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9

Equatorial Biomass Society

Reports from Project Members

Grant-in-Aid for Scientific Research (S)
Planted Forests in Equatorial Southeast Asia: Human-nature Interactions in High Biomass Society

Harvesting in a smallholder's oil palm garden
(Photo by Ryoji Soda)

Bird Surveys in Tropical Plantations

Motoko Fujita (Center for Southeast Asian Studies, Kyoto University)

I started researches on birds in plantations in Indonesia in 2007. The main focus was on the avian diversity in acacia plantations of Company M in Palembang with which RISH (Research Institute for Sustainable Humanosphere, Kyoto University) had just started a joint study on acacia. The goal of my research was conservation of the biodiversity by management, as the decrease in biodiversity is a hot issue. Until then, I had been conducting fieldwork only in Japan and this was my first time to do research in Indonesia. I landed at Jakarta airport with a mix of 70% excitement and 30% anxiety as I had been told much about the difficulty and attractiveness of Indonesia from others. My first impression of Jakarta was the exotic aroma that pervaded the air, which I realized later was Gudang Garam.

Palembang is a one-hour flight from Jakarta and the city once flourished as the capital of Srivijaya kingdom. Today, the city's economy relies on crude oil, rubber plantations, and acacia plantations for pulp chips. The local camp site of Company M is a 4-5 hour drive from Palembang. In 2010, I started the cooperative project of CSEAS with Company S, which has its concession in peat land in Riau. Although I have no research experience in the concessions in Malaysia yet, I share my experience in Indonesia in the hope that it might help other members when conducting research with concession companies.

Research permission and cooperation from the company

Both similarities and differences in the collaborative system toward the research between Company M in Palembang and Company S in Riau provided interesting information on the company's policy. Since the research projects are financially independent from the company, it is not easy to ask for permission and cooperation for the research.

For example, the president of Company M changes every three years, so a sudden decline in research might happen according to the president's policy. Mr. S, who was the president of the company when I started my research, was quite cooperative. He even arranged his schedule so that he could join me at the research sites and observe the exotic birds with his binoculars. The company's attitude, however, changed dramatically after his resignation. They insisted that a biodiversity survey was somewhat harmful to the company's corporate activities. Looking back on it all, I should have visited the company more often to make reports on my research and findings. Now I think that my lack of enthusiasm to share my research findings with the company might have caused the company's indifference. I remembered the words of Mr. S who once said "Birds are good for drawing public attention as they are beautiful but termites are not such attractive samples." Biologists think that biodiversity conservation should be considered for all organisms, but for the public in general, this is not the case. For instance, there is a large gap between the attentions paid to Sumatran tigers and earthworms. And this difference is recognized not only among the general public or private companies, but also can be found among the NGOs. The role of earthworms is actually quite significant in ecosystems. But it is not easy to collect donations for earthworms; "Save the forest for the tigers" is much more appealing to the public than "Save the forest for the earthworms."

On the other hand, obtaining research permission from Company S was relatively easy. The company proclaims biodiversity as one of its corporate strategies and designates some parts of its concessions as

biodiversity conservation areas. Therefore, biodiversity research of larger mammals and birds in the conservation area was welcomed. The study advocated the development of a new monitoring methodology and this held great appeal for them.

Another problem that arose in the plantation research was the difficulty of obtaining maps. Company M strictly prohibits taking out of the forest physiognomy charts on which tree age information is clearly shown. This is because we could estimate annual timber production from the chart. If no maps are available, I have to make them by myself. This was a good opportunity for me to learn how to use satellite images by remote sensing to make land-use maps, but it was a time-consuming process. On the other hand, Company S allowed us to make photocopies of the forest physiognomy charts without any difficulty. I have no idea why this difference exists between the two companies.

There were also clear differences between these two companies in the working style of the employees. Company M allowed its employees to take four days off after working ten consecutive days, since most of their employees' families lived far from the working sites. This allows the company to have someone working every day, so I could conduct my research almost any day of the week. For Company S, it was a different story as many of the employees live in the neighborhood, so most of them took their days off over weekends. Although they could have more time off if they worked weekends, we seldom found anyone in the office on Saturdays or Sundays. At the early stage of the research our request to go into the forests on weekends was declined as no company staff was available. We insisted on going to the forest by ourselves but the company did not allow us to go without the guidance of the staff. Bird surveys usually start early in the morning (6:00 a.m.) but this request was also unacceptable for the company as the employees' working hours were 8:00 to 16:00. We were at a loss as to what to do. After long discussions, we finally managed to obtain their cooperation on weekends by asking their supervisors to write a letter of support to help our research as part of their job assignment. With this formal instruction, they were able to have time off in lieu. However, there was still no way for us to go to forests early in the morning. I have experience of working with a logging Company K in Kalimantan for another project. In Company K, every day except for the national holidays was a working day. The logging site was located far from the town; we had to switch cars three times for the 11-hour drive. As the employees had to work in such a remote area, many of them brought their families with them. Employees of Company K didn't complain about having to walk into the forests with us early in the morning. Sometimes we departed the camp at 5:00 and returned at 17:00. I should emphasize that we need to confirm the working style of the employees beforehand for smooth execution of the research activity.

For inter-disciplinary projects, the research activities conducted by social scientists are sometimes declined when they conduct surveys in plantations or with logging companies. The policies on this issue were not consistent among the logging companies though. In 2008, we started to search for a candidate site for transdisciplinary field work in the Global COE program. The field of Company M, where our joint research had already been progressed, was the

Photo1: Meeting at Company S (photo by Hiromitsu Samejima)

first candidate site. Although there was little problem with scientific research, the company was not happy with the social research on land conflicts and the livelihood of the local people. The company was in the middle of a strained situation with the local people caused by the confusion of the post-Suharto administration. Company M was highly skeptical of social scientists, since it believed that it was the research groups from overseas that had further complicated the land issues. Company S of Riau, on the other hand, approved the social researches in their field, although it was not very excited by the prospect. Therefore, we decided to launch joint research with Company S. It is unclear why they adopted such an open mind to social researches, but this large company probably has the capacity to deal with social researches, considering that they need to handle frequent criticism from environmental NGOs. Incidentally, Company K in Kalimantan surprisingly asked us to investigate the conflicts between the company and local residents, but this is a rare case. I guess they needed the performance record of social research, since they obtained a Forest Stewardship Council (FSC) certification, which needs to be assessed periodically for renewal.

Problems of reward

Rewarding of the workers is always a major issue. In the case of group research it is important to arrange the amount in advance, to avoid confusion among the members. When there is a large budget, we might consider paying a high rate. But this sometimes causes trouble. As is often pointed out, once the payment is fixed at a high rate, it becomes the standard and other research groups will be forced to pay the same rate. The best way might be to consult with the local counterpart in advance about the appropriate amount of payment.

I had some problems with this issue while in the field. Among others, overtime payment puzzled me a lot. My understanding of overtime was to pay on an hourly basis when the workers needed to work outside of their regular working hours of 7:00-16:00. At that time, our bird survey was conducted from 6:00 to 18:00, so there were a few hours of overtime work each day. We took a few days off every two weeks, because I didn't want to make the schedule too tight. At the first meeting with the driver and the company staff, I explained to them about the schedule and guaranteed that they would be paid extra wages for their overtime work, which might be approximately two hours a day. So, I recorded the start and finish time of the surveys every day. At the end of the survey, I showed the actual working time record and told them that the amount of overtime would be about 500,000 Rupiah (more or less 5,000 yen). But the driver calculated an amount that was three times more than that, which worked out to be 1.5 times that of his monthly salary. I asked the driver to explain but his claim didn't make any sense to me. The hourly rate was much higher than my calculation, and working hours were almost double that of my record. It seemed that he had factored the no-working days and no-overtime days into his calculations. His explanations in Indonesian were difficult for me to follow, and I could not find a way out as I was running out of budget. It was Ms. M, a capable secretary, who solved this problem. She made me realize that I was totally ignorant of the business customs there. She pointed out that he was correct since it was calculated based on Indonesian labor law. She gave a clear and detailed explanation of the complex calculation of the overtime payment. In short, (1) if you employ someone for a certain period of time and guarantee payment for the overtime work, off days are included in the payment as well, (2) if you agree to pay two-hours' overtime a day, then the payment for the first hour is X Rp (X = 1/173 of total monthly payment) but for the subsequent hours, the amount will be AX Rp (A was probably 1.5). In this case, the odds were against me. Ms. M kindly visited the car owner to explain the situation and asked him to overlook my mistake. She managed to settle

the problem of the owner paying an extra amount of overtime work to the driver. I really appreciated Ms. M's help on this. Since then, I always make sure that I am familiar with the overtime payment before I employ local people.

Languages

When conducting research in foreign countries, communicating in the native language gives a great advantage to the researchers. It is not mandatory for the scientific researchers as long as you have a good interpreter. But it will help you and make things smoother if you can speak the local language. That was my attitude until I had a problem with communication. My first fieldwork assignment in Company M went quite smoothly. "Terima kasih" was all I could say so I had to communicate in English with local staff. Fortunately, the company assigned me with a member of staff, a young lady, who spoke fluent English; with her perfect arrangement and assistance I could finish my research activities without any problems. But the next time I went to the field, she had resigned from the company to study abroad. Since an English-speaking assistant from Bogor was with me, I was optimistic even though my Indonesian capability remained quite limited (I could manage to say a few simple phrases such as "There's a bird on that deadwood.") One day, after a week had passed, the driver disappeared after he went to the town to fill the car with gasoline. I could not go to the field without a car. He was not answering his mobile phone. The car was found later on a dirt road, destroyed, wrecked, laying on its side. The driver was not hurt by the accident, but he ran away as he was afraid of taking responsibility for the accident. The biggest problem was how to repair the rental car. It was difficult to believe from a Japanese perspective, but the rental car didn't have any insurance at all! A necessary repair charge, about 90,000 Japanese yen in this case, was supposed to be paid half by the car owner and the other half by the renter. But according to the agent, the car owner was

Photo2: A heavily-damaged rented car (photo by Motoko Fujita)

unwilling to pay half of the repair charge. The odds were stacked against me. The company staff was sorry to see me in deep trouble, and negotiated with the agent to settle that matter. But it was me who decided everything and signed the documents. The staff was very cooperative and kind enough to explain things in Indonesian until I fully understood. I had never been so eager to understand what they were talking about, and as a result, I learned lots of Indonesian words in a very short time. With their great help, it was settled that I would pay 45,000 yen for the repair cost. Actually, I had been given two options for rental cars for the fieldwork; a 4WD car, provided by Company M, with full insurance coverage but expensive, and the car that I rented. The rental fee for the 4WD car was about 250,000 yen for less than two months excluding gas. To save my research budget, I rented a cheaper non-4WD car from a rental car shop in the town (about 170,000 for two months). The lesson I learnt is that we should rent a 4WD car if we have to travel on dirt roads even though it's expensive.

As a result of these events, my Indonesian has improved slightly so that I can manage to perform simple tasks or negotiations. However, there is a negative effect of this. When people know that I understand and speak Indonesian, they approach me directly regarding their needs. Most frequently, this consists of requests for borrowing money for vari-

ous reasons; their children are sick, or they have lost their jobs. But there is one thing that is clear. If you lend some money to them, you will never get the money back. “Minta pinjam uang” is Indonesian for borrowing money, but I think it is more precise to say “minta kasih uang” which means “give me some money”.

Joyful fieldworks

Collaborating with a private company is not mainstream in the area of ecological science. Moreover, when working with a plantation company, which is often a target of criticism of biodiversity decline, publishing the results sometimes requires extreme care. Natural forests have far richer biodiversity compared to plantations. First of all, the bird species that inhabit natural forests and plantations are different. In natural forests, birds that prefer deep forests are found and most of them are very cautious and shy. In plantations, on the other hand, most bird species favor open spaces. If most of the surrounding environments are natural forests, with little open spaces, those open habitats also may be an important habitat for birds. But now, natural forests are decreasing and open habitats are spreading. To conserve bird biodiversity, we need to preserve as much natural forest as possible. But how do we do this? Setting a large area of natural forest as a protected area is one way, or retaining a strip of natural forest along a small river is also possible. It is easy to criticize plantations, but what scientists should do is to record their impacts in a scientific manner, so that we know how to conserve biodiversity.

Ultimately, fieldwork in tropical forests provides me with valuable experience that no other place can offer. Morning starts with the chorus of various birds, followed by gibbons echoing through the deep forest, and soon the forest is filled with the overwhelming power of wild creatures. Once the heat has subsided in the evening, the breeze will relax you. Although troublesome from time to time, I like the people and their way of living in tropical areas. To me, they seem to be very flexible and adaptable, possibly because of the ethnic diversity of their communities. In the tropics, there is something special that really attracts me, which I cannot find in Japan. Southeast Asia has been experiencing drastic changes in recent years, but I hope the landscape here continues to deserve the label “beautiful” forever.

Photo3: Black-capped Monarch (photo by Motoko Fujita)

Photo4: Rufous-backed Kingfisher (photo by Motoko Fujita)

The Key to the Bird Nest Business Lies in Bird House

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The key to the bird nest business lies in houses

The bird nest business is flourishing in urban areas along the Sarawak coast. Success in this business, which involves gathering the nests of cave swiftlets, a type of swiftlet, for sale (see Photograph 1), depends on being able to gather as many large nests as possible. To that end, people build structures that provide an environment that facilitates nest-building by the birds. Throughout this paper, I will refer to these structures as "bird house." Unlike long-established methods for gathering bird nests built in caves, use of bird house depends on having the birds use the houses to build their nests. People employ a variety of creative measures to entice them to do so. It is no exaggeration to say that whether the bird nest business is successful—whether numerous swiftlet can be attracted to the bird house and enticed to make large numbers of high-quality nests—depends on these measures.

In this paper, I will report on bird house (see Photograph 2) being used to conduct research in this project into the ecology of cave swiftlet. My objective is to decipher the creative measures adopted to attract swiftlet based on the placement, building methods, interior space, and interior environment of these bird houses. I conducted a site survey from February 14 to 20, 2013. The bird houses in question have been built along the road from Bintulu to Sebauh, about half an hour by car. All were recently built structures that had been completed in 2012. According to Mr. T, who manages bird house in the area, the swiftlet will come to the houses gradually in the evening. The effort is off to a good start.

It is primarily Mr. T, his wife Mrs. D, his son B, and his daughter L who are responsible for building and managing the bird house. The actual construction of the house is carried out by several residents of Asap, where Mr. T and Mrs. D live. Asap is a region that lies about half a day inland by car from Bintulu. For his part, Mr. T's son B lives in Kuching and operates a number of bird houses in Kuching and Bintulu. Mr. T's daughter L lives in Bintulu, where she runs a company that harvests and sells lumber.

Photo 1: An edible bird nest
(photographed by the author at the Sarawak Museum on February 15, 2013)

Creative measures to entice swiftlet to visit bird house

When people rent a condominium or apartment, they make an overall decision after comparing such factors as exposure to sunlight, floor plan, building age, rent, and proximity to the nearest train station with their own lifestyle. In the same way, is it not likely that swiftlet decide whether to take up residence in a house based on how well it matches their own "lifestyle" (ecology). In this section, I will examine the creative measures that people have implemented in order to entice swiftlet to use the houses along the lines of the characteristics of those houses.

(1) Location: Peatland on the outskirts of Bintulu. Good ventilation, good view. Good access to oil palm plantations.

Mr. B, who was overseeing the construction of the bird house, chose this location because he owns land

Photo 2 : The bird house used in this Project
(photographed by the author at the peatland areas around Bintulu on February 14, 2013)

here. The land was originally owned by a nearby Iban people, but Mr. B purchased 10 to 15 acres[1] of it. In Mr. B's view, the large number of insects, on which swiftlet feed, in the peatland and nearby palm oil plantations made this site well suited for a bird house. The bird house is surrounded by untouched peatland owned by Mr. B. Palm oil plantations can be seen nearby along the road leading to Sebauh, along with scattered bird houses. There are no buildings near this bird house, which is exposed to the wind and enjoys broad views of the surrounding area.

(2) Construction method and layout: Wooden frame, three-story structure. Vaulted, open area at the entrance. Air holes ensure good airflow.

The most noteworthy characteristic of this bird house is its wooden construction. Most bird houses are built from concrete. It is likely that this preference reflects a belief that concrete provides an environment that closely resembles the caves in which swiftlet build their nests in the first place. However, this bird house was built using wood in an effort to keep down the cost of construction. According to a site survey conducted by the author, the cost of constructing this bird house was in fact less than the cost of constructing a concrete house[2].

The exterior dimensions of this bird house (see Figure 1) are 720 (W) × 1,800 (D) × 705 (H) centimeters. There are 24 air holes each on the eastern and western sides of the structure, to which PVC tubes are attached. There is an entrance for the swiftlet on the top of the northern side of the house. This entrance measures 60 (H) × 90 (W) centimeters. After comparing the size of this house's entrance with other bird house, I found that this house has a somewhat large entrance. There are entrances to provide access for human workers to the small rooms on the south and east sides of the house. There is a control room containing audio equipment on the southern side of the house.

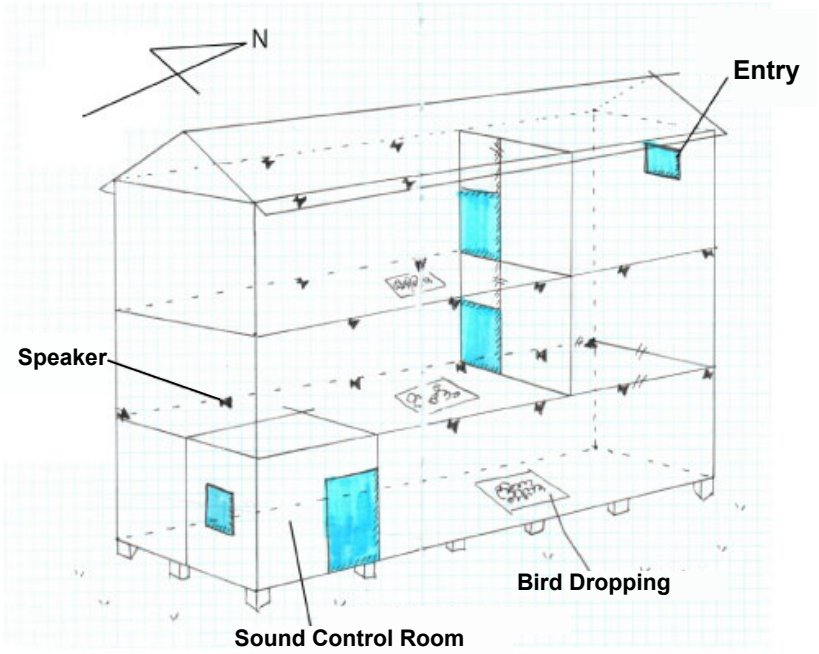


Figure 1 : Illustration of the interior of a bird house
(drawn by the author based on measurements taken at the site)

This bird house was built using a simple framing method. A foundation was laid, and a subfloor was built on top of the foundation. A floor and walls of plywood were then nailed in place. The foundation is designed so as not to sink into the peatland. Normal concrete bird house require an involved process to construct their foundations, including the boring of deep holes that are then filled with stone and gravel. By contrast, this bird house uses a simple foundation construction process in which a number of wooden stakes were driven vertically into the ground. Wooden horizontal crosspieces were then secured to the stakes in the shape of a cross. While it is unclear whether this foundation construction method is sufficient absent a careful evaluation of its strength, it can at a minimum be concluded that, since the weight of the wooden house is far less than that of the concrete house, the wooden house does not require the same involved foundation construction.

Principal building materials included Belian (*Eusideroxylon zwageri* Teijsm. & Binn.) and Meranti (*Shorea* spp., *Parashorea* spp.) square lumber and boards as well as plywood. Belian has been used for the foundation and the columns between the foundation and the upper portion of the house, both areas that require an especially high level of strength and durability. Meranti has been used for other structural members, and plywood has been used for the floors, ceilings, and walls. Members have been joined using screws and wedges (for columns and boards) and nails (for plywood).

The construction methods and design of the bird house were chosen together by carpenters involved in its construction and B's parents D and T. A particular area of discussion focused on the question of what kind of foundation to build on the loose base provided by the peatland. According to B, builders in Asap dig holes in the ground when building a foundation, insert stakes of about 2 meters in length, and secure them in place by backfilling the holes with dirt. Then horizontal members are attached to the stakes with screws to complete the foundation. Since the soil in Asap is dry, this approach provides adequate support for structures. This account suggests that they chose the construction method for this bird house's foundation based on their experience to date with similar construction. The same observation can be made concerning not only the foundation, but also the entire house.

The house is a three-story structure. There is a vaulted opening on the northern side, and after coming in through the entrance, swiftlet proceed into this open space, from which they move to the house's individual floors. Each floor has an entrance/exit that opens on the western side of the house.

(3) Interior environment: An adequate level of attention has been paid to audible swiftlet calls and odor.

There are about 20 speakers inside the bird house, including large speakers on both sides of the swiftlet entrance and small speakers on the tops of the columns. These speakers are connected to an MP3 player in the control room that plays a recording of swiftlet calls. The swiftlet calls played back on these speakers play an important role in attracting swiftlet to the house. The owner of the bird house has tried various speaker types and locations through a process of trial and error and creative modification in order to attract as many swiftlet as possible to the house. D described the audio equipment at a level of detail that suggested the enormous amount of attention he has paid to this aspect of the house's design. B explained that he had obtained a good recording of swiftlet calls and that the birds would come to the house immediately if this recording were played. In this way, it seems likely that the house owners find the process of developing ideas and creatively figuring out how to attract swiftlet appealing.

Inside the bird house, an odor that the swiftlet find attractive hangs in the air. The floors of each story are covered with the birds' droppings, spreading an ammonia odor throughout the structure. The owners say that this odor is identical to the one that can be found inside the caves. Furthermore, the walls and floors of the house

have been coated with an ammonia and water solution. They explained that swiftlet would not come to newly constructed houses due to the smell of the lumber and paint used in their construction.

Family networks that span villages and cities to build bird houses

The procurement of materials for, and the construction of, this house drew on the skills of the family network. These tasks were overseen by the families of D and T, who are the parents of B. D and T live in Asap, and they use Asap residents as labor to carry materials and perform carpentry work. Among the couple's children, including B, are residents of Bintulu and Kuching. They take responsibility for procuring building supplies such as screws, nails, and plywood as well as the speakers and other audio equipment. Let's briefly examine how responsibility for tasks such as procurement of materials and building work is divided among family members.

Lumber, which is the principal building material, is harvested from a timber concession near Bakun that is owned by the lumber company run by L, the daughter. Punan people living in Bakun harvested and processed the lumber. L transported the lumber from the concession by boat down the river to Bakun and then over logging roads to Asap. Then the lumber was transported from Asap to the bird house construction site. The owners said that loading and unloading of the lumber as well as its transport at the site was handled primarily by two or three Indonesians living in Asap. On the other hand, B purchased the speakers, amplifier, and other audio equipment in Kuching and transported it to the site.

All bird house construction work is performed by men from Asap. Farming is their primary job, but they also do carpentry work as needed. They spend about one week to build each house, sleeping at the site as they do so or traveling back and forth between the site and Asap. Five or six carpenters work at once in a team whose composition sometimes changes. Indonesians living in Asap transport lumber at the construction site. There are always two or three Indonesians at the site, and they are responsible for that work. The composition of that team is also subject to change as circumstances dictate.

Striving to create a successful example of a wooden bird house

The above provides a brief report of what my site survey of the construction of this bird house found. It differs from other bird house in its wooden construction, but in its other characteristics it may generally be considered to compare favorably with other such structures. I learned that D and T as well as their child B played the lead role in the construction of the house, bringing together and mobilizing materials and labor from Bakun, Asap, Bintulu, Kuching, and other locations. Portions of a family network that span villages and cities are also apparent in that aspect of the construction.

Incidentally, there are arguments both for and against wooden bird house. One group, exemplified by B, who was involved in this construction project, claims that swiftlet will occupy good houses, regardless of whether they are constructed from wood or concrete, and that wooden construction is not problematic. By contrast, Dr. L of the Sarawak Museum, who has detailed knowledge of swiftlet ecology and bird house, casts doubt on this approach, suggesting that the temperature inside a wooden house would rise and prevent swiftlet from occupying the structure. It appears that additional study will be necessary in the future in order to determine whether the house in question in fact functions as a bird house.

Additionally, if research into swiftlet ecology continues, new methods for improving bird house based on the birds' ecological characteristics may be discovered. I am hopeful in this respect.

Notes

[1] One acre is equal to about 0.4 hectare.

[2] Construction costs were calculated based on interviews of E, who owns a concrete bird house in Sadongjaya, which is about one hour by car from Kuching, and B, who was involved in the construction of this bird house.

Land Use Mapping Exercise along Kemena River - Tubau – lower Jelalong

Jason Hon (WWF Malaysia)

Materials

Satellite Images

High resolution multi-spectral and panchromatic satellite images were obtained from Digital Globe http://www.digitalglobe.com. The images were obtained in two batches, under delivery orders 052896239040_01 (inclusive of Product 01 and 02) and 052927222010_01 (Product 01). In this report, these images are conveniently referred to its geographical area based on prominent features. Hence, the western portion is coded as TubauImage (named after Tubau Bazaar), whereas the eastern portion is coded as JelalongImage (named after Jelalong River) (Figure 1). TubauImage was captured between 5 to 13 August 2012 and JelalongImage on 5 August 2012. Multi-spectral and panchromatic raster datasets, with cell sizes of 2 metres and 0.5 metres respectively were obtained.

ArcGIS 10.1

Analyses were carried out in software ArcGIS 10.1 developed by Environmental Systems Research Institute, Inc. (Esri©). Data frame properties follow that of raster datasets from DigiGlobe, which were projected based on the WGS_84_UTM_zone_49N) (Transverse_Mercator) coordinate system. Multispectral raster dataset was pan-sharped with panchromatic raster dataset to create red-green-blue (RGB) raster with the resolution of the panchromatic raster. The raster data was first analysed using the Normalized Difference Vegetation Index (NDVI) to segregate vegetated and non-vegetated areas. Expert interpretation based on visual analyses and ability to discern vegetation types were carried out to delineate the boundaries and categorize the different class of vegetated areas. For detailed classification, see section on Classification of land use.

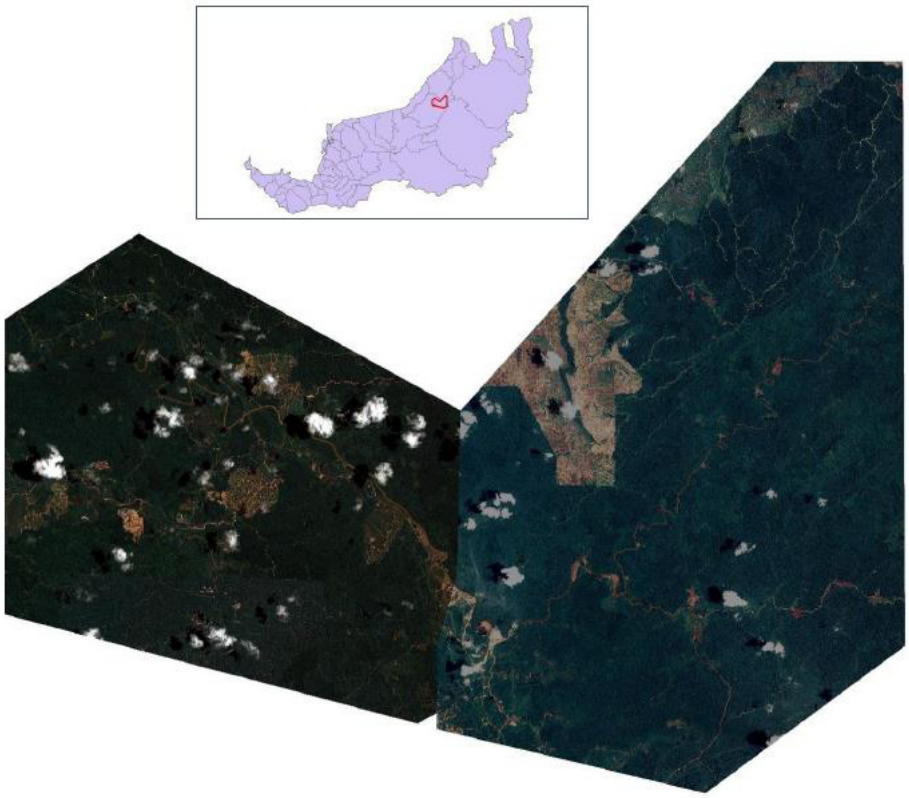


Figure 1: The Map of Sarawak indicating the location of project area; and RGB composite of TubauImage (west) and JelalongImage (east)

Classification of land use

Altogether, 9 major categories of land uses were identified, which were further classified into finer categories. The rules and criteria for each category is listed. Because of the limitations of the methodology used i.e. visual analyses and interpretation, a more generalized set of rules were only applied, notably for vegetated areas. The land use classifications consist of:

1. Forested area

a. Forests – tall standing, closed canopy

b. Degraded forests – more than 30% canopy gaps, uneven canopy, presence of old tracks / shrubs

c. Forest clearing – cleared forests, felled trees, exposed earth, canopy gaps with exposed earth, sometimes with presence of grass and shrubs,

d. Forest clearing for oil palm – cleared forests adjacent to oil palm plantation that are likely to be converted to oil palm plantation

2. Oil Palm planted areas

a. Mature oil palm – fruiting trees, closed canopy

b. Young oil palm – non-fruiting trees, small crowns, gaps in canopy with exposed earth

c. Temuda Yr 0 oil palm – temuda recently planted with oil palm in the same year

d. Plantation terrace – plantation terrace not yet planted with oil palm

e. Nursery – nursery for oil palm

3. Temuda

a. Old temuda – swidden agriculture site left behind for more than 5 years

b. Intermediate temuda – left aside swidden agriculture site, left idle for between 2-5 years, dominated by grass with shrubs present,

c. Recent temuda – recently created swidden agriculture site, cleared less than 2 years before, dominated by shrubs, or recently planted

d. Temuda bare ground – recently cleared forest (small scale basis) for swidden agriculture activity or for planting of crops by local villagers

4. Cash crops

a. Rubber – rubber plantations

b. Orchards – tall fruit trees such as durian, mango, jackfruits, palms

c. Other cash crops – tapioca, pepper, UnId cultivated farms

5. Acacia

a. Acacia plantation – planted forest with acacia species (other tree species may be planted or present)

b. Acacia recent planting or clearing – site adjacent to existing acacia plantation that is cleared for plantation expansion, or has just been recently planted

6. Water bodies

a. Major river – Kemena River, Tubau River, Jelalong River

b. Small river – tributaries of major rivers, upstream of major rivers

c. Irrigation – man made channels for irrigation purposes, usually to drain peat water for oil palm cultivation

d. Ponds and lakes – man made or natural ponds or lakes, including aquaculture

7. Roads

a. Major expressway – Simpang Bakun to Tubau expressway

b. Secondary road – arterial roads branching from major expressway or connecting major settlements

c. Logging road – unpaved roads, used predominantly of logging activities

d. Plantation road – unpaved roads inside oil palm plantation

8. Man-made structures

a. Buildings – settlements, shops, villages, clinics, schools and any forms of building

b. Logponds – collection points for logs

c. Powerline – high voltage powerline

9. Keresa Plantation – a separate category specifically for Keresa Plantations Sdn Bhd

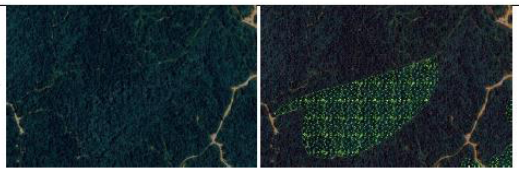
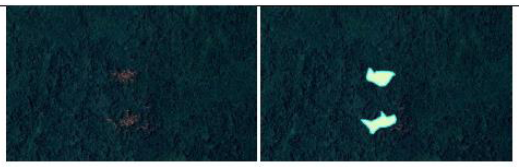
a. Offices and staff barracks

b. Palm oil refinery

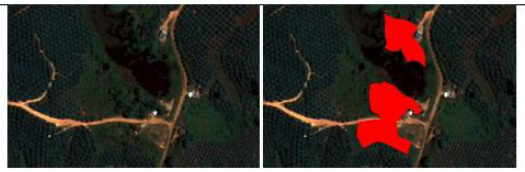
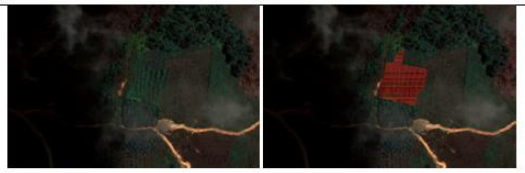
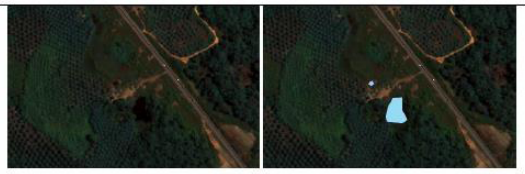
c. Oxidation Ponds

10. Grass and shrubs – grassy areas or shrubs created by construction of roads, powerline, settlements etc.

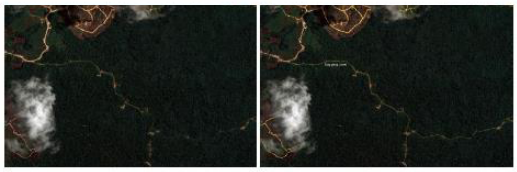
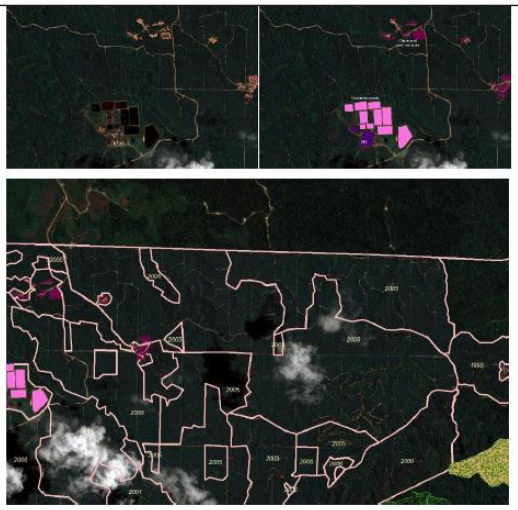
Examples of mapping exercise

Major category	*Refined classes **	*Name of layer in ArcGis*	*Example of raster dataset*
Forest	Forest	Forests	
	Degraded forest	Degraded_forest	
	Forest clearing	Forest_clearing	
	Forest clearing for oil palm	Forest_clearing_oil_palm	
Oil Palm	Mature oil palm	Oil_palm_plantation-mature	
	Young oil palm	Oil_palm_plantation-young	
	Recently planted oil palm	Oil_palm_plantation_Yr0	
	Plantation terrace	Plantation_terrace	
	Nursery	Nursery	
	Cleared temuda recently planted with oil palm	TemudaYr0_OilPalm	

Examples of mapping exercise

Major category	*Refined classes **	*Name of layer in ArcGis*	*Example of raster dataset*
Temuda	Old temuda	Temuda_old	
	Intermediate temuda	Temuda_intermediate	
	Recent temuda	Temuda_recent	
	Temuda bare ground	Temuda_bare_ground	
Cash crops	Rubber trees	Rubber	
	Orchards	Orchard	
	Other cash crops	Cash_crop_others	
Acacia	Mature acacia plantation	Acacia_plantation	
	Recently planted acacia or recently cleared site for acacia plantation	Acacia_recent_planting_or_recent_clearing	
Water bodies	Major rivers	River_Sg_Kemena1	
	Small rivers	Small_rivers	
	Irrigation channels	Irrigation	
	Ponds and lakes	Water	
Roads	Major expressway	Simpang_Bakun_Tubau_main_road	
	Secondary road	Secondary_road	
	Plantation road	Plantation_roads	

Examples of mapping exercise

Major category	*Refined classes **	*Name of layer in ArcGis*	*Example of raster dataset*
	Logging road	Logging_roads	
Man-made structures	Buildings	Building	
	Logponds	Logpond	
	Powerline	Powerline	
Keresa Plantations	Keresa Oil Palm Plantations Sdn Bhd, and contains offices and barracks; oil palm mill; and oxidation pond.	Keresa_Plantation; Office_and_staff_barracks_Keresa; Palm oil refinery; and Oxidation Ponds. Data on planting plan for oil palm according to year is embedded in the Keresa_Plantation layer.	
Grass and shrubs	Grassy areas, sometimes consisting shrubs	Grass_and_shrubs	

* Order of classes follow Classification of land use. Parentheses show name of layer in ArcGIS.

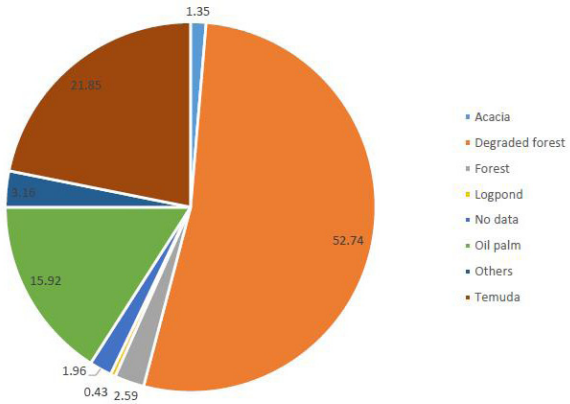


Figure 3: Pie Chart showing the percentage of major land use types

Results

Of the two raster dataset, 96.84% of the area was successfully classified. The remaining 3.16% was covered in cloud, and therefore, could not be mapped correctly.

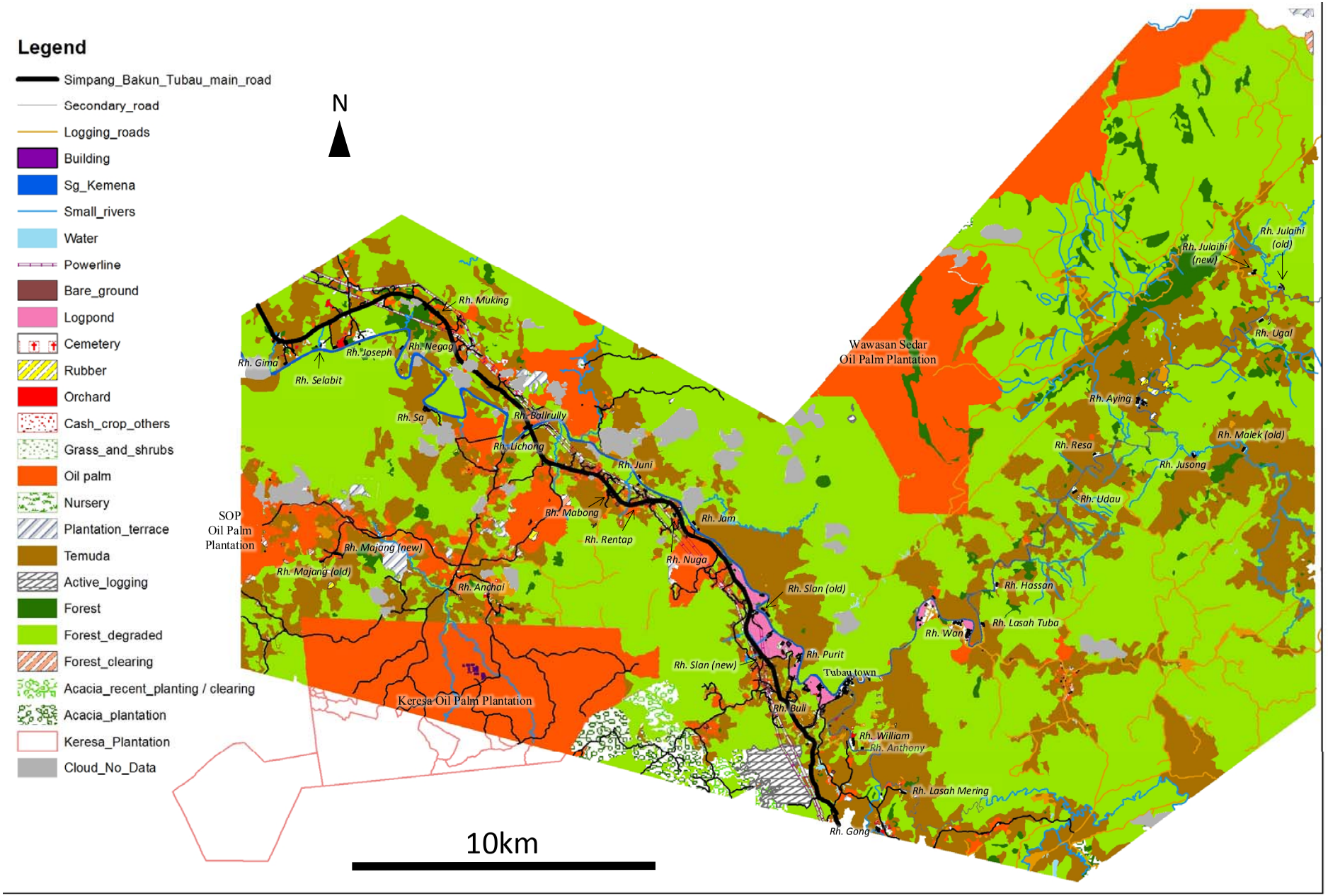
Forested area represented the most of the area, amounting to 55.33% of the project area. Of this, good standing forests accounted for 2.59%, whereas the remaining 52.74% of the forest category was classified as degraded forests or forest clearings. The second highest coverage category was temuda, which represented 21.85% of the project area. Out of this, old temuda represented 17.53% of the project area, the largest of the temuda category. This was followed by intermediate and recently opened temuda. A collective figure of 3.67% for intermediate and recently created temuda was reported because of the high probability of overlapping in land use category between these two. Recently cleared forests, adjacent to temuda was more likely a temuda itself, and was therefore classified as "temuda bare ground", which represented 0.65% of the project area. Within the temuda category, recently created temuda i.e. less than 2 years old, represented about 3.99%, meaning to say that biannually, local people used very little land for swidden agriculture purposes. If converted to area, this accounted for 528.10 hectares or 0.85% of the project area. On top of that, another 0.11% of temuda within the project was converted and planted with oil palm, but this figure could be under reported because a large portion of young oil palm planted areas could have been converted from temuda as well.

Oil palm plated area accounted for 15.92% of the project area, the third largest major land use type. Within this category, matured oil palms covered 9.12% or 5,666 hectares of the project area, followed by young oil palms which covered 6.36% or 3,954 hectares of the project area. About 0.32% of the project area was classified as plantation terrace, more likely to be planted with oil palm. Some overlaps of land use with temuda area that were planted with oil palm was also observed, and it cannot be confidently determined where the exact boundaries between recently converted temuda for oil palm or expanded oil palm plantation. The boundaries between some of the larger oil palm plantations operated by companies and smallholders plantation were not evident, and this could have also resulted in some overlaps of land use classification.

Although the project area falls inside the Sarawak Planted Forest project area, a large proportion of the area have not been converted into acacia plantation. Area classifies as planted or worked on for acacia plantation covered only 1.35% of the project area.

	Land use	Land use - classified	Hectare (ha)	Percentage of project area (%)
1	Whole map	Whole map	62,133.79	100
2	Acacia	Acacia planted	590.22	0.95
3	Acacia	Acacia recently planted	245.66	0.40
4	Temuda	Temuda bare ground	404.80	0.65
5	Temuda	Temuda intermediate	1,750.72	2.82
6	Temuda	Temuda old	10,893.70	17.53
7	Temuda	Temuda recent	528.10	0.85
8	Oil palm	Temuda Year 0 with oil palm	69.13	0.11
9	Oil palm	Oil palm mature	5,665.98	9.12
10	Oil palm	Oil palm young (<3yrs)	3,953.61	6.36
11	Oil palm	Plantation terrace	201.41	0.32
12	Forest	Forest	1,608.45	2.59
13	Degraded forest	Degraded / recently logged over / recently disturbed forests	32,685.78	52.61
14	Degraded forest	Forest clearing	84.53	0.14
15	Logpond	Logpond	266.32	0.43
16	No data	Cloud / no data	1,219.12	1.96
17	Others	Others	1,966.27	3.16

Table 1: Coverage of Land Use Types of the Project Area



Land Use Map of Kemena River - Tubau - Lower Jelarong Region in Bintulu

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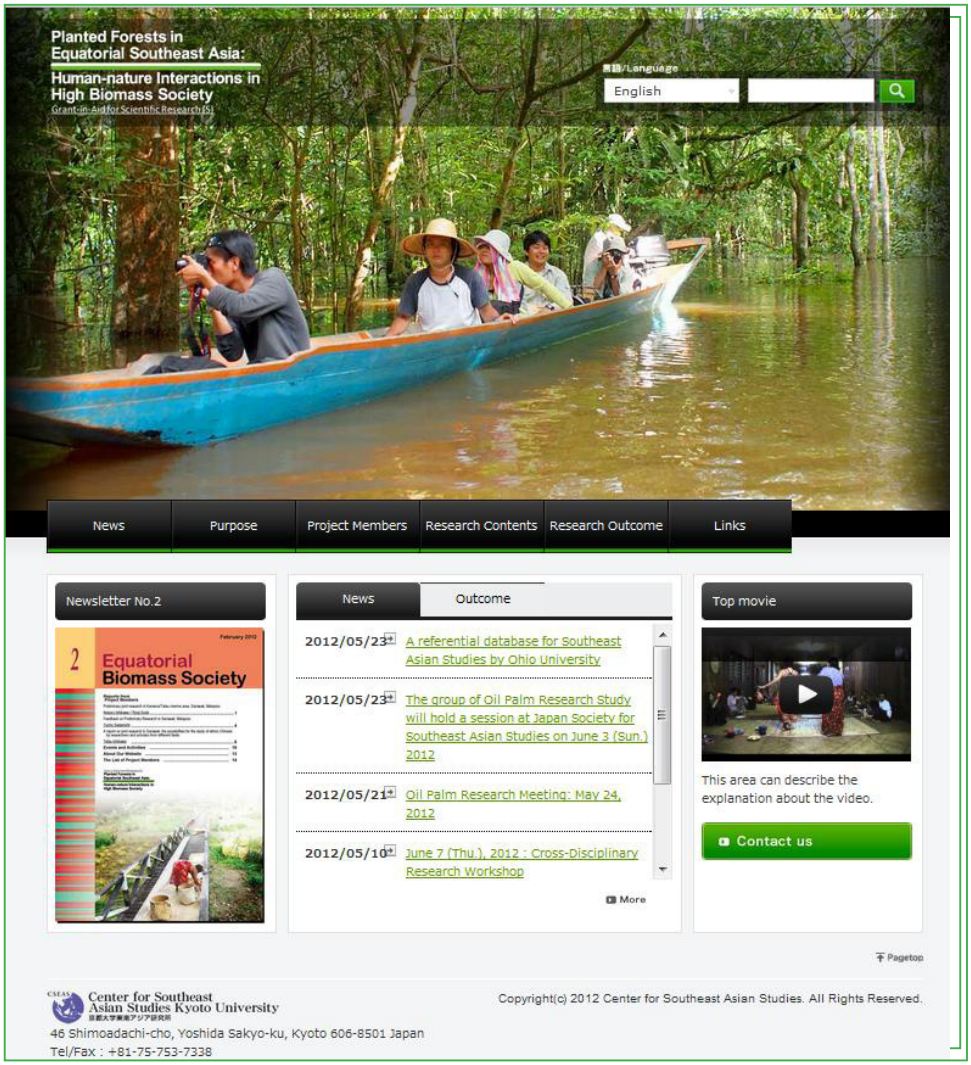
http://biomasssociety.org/en/



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It covers articles, event information, videos, research outcomes newsletters and much more.

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A concrete bird house built on peat land area near Asajaya
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(Photo by Motoko Fujita)