Final Evaluation Report

Your Details	
Full Name	Bùi Văn Bắc
Project Title	Assessing changes in dung-beetle communities and their functional diversity among forest types over limestone of Huulien Nature Reserve in northern Vietnam
Application ID	35743-1
Date of this Report	18th January 2023

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Determining changes in community composition and functional diversity of dung beetles along a forest disturbance gradient in low elevation karst ecosystems of Huu Lien NR (northern Vietnam).				It turned out that functional diversity (i.e., Rao index) rather than taxonomic diversity (e.g., species richness, Shannon diversity) reflected changes of dung beetles along a forest disturbance.
Providing quantitative information on the value of specific types of disturbed forests for conservation of dung beetles as well as their strong associations				Primary forests showed the highest functional diversity of dung beetles, while eucalyptus plantations had the lowest functional diversity.
Providing effective solutions for the biodiversity conservation of dung beetles in the study area				Protection of remaining intact forest areas are extremely important to maintain functional diversity of dung beetles

2. Describe the three most important outcomes of your project.

a). This study examined the changes in the taxonomic and functional diversity of dung beetles across a gradient of forest disturbances in low elevation karst ecosystems in Vietnam. It was found that old-growth forests (consisting of primary forests and old secondary forests) had significantly higher levels of taxonomic diversity (including richness, abundance, and Shannon diversity) and functional diversity (measured by Rao's quadratic entropy) of dung beetles, compared to young-growth forests (comprising of young secondary forests and eucalyptus plantations). While there were no significant differences in richness and Shannon diversity between the two types of old-growth forests or the two types of young-growth forests, functional diversity varied significantly among the four forest types. The findings suggest that functional diversity, as opposed to taxonomic diversity, is a better indicator of how dung beetle communities respond to forest disturbances. The use of functional traits also provided a more effective means of detecting patterns of community change caused by different types of forest disturbances in karst ecosystems.

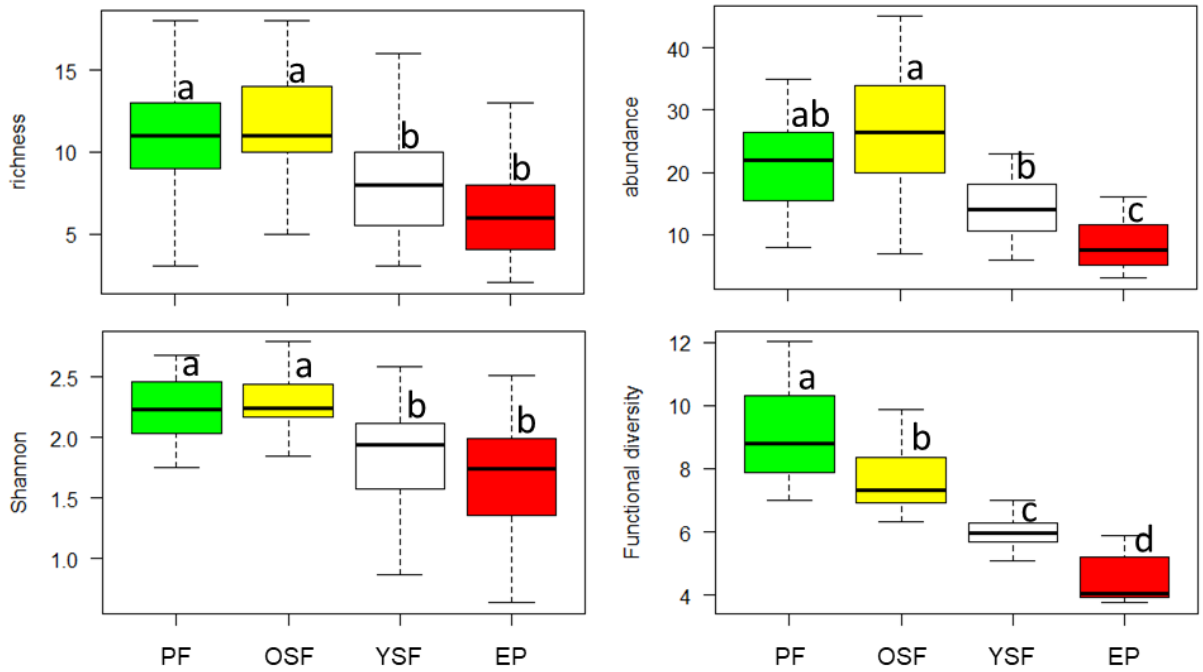

Figure 2. Boxplots of species richness, Shannon diversity index, abundance and Rao's quadratic entropy in four forest types: Primary forests (PF), old secondary forests (OSF), young secondary forests (YSF) and eucalyptus plantations (EP) in Huu Lien Nature Reserve. Different letters indicate statistically significant differences at $p<0.05$. Boxplots with no common letters are significantly different ($p<0.05$).

b). There were significant variations in the community structure of dung beetles among the four forest types studied. It was found that eucalyptus plantations (10 years old) and young secondary forests (<10 years) had a lack of larger-bodied dung beetle species. This may result in a reduction of the ecosystem services provided by dung-beetle communities that live outside of intact forests, as previous research has demonstrated that larger dung-beetle species play a critical role in removing animal dung pats. While old (35-40 years) secondary forests had similar levels of dung-beetle richness, abundance, and species richness to primary forests, the community structure of functional groups still differed between the two forest types, indicating that there may still be differences in ecosystem functions provided by dung beetles between primary and old secondary forests. As such, it is important to protect and maintain intact forest areas in conservation decisions.

c). We identified the dung-beetle species that can serve as bio-indicators for the four forest types studied in the research area, according to Dufrene & Legendre (1997) (see table 1)

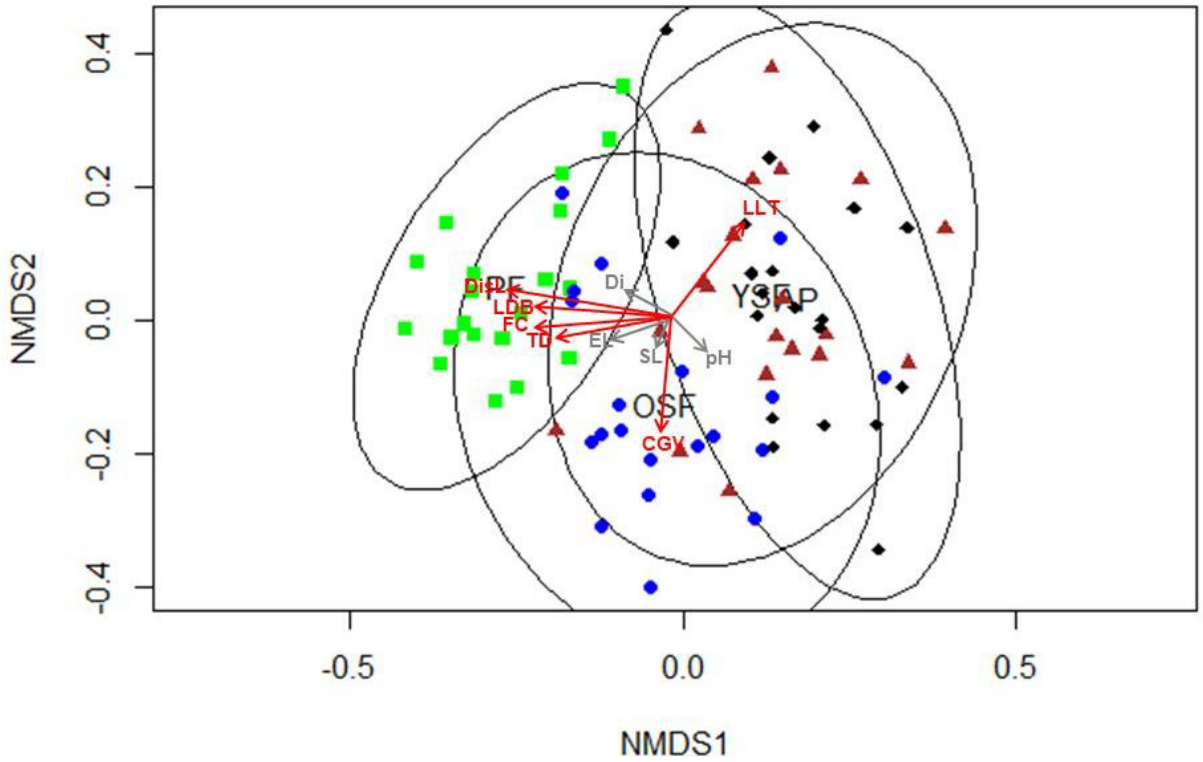

Figure 3. NMDS ordination showing differences in community structures of dung beetles between four forest types: Primary forests (PF, green), old secondary forests (OSF, blue), young secondary forests (YSF, brown) and eucalyptus plantations (EP, black) (Stress value: 0.06). Ellipsoids represent 95% confidence intervals surrounding centroids of each forest type. The fitted vectors of environmental variables and dung-beetle abundance are displayed for significant ($p < 0.05$, red arrows) and non-significant (grey arrows) variables. Distance to lakes (DisL), forest canopy cover (FC), tree density (TD), cover of ground vegetation (CGV), leaf litter thickness (LTT), diameter of tree (Di), elevation (EL) and slope (SL), soil pH (PH)and Large-bodied dung beetles (LDB).

Table 1. The list of bio-indicator dung beetles for the four forest types in Huu Lien Nature Reserve

Species	**Forest type**	**P* value**
Aphodius elegans	Primary forests	<0.001
Catharsius molossus	Old secondary forests	0.001
Paragymnopleurus melanarius	Old secondary forests	0.02
Onthophagus dorsofasciatus	Young secondary forests	<0.001
Copris reflexus Fabricius	Eucalyptus plantations	0.04
Sinodrepanus similis	Eucalyptus plantations	0.03

Below left: Aphodius elegans. Below right: Copris reflexus.

Below left: Paragymnopleurus melanarius. Below right: Catharsius molossus.

Below left: Onthophagus dorsofasciatus. Below right: Sinodrepanus similis.

Figure 4. Indicator dung-beetle species of specific forest types.

This work enhanced capacity building and raised awareness among local stakeholders (including park staffs and local communities) in conserving dung-beetle species as well as their close associations (i.e., mammals). A total of 60 local people were more aware of the role of dung-beetle species in forest ecosystems. The project allowed for increasing the level of attention at local level on the conservation of dung-beetle species, as well as for using dung beetles as bio-indicators for forest quality. Twenty local people were trained in dung-beetle monitoring techniques. Particularly five park staff of Huu Lien Nature Reserve became independent in setting up of a survey methodology of dung beetles in karst ecosystems that could be applied in other sites and in other research.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

- Because of the challenging landscape with steep and isolated mountains, divided by streams and karst lakes in Huu Lien NR, it was not possible to establish a transect that covers all four levels of forest disturbances (including primary forests, old secondary forests (>30 years), young secondary forests (<10 years), and eucalyptus plantations) at an elevation range between 200 and 400 m. Instead, we used the available map of forest types in Huu Lien NR to identify the distribution of the four levels of forest disturbances, and then strategically placed traps in each forest type.

- During the initial field survey, dung beetles were collected from traps after 72 hours of exposure. However, many other animals such as snakes, lizards, frogs, and spiders were found to have been accidentally trapped and died. As a result, in subsequent field surveys, traps were checked daily during the trapping time to collect dung beetles and release any other trapped animals. To further prevent small mammals like rodents from being trapped, a squared metallic mesh measuring 25 x 25 cm (with 2 x 2 cm holes) was placed over the plastic bucket of the traps. This required more time and effort, but it was crucial in order to minimize unnecessary deaths or harm to other animals.

Figure 1. New pitfall trap design: plastic bucket covered with a squared metallic mesh (2 x 2 cm holes) to prevent small mammals to fall in the traps.

4. Describe the involvement of local communities and how they have benefitted from the project.

The five staff of Huu Lien Nature Reserve and 50 local people were participated in training courses on the dung beetle sampling (including: selecting survey sites, setting up survey transects and searching dung beetles in tropical forests over limestone). They learnt about how to sample specific insect groups that are used to assess or measure biodiversity to help identify conservation priority areas in Huu Lien NR.

Particularly the five nature reserve staff and 20 local people were trained in the investigation of dung beetles, using baited pitfall traps and flight intercept traps, to evaluate effects of human land-use changes on biodiversity. Additionally, they were guided to use field equipment such as GPS, camera, and were involved in the assessment of threat posed by human activities in Huulien NR. The five staff of the Huu Lien Nature Reserve were guided to build the collection of dung beetle species (focusing on rare and bio-indicator dung beetle species) for nature conservation education.

The community leader and managers of Huu Lien Nature Reserve were involved in our presentation on the project results that covered the conservation value of the forest types for dung beetles and the effects of forest conversion on dung beetle biodiversity in Huu Lien NR.

Figure 5. Project activities involved local communities. Left: Workshops on dung-beetle conservation. Right: Field training course to dung-beetle sampling.

Figure 5 (continued). Project activities involved local communities. Top: Field training field to dung-beetle monitoring. Bottom: Training courses on establishing the reference collections of dung-beetle specimens.

5. Are there any plans to continue this work?

Yes, there are. We are planning to conduct comprehensive surveys of dung beetles inhabiting spatially separated karst ecosystems to give a full assessment of the population and conservation status of the rare and endangered dung beetle species in karst ecosystems, using the IUCN Red List criteria.

6. How do you plan to share the results of your work with others?

We shared the project results with local communities and managers of the Huu Lien Nature Reserve through the presentation, seminar and final report.

We are planning to share the project results with students and updated the project results in our lectures on Insects at the Vietnam National University of Forestry (Vietnam). Now, we are also preparing a manuscript to publish our results in peer-reviewed journals.

7. Looking ahead, what do you feel are the important next steps?

Determining the population and conservation status of the rare and endangered dung beetle species in spatially separated karst ecosystems, using the IUCN Red List

criteria, and detecting suitable distributions of these dung beetles under climate change scenarios.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

I included the Rufford Foundation logo on t-shirts distributed to local stakeholders. The logo was also added to presentations given at seminars held in local communities and at Vietnam National University of Forestry (Vietnam). Furthermore, we erected a banner on dung beetle conservation, featuring the foundation's logo, at the entrance of the ecotourism centre in Huu Lien Commune.

We also familiarised our colleagues and local conservationists with the Rufford Foundation during the course of our work.

Figure 6. The Rufford Foundation logo was used in the project activities.

9. Provide a full list of all the members of your team and their role in the project.

Dr. Bui Van Bac (Principal investigator) participated in all the project activities: planning; contacting with local authorities; conducting field surveys and data analysis; organizing training courses, meetings, and seminar; and writing reports and manuscripts for publication.

Dr. Nguyen Dac Manh (team member, a lecturer at the Wildlife Department, Vietnam National University of Forestry (VNUF), email address: manhfuv@gmail.com) conducted filed surveys (i.e., including selecting sampling sites, setting up traps, and collecting dung beetles and environmental data).

Ms. Nguyen Thi Mai Luong (team member, a lecturer at the Forest Protection Department, Vietnam National University of Forestry (VNUF), email address: mailuong.vfu2010@gmail.com) were responsible for building the reference collection of dung-beetle specimens collected during the course of the project.

Mr. Hoang Doan Phu (a forest ranger of the Huu Lien Nature Reserve) conducted field surveys with the team members)

Mr. Vi Hai Chau (a forest ranger of the Huu Lien Nature Reserve) conducted field surveys with the team members)

Mr. Hoang Duc Tuong (a forest ranger of the Huu Lien Nature Reserve) conducted field surveys with the team members)

Mr. Trieu Van Su (local people) conducted field surveys with the team members.

Mr. Hoang Minh Tien (local people) conducted field surveys with the team members.

Mr. Hoang Van Thinh (local people) conducted field surveys with the team members.

10. Any other comments?

I would like to express my gratitude to The Rufford Foundation for your financial support to conduct this work that is very important to contribute my early career growth in nature conservation.