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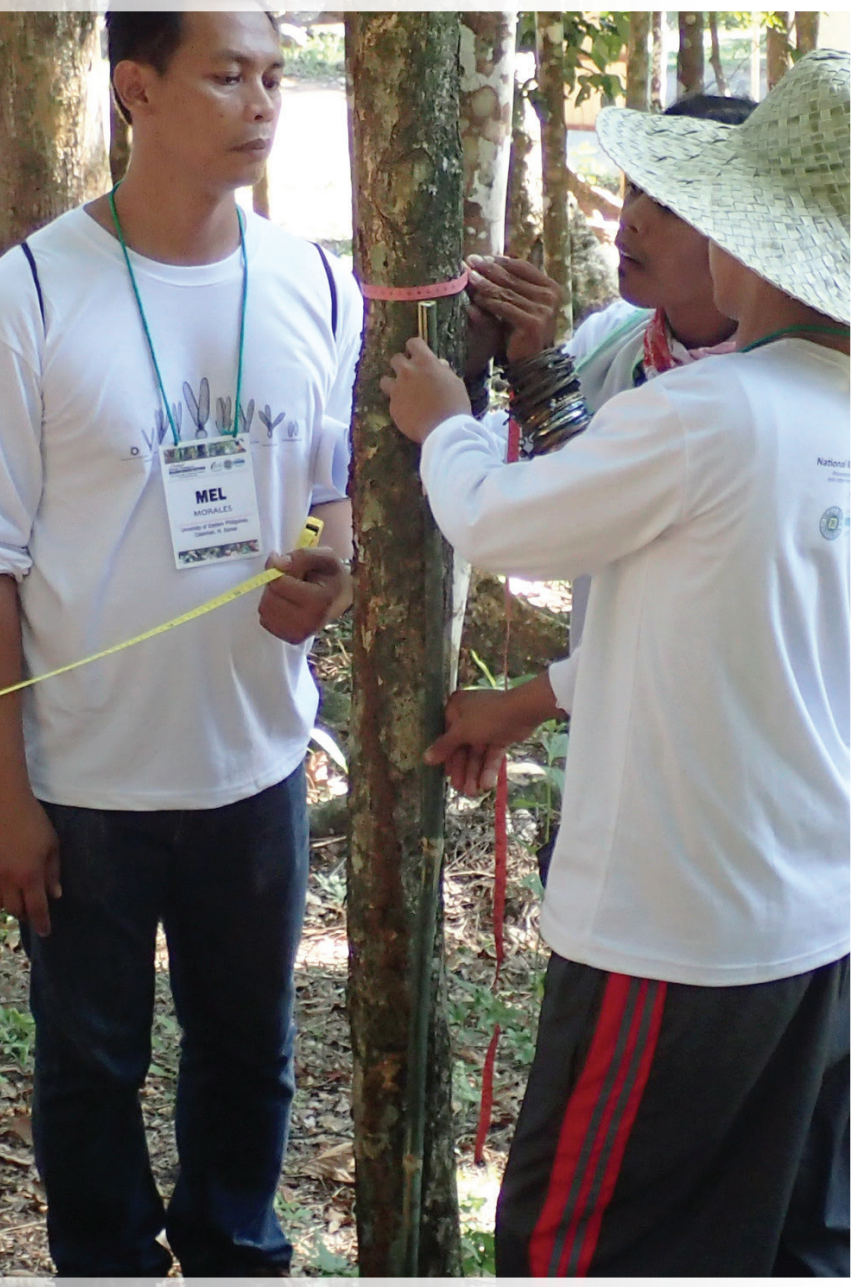

Key Messages from the International Symposium on Monitoring Forest Restoration for Adaptive Management

November 27, 2015
Philippines

Sponsored by the Environmental Leadership & Training Initiative (ELTI), the Rain Forest Restoration Initiative (RFRI), and the Philippine Department of Environment & Natural Resources (DENR)

Symposium Proceedings

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ELTI recognizes the generosity of the Arcadia Fund, whose funding supports ELTI and helped make this event possible. We would also like to thank DENR and RFRI for their support in organizing and holding this event.

List of Acronyms

DBH	Diameter at breast height
DENR	Department of Environment & Natural Resources
ELTI	Environmental Leadership & Training Initiative
EO	Executive Order
FORRU	Forest Restoration Research Unit
GPS	Global Positioning System
LiDAR	Light Detection and Ranging
M & E	Monitoring & Evaluation
NGP	National Greening Program
PO	Peoples' Organization
REDD+	Reducing Emissions from Deforestation & Forest Degradation through conservation, sustainable management of forests and enhancement carbon stocks in developing countries
RFRI	Rain Forest Restoration Initiative
UAV	Unmanned Aerial Vehicle

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Introduction

Forest restoration has become an increasingly popular tool for mitigating the loss of ecosystem services resulting from deforestation and forest degradation. It has also become a preferred yet controversial global climate change mitigation strategy. A variety of restoration strategies that address both ecological and social needs have emerged. However, aside from formal research projects, very few restoration initiatives seem to conduct long-term monitoring and evaluation. It is, therefore, difficult to assess the effectiveness of the restoration activities, and make the necessary changes to achieve the proposed outcomes. It also limits the ability for broader institutional and societal learning about appropriate, robust restoration practices.

Until recently, monitoring for forest restoration has required field-based assessments, which can be costly and time-consuming. Advances in technology, such as the use of drones and remote sensing, present more efficient alternatives to monitoring large-scale restoration projects. While the new technologies do not completely replace the need for field-based monitoring, they complement the traditional approaches in a way that could provide for a more judicious use of limited resources, while at the same time, rendering the big picture of what is being achieved in the field versus what is hoped to be achieved by restoration programs.

To raise awareness about evolving trends, the Environmental Leadership and Training Initiative (ELTI), together with the Rain Forest Restoration Initiative (RFRI) and the Philippine Department of Environment and Natural Resources (DENR), held an International Symposium on Monitoring Forest Restoration for Adaptive Management on November 27, 2015, at the Biodiversity Management Bureau Training Center in Ninoy Aquino Parks & Wildlife Compound in Quezon City, Philippines. The objectives of the symposium were to introduce

different forest restoration strategies, explore innovations for monitoring and evaluating restoration projects, as well as discuss ideas for improving restoration implementation and monitoring in the Philippines.

The topic of the symposium was considered particularly opportune as the Philippine's National Greening Program (NGP), a national initiative to restore 1.5 million hectares of degraded lands between 2011 and 2016, enters its final year of field operations. The DENR claims that the program has been highly successful, but numerous civil society organizations, including members of the RFRI network, are calling for a more reliable and transparent accounting of both the positive and negative aspects of the program's implementation – beyond what is regarded as the government's self validation and promotion. The importance of this introspection, and efforts towards third-party verification and methodology upgrades is even more relevant with the signing of Executive Order 193, which expands the coverage of the NGP to the remaining 7.1 million hectares of unproductive, denuded forestlands until the year 2028.

The symposium was enriched by the knowledge and expertise of national and international scientists and practitioners from the Philippines, Singapore, Thailand, Costa Rica, and Australia. This booklet lays out some of the key messages of the presentations and allows interested parties to explore further by providing a list of associated publications as well as contact information of the speakers. The goal of this document is to provide policy makers, researchers, practitioners, and other stakeholders with some of the latest advancements and expert insights on forest restoration and monitoring approaches, in order for them to make better-informed decisions about how to meet their restoration objectives in the most effective and efficient way possible.

Presentation #1

Opening Message

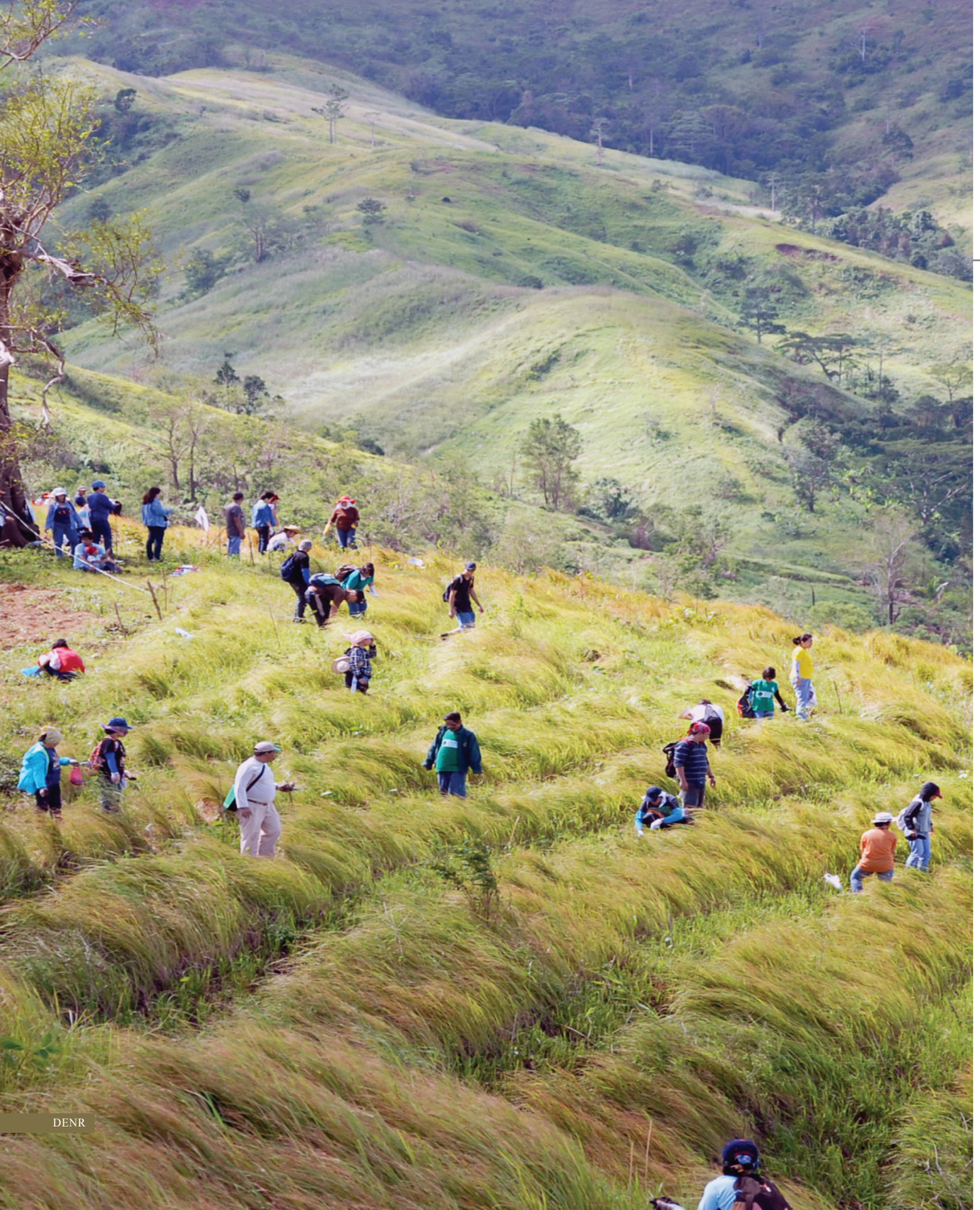
Dr. David Neidel

ELTI,
Singapore

Dr. Neidel set the context for the symposium by outlining the growing international attention to forest restoration as reflected in the Bonn Challenge, the New York Declaration on Forests, the Aichi Targets of the Convention on Biological Diversity, and the United Nations REDD+ program. While each has its own particular focus, the overall common goal of these restoration initiatives is to restore the range of ecosystem services, which have been lost due to the rampant deforestation and forest degradation. Such services include:

- provisioning services (e.g., supplying food, medicine, timber and fuel);
- regulating services (e.g., carbon sequestration and climate regulation, air and water purification, and pest and disease control);
- cultural services (e.g., aesthetic, recreational, and spiritual uses); and
- supporting services (e.g., soil formation, photosynthesis, and nutrient cycling).

Ideally, all relevant stakeholder groups would be involved in the design, planning, and implementation of the restoration efforts. Moreover, a monitoring program with indicators that reflect the objectives of the project, and can therefore accurately evaluate the success of the project, would also be incorporated. A robust monitoring system would allow for midcourse corrections, if social and ecological goals are not being met, and would facilitate the dissemination of lessons learned to influence future projects. Unfortunately, very little, good quality monitoring actually takes place due to short-term and inconsistent funding, limited technical capacity to collect the right data and analyze, and the fact that local stakeholders don't see much value in it, or have other priorities. When monitoring does occur, the results are often unreliable or not trusted by other stakeholders, which were not directly involved in the monitoring. As such, the monitoring ends up having little or no impact on how future restoration is conducted. Nevertheless, there are a number of innovations underway and this symposium was designed to examine them, as well as the opportunities and constraints for implementing them in the Philippines.



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PRESENTATION #2

Welcome Remarks

Ms. Mayumi Quintos-Natividad

DENR Forest Management Bureau, Philippines

Speaking on behalf of DENR Forest Management Bureau Director Ricardo Calderon, Ms. Quintos-Natividad thanked ELTI for initiating this symposium on monitoring and evaluation (M & E) of reforestation projects in the country. The significance of M & E in any project cannot be overemphasized as it serves as a beacon to guide implementers on the crucial next steps to take. This is true especially for a government priority program such as the NGP that seeks to not only rehabilitate the environment, but also to improve the lives of forest-dependent communities. She further stressed that M & E is being rigorously conducted for the NGP sites, all of which are geotagged and labeled with the location, size of the area, species planted and the intended beneficiaries. Field validation and evaluation are also being done periodically to determine if the project is meeting the targets, or if there is the need for a catch-up plan. In preparation for the completion of the NGP next year, the DENR is also planning to deploy several teams of evaluators to the sites planted with high-value crops to draw out information on growth performance, yield and the economic gains of the beneficiaries. With the extension of the NGP until 2028, Ms. Quintos-Natividad expressed hope that the lessons learned from the M & E of this first phase would prove useful in designing the future implementation of the program. She encouraged continued collaboration with the civil society organizations to strengthen the pool of expertise and experience to make the NGP a legitimately successful restoration program for all.

S. Elliott

PRESENTATION #3

Restoring Tropical Forests: Planning Strategies and Monitoring Results

Dr. Stephen Elliott

Forest Restoration Research Unit (FORRU) – Chiang Mai University, Thailand

Dr. Elliott outlined how to select appropriate forest restoration approaches that are suited to the prevailing levels of degradation, as well as the site and landscape thresholds. He then described different biophysical assessments used to monitor the progress of restoration projects in terms of biodiversity, biomass/carbon and structural complexity.

Key Messages

- According to the FORRU definition, forest restoration is a process of "*directing and accelerating ecological succession towards an indigenous forest ecosystem of the maximum biomass, structural complexity, biodiversity, and ecological functioning, which are self-sustainable within climactic and soil limitations.*"
- This definition points to four parameters that should be the focus of monitoring: biomass, structural complexity, biodiversity, and ecological function.
- To do proper monitoring, data must be collected from the target forest plots, restoration plots, and control site (non-treated natural regeneration) to determine how much the restoration interventions were able to accelerate forest succession towards the target forest condition, over and above that which would occur naturally, i.e., compared with the control plots.
- At the start of restoration projects, baseline data on tree height, root collar diameter and crown width should be collected to define the starting conditions. If the project involves tree planting, such data should be collected from the planted tree about 2 weeks after they go into the ground to allow time for them to acclimate.
- The most important monitoring time is at the end of the 2nd rainy season after planting. By that time, planted trees have either established well or died so you can keep track of survival or mortality. Monitoring can be done more frequently if needed, and if the resources are available.
- Photo monitoring is also important for documentation. A good time series of photos is often more convincing than tables of data.

- Monitoring for carbon requires much more work, relying on the use of relatively inaccurate allometric equations or expensive Light Detection And Ranging (LiDAR) technology.
- Monitoring the return of birds and mammals is the ultimate test of restoration success. It quantifies the extent to which animal species recognize restored forest as a suitable habitat. It can be done with both low technology methods, such as direct observation or finding tracks and signs etc., and high tech ones, such as camera traps, thermal imaging etc.

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PRESENTATION #4

Applied Nucleation and Forest Recovery in the Neotropics: a Decade-long Restoration Study

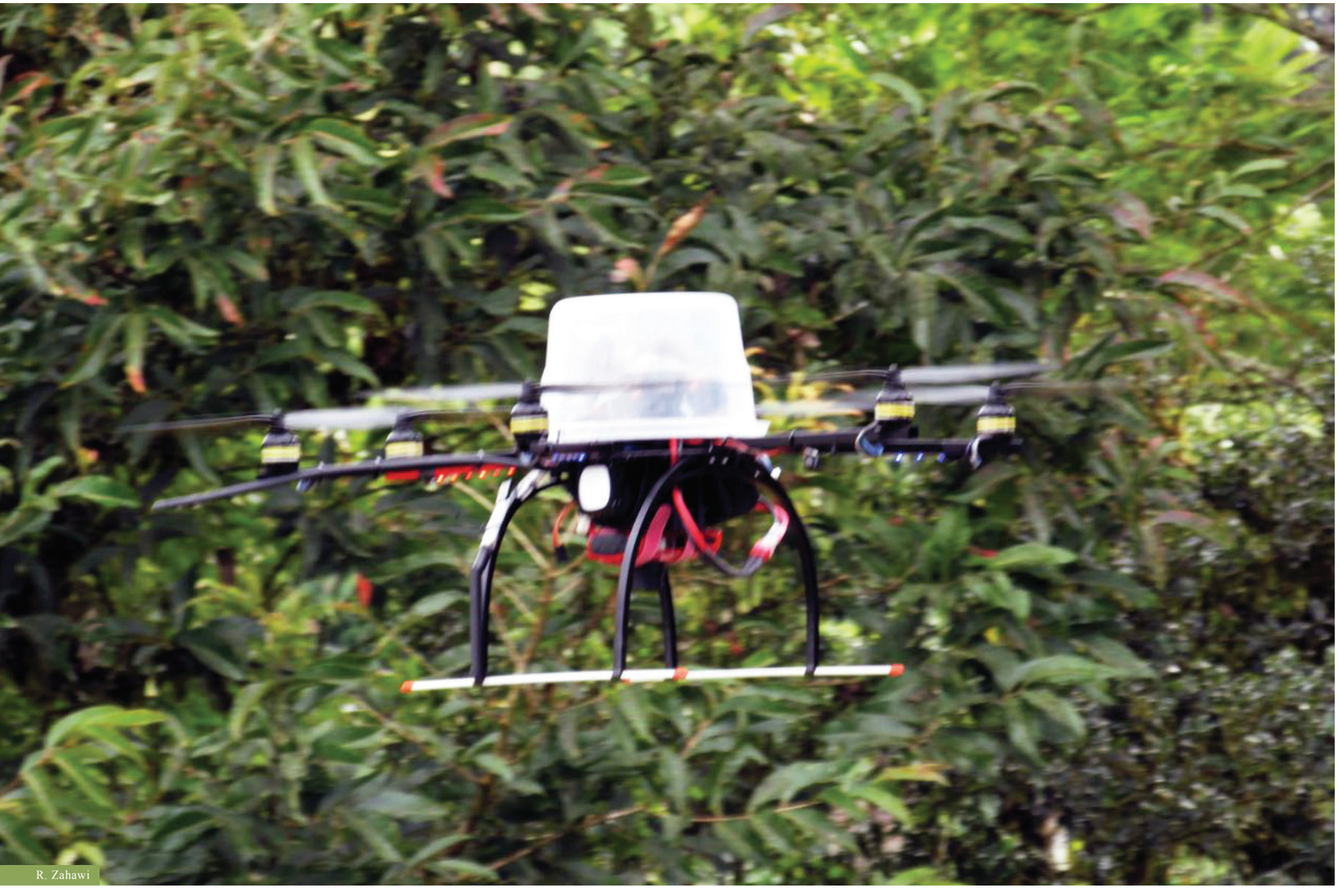
Dr. Rakan Zahawi

Organization
for Tropical Studies,
Costa Rica

Dr. Zahawi gave an introduction to a long-term research project on applied nucleation and drone-based monitoring that he and his colleagues have been conducting in Costa Rica.

Key Messages

- Applied nucleation is a reforestation method that consists of planting "islands" of vegetation rather than planting the entire area. It is intended to mimic the patchiness of natural regeneration and is cheaper than conventional planting.
- The forest islands expand over time to fill up the area between the islands and have similar levels of recovery to conventional patterns of planting.
- Large and medium sized islands are better, with 10m x 10 m being an ideal size, since they are more frequently visited by the birds as compared to the small islands.
- Both birds and bats play an important role in dispersing seeds, but birds are more attracted to areas with planted trees, whereas bats visited planted areas and areas regenerating naturally almost equally.
- Seed-dispersing birds have been found to visit restoration sites that are far away from intact forest at a higher rate than restoration areas near intact forest. This is likely because birds generally prefer to visit good quality forest but will go to forest restoration sites if there is nothing better around.
- It is important to note that there can be an order of magnitude differences between sites in terms of tree growth rates, making it important to adequately replicate the system.
- Measuring growth rates at 2 years is a good indicator of how successful your site will be.
- Unmanned aerial vehicles (or drones) using a 10 megapixel point-and-shoot digital camera and open-source software can



R. Zahawi

be used to monitor a variety of measures of forest recovery, with the data matching the quality of data from conventional field techniques, but at a lower cost.

- Drones can also be used to measure data like leaf flush, tree architecture, elevation islands, etc., which would be too costly to measure through field methods.
- Drones are cheaper and can be used more frequently than conventional field methods, but require training to operate and may entail unexpected costs (e.g., from crashes).

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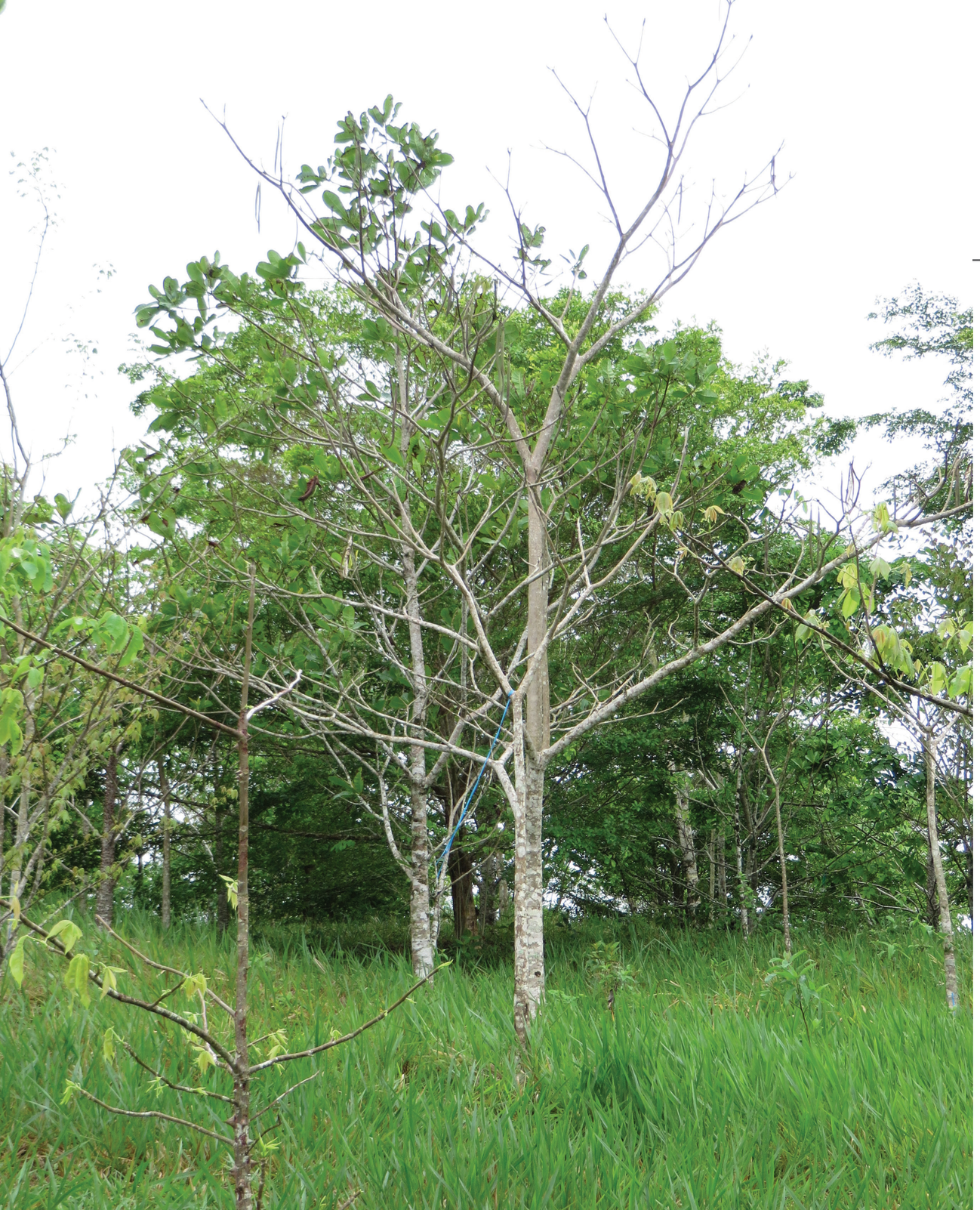

PRESENTATION #5

The Agua Salud Project: a Watershed-level Study on Reforestation and Ecosystem Services in the Panama Canal Watershed

Dr. Michiel van Breugel

Yale-National University of Singapore (NUS) College, Singapore

Dr. van Breugel gave an introduction to the Agua Salud project in Panama, which is a long-term research project set up to determine the environmental services provided by different land use types in the Panama Canal Watershed.

Key Messages

- Data from the Agua Salud Project lends support to the idea that forests act like a sponge, storing water during the wet season and releasing it during the dry season.
- Conversely, more water flows out from an agricultural field during the wet season, exacerbating high levels of runoff, and less during the dry season, doing little to mitigate water shortages.
- Forest regulation of water is particularly important at times of peak rainfall.
- One needs to be careful in extrapolating the results from the Agua Salud Project since the effects of topography and soils might vary per site.
- Species selection trials of more than 70 species for reforestation, grown in four areas marked by difference of rainfall and soil fertility, revealed that while some species performed better than others, there were significant variations in growth rate within sites and across sites.
- To accurately measure carbon stocks in forests in human-dominated landscapes, you need several experimental plots to account for the heterogeneity in forest age and structure.
- Lianas have a negative effect on tree growth, i.e., reducing lianas reduces competition, but there could be side effects on biodiversity that would need to be considered.

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Smithsonian Tropical Research Institute (STRI)

DENR

Presentation #6

The Philippine National Greening Program

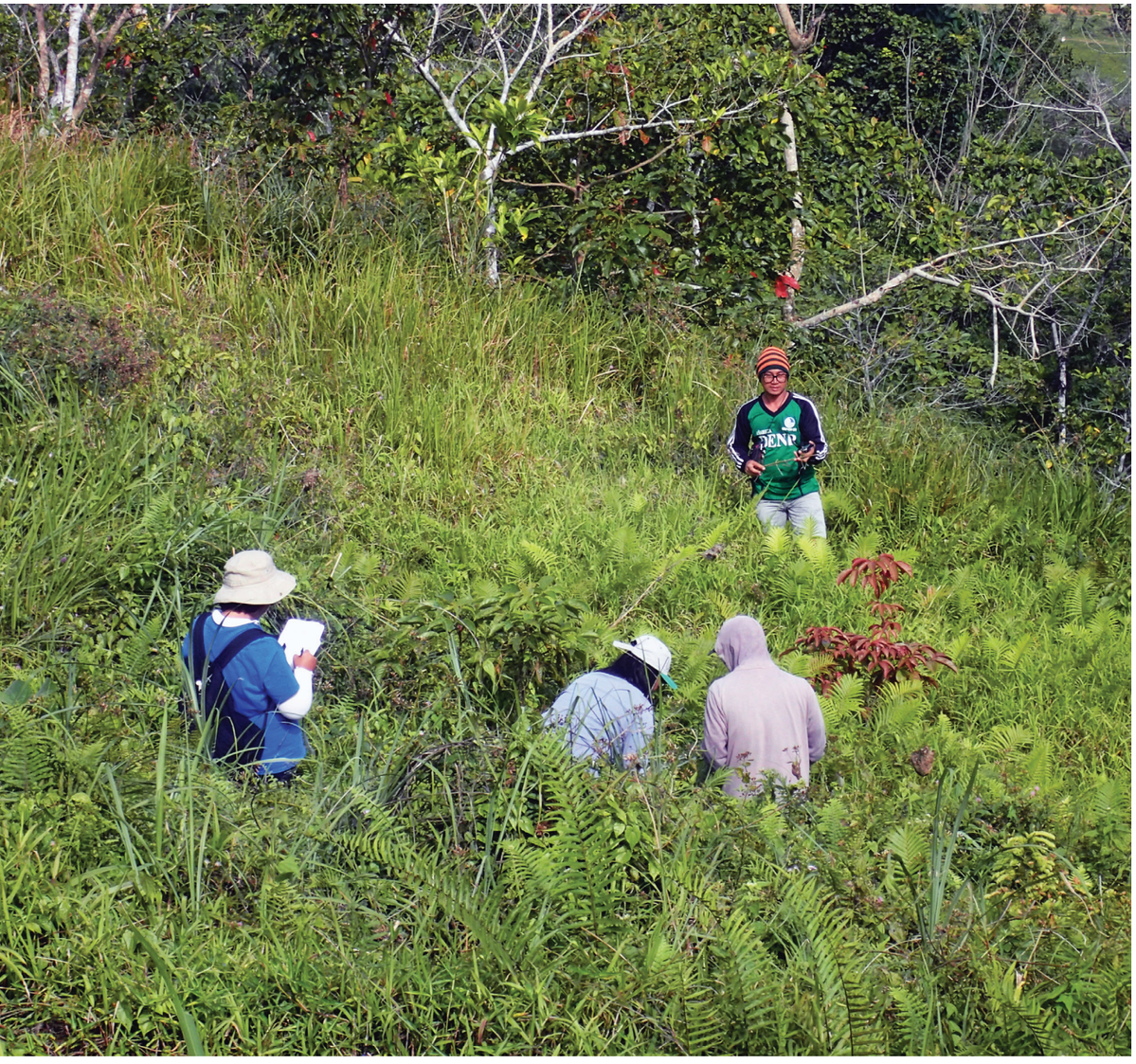
For. Ma. Teresa Aquino

DENR
Forest Management Bureau,
Philippines

Forester Aquino reviewed the objectives of the NGP and summarized the major accomplishments of the program through a brief presentation and a promotional video by the department.

Key Message

- Executive Order (EO) 26 established the National Greening Program to plant 1.5 billion trees over 1.5 million hectares of degraded land between 2011-2016.
- NGP is aimed not only at reforestation, but also at
- poverty reduction, food security, environmental stability, biodiversity conservation, and climate change mitigation and adaptation.
- This EO was also intended to offset the impacts of EO 23 – a logging moratorium in natural and residual forests promulgated in 2011 – that negatively affected the forest-dependent communities' way of life and livelihoods. NGP now provides an alternative source of income for these communities.
- The NGP used a "commodity roadmap", which is a list of the types (e.g., economically valuable trees such as timber, rubber, coffee, cacao, fuelwood) and numbers of trees to plant by region based on comparative advantage of regions and national annual commodity targets.
- Only native species were and are to be planted in protected areas, protection forests, and mangrove areas.
- The NGP is not a program of the DENR alone. The program adopted a 'Convergence Initiative' approach, which enjoins other government departments and agencies, as well as the private sector and the broader civil society. This approach enabled the DENR to leverage its limited financial, technical and human resources.
- NGP has features or strategies that have never been implemented before in any reforestation program in the country, namely, social mobilization, harmonization or convergence of initiatives, optimization of science and technology, and provisioning of incentives.



- NGP has incorporated good governance measures into its M & E system to ensure transparency and accountability. All NGP sites are geo-tagged, complete with geographic coordinates, a time stamp, list of species used, and list of documents pertaining to the contracts and transactions with the beneficiaries.

References

NGP Audio Visual Presentation: available at https://www.youtube.com/watch?v=M5EB4fMfxWM or http://ngp.denr.gov.ph/index.php/example-pages/videos

J. Herbohn

PRESENTATION #7

Assessing and Monitoring Reforestation Success: Making sure the Lessons from the Past are Learnt and Applied

Dr. John Herbohn

University of Sunshine Coast, Australia

Dr. Herbohn synthesized the results from research that he and his team have been conducting in the Philippines over the last 20 years. In particular, he discussed a comprehensive conceptual model that links environmental success indicators of reforestation projects with identified social, economic, technical and governance factors. He also shared recent research findings on the impact of Super typhoon 'Haiyan' (locally known as 'Yolanda') on one of their experimental planting sites in Leyte province.

Key Messages

- Proper tree establishment practices are important, but the activities done before and after planting (e.g., community engagement capacity building, and post-planting maintenance) are the ones that determine the success of the project.
- Livelihoods, including communities benefiting directly from the trees, are an essential element of reforestation projects and must go beyond just paying people to plant trees, which has been the predominant practice in conventional reforestation.
- Planting mixtures of species is dynamic, and there are a lot of uncertainties and technical gaps in knowing how best to combine different tree species.
- Preliminary data indicates that mixtures of tree species versus monocultures, for example, appear to provide better buffering effects from typhoons. Mixtures of at least four species suffered less damage than monocultures or mixtures with less than four species.
- A number of exotic species that are favored by the DENR, including *Swietenia macrophylla* and *Gmelina arborea*, did not perform well/survive under typhoon conditions. Other species varied considerably in their susceptibility and resilience to wind damage, although natives tended to have less damage, i.e., they lost their leaves rather than being uprooted or suffering major stem damage.

J. Herbohn

- Surface runoff, even under typhoon conditions, was much reduced after reforestation due to improved infiltration, added rainfall interception, and increased soil water storage capacity.
- Funding agencies need to invest appropriate amounts in pre- and post-planting activities. Equally important, rather than aiming for big reforestation targets, focusing on the quality and sustainability of the planted sites would prove to be a more profitable investment in the long run.
- The NGP is significantly better designed than past reforestation efforts, but there are still many problems that need to be addressed.

- Monitoring and assessment should be more than simply recording the size of the area planted and the number of seedlings surviving after 6 months. Done well, monitoring can provide significant input on how to refine existing programs and develop new ones.

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PRESENTATION #8

Pilot Testing Best Practices in Designing and Implementing a Community-based Forest Restoration Program

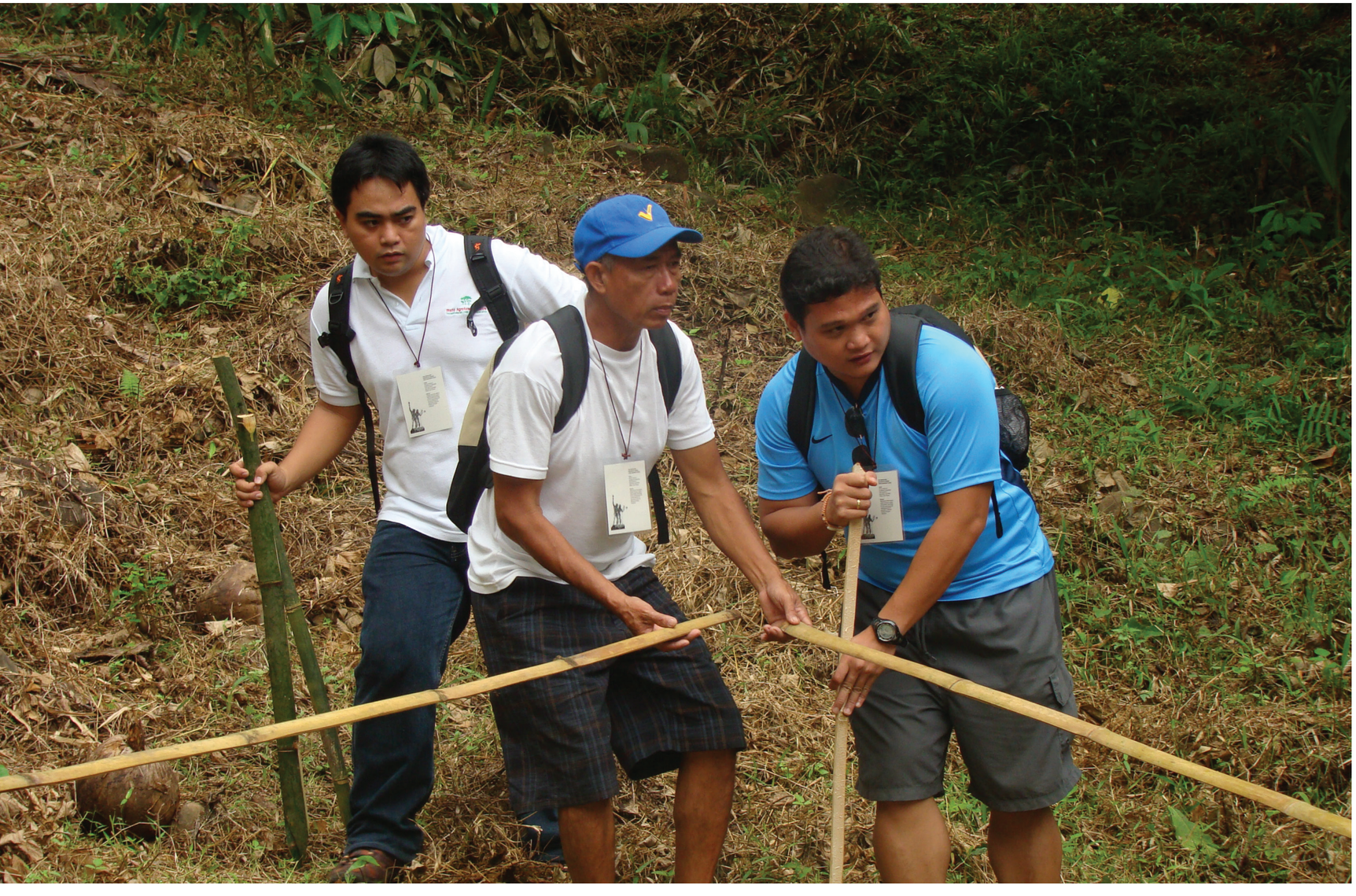
Dr. Nestor Gregorio

University of Sunshine Coast, Australia

Dr. Gregorio is a member of John Herbohn's research team and reported on a 26-hectare pilot reforestation project being conducted in the island province of Biliran in the central Philippines.

Key Messages

- Community-based forest management is applicable in a wide range of areas, but must be adjusted to match the social and ecological circumstances, and the political environment of the site.
- There must be adequate social preparation, both in terms of explaining the project benefits and in gaining the necessary commitments for local stakeholders.
- There must be a strong and honest leadership in the Peoples' Organization (PO) because community-based reforestation requires mobilizing a significant number of people – many of whom are resource-constrained and less educated – to work together on managing the tree plantation for several years.
- Corruption in the form of mishandling funds is one reason why POs often disband, so developing transparent methods for managing funds is essential.
- People understand the financial and ecological importance of trees, but they live from day to day and need to provide for their families. It is, therefore, imperative to deliver timely monetary and financial incentives, especially in the early phase of the project when they do not receive economic benefits from the plantations.
- There must be adequate institutional arrangements and a supportive governance setting to ensure that smallholders realize the benefits.
- The best practices applied to this site include: dividing the area into blocks according to land-use (i.e., production, protection and agro-foretsry zones), planting during the wet season, large planting holes, fertilizer application at optimum amount, prop-



er hauling and planting methods, weeding, establishment of fire lines, and regular patrolling.

- It is virtually impossible to get people to manage trees on land for which they do not have tenurial rights.
- Continuing support from extension workers is key to project success. Not only does the extension work provide useful input and timely feedback, but it also reminds the PO members that the project is considered important.
- Women play a vital role in community-based reforestation, especially in the early stages when income from the livelihoods component is not yet substantial; therefore, the men need to find work elsewhere in the mean time.

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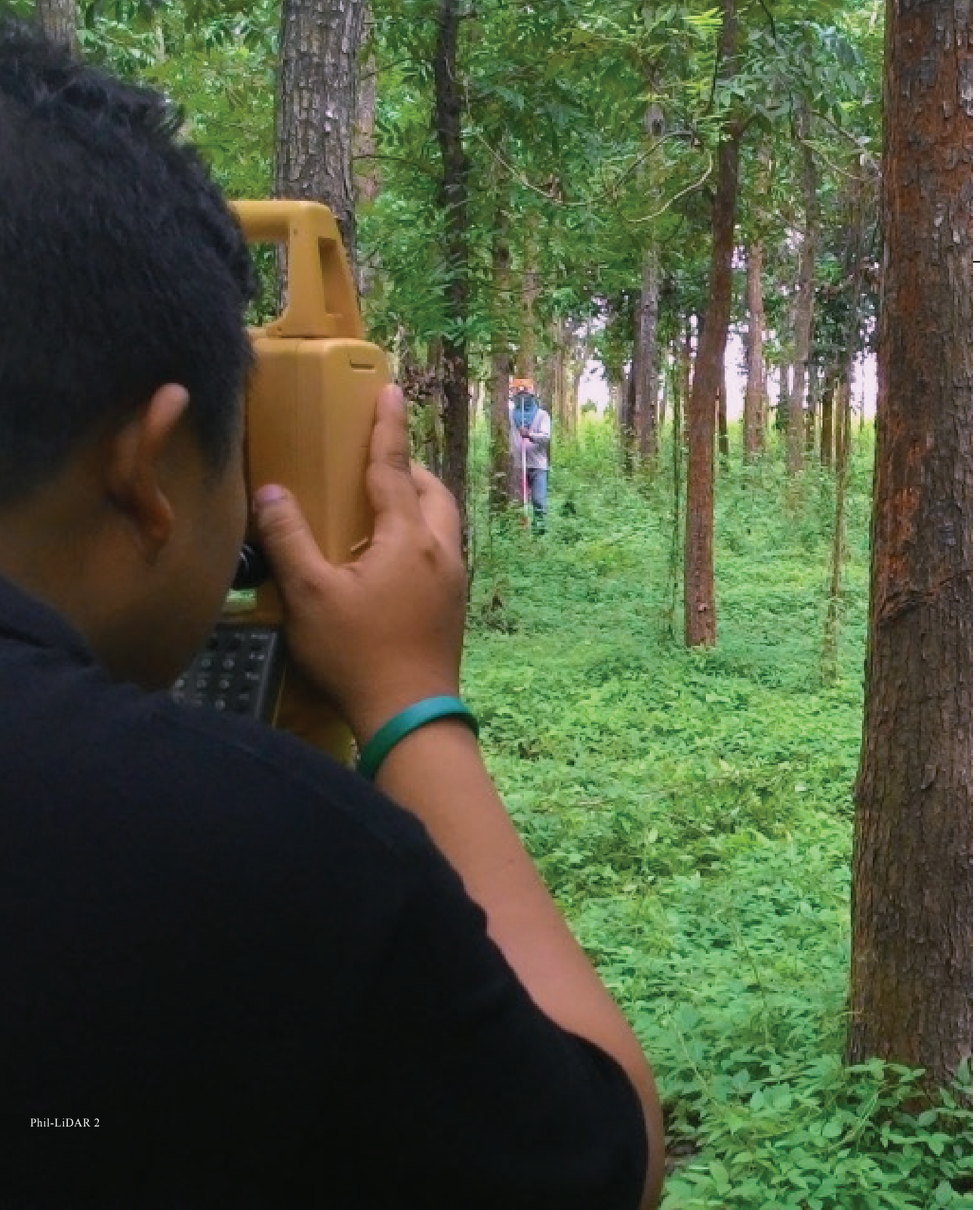

PRESENTATION #9

Phil-LiDAR 2: Forest Resource Assessment

Dr. Enrico Paringit

University of the Philippines-Diliman, Philippines

Dr. Paringit spoke of the work that his team is doing at the Philippine-LiDAR Program of the University of the Philippines-Diliman on generating high-resolution natural hazard maps to identify watershed areas most prone to flooding. The program started with 21 river basins in 2014, and has been extended to 257 more. His team is now working on developing methods to process LiDAR data to survey forests.

Key Messages

- With the flood mapping work completed, the LiDAR instruments and existing data can be repurposed for other needs, such as agricultural, coastal resources, forest resources, hydrologic datasets, and renewable energy resources.
- Within forestry, airborne LiDAR data could be used to give insights into forest architecture and structure, including the number of trees, canopy height, canopy cover, stand density, average diameter at breast height (DBH), biomass, and carbon stocks. LiDAR data can also be used to map the distribution of different forest types. The availability of information on these forest biophysical characteristics could potentially enhance forest conservation and management.
- One of the key challenges is coming up with data products that are most relevant for the forestry sector, so Dr. Paringit requested for input from the forestry experts.
- One other possible use for high resolution LiDAR data would be surveying and assessing the NGP sites.

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PRESENTATION #10

Technological Prospects for Monitoring Forest Restoration Success

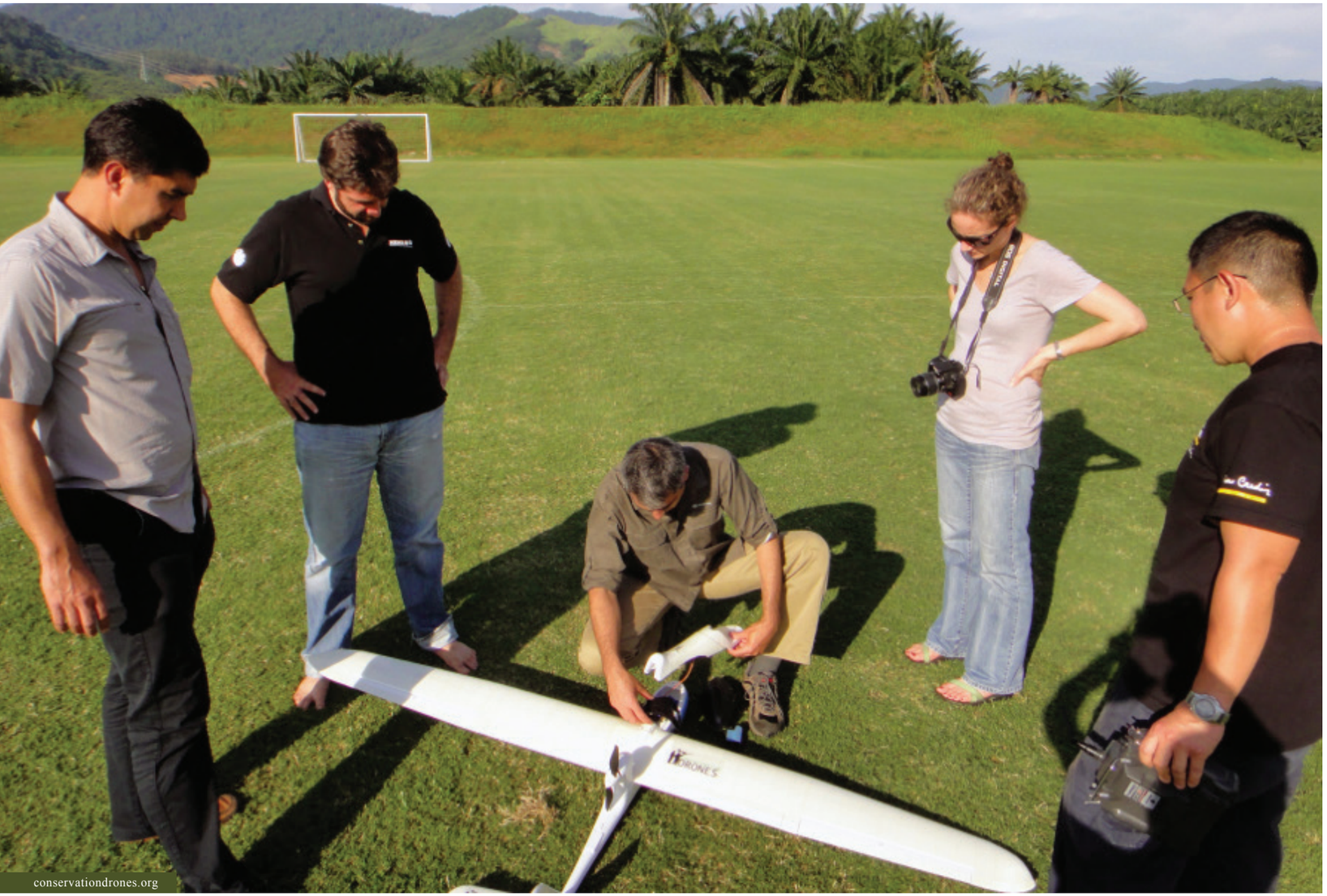
Dr. Ryan Chisholm

National University of Singapore, Singapore

Dr. Chisholm has been exploring the possibility of using new remote sensing technologies to address large-scale questions in theoretical ecology. These technologies have the potential to collect data on forest structure, biomass, productivity, and other ecological parameters more cheaply, efficiently, and effectively than field-based measurements. They can also be applied to monitor forest restoration sites.

Key Messages

- Ideally, automated forest restoration monitoring technologies would be aerial, or able to fly, to allow for data collection above and below the canopy, and be autonomous, i.e., without the need for a pilot. If this technology existed, we would be able to have drones fly off and collect a huge amount of data, which could later be sorted for answering whatever kinds of questions were of interest.
- A prototype of this sort was recently tested in Singapore. It gave good estimates of tree diameter in an urban tree stand, but did not work well in a primary forest area due to sloping ground, lianas, and other factors. GPS or some localization technology is needed to help stitch the pieces of data together.
- In order to use autonomous drones for forest restoration monitoring, we will need the following four things: 1. clarity on the goal of restoration, 2. measurable indicators that correlate with the desired ecosystem function, 3. sensors to measure the data, and 4. a drone or other type of platform.
- Restoration can be pursued for a number of reasons, including carbon, watershed rehabilitation, timber, recreation, biodiversity, or a combination of those reasons.
- Only some ecosystem functions can be directly measured. It is relatively straightforward to measure productivity and biomass, but harder to measure nutrient cycling or biodiversity, in which case, some sort of proxy would be needed.



- There is currently a range of sensors that could potentially be used, namely LiDAR, visual range cameras, multi-spectral cameras, chemical samplers, and others that will be developed over time.
- The main two types of drones are fixed wing, which consists of a rigid wing that has a predetermined airfoil, and rotary wing (also known as rotorcraft), which consists of two or more rotary blades that revolve around a fixed mast, known as a rotor. Fixed wing drones are more energy efficient and can cover a larger area, while rotorcrafts would be easier to navigate within the lower canopy. A major limitation to the rotorcraft, though, is the battery life.
- Ground-based platforms are also available, but are difficult to use due to the problem of mobility within a forested setting.
- The biggest challenges we face in being able to have drones independently fly to collect large amounts of data are intelligent navigation below canopy, species identification, and battery life.

References

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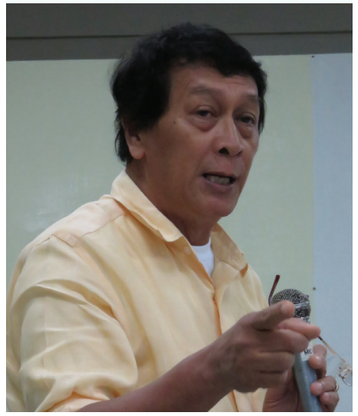
PRESENTATION #11

Closing Remarks

Dr. Edwino Fernando

University of the Philippines-Los Baños, Philippines



Dr. Fernando closed the session by relating the challenges that he sees in trying to rehabilitate mining areas in the Philippines. These are some of the most challenging environments to rehabilitate, but the effort is necessary since there are major on-site and off-site impacts. Because mining areas are low in nutrients and high in heavy metals, they often have a number of very rare, site-restricted species, therefore rehabilitation from a biodiversity standpoint is very important as well. The mining industry has already launched a number of sustainable development initiatives, including the International Council on Mining and Minerals, but little positive work is being done in the Philippines. Currently, many mine site initiatives use non-native grass and tree species. Looking around these sites, however, one notices that there are a number of native species that are growing very well, despite the harsh conditions. Some species are also useful in absorbing and accumulating heavy metals from heavily contaminated sites. Rather than purchasing the exotics from commercial nurseries, the mining sector should be more forward-looking by rescuing local vegetation and propagating it for replanting once the site can be rehabilitated. While this is not currently in the mining regulations, Dr. Fernando would like to see mining companies make a commitment to restoring the biodiversity of the area. Dr. Fernando ended with a quote from E.O. Wilson,“There can be no purpose more enspiriting than to begin the age of restoration, reweaving the wondrous diversity of life that still surrounds us.”

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