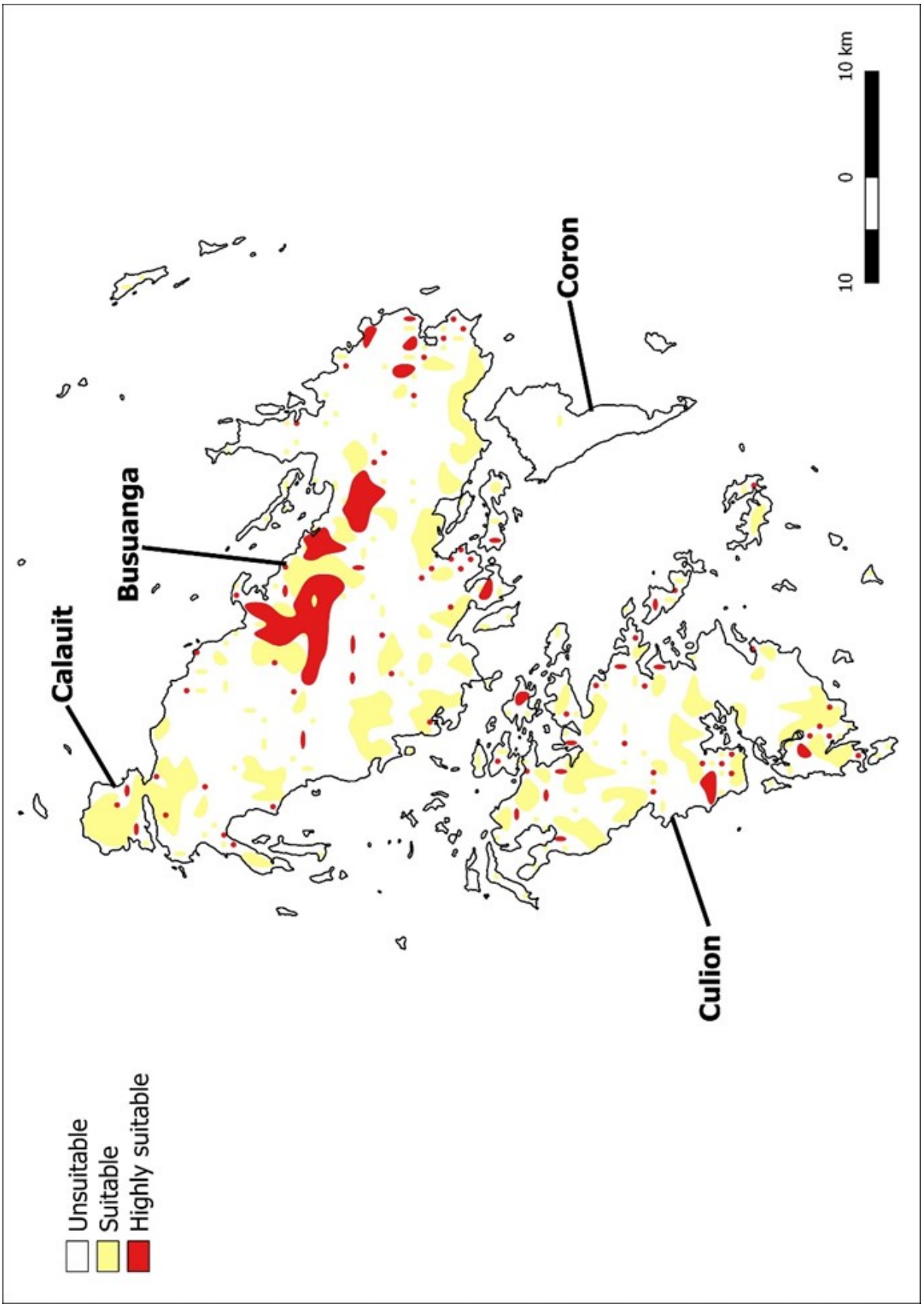

Figure 4. Predicted suitable areas for Calamian Deer on Calamian Islands, generated using Maxent.

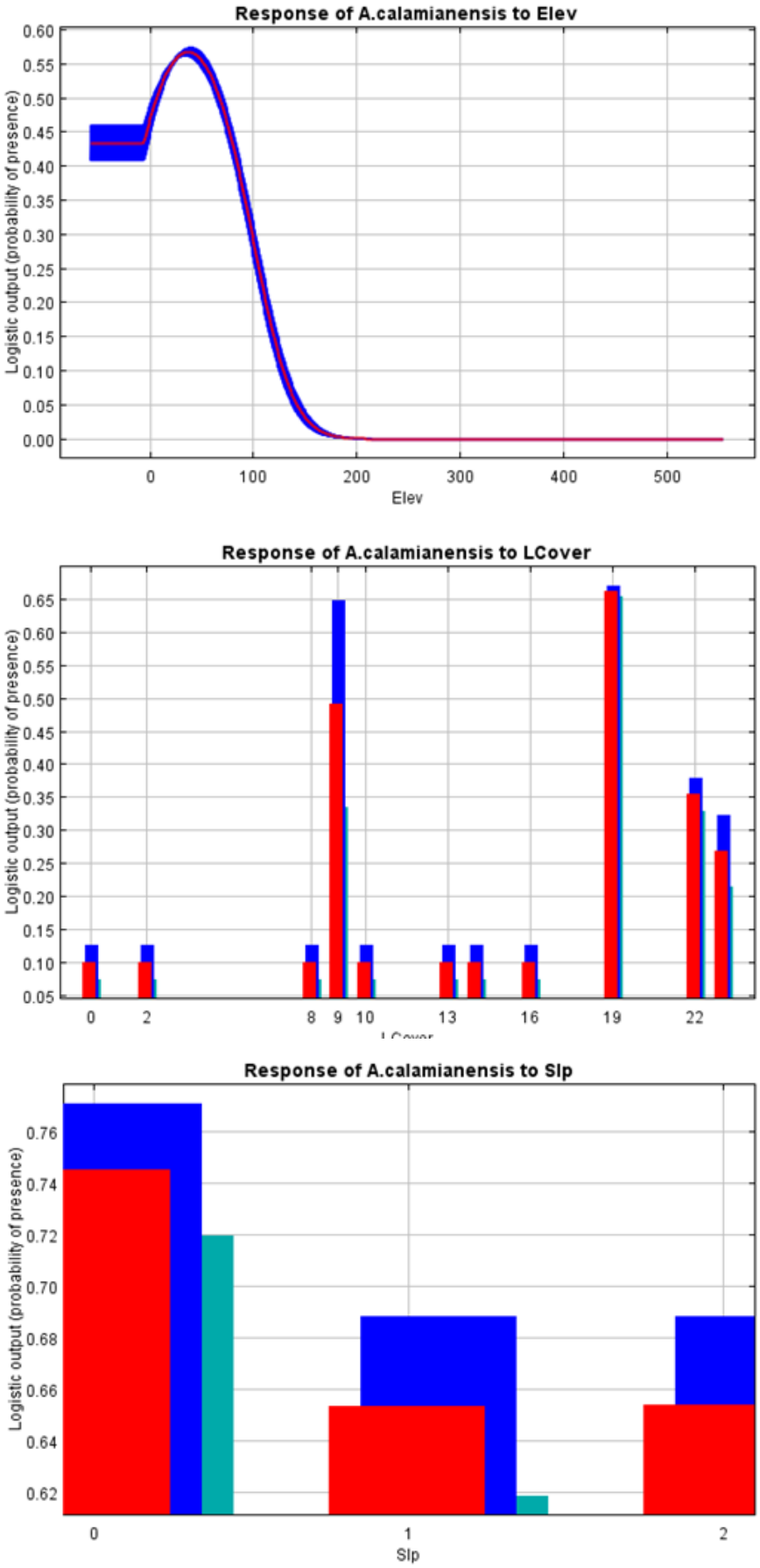

Figure 5. Response graph of the three environmental variables (from top - elevation, vegetation or land cover types and slope) with highest contribution to species habitat suitability model. The x-axis values of elevation are in meters; land cover types with high probability of species presence are coded as follows: 9 - mangrove forest, 10 - grassland; and slope 0 and 1 is < 10°.

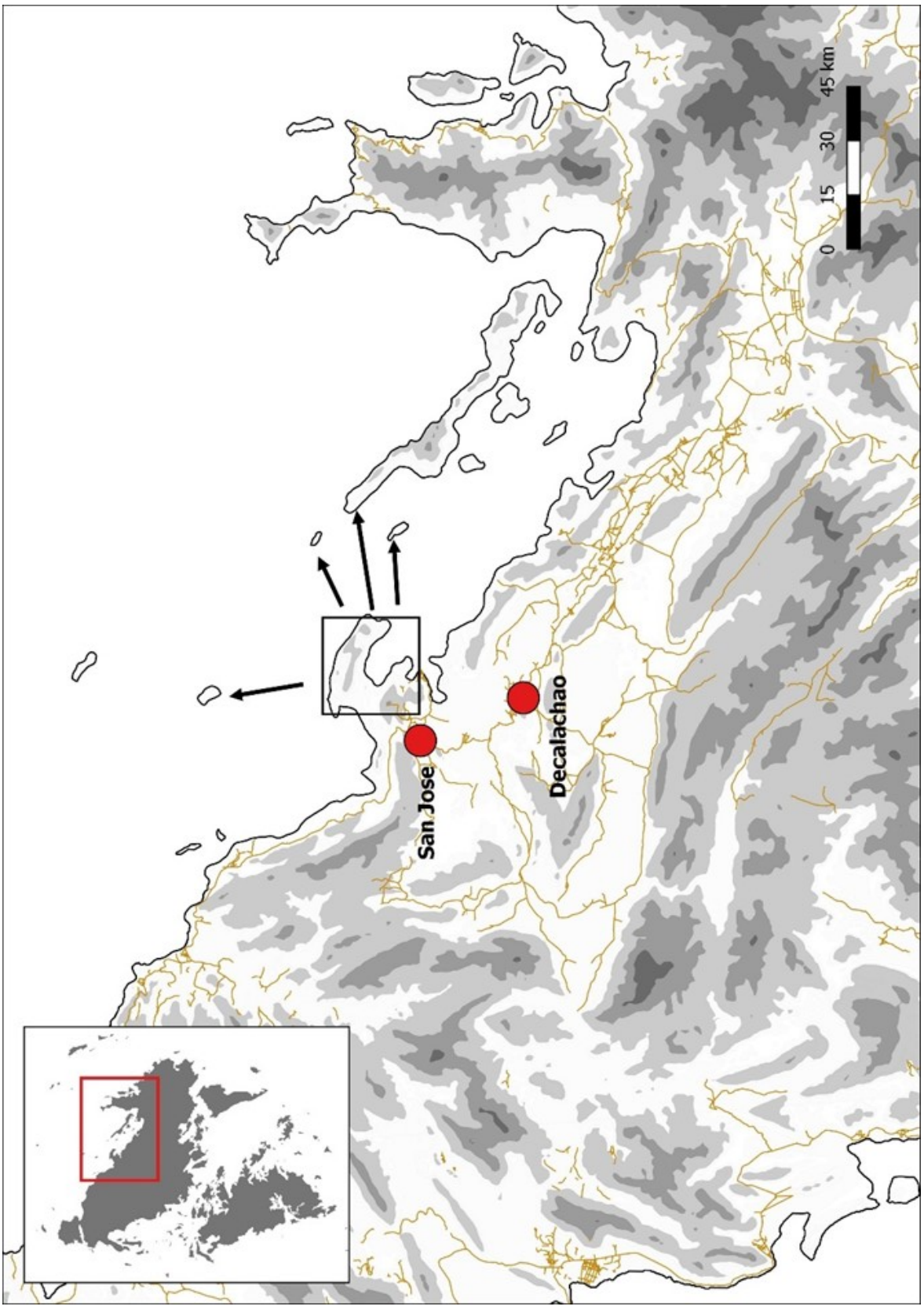

Figure 6. Map showing an example of retreat path (indicated by arrows) of Calamian Deer to small islands.

Did you know?

Endemic to Palawan, this bird is known for its bright red head, golden-yellow back with dark-colored ear cover spot. It belongs to the woodpecker family and is an indicator of forest health. It inhabits primary and secondary forests.

Under the International Union for Conservation of Nature (IUCN) Red List, it is categorized as endangered.

Red-headed Flameback

(Chrysocolaptes erythrocephalus)

Photo credits: Erickson Tabayag

Our Palawan
The Scientific Journal of Palawan Council for Sustainable Development
Feature Article
This article is also available on-line at www.pkp.pcsd.gov.ph

Reaching the Broader Scope: The 3rd National Conference on Sustainable Development and 4th Palawan Research Symposium

Arnica D. Mortillero*

Keywords:
Symposium
Conference
Science-based
Palawan
PCSDS

SUMMARY

The Palawan Council for Sustainable Development Staff (PCSDS) organizes research symposia and conferences among its various services delivered to the Palaweños every year. In 2017, it has offered the 3rd National Conference on Sustainable Development and 4th Palawan Research Symposium which was highly appreciated not only by the local researchers but also by the participants from outside of the province. The conference became a venue wherein key findings and policy implications were brought up, educating and informing the attendees on science-based information.

**Research and Policy Analyst, EPMKMD, PCSDS*
A compendium of the 2017 conference organized by the PCSDS and its partners in the Palawan Knowledge Platform held on July 27-28, 2017 at Citystate Asturias Hotel, Puerto Princesa City.

IINTRODUCTION

Since 2013, the Palawan Council for Sustainable Development Staff has been organizing symposia and conferences to encourage researches in sharing their key findings which are relevant to the attainment of Palawan's sustainable development. Initially, the research symposia were limited to the Palawan researches. Findings are mostly applicable only for a smaller scale and localized but the presentation of such information were crucial since the usefulness of the implications to policies raised by these studies are readily applicable for the province.

To further explore other options and strategies that Palawan and the Philippines can adopt, the yearly event eventually upgraded into a national conference which attracted researches and professionals outside of the province. The symposium became a good venue to share ideas, concepts and information on how to deal with the wide array of sustainable development concerns through learning from the different perspectives and scenarios from across the country.

Organizing the 3rd NCSD and 4th Palawan Research Symposium

By 2017, the efforts to call all interested students, researchers and professionals in the country were intensified. Unlike the previous years of holding the event, a wider range of participants were targeted and papers coming from multiple disciplines were entertained. With the theme "Conserving Biodiversity, Promoting Green Growth and Sustaining Inclusive Development based on Science", researchers on various fields had more chances and opportunity to join and be part of the conference.

Aside from researchers, key staff from the different local government units (LGUs) were also invited to witness the presentations. This is to bridge and effectively communicate the findings of the researches to them as the local policy makers. Highlighting the policy implications of the studies, the LGUs can then and there learn and adopt strategies and interventions to resolve their local problems.

With 245 participants who took part in the conference, 26% were from LGUs outside Palawan. These representatives willingly expressed their interest to join and learn from the research presentations. By the numbers, this is already a good indicator that there are good chances of sharing the useful information to the greater community, as compared to a research conference with only scientists and researchers as the participants.

Learning Platforms

With a total of 100 presentations, the 3rd National Conference on Sustainable Development was indeed overwhelmed with researches from the different parts of the Philippines to showcase findings from the various disciplines of science. Nearly half (46 entries) were presented orally while the remaining were scientific posters and poster exhibits from the local partners through the Palawan Knowledge Platform for Biodiversity and Sustainable Development (PKPBSD). These studies were given the limelight where the local and national spectators were able to gain new knowledge and information from among their findings. The PKPBSD is a knowledge platform in Palawan with a number of member agencies who are engaged in researches and other technical expertise which can generate information relevant to the province's biodiversity and sustainable development.

Aside from the presentations, the line-up of national and international speakers and their talks also perked up the participants and positively gained their attention. Since the invitees were intentionally from the different sectors and not only focusing on the hard sciences, the participants were able to enjoy and digest the discussion.

Specifically, the presentation about the People's Survival Fund has turned the heads of the LGU representatives. Through Engr. Glenn Banaguas, Executive Director of Environment and Climate Change Research Institute (ECCRI) of De La Salle Araneta University, the participants learned the dynamics of PSF and possible ways to tap it for the benefit of their communities. Other notable learnings were about the AmBisyon Natin 2040: The Philippine Development Plan 2017-2022, Green Growth Index, Kyoto Protocol and Paris Agreement, Biodiversity Conservation, Sustainability Science and the UN Sustainable Development Goals (UN-SDG), Fisheries in South China Sea and Food-Energy-Water System Nexus.

Incentives from Information

If being able to present your paper on a national conference is rewarding enough for researchers with the satisfaction of having their information shared to the people, the 3rd NCSD still had a chance to give incentives to these bright minds. During the whole event, presentations from the chosen entries were judged based from a set of criteria. The best papers from each sub-theme and category were then awarded as part of the closing ceremony of the conference. This is to show appreciation to the researchers with their efforts and their willingness to share their findings in educating the people. It is also a strategy to encourage local researchers and students to continue joining the annual event. Tokens of appreciation were handed over to the best presentations, along with minimal cash reward as an incentive from the organizing team. The complete list of winners for oral and poster competing categories can be found on Tables 5 and 6.

CONCLUSION

By giving a good venue where science and people can come together, cascading of information can be easier. The researches, no matter how small or big, all go back for the benefit of the people and the environment, thus, it is important to find ways on how to bridge them. The 3rd National Conference of Sustainable Development and 4th Palawan Research Symposium was a success by unifying the researchers, students and local policy makers in appreciating each other's role in attaining sustainable development.

Figure 1. (Top left) Ribbon cutting ceremonies for the opening of scientific poster exhibits led by Hon. Vice Governor Victorino M. Socrates; (top right) Awarding of certificates and prizes for winning presentations and (bottom) a group photo of the presenters, guest speakers and the PCSD Staff.

Table 1. List of Oral Competing Presentations.

Ecological Theme	Social Theme	Economic Theme
Antimicrobial Potential of Crude Extracts of *Caulerpa spp. (Chlorophyceae)* of Honda Bay, Puerto Princesa City, Palawan, Philippines *Jeric B. Gonzales and Jhonamie Mabuhay-Omar*	Integrating the Pala'wans Indigenous Knowledge with Science Concepts for Natural Disaster Risk Reduction in Southern Palawan *Shellamai Roa and Ramon M. Docto*	Biodiversity Value of Rasa Island Wildlife Sanctuary in Narra, Palawan *Nicomedes D. Briones, Jonson M. Javier, Allaine T. Baaco and Sevella G. Tabayag*
Identification of Associated Fungi in Mulberry *(Morus alba L.)* Using qPCR *Nympha C. Cuizon and Jerwin R. Undan*	Cultural Mapping: Tangible and Intangible Cultures of Tagbanuas in San Vicente *Micah A. Balbon, Vanessa S. Francisco, Mark Joseph J. Buncag and Frederick R. Caabay*	Thermoelectric Power Generator using Charcoal Stove as Heat Source *Michael Arvin G. Gabinete, Charlie M. Java, Herbert D. Hugo, Estrella C. Macabutas, and Celfrancis T. Cayaon*
Antimicrobial Property of the epidermal mucus of Tilapia *Oreochromis spp.* *Recca E. Sajorne and Jhonamie A. Mabuhay-Omar*	The competencies and needs of Palaweño Nurses: Their implications to the educational administration of nursing schools in Palawan. *Roy Albert N. Acosta*	Hydropower Capacity Assessment of the Existing Agricultural Irrigation Canal *Jibsam F. Andres*
Diversity of Meiofauna in Pujada Island, City of Mati, Davao Oriental, Philippines *Cirilo O. Ybañez Jr and Rancil Quin M. Salang*	Understanding and Mastering the Mathematical Components of the Four Gas Laws Utilizing the Prevotem - 112 Teaching Strategy *Otelio Hipolito Juanzo Jr.*	Alternative Materials for Ceiling Board Production Utilizing Trashed Papers and Cardboard *Jun Loyd T.Celespara, and Reycielo G. Bonina*
Effective Vegetative Propagation Techniques in Raising Seedlings of Breadfruit *(Artocarpus altilis)* *Susana T. Labasano and Marjhun A. Nazareth*	Impact of Small Scale Mining at Little Caramay, Roxas, Palawan *Flornita N. Ferrer and Miriam M. Darap*	Alternative Concrete Hollow Blocks Filler Using Red Mud as Mortar *Leo S. Gabo and Roselin C. Pendon*
Stomach Content of Blue Swimming Crab *(Portunus pelagicus)* from Honda Bay and Ulugan Bay, Puerto Princesa City, Palawan, Philippines *Archie A. Barlas, Juliana C. Baylon and Lota A. Creencia*	Employee's Productivity and Accountability in the Local Government Unit of Brooke's Point, Palawan: Its Effect on the Program of "Inclusive Growth" under the Philippine Development Plan 2011-2016 *Dante V. Ariñez*	An Analysis of Sight Distances Considering both the Vertical and Horizontal Curves of A Tourist Bound Destination Highway in Camarines Sur: The Lagonoy-Presentacion Section *Raymundo V. Romero*
Better with Less: Alternative Nursery Rearing and Reduced Micro-Algal Species Feeding on Black Lip Pearl Oyster *Pinctada margaritifera* *Jesus E. Bream, Redentor D. Diaz and Roger G. Dolorosa*	Traffic Situation Analysis and Evaluation of the Level of Implementation of the Traffic Management of Puerto Princesa City *Cesario A. Bacosa Jr.*	Hemagglutination and antimicrobial potential of leaf crude extracts of indigenous plants of Palawan, Philippines *Jhonamie Mabuhay-Omar and Althea Lee L. Lerom*
Grow-out culture of black-lip pearl oyster in bamboo baskets with and without periodic cleaning *Ryan Gonzales, Ariel Valoroso, Redentor Diaz, Guillermo Guillem and Roger G. Dolorosa*	Instructional supervisory practices of selected secondary school principals in the city division of Puerto Princesa: Basis for instructional development *Roy Albert N. Acosta*	Abalone *Haliotis asinina* farming using indigenous materials in Palawan, Philippines *Lota Creencia, John Roderick Madarcos, Jaysee Matillano and Riza San Juan*
Coastal Erosion Analysis and Mitigations of Agutaya, Palawan: Effect of the Climate Change *Cesario A. Bacosa Jr.*	Ecotourism and Solid Waste Management in Pandin Lake, Laguna, Philippines *Reeden B. Bicomong*	Development of a Convective-Radiative Type of Copra Dryer *Estrella C. Macabutas and Reynaldo B. Magay*
Ecological Impact of Idle Fishpond on the Intertidal Fish Assemblage *Herminie P. Palla, Bernaldo Montaño, Rommel Valencia, and Nelson Noa*		

Table 2. List of Oral Non-competing Presentations.

Ecological Theme	Social Theme	Economic Theme
Production Performance and Some External Shell Egg Quality of Indigenous and Exotic Strains of Chicken *Marilyn C. Baaco*	Compliance to the core competencies standard of Nursing practice in Palawan *Paineir B. Castigador*	Development of Banana Slicer for Longitudinal Chips *Irven B. Cuen, Milysa M. Palapa and Crisharine T. Venturillo*
Analysis of Flood Occurrence Vulnerability of Puerto Princesa City *Cesario A. Bacosa Jr.; and Jessani Llanto*	Uses and Perceived Effectiveness of Bunog *(Garcinia benthami*) in the selected Barangay of Aborlan, Palawan *Cedrick E. Abdulhamid and April Grace O. Liao*	Design and Fabrication of Prototype Curtis Steam Turbine *Ulyses N. Nejal Jr., Julem B. Ganje, Herbert D. Hugo, Estrella C. Macabutas, and Celfrancis T. Cayaon*
Biophysical Assessment of Inandeng Watershed, San Vicente, Palawan *Hannah Maica S. Caridad and Mark Joseph J. Buncag*	Uses and Perceived Effectiveness of Pipiyasutun *(Sapindus baccatus blanco)* in the selected Barangay of Aborlan, Palawan *Isabelle Ingrid E. Sarceda; Amin Khan Omar; and April Grace Liao*	Development of Improved Mechanized Coconut Dehusker *Irven B. Cuen, Philip T. Badenas and Markko Jay B. Talon*
Product Development of Abalone in Palawan: Standardization of Procedure for Veggie Balls *Benjamin J. Gonzales, Rosario J. Bundal, Carmela Mae M. Cervantes and Ronnie P. Yayen*	Customers' Satisfaction: A Comparison of Service Quality of Two Selected Banks in Puerto Princesa City *Lhynette Tabangay Zambales*	Air Filter with Activated Charcoal for Confined Space *Rolando F. Billedo Jr., and Estrella C. Macabutas*
Special Presentation (Protect Wildlife Project): Overview of Tongkat Ali	Waste Management in Poblacion, Roxas, Palawan *Frank Joe Mojica and Rodalyn L. Montecillo*	Performance of Improvised Electronic Ballast to Reuse Busted Compact Fluorescent Lamp *Benjie R. Martinez, Jibsam F Andres, and Benmar Chris S. Patiño*
Special Presentation (Protect Wildlife Project): Using Geospatial Analysis in Engaging LGUs to Integrate Conservation and Development -Related Land Uses in the Mount Mantalingahan Protected Landscape	Special Presentation (Protect Wildlife Project): Blending Predictive Policing, Intelligence-led and Problem-Oriented Policing Approaches in Wildlife Law Enforcement in Palawan	Impact of ICT in Selected BSED II of Western Philippines University *Armie C. Ibay*

Table 3. List of Poster Competing entries.

Ecological Theme	
Growth and survival of black-lip pearl oyster *Pinctada margaritifera* in net baskets with bamboo and metal frames subjected to cleaning and without cleaning conditions *Francis Rey Cueba, Ariel Valoroso, Redentor Diaz, Guillermo Guillem and Roger Dolorosa*	Observations on the Palawan Bearded pig *Sus ahoenobarbus* in the Cleopatra's Needle Critical Habitat: A Need to Conserve *Paris N. Marler and Karina M. Reyes-Antonio*
Backyard propagation of the black-lip pearl oyster *Pinctada margaritifera* fed with reduced number of microalgal species *Princess Psyra Mae B. Dela Cruz, Redentor D. Diaz and Roger G. Dolorosa*	Mangrove Crab Fattening Using Different Diets in Concrete Tanks *Elmer G. Villanueva, and Rodulf Anthony T. Balisco*
Addition to the list of Bivalves and Shelled Gastropods of Tubbataha Reefs Natural Park, Cagayancillo, Palawan, Philippines: 2014 survey *Dolorosa RG, Picardal RM, Conales JR SF, Bundal NA and CP Caranay Jr.*	The fisheries of Spanner crab *Ranina ranina* (Linnaeus, 1758) in Araceli, Palawan, Philippines *Reymart S. Dagaraga and Roger G. Dolorosa*
Profitability of mangrove crab (*Scylla* spp.) fattening fed with trash fish enriched with different levels of dextrose powder *Ernie P. Fontamillas, Jeanne P. Cabiguen-Cornel and Roger G. Dolorosa*	Isolation and characterization of antimicrobial producing bacterial symbionts from *Haliotis asinine* *Czarina Hazel S. Santiago and Jhonamie Mabuhay-Omar*
The use of rattan baskets and the effects of absence of periodic cleaning on the grow-out culture of black-lip pearl oyster *Pinctada margaritifera* *Gaddy Garganta, Ariel Valoroso, Redentor Diaz, Guillermo Guillem and Roger Dolorosa*	Population Survey of Marine Turtles in Boracay Using A Citizen Science Approach *Bryan Sausa Madera*
Checklist of bivalves and shelled gastropods in Binduyan, Puerto Princesa City and three small islands in southern Palawan, Philippines *Shemarie E. Hombre, Aram Jehu Molleno and Roger G. Dolorosa*	Enumeration, Isolation and Characterization of Actinomycetes with Antibiotic-Producing Potential From the Rhizosphere of Mangrove Plant *Camptostemon philippensis* *Jenevieve P. Hara and Jhonamie Mabuhay-Omar*
Sex Ratio and Hepato-Gonadosomatic Characteristics of Horseshoe Crab (*Tachypleus tridentatus*) in Honda Bay, Puerto Princesa City, Palawan *Dyns Sheiryll S. Collantes, Juliana C. Baylon and Lota A. Creencia*	The Commercially-Exploited Sea Cucumber of Pag-Asa Island, Kalayaan Island Group, Philippines *Jeric B. Gonzales*
Carbon Footprints of Island-Urban and Rural-based Youth Students in Palawan, Philippines *Benjamin J. Gonzales and Sheena Rose B. Millendez*	Species Inventory and Catch Per Unit Effort of Reef Fishes of Pag-Asa Island, Kalayaan Island Group, Philippines *Jeric B. Gonzales and Bernie G. Mantes*
Fisheries of Zebra Mantis Shrimp *Lysios quillina* maculata in Honda Bay, Puerto Princesa, Palawan *Lally Ann Monfiel, Sheen Rose B. Millendez and Benjamin J. Gonzales*	Valuing the Valueless: Reaping the Hidden Medicinal Wonders of Cashew *Anacardium occi-dentale L.* By-product *Menilo E. Rabina*
The Groupers of Pag-Asa Island, Kalayaan Island Group, Philippines *Jeric B. Gonzales and Bernie G. Mantes*	

Continuation of Table 3

Social Theme	
The Impact of Technology in Education for the Bachelor of Science in Civil Engineering Students and Teacher of WPU *Armie C. Ibay*	Bliss in Messy Water? Systems Analysis on the Sustainability of Calumpang River for Ecotourism in Batangas City, Philippines *Anacleto M. Caringal, Jhoanna O. Santiago, Arnica L. De Guzman, Kathleen Fae M. Opaco and Jesusita O. Coladilla*
The Effect of Social Media in the Selected BSED II Students of WPU-Main Campus *Armie C. Ibay*	
Economic Theme	
Will Water Run Dry? An Analysis of Water Use Behavior of Female Dormitory Residents Using the Transactional Worldview Approach *Maria Adelia C. Belen, Arnica L. De Guzman-Mortillero, and Gloria Luz M. Nelson*	Understanding the Waste Incineration Practice of Pila, Laguna, Philippines through Transactional Approach *Ma. Russell A. Natoza, Carmelita M. Rebancos, Hermilea Marie C. Castillo, and Rex B. Demafelis*
Social Benefits and Impacts of Mangrove Resource Utilization in Rio Tuba, Bataraza, Palawan, Philippines: People and Mangrove Forest *B.J. Gonzales, R.S. Sariego and B.S. Montaño*	Impact of Tourism Industry in Barangay Tagabinet, Puerto Princesa City, Palawan *Karen G. Madarcos, Joel G. Becira, Mercedita H. Dequito and Reymond B. Garduce*

Table 4. Topics discussed during the 2017 symposium and the invited guest speakers from various agencies across the country and abroad.

Topic	Speaker
Green Growth Performance Measurement	**Mr. Aidan Kennedy** Global Green Growth Institute Seoul, South Korea
A Critical Review of Paris Climate Change Agreement	**Dr. Dai Yeun-Jeong** Executive Director Asia Climate Change Education Centre Jeju Biosphere Reserve, Korea
Sustainability Science and the United Nations New Sustainable Development Goals (Agenda 2030)	**Dr. Shahbaz Khan** Director of UNESCO Office Jakarta UNESCO Jakarta, Indonesia
Conserving Biodiversity for Sustainable Development	**Mr. Wilbur Dee** Protect Wildlife Project - USAID
Philippines' AmBisyon Natin 2040 and the Philippine Development Plan 2017-2022	**Dr. Adoracion M. Navarro** Deputy Director General National Economic Development Authority
Converging on the Fisheries in the South China Sea	**Dr. Ma. Carmen A. Lagman** De La Salle University
Climate Smart Philippines: Food-Energy-Water Nexus System and Accessing People's Survival Fund	**Engr. Glenn Banaguas, OYS** Executive Director Environmental and Climate Change Research Institute, De La Salle Araneta University

Table 5. Winners of the 3rd National Conference on Sustainable Development and 4th Palawan Research Symposium, Oral Competing Category.

	Theme 1- Biological	Theme 2- Social	Theme 3- Economic
BEST POSTER	Better with Less: Alternative Nursery Rearing and Reduced Micro-Algal Species Feeding on Black Lip Pearl Oyster *Pinctada margaritifera* *Jesus E. Bream, Redentor D. Diaz and Roger G. Dolorosa*	Employee's Productivity and Accountability in the Local Government Unit of Brooke's Point, Palawan: Its Effect on the Program of "Inclusive Growth" under the Philippine Development Plan 2011-2016 *Dante V. Ariñez*	Hemagglutination and antimicrobial potential of leaf crude extracts of indigenous plants of Palawan, Philippines *Jhonamie Mabuhay-Omar and Althea Lee L. Lerom*
1ST RUNNER UP	Ecological Impact of Idle Fishpond on the Intertidal Fish Assemblage *Herminie P. Palla, Bernaldo Montaño, Rommel Valencia, and Nelson Noa*	Understanding and Mastering the Mathematical Components of the Four Gas Laws Utilizing the Prevotem - 112 Teaching Strategy *Otelio Hipolito Juanzo Jr.*	Abalone *Haliotis asinina* farming using indigenous materials in Palawan, Philippines *Lota Creencia, John Roderick Madarcos, Jaysee Matillano and Riza San Juan*
2ND RUNNER UP	Antimicrobial Property of the epidermal mucus of Tilapia *Oreochromis spp.* *Recca E. Sajorne and Jhonamie A. Mabuhay-Omar*	Traffic Situation Analysis and Evaluation of the Level of Implementation of the Traffic Management of Puerto Princesa City *Cesario A. Bacosa Jr*	Biodiversity Value of Rasa Island Wildlife Sanctuary in Narra, Palawan *Nicomedes D. Briones, Jonson M. Javier, Allaine T. Baaco and Sevella G. Tabayag*

Table 6. Winners of the 3rd National Conference on Sustainable Development and 4th Palawan Research Symposium, Poster Competing Category.

	Theme 1- Biological	Theme 2- Social	Theme 3- Economic
BEST POSTER	Profitability of mangrove crab (*Scylla* spp.) fattening fed with trash fish enriched with different levels of dextrose powder *Ernie P. Fontamillas, Jeanne P. Cabiguen-Cornel, and Roger G. Dolorosa*	Will Water Run Dry? An Analysis of Water Use Behavior of Female Dormitory Residents Using the Transactional Worldview Approach *Maria Adelia C. Belen, Arnica L. De Guzman, and Gloria Luz M. Nelson*	Bliss in Messy Water? Systems Analysis on the Sustainability of Calumpang River for Ecotourism in Batangas City, Philippines *Anacleto M. Caringal, Jhoanna O. Santiago, Arnica L. De Guzman, Kathleen Fae M. Opaco and Jesusita O. Coladilla*
1ST RUNNER UP	Valuing the Valueless: Reaping the Hidden Medicinal Wonders of Cashew *Anacardium occidentale L.* By-product *Menillo E. Rabina*	X	X
2ND RUNNER UP	Backyard propagation of the black-lip Pearl Oyster *Pinctada margaritifera* fed with reduced number of microalgal species *Princess Psyra Mae B. Dela Cruz, Redentor D. Diaz and Roger G. Dolorosa*	X	X

ACKNOWLEDGMENTS

The PCSDS would like to thank its partners in the Palawan Knowledge Platform for Biodiversity and Sustainable Development; Holy Trinity University, Palawan State University, Palawan Polytechnic College Inc., and Western Philippines University as collaborators; the Protect Wildlife Project-USAID as the co-organizer and main sponsor and Galoc Production Company as sponsor.

Our Palawan
The Scientific Journal of Palawan Council for Sustainable Development
Forum and Conference Paper
This article is also available on-line at www.pkp.pcsd.gov.ph

Sustainable and Responsible Mining in Palawan Biosphere Reserve (Philippines): Assessment of Rio Tuba Nickel Mining Corporation (RTNMC) and Coral Bay Nickel Corporation (CBNC) Using the Sustainable Management Online Tool (SMOT)

Kirsten Louise C. Sagun*

ABSTRACT

Mineral extraction industry in the Philippines has taken heavy criticism through the years due to unsustainable practices. For Palawan, the challenge is in a higher magnitude since the province is declared by UNESCO as a Biosphere Reserve and is protected by a special law, RA 7611 or the Strategic Environmental Plan for Palawan. This motivated the Palawan Council for Sustainable Development Staff (PCSDS) to adopt an assessment tool developed by a Canadian biosphere reserve, the Sustainable Management Online Tool (SMOT) for Palawan's mining industry. This paper presents the results of the SMOT assessment for Rio Tuba Nickel Mining Corporation (RTNMC) and Coral Bay Nickel Corporation (CBNC). Generally, assessment of the company's performance produced an overall result of proactive. The assessment results can be used for decision-making through which the company will be able to ensure that their policies and projects promote sustainable development and responsible mining.

Keywords:
SMOT
mining
sustainable development

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This paper was presented in the Minerals Industry Symposium as part of the 64th Annual National Mine Safety and Environment Conference last 21 November 2017 at Camp John Hay and Cultural Center, Baguio City.

INTRODUCTION

The main objective of SMOT is to promote the integration of sustainable development principles or goals in the design and implementation of policies and projects of extractive industries in Palawan. This will allow the company to check which goal must be prioritized to allow continuous internal improvement as well as improve the lives of the communities affected by their operations. This is also consistent with the theme of the recent Mining Philippines International Conference and Exhibit, *"Responsible Mining: Moving Beyond Compliance.*" PCSDS is striving to make Palawan's mineral extraction industry to go beyond compliance, and SMOT is the means to achieve it.

Palawan was declared by UNESCO as a Biosphere Reserve in 1990**.** As such, the province strives to be a site of excellence to explore and demonstrate approaches to sustainable development and conservation on a regional scale. Palawan also has a unique and special law governing the management of its environment and resources, the Republic Act 7611 or the Strategic Environmental Plan for Palawan Act. It is a comprehensive framework that follows the general philosophy of sustainable development. The Palawan Council for Sustainable Development (PCSD) is the administrative body created for the implementation of the SEP Law, supported by a professional support / technical staff. SEP is implemented through the Environmentally Critical Areas Network. It identifies zones that have specific development activities that may be allowed or prohibited.

The high standards for conservation and development in Palawan has set a tremendous challenge for its mineral extraction industry, but this challenge is taken as a great opportunity to demonstrate Palawan's leadership in terms of applying principles of sustainable development in mining. The largely mined mineral in Palawan is nickel. Three mining companies and one processing company export nickel ore, or semi-processed ore, in Palawan: RTNMC, CBNC, BNC and CMDC.

The Palawan Council for Sustainable Development Staff (PCSDS) started implementing a tool called the Sustainable Management Online Tool (SMOT) to assess the mining companies in Palawan. The implementation of the tool is supported by the DENR-Mines and Geosciences Bureau MIMAROPA (MGB MIMAROPA), Manicouagan-Uapishka Biosphere Reserve of Canada (RMBMU), and the four mining companies in Palawan: Rio Tuba Nickel Mining Corporation (RTNMC), Coral Bay Nickel Corporation (CBNC), Berong Nickel Corporation (BNC), and Citinickel Mines and Development Corporation (CMDC).

PCSDS Executive Director Nelson Devanadera first came across SMOT while attending the 4th World Congress for Biosphere Reserves in March 2016 in Lima, Peru. SMOT was presented by Jean-Philippe L. Messier, founder and Executive Director of the "Reserve Mondiale de la Biosphere de Manicouagan-Uapishka" or RMBMU of Canada. RMBMU designed SMOT to monitor and assess the incorporation of sustainable development efforts of the extractive industry within their BR.

The pilot implementation of the Sustainable Management Online Tool (SMOT) involves these companies. The first consultation was conducted with RTNMC and CBNC last August 2016. By February of this year, 2017, their initial assessments were completed.

METHODOLOGY

SMOT is recognized by PCSDS as highly suitable for Palawan. It is anchored on the 10 principles of the International Council on Mining and Metals or ICMM which tackles the basic dimensions of sustainable development (SD): economic, social, environmental and governance.

An overview of the SD dimensions is portrayed through a web map, including its corresponding ICMM principles and objectives. The economic dimension contains ICMM principle 9 with its 5 objectives that assess the company's contribution to the impact communities. Social dimension contains ICMM principles 3 and 5 with their 10 objectives that tackle the policies and practices on health and safety, fundamental human rights and fair conditions with the company's employees and the community.

Environmental dimension contains ICMM principles 6, 7, and 8, and the 13 objectives tackle company policies on

environmental performance, biodiversity conservation, land-use planning, and responsible product design and disposal. Governance dimension contains the remaining four ICMM principles 1, 2, 4 and 10. Its 17 objectives tackle the company's business practices, corporate governance, sustainable development integration, risk management strategies and transparency.

Overall, the 45 objectives serve as the "questionnaires" that the company must respond to (See Table 1, 2 and 3).

Since the tool is new in the Philippines and only being pioneered in Palawan, the initial step was to conduct a consultation with the mining company, the multi-partite monitoring team (MMT) and the Mines Rehabilitation Fund Committee (MRFC). After the approval of the mining company, PCSDS scheduled a formal assessment.

At the onset, the mining company conducted a self-assessment for each of the SMOT objective. The attendees for the assessment were representatives from the company's health, safety and environment unit, human resource, administrative office, and community relations, and was facilitated by PCSDS. The MMT validated the company's self-assessment wherein each objective was deliberated to ensure that the responses including performance ratings were justified.

A statistics of the overall response can also be accessed vis-à-vis sustainable development dimensions, showing various tables and graphs. In the assessment, each objective is assessed based on its importance to the company and their level of performance. Importance is ranked as 'not applicable', 'not very relevant', 'desirable' and 'required', while the company's performance is categorized as 'absent', 'weak', 'compliant', 'proactive' or 'outstanding'. The ratings must be justified with a list of current activities, policies and projects that are verifiable or with concrete means of verification.

Table 1. SMOT Objectives under the Economic Dimension of Sustainability.

ICMM Principle	SMOT Objective
ICMM Principle 9. Contribute to the social, economic and institutional development of the communities in which we operate	1. Engage at the earliest practical stage with likely affected parties to discuss and respond to issues and conflicts concerning the management of social impacts
	2. Ensure that appropriate systems are in place for ongoing interaction with affected parties, making sure that minorities and other marginalized groups have equitable and culturally appropriate means of engagement
	3. Contribute to community development from project development through closure in collaboration with host communities and their representatives
	4. Encourage partnerships with governments and non-governmental organizations to ensure that programs (such as community health, education, local business development) are well designed and effectively delivered
	5. Enhance social and economic development by seeking opportunities to address poverty

Table 2. SMOT Objectives under the Social Dimension of Sustainability.

ICMM Principle	SMOT Objective
ICMM Principle 3. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities	6. Ensure fair remuneration and work conditions for all employees and do not use forced, compulsory or child labor 7. Provide for the constructive engagement of employees on matters of mutual concern 8. Implement policies and practices designed to eliminate harassment and unfair discrimination in all aspects of our activities 9. Ensure that all relevant staff, including security personnel, are provided with appropriate cultural and human rights training and guidance 10. Minimize involuntary resettlement, and compensate fairly for adverse effects on the community where they cannot be avoided 11. Respect the culture and heritage of local communities, including Indigenous Peoples
ICMM Principle 5: Seek continual improvement of our health and safety performance	12. Implement a management system focused on continual improvement of all aspects of operations that could have a significant impact on the health and safety of our own employees, those of contractors and the communities where we operate 13. Take all practical and reasonable measures to eliminate workplace fatalities, injuries and diseases among our own employees and those of contractors 14. Provide all employees with health and safety training, and require employees of contractors to have undergone such training 15. Rehabilitate and reintegrate employees into operations following illness or injury, where feasible

Table 3. SMOT Objectives under the Environment Dimension of Sustainability.

ICMM Principle	SMOT Objective
ICMM Principle 6. Seek continual improvement of our environmental performance	Assess the positive and negative, the direct and indirect, and the cumulative environmental impacts of new projects – from exploration through closure
	Implement an environmental management system focused on continual improvement to review, prevent, mitigate or ameliorate adverse environmental impacts
	Rehabilitate land disturbed or occupied by operations in accordance with appropriate post-mining land uses
	Provide for safe storage and disposal of residual wastes and process residues
	Design and plan all operations so that adequate resources are available to meet the closure requirements of all operations
	Respect the culture and heritage of local communities, including Indigenous Peoples
ICMM Principle 7. Contribute to conservation of biodiversity and integrated approaches to land use planning	Respect legally designated protected areas
	Disseminate scientific data on and promote practices and experiences in biodiversity assessment and management
	Support the development and implementation of scientifically sound, inclusive and transparent procedures for integrated approaches to land use planning, biodiversity, conservation and mining
ICMM Principle 8. Facilitate and encourage responsible product design, use, re-use, recycling and disposal of our products	Conduct or support research and innovation that promotes the use of products and technologies that are safe and efficient in their use of energy, natural resources and other materials
	Develop and promote the concept of integrated materials management throughout the metals and minerals value chain
	Provide regulators and other stakeholders with scientifically sound data and analysis regarding our products and operations as a basis for regulatory decisions
	Support the development of scientifically sound policies, regulations, product standards and material choice decisions that encourage the safe use of mineral and metal products

Table 4. SMOT Objectives under the Governance Dimension of Sustainability.

ICMM Principle	SMOT Objective
ICMM Principle 1. Implement and maintain ethical business practices and sound systems of corporate governance	Develop and implement company statements of ethical business principles, and practices that management is committed to enforcing
	Implement policies and practices that seek to prevent bribery and corruption
	Comply with or exceed the requirements of host-country laws and regulations
	Work with governments, industry and other stakeholders to achieve appropriate and effective public policy, laws, regulations and procedures that facilitate the mining, minerals and metals sector's contribution to sustainable development within national sustainable development strategies
ICMM Principle 2. Integrate sustainable development considerations within the corporate decision-making process	Integrate sustainable development principles into company policies and practices
	Plan, design, operate and close operations in a manner that enhances sustainable development
	Implement good practice and innovate to improve social, environmental and economic performance while enhancing shareholder value
	Encourage customers, business partners and suppliers of goods and services to adopt principles and practices that are comparable to our own
	Provide sustainable development training to ensure adequate competency at all levels among our own employees and those of contractors
	Support public policies and practices that foster open and competitive markets
ICMM Principle 4. Implement risk management strategies based on valid data and sound science	Consult with interested and affected parties in the identification, assessment and management of all significant social, health, safety, environmental and economic impacts associated with our activities
	Ensure regular review and updating of risk management systems
	Inform potentially affected parties of significant risks from mining, minerals and metals operations and of the measures that will be taken to manage the potential risks effectively
	Develop, maintain and test effective emergency response procedures in collaboration with potentially affected parties
ICMM Principle 10. Implement effective and transparent engagement, communication and independently verified reporting arrangements with our stakeholders	Report on our economic, social and environmental performance and contribution to sustainable development
	Provide information that is timely, accurate and relevant
	Engage with and respond to stakeholders through open consultation processes

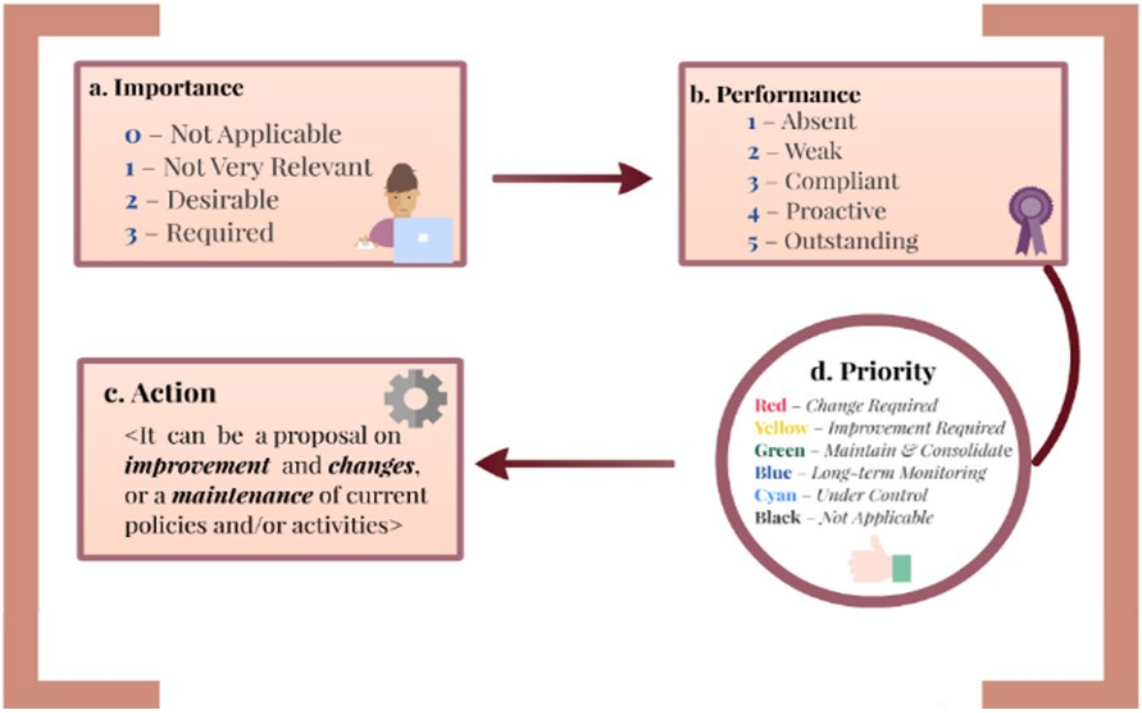

Figure 1. The SMOT Assessment Flow Chart.

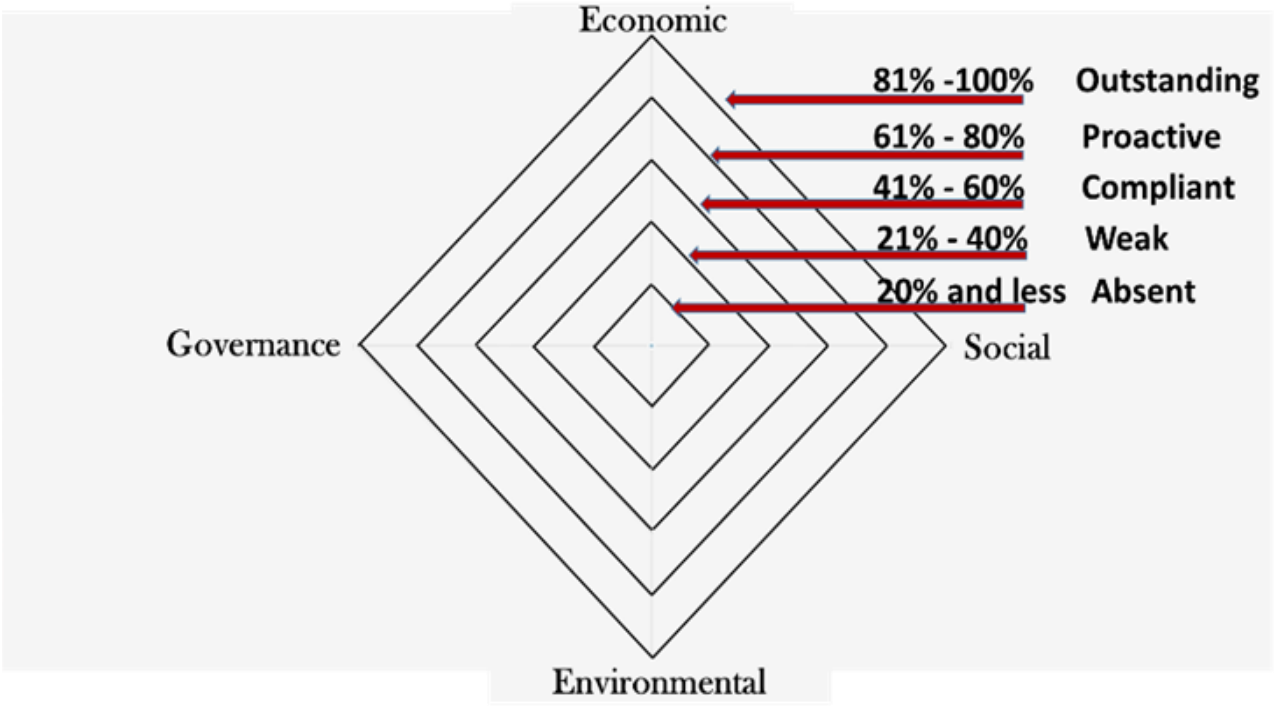

Figure 2. The SMOT Diamond where results are plotted after the assessment to evaluate the strong and weak points of the company.

RESULTS AND DISCUSSION

SMOT Assessment Results of RTNMC and CBNC

The objective for each sustainable development dimension of RTNMC and CBNC was identified to demonstrate how the assessment works.

For the environmental dimension in the objective "*Respect legally designated protected areas,*" RTNMC rated its importance as desirable and their performance as proactive. The tool recommended that their current activities be maintained and consolidated. The company thus listed the following as future actions: to continuously support the protection of Ursula Island and the mangrove rehabilitation project, establishment of herbarium of the native species present in the impact areas, and collection of the seedlings of native/endemic plant species for future propagation."

For the social dimension under the objective "*Provide all employees with health and safety training, and require employees of contractors to have undergone such training*," RTNMC rated its importance as "Required" and that they perform "Proactively". The SMOT recommendation is to maintain and consolidate. The company thus listed the following future actions: to ensure continuous improvement of policies to ensuring safe and healthy work conditions, ensure that employees under manpower contractors had undergone safety and health training, conduct safety orientation for employees, contractors and visitors prior to working the mine site, and continuously perform emergency preparedness drill as scheduled.

For the economic dimension with the objective "*Contribute to community development from project development through closure in collaboration with host communities and their representatives,*" CBNC identified the importance as "Required" and has rated their performance as "Proactive". SMOT suggestion is to maintain and consolidate, so for their future actions, they listed that they will enhance the livelihood component of SDMP and continue implementation of SDMP with agricultural programs.

For the governance dimension under the objective *"Develop and implement company statements of ethical business principles, and practices that management is committed to enforcing,"* CBNC has rated their importance as required and that they have performed proactively. The SMOT suggestion is to maintain and consolidate, so for plans, the company listed the following: more researches on resource use efficiency, maintain SEP

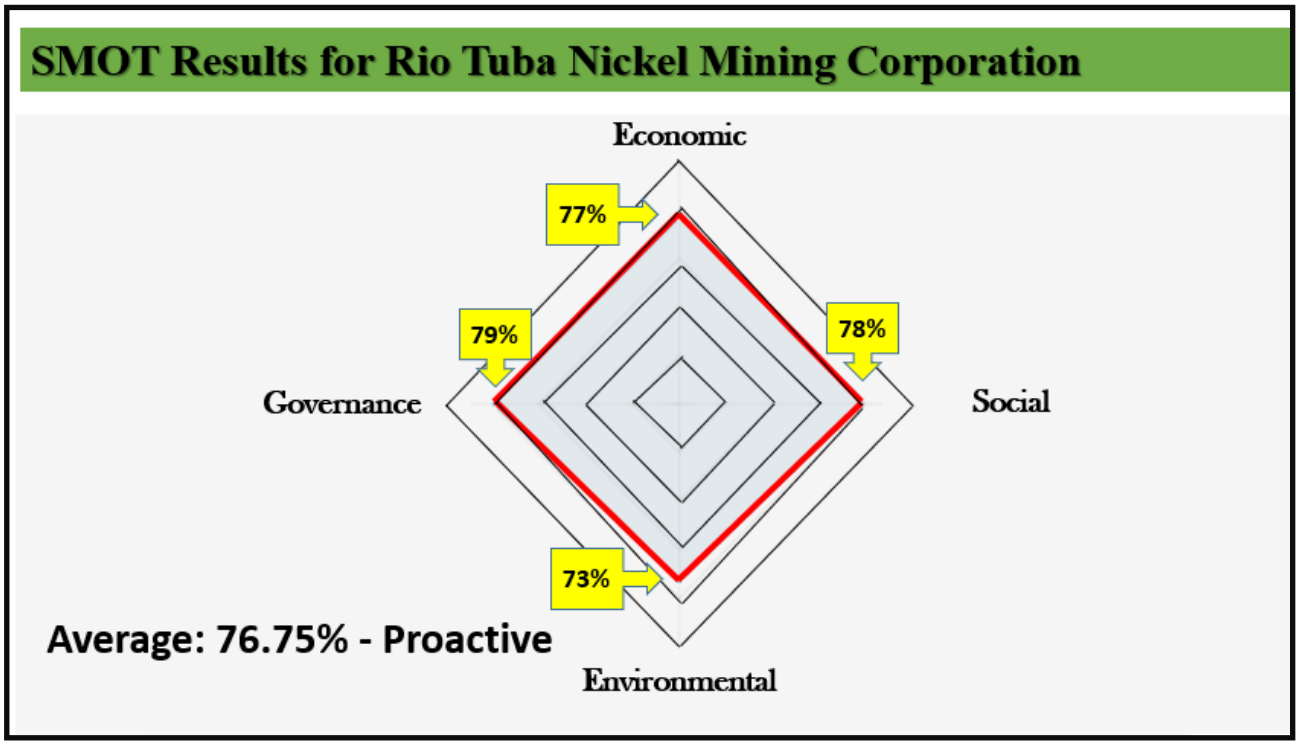

Figure 3. SMOT results of the Rio Tuba Nickel Mining Corporation (2017).

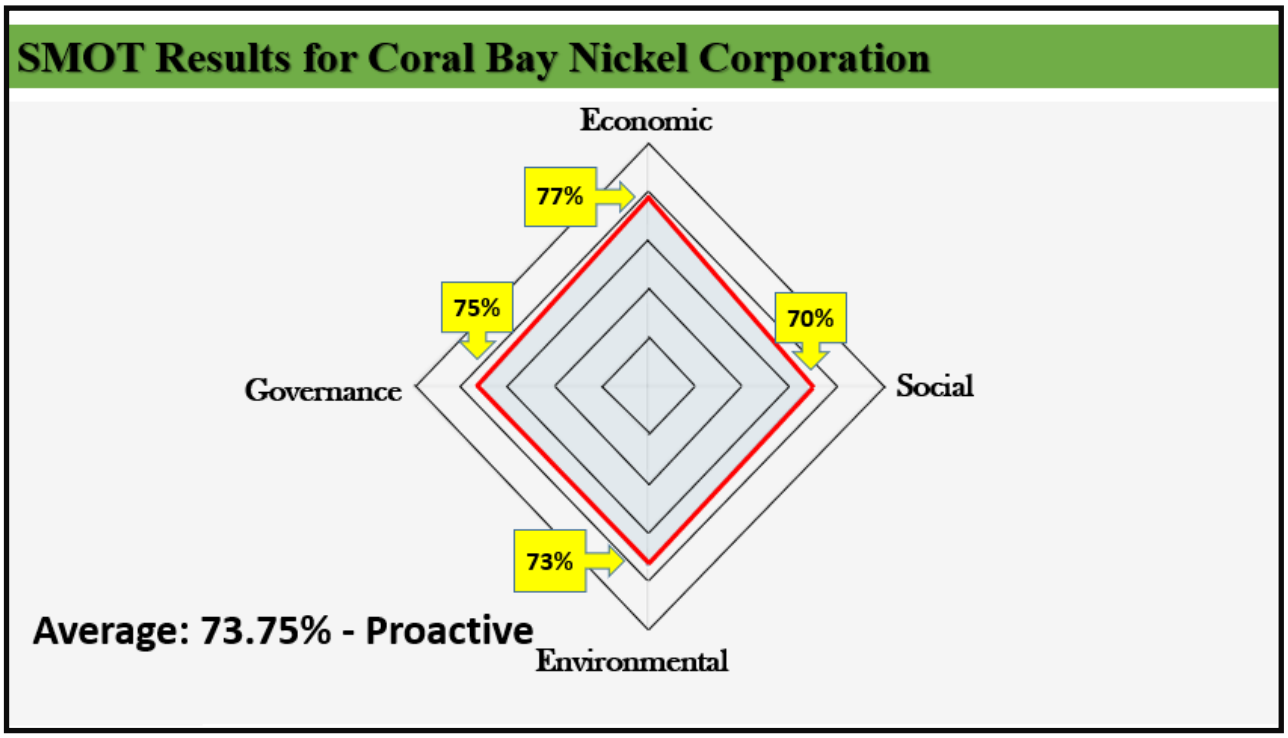

Figure 4. SMOT results of the Coral Bay Nickel Corporation (2017).

clearance compliance, continue increasing the livelihood potential of rehabilitation projects such as the Tailings Storage Facility - 1, and sustain the improvement of all reforestation projects.

After completing the assessment and validation of the objectives, the results of RTNMC and CBNC show that they both performed proactively in all four dimensions of sustainable development. In its graphical form, it can be observed that RTNMC scored highest in their governance performance with a 79% rating. Their social, economic and governance dimensions fall between 73% to 78% obtaining an average score of 76.75%. The overall results for the company fall under the range for a proactive rating of 61% to 80%.

CONCLUSION AND POLICY RECOMMENDATIONS

Based on the validated assessment results of RTNMC and CBNC, their performance ratings in relation to the SD dimensions were both proactive, with an average score of 76.75% and 73.75%, respectively. This initial results will be the baseline for the next assessments.

The assessment allows sustainable development principles and practices to be integrated in the mining industry to ensure that a company's policies and projects promote sustainable development and responsible mining. There is a need to maintain a balance in the four dimensions to address the needs of the communities affected by mining activities, directly and indirectly, and ensure that the company efficiently manages operations without compromising the environment and assuring a good future for the next generations.

This tool has a potential for success in the mining industry that other industries are being considered to also employ a similar tool such as agricultural plantation development, tourism, and fisheries industry to have a similar sustainable management tool be applied.

The experiences with the use of the tool can be an eye-opener to the possibility of integrating sustainable development principles and practices in the mining industry. Let this encourage and strengthen sustainable development in the industry, and prove that responsible mining is possible.

REFERENCE

ICMM 10 Principles, https://www.icmm.com/en-gb/about-us/member-commitments/icmm-10-principles

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Zero Carbon Resorts and Green Hotel Certification in Palawan Biosphere Reserve, Philippines

Engr. Madrono P. Cabrestante Jr.*

ABSTRACT

Palawan, a UNESCO-declared Biosphere Reserve is facing several development challenges due to the boom of tourism in the province. Energy demand led to initiatives that would sustain development. Zero Carbon Resorts (ZCR) Project is one of such initiatives which challenges the tourism sector and related enterprises in engaging in energy efficiency. Since the project's implementation, it was realized how important it is to explore the potentials of renewable energy while taking note of energy saving practices which is beneficial not only to the tourism establishments but also for the conservation of Palawan's environment.

Keywords:
Zero Carbon Resorts Project
Green Hotel Certification
Energy

*Project Coordinator of the Palawan Council for Sustainable Development Staff-Zero Carbon Resorts Project (ZCR)
Paper presented during the International Expert Workshop Renewable Energies and Biosphere Reserves, 11-13 September 2017 in Bliesgau Biosphere Reserve, Saarland, Germany, organized by the German Federal Agency for Nature Conservation, the UNESCO MAB-Programme, the Ministry for the Environment and the Consumer Protection of the Saarland and Bliesgau Biosphere Reserve

INTRODUCTION

Being a UNESCO-declared biosphere reserve, Palawan serves as model of sustainable development. Palawan is blessed with rich natural resources having a large expanse of forest covering more than 600,000 hectares (or 54%), the highest in the country, contributing 38% of the Philippines' biodiversity. It is home to more than 1,700 species of flowering plants and more than 1,100 species of terrestrial vertebrates. Its species of terrestrial and marine vertebrate wildlife accounts for 40% of the wildlife species in the entire country while 32 out of 228 Key Biodiversity Areas in the Philippines are found here. Aside from being declared as a biosphere reserve, Palawan was also proclaimed as a Game Refuge and Bird Sanctuary, and a Mangrove and Swamp Forest Reserve in the 1980s. It was recognized by the international magazine "Science" Palawan in 2013 as the 4th Irreplaceable Place in the World owing to its high endemicity and mega-biodiversity.

Having all of these, it is just normal to expect environment-friendly activities and initiatives for the province.

Palawan's Pride

The Palawan Archipelago is composed of 1,768 islands and islets covering a land area of 1.5 million hectares, with a coastline of 2,000 km in the western Philippines, at the periphery of the South China Sea. It was designated a biosphere reserve in 1990 by UNESCO's Man and the Biosphere Programme, where two of its world renowned natural assets were also declared as World Heritage Sites: the Puerto Princesa Subterranean River National Park (also one of the New 7 Wonders of Nature) and the Tubbataha Reefs Natural Park. From 2013 till this year, Palawan has consistently been cited by both Conde Nast Traveler & Travel+Leisure magazines as the *World's Best Island, the Top Island of the World*, or *World's Friendliest Island*. The tourist arrivals increased to more than 50 folds, from barely 14,000 in 1992 to about a million in 2017.

With the increasing demand for tourism, the province is starting to explore various developments and expansion of various services needed to cater the local and international tourists. One such challenge involves power source.

The Palawan power system is composed of two (2) main grids and 23 microgrids. As of 2014, Palawan has a total dependable capacity of 65 MW with a total peak demand of 45 MW. The Backbone Grid has an existing total dependable capacity of 54.6 MW supplied by independent power providers. Meanwhile, the current generation mix of Palawan is bunker C and diesel (JEDAG 2015).

Palawan has these energy demand forecast (JEDAG 2015):

- Base of 52 MW to 129-198 MW by 2025, and 258~365 MW in 2035
- Energy Scenarios:
    1. Driven by the goal of having a technology-neutral power supply plan, alternative options considering fossil-based and conventional technologies such as diesel, Bunker C and coal were equally treated as indicative power generation mix for the main grid. The bottom-line however is still the mix with the lowest generation cost and blended rate.
    2. As a result of the simulations, under the conservative scenario, by 2018, Palawan Main Grid will have a total power supply of about 295.06 GWh and 18.3 percent (54.14 GWh) of which is renewable energy. Likewise, by 2025, the total power supply will increase to 635.7 GWh and the share of RE resources is about 69 percent.
    3. Meanwhile, under the aggressive scenario, total power supply for main grid by 2018 will be at 403.98 GWh which will increase to 803.62 GWh in 2025. Also, in 2018 the share of RE generation will increase from 42.3 percent (171.08 GWh) to 89.2 percent (717.11 GWh) in 2025.

Energy Initiatives and Undertakings

To minimize potential risks of too much dependence on diesel power for developmental projects, various green innovations were initiated in the Province. For instance, the use of renewable energy was explored by a USAID-funded project in Green Island of Northern Palawan where a hybrid energy system is built. It is the first hybrid renewable energy system in the province consisting of a 2.5 kW solar array, a 5kW vertical axis wind turbine and a biomass

gasifier genset. Through USAID's Climate Change and Clean Energy Project, USAID helped build in the island a 25.5kW Hybrid Renewable Energy (RE) Power System composed of a biomass gasifier which uses plant-derived energy, along with solar panels and wind turbines. As part of the sustainability plan, the project includes an ice-flake machine maker to help preserve the catch of fisherfolk, and a reverse-osmosis machine as a source of potable water for the residents of Green Island.

On a commercial level, one of the biggest malls in Puerto Princesa (Robinson's Place-Palawan) has also ventured into green energy. They have installed the biggest off-grid rooftop solar panel in the country, pouring in about $2 million to harness the power of the sun. The 1.2- megawatt (MW), 4,700 solar photo-voltaic panels rooftop solar system in the mall was the company's contribution to protecting the province's natural beauty and fragile ecosystem which have made it the Philippine's top eco-tourism destination.

THE ZERO CARBON RESORTS (ZCR) PROJECT

The ZCR for Sustainable Tourism Project is a 4-year project funded by the European Union's SWITCH-Asia Program, to promote sustainable production and consumption. The project lead is *Gruppe Angepasste Technologie,GrAT or Centre for Appropriate Technology* based in the University of Vienna in Austria. Other partners are *Green Leaf Foundation* and *Healthy Public Policy Foundation of Thailand* and *Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas,* Spain. As project partner, Palawan BR's onsite management authority, the Palawan Council for Sustainable Development, implements the ZCR in the key tourism sites of El Nido, Coron-Busuanga, San Vicente and Puerto Princesa City.

The ZCR aims at contributing to sustainable development in the tourism sector and its value chain. It shall also make the tourism industry energy efficient in a sustainable and competitive way through a progressive approach, thus, engaging the 3R methodology: reduce, replace and redesign.

Reduce: This pertains to saving energy through low or no cost measures like peak load management, good housekeeping practices, technical adaptation, and guest involvement**.** In tourist establishments, we influence guest and staff behavior towards lowering resources consumption.

Replace: This involves implementation with medium to high investment costs. It includes a switch to renewable energy resources or materials; substituting outdated and inefficient technologies with more efficient ones.

Redesign: This pertains to development of energy and water autonomous establishments, and the adoption of knowledge from ZCR learning centers.

ZCR: Palawan Experiences

The ZCR promotes sustainable and responsible consumption and production. These principles are being provided to each member to implement in order to achieve the expected results of reducing energy and water consumption. ZCR members in Palawan have adopted appropriate technologies being promoted by the project, which include among others: 1) effective daylight usage, 2) waste re-utilization, 3) natural ventilation, 4) light colored roofing, and 5) low water consumption. The use of renewable energy sources and appropriate technologies, such as i) LED lights, ii) solar water heater, iii) Photovoltaic panels, and iv) energy efficient air conditioning units are also promoted.

ZCR's core areas in Palawan are situated in the tourist sites of Puerto Princesa City, San Vicente/Port Barton, El Nido, and Coron. As of May 5, 2017, there are already 331 ZCR members in Palawan. Generally, the members are the micro, small and medium-sized tourism enterprises, which include hotels, resorts and any form of accommodation. Other tourism-related establishments such as restaurants, dive shops, and souvenir shops were also invited. The ZCR Project is also implemented by GrAT in key tourism sites in the Philippines such as Boracay, Cebu and Bohol.

Members throughout Palawan have shown significant results applying the recommendations from the ZCR 3R methodology. The most notable benefit is the amount of energy and water saved which ranges from 20% to 40% from their current electricity and water bills.

The Project established in Palawan a

"ZCR Bamboo Showcase Cottage" that is carbon-neutral and energy self-sufficient as a model for future development. This prototype which can be used by those who desire to build energy and water autonomous cottage building, also utilizes locally-available materials. Solar panels supply electric power for the entire cottage. Installed technologies include: tubular solar lightings, solar water heater, solar cooker, and others. Rainwater is harvested and purified before going to the cistern. Waste water is treated naturally. The whole building performance is monitored and analyzed for knowledge transfer and dissemination. In comparison to a standard conventional resort cottage which may consume around 20,000 kW per year, the cottage only consumes 720 kW per year or barely 4%.

ZCR Members' Adoption of Renewable Energy-Based Practices

Through the conduct of field validations, results revealed that half of the member SMEs implement ZCR or green practices in the following fields: Energy Management, Energy Services (water heating, washing & drying, and, pumping and motors), and Water Management.

The ZCR Awards

To promote the best practices, the ZCR Project recognizes the best performing ZCR members through provision of awards. For instance, the "ZCR Zero Carbon Awards" are being conferred since 2015. This annual awarding to MSMEs help encourage other members and prospect entities to get involved in the ZCR project. In the subsequent years, this shall be institutionalized as "Green Hotel Certification" in Palawan or Philippines which may also mean additional plus points for the establishments.

CONCLUSION

With the boom of development that starts to hit Palawan, it is gradually realized that there is a need to explore the potentials of renewable resources. This is to help suffice the demands of the province's growing economy without greatly affecting Palawan's unique environment. And since it is important to pursue sustainable development, it is important that our energy sources should be more of the greener options so as not to compromise the environment for the future generations.

Table 1. ZCR members and their current green practices per type, 2017.

ZCR member-establishments with the following:	**Number and % of Establishments (n=116)**	
Renewable Energy Power Source (Solar / Photovoltaic Panels)	7	(6 %)
Solar Water Heaters	20	(17 %)
Using other solar technologies (solar tubes, outdoor lights)	2	(2 %)
Practicing sun drying of linens and solar disinfection (SODIS)	80	(69 %)
Maximizing the use of natural daylight	113	(97 %)
with at least 70% LED lights	87	(75 %)

REFERENCE

Joint Energy Development Advisory Group (JEDAG). 2015. Palawan Island Power Development Plan 2015-2035.

PCSDS. 2015 State of the Environment Report of Palawan, A Biosphere Reserve. Palawan Council for Sustainable Development Staff

Supplemental Information

Interview with focal person Madrono P. Cabrestante Jr. with UNESCO Germany

(English translation)

For these past two years, Mr Madrono Cabrestante has been the focal point for the Palawan biosphere reserve in the Philippines. He is currently the coordinator of the zero carbon resort project, funded by the European Union under its Switch Asia programme and implemented by the University of Vienna's Gruppe Angepasste Technologie with many local partners. Mr Cabrestante has been born and a native of the island of Palawan in the Philippines.

What makes the Palawan biosphere reserve special?

Palawan is an archipelago which is part of the Philippine Islands and has itself more than 1700 islands of the country's 7,100 islands. Of the 12 types of forests which can be found on the Philippine Islands, Palawan is home to 11 types of forests. It has many natural ecosystems of high value and high biodiversity. Palawan also offers very spectacular Karst formations, among them the Puerto Princesa Subterranean River National Park (or the underground river), which has been voted as one of the New 7 Wonders of Nature. Some of our earlier tourist destinations have been developed by Japanese companies, which have brought in very high value tourists. Today, Palawan is recognised all over the world as a tourism highlight. At the same time, our islands are at the crossroads of political debates, because we are adjacent to the West Philippine Sea, or as others call it, the South China Sea, which boasts important natural resources in the coastal and marine areas, such as deposits of oil and natural gas.

Today, you are mainly working on the zero carbon resort project. How was this project been initiated and what are its main successes?

Our office has networked with the European Union for many years and we have been the recipient of many European Union funded projects such as forestry initiatives, back to the 1980s. Most recently, we wanted to tackle, together with the European Union, the impact of the influx of tourists on our island. Therefore, we did research on how we could but best cope with tourism and at the same time mitigate climate change. We found out that the European Union is already active in some zero carbon projects. Coincidentally, an academic group from Vienna also obtained funding from EU on this initiative and networked with us, which is why today we partner with them. Our local partners in the project are key tourism establishments on the island, in specific focus areas in northern Palawan, such as Coron, El Nido, San Vicente, and Puerto Princesa. We cooperate with tourism establishments that are ready to adopt the so-called 3R principles. This means: Reduction in energy consumption, water consumption and emissions; Replacement of old technologies and in addition, as well as Redesign (of the establishment to be energy and resource efficient). We have identified the key establishments, and they need to implement at least one of the 3R principles. More than 320 establishments have agreed to work with us on this programme.

What is the concrete contribution of your biosphere reserve team?

We work with the tourism establishments in conducting the baseline assessment of their consumption of energy, water and other resources. We provide recommendations on how they can reduce their consumption, and how they can replace technologies. For the moment these are assessments which are done by us for free. For us it is most important that the establishments really implement our recommendations.

What is your leverage to make the resorts move forward?

In 2015, we have identified the best performing establishments. Based on their example, we have defined parameters one how to reward well performing establishments across the island. We use these parameters as criteria for a new form of award.

For the moment, any implementation of recommended measures by establishments is fully voluntary, because so far we do not have a specific regulation by the government in place. Therefore, we need to implement an incentive scheme which is fully voluntary – and this is that we provide recognition to the most successful establishments. Recognition does not mean accreditation, but rather a certificate which can be displayed at the local premises. This helps establishments to build their brand, and to showcase that they are practising green practices.

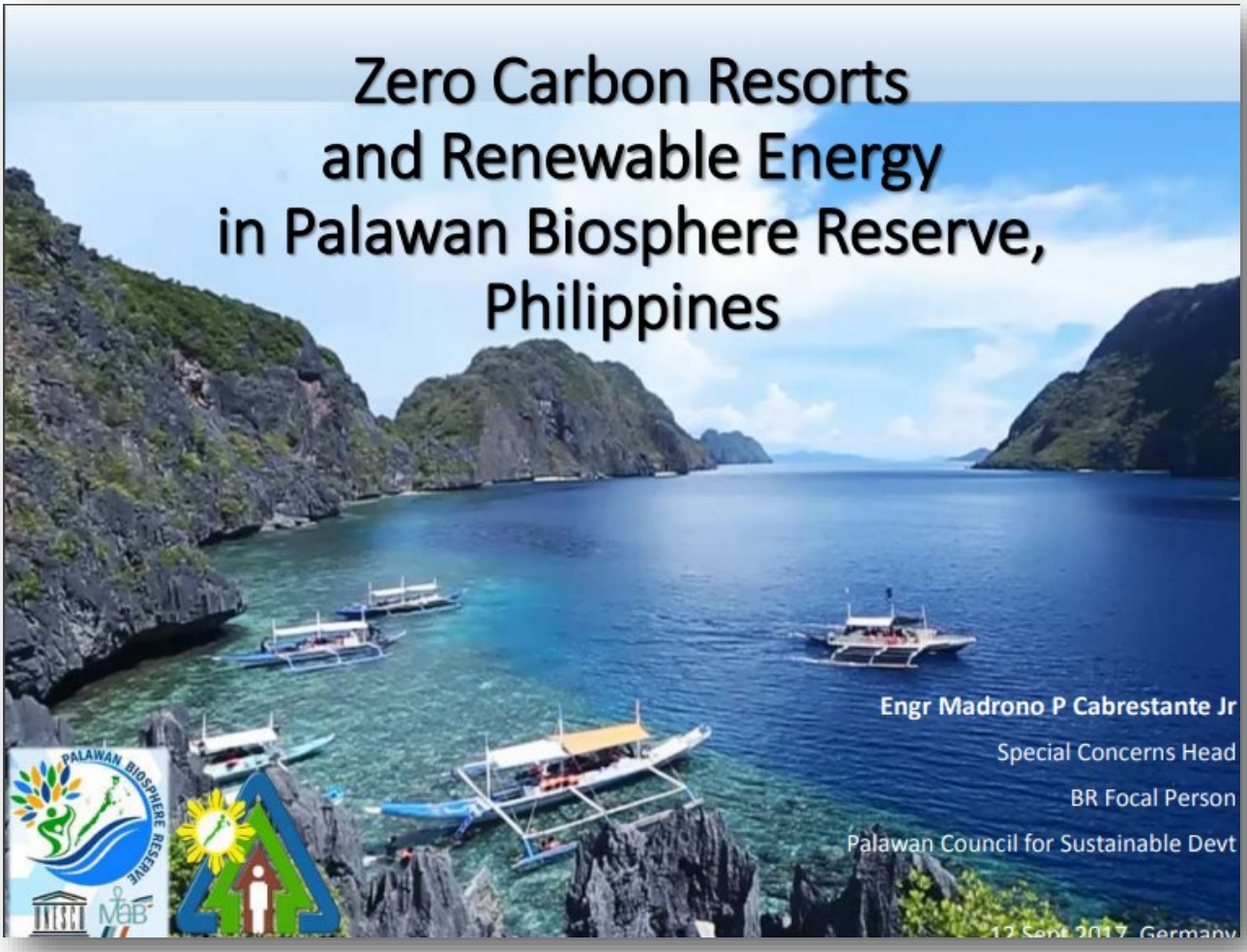
The parameters and criteria for the award had been defined by a committee involving academicians, scientists, local community officials and the Ministries of Tourism as well as that of Trade and Industry of our country. We have quite a long checklist with about 220 individual indicators. We make calls for nominations for awards and after the deadline validate all the nominees, based on self-pre-assessment by the local establishments, also to providing evidence. They also need an accreditation by the Ministry of Tourism of our country, a clearance from our agency (Palawan Council for Sustainable Development, the on-site management authority of the Palawan Biosphere Reserve) and a clearance of several other authorities, as minimum requirements. Those establishments obtaining at least 70% of the maximum number of points receive an award, with different levels of recognition. In our most recent awards scheme in June 2017, we have received about 16 pre-assessment documents and provided awards to eight establishments. Only one establishment has received the top price.

In the future, we will strengthen the ambition of the award criteria and it will become more difficult to obtain the awards at the different levels. We hope that in a few years from now all the tourism establishments on Palawan Island will participate. By then, we will no longer be giving awards to establishments who fulfil only 70% of the criteria, but only to those who will fulfil, say for example, 95% of the criteria.

So, for now, our awards scheme is an intermediate stage, rather an incentive and a step on the way towards the effort to turning all tourism establishments on the Palawan islands into zero carbon resorts.

What is your long term strategy in order to make Palawan emissions-free?

Carbon neutrality is a key goal across all islands of Palawan. Some local authorities and companies are well advanced in this regard, because they large forest areas which allow them to offset carbon in forests. This is actually an important opportunity for Palawan, because with 54% of forest cover, the archipelago has the highest share of forest cover of all provinces and regions of the Philippines.
The goal for the entire province is to reach a share of renewable energies of up to 85% of the entire energy mix. For the moment, we still depend very much on diesel, although Palawan is a source for natural gas. The province cannot use it, because the natural gas is shipped to Manila and Luzon.
There are only some initial experiments with solar energy. We have also looked at the potential of wind and the provincial government would like to expand mini hydro energy installations. We are in the excellent situation that the provincial governor has as one of his key goals to make the island a top tourism destination with a very low carbon footprint and high energy sufficiency.



Zero Carbon Resorts Towards Sustainable Development of the Tourism Sectors in the Philippines and Thailand (ZCR for Sustainable Tourism)

I. Duration/Area of Coverage

May 2014 to May 2018, being implemented in Palawan, Philippines and Thailand
(Extended until August 2018)

II. Funding Institution: Foreign/Local

The project is financially supported by the European Union under the SWITCH-Asia Program, and is being implemented by GrAT- Center for Appropriate Technology, Austria (Project Lead); CIEMAT, Plataforma Solar de Almeria (PSA), Spain; Green Leaf Foundation (GLF), Thailand; Healthy Public Policy Foundation (HPPF), Thailand; and Palawan Council for Sustainable Development (PCSD), Palawan, Philippines.

III. Objectives

This project will not only continue the replication of ZCR Phase 1 strategies in many regions of the Philippines but expand and adapt the method to Thailand. With additional focus on access to finance and match with Green Hotel certification, a cross country exchange of best practices will be facilitated through exchange visits and strong policy dialogue.

The project aims to contribute to the sustainable development of the tourism sector and its value chain in the Philippines and Thailand with focus on reduction of resource consumption and CO_2 emissions. In both countries, small and medium enterprises (SMEs) will demonstrate the value of green tourism by increasing resource efficiency and using renewable energy.

IV. Updates on Activities

The ZCR project officially ended last 30 April 2018 but was extended until 31 August 2018.

The following are the highlights of the activities of the project in year 4:

- Recognition and Promotion of ZCR Project: Recognition of 5 SMEs for the ZCR Special awards: Sangat, Daluyon, Astoria, Balay Tuko and Asia Grand view Hotel.
- Development of Green Hotel Certification:
  - The PCSDS Exec. Director participated in the formal launching of "Anahaw- the Philippine Green Hotel Certification" on 31 January 2018 at Diamond Hotel, Manila.
  - Among the 12 SMEs who applied for the ZCR Awards, only 10 SMEs passed the qualifications and were validated. Five (5) of them garnered awards, which was confererred on 19 June 2018 during the SEP Anniversary Fellowship Night.
  - Four SMEs in Puerto Princesa as well as other members in El Nido and Coron, Palawan applied for ANAHAW, the Philippine Sustainable Tourism Certification. On August 04-06, the four SMEs in Puerto were validated and was assessed by the Anahaw Certificate Validation team together with the project staff. A total of six members were awarded various levels of Anahaw Certification on August 31: Daluyon (level 4), Sangat (level 4),

Balay Tuko (level 2) Puerto Pension (level 2) Coron Hilltop (level 2) and Qi Lodge (level 2).

- Link ZCR to the Academe: The Palawan State University through Engr. Nena Zara and Architect Norlyn Evangelio participated on the shortlisting and on-site validation of applicants for the 2017 ZCR Awards.
- The PCSDS established its good relationship with Palawan State University, its partner academe. A total of 80 students from architecture and engineering courses have visited and learned about the ZCR technologies.
- Conduct cross visits to showcase best practice SMEs between Thailand and Philippines: Three (3) SMEs from Palawan were able to join the Thailand visit and learn exemplary practices from best performing SMEs in the said country. While nine (9) representatives from Thailand were able to learn about the best practices of best-performing SME members in Palawan through powerpoint presentation.
- Country Specific Policy Forum between policy makers, LGU and tourism SCP stakeholders:
  - ZCR National Policy Forum on Sustainable Consumption and Production in Tourism sector was conducted on 07 February 2018 at New World Manila Bay Hotel where 91 participants attended. Current policies in relation to the event were reviewed and the commitment of support was signed.
  - Orientation workshop on Zero Carbon and Green Building Policy was held at VJR Hall, Palawan on 26-27 April 2018. Fifty six (56) participants attended.
  - A draft of the white policy book was submitted to GrAT for review. This was approved and adopted by PCSD thru PCSD Resolution No. 18-642 as basis in the formulation of Zero Carbon and Green Building Policy for Palawan and Puerto Princesa City since 14 September 2018.
- Operation and Maintenance of the ZCR Cottage:
  - Demonstration cottage has undergone renovation with close supervision by the PCSDS-ZCR Team. The renovation focused on the receiving area where bamboo was replaced with good lumber and *anibong* floor was replaced with bamboo.
  - Well-maintained ZCR cottage and landscape.

V. Contact Person

PCSDS

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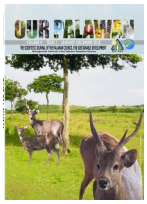
Developing Sustainable Alternative Livelihoods in Coastal Fishing Communities in the Coral Triangle: Indonesia and Philippines



I. Duration/Area of Coverage
March 2015—November 2018
Balabac, Palawan, Philippines

II. Funding Institution
Asian Development Bank – Japan Fund for Poverty Reduction (JFPR 9160)

III. Implementing Partners
- Palawan Council for Sustainable Development Staff
- Center for Environment and Sustainable Development Foundation, Incorporated

IV. Project Objective
Develop alternative livelihoods by pilot-testing support mechanisms that will involve women and indigenous people.

V. Major Accomplishments

Particulars	Project Target	Achieved	Breakdown	
Number of Partner Villages	7	12	Agutayan Bancalaan Catagupan Indalawan Melville Pasig Rabor Salang	Ramos Malinsuno Sebaring Mangsee
Number of Livelihood Units with Business Plans	40	42		
Number of Women-led Households with Livelihoods	30%	46 %		
No. of Model Alternative Livelihoods	2	4	*Livestock Farming:* Goat Raising Poultry Seaweed Farming	*Technical Skills Development:* Welding Masonry Carpentry Food Processing Mat Weaving
No. of Target Beneficiar-ies	275	409	220 Male 189 Female	

BREAKDOWN OF LIVELIHOOD COMMUNITY PARTNERS BY LIVELIHOOD TYPE

Livelihood Module	Gender		Total
	Male	Female	
Poultry Production	9	11	20
Goat Raising	48	32	80
Seaweeds Farming Trainings I	56	34	90
Seaweeds Farming Batch II	43	57	100
Skills Training			
Masonry NC II	19		19
Welding NC II	20		20
Carpentry NC II	21		21
Food Processing	3	16	19
Mat Weaving Batch I		20	20
Mat Weaving Batch II		20	20
Total	***219***	***190***	***409***

For more information

PCSDS

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Project Manager

Madrono P. Cabrestante Jr.
Project Supervisor

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Municipality of Balabac (Local Technical Working Group):

Mr. Manuelo Redison
Municipal Agriculturist

Mrs. Lorna Gapilango
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Mr. Said Alih Shah
Secretary to the Sanggunian

Beneficiaries and participants of the JFPR Skills Training in Balabac, Palawan.

About the Main Authors

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Palawan peacock pheasant (*Polyplectron napoleonis)*— Puerto Princesa's pride and flagship species.

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