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Cover Photo : The Javan sunbird or scarlet sunbird (*Aethopyga mystacalis*) is a species of bird that endemic to moist lowland forest and moist montane forest of Java and Bali, Indonesia (©Robithotul Huda, 2019)
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GUEST EDITORIAL

Promoting interdisciplinary approaches to solving the complexity of environmental problems in Indonesia

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INTRODUCTION

As an ecologist, I believe we are now seeing the maturing of what we could call the Age of Ecology. An Age in which we finally develop that coherent and essential mainstream narrative for our future; one in which we tackle the interdependencies of nature loss, the climate emergency, and unsustainable production and consumption.

The challenge has always been to recognise that the world is our bank account, and we live sustainably only by using its interest, not digging into our capital. If we do withdraw more capital, we must then find ways of investing more, to increase our capital. You can hear this language finally gaining much more traction today as politicians, managers and the public use the phrases natural and social capital, as well as the financial and manufactured capital, and recognise our dependencies on the natural environment.

As such, I fully support the holistic, interdisciplinary sentiments and recommendations of Purwanto et al. (2020) in their introduction to the first issue of the Indonesian Journal of Applied Environmental Studies (InJAST). I have promoted interdisciplinary approaches to solving complex environmental problems throughout my career and worked with other academics and practitioners to support the realisation of the societal and economic impact of their research. We have increasingly recognised research impact institutionally and financially, but one main weakness persists and that is the availability of academic journals for publishing such interdisciplinary work. This journal can offer such a space for researchers and encourage the recognition and promotion of evidence to policy and practice communications. Most of all, this journal can foster the culture and confidence to ask the right questions to support the development of evidence-based decision making in policy and operational activities. I have spent a lot of time working with researchers who are doing excellent research but not asking the best questions to help improve management and utilisation of natural resources. Providing a forum in which students and early career researchers can confidently explore the rough answers to the right questions rather than the precise answers to the wrong questions, to paraphrase John Tukey (1915–2000), would be a wonderful role for InJAST.

I am delighted to be asked to share my environmental experiences and perspectives in this guest editorial for the second issue of InJAST, reflecting for me a long association with Indonesia and Indonesian environmental managers, conservationists and foresters. I have worked around the world, especially in the tropics, firstly as part of scientific expeditions and then leading increasingly complex research and development programmes and institutions. Since returning to the UK, I have been involved in enhancing the quality and impact of scientific and interdisciplinary research and supporting the application and institutionalisation of the ecosystem approach and ecosystem services assessments. Here, I will focus on three major tropical environmental management programmes, two in Indonesia and one in Guyana, South America.

These were complemented by subsequent involvement in the UK Government's environmental management system. All reflect the evolution of environmental management and the emergence of the ecosystem approach, now being institutionalised slowly but surely around the world.

ENVIRONMENTAL MANAGEMENT DEVELOPMENT IN INDONESIA

Following scientific and exploratory expeditions particularly to Indonesia and Malaysia, I was privileged in the 1990s to become part of the long-term Environmental Management Development in Indonesia (EMDI) programme, run jointly by the Indonesian Ministry of State for Environment (*Kementerian Lingkungan Hidup*/KLH) and Dalhousie University, Canada (CIDA-funded). EMDI provided comprehensive cross-disciplinary and interdisciplinary frameworks to advance environmental management capabilities through institutional strengthening and human resource development at many scales, from village level through to central government, especially with the Environmental Impact Management Agency

(*Badan Pengendalian Dampak Lingkungan*/BAPEDAL). This remarkably advanced and innovative programme involved the Indonesian Ministry and government agencies, NGOs, industrial and consulting firms, and several universities across the archipelago in co-producing a coherent range of really pioneering approaches to national environmental management:

1. Spatial planning and regional environmental management, especially applying, for the time, pioneering GIS-based resource evaluation systems.
2. Environmental impact assessment (EIA) guidance and application and, well ahead of its time globally, integrating social impact assessment into the comprehensive EIA system.
3. Establishment of pollution-related environmental quality standards, especially, and today very topical globally, air quality emissions standards.
4. Hazardous substance regulations, management and training.
5. Marine and coastal environmental management, producing guidelines for the sustainable development and conservation of sensitive coastal ecosystems such as coral reefs, sea grass beds, and mangroves, with an exemplar marine park management plan for the Taka Bone Rate atoll by KLH and the Forest Protection and Nature Conservation (*Perlindungan Hutan dan Pelestarian Alam*/PHPA) of the Ministry of Forestry. The pioneering assessment of the multiple benefits derived from mangroves (Ruitenbeek 1992) continues to be cited today, e.g., Rumahorbo et al. (2020).
6. Environmental management support systems, strengthening the Government environmental statistics programme, regional balance sheets and state of environment reporting, as well as a foundational library in KLH.
7. Enhanced environmental law capabilities, improving compliance with environmental regulations standards and requirements.
8. Macro-policy support for policy formulation and analysis to serve integrated and long-term planning needs, especially in being able to respond to priority and emerging issues. It included development of a national strategy for terrestrial biodiversity and work on natural resources and environmental accounting. The latter was designed to estimate stock and depletion of natural resources and develop polices to evaluate the management of the environment.
9. Training and publications programmes. Along with the development of a Ministry-based library, graduate fellowships were offered in environmental management to government civil servants, NGOs and university academics, and a series of books were produced and published.

The publication programme proved to be an exceptional aspect and one rarely emulated by even the most comprehensive of later support programmes. Based on the original *Ecology of Sumatra* (Whitten et al. 1984) and *Ecology of Sulawesi* (Whitten et al., 1987) lead-authored by the inspirational Tony Whitten (1953-2017), EMDI established the bilingual *Ecology of Indonesia* book series with four new volumes on the ecology of *Java and Bali* (Whitten et al., 1996), *Kalimantan* (MacKinnon et al., 1997), the *Indonesian Seas* (Tomascik et al., 1997a, b), and *Nusa Tenggara and Maluku* (Monk et al., 1997). *The Ecology of Papua* (Marshall and Beehler, 2007a, b) was funded later by BP and the Gordon and Betty Moore Foundation. In addition to normal academic literature sources, the EMDI authors and their teams made substantial efforts to retrieve the extensive grey literature relating to the regions from local government and universities, consultancies, and colonial archives. Copies of all literature cited were lodged with the relevant local universities' Centres for Environmental Studies, and the books themselves distributed throughout the appropriate regions. The comprehensiveness of the data gathered and analysed to form the evidence base for future conservation and development can be illustrated by a summary of the volume for which I was lead author, *The Ecology of Nusa Tenggara and Maluku*. We presented baseline data as of the 1990s on this complex region's geology, climate, soils, biodiversity, ecosystems, people, and marine and land use, and discussed these in a historical as well as a developmental context. We compared traditional laws and customs around natural resource management with emerging national environmental laws and provided guidelines for researchers on beneficial ecological and socio-economic research projects. Many of these projects are still needed, their results providing vital guidance to the future development of one of the most vulnerable areas of Indonesia. As I wrote at the time *"The complexity and vulnerability of these islands mean that development and environment are inextricably linked. If this is not understood and acted upon, there is no possibility for the ecologically sustainable development of Nusa Tenggara and Maluku."* Whilst *The Ecology of Indonesia* series is now out of print, the English language versions are available on Kindle and they remain a significant baseline source of information for Government, NGOs, developers, researchers and students on the ecosystems, natural resources, and human activity and development across Indonesia.

I have described the EMDI programme in considerable detail because it illustrates what I see as essential for the sustainable management of natural resources of any country, that holistic, cross-departmental recognition and assessment of

complex challenges not solved by purely technological or regulatory approaches but by integrating historical, present and future socio-economic elements.

LEUSER ECOSYSTEM

My second example from my experiences in this emerging approach to the sustainable management of natural resources focusses on the Leuser Ecosystem on the island of Sumatra. Located across North Sumatra and Aceh provinces, Leuser is still one of the richest expanses of tropical rain forest between India and the Philippines. It stretches from the peaks of Mt Leuser at 3,400m asl into the wooded interior and down to the lowland plains and beaches of the Indian Ocean, and includes nine rivers, three lakes, and over 185,000 hectares of carbon-rich peatlands. It was and still is a crucial source of clean drinking water and agricultural livelihoods for two to four million people. It covers more than two million hectares, encompassing the designated Gunung Leuser National Park (a UNESCO Man and Biosphere Reserve since 1981 and on the list of World Heritage in Danger since 2011), adjacent logging concessions, plantations, and protection forests. The Leuser Ecosystem was legally recognised in 1995 through a Ministry of Forestry Decree (No.227/KPTS-II/1995), and then by a Presidential Decree in 1998 (No.33/1998). Through the Regulation of Aceh's Governor in 2006 (No. 11/2006), the management of the Leuser Ecosystem in the Aceh region was, and still is, mandated by the Central Government of Indonesia to the Provincial Government of Aceh, with implementation on the ground being carried out by the Leuser Ecosystem Management Agency (*Badan Pengelola Kawasan Ekosistem Leuser*/BPKEL). Then, in 2008 the Government Regulation No. 26/2008 on the National Spatial Plan established the Ecosystem Leuser as a National Strategic Area, which is an area of national interest for the benefits of economic development and the environment.

During the 1980s and early 1990s, 6.7 million hectares, or 29%, of Sumatra's forest cover disappeared, and the largest tract of undisturbed forest was around the Gunung Leuser National Park. In the mid-1990s, the Leuser Development Programme (LDP) started as a cooperative venture between the European Union and the Government of Indonesia. This Integrated Conservation and Development Programme was a ground-breaking experiment to support one of the newest and largest conservation areas in Indonesia under an undeveloped and novel managerial system – giving a conservation concession to an NGO, the Leuser International Foundation. The LDP was co-produced and executed in partnership with many government agencies and NGOs, the latter being involved especially in monitoring activities, research, microproject implementation, training programmes, and local community engagement. It was one of the first moves towards a landscape-planning and adaptive management approach to conservation planning (Wells et al., 1999) and championed wider application of spatial planning with the regional and local governments to avoid social and environmental problems, such as locating new builds on seasonally flooded land. The LDP has since been extensively analysed and reviewed, contributing lessons to the continuing sustainable management and utilisation approaches in the area and elsewhere (e.g., Monk and Purba, 1999; Monk, 2001; Kelman, 2013).

My role in the LDP was to co-lead the setting up and management of the research, monitoring, and information programme in partnership with Dr Zainal Abidin Pian from Syiah Kuala University in Banda Aceh. We highlighted research priorities, supported both pure and applied research of relevance to the management and conservation of the Leuser Ecosystem, and built up an extensive open-access environmental management library in Medan. Studies were undertaken by Indonesian researchers and students from several universities as well as by international researchers and consultants. Probably one of the most significant outputs was that of van Beukering et al. (2003, 2009), who provided the first total economic value (TEV) of the ecosystem services and benefits of any rain forest area, evaluating the economic consequences of deforestation versus conservation scenarios for the Leuser Ecosystem. Most innovatively and influentially, they explored the trade-off between short-term gains for some stakeholders versus larger long-term losses for others. It became an exemplar of innovative valuation of multiple benefits from natural resources as recognised by multiple stakeholders, from local communities to the global community (TEEB, 2009; Förster and Berghöfer, 2010; Brander and Eppin, 2015).

IWOKRAMA

The phrase 'one planet living' is being rapidly adopted around the world in the face of Covid-19 impacts. It was, however, the Brundtland Report (Brundtland, 1987) that introduced this phrase, articulating the increasing concerns of the times around unsustainable living, food security, and the 'greenhouse effect'. The Brundtland Report set the scene for the 1992 United Nations Conference on Environment and Development, also known as the Rio or Earth Summit, focussing a generation on sustainable living. By 1992, with more than half the world's tropical forests already converted to non-forest uses, a more equitable, sustainable approach particularly to rain forest management was urgently required. This approach was articulated through the United Nations (UN) Convention on Biological Diversity (CBD), opened at Rio and coming into force in 1993. The CBD was the first legal tool dedicated to promoting sustainable development by recognising that biological diversity is

about more than plants, animals and microorganisms and their ecosystems. It was also about our dependency on the natural world for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live.

The CBD introduced the ecosystem approach and its related idea of ecosystem services assessments, which increasingly became the basis for natural resource management and a critically important tool to deliver sustainable development. What is rarely recognised, however, is that two years after the Brundtland Report appeared and two years before the Rio Summit and the CBD focussed the world, the then President of Guyana, Desmond Hoyte, had pledged one million acres (370,000 hectares) of rain forest to the international community as *"Guyana's gift to the world and a donation to the lungs of mankind"*, at the 1989 Commonwealth Heads of Government Meeting. It was to be used as an experimental centre to demonstrate whether or not rain forests could be conserved and sustainably used whilst making a significant contribution to both local and national economic development.

From its launch in 1996, the Iwokrama International Centre for Rain Forest Conservation and Development began to build up programmes of pluralistic partnerships at the local, national, regional and international levels. Local people were directly involved in all aspects, including compiling biodiversity inventories, planning management strategies, and training rangers. An exceptionally strong and focussed programme developed and supported representation systems for indigenous and local communities with clear connections and reliance on the area's natural resources. The UN provided initial funding, and by 2000 the Centre had become a multi-donor international programme. Iwokrama's donors were also then hoping that the Centre itself might become financially independent, using profits from experimental ecologically and economically sustainable eco-tourism, training programmes, and sale of timber and other forest products, in addition to contributing significantly to both local and national economic development. After I joined the Centre in mid-2001 as their Director General to start that business-focussed transition, a detailed economic analysis of this forest resource again clearly demonstrated that sustainable utilisation would generate twice the economic value of unsustainable utilisation (van Beukering and van Heeren, 2002; van Beukering, 2003). Once again, local communities would be the ones to benefit most from this process of sustainable utilisation through diverse activities such as fisheries, agriculture, tourism, non-timber forest products, and timber, with more global benefits and services such as biodiversity and carbon sequestration also benefiting regional and international communities. This emphasized the challenge of developing a vision for such large-scale management of natural resources that could be owned by all levels of stakeholders through an effective coordination and management body. The Centre continues to deliver clear field-based demonstrations of effectiveness of sustainable forest management and utilisation for both biodiversity and stakeholders and is widely recognised as an exemplar for co-management as the key workable option for successful natural resource management.

GLOBAL PROGRAMMES AND LEGISLATION CHANGES t

Let's step back from these specific field examples and consider in more detail what was happening globally to embed sustainable development into society and politics. The start of the 21st century saw the international community pay increasing attention to sustainable development and the sustainable management of natural resources through the application of the ecosystem approach and ecosystem services assessments. Political calls for actions to achieve sustainable development have been reinforced by increasing applied interdisciplinary assessments and development of tools. The functional links between biodiversity, health and human well-being were recognised through the eight UN Millennium Development Goals (MDGs) with targets for 2000–2015 to: eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality; improve maternal health; combat HIV/AIDS, malaria, and other diseases; ensure environmental sustainability; and develop a global partnership for development. The associated 2001–2005 Millennium Ecosystem Assessment (MA) addressed the consequences of global changes of human well-being in ecosystems and provided a scientific basis for improving conservation and sustainable use of living resources through the first global survey of ecological services (MA, 2005). The global MA inspired the world's first national assessment: UK's National Ecosystem Assessment or NEA (UK National Ecosystem Assessment 2011, 2014). Other national assessments of various forms and shapes have followed, e.g., Schröter et al. (2016). Following the MA, several global initiatives emerged to develop scientifically based frameworks for the application of ecosystem services assessment into political and institutional decision making:

1. 2007: The Economics of Ecosystems and Biodiversity (TEEB) global initiative focusses on *"making nature's values visible"* and mainstreaming the values of biodiversity and ecosystem services into decision making at all levels.
2. 2010: The World Bank-led global partnership Wealth Accounting and the Valuation of Ecosystem Services (WAVES) aimed to ensure that natural

resources were mainstreamed in development planning and national economic accounts. Indonesia joined WAVES as one of its core implementing countries in late 2013. WAVES is now part of the broader World Bank umbrella initiative, the Global Program for Sustainability (GPS).

3. 2012: The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) aims to improve the interface between science and policy on issues of biodiversity and ecosystem services.

As the MDG era ended in 2015, the UN launched the 2030 Agenda for Sustainable Development to be delivered through 17 Sustainable Development Goals (SDGs) over the next 15 years. The SDGs crystallise the global understanding that humans are intimately connected and dependent on our natural environment. Actions to end poverty and other deprivations are intimately connected with strategies that improve health and education, reduce inequality, spur economic growth, and tackle the climate emergency and biodiversity loss. Warnings continue to emerge especially from IPBES, e.g., their regional biodiversity assessments and the state of land degradation report (IPBES, 2018) demonstrated that damaged environments threaten the well-being of 3.2 billion people. Their first Global Biodiversity Assessment (IPBES, 2019a, b) provided the most comprehensive global official base of evidence for policy makers ever seen, reviewing approximately 15,000 scientific and government sources, alongside indigenous and local knowledge sources from around the world. The report's conclusions reconfirm the links between biodiversity loss and impacts to human societies in various areas critical for human survival.

WELSH LEGISLATION

A necessary family commitment had led to my return to the UK when much of this exciting global progress was being made. Working in the UK Government's environmental protection agency meant I was part of some of this, especially the UK's NEA. When I moved to Wales its devolved administration was preparing to become the first country in the world to embed sustainable development and the UN's SDGs into law, in the Well-being of Future Generations (Wales) Act 2015 (WBFG). This Act formed the keystone of a highly innovative framework of legislation that aimed to deliver sustainable development through integrated land, water, and air management underpinned by an ecosystem services approach: the Planning (Wales) Act 2015; and the Environment (Wales) Act 2016.

The WBFG strengthened existing governance arrangements for improving the well-being of Wales to ensure that present needs are met without compromising the ability of future generations to meet their own needs – embracing one planet living. It set ambitious and long-term goals for a prosperous, resilient, healthier, more equal Wales, of vibrant culture with cohesive communities, and which is globally responsible in its actions. Shared outcomes for Wales were articulated through seven Well-being Goals, to which the public services bodies listed within the Act should maximise their contribution when delivering their functions and activities. These Well-being Goals map clearly back to the international SDGs. The WBFG utilises these principles of sustainable development to define five ways of working that set out how decisions must be taken and actions delivered: considering the long term, being preventative, involving people, taking integrated decisions, and delivering collaboratively. Applying these five ways of working breaks down policy and operational silos and ensures an outcome focus to public service delivery that improves the well-being of Wales, socially, environmentally, economically and culturally.

Environmental management in Wales under this legislation has not surprisingly also taken an innovative route. It is undertaken by Natural Resources Wales (NRW), with whom I work. It is the largest Welsh Government Sponsored Body – employing 1,900 staff across Wales with an annual budget of UK £180 million – with the remit to deliver and coordinate the sustainable management and utilisation of the natural resources of Wales through the application of the ecosystem approach. It therefore quite logically but innovatively brings together the traditional environmental protection and regulation government agency with those for conservation and forestry. In Indonesia, this might be like amalgamating BAPEDAL with the field arms of several of the Ministry of Environment and Forestry Directorates General, e.g., Directorate General of Nature Resources and Ecosystem Conservation (*Direktorat Jenderal Konservasi Sumber Daya Alam dan Ekosistem*/KSDAE).

NRW is the first government organisation to operationalise an ecosystems approach formally. To do so has immense challenges for governments and communities that must embrace uncertainty, adaptive management, and co-production. Policy, practice and law in the field of nature and landscape are increasingly moving from a traditional regulatory approach of conservation and mitigation towards this dynamic, 'beyond-regulation' ecosystem approach, and draw on understanding and considering complex systems and making effective linkages between nature, place and society. The implications of this change are still to be recognised and tackled from institutional, theoretical and methodological perspectives. Understanding the ecological terms and applications of terms such as resilience, natural capital and ecosystem services, and the institutional and disciplinary challenges of adopting

landscape-scale approaches and nature-based solutions continue (Cowling et al., 2008; Kirsop-Taylor and Hejnowicz, 2020; Kirsop-Taylor et al., 2020).

INDONESIAN JOURNAL OF APPLIED ENVIRONMENTAL STUDIES

Today, the complexity of our global, national and local challenges demands solutions from an ever-increasing juxtaposition of technological, scientific, social, political and economic disciplines. InJAST provides the expanding community of nationally produced environmental managers and researchers with a new platform on which to share the range of subjects and insights that can guide and drive the sustainable management and utilisation of Indonesia. Universities and academics have never before worked in such critical times as producers and promoters of knowledge, skills, and innovation, to raise awareness and understanding, develop or revisit frameworks, and offer solutions, be they short-term fixes or, more importantly, those long-term transformations.

We know that reconciling conservation and development has been notoriously difficult for several decades, and the pursuit of this has led at times to extremely polarised positions and contentious debate. But we do now have global and local frameworks, and the tools, to enable us to focus on trade-offs and synergies between conservation, utilisation, and development, capacity building, and co-production. This calls for considerable breadth of appreciation, understanding and interdisciplinarity. We can do this.

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NEWS, NOTES & EVENTS

The Online Journal System now live for submission and peer-review

Dolly Priatna and **Kathryn A. Monk** (**Eds.**)

Producing the first issue of a new scientific journal is an exciting and stressful time for any editorial board. Producing the second issue is more quietly satisfying with different concerns. Everyone was supportive and interested in the launch, but will they now follow up with challenging papers and relevant information to share, and will colleagues use and share this journal? A significant step forwards in the production of The Indonesian Journal of Applied Environmental Studies (InJAST), is that the Online Journal System is now live. This has meant that, whereas all work for the first issue was undertaken through email communication, for this second issue, all manuscript submissions and their peer-review processes have been managed successfully online.

A major and much appreciated demonstration of support for InJAST is the MoU that has now been signed between the Graduate School of Environment Management in Pakuan University and PERWAKU (Perhimpunan Cendikiawan Lingkungan Indonesia; the Indonesian Association of Environmental Scholars), one of their key collaborations being to publish collaboratively InJAST. The MoU was signed auspiciously on 5 June 2020, the 16th anniversary of PERWAKU and the 46th anniversary of World Environment Day.

World Environment Day 2020 sought to *"engage governments, businesses, celebrities and citizens to focus their efforts on a pressing environmental issue… the theme is biodiversity – a concern that is both urgent and existential. Recent events, from bushfires in Brazil, the United States, and Australia to locust infestations across East Africa – and now, a global disease pandemic – demonstrate the interdependence of humans and the webs of life, in which they exist."*

Also to mark World Environment Day, Pakuan University and PERWAKU, together with Andalas University, held a webinar focussed on the Protection and Management of The Environment of the Covid-19 Era. This global pandemic has of course affected everyone from all walks of life, and the webinar explored the dangers of over use and destruction of the natural world, the benefits all humans derive from nature for our survival, and the demands for good focussed environmental management. Although incredibly tragic, the pandemic has perhaps focussed governments, businesses and communities alike on our relationship with nature.

All such concerns lie within the globally recognised nexus of the nature crisis, the climate emergency, and unsustainable production and consumption. Environmental managers must understand and bring into account a wide array of subjects and approaches, not just science and technology but also social sciences, behavioural insights, economics, policy and regulation, and the arts and humanities, when tackling such problems. In Indonesia, and elsewhere, these challenges include deforestation, habitat loss and air pollution from forest fires, and water and air pollution from industrial and urban development. The second issue of InJAST illustrates this breadth of interest, concern, and focussed research, comprising papers on environmental policy, the UN Sustainable Development Goals, natural resources management, biodiversity of restored habitats, and progression in methodological approaches.

As Editors-in-Chief, we are very pleased to see this second issue appear and encourage our colleagues from all sectors to submit their papers covering primary research, reviews, and research into policy and practice.

InJAST's website and online submission portal is:
https://journal.unpak.ac.id/index.php/InJAST/index

Submissions can also be directed to the Chief Editors at: **injast@unpak.ac.id**

Comments on InJAST's website, reporting portal issues and other issues, should be addressed to the Editorial Manager at: **editor_injast@unpak.ac.id**

NOTES

Environmental Education in Indonesia: Creating Responsible Citizens in the Global South?

Indonesia's wealth of natural resources is being exploited at breakneck speed, and environmental awareness and knowledge among the populace is limited. This book examines how young people learn about the environment to see how education can help to develop environmental awareness and avert vast environmental destruction, not only in Indonesia, but also in the Global South more generally. Based on in-depth studies conducted in the cities of Yogyakarta and Surabaya, complemented with surveys of students in secondary schools, *Environmental Education in Indonesia* examines educational curricula, pedagogy and "green" activities to reveal what is currently being done in schools to educate children about the environment. The book investigates the shortcomings in environment education, including underqualified teachers, the civil service mentality, the still-pervasive chalk-and-talk pedagogy and the effect of the examination system. It also analyses the role of local government in supporting (or not) environmental education, and the contribution of environmental NGOs. The book establishes that young people are not currently being exposed to effective environmental education, and the authors propose that the best and most culturally appropriate way forward in Indonesia is to frame pro-environment behaviour and responsibility as a form of citizenship, and specifically that environmental education should be taught as a separate subject. This book will be of great interest to students and scholars of contemporary Indonesia and Southeast Asia, education for sustainability and environmental education, as well as sustainability and sustainable development more generally.

Parker & Prabawa-Sear (2020). *Environmental Education in Indonesia: Creating Responsible Citizens in the Global South?*. Routledge, New York, USA.

Natural products for surface water coagulation: An alternative sustainable solution for rural areas

This research aims at process optimization using response surface methodology (RSM) for coagulation of surface water by coagulants extracted from natural product. Apricot seeds extract (ASE), peach seeds extract (PSE) and mango seeds extract (MSE) were evaluated. The optimum operating conditions for ASE and PSE at initial turbidity of 27.5 NTU were pH 7 and coagulant dose of 45 mg/l. However, the optimum operating conditions for MSE at initial turbidity of 27.5 NTU were pH 5.5 and MSE dose of 45 mg/l. Under the optimum conditions, residual turbidity without filtration was 9.13, 10.3, 5.81 NTU for ASE, PSE and MSE, respectively. MSE could be used as secondary coagulant with the alum. At low turbidity surface water treatment, ratios of 20/80, 40/60 and 60/40 MSE/alum achieved residual turbidity of less than 1 NTU which comply with the Egyptian Standards. However, at medium turbidity surface water, ratio of 20/80 MSE/alum achieved residual turbidity of less than 1 NTU.

Elmolla et al. (2020). Natural products for surface aater coagulation: An alternative sustainable solution for rural areas. *International Journal of Environmental Research* **14**:489-499.

Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy

The practice of social distancing and wearing masks has been popular worldwide in combating the contraction of COVID-19. Undeniably, although such practices help control the COVID-19 pandemic to a greater extent, the complete control of virus-laden droplet and aerosol transmission by such practices is poorly understood. This review paper intends to outline the literature concerning the transmission of virus-laden droplets and aerosols in different environmental settings and demonstrates the behavior of droplets and aerosols resulted from a cough-jet of an infected person in various confined spaces. The case studies that have come out in different countries have, with prima facie evidence, manifested that the airborne transmission plays a profound role in contracting susceptible hosts. The infection propensities in confined spaces (airplane, passenger car, and healthcare center) by the transmission of droplets and aerosols under varying ventilation conditions were discussed. Interestingly, the nosocomial transmission by airborne SARS-CoV-2 virus-laden aerosols in healthcare facilities may be plausible. Hence, clearly defined, science-based administrative, clinical, and physical measures are of paramount importance to eradicate the COVID-19 pandemic from the world.

Jayaweera et. al. (2020). Transmission of COVID-19 virus by droplets and aerosols: A critical review on the unresolved dichotomy. *Environmental Research* **188**:1-18.

Decline in $PM_{2.5}$ concentrations over major cities around the world associated with COVID-19

The COVID-19 started from Wuhan city in China, slowly spread across the globe after December 2019. Due to movement of people from one city to other cities, one country to other countries, infection spreads and COVID-19 became a pandemic. Efforts were made at local, regional and national levels to lockdown

the movement of people and to keep infected one in quarantine or isolation to stop the spread of COVID-19. The traffic, market and small industries were closed, as a result pronounced decline in the concentrations of particulate matters (PM) were observed. Normally these sources contribute to the high concentrations of particulate matters ($PM_{2.5}$) which represents air quality of a location. In this short communication, we present analysis of $PM_{2.5}$ of major cities (New York, Los Angeles, Zaragoza, Rome, Dubai, Delhi, Mumbai, Beijing and Shanghai) around the world suffered severely with the COVID-19. Our analysis shows decline in $PM_{2.5}$ concentration due to lockdown, mainly due to less movement of people to keep "social distancing" to control the spread of CORONA-19. The low concentrations of $PM_{2.5}$ reflect the efforts made in the cities to curb the spread of infection, that improve air quality.

Chauhan & Singh (2020). Decline in PM2.5 concentrations over major cities around the world associated with COVID-19. *Environmental Research* **187**:1-4.

Climate change research in Asia: A knowledge synthesis of Asia-Pacific Network for Global Change Research (2013–2018)

Countering climate challenges requires genuine multi-layered approaches in cooperation with various stakeholders. Spanning 20 years, the Asia-Pacific Network for Global Change Research (APN) has been facilitating the research community to provide regional and grassroots results and solutions, while acting as a mechanism to encourage science-policy-stakeholder dialogue. This paper outlines the relevance of APN projects to IPCC policymaking by laying out knowledge products and lessons learned from the projects. It also narrates how regional research and capacity building assist in responding to the increasing urgency across climate change and the SDGs. A synthesis of project-generated knowledge was garnered from research and capacity development studies conducted under the auspices of APN to identify their scope and level of policy relevance. A combined typology and solution scanning with Likert scale as relevance rating was employed to categorize contribution against key themes of the IPCC sixth assessment report. Findings suggest 115 distinct and relevant projects completed mostly in Southeast Asia, South Asia and Temperate East Asia, with many of them asserting community-based adaptation and mitigation surrounding issues on ecosystems and biodiversity, extreme weather events, water-food-energy nexus, sustainable waste management, and climate education. Findings also show 163 knowledge products in which majority of them (66.87%) were peer-reviewed journal articles, 11.04% were reports, 7.98% were policy briefs, 6.75% were guidelines and tools, 4.91% were books and 2.45% were perspectives and opinions. With the evolving synergies between global climate targets and the SDGs, it is recommended that APN solidify its role in science-policy partnerships and networking by creating improved interlinkages for disseminating knowledge gaps filled and in replicating lessons learned and best practices found in APN knowledge products. In addition to science-policy dialogues and output synthesis, a regular review of APN research and capacity development outcomes will help in realizing these important aspects toward wider policy impact.

Uchiyama et. al. (2020). Climate change research in Asia: A knowledge synthesis of Asia-Pacific Network for Global Change Research (2013–2018). *Environmental Research* **188**:1-10.

On the conservation value of historic canals for aquatic ecosystems

While fragmentation and habitat loss due to water infrastructure threaten freshwater biodiversity worldwide, historic canals have the potential to contribute to both cultural heritage and biodiversity conservation. Shifting management objectives regarding historic canals from development to recreation and conservation offer opportunities for achieving conservation targets in these anthropogenic systems. However, managing historic canals often involves multiple objectives (e.g., nature conservation vs historic preservation). We reviewed ecological studies in various types of canal systems, examined the potential of historic canals to contribute to biodiversity conservation, and provided suggestions to promote biodiversity conservation given the opportunities and challenges in canal management. Canal characteristics (e.g., size, main use, surrounding environment, physical and hydrological properties) can be used to qualify or quantify their potential conservation value and risk. Changing management regimes to mimic natural flow, enhance habitat complexity, and modify connectivity could improve ecosystem functions and services in canals. To achieve conservation potential of historic canals, studies are required to fill knowledge gaps and to understand trade-offs among often competing objectives. The use of decision analysis such as structured decision making allows managers to incorporate multiple objectives, evaluate trade-offs, and address uncertainties in historic canal management.

Lin et al. (2020). On the conservation value of historic canals for aquatic ecosystems. *Biological Conservation* **251**:1-10

Combining spatial modeling tools and biological data for improved multispecies assessment in restoration areas

Habitat restoration is one of the actions to reduce landscape fragmentation by promoting connectivity and thus biodiversity. But knowing where to implement these habitats is a major issue and planners lack guidance for answering this question, in particular when it involves multiple species and over a large area. We proposed to combine biological data, habitat suitability models and spatial graphs to improve multiscale and multispecies connectivity in Ile-de-France, a highly artificialized region of 12,000 km^2. The framework consisted of i) modeling habitat suitability for eight pond-dwelling species (*Alytes obstetricans, Bufo bufo, Epidalea calamita, Hyla arborea, Rana temporaria, Salamandra salamandra, Triturus cristatus, and Natrix natrix*), ii) modeling the ecological network for each species, iii) prioritizing each sampling point depending on the gain in connectivity if a new pond was created there and iv) combining single-species results to identify the areas that could improve multispecies connectivity. The multivariate statistical analysis revealed that transitional forest environments appeared to be the most strategic areas for improving multispecific connectivity (at least for 5 species). Targeted addition of habitat within an ecological network can increase habitat density in deficient areas and reconnect network sub-parts. This approach is therefore promising to guide conservation actions and "no net loss" biodiversity measures, especially the final stage of offset in the mitigation hierarchy.

Clauzel & Godet (2020). Combining spatial modeling tools and biological data for improved multispecies assessment in restoration areas. *Biological Conservation* **250**:1-11.

Towards biocultural approaches to peatland conservation: The case for fish and livelihoods in Indonesia

Conservation projects are likely to fail if plans to preserve important wildlife habitats and species are not co-developed between conservation organisations and local communities to reflect the needs and diverse values of the latter. Tropical peatland conservation represents a case in point: local community livelihoods have only recently come into focus, particularly within academic literature. Instead, many previous studies emphasise the need to conserve intact peat swamp forests for their carbon storage, as a habitat for flagship species such as the orangutan, and to provide fire-free landscapes. Here, we explore the socio-environmental issues being faced in the peatland landscapes of Central Kalimantan, Indonesia. This includes the loss of peat-swamp forest, decreases in peatland fish populations and related socio-cultural challenges such as potential loss of fishing livelihoods along with historic and continued experiences of marginalisation of indigenous communities. To find solutions to these complex and interrelated problems, an interdisciplinary approach which focuses on interdependencies and includes multiple worldviews is required. We propose an approach which deploys both Ethan Miller's use of livelihoods (incl. Miller, 2019) and biocultural approaches to conservation to analyse human-nonhuman relationships, with a focus on fish and fishing livelihoods. We draw on data from in-depth social and ecological research in two village communities in Central Kalimantan, and in so doing illustrate how fish conservation has the potential to support important biocultural and livelihood relationships between human and nonhuman communities in peatland areas. Our findings lend support to previous calls for biocultural approaches to conservation in other socio-ecological contexts, and lead us to conclude that tropical peatland conservation initiatives that integrate such approaches will result in improved outcomes for peatlands, forests, biodiversity and people. These findings will be relevant to other tropical peatland areas with high dependence on fishing as a source of livelihood, such as the peatlands of the Amazon and Congo basins.

Thornton et al. (2020). Towards biocultural approaches to peatland conservation: The case for fish and livelihoods in Indonesia. *Environmental Science & Policy* **114**:341-351.

Domestic water supply, residential water use behaviour, and household willingness to pay: The case of Banda Aceh, Indonesia after ten years since the 2004 Indian Ocean Tsunami

In this study, we developed a preliminary assessment of current domestic water supply and use in Banda Aceh, Indonesia, a city that was hardest hit by the Indian Ocean Tsunami of 2004. The motivation was to develop understanding of the status and future direction for improvement of domestic water supply after 10 years of post-tsunami reconstruction. For this purpose, we collected primary and secondary information from both water utility and residential households. In particular, we conducted household survey to examine water use behaviour in relation to domestic water supply by local utility, public perception on water supply service, and household willingness to pay (WTP) for reliable water supply. Our study results show that domestic water supply in the city has been improving in service coverage but is subject to high percentages of non-revenue water, financial loss, and poor performance. Despite available tap water, residential households access multiple water sources differentially between drinking and non-drinking purposes. All survey respondents are willing to pay for

reliable water supply service, with median WTP estimated at approximately 190% of current household monthly water bill. Most respondents have a concentrated WTP distribution whose mean depends mainly on household income, family size, and water use behaviour. The study findings fill in the knowledge gap in the literature while informing improvement of domestic water supply in Banda Aceh, Indonesia.

Jiang & Rohendi (2020). Domestic water supply, residential water use behaviour, and household willingness to pay: The case of Banda Aceh, Indonesia after ten years since the 2004 Indian Ocean Tsunami. *Environmental Science & Policy* **89**:10-22.

EVENTS

The 6th Spatial Statistics Conference 2021: Climate and the Environment

Welcome to the 6th Spatial Statistics conference, which will be held at the University of Colorado Boulder, USA, from 20 – 23 July 2021 under the theme Climate and the Environment. The conference will provide a forum to debate and discuss how to use spatially referenced data to advance our understanding and provide support for decision making in the domain of Earth system dynamics. This conference will focus on climate change dynamics, their causes, their effects and their future. The conference theme will be the perspective of the Earth as a *unified system* with connections and feedbacks between physical and biological spheres and also human activities. Crucial developments in the methodology are in new scalable methods, spatio-temporal statistics, prediction and statistical aspects of modeling, like spatial and spatio-temporal extremes, attribution and forecasting. Abstract submission deadline 15 January 2021.

4th International Conference on Global Food Security. Achieving local and global food security: at what costs?

As the COVID-19 pandemic continues to create so much uncertainty, we have made the decision to cancel the in-person 4th International Conference on Global Food Security that was scheduled for 6-9 December 2020 in Montpellier, France. The 4th International Conference on Global Food Security Online will take place as a live-streamed and interactive event 7-9 December 2020, 12:00-18:00 CET, with pre-conference mini-symposia on 4 December 2020, 12:00-18:00 CET. Register now to participate in an interactive conference experience direct from your desktop or mobile device: live-stream presentations and take part in discussion through live chat and Q&A. Author registration deadline: 23 October 2020. Registration deadline for live participation (non-presenting delegates): 3 December 2020. Your registration includes on-demand access for 30 days (from one day after the conference).

GLF Biodiversity Digital Conference: One World – One Health (28 - 29 Oct 2020, Online)

With global health pandemics and climate change creating a world of unknowns, we still have the power to step up to restore the earth. Join thousands of biodiversity experts, scientists, policymakers, journalists, activists, private sector and Indigenous groups at the GLF Biodiversity Digital Conference to learn how the world's leading organizations are uniting in the wake of COVID-19 to conserve and protect the world's disappearing biodiversity—from seeds to sea turtles. Held under the theme 'One World − One Health', this two-day event will reach tens of millions of people, spotlight ecosystem restoration and contribute to the UN CBD's Post-2020 Global Biodiversity Framework, making 2020 the super year for nature and biodiversity.

3rd KOBI Congress, International and National Conferences

This conference held by collaboration of Konsorsium Biologi Indonesia (KOBI) with Biology Department Faculty of Mathematics and Natural Sciences University of Bengkulu. This event will be held on Tuesday-Wednesday, November 24-25, 2020. We are pleased to invite you to attend this event, which will be organised by KOBI and Biology Department University of Bengkulu, Indonesia. This is a virtual international and national conference to present research results and to analyse current conditions and all scope of biology. Focus and Scope: Molecular Biology and Biotechnology, Conservation and Environmental Biology, Agricultural and Marine Biology, Microbiology and Health Biology, Development and Function Biology.

International Conference on Human-Wildlife Conflict and Coexistence

The IUCN Species Survival Commission (SSC) Human-Wildlife Conflict Task Force, the Global Environment Facility-funded and World Bank-led Global Wildlife Program and the Wildlife Conservation Research Unit at Oxford University's Department of Zoology are co-hosting this International Conference on Human-Wildlife Conflict and Coexistence in Oxford, UK, in 2021. The conference is organised in collaboration with the IUCN Commission on Environmental, Economic and Social Policy (CEESP), the Food and Agriculture Organization (FAO) of the United Nations, the United Nations Development Programme (UNDP) and several more organisations. Human-wildlife conflict is one of the most pressing threats to biodiversity conservation and achievement of sustainable development. These conflicts threaten the healthy co-existence of people and wildlife and undermine conservation efforts. Collaboration across

disciplines and sectors is needed in this to address human-wildlife conflicts world-wide. It will be an interdisciplinary event, actively seeking participation from presenters and discussants from fields such as ecology, animal behaviour, psychology, law, conflict analysis, mediation, peacebuilding, international development, economics, anthropology and others, to understand human-wildlife conflict through various viewpoints, learn from each other, and build new links and collaborations.

Postponement of the IUCN World Conservation Congress – New dates will be announced in due course

In view of the sanitary situation associated with the COVID-19 pandemic, France and the International Union for Conservation of Nature (IUCN) have decided to postpone the IUCN World Conservation Congress, which was to be held in January 2021 in Marseille. New dates for the event will be announced in due course. France and IUCN remain fully committed to the development of a global framework for the conservation of biodiversity and will continue to act towards this objective. We will provide more information on preparation, programme, logistics and more on the page dedicated to the Congress postponement as it becomes available.

Assessing the species diversity in non-conservation areas: The first systematic camera trapping survey in the Batang Angkola landscape, North Sumatra, Indonesia

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ABSTRACT

Assessing the species diversity in non-conservation areas is crucial to understanding for conservation interventions and management. We used camera trapping to investigate the species diversity in the Batang Angkola Landscape, North Sumatra. The study on species diversity in the area was conducted from February to June 2020. The aim of this study was to assess the species diversity in Batang Angkola Landscape as a reference for the improvement of the management and policy with a special interest in proving the existence of wildlife species in the landscape. We compiled a species diversity, richness and evenness data which were analysed by Shannon Wiener. Based on 1,283 photographs at 60 camera traps stations during 2,923 trap days, we identified 27 different species (24 species were terrestrial mammals, 2 bird species, and 1 species was reptile), including five classified as threatened according to the IUCN. Based on the calculation of the Relative Abundance Indices for each species per 100 trap days, pig-tailed macaque had the highest RAI (3.63 photographed/100 trap days), followed by wild boar and muntjac deer were (1.33 and 1.27 photographed/100 traps days respectively). Based on Shannon Weiner's analysis shows the analysis of species diversity (H), which showed that in the northern and southern areas it were moderate category (2.40 and 2.45 respectively). The level of evenness between north and south areas shows high evenness (0.77 and 0.79 respectively). Meanwhile, the level of species richness between north and south shows moderate to high levels in the two areas (3.95 and 4.42 respectively). Our findings suggest that Batang Angkola Landscape supports a high species richness. Continued survey efforts need to be combined with detailed ecological data collection and effective management in the region.

ABSTRAK

Menilai keanekaragaman spesies di kawasan non-konservasi sangat penting untuk memahami upaya pengelolaan dan intervensi konservasi. Kami menggunakan *camera trap* untuk menyelidiki keanekaragaman spesies di Bentang Alam Batang Angkola di Sumatera Utara. Kajian keanekaragaman jenis di kawasan ini dilakukan selama 5 bulan dari Februari hingga Juni 2020. Tujuan penelitian ini adalah untuk mengkaji keanekaragaman jenis di bentang alam Batang Angkola sebagai acuan perbaikan tata kelola dan kebijakan, spesifik pada membuktikan keberadaan spesies satwa liar. Data keanekaragaman spesies, kekayaan dan kemerataan yang kami kumpulkan, dianalisis dengan Shannon wiener. Berdasarkan 1.283 foto di 60 stasiun perangkap kamera selama 2.923 hari rekam, kami mengidentifikasi 27 spesies berbeda (24 spesies mamalia darat, 2 spesies burung, dan 1 spesies reptil), termasuk lima jenis yang diklasifikasikan sebagai satwa terancam menurut IUCN. Berdasarkan perhitungan Indeks Kelimpahan Relatif untuk setiap spesies per 100 hari rekam, beruk memiliki RAI tertinggi (3,63 foto / 100 hari rekam), disusul babi hutan dan kijang (masing-masing 1,33 dan 1,27 foto / 100 hari rekam). Berdasarkan analisis Shannon-Weiner untuk keanekaragaman jenis (H) menunjukkan bahwa di wilayah utara dan selatan dalam kategori sedang (masing-masing 2,40 dan 2,45). Tingkat kemerataan antara wilayah utara dan selatan menunjukkan tingkat kategori kemerataan yang tinggi (masing-masing 0,77 dan 0,79). Tingkat kekayaan spesies antara utara dan selatan menunjukkan kategori tingkat sedang hingga tinggi di kedua wilayah tersebut (masing-masing 3,95 dan 4,42). Temuan kami menunjukkan bahwa Bentang Alam Batang Angkola mendukung kekayaan spesies yang tinggi. Upaya survey lanjutan perlu digabungkan dengan pengumpulan data ekologi yang terperinci dan pengelolaan yang efektif di wilayah tersebut.

Keywords: batang angkola, *camera trap*, hutan produksi, hutan lindung, keragaman jenis.

INTRODUCTION

Sumatra is part of Southeast Asia's Sundaland biodiversity hotspot, recognized as one of the 25 richest and most threatened reservoirs of plant and animal life on Earth (Perbatakusuma et al., 2010). The important Sumatra ecosystems which consist of freshwater swamps, lowland rainforest, montane rainforest, peat

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swamps, and tropical pine forest (Whitten et al. 2000; Wikramanayake et al., 2002), are home to more than 10,000 plant species, 210 mammal species are uniques, including the Sumatran orangutan (*Pongo abelli*), Sumatran elephant (*Elephas maximus sumatrensis*), Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and Sumatran tiger (*Panthera tigris sumatrae*) (Perbatakusuma et al., 2010).

The impact of anthropogenic activities on land use worldwide includes accelerated deforestation and habitat fragmentation caused by conversion for other land use purposes and infrastructure developments, further contributing to declining local biodiversity (Newbold et al., 2015). Much of biodiversity in Sumatra is at risk due to vast areas of primary forest (up to 0.38million hectares per year) being cleared for timber products or converted to other land uses, such as agriculture (e.g. coffee, rubber), oil palm, and *Acacia mangium* tree plantations (Margono et al., 2012; Sodhi et al., 2004; Stibig et al., 2014). These habitat loss have been linked to population declines in many mammals, including flagship species such as Sumatran tiger, Sumatran rhinoceros, and Asian elephant (Kinnaird et al., 2003; Linkie et al., 2003; Hedges et al., 2005; Isnan et al., 2006).

Traditionally, wildlife conservation often focuses on conservation areas, management of which forms the core of most countries' conservation efforts. In many cases, land outside protected areas also have conservation values. Whilst this is rarely of the quality found in protected areas, using the conservation potential of unprotected lands can help overcome many of the shortfalls of the protected area system. For certain species, especially those which naturally occur at very low population densities, this support could tip the balance from extinction to survival (Maddox et al., 2007). Despite the potential value in alleviating the restrictions of protected areas, biodiversity on unprotected lands is under-researched and poorly understood scientifically (Shafer, 1999).

Wildlife diversities are known to exist in several nature reserves, wildlife reserves, national parks, and protected forests, including in Batang Gadis National Park (BGNP) and Batang Toru Protected Forest (BTPF) in North Sumatra. The actual species distribution and number of individuals of wildlife in Northern Sumatra is still being investigated, and there are only few scientific data sets that have been systematically collected, especially within the Batang Angkola landscape (BAL). Batang Angkola is one of the key biodiversity areas in North Sumatra, connecting three other critical ecosystems, namely BGNP, BTPF and Barumun Wildlife Reserve (BWR).

Conservation International Indonesia (CI Indonesia) has worked in North Sumatra since 2002 to support the protection and connection of these biodiversity hotspots, which are currently under threat from the agriculture sectors. In early 2019, CI Indonesia and the Forestry Management Unit (FMU) (under local government management) recorded tiger scats and footprints in the forest from the first ever biological surveys in BAL (4,800 hectares [ha]). This area was selected because there had never been scientific research into the presence of the wildlife here. Moreover, it was suspected that BAL was the trajectory of Sumatran tigers moving between BGNP and BWR.

Protecting wildlife and their habitat requires a landscape approach to ensure that habitat connections are maintained. To maintain and improve the biological connectivity in the landscapes between BGNP and BWR is crucial for wide-ranging species such as the Sumatran tiger. Therefore, the aim of this study is to assess the species diversity in BAL as a reference for the improvement of the management and policy for the landscape, with a special interest in proving the existence of wildlife species in the non-conservation area.

METHODS

Study Area

Study was conducted in Batang Angkola Landscape from February to June 2020. The study site was located at 01°18'28.78" N and 99°14'34.51" E, at altitudes of 90 to 1,422 m above sea level (Figure 1). The area consists of protected forest and production forest, including concession area under managed by Forest Management Unit of North Sumatra. The study was conducted in two main areas in Batang Angkola (the north and south areas) that cover a total of 47,518 ha. The north area was surveyed from February 5 to March 29, 2020, covering 23,200 ha and south area was surveyed from May 17 to June 25, 2020, covering 24,318 ha. This area directly connect to Batang Gadis National Park, which is confirmed home-range for Sumatran tiger.

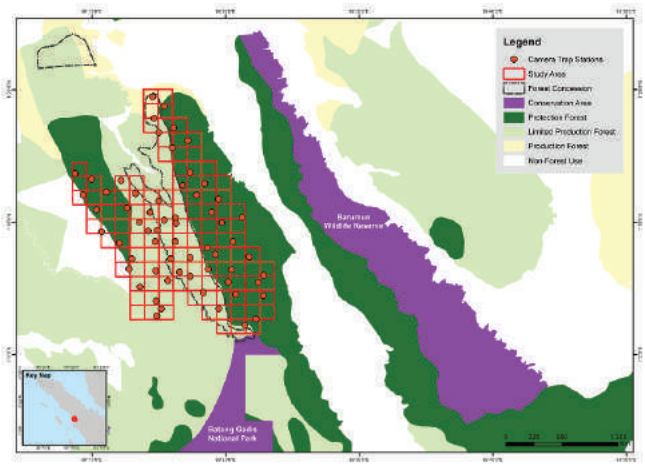

Figure 1. Map of study area that cover a total of 47,518 ha, most of it is protection and production forest, including a concession area (with total of 15,000 ha). The map also shown connectivity of critical landscape in North Sumatra.

Data Collection

We used 30 camera traps (*Cuddeback X Change Color Model 1279*) for this study. A single of 30 camera traps at 60 trapping stations deployed on the study area, encompassing an area of approx. 47,518 ha. Ideally such cameras should be set up in pairs to allow both sides of recognizable animals to be photographed (Karanth and Nichols, 2002). However, because we were limited by our number of camera traps, all camera traps were deployed with a single camera in each location, and we separated the survey to become two sections, the north and south sections.

The cameras were set in the forest within in a grid of four km^2 across elevational and vegetation type gradients. We selected areas that had applied alongside camera trap standardized design so that the results could be analyzed according to the latest analysis. We installed 30 camera traps in 30 stations in each section. In first section, we installed 30 camera traps in north area. After 60 days operated in the north area, we pick up them, checked camera conditions, replaced batteries and memory cards. We moved them to south sections in same number camera traps in other 30 stations in south area. After 60 days operated in the south area, we pick up them and all results were entered into database for each sampling areas.

Data Analyses

For sampling efforts, we analyze used a Relative Abundance Indices (RAI) measure for each captured species. RAI represents the number of independent pictures for each species per 100 trap days. We followed the definition of independent pictures as (1) consecutive photographs of different individuals of the same or different species, (2) consecutive photographs of individuals of the same species taken more than 0.5 hours apart, (3) non-consecutive photos of individuals of the same species (O'Brien et al., 2003).

RAI was determined using encounter rates that give basic ordinal scales of abundance. It was calculated as:

$$\mathbf{RAI = SF/TD*}100$$

Where: RAI = Relative Abundance Index; SF = number of species photograph, TD = trap days

We used Shannon-Weiner diversity index H (Shannon, 1948), an index indicating the diversity of species photograph from all camera traps for each day of the study in each section sampling areas. Species richness and abundance were defined as the total number of species and total number of contacts respectively (Table 1). We followed Kiros et al., (2018) for Shannon-Weiner diversity index (H´) was used to analyse species diversity was calculated as:

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right)\times \ln\left(\frac{ni}{N}\right)$$

Where H' = Shannon-Weiner diversity index; pi = proportion of the photograph species from species i.;
Evenness index (J') was calculated by following the equation.

$$J' = \frac{H'}{\ln S}$$

Where: H' = Shannon Weiner diversity index and S = number of species.
Richness index (D) was calculated by the following equation

$$D = \frac{S-1}{\ln N}$$

Where: D = Richness index, S = Total number of species and N = Total number of individuals.

Table 1. Shannon-Weiner Index criteria's.

Criteria for index of species diversity (H')	Criteria for Evenness index (J')	Criteria for Richness index (D)
H'<1 a low level of species diversity,	J' ≤ 0.4 low evenness	D <1.5 a low level of species richness
1 <H'<3 a moderate level of species diversity	0.4 < J'<0.6 moderate evenness	1.5> D> 4 a moderate level of species richness
H'> 3 indicates a high level of species diversity	J'≥ 0.6 high evenness	D> 4 a high level of species richness

RESULTS AND DISCUSSION

Capture Rates

There were 60 stations that had been camera trap installed in the field during this study. However, there were only 58 stations where camera traps working properly, while the others 2 stations did not get any pictures, caused by cameras error. Of these 58 stations, the results reveal the significance and diversity of the Batang Angkola Landscape. A total of 1,283 animal photographs (341 independent photographs) of at least 27 different species (24 species were terrestrial mammals, 2 bird species, and 1 species was reptile) were recorded from a total of 2,923 trap days. Carbone et al., (2001) suggested a minimum of 1,000 trap days

were required to obtain comprehensive information on diversity and population estimation of certain cryptic mammalian species. Example images for every species captured in the survey are provided in Appendix1.

Based on results during period camera trapping, notable results from this period of surveying include two Critically Endangered species (Sumatran tiger and Sunda pangolin *Manis javanica*), three endangered species (Sumatran clouded leopard *Neofelis diardi*, Malay tapir *Tapirus indicus*, and Black Sumatran langur *Presbytis sumatrana*), five vulnerable (Malay sun bear *Helarctos malayanus*, Sambar deer *Rusa unicolor*, Sumatran serow *Capricornis sumatraensis*, Binturong *Arctictis binturong*, Pig-tailed macaque *Macaca nemestrina*), three species endemic to Sumatra (Sumatran tiger, Sumatran clouded leopard, Black Sumatran langur) and five of the six species of Sumatran wild cats (Sumatran tiger, Sumatran clouded leopard, Asiatic golden cat, Marbled cat, and Leopard cat). See Table 2 contains the list of identified species and IUCN Red List classifications.

Table 2. Identified species during the Camera Trapping at Batang Angkola Landscape.

Species	Common name	IUCN Relist Status
Panthera tigris sumatrae	Sumatran tiger	Critically Endangered
Neofelis diardii	Sumatran clouded leopard	Endangered
Catopuma temminckii	Asiatic golden cat	Near threatened
Pardofelis marmorata	Marbled cat	Near threatened
Prionailurus bengalensis	Leopard cat	Least concern
Helarctos malayanus	Sun bear	Vulnerable
Hemigalus derbyanus	Banded palm civet	Near threatened
Herpestes brachyurus	Short-tailed mongoose	Least concern
Paguma larvata	Masked palm civet	Least concern
Martes flavigula	Yellow-throated marten	Least concern
Herpestes semitorquatus	Collared mongoose	Least concern
Arctictis binturong	Binturong	Vulnerable
Tapirus Indicus	Malay tapir	Endangered
Rusa unicolor	Sambar deer	Vulnerable
Sus scrofa	Wild boar	Least concern
Tragulus kanchil	Lesser mouse deer	Least concern
Muntiacus muntjak	Muntjak	Least concern
Capricornis sumatraensis	Sumatran serow	Vulnerable
Presbytis sumatrana	Black sumatran langur	Endangered
Macaca nemestrina	Pig-tailed macaque	Vulnerable
Macaca fascicularis	Long-tailed macaque	Least concern
Manis javanica	Sunda pangolin	Critically Endangered
Rattus tiomanicus	Malayan field rat	Least concern
Hystrix brachyuran	Malayan porcupine	Least concern
Argusianus argus	Great argus	Near threatened
Chalcophaps indica	Emerald dove	Least concern
Varanus salvator	Common water monitor	Least concern

Based on the calculation of the relative abundance index in the two areas, the values obtained for each species, where the Pig-tailed macaque, Wild boar , and Barking deer had the highest RAI (3.63, 1.33, and 1.27 photographed/100 trap days, respectively) compared to other species. Whilst the Sumatran tiger, as the top predators in the region, placed at 18th rank with a RAI value of 0.07. Based on trophic level (based on the type of food) which is divided into three categories i.e. herbivores, carnivores and omnivores, the relative abundance of herbivores has a high value. Therefore, the pyramid of food web will be formed properly and the balance of the ecosystem in the research location will be occurred Huda et al., (2020). This is in line with the study of Huda et al., (2020) which the Sumatran tiger in Batutegi Protected Forest, has the position of

15th rank of RAI with a value of 0.13, and Santosa et al., (2008) which obtained 14 species of herbivores, five species of carnivores, and three species of omnivores in Tanjung Puting National Park, Central Kalimantan.Indices for each species per 100 trap days, Pig-tailed macaque had the highest RAI (3.63 photographed /100 trap days), followed by Wild boar and Muntjac were (1.33 and 1.27 photographed/100 traps days respectively) (Figure 2).

Camera traps, which have increasingly been used in wildlife studies (Wemmer et al., 1996), are ideal for identifying the species inhabiting a particular area, monitoring relative and absolute abundance of species, and studying activity patterns (Karanth, 1995; van Schaik and Griffths, 1996; Karanth and Nichols, 1998; Kawanishi et al., 1999; Koerth and Kroll, 2000; McCuUough et al., 2000; Martorello et al., 2001; O'Brien et al., 2003). Camera traps have become an indispensable tool in many wildlife studies worldwide ranging from simple documentation of animal presence to rigorous investigation of animal ecology based on quantitative, experimental and statistical inference (Sunarto et al., 2013).

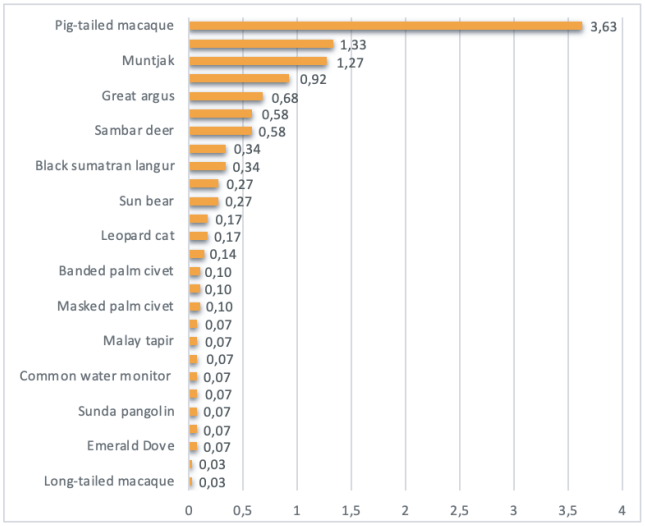

Figure 2. Relative Abundance Indices (RAI's) for each animal photograph per 100 trap days.

Based on the calculation of the relative abundance index in the two areas, the values obtained for each species, where the Pig-tailed macaque, Wild boar , and Barking deer had the highest RAI (3.63, 1.33, and 1.27 photographed/100 trap days, respectively) compared to other species. Whilst the Sumatran tiger, as the top predators in the region, placed at 18th rank with a RAI value of 0.07. Based on trophic level (based on the type of food) which is divided into three categories i.e. herbivores, carnivores and omnivores, the relative abundance of herbivores has a high value. Therefore, the pyramid of food web will be formed properly and the balance of the ecosystem in the research location will be occurred Huda et al., (2020). This is in line with the study of Huda et al., (2020) which the Sumatran tiger in Batutegi Protected Forest, has the position of 15th rank of RAI with a value of 0.13, and Santosa et al., (2008) which obtained 14 species of herbivores, five species of carnivores, and three species of omnivores in Tanjung Puting National Park, Central Kalimantan.

The Pig-tailed macaque and Wild boar are the highest RAI value, because both animals are generally in large groups at one time so that when they were in front of the camera trap, each individual will be captured. In hill dipterocarp forest in West Sumatra, Pig tailed macaque had an average group size of 10.5 individuals (range = 1-20 individuals), larger than in montane forests which had an average group size was 7 individuals (range = 6-8 individuals), whilst in sub-montane forests the average group size was 9.5 individuals. Moreover, in lowland forest, the average group size of this macaque was 8.5 individuals (range= 1-13 individuals) being slightly smaller than in sub-montane forests and slightly larger than in the montane forests (Yanuar et al., 2009). The Wild boar is one of the most widely distributed ungulates in the world due to its high reproductive rate, adaptability, and opportunistic feeding (Herrero et al., 2006; Cuevas et al., 2010; Ballari and Barrios-García, 2014). At the same time, the wild boar is an important prey base for endangered large carnivores (Karanth and Sunquist, 1995) as well as a robust species for hunting that can relieve pressure on other wildlife species (Barrios-García and Ballari, 2012).

Based on the results of this study, the five species of felids were found in the areas, namely Leopard cat, Marbled cat, Asiatic golden cat, Sumatran clouded leopard and Sumatran tiger. As a top predator, the Felids family can be used as an umbrella species in species conservation efforts in the area of Batang Angkola Forest Area. In species conservation efforts, the determination of umbrella species is very important because when an umbrella species is protected, the effort will also be protecting the other species (Choudhury, 2013). The establishment of umbrella species is expected to minimize the need for human resources and funding that is still low to support wildlife conservation (Kiffner et al., 2015).

During the survey period, only two tiger photographs were collected (two images of the same female) were taken from 60 camera stations. Tigers have wide ranges, are difficult to detect and are elusive. The low number of tiger photos findings in Batang Angkola cannot be taken to mean that there are no more individual tigers in the forest apart from the photographed female. This is probably due to human factors, nature and equipment (camera trap). The human factor may be improper placement of the camera points. Terrain conditions that are difficult to reach due to hilly and steep ravines limited the team's

movement in achieving the right location for the camera installation. The camera traps operated in the field were also affected by the weather. The sensor sensitivity level will decrease when the camera is in a relatively open and hot area.

Failures to detect species are common errors in surveys and are related to the detection probability of each species (Gu and Swihart, 2004). The choices about where and when the camera traps will be placed can influence the sampling process. These choices can lead to biased results because species use the environment differently and researchers use different criteria to define the best sampling locations (Larrucea et al., 2007). The detection of mammals may vary depending on the animal's sex, age, social status (alpha or beta and resident or transient) and territoriality (Larrucea et al., 2007), human pressure and the physical environment (Guil et al,. 2010). Species with large home ranges and migratory species present a particular set of challenges, because their habitat requirements often extend beyond the boundaries of protected areas (Lambeck, 1997; Caro and O'Doherty, 1999; Sanderson et al., 2001).

Species Diversity, Richness, and Evenness

The calculation of Shannon-Weiner analyses for every species on each sections of sampling areas is showed in Table 3. Based on Shannon Weiner analysis shows the level of diversity is a moderate category in both north and south sections. Level of evenness is high category in both north and south sections, and the level of species richness is moderate category in north section and high category in south section (Table 4).

Table 8. The calculation of Shannon Weiner analyses for every species on each sections of sampling areas.

Species	North Section				South Section			
	n	*pi*	*ln pi*	*pi x ln pi*	*n*	*pi*	*ln pi*	*pi x ln pi*
Sumatran tiger *Panthera tigris sumatrae*	2	0.01	-4.38	-0.06				
Sumatran clouded leopard *Neofelis diardii*	2	0.01	-4.38	-0.06				
Asiatic golden cat *Catopuma temminckii*	6	0.04	-3.28	-0.12	4	0.02	-3.82	-0.08
Marbled cat *Pardofelis marmorata*	2	0.01	-4.38	-0.05	2	0.01	-4.52	-0.05
Leopard cat *Prionailurus bengalensis*	2	0.01	-4.38	-0.05	3	0.02	-4.11	-0.07
Sun bear *Helarctos malayanus*	3	0.02	-3.98	-0.07	5	0.03	-3.60	-0.10
Banded palm civet *Hemigalus derbyanus*	1	0.01	-5.08	-0.03	2	0.01	-4.52	-0.05
Short-tailed mongoose *Herpestes brachyurus*	2	0.01	-4.38	-0.05	1	0.01	-5.21	-0.03
Masked palm civet *Paguma larvata*	1	0.01	-5.08	-0.03	2	0.01	-4.52	-0.05
Yellow-throated marten *Martes flavigula*					2	0.01	-4.52	-0.05
Long-tailed mongoose *Herpestes semitorquatus*					2	0.01	-4.52	-0.05
Binturong *Arctictis binturong*					1	0.01	-5.21	-0.03
Malay Tapir *Tapirus Indicus*	1	0.01	-5.08	-0.03	1	0.01	-5.21	-0.03
Sambar deer *Rusa unicolor*	11	0.07	-2.68	-0.18	6	0.03	-3.42	-0.11
Wild boar *Sus scrofa*	25	0.16	-1.86	-0.29	14	0.08	-2.57	-0.20
Lesser mouse deer *Tragulus kanchil*	8	0.05	-3.00	-0.15	9	0.05	-3.01	-0.15
Muntjak *Muntiacus muntjac*	17	0.11	-2.24	-0.24	20	0.11	-2.21	-0.24
Sumatran serow *Capricornis sumatraensis*	6	0.04	-3.28	-0.12	2	0.01	-4.52	-0.05
Black sumatran langur *Presbytis sumatrana*	2	0.01	-4.38	-0.05	8	0.04	-3.13	-0.14
Pig-tailed macaque *Macaca nemestrina*	47	0.29	-1.23	-0.36	59	0.32	-1.13	-0.36
Long-tailed macaque *Macaca fascicularis*					1	0.01	-5.21	-0.03
Sunda pangolin *Manis javanica*	2	0.01	-4.38	-0.05	1	0.01	-5.21	-0.03
Malayan porcupine *Hystrix brachyuran*	9	0.06	-2.88	-0.16	18	0.10	-2.32	-0.23
Malayan Field Rat *Rattus tiomanicus*					5	0.03	-3.60	-0.10
Great argus *Argusianus argus*	8	0.05	-3.00	-0.15	12	0.07	-2.72	-0.18
Emerald Dove *Chalcophaps indica*					2	0.01	-4.52	-0.05
Common water monitor *Varanus salvator*	2	0.01	-4.38	-0.05				
	159			-2.40	182			-2.45

Table 4. Overall diversity, evenness, and species richness indexes

Site	S	N	H'	Category	J'	Category	D'	Category
North section	21	159	2.40	Moderate	0.79	High	3.95	Moderate
South section	24	182	2.45	Moderate	0.77	High	4.42	High

(S)=total number of species, (N)=total number of individuals
(D')=species richness index, (J')=Evenness index and (H')=Shannon diversity

Diversity is identical to the stability of an ecosystem, where the diversity of an ecosystem is relatively high then the condition of that ecosystem tends to be stable (Odum, 1983; Fachrul, 2012). Indriyatno (2006) stated that the species diversity is high if the community is composed of many species with an abundance of the same species or almost the same species diversity, resulting in high complexity, because the interactions that occur within the community are very high.

There were critically endangered Sumatran tigers and Sunda pangolin detected in the study area, also endangered species of Malayan tapir, Clouded leopard and Sumatran black langur, shows the high richness of wildlife species in the study area.

The results of the analysis of species diversity (H), which showed that in the northern and southern areas it were moderate (2.40 and 2.45 respectively). The level of evenness between north and south areas shows high evenness (0.77 and 0.79 respectively). This shows that the distribution of animal species in 60 stations is relatively evenly distributed despite different altitudes. In the results, the level of species richness between north and south shows moderate to high levels in the two areas (3.95 and 4.42 respectively). This result is quite surprising, considering that the study locations are protected and production forests, where in production forests, timber harvesting is still being done. Moreover, there is a concession of 15,000 ha which is still actively producing timber woods. This finding is very important for forest management in planning and evaluating on the implementation of production activities by considering the presence of wild animals in the area. According Maddox et al., (2007), the impact of existing concessions can be mitigated, provided that the company is prepared to set some land aside. If degraded habitats can be made to retain conservation value for certain species, the added habitat and potential connectivity between protected areas could provide key linkages and greatly increase the potential for both the maintenance of ecosystem services and conservation of wildlife. This has significant implications for many conservation and land use policies which prioritise by habitat quality.

During the field survey, the team also found threats to the wildlife habitat, in the form of land clearing by the local community for agricultural / plantation activities. The finding that threats to wildlife and their habitats still occur in the area requires special attention from FMU. Suggested approach to reduce threats and control human disturbance include a combination of protection/law enforcement, awareness and alternative livelihood. The role of human disturbance in suppressing large mammal population has been documented, especially in Sumatra (Griffiths and Schaik, 1993; Kinnaird et al., 2003; Wibisono and Pusparini 2010). The main challenge of biodiversity conservation efforts is maintaining habitat quality and connectivity in the face of anthropogenic disturbance (Wang et al., 2014). Many protected areas are embedded within human-modified landscapes, where agriculture and urbanization have determined landscape structure and may represent major disturbances to natural ecosystems. Habitat loss and fragmentation are a major threat to biodiversity conservation in this context (Melo et al., 2013a). Maintaining a primary forest refuge for tigers is important (Linkie et al., 2008). As additional to support a primary forest refuge for tigers, forest production, and plantation areas in surrounding of the reserve should also be well managed. Conservation outside protected areas is essential if many wildlife populations and endangered species are to survive into the future. Conservation values outside protected areas have to be managed and protected. If conservation is to be effective outside protected areas, it has to be carried out and coordinated at a landscape level (Maddox et al., 2007).

RECOMMENDATIONS

Refers to the study results, based upon the findings of this survey, our observations and recommendations are as follow:

- The relatively high number of endangered and critical species illustrates the forest's contribution to conserving Sumatra's biodiversity. Nevertheless, many of the higher order taxa such as the Sumatran tiger have vast home-ranges that are highly sensitive to forest fragmentation. The utmost priority should be given to maintaining the connectivity of Batang Angkola forest and adjacent areas ecosystems including Batang Gadis National Park. To that end, it is recommended that FMU and relevant stakeholders examine how a biodiversity corridor can be established in the face of land-use change pressures.

- Evidence of illegal and destructive activities in Batang Angkola requires increased patrol and law enforcement efforts. We recommend to support to increase of FMU's capacity both the protect the forest and to continue to improve the long-term forest management plan (*Rencana Pengelolaan Hutan Jangka Panjang*-RPHJP).
- The upscaling of the monitoring programme to a number of reserves is recommended, allowing population trends to be tracked across the landscape. Important to continue implement camera trapping and investigate additional sites that may benefit from this important conservation tool, within funding limitations. Implementing such a monitoring program would allow a coordinated and adaptive approach to conserving priority species and allocating resources.
- Infrastructure plans must integrate to biodiversity goals through the establishment of a Provincial Strategic Area (*Kawasan Strategis Provinsi*) of Batang Gadis Ecosystem which will connect both Batang Angkola Protected Forest and Batang Gadis National Park. This Strategic area will promote sustainable forest management, watershed conservation, environmental services and protection, and elevating the livelihoods of local communities.

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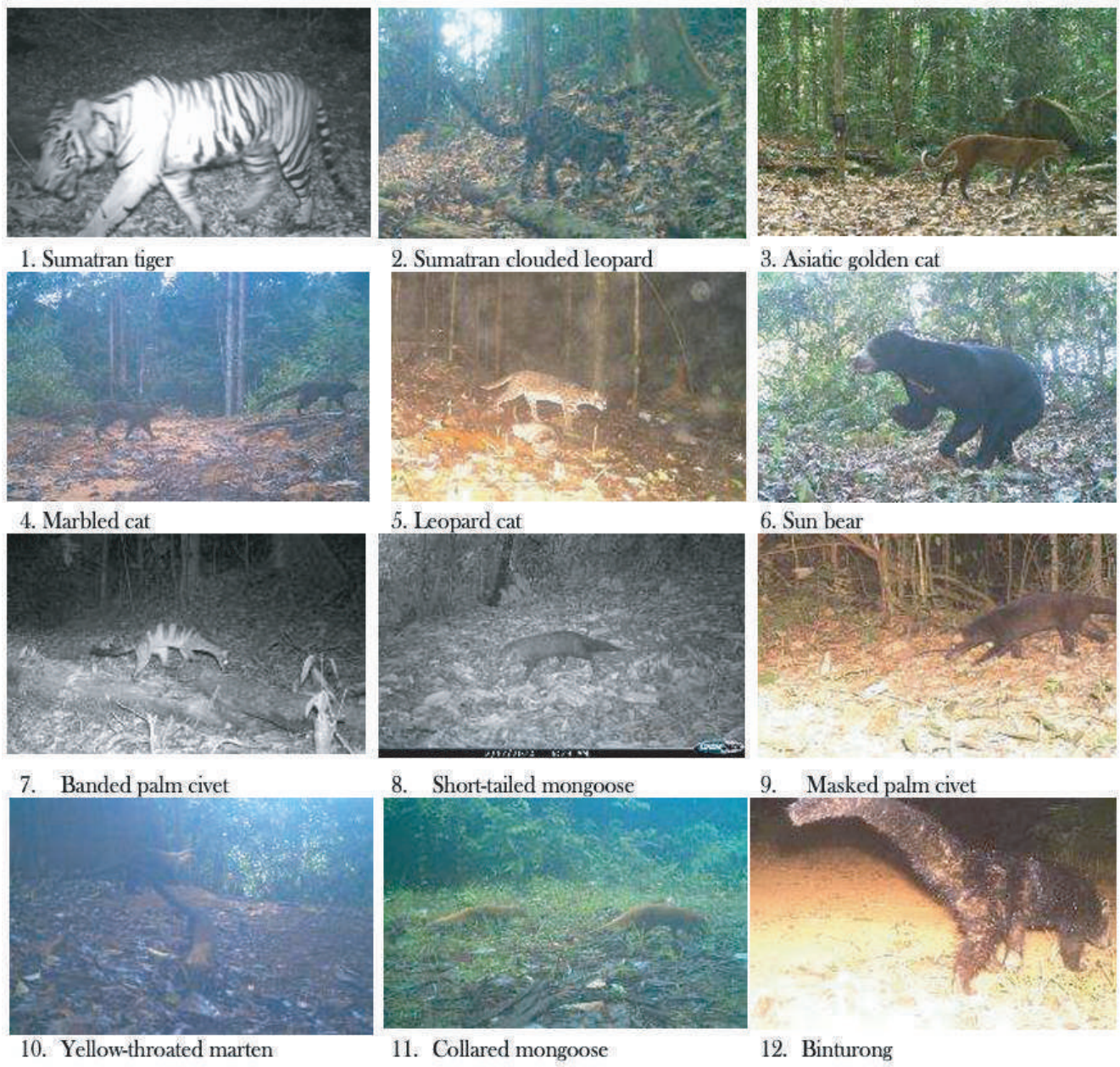
Appendix 1. Selection of animals photographs taken by camera traps during 2020 survey, Batang Angkola.Landscape.



13. Malay tapir

14. Sumatran serow

15. Sambar deer

16. Wild boar

17. Muntjak

18. Lesser mouse deer

19. Black sumatran langur

20. Pig-tailed macaque

21. Long-tailed macaque

22. Sunda pangolin

23. Malayan porcupine

24. Malayan field rat

25. Great argus

26. Emerald dove

27. Common water monitor

An evaluation of a community-based forest restoration programme in Gunung Gede Pangrango National Park, West Java, Indonesia

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ABSTRACT

Forest restoration is needed to improve the condition of degraded ecosystems and boost up the ecological services. The existence of forest areas, especially in Indonesia, cannot be separated from the livelihoods of the people living around them. The purpose of this study was to evaluate whether the feasabiluty of the community-based forest restoration programme, implemented by the Gunung Gede Pangrango National Park Agency (BBGGPNP) and its partners, is feasible and can support efforts to restore forest ecosystem functioning and build community independence in managing the forest ecosystem. This study used the Context, Input, Process and Product (CIPP) method. This is an evaluation model which provides an analytical and rational basis for programme decision-making, based on a cycle of planning, structuring, implementing and reviewing and revising decisions, examined through a different aspect of evaluation –context, input, process and product evaluation. Data were obtained from field observations, interviews and document analysis. Aspects of the programme 'Context' were found to be categorized as good and can become the basis for programme implementation, Programme 'Inputs' were also determined to be good, and fulfilled the criteria required to support the achievement of programme objectives. The 'Process' aspects were found to be sufficient, with key areas for improvement included the need for better coordination with partners and the need to respond to technical restoration requirements by adjusting the area of land to be restored, the number of trees to be planted, and by considering the technical rule of restoration. The 'Product' aspect of the programme were shown to be good, is shown by the achievement of the target amount and growth of trees and the increased capacity of human resources as well as the development of independent businesses in the ex-encroachers who were the programme participants. Based on these results, it can be concluded that the community-based forest restoration programme such as conducted by the GGPNP Agency is feasible and can be implemented in similar sites.

ABSTRAK

Restorasi hutan diperlukan untuk memperbaiki fungsi ekosistem hutan yang terdegradasi. Keberadaan kawasan hutan, khususnya di Indonesia, tidak dapat dipisahkan dengan penghidupan masyarakat yang tinggal di sekitarnya. Tujuan dari penelitian ini adalah untuk mengevaluasi apakah program restorasi hutan berbasis pemberdayaan masyarakat yang dilaksanakan oleh Balai Besar Taman Nasional Gunung Gede Pangrango (BBTNGGP) bersama mitranya, layak serta dapat mendukung upaya pemulihan fungsi ekosistem hutan dan membangun kemandirian masyarakat. Penelitian ini menggunakan metode CIPP, yaitu model evaluasi pada aspek *Context, Input, Process* dan *Product*. Data diperoleh dari hasil observasi lapangan, wawancara dan analis dokumen. Berdasarkan analisis data, dapat disimpulkan bahwa program restorasi hutan berbasis pemberdayaan masyarakat layak untuk diterapkan sebagai upaya memulihkan fungsi ekosistem hutan dan membangun kemandirian masyarakat di sekitar hutan. Aspek Konteks program berkategori baik dan dapat menjadi dasar utama pelaksanaan program, Aspek Input program baik, telah memenuhi kriteria yang mendukung tercapainya tujuan program, Aspek Proses berkategori cukup, perlu melakukan koordinasi yang lebih baik dengan pihak mitra untuk lebih berkomitmen dan perlu untuk melakukan penyesuaian antara target luasan lahan yang direstorasi dengan jumlah pohon yang ditanam dengan mempertimbangkan aturan teknis restorasi. Aspek Produk berkategori baik ditunjukkan dengan tercapainya target jumlah dan pertumbuhan pohon dan meningkatnya kapasitas SDM serta terbangunnya usaha mandiri pada masyarakat eks perambah yang menjadi peserta program.

Keywords: *CIPP, forest restoration, community empowerment, Gunung Gede Pangrango National Park*

INTRODUCTION

Deforestation and degradation due to community encroachment are the biggest problems facing the management of the Gunung Gede Pangrango National Park (GGPNP), the largest remaining conservation area on the Island of Java. Therefore, various aspects related to the interests of community to meet their daily needs and their influence on their conservation behavior cannot be separated from the management. Deforestation and land degradation, and the decrease of forest area and quality, has occurred as a result of illegal logging and/or forest conversion, this reduce the quality and quantity of natural resources,

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timber and non-timber forest products, biodiversity, and decreases ecological services such as water sources (Vásquez-Grandón et al., 2018)

Tenurial conflicts between the national parks and village communities, are typical across all conservation areas in Indonesia and have continued for a long time. In GGPNP tenurial conflicts arise fro the expansion of the national park area, transferred from Perhutani's (State Owned Forest Company) land which is being managed by the Collaboration with Community Forest Management (PHBM) mechanism. With the addition of Perhutani land area, it has inherited several problems in the area, namely the existence of several degraded areas, in form of open areas grown with shrubs, secondary forest with Pinus and Agathis trees vegetation, and areas cultivated by former PHBM communities. The 2016 GGPNP area zoning data showed that the area of GGPNP was 24,615 Ha, of which 4,130 Ha (17%) was deforested areas and in much need of restoration efforts.

In efforts to solve tenurial conflicts, solutions are needed that can accommodate all interests of the conflicting parties. Community activities in forest areas that are unsustainable in nature can have adverse impacts on both the forest area and the communities themselves. On the other hand, the community are also potential resource for GGPNP to support efforts to conserve the area. Thus, the interests of the community in fulfilling their daily needs and their behaviour cannot be separated in the management of GGPNP.

Restoring degraded forest areas, require resorces (JICA RECA, 2014), Prihadi et al., 2018) that cannot be fully funded from the government budget. The allocation for environmental spending in 2010 was only 0.94 percent of the total central government budget. While in 2011 the allocatoon was 1.05 percent and in 2012 it was 1.19 percent (Hadi et al., 2013).

Since 2014, GGPNP Agency has implemented a cooperation programme with stakeholders or partners who have a commitment to support biodiversity conservation efforts, especially in the GGPNP conservation area. This form of support has been formalized as a cooperation agreement, outlining a work programme that support efforts to conserve biodiversity in conservation areas, alongside supporting community empowerment- based (community-based) forest ecosystem restoration in GGPNP.

In aperiod of six years (January 2014-December 2019), there 16 Cooperation Agreements (PKS) ratified and 7 PKS still ini process, which are carried out by GGPNP Agency with various cooperation partners. The purpose of the PKS is to support various conservation efforts, including the restoration of the area through a community empowerment-based forest restoration programme.

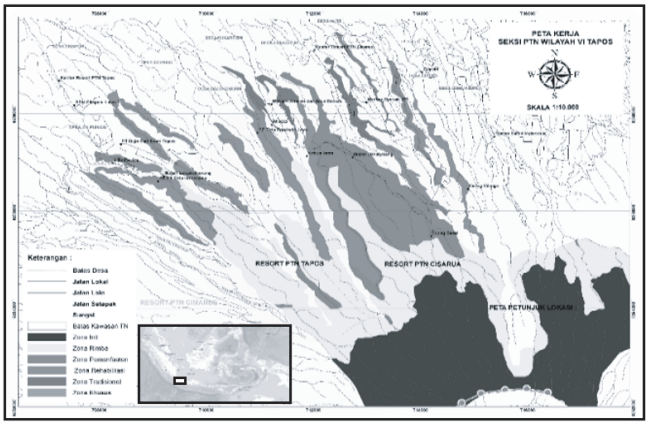

Figure 1. Map of Tapos Resort focal area , GGPNP.

METHODS

This research was carried out at the working area of the Tapos's National Park Management (PTN) of the GGPNP. Administratively it is located in Citapen village, Ciawi subdistrict, Bogor Regency, West Java Province. The research was conducted through an evaluation approach that focused on the condition that although the implementation of the empowerment-based forest restoration programme had continued for a long time, had encountered various problems including:

1) There is still a large land area cultivated by the community;
2) Not yet optimal activities regarding empowerment /switching from cultivators to other independent businesses;
3) Some independent business empowerment activities were not running optimally;
4) The task and function of implementing the programme (GGPNP officers) is not yet optimal in managing, monitoring and evaluating empowerment-based forest restoration activities.

The research was carried out using the CIPP (Context, Input, Process, Product) evaluation model (Stufflebeam & Shinkfield, 2007), through several steps of research: The first step was a literature study and observation aimed at gathering information and theories related to the implementation of community empowerment-based forest restoration programme, especially in the working area of Tapos. The second step was to carry out an evaluation of the community empowerment-based forest retoration programme to measure the feasibility of the programme and identify where recommendation could be made on improvements that would improve the performance of the programme.

Literature Study

An extensive literature review was undertaken for this research from experts (practitioners and academics) as well as experts in the environmental field, especially

regarding the application of the CIPP evaluation model, forest restoration, and community empowerment.

Data Collection

Data collection was carried out by means of observation, interviews and document analysis, to collect data, information and documentation related to community empowerment-based forest restoration programme at the PTN Tapos, GGPNP.

Evaluation Model

The evaluation model used in this study is the CIPP (Context, Input, Process, and Product) model developed by Stufflebeam & Shinkfield (2007). This evaluation model is an evaluation approach oriented towards decision makers (a decision oriented evaluation approach structured). The followings are the descriptions of CIPP evaluation models (Context, Input, Process, and Product):

Context evaluation

Context evaluation is often called as a needs assessment, asking "What needs to be done?" in assisting to assess problems, assets and opportunities in the context of a define community and environment (Stufflebeam & Coryn, 2014). Context evaluation discusses the steps of identifying programme targets starting from identifying the needs of service providers and the needs of the community who are the background of the programme (Zhang et al., 2011). Context evaluation contains the analysis of the strengths and weaknesses of certain objects, the relevance and linkages as well as the relevance and linkages of the programme. Context evaluation is also the most basic stage that has a mission to provide a rational/foundation for goal setting.

Input evaluation

Input evaluation assists in organizing decisions, determines existing sources, and asks: what alternatives to be taken?. What are the plans and strategies to achieve the goals?. What are the working procedures to achieve them?. The main orientation of input evaluation is to determine how programme objectives are achieved (Stufflebeam & Shinkfield, 2007).

Process evaluation

Process evaluation includes the collection of assessment data that has been determined and applied in programme implementation practices. Basically, the process evaluation is directed to find out how far the plans have been implemented in the programme and what components need to be improved.

Product evaluation

Product evaluation is an assessment conducted to measure the success of the programme in achieving the goals that have been set. The resulted data will determine whether the programme to be continued, modified or stopped.

RESULTS AND DISCUSSION

Context Evaluation

The results of the evaluation found that the main context of the programme activities was dealing with the key problem of encroachment in to the national park, which causes area fragmentation, deforestation and degradation. This align to the problems faced by conservation area management institutions, especially those that have expanded the conservation area, taking in areas of cultivation, without community involvement is still not optimal in utilizing the national park area in a sustainable manner in the form of community-based tourism management to support social, economic and community welfare. Diantoro (2011) stated that in general, the problems that have appeared followed the presence of national park policies (post establishment and gazettement of national parks) were more related to land disputes in the context of use and designation.

This happens when there is a differences in stakeholder interests that are conflicting, particularly interests for conservation purposes on the one hand and interests for cultivation purposes (production) on the other. The interest for conservation purposes requires limiting the use and ultilization of land, while on the contrary, the interest for the purpose of cultivation requires the use and utilization of the land to be as optimal as possible, to maximize production and yield thus necessitating conversion (conversion of function) from "idle" forest productive land.

The objectives of the community empowerment-based forest restoration programme are to restore degraded forests and achieve independence from smallholders and reduce dependence on cultivated land through forest restoration and empowerment activities. To achieve this goal, GGPNP and partners collaborated as outlined in the form of a Cooperation Agreement (PKS) with the scope of restoring ecosystem functions with community empowerment-based forest restoration activities.

This is in accordance with the policy for the formation of GGPNP Agency which was set through the Ministry of Forestry Decree Number P.03 / Menhut-II / 2007, where the main function is to control the impact of damage to living natural resources, sustainable use of living natural resources and their ecosystems and empowerment of communities in and around the area. The programme is based on Cooperation Agreements with partners, which is strengthened by applicable regulations, namely: Regulation of Director General of Conservation of Natural Resources and Ecosystems No. P.6/2018 on Technical Guidelines for

Table 1. Assesment result of Context evaluation.

Focus	Sub Focus/ Criteria	Parameter	Indicator	Score	Evaluaion Scoree	Value Aspect	Categor y Aspect
Context Evaluation	Background	Problems in form of land cultivation and land degradation are the main backgrounds of the programme	The programme background is in accordance with the GGPNP Agency policy, related to ecosystem restoration	5	5		
			The programme background is in accordance with the GGPNP Agency policy, but not related to ecosystem restoration	3			
			The programme background is not in accordance with GGPNP Agency policy	1			
	Legal Basis	The programme has clear and relevant regulations	Programme based on PKS (Colaboration Agreement) and legal regulations relevant to ecosystem restoration	5	5		
			Programme based on PKS and legal regulations that are not relevant to ecosystem restoration	3			
			The programme has absolutely no legal basis	1			
	Aim	Forest restoration and community independence	The programme aimed at restoring forests and increase community independence	5	5		
			The programme only aimed at restoring forests	3			
			The programme has objectives other than forest restoration and increasing community independence	1			
Total I					**15**	**100%**	**Good**

Conservation Partnership Cooperation in Nature Reserve Areas and Nature Conservation Areas; Minister of Environment and Forestry Regulation No. P.48/2016 concerning Ecosystem Restoration; Minister of Environment and Forestry Regulation No. P.43/2016 on Community Empowerment; and Minister of Environment and Forestry Regulation No. P.44/MENLHK/ SETJEN/KUM.1/6/2017 concerning Amendments to P.85/2014 concerning Cooperation in the Implementation of Nature Reserve Areas (KSA) and Nature Conservation Areas (KPA).

Input Evaluation

Forest restoration and community empowerment programme have adequate guidelines to support the implementation. RPP (Programme Implementation Plan) and RKT (Annual Work Plan) as the main guidelines detailing each type of activity along with the budget plan and the person in charge of the activity. In the implementation of the training, there are complete guidelines/instructions from credible institutions, namely:

a. Programme Implementation Plan (RPP);

b. Annual Work Plan (RKT);

c. Technical Guidelines for Restoration in Conservation Areas in Mountainous Tropical Rainforests and Tropical Monsoon Forests issued by KSDAE in collaboration with JICA;

d. Guidelines for Planting Procedures and Species Enrichment in the Context of Restoring Land Ecosystems in Nature Reserves and Nature Conservation Areas, originated from the Director General KSDAE Regulation No. P. 12/KSDAE-Se-V / 2015;

e. Guidelines for Honey Bee (*Trigona* sp.) Cultivation issued by *Balitbang* (Research and Development Agency) of Ministry of Environment and Forestry;

f. Ecotourism Training Materials issued by the Driving Team of Tegalwaru Bogor Business Tourism Village.

Table 2. Asesment result of Input evaluation.

Focus	Sub Focus/ Criteria	Parameter	Indicator	Score	Evaluation Score	value Aspect	Category Aspect
Input Evaluation	Guidelines / guidelines / implementation instructions	Guidelines / guides / instructions In good quality	The guidelines/guides/instructions used are complete and have a good quality according to the activities in the programme	5	5		
			Guidelines/guides/instructions used are incomplete and of less quality	3			
			There are absolutely no guidelines/guides/instructions	1			
	Strategy	Strategies prepared in the programme	The prepared strategy is able to support the implementation and objectives of the programme	3	5		
			The strategy prepared is able to support implementation but it did not pay attention to programme objectives	2			
			There is no strategy	1			
	Implementation organisation	Organization and human resources (HR) that carry out the programme	There is an organizational structure and competent human resources	5	3		
			here is no organizational structure, but there are competent human resources	3			
			There was no organizational structure and competent human resources	1			
Total II					**13**	**87%**	**Good**

In order for the implementation of the programme to run smoothly and achieve the stated objectives, various strategies have been designed as outlined in programme planning, namely:

g. Formation of Forest Farmers Group (KTH), formation of KTH facilitates the coordination between programme implementers and cultivators as programme participants. By making cultivators as programme participants they have the opportunity to provide a multiplier effect, namely the community received wages during the restoration programme and have increased their skills and knowledge through training so they are able act independently, and targets for forest restoration can be realized;

h. A strategy has been formulated to increase the capacity of community human resources through training activities and support for independent business infrastructure, including training on honey bee cultivation and ecotourism;

i. The KTH group that was formed was granted area management rights for ecotourism activities;

j. The strategy of selecting endemic and rare species as restoration plants can highlight the restoration location unique value which can encourage people's interest in visiting and has the potential to become an environmental-based tourism potential (ecotourism). As a programme that involves the role of external stakeholders in its implementation, the existence of an organizational structure is very important to support implementation of programme and minimize confusion over the obligations and responsibilities of each personnel either from within (officers) or from outside parties (partners). Based on the results of the research, GGPNP Agency did not specifically form an organization responsible for the implementation of the programme, instead each officer has a clear duty and function that is inherent in his or her position to support the programme. A clear organizational structure is required in operating the programme so that the implementing staff can be formed from competent and qualified human resources (Jones et al., 1991).

Process Evaluation

Based on the research results, the entire programme implementation did not all progress according to plan. All activities that were part of the scope of activities as contained in the PKS document generally contained in the RPP and RKT had been carried out in order to fulfill obligations as in the PKS document, however several activities were found not to have been implemented in the previous year, which were in turn then planned (carry over) to be carried out in the following year. Especially in the implementation of forest restoration, the implementation of activities must be carried out continuously and sequentially, any activities that were not able to be carried out for 1 fiscal year, would then affect plant growth conditions. For example, if planting has been carried out, but there is a delay in plant maintenance, this would likely interfere with the plant growth and even may cause plants to die

which of course would affect the achievement of the programme goals.

Table 3. Assesment result of Process evaluation.

Focus	Sub Focus/ Criteria	Parameter	Indicator	Score	Score Evaluation	Aspect value	Category Aspect
Process Evaluation	The suitability of planning with implementation	Programme realization is in accordance with the targets planned in the RKT/RPP	100% of planned activities can be carried out	5	3		
			Activities completed but not entirely	3			
			Not implemented at all	1			
	Inhibiting factors	There are factors that hinder programme implementation	There are no obstacles in implementation	5	3		
			There are obstacles ,but solution was found in implementation	3			
			There are obstacles that cannot be found a solution	1			
	Supporting factors	There are factors that support the implementation of the programme	There is support for implementation in accordance with programme objectives	5	5		
			There is support in implementation but it was different from programme objectives	3			
			No support at all	1			
Total III					**11**	**73%**	**Sufficient**

There were several problems faced during programme implementation in the forms of:

k. Less optimal performance of the third party appointed by the partner. This directly affected the realization of the achievement of the target activities to be achieved where there was in one budget year, namely in 2019 there was no activity at all, the solution to this problem was to include 2019 activities in the 2020 activity plan;

l. There was a problem where the topography of the land was so steep that it was not possible to plant this area, this will affect the success of the target size of area to be restored. The solutions implemented by the programme implementers were to narrow the spacing or planting distance and carry out planting according to the targeted amount of trees planted. The strategy of selecting endemic and rare species as restoration plants can give the restoration location an object of unique value which is expected to encourage people's interest in coming and has the potential to become an environmental-based tourism potential (ecotourism). As a programme that involves the role of external stakeholders in its implementation, the existence of an organizational structure is very important to support programme implementation and minimize confusion over the obligations and responsibilities of each personnel both from within (officers) and from outside parties (partners). Based on the research results, GGPNP Agency does not specifically form an organization that is responsible for programme implementation, it is based on the fact that each officer has a duty and function that is inherent in his position. A clear organizational structure is required in operating the programme so that the implementing staff can be formed from competent and qualified human resources (Jones et al., 1991);

m. The difficulty of maintaining the cohesiveness of KTH members, so that they remain committed to running and achieving programme goals. The solution is for GGPNP Agency to continue to provide assistance in the implementing the programme after the cooperation with partners has ended.

Apart from the problems that hamper programme implementation, there are several factors that were found to support programme implementation and objectives, namely:

n. Assistance for honey bee hive from parties outside the programme;

o. There is a camping equipment grant, including fly sheets and tents from visitors to the ecotourism site;

p. There is cooperation with scouts and nature lover groups in tourism management to build tourist facilities as a vehicle for knowledge transfer and

management;

q. There is guidance from the Litbang (Research and Development Agency) of the Ministry of Environment and Forestry to KTH members related to honey bee cultivation, and;

r. The village plan to propose honey bee cultivation and ecotourism activities as a village programme in order to obtain guidance and support from the local government. This increases the optimism of the KTH group to seriously run and manage the ongoing programme.

Product Evaluation

The implementation of restoration activities as part of the programme activities has been carried out sequentially according to the forest restoration stages. From 2017 to 2019, planting of 41 Ha (55%) has been carried out, not in accordance with the target area of 75 Ha. The report on the results of implementation of activity showed the target number of trees planted can be achieved with the number of trees planted as many as 21,350 from the target of 28,350 stems (75%).

Table 4. Assesment result of Product evaluation.

Focus	Sub Focus/ Criteria	Parameter	Indicator	Score	Evaluation score	Aspect Value	Aspect Category
Product Evaluation	Forest restoration	% area and plants grown	100 <X> 75% of the area has been restored to forest and living plants were in good condition	5	3		
			75% <X> 50% of the area restored to forest and living plants in good condition	3			
			50% < area restored to forest and the living plants in good condition	1			
	Independence and community participation in the conservation of the GGPNP area	The amount of farmers who have switched their business from cultivating the land (destructive) to other independent businesses (constructive)	100% of cultivators participating in the programme switched their businesses independently (not dependent on cultivated land)	5	5		
			> 50% of cultivators participating in the programme switched their businesses independently (not depending on cultivation land)	3			
			Ccultivators of programme participants still depend on cultivation land	1			
Total IV					**8**	**80%**	**Good**

The decision to revise the density has an effect on the number of plants per hectare, from the original RPP based on the average number of plants 275 stems/Ha to 500 - 1,000 stems/Ha. However, in accordance with the Minister of Environment and Forestry Regulation P.105/2018 stated that intensive reforestation is carried out in conservation areas and prioritized in areas that already have an Ecosystem Recovery Plan (RPE) with a density of plants between 625 to 1,100 stems/Ha. The results showed that KTH members as programme participants have a strong desire to increase capability and increase independence, all KTH members have left their activities to cultivate land and are trying to develop honey bee cultivation that is integrated with ecotourism locations which in its management is handed over to KTH which also has Business Permit for the Provision of Natural Tourism Services (IUPJWA) for the provision of food and beverages. The results of KTH honey bee cultivation have now shown good results. In the beginning the programme provided four (4) hives, which has now been scaled to 64 hives. The average outputs from one (1) hive per month is 300 grams of honey, which is then sold for approx. IDR 150,000 per 250 gram bottle.

CONCLUSION

Based on the results of evaluation research on community empowerment-based forest restoration programme in the work area of the PTN Tapos GGPNP the following conclusions can be drawn:

a. Evaluation of the context is good, because the background of programme implementation is in accordance with the GGPNP Agency policy direction, there is a legal basis that covers the implementation of the programme and the programme objectives are supporting the objectives of managing GGPNP.

b. Evaluation of input is good, because there are clear guidelines/ instructions in programme implementation, there are strategies developed to

support the achievement of programme objectives and programme implementers play a good role according to their respective duties and functions even though there is no programme implementing organizational structure specially made during the programme was running.

c. Process of evaluation is considered sufficient, because there is a mismatch between programme implementation and planning, there are obstacles in the implementation of the programme but there are solutions to existing obstacles, and there is external support in programme implementation that helps the programme's success.

d. The evaluation of the product is good, because the former encroachment area has been successfully restored even though it is does not cover the target area (55%), the number of trees planted and growing well has reached 75% of the target set. The encroachers targeted by the programme for community empowerment efforts in the form of ecotourism management and honey bee cultivation. This is in line with the results of research by Qodriyatun (2016) which showed that ecosystem restoration activities provide a direct contribution to improving the welfare of communities around the forests through community empowerment activities carried out by ecosystem restoration concession holders.

e. The results of the evaluation research on community empowerment-based forest restoration programme in the working area of the PTN Tapos GGPNP Resort show that overall it is well implemented. Even though in its implementation the number of encroachers who were successfully excluded and the area of cultivated land that was successfully restored did not reach 100% target, the community empowerment-based forest restoration programme could be continued, but some improvements are still needed related to the organization of programme implementers, strengthening the commitment of partners in cooperation and adjustments between the target area and the amount of trees planted, and the strategy for selecting the tree species.

RECOMMENDATIONS

Recommendations for the implementation of a community empowerment-based forest restoration programme in the working area of the PTN Tapos GGPNP Resort include:

a. Evaluation of Context – it is necessary to review and enrich the legal basis of programme implementation with other legal products that accommodate various community interests in order to meet the expected quantity and quality, and align the background and objectives of programme implementation with the vision and mission of GGPNP Agency and the objectives of the management of the GGPNP area.

b. Input Evaluation – to improve the quality of planning for area restoration activities through forest restoration and community empowerment carried out with a cooperation scheme between GGPNP Agency and partners, it is proposed that guidelines to be drawn up related to the preparation of RPP (Programme Implementation Plan) and RKT (Annual Work Plan) which contain implementation steps with budgeting adjusted to cost standards (NSPK) issued by the Director General of KSDAE (Conservation of Natural Resource and Ecosystem) or can refer to the *Perdirjen* (Regulation of Director General) PDASHL No.4/2018 concerning Guidelines for Technical Design Preparation. GGPNP Agency can carry out its role to issue warning to cooperation partners if things are found not to be in accordance with the planning documents, and build multi-stakeholder cooperation or collaboration by adhering to the principles of mutual respect, mutual trust and mutual benefit. The training material should not only be in technical terms but also provide EQ (Emotional Quotient) training because including the ability to manage emotions and the ability to motivate stakeholders plays an important role in the continued success of a programme, as encroachers have a low educational background it is key to utilize an emotive approach. It is better if the organizational structure for implementing the programme is made/ defined so that it is clearer and more focused regarding the duties and functions in terms of assistance and supervision of programme implementation.

c. Process Evaluation – the evaluation system that has been conducted by GGPNP Agency so far should still be used for future programme by considering the input from the evaluation results in order for the programme quality becoming even better. The implementation of the programme requires a high commitment from both parties working together on agreed matters and applies four principles of governance, namely: 1) participation; 2) openness; 3) collective responsibility; and 4) accountability in order to solve problems and develop the potential of conservation areas and their buffer areas so that the objectives of programme implementation are achieved as targeted. There needs to be an adjustment to the target area plan with the density of trees to be planted by referring to Ministry of Environment and Forestry Regulation of P.105/2018 concerning Implementation Procedures, Support Activities, Incentives, and Development and Control of Forest and Land

Rehabilitation Activities. The strategy for selecting plant species must take into account the ecological, social and economic factors of local forest species. In terms of ecological factors, namely in accordance with the area concerned (local species) and economic factors must consider high selling value and from the social aspect it can be accepted by the community as a developed species (elite product) which can improve the sustainability of the economic and social functions of the people living around it. In tree planting, it is very important to follow the sequential steps of planting till maintenance is reached, in accordance with the recommed time frame. Delaying one of these steps can risk planting failure, therefore there needs to be a strong commitment from the parties concerned so that the stages of carrying out activities can be realized as planned. We recommend that bringing in instructors/ resource persons who are not only familiar with the material and are experienced in their fields but also help build networks in the promotion and marketing process.

d. Product evaluation – the implementation of forest restoration activities should still prioritize the achievement of the target area to be restored by taking into account the field conditions that are more feasible for planting so that the target area can still be achieved, although plant distance/spacing is less, it is expected that natural regeneration/succession will occur in the future in restoration area. Area restoration activities through forest restoration and community empowerment should be carried out by local communities with the aim of building a sense of community care and increasing success. This can be realized if the community institutions involved are independent and strong, in this case the LBC Lestari Forest Farmer Group, so that all requirements and qualifications in technical implementation in the field can be delegated to KTH (Forest Farmer Group).

e. It is necessary to revise the implementation of the future community empowerment-based forest restoration programme at GGPNP Agency by considering the results of the CIPP evaluation that has been carried out in an effort to improve the implementation of subsequent programme.

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A preliminary study of bird and mammal diversity within restoration areas in the Gunung Gede Pangrango National Park, West Java, Indonesia

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ABSTRACT

Since 2008, Conservation International Indonesia (CI Indonesia) has been working together with Gunung Gede Pangrango National Park (GGPNP) to develop ecosystem restoration program in extended critical land area of National Park. More than 120,000 trees of 8 native species trees planted in an area of 300 hectares. Now the ecosystem has been restored and provides multiple benefits including become a new habitat for wildlife. A preliminary study on birds and mammals diversity in restored area was conducted from April to May 2018 in Nagrak Resort, GGPNP. The aim of this study is to assess the diversity of birds and mammals within ecosystem restored in the GGPNP. Bird surveys use point counts method, and mammals use camera trap. The results showed a total of 33 bird species of 22 families with the total number recorded of 1,881 individuals. A total of 10 mammal species of 7 families were captured in the study area with a total of 623 trap days produced 113 independent photos of mammals. The species of mammals consist of Javan leopard (*Panthera pardus melas*), Leopard cat (*Prionailurus bengalensis*), Common palm-civet (*Paradoxurus hermaphroditus*), Small indian-civet (*Viverricula indica*), Javan gold-spotted mongoose (*Hervestes javanicus*), Muntjac (*Muntiacus muntjac*), Long-tiled macaque (*Macaca fascicularis*), Javan porcupine (*Hystrix javanicus*), Wild boar (*Sus scrofa*), and Malayan field rat (*Rattus tiomanicus*). The results obtained are evidence that restoring ecosystems is important not only for social and economic aspects but also ecology for wildlife. The data gathered in this study will provide an important basis for future research and conservation management, and also provide support for biodiversity monitoring.

ABSTRAK

Sejak tahun 2008, Conservation International Indonesia (CI Indonesia) bersama Taman Nasional Gunung Gede Pangrango (TNGGP) mengembangkan program pemulihan ekosistem di area perluasan taman nasional. Lebih dari 120.000 dari 8 jenis pohon jenis asli taman nasional telah ditanam di luasan 300 hektar. Kini kondisi area telah menjadi hutan kembali dan menyediakan berbagai jasa ekosistem termasuk menjadi habitat satwa liar. Studi pendahuluan tentang keanekaragaman jenis burung dan mamalia di area restorasi dilakukan selama 2 bulan yaitu dari bulan April hingga Mei 2018 di Resot Nagrak TNGGP. Survei burung menggunakan metode *point count*, sedangkan mamalia dengan menggunakan *camera trap*. Hasil menunjukkan sebanyak 33 jenis burung dari 22 famili dengan jumlah total tercatat 1.881 individu. Terdeteksi 10 jenis mamalia dari 7 famili di area penelitian dengan total 623 hari rekam dan menghasilkan 113 foto independen mamalia. Jenis mamalia tersebut yaitu Macan tutul jawa (*Panthera pardus melas*), Kucing hutan (*Prionailurus bengalensis*), Musang luwak (*Paradoxurus hermaphroditus*), Musang rase (*Viverricula indica*), Garangan jawa (*Hervestes javanicus*), Kijang (*Muntiacus muntjac*), Monyet ekor panjang (*Macaca fascicularis*), Landak jawa (*Hystrix javanicus*), Babi hutan (*Sus scrofa*), dan Tikus belukar (*Rattus tiomanicus*). Hasil yang diperoleh menjadi bukti bahwa memulihkan ekosistem penting tidak hanya dalam aspek sosial dan ekonomi namun juga ekologi bagi satwa liar. Data yang dikumpulkan dalam penelitian ini akan memberikan dasar penting untuk penelitian masa depan dan manajemen konservasi, dan juga menyediakan dukungan untuk pemantauan keanekaragaman hayati.

Keywords: *Birds, camera trap, diversity, mammals, restoration*

INTRODUCTION

Land degradation is one of the major environmental issues of the 21st century because of its impact on biodiversity, food security and environmental quality (Butchart et al., 2005). Ecosystem restoration on a landscape level, alongside the sustainable management of other land-use types including agriculture, pasturelands, forestry, and the expansion and consolidation of protected areas, is increasingly recognized as a necessary part of a package of activities for biodiversity conservation, enhanced ecosystem services and sustainable development (Aronson and Alexander, 2013; Menz et al.,2013a; Rey Benayas et al., 2009; Bullock et al., 2011).

Restoration activities are not typically conducted with the goal of restoring a single ecosystem service. Rather, there is an implicit understanding that 'healthy' of ecosystems provide a large number of services and can serve to increase multiple ecosystem services (Bernhardt et al. 2005). Restoration can be enhancing

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native ecosystem functions and avoiding further reduction or conversion of natural habitat cover, or loss in other natural ecosystems (Latawiec et al., 2015).

Many protected areas are embedded within human-modified landscapes, where agriculture and urbanization have determined landscape structure and may represent major disturbances to natural ecosystems. Habitat loss and fragmentation are a major threat to biodiversity conservation in this context (Melo et al., 2013a).

The restoration of areas next to forest fragments should reduce edge effects as well as provide additional habitat, which should result in an increase in population size for several species, reducing the chances of future extinction. A small number of cases have demonstrated that restored areas can indeed provide additional suitable habitat for forest species (Donner et al., 2010; Reid et al., 2014).

In general, there is a lack of studies on the recovery of wildlife in reforested areas (Block et al., 2011), possibly because it is assumed that if the flora is re-established then wildlife will return to the reforested areas (Thompson and Thompson, 2004). However, animals provide important ecosystem function and if restored areas are to be implemented to reduce habitat loss and improve biodiversity, reforested areas also need to provide appropriate habitat to native fauna (Santos et al., 2016).

Many bird species can be highly dependent on forests (Seaman and Schulze, 2010; Gillies and Clair, 2008). These species occur exclusively or preferentially in the forest interior, suggesting that their performance is directly related to tree size and density (Seaman and Schulze, 2010). Birds are widely used as bioindicators for the monitoring of ecosystems under restoration, as they commonly present fast responses to forest development (Morrison et al., 2010; Lindell et al., 2012), and perform important ecological functions such as pollination, seed dispersal, and predation (Slocum and Horwitz, 2000; Zamora and Montagnini, 2007). Furthermore, mammals play an important role in ecosystems by providing essential services, such as regulating insect populations, seed dispersal, pollination, and ecosystem engineering (Beck, et al., 2010). They also act as indicators of general ecosystem health and are sensitive to anthropogenic disturbances that cause changes in the environment (Feldhamer et al., 2014).

According Supriatna (2006), an island of about 130,000 km^2, Java has been overcrowded for the last 200 years. Most of the natural forests remaining are in national parks or other, variously effective, forms of protected areas, including those for watershed conservation. Large areas of forest cover on the island are tree plantations (teak, pine, and others), mixed community forests, or forest research areas (silviculture). Java continues to lose its forests - significantly so following the Indonesian government's decentralization of forest management to the regencies. The major cause of natural forest loss today is not, however, industrial-scale logging, but encroachment and depredation by smallholders - tree cutting for subsistence plots, collection of firewood, forest fires, and charcoal production.

As a conservation area in West Java province, Gunung Gede Pangrango National Park (GGPNP) plays an important role as a biodiversity reserve. It was recorded that about 900 native and 30 exotic plants species, 1,500 species of flower plants, 400 species of ferns, 250 species of birds, 300 species of insects, 110 species of mammals, 75 species of reptiles, and five species of primates (Wiratno et al., 2004). In 2003, there were 7,655 hectares expansion of ecosystems in the GGPNP, consist of former tree plantations managed by Perhutani (Forestry State Enterprise), and bare or degraded lands. Species of the plantation are Merkus pine (*Pinus merkusii*), Rasamala (Altingia excelsa), and Dammar pine (Agathis dammara). Several parts of the expansion area are being encroached by local communities for small scale agricultural activities. The land that is being encroached on are typically on the slopes of the mountain, with steepness of more than 300°, and are very sensitive to landslides and soil erosion.

Vegetation on the bare lands typically consists of shrubs and tall grasses and often cleared by the communities to be used for short-term agriculture activities.

Since 2008, Conservation International Indonesia (CI Indonesia) has been working together with GGPNP to develop of "the green wall" ecosystem restoration program to restore ecosystems of 300 hectares at critical land in extended area of national park. The green wall is a comprehensive restoration approach that integrates the planting trees efforts with community empowerment, education/outreach and biodiversity monitoring surveys, and putting the people as the main actors and beneficiaries of the ecosystem restoration. There were 120,000 native species of trees and additions 15,000 fruit trees planted as a green belt in an area of 300 hectares. Consequently, today, the ecosystem has been restored and provides multiple benefits to the communities, i.e fresh water, landslide preventions, habitats of wild and endangered animals, locations for education and research, recreation areas and alternative livelihoods. After 10 years, a variety of research will inform and support the ecosystem restoration program in GGPNP. Biodiversity monitoring system is in place to update and enrich the scientifically based biodiversity information for restored sites are required. Therefore, the aim of this study is to assess the current diversity on mammals and bird within ecosystem restored in the GGPNP.

Table 1. List of bird diversity on six-point observations.

Family	Common name	Scientific name	Local name	Point 1 (N)	Point 2 (N)	Point 3 (N)	Point 4 (N)	Point 5 (N)	Point 6 (N)
Nectariniidae	Javan sunbird	*Aethopyga mystacalis*	Burung madu jawa	4	5	6	5	1	5
Cuculidae	Little spiderhunter	*Arachnothera longirostra*	Pijantung kecil	12	20	8	12	12	6
	Plaintive cuckoo	*Cacomantis merulinus*	Wiwik kelabu	6	12	0	6	12	0
	Lesser coucal	*Centropus bengalensis*	Bubut alang-alang	24	0	0	6	12	0
Silviidae	Rusty-breasted cuckoo	*Cacomantis sepulcralis*	Wiwik uncuing	18	6	0	6	6	0
	Olive-backed tailorbird	*Orthotomus sepium*	Cinenen jawa	42	12	12	36	0	12
Dicruridae	Bar-winged prinia	*Prinia familiaris*	Perenjak jawa	30	13	12	8	18	7
	Ashy drongo	*Dicrurus lecophaeus*	Srigunting kelabu	6	7	0	6	1	0
Dicaeidae	Black drongo	*Dicrurus macrocercus*	Srigunting hitam	7	6	1	6	6	0
	Scarlet-headed flowerpecker	*Dicaeum trochileum*	Cabai jawa	13	6	13	0	25	0
Alcedinidae	Orange-bellied flowerpecker	*Dicaeum trigonostigma*	Cabai bunga api	20	0	13	0	7	0
	Javan kingfisher	*Halcyon cyanoventris*	Cekakak jawa	18	2	6	7	12	0
Picidae	Collared kingfisher	*Todirhamphus chloris*	Cekakak sungai	14	6	0	13	18	1
	Fulvous-breasted woodpecker	*Dendrocopos macei*	Caladi ulam	24	14	0	21	0	6
Accipitridae	Sunda woodpecker	*Dendrocopos moluccensis*	Caladi tilik	18	0	18	12	18	12
	Black eagle	*Ictinaetus malaiensis*	Elang hitam	12	12	0	0	0	0
Pycnonotiidae	Javan-hawk eagle	*Nisaetus bartelsi*	Elang jawa	6	0	0	0	0	0
	Sooty-headed bulbul	*Pycnonotus aurigaster*	Cucak kutilang	48	6	18	24	24	30
	Yellow-vented bulbul	*Pycnonotus goiavier*	Merbah cirukcuk	39	14	18	25	6	38
	Black-capped bulbul	*Pycnonotus melanicterus*	Cucak kuning	50	3	27	30	30	0
Chloropseidae	Common iora	*Aegithina tiphia*	Cipoh kacat	30	0	18	24	12	8
Apodidae	Little swift	*Apus affinis*	Kapinis rumah	18	6	12	24	0	0
Ploceidae	Javan munia	*Lonchura leucogastroides*	Bondol jawa	39	0	12	30	5	0
Zosteropidae	Common white-eye	*Zosterops palpebrosus*	Kacamata biasa	8	2	11	2	11	6
Accipitridae	Changeable hawk-Eagle	*Nisaetus cirrhatus*	Elang brontok	12	6	0	0	0	0
Sittidae	Velvet-fronted nuthatch	*Sitta frontalis*	Munguk beledu	0	12	12	0	6	0
Artamidae	White-breasted wood-swallow	*Artamus leucorhynchus*	Kekep babi	6	12	0	0	18	0
Cuculidae	Red-billed malkoha	*Phaenicophaeus javanicus*	Kadalan kembang	6	6	6	12	0	0
Strigiformes	Collared scopsowl	*Otus lempiji*	Celepuk reban	0	0	6	0	6	0
Phasianidae	Chestnut-bellied partridge	*Arborophila javanica*	Puyuh gonggong jawa	24	6	0	24	12	6
Timaliidae	Horsfileld's babbler	*Melacocincla sepiarium*	Pelanduk semak	6	6	18	0	24	0
Columbidae	Spotted dove	*Streptopelia chinensis*	Tekukur biasa	30	0	12	24	6	6
Laniidae	Long-tailed shrike	*Lanius schach*	Bentet kelabu	6	6	6	0	0	0
				596	206	265	363	308	143

METHODS

Study Area

The study was conducted from April to May 2018 in Nagrak Resort, Gunung Gede Pangrango National Park (GGPNP) West Java, Indonesia. GGPNP is a conservation area that has management system to protects the last of the remaining tropical rain forest remnants in Java. and one of the few conservation areas in the region that is well preserved. Established in 1980 as one of the first national parks in Indonesia, it has been declared one of six Biosphere Reserves in Indonesia by UNESCO (Wardojo, 1997). The GGPNP has a total area of 24,270 hectares and contains high biodiversity, as home to the endangered Javan gibbon (Hylobates moloch), Javan hawk eagle (*Nisaetus bartelsi*), Javan leopard (*Panthera pardus melas*), Grizzled leaf monkey (*Presbytis comata*), Javan slow loris (*Nycticebus javaniscus*), and many other threatened endemic species. A majority of the park consists of tropical mountain forest ecosystem at an altitude between 700-3,019m asl. The study area covered 300 hectares (106°50'13.55'' E / 06°49'08.57'' S) at an altitude range from 600 -700m asl (Figure 1).

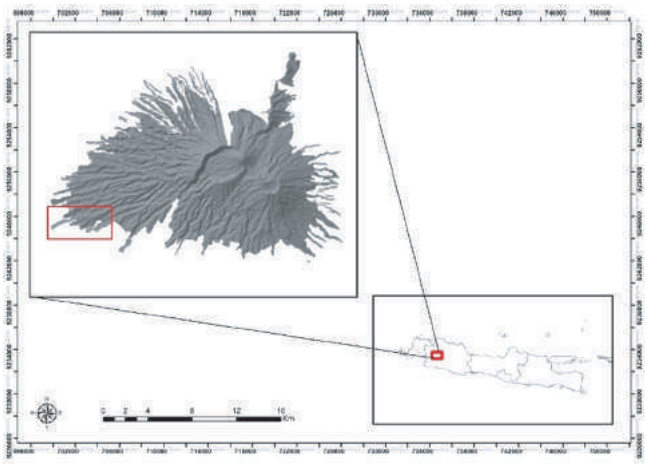

Figure 1. The map of study area at restored areas in GGPNP.

Data collection and Analysis

For bird survey, data were collected using point count method (Bibby et al., 2000) on 20 days, in the beginning with increased bird activity (6:00-10:00 a.m.) and late afternoon (3:00-5:00 p.m). Six-point counts were surveyed once per day in each morning and afternoon. The time for sampling in each point was 15 minutes, and another 15 minutes was the time necessary for the displacement of the observer from one point to another. Only birds seen were recorded in study area. Bird richness and abundance were defined as the total number of species and total number of contacts respectively.

We used Shannon-Weiner diversity index H' (Shannon, 1948), and followed Kiros et al., (2018) to analyse bird diversity was calculated as:

$$H' = -\sum_{i=1}^{s}\left(\frac{ni}{N}\right)\times \ln\left(\frac{ni}{N}\right)$$

Where H' = index of species diversity, ni is the number of individuals in a species, S is the total number of species (species richness), and N is the total number of individuals. With the criteria: H'<1 a low level of species diversity, 1 <H'<3 a moderate level of species diversity, H'> 3 indicates a high level of species diversity.

Evenness index (J') was calculated by following the equation:

$$J' = \frac{H'}{\ln S}$$

Where: H' = Shannon Weiner diversity index and S = Number of species. With the criteria: J' ≤ 0.4 low evenness, 0.4 < J'<0.6 moderate evenness, J'≥ 0.6 high evenness.

Richness index (D) was calculated by the following equation:

$$D = \frac{S-1}{\ln N}$$

Where: D = Richness index, S = Total number of species and N = Total number of individuals. With the criteria: D <2.5 a low level of species richness, 1.5> D> 4 a moderate level of species richness, D> 4 a high level of species richness.

For mammal survey, we deployed a single of 10 camera traps at 10 trapping stations on the study area, encompassing an area of approx. 15 km². We deployed camera traps a location with evidences of mammal's presence e.g. footprints, faeces, urine, as well as scratch on the trees to maximise the chances of positive recording. We visited checked camera conditions, replaced batteries and memory cards approx. once every month. All results were entered into database for monthly sampling categories. Relative abundance Index (RAI) of mammals species was determined using encounter rates that give basic ordinal scales of abundance (O'Brien et al., 2003; Kawanishi and Sunquist, 2004). It was calculated as:

RAI= SF/TD*100

Where: RAI = Relative Abundance Index; SF = number of species photograph, TD = trap days

RESULTS

Birds diversity

Of 1,881 bird observed, there were 22 bird families and 33 species recorded in the six point sites sample (Table 1). The total number was recorded of 596 bird individuals consist of 31 bird species at point 1 (596 individuals). Meanwhile, there were 25 bird species recorded from point 2 (206 individuals), 22 birds from point 3 (265 individuals), 23 birds from point 4 (363 individuals), 25 birds from point 5 (308 individuals), and 15 birds from point 6 (143 individuals) (Table 1).

Based on Shannon Weiner analysis showed the level of diversity is a moderate at point 3,4,6 to high at point 1,2,5 category. The level of evenness is high found at point 1-6 category, and the level of species richness is low (point 6), moderate (point 3-4), and high (point 1-2) (Table 2).

Mammals diversity

A total of 10 mammal species of 7 families were captured in the study area. From April to May 2018, a total of two survey periods and 4 samplings were undertaken. A total of 623 camera trap days produced 113 independent photos of mammals (Table 3).

Table 2. Overall diversity, evenness and species richness indexes birds.

Point	S	N	H'	Category	J'	Category	D'	Category
1	31	596	3.206	High	0.934	High	4.695	High
2	25	206	3.084	High	0.958	High	4.129	High
3	22	265	2.970	Moderate	0.961	High	3.764	Moderate
4	23	363	2.932	Moderate	0.935	High	3.733	Moderate
5	25	308	3.020	High	0.938	High	4.188	High
6	15	143	2.221	Moderate	0.820	High	2.821	Low

(S)=total number of species, (N)=total number of individuals
(D')=species richness index, (J')=Evenness index and (H')=Shannon diversity

Table 3. Mammals diversity undertaken by camera trap during April to May 2018

Family	Common name	Scientific name	Local name	Number of pictures	%	RAI
Felidae	Javan Leopard	*Panthera pardus melas*	Macan tutul jawa	4	3.54	0.64
	Leopard cat	*Prionailurus bengalensis*	Kucing hutan	10	8.85	1.61
Viverridae	Common palm-civet	*Paradoxurus hermaphroditus*	Musang Luwak	15	13.27	2.41
	Small indian-civet	*Viverricula indica*	Musang rase	6	5.31	0.96
Herpestidae	Javan gold-spotted mongoose	*Herpestes javanicus*	Garangan jawa	10	8.85	1.61
Hystricidae	Javan porcupine	*Hystrix javanicus*	Landak jawa	6	5.31	0.96
Suidae	Wild boar	*Sus scrofa*	Babi hutan	30	26.55	4.82
Cervidae	Muntjac	*Muntiacus muntjac*	Kijang	2	1.77	0.32
Cercopithecidae	Long-tiled macaque	*Macaca fascicularis*	Monyet ekor panjang	22	19.47	3.53
Muridae	Malayan field rat	*Rattus tiomanicus*	Tikus belukar	8	7.08	1.28

RAI=Relative Abundance Index

Figure 2. The condition of restoration areas, before and after.

RESULTS

The one of objective of reforestation program is to restore the forest ecosystem in the GGPNP, that provides habitat healthy for birds and mammals and other wildlife. After 10 years, the program achievement are 120,000 forest trees planted in an area of 300 hectares (Table 4), and the area now turned into a forest area (Figure 2). Number of indicators based on the monitoring in 2018 showed that the ecosystem functions has been restored, including the living of wildlife animal in the region.

Based on last annual monitoring that was carried out in November 2017, data on the development of trees planted were growth, namely 114,000 (95%) in good / living conditions and 6,000 (5%) trees that no growth or dead. All dead trees are always replaced with new ones (embroidery). Based on routine monitoring, three tree species were recorded that were quite strong even

Table 4. Native species of trees planted period 2008-2018

Native species	Number of trees
Rasamala (*Altingia excelsa*)	9,000
Puspa (*Schima wallichii*)	5,200
Manglid (*Magnolia blumei*)	41,700
Suren (*Toona sureni*)	20,500
Kisireum (*Syzigium rostrattum*)	2,200
Salam (*Eugenia clavimirtus*)	16,400
Janitri (*Elaeocarpus pierrei*)	15,000
Lame (*Alstonia scholaris)*	10,000
Total	**120,000**

in bad weather conditions, namely Manglid (*Maglonia blumei*), Kisireum (*Syzigium rostrattum*), and Salam (*Eugenia clavimirtus*). Until now it is known that the average plant growth of each species per year ranges from 57 to 120.5 cm and the average growth of stem diameter per species per year ranges from 6.5 to16.2 cm.

Birds are commonly used as indicators of biodiversity, especially where numbers of species are high (Larsen et al.,2012). Birds are widespread around the world, diverse and sensitive to changes lower down in the food chain and persistent pollutants. Furthermore, bird ecology is on the whole well understood, making it easier to interpret their fluctuations (Gregory, 2006).

The average overall species richness, abundance and density were high at Sooty-headed bulbul (*Pycnonotus aurigaster*) (Figure 3), Yellow-vented bulbul (*Pycnonotus goiavier*), Black-capped bulbul (*Pycnonotus melanicterus*), and Javan munia (*Lonchura leucogastroides*). In this study, the three bulbul species were the most common species along in the restored area. These bird species are commonly found on the edge of the forest, which are types of fruit feeders, seeds and insects, and are tolerant of habitat changes.

Several of bulbul species are known for their tolerance for human-disturbed areas and secondary forest (Corlett and Hau, 2000). As facultative frugivore consumers, bulbuls are important as seed dispersers and colonists (Corlett, 1998) as they eat the small fruits of pioneer trees (Thornton, 1997). Their high abundance observed in the forest edge may be as an indicator that regeneration of the forest edge is slowly taking place.

The level of restoration, i.e low, moderate and high categories can be influencing to the condition of the restored area. Tree planting time in the 300-hectares area is divided into two periods. First period was 2008-2010 and the second period was 2010-2012. The next period which began in 2013 was used to maintain the trees that had been planted. Therefore, the level of tree growth in the restoration area varies. Trees planted in the initial period have growth rates reaching more than 10 m trees high and tree canopies have been sustained, such as at point posts of 1,2, and 5. Whereas trees planted in the last period of tree growth rates are below 10m high, such as at point locations 3, 4, and 6.

The high number observed of Black-capped bulbuls at the forest edge suggests that the species could play an important role in restoration of secondary forest (Wunderle, 1997). Forest edge may be able to attract seed dispersing birds will be depended on agricultural gardens, where food availability remains high (Parrotta et al.,1997).

In addition to the common birds, during the observation, there were 3 species of eagles, namely Javan hawk eagle (*Nisaetus bartelsi*), Black eagle (*Ictinaetus malaiensis*) and Changeable hawk-eagle (*Nisaetus cirrhatus*). These three species are predator whose existence is found when perched on the study area. Their presence is due to the restoration area adjacent to the national park's natural forest which is known as the habitat of the three species of eagles.

Figure 3. Sooty-headed bulbul (*Pycnonotus aurigaster*) in study area (Photo by CI).

Reforested areas usually have a lower number of bird species that prefer forest habitats and recolonizing bird species tend to be opportunists, as well as generalist species (Critescuetal, 2012). Birds tend to respond well to reforested areas will usually present similar bird richness to reference forest areas, however, bird composition will usually be different (Munro et al., 2011; Catterrall et al., 2012; Freeman et al.,2015).

In Table 3 shows the highest of relative abundance index (RAI) in two species of mammals, e.g wild boar (*Sus scrofa*) and long-tailed macaque (*Macaca fascicularis*). These two species are tolerant mammals and are commonly found on the edge of the forest even to village areas and are occasionally considered as pests because they damage agricultural products of the village community. Beside both species are in group and produce many offspring.

The wild boar (*Sus scrofa*) is one of the most widely distributed ungulates in the world due to its high reproductive rate, adaptability, and opportunistic feeding (Herrero et al., 2006; Cuevas et al., 2010; Ballari and Barrios-García, 2014). In many places wild boars are considered as a pest species because they damage food crops, transmit diseases to livestock (Meng et al., 2009). At the same time, the wild boar is an important prey base for endangered large carnivores (Karanth and Sunquist, 1995) as well as a robust species for hunting that can relieve pressure on other wildlife species (Barrios-García and Ballari, 2012).

Long-tailed macaques (*Macaca fascicularis*) have the third most widespread geographically distribution among primates, after human and rhesus macaques (*M. mulatta*), distributed over a wide area of Southeast Asia, including the Indo-Malay Peninsula and islands of Indonesia, Malaysia and the Philippine (Fooden,

Figure 4. The Javan leopard captured by camera trap in restoration area.

1995). They inhabit a wide variety of habitats, including primary lowland rainforests, disturbed and secondary rainforests, riverine, swampy and coastal forests of nipa palm and mangrove. Typically, they have been observed in the disturbed habitats and the forest periphery. They adapt well to human settlements and are considered animals pests where can damage farms and gardens around villages (Aggimarangsee, 1992; Fooden, 1995).

The presence of mammals, especially top predators in the forests is an indicator of the state of conservation of the site, following the rationale that wildlife species require a habitat with sufficient carrying capacity for their biological requirements (Farneda et al., 2015; Herna´ndez-Huerta, 1992) and because top predator mammals promote biodiversity by regulating meso predator density (Ripple et al., 2013; Ritchie and Johnson, 2009). One species of mammal that is unexpectedly captured by camera trap was the Javan leopard in study area (Figure 4). It seen as a young leopard wandering in search of territory. In addition, prey that lives in the restoration area encourages the leopard to approach the prey. In IUCN Red list, the javan leopard it as Critically Endangered (Ario et al., 2008). Javan leopard in the GGPNP was first captured by camera traps on 2002, where since 1980, the presence of javan leopard in GGPNP was found based on their footprints, feces, food scraps, urine, and scratches on trees (Ario et al., 2018). The finding in this study will provide an important basis for future research and conservation management, and also provide support for biodiversity monitoring in GGPNP.

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Development of educational multimedia to improve the understanding of nature conservation: A study of Gunung Gede Pangrango National Park's conservation volunteers

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ABSTRACT

The purpose of this research is to develop a multimedia conservation of education application, and to determine its effectiveness in understanding the nature conservation of conservation cadres or volunteers in the national park area. This research used the *Research and Development* method of the model *Borg & Gall* which was modified into five stages, were *Research and Information Collecting, Planning, Developing Preliminary of Product, Preliminary Field Testing and Main Product Revision.* While the application development stage used the SDLC (*System Development Life Cycle*) method which consisted of planning, analysis, design, implementation and testing stages. Data obtained from the validation of material experts and multimedia experts. The effectiveness test used the analysis of the N-Gain value of each indicator of the *pretest* and *posttest questions.* To develop educational multimedia applications need to analysis, preparing the designs and materials, developing the application, validating applications by experts, assessing the quality of application systems, small and large scaling field trials and evaluation. The purpose research product is the digital information entitled E-Info of Nature Conservation Media which can be accessed free of charge via the link (*ika.gedepangrango.org*). According to data analysis we concluded that the development of educational multimedia applications can increase understanding of nature conservation for conservation volunteers in the national park area. The Scores *pretest* and *posttest* obtained an average N-Gain score of 0.73 and a percentage score of 73.33% with the criteria ``High" and the criteria "Quite Effective", which means E-Info Application The media developed is suitable to be applied and quite effective in increasing respondents' understanding of conservation.

ABSTRAK

Tujuan dari penelitian ini adalah untuk mengembangkan aplikasi multimedia edukasi konservasi dan untuk mengetahui tingkat efektivitasnya terhadap pemahaman konservasi alam para kader konservasi di wilayah taman nasional. Penelitian ini menggunakan metode *Research and Development* model *Borg & Gall* yang dimodifikasi menjadi lima tahapan yaitu *Research and Information Collecting, Planning, Develop Preliminary of Product, Preliminary Field Testing dan Main Product Revision*. Sedangkan tahapan pengembangan aplikasinya menggunakan metode SDLC (*System Development Life Cycle*) yang terdiri dari tahapan perencanaan, analisis, desain, implementasi dan tesing. Data diperoleh dari hasil validasi dua ahli yaitu ahli materi dan ahli multimedia. Uji keefektifan menggunakan analisis nilai N-Gain dari setiap indikator soal *pretest* dan *posttest*. Langkah-langkah untuk mengembangkan aplikasi multimedia edukasi yaitu analisis kebutuhan, penyusunan desain dan materi, pengembangan aplikasi, memvalidasi aplikasi oleh para ahli, penilaian kualitas sistem aplikasi, uji coba lapangan skala kecil dan skala luas serta evaluasi. Produk yang dihasilkan adalah informasi digital berjudul E-Info Media Konservasi Alam yang dapat diakses secara gratis melalui link (*ika.gedepangrango.org*). Berdasarkan analisis data disimpulkan bahwa pengembangan aplikasi multimedia edukasi dapat meningkatkan pemahaman konservasi alam bagi para kader konservasi di wilayah taman nasional. Skor *pretest* dan *posttest* diperoleh rata-rata skor N-Gain yaitu 0,73 dan skor prosentase 73,33% dengan kriteria "Tinggi" dan kriteria "Cukup Efektif" yang artinya Aplikasi E-Info Media yang dikembangkan layak untuk digunakan dan cukup efektif dalam meningkatkan pemahaman konservasi responden.

Keywords: *Education, multimedia application, nature conservation, Gunung Gede Pangrango National Park, Indonesia*

INTRODUCTION

Natural resources are all those that come from the earth, the biosphere, and the atmosphere, whose existence depends on human activities. All parts of our natural environment (grains, trees, soil, water, air, sun, rivers) are natural resources (Hunker, 1964). Living natural resources and their ecosystems collectively have functions and benefits as the constituent elements of the living environment which are interdependent and mutually influencing so that their presence cannot be replaced. This shows that living natural resources and their ecosystems have an important position and role for human life, so community involvement in conservation efforts is also very important. Community participation in conservation in Portugal is 43% ineffective. In contrast to Fiji which uses an approach

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bottom up with community involvement of 88%, and it shows that conservation is going well (Thaman, et.al. 2016).

In developing community participation, the government seeks to encourage community independent participation in conservation through various programs, including by providing conservation education materials to increase community knowledge and understanding of conservation. One of the mechanisms applied in developing countries in Asia, Africa and Latin America for successful conservation is by providing control to communities over resources, as well as supplements in the form of conservation education (Nilson, et.al. 2016).

Currently, the use of digital technology is increasingly massive and developing, therefore it is necessary to have a technology-based conservation education strategy so that it can provide the same understanding between the two parties, including through public literacy. Public literacy requires the right medium or way so that the message conveyed can be well received and understood by people with different levels of knowledge, experience and levels of technological literacy (Wiratno, 2020).

Technology-based literacy is known as digital literacy. This term was first put forward by Gilster (1997) as the ability to understand and use information from various digital sources (Gilster, 1997). Digital literacy innovation for the benefit of conservation education can be carried out through the development of a nature conservation education multimedia application. This innovation provides many advantages, including relatively cheap technology costs, reducing the digital divide, portable facilities because learning can be done anywhere and anytime and makes the learning process fun. According to Sudjana (2002), learning media is one of the important elements in learning and learning that can enhance the learning process, so that in the end it is expected to enhance learning outcomes (Sudjana & Rivai, 2002). The same thing was explained by Muhammad (2002) who emphasized the importance of media as a tool to stimulate the learning process (Muhammad, 2002). The use of instructional media in the teaching and learning process can generate new desires and interests, generate motivation and stimulation of learning activities and even bring psychological influences on participants. The use of instructional media will greatly help the effectiveness of the learning process as well as the delivery of messages and lesson content so that it can help participants increase understanding because it presents information in an attractive and reliable manner. In addition, learning media can also facilitate data interpretation and condense information. This allows the achievement of learning objectives, which in turn can improve learning processes and outcomes (Hamalik, et.al. 2002).

Multimedia can accommodate different learning styles and has the potential to create an environment *multisensory* that supports certain learning styles (Phillips, 1997). Multimedia can help participants achieve a wide variety of goals and participants benefit from multimedia which includes text, graphics, images, audio and video (Agnew, et.al. 1996).

METHODS

The development of a multimedia application for nature conservation education was carried out by modifying the model development procedure Borg & Gall into five stages, namely:

1. ***Research and Information Collecting stage***, by conducting field studies and literature studies. Field studies are carried out by analyzing the conditions of the *existing* nature conservation materials, analyzing ways to convey information on nature conservation and analyzing needs. Meanwhile, literature study is carried out by examining books and sources that are relevant to the research to be carried out.
2. ***Planning stage***, begins with material mapping through an assessment of the concept of nature conservation followed by determining themes and objectives and collecting materials from various sources, followed by designing educational multimedia applications and determining the content of the parts of the material to be developed.
3. ***Develop Preliminary of Product stage***, compiling and designing parts that have been planned into an initial product draft for consultation with experts and correcting if there is a mismatch in the material or approach used so that the product formulated can be used to increase understanding of nature conservation. At this stage an evaluation instrument is also prepared to assess the quality of the product being developed.
4. ***Preliminary Field Testing Stage***, after the product is declared valid and feasible to be tested, then the product can then be tested on selected conservation volunteers. Small-scale field trials were carried out on conservation volunteers around Gunung Gede Pangrango National Park Center with 9 subjects, while large-scale trials were carried out on 18 respondents in Cianjur, Sukabumi, Bandung and Pandeglang districts. The results of this field trial will be obtained in the form of the results of the assessment of conservation volunteers on multimedia educational applications and the results of tests on understanding of nature conservation.

5. ***Main Product Revision (Revision of Field Trial Results) stage***, after the educational multimedia application product is tested, then revision of the field trial results is carried out. The revision is based on data obtained from the results of field trials and the assessment of conservation volunteers on the product and is a stage of product refinement.

Research Design

The software used in application development is *Flip PDF Professional* version 2.4.9.31. The preparation of the design is by compiling a framework consisting of a cover, foreword, a table of contents and material content that combines narration, photos, videos, website links and youtube links according to the theme discussed.

The material developed is in the form of digital literacy media about nature conservation which includes information on forests and forestry, conservation areas, national parks, management models of Gunung Gede Pangrango National Park and nature conservation which contains conservation education programs. In terms of *content*, the material presented is adjusted to the characteristics and needs of people who want information that is more dynamic, interactive and has more curiosity.

RESULTS

Analysis of the information material used in implementing conservation education currently consists of projection media in the form of presentation materials presented using an *infocus* and printed media in the form of nature conservation education modules and information books on the potential of national parks. The advantages of in-projection media *focus* are that the same material can be conveyed to the audience simultaneously, but the drawbacks require a little room for light, and must always *update* the material and not be interactive, in this case *the skills* facilitators play an important role in presenting the material attractively. Meanwhile, the use of print media in the current digital era is considered less effective and efficient because it is less attractive than audio-visual media, it is difficult to *update* material, is not interactive, printing costs are more expensive when displaying colorful illustrations or photos, it is difficult to display motion on the page. printed media, the media printing process often takes several days or even months depending on the printing equipment and the complexity of the information on the printed page and it is difficult to repair. The material that the national park wants to convey is mostly information on the potential of the area that must be presented by collaborating the narrative with photos/images as well as a combination of audio-visuals so that it can attract audiences to learn about and participate in conservation efforts. This cannot be conveyed properly if you rely on projection media and print media only. In addition, the use of projection media and print media in the industrial era 4.0 is deemed ineffective for the millennial generation who always take advantage of technological sophistication in carrying out various activities. Millennials also cannot be separated from their gadgets in finding the information they need.

Analysis of the implementation of nature conservation information delivery shows that so far they still rely on the ability of officers as facilitators, even though not all officers have the *skills* to communicate so that the dissemination of conservation information to the community experiences obstacles both in quality and quantity. Based on the results of the interview, the implementation of environmental conservation education is carried out about 9 times a year and spread across three districts, namely Cianjur, Sukabumi and Bogor. Based on the results of the identification of the potential of natural resources and the economy of the buffer villages in the scope of the Mount Gede Pangrango National Park in 2017, there were 60 buffer villages spread across three districts and were the main target of the love development program.

From the two facts in the field, a needs analysis was carried out for the development of a multimedia application for nature conservation education. By relying on the print media and the ability of officers as facilitators of the love of nature program in the form of conservation, the education cannot run optimally, so that efforts are needed to develop materials that are more effective and efficient and fulfill elements of informative, attractive, interactive, broad reach and suitable to the characteristics of society in the digital era currently. The referred development of the material through the development of nature conservation education multimedia applications. Multimedia applications have attractiveness so that they can motivate participants to learn more material and make models that the audience will emulate. Multimedia applications can also prepare interesting variations so that they can encourage the level of speed of learning about a subject or problem and the breadth of the audience is not limited by time and distance. According to several studies, it is known that multimedia-based educational media has a positive influence on users in forming interest and motivation to learn as well as increasing user knowledge and understanding.

Development

Initially, the development of digital information development used the application *FlipBookPDF.Net* online which was published in Html form. After testing and validation stage one by material experts and media experts, there are several weaknesses in the early stage application development using the online FlipBook, namely:

Revision of Material Expert	Revision of Media Expert
1. The content of the material presented is not a stage / guide for conservation volunteers, so the title **E-Book Ready to Become Conservation Volunteer** must be replaced, so that it is more relevant and in accordance with the content of the material. 2. The content of the material is a combination of several information, you should make a title that describes the information and it is better not to use the word E-Book. 3. Improvements to sentences in the foreword need to be revised to make them more attractive to readers. 4. Material enrichment on each subject while still paying attention to the aesthetic elements in designing the layout between text, images, videos and links to keep it interesting. 5. Videos and links cannot be connected yet, need to be cross-checked again. 6. It is necessary to pay attention to the presentation of website links or youtube links, it must refer to the information material to be delivered and according to the needs, because there are several titles on the link but after checking the contents are not relevant. 7. Additional material on the use of national parks as alternative tourist attractions that can support economic empowerment.	1. Videos and website links or youtube links are not connected and cannot be opened, so it is necessary to revise the application if you want to display videos and website links and youtube links. 2. FlippingBook can be tried to use based on templates and published using the template owner's server. 3. Another alternative is to use the *Flip PDF Professional* software version 2.4.9.31. application-based *full version* and can be published on a server with a domain that has been previously created.

Based on the results of validation and input from experts, improvements were made to the digital information developed. Revisions to the material were made in accordance with the direction of material experts and changed the title of the E-Book Ready to Become a Conservation Volunteer changed to E-Info Media Conservation Nature. The next application development stage uses the SDLC (methodology*System Development Life Cycle*) or in Indonesian it is called the system development life cycle. SDLC is used to develop a faster system, maintain and use an information system so that it can run according to what is expected, with the following stages: a) the planning stage, by identifying the needs needed in the application; b) the analysis stage, by analyzing data or information from the needs obtained from the planning stage, in order to determine dynamic or static data in the application; c) the design stage, by making a *prototyping* of the E-Info Media application both from its graphic design, color and *layout* . This is to facilitate the creation of program code; d) the implementation stage, by writing a program from the analysis and design that has been made so that it can determine a suitable programming language for the application. The programming language used by *Javascript* and HTML is the Language *Hypertext Markup*. Furthermore, the *hardware* and *software resources* for the *web server are selected*. *Software* used in application development, namely *software Flip PDF Professional* version 2.4.9.31. After making the program, the application is uploaded to the server with the domain that was previously created and e) the testing stage, testing the application to find out whether there are *bugs* or *errors*.

Not only developers, the target of application users is also testing applications that have been made through the SUMI method (*software usability measurement inventory*), namely by distributing questionnaires to 11 respondents with various educational and occupational backgrounds via *google form* to assess aspects of *efficiency, affect, helpfulness, control* and *learnability*. The SUMI questionnaire consists of 50 statements, in which statements that lead to a more positive direction to the system are given a score of 4, 2, 0 for responses to agree, do not know and disagree. The results of the SUMI questionnaire show that in all categories *usability* and *global score* there are still scores below the average score of 50, namely in the category *control* which only reaches a score of 43 and *learnability* reaches a score of 48. While for the average score in the category *Efficiency* is 80, *Affect* is at score of 50 and *HelpfullnessSUMI* at a score of 69. The measure of the level of user satisfaction based on the method is taken from the average value, if it is more than the average value, it is included in the criteria of being quite satisfied or satisfied, while below average is the criterion of less satisfied. From the results of the SUMI questionnaire conducted, of the 5 aspects assessed, 3 aspects scored above average (50 up) while 2 aspects scored below average. However, it can be said that users are quite satisfied in accessing and operating the E-Info Media application.

In general, the development steps for the *Flip PDF Professional* version 2.4.9.31 application are the same as for the application *FlipBookPDF.NET* Online. The results of the improvement by paying attention to the opinions of experts, a multimedia educational application that was successfully developed was entitled E-Info Media for Nature Conservation and published on the website of the Mount Gede Pangrango National Park with the link address *http://Ika.gedepangrango.org.*

Trials

Small-scale field trials were carried out on conservation volunteers around the Cianjur Region I

National Park Management Division in the Cipanas, Pacet and Cugenang Districts with 9 conservation volunteers as the subject. The results of small-scale field trials show that the response of conservation volunteers in assessing the application developed by E-Info Media is very positive and reaches a percentage value of 91.11% with the criteria "Very Good" meaning that the E-Info Media application developed is suitable for use. The assessment on each aspect also shows the criteria of "Very Good" where the aspects of the presentation of the material, the benefits of application and application can motivate to get a high percentage of value, namely 94.44% and aspects of content suitability score 88.89%, while aspects of conformity with the needs of conservation volunteers obtained a value of 83.33%.

In small-scale field trials, the respondent also measured the level of understanding of nature conservation by giving multiple choice test questions that were carried out through the *pretest* and *posttest*. The results of the T test analysis showed that t count -9.38876 and t table -1.7459. Based on the criteria t count is not between the t table, then reject H0 and accept H1. This means that the use of the E-Info Media application affects the understanding of nature conservation because there are differences in the scores before and after, with the difference in the average score of 32.78.

At this stage, the researcher also measures the effectiveness of the product being developed to increase understanding of nature conservation through the calculation of N-Gain. From the pretest and posttest scores, the average N-Gain score was 0.68. Based on Melzer's criteria, if the mean N-Gain score is between 0.3 and 0.7, it is considered moderate. Based on criteria of Hake (1999), measurements were made on the percentage of the N-Gain score, and if the N-Gain percentage score was between 56-75, it was considered quite effective. From the calculation results in the table above, it is known that the N-Gain mean value is 0.68, which means that the feasibility level of the E-Info Media application developed is included in the "Medium" criteria and the N-Gain percentage score shows the number 68.36 which means the E-Application. The Info Media developed meets the criteria "Effective Enough" to be used and has an effect on increasing the respondents' understanding of conservation.

Large-scale field trials were carried out by redistributing pretest questions, then spreading the E-Info Media application link that had been developed, then spreading the posttest questions back to a wider range of respondents, namely to 18 respondents from Cianjur, Bandung, Sukabumi and Pandeglang . The results of the t test analysis showed that t count -8,85924 and t table -1,6909. Based on the criteria t count is not between the t table, then reject H_0 and accept H_1. This means that the use of the E-Info Media application affects the understanding of nature conservation because there are differences in the scores before and after, with a difference in the average score of 29.78. Meanwhile, the pretest and posttest scores obtained an average N-Gain score of 0.73. Based on Melzer's criteria, if the mean N-Gain score is more than 0.7, it is considered a “high” criterion. Based on criteria of Hake (1999), measurements were made on the percentage of the N-Gain score, and if the N-Gain percentage score was between 56-75, it was categorized as "Effective Enough". From the calculation results in the table above, it is known that the mean value of N-Gain is 0.73, which means that the feasibility level of the E-Info Media application developed is included in the "High" criteria and the N-Gain percentage score shows the number 73.33, which means the E-Application The Info Media developed meets the criteria "Effective Enough" to be used and has an effect on increasing the respondents' understanding of conservation.

Revision of Trial Results

From the results of field trials 75% of respondents stated that the E-Info Media application was good because the information presented was not monotonous and attractive by collaborating articles, images, videos and website links and youtube links so that it was in accordance with the characteristics of current users who always use gadgets to explore cyberspace. However, through the disseminated conservation volunteer response instrument, some input and suggestions were obtained from respondents regarding the E-Info Media application being developed, namely that they must continue to update the information presented, further increasing the element of attractiveness that can be accepted by all groups, holding meetings for deepen the material or evaluate the material that has been presented on the E-Info Media application and complete the application with instructions for use. Most of the inputs and suggestions from respondents are to maintain the sustainable use of the E-Info Media application so that it does not affect the improvement of the E-Info Media application that has been developed.

DISCUSSION

In product development, many changes have been made to the information material in the E-Info Media application based on input and suggestions from material experts. Increasing and improving information material on the *website* is one way to influence visitors' websites to remember the key information submitted (Desra, 2020) so that improvements to the information material presented are expected to make it easier for information to be more quickly embedded in the minds of visitors.

Validation was also carried out by media experts, where in stage 2 a percentage of 89.58% was obtained with the criteria "No Need for Revision", meaning that the digital information made was suitable for use. The results of this study are in line with the opinion of O'Brien (2004) which states that there are three dimensions of information quality, namely the information (*time dimension time dimension*), the information (*content dimension content dimension*) and the information (*form dimension from dimension*). Regarding the time dimension, information is said to be of quality if it meets the criteria, *up to date* namely information that is submitted on time, quickly presented and available at any time (not limited by time), this will satisfy users. Regarding the content dimension, that the information provided is accurate and in accordance with user needs. Meanwhile, regarding the shape dimension, it is stated that the effective media used to convey information to users can provide satisfaction to users. In this case, the E-Info Media application is built based on the internet and can be accessed *online* and has no time limit considered very effective in conveying nature conservation information to the public because the media used is in accordance with the characteristics of millennials so that it can provide satisfaction to its users.

The results of the attractiveness test show that the user response in assessing the E-Info Media application is very positive and reaches a percentage value of 91.11% with the criteria "Very Good". According to Widiyanto & Prasilowati (2015), adesign is said to be attractive if its content and appearance are able to attract internet users to visit the website and the attractiveness of the design *website* has a positive and significant impact on user perceptions. Thus, it can be said that the E-Info Media application developed is considered attractive and worthy of use.

Based on the results of the SUMI questionnaire, there are 3 aspects that score above average (50 up), so it can be said that users are "quite satisfied" in accessing and operating the E-Info Media application because it is easy to use and can add new knowledge. This is in accordance with the opinion of Barnes & Vidgen (2003) which states that the quality of use (*usability*) includes the ease of learning the website, the ease of understanding, the ease of browsing, the ease of use, the attractiveness of the website, a pleasant interface, good competence and providing new fun experience. The opinion of Davis (1993) states that all factors, namely ease of use, perceived benefits and attitudes affect decisions in using technology. So it can be concluded that the ease of use of the E-Info Media application is one of the attractions for users to access the application.

The results of small-scale and large-scale field trials showed a change in the assessment of the feasibility level based on the Meltzer (2002) criteria, where in small-scale trials the criteria were "Medium" but on scale trials they reached the "High" criteria. Meanwhile, based on Hake (1999), the evaluation of the E-Info Media application meets the criteria "Effective Enough" to be used and has an effect on increasing the user's understanding of conservation. Maflikhah (2010) provides several dimensions regarding the benefits of information technology. The benefit with an estimate of two factors is divided into two categories, namely benefit and effectiveness. The dimension of benefit has the function of a) making work easier, b) useful and 3) increasing productivity. While effectiveness functions a) enhance effectiveness and b) develop employee performance. Maflikhah's opinion clarifies that using digital technology to obtain information can contribute positively to users, so that the results of this study can strengthen the conclusion that the benefits of digital information made in the form of E-Info Media have a positive effect on users and can increase users' understanding of the information presented.

From the results of field trials 75% of respondents stated that the E-Info Media application was good because the information presented was not monotonous and attractive by collaborating articles, images, videos and website links and YouTube links so that they were in accordance with the characteristics of current millennial users, so that researchers did not Many revisions to the product being developed, only add instructions for using the application on the first page after the cover.

The advantages of the E-Info Media product being developed are: 1) E-Info Media provides information on nature conservation that is broader than just a printed book, because it provides a *website* and a *linkYouTube link* that can be accessed by users and allows users to get more information from these links ; 2) E-Info Media can be accessed by all groups regardless of distance and time limit; 3) collaborative information presented provides a special attraction for the user so that it is not boring; 4) E-Info Media can be accessed via laptop, PC or *smartphone* ; 5) E-Info Media also assists the national park program in disseminating conservation information to the wider community; 6) it is possible to add the required information; 7) the presentation of information with audio visual features in the E-Info Media application can accommodate users with various learning styles, where according to Bobby De Potter a person's learning style is divided into 3 types, namely 1) visual learning styles that focus on vision and appropriate learning methods for this type through pictures or videos; 2) auditory learning styles that rely on hearing to receive information and knowledge; 3) kinesthetic learning style that involves movement even though it is simple by clicking fingers, the whole learning style is possible through the E-Info Media educational application. While the drawbacks

are 1) E-Info Media can only be accessed *online*; 2) need *frequent maintenance* / maintenance for additional information.

CONCLUSION

1. The product of the E-Info Media application developed can be applied by all groups regardless of distance and time limits through the link ika.gedepangrango.org. This was supported by the results of large-scale trials that followed by participants who taken part in the pretest and posttest understanding of conservation. They had educational background from Junior High School to graduate school and have work backgrounds as students, students, farmers, private employees, entrepreneurs, teachers and lecturers.
2. Users can access this application for free and very easily by using a computer, laptop or smartphone.
3. The presentation of information with audio visual features in the E-Info Media application can accommodate users with various learning styles, both visual learning styles (which focus on vision),
4. The E-Info Media application that completed by auditory learning styles (which rely on hearing) and kinesthetic learning styles (which involve simple movements), so it have a positive effect on user knowledge and understanding.
5. The E-Info Media application was built using the gedepangrango.org domain, so that it can assist the national park program in disseminating conservation information to the public. Therefore, we recommend to the Gunung Gede Pangrango National Park management to maintain the E-Info Media application, up date the information, and use it as a reference or material guide in implementing the formation and fostering of conservation volunteers or volunteers.

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Organoleptic testing of coconut midrib ash and alcohol as preservatives of insect specimens

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ABSTRACT

This study uses a Completely Randomized Design experimental method (CRD) consisting of three treatments with a range of 5 days, 10 days and 15 days, with each treatment uses three insect specimens. The treatments in this study were; P1 (200 mg ash + 200 ml distilled water), P2 (70% alcohol), and P0 (control). To observe the changes in texture, aroma and color in the inspect specimens, 50 panelists were engaged, who were aged between 17-30 years, that were not color blind and/or reporting any ill health at the time of sampling. Panelists observed the specimens for texture, aroma and color. Resulting data was analyzed using t test, frequency tabulation, histogram data and normality test. The texture testing treatments yielded t_{count} = 0.02521 (p> 0.05) showing no significance between the coconut midrib ash and alcohol preserved samples, with the H_o accepted, so there is no difference in the texture of insect specimens preserved in either coconut midrib ash or alcohol. The aroma test resulted in t_{count} = 0.00908 (p> 0.05) showing again there was no significant difference between insect specimens preserved in coconut midrib ash and alcohol. Thus, the H_o can be accepted, with no difference in the aroma of insect specimens preserved in coconut midrib ash or with alcohol. The color test resulted in a t_{count} = 0.05635 (p> 0.05), giving a insignificant result between insect specimens preserved in coconut midrib ash or alcohol. Thus, the H_o can be accepted, and there is no difference in color of insect specimens preserved with coconut midrib ash or those preserved with alcohol. From the overall results and analysis, we can conclude there is no difference in the quality insect specimens preserved either by coconut midrib ash and alcohol for a maximum 15 days.

ABSTRAK

Penelitian ini menggunakan metode eksperimen rancangan acak lengkap (RAL) yang terdiri dari tiga perlakuan dengan kisaran lama waktu 5 hari, 10 hari, dan 15 hari. Setiap satuan percobaan menggunakan tiga spesimen serangga, perlakuan dalam penelitian ini meliputi P1 (200 mg abu + 200 ml aquades), P2 (alkohol 70%), dan P0 (kontrol). Parameter yang diamati mengenai tekstur, aroma dan warna. Untuk mengamati perubahan tekstur, aroma dan warna yang terjadi, dilakukan oleh 50 orang panelis yang berusia antara 17-30 tahun dengan kriteria tidak buta warna dan tidak sedang dalam keadaan sakit. Data yang diperoleh dianalisis dengan menggunakan uji t, tabulasi frekuensi, data histogram dan uji normalitas. Berdasarkan hasil penelitian, pengujian tekstur menghasilkan nilai t_{hitung} = 0,02521 (p > 0,05), diperoleh hasil yang tidak berbeda secara signifikan antara perlakuan dengan abu pelepah kelapa dan alkohol terhadap tekstur spesimen serangga. Dengan demikian dapat disimpulkan bahwa tidak terdapat perbedaan tekstur spesimen serangga yang diawetkan dengan abu pelepah kelapa dengan yang diawetkan dengan alkohol. Pengujian aroma menghasilkan nilai t_{hitung} = 0,00908 (p > 0,05), diperoleh hasil tidak berbeda secara signifikan antara perlakuan dengan abu pelepah kelapa dan perlakuan dengan alkohol. Dengan demikian dapat disimpulkan bahwa tidak terdapat perbedaan warna spesimen serangga antara yang diawetkan dengan abu pelepah kelapa dengan yang diawetkan dengan alkohol. Dari hasil pengamatan dapat disimpulkan bahwa tidak ada perbedaan kualitas antara specimen serangga yang diawetkan dengan abu pelepah kelapa dengan yang diawertkan dengan alcohol dalam waktu maksimum 15 hari.

Keywords: *Alcohol, coconut midrib ash, insect preservative.t*

INTRODUCTION

Organoleptic testing or sensory evaluation is defined as the scientific assessment of characteristics material using the senses of sight, taste, smell, touch and hearing, with sensory reaction recorded.

According to research by Suharna & Rahayu (2000), despite using alcohol in high concentration in sample preservation growth of the fungus *Monascus* sp may still occur. The source of this contamination can come from the specimen, be airborne or from the preserving alcohol which may have been contaminated with fungus.

When considering these potential negative effects from using alcohol as a sample preservative, it is necessary to look for alternatives that are more effective preservatives and safer. These may include natural ingredients such as coconut midrib waste, which when burnt gives ash. This ash has not been used much except for washing dishes and other kitchen utensils in

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the villages. According to Abdul (2010), coconut midrib ash contains Magnesium (Mg) and Potassium (K) which forms chemical salts; $MgCl_2$ (Magnesium Chloride) and KCl (Potassium Chloride). Each element has anti-microbial properties.

The purpose of organoleptic testing is to determine the differences between the texture, aroma and color of insect specimens preserved with coconut midrib ash against those preserved in alcohol.

Rahmatulloh et al. (2017), used organoleptic tests to determine the variation of skin texture, hair, and aroma of taxidermied mice after 45 days, having been treated with various concentrations of coconut midribs ash and borax. Results reported in this study included:

1. *Skin Texture*

The combination of coconut midrib ash and borax gave slightly better skin texture on the samples. The treatment given relatively has the same effect on the skin texture of mice after preserving for 45 days. This is due to the content of $MgCl_2$ and KCl contained in coconut midribs as an anti-microbial.

2. *Hair Texture*

The application of borax was observed to have a slightly better texture of hair, which relatively has the same effect on the texture of the mice's hair after preserving for 45 days.

3. *Aroma*

The combination of coconut midrib ash and borax were observed to have a slightly nicer roma (no foul smell), after preserving for 45 days. This was due to the salt content found in coconut midribs, which has anti-microbial properties and borax ash which acts as an antiseptic, which kills or inhibit the growth of microorganisms found in animal tissue.

4. *Color*

Negara (2016) argue that the color is primary sensory response that observes will use in organoleptic testing.

Based on the description of the theories above, the organoleptic sensing approach can be replicated when determining viable natural alterative to preserving insect specimens.

METHODS

This study employed an experimental method. The design employed was a Completely Randomized Design (CRD) with one factor consisting of 3 treatments, namely:

P_1 = Preservation for 5 days, 10 days and 15 days.

P_2 = Preservation for 5 days, 10 days and 15 days.

P_0 = Preservation for 5 days, 10 days and 15 days.

Research Procedure

1. *Preparation Stag*

In the first stage, 20 pieces of coconut midribs harvested and laid out in the sun to dry. After the coconut midribs were dried, they are burnt to produce ash used for preparing the specimens.

2. *Production Stage*

200 mg of coconut midrib ash was to create a treatment, mixed with 200 ml of distilled water, and stirred thoroughly, and allowed to stand for 15 minutes. After 15 minutes, each treatment of coconut midrib ash water was filtered and decanted into a sterilized bottle.

3. *Preservation Stage*

9 selected insect specimens were anesthetized using Chloroform. For the coconut ash treatment - insect needle containing coconut ash treatment was injected into the abdomen of the insect specimen until it is evenly spread throughout its body. Researchers manipulated the shape of the wing and leg models with tweezers, to give the desired shape. Once in place, the desired shape was locked using a pin. Specimens were also treated with camphor to deter insect predation as they dried naturally. Specimens were preserved either in coconut midrib ash or 70% alcohol, for a period of 5 days, 10 days or 15 days.

4. *Organoleptic Testing*

Organoleptic testing was employed to determine the preservation of insect specimens. Respondents used their senses to determine the texture, aroma and color of a given insect specimen. Different respondents were invited to observe the specimens at 5, 10 and 15 days. Organoleptic testing for specimen texture was carried out by respondents observing samples using a magnifying glass or by directly smelling or using sense of touch. The organoleptic test for aroma of a specimen was carried out using the respondents sense of smell to determine the level or odor given off by a specimen. The scale used for textures is in the form of ten hedonic scales, namely 1 (very many holes in the sample) up to 10 (whole intact), Aroma is 1 (very foul odor) to 10 (Odorless), while for color 1 (very faded) to with 10 (fixed). For quality of colour of a specimen, each respondent used the sense of vision. Each of the senses was used to compare the preserved insect specimens against living specimens to determine the quality of preservation.

The number of respondents involved the organoleptic testing were 50 people. Organoleptic tests were carried out on museum visitors between the ages of 17-30 years, with respondents qualifying to participants that were neither color blind or not ill.

Data Collection Techniques

In this stage of research, data was obtained and recorded using a questionnaire technique. The insect preservation organoleptic or hedonic tests and results were calculated using t tests, frequency distribution, histogram data and normality tests.

RESULTS

1. *Texture*

The results of the texture observations can be seen in Figure 1. The greatest organoleptic value was found in treatment 2 with a mean value of 27.44. Followed by treatment 1 - coconut midrib ash which had a mean value of 27.42, and the smallest result was the control treatment with a mean value of 14.10.

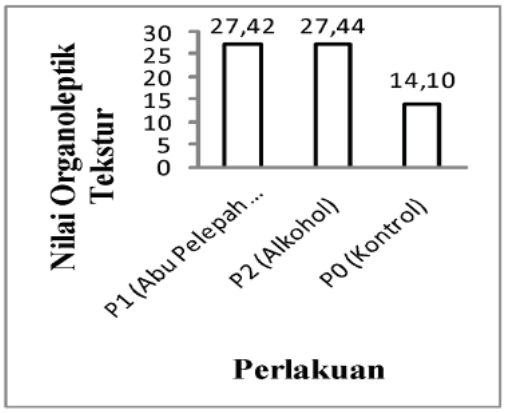

Figure 1. Organoleptic scores of texture.

2. *Aroma*

The results of the aroma observations can be seen in Figure 2. The greatest organoleptic value was found in treatment 2 (alcohol) with a mean value of 22.50. Then followed by treatment 1 (coconut midrib ash) with mean value of 22.48, and the lowest result was recorded for the control treatment with a mean value of 12.70.

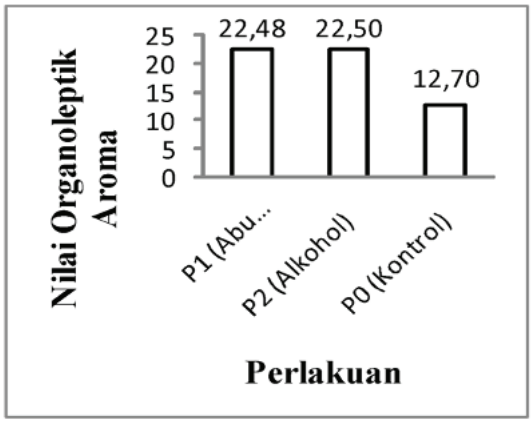

Figure 2. Organoleptic scores of aroma.

3. *Color*

The results of the color observation can be seen in Figure 3. The greatest organoleptic value was found in treatment 2 (alcohol) with a mean value of 22.52. Treatment 1 (coconut midrib ash) recorded an average value of 22.36, while the lowest value was recorded in the control treatment with a mean value of 12.88.

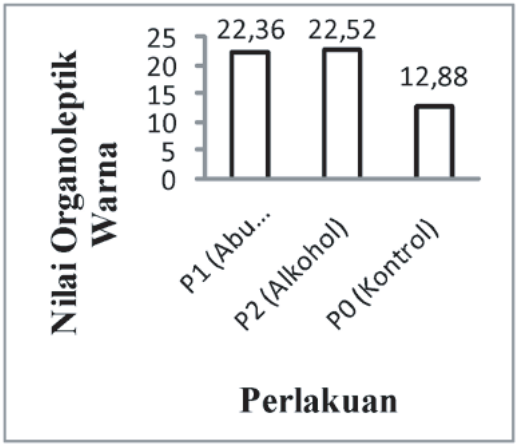

Figure 3. Organoleptic scores of color.

DISCUSSION

Based on the results of the study, the texture test resulted in a value of t_{count} = 0.02521 (p> 0.05), giving a insignificant result between coconut midrib ash and alcohol. It can be concluded that the H_o is accepted and there is no difference in the texture of insect specimens preserved with coconut midrib ash or those preserved with alcohol.

Test the aroma of the value of t_{count} = 0.00908 (p> 0.05), determined a insignificant results between coconut midrib ash and alcohol. Thus, it can be concluded that H_o is accepted, It can concluded there is no difference in the aroma of insect specimens preserved with coconut midrib ash and those preserved with alcohol.

Testing the color value of t_{count} = 0.05635 (p> 0.05), determined a insignificant results between coconut midrib ash and alcohol. It can be concluded that H_o is accepted, so there is no difference in the aroma of insect specimens preserved with coconut midrib ash and those preserved with alcohol.

In Rahmatulloh et al. (2017), coconut midrib ash and borax, (P3) showed a slightly better skin texture with mean of 2,887, followed by P1 (2,875) and P2 (2,850). Testing the skin texture obtained F_{count} value = 0.025 (p> 0.05), this showed all treatments had relatively the same effect on the skin texture of mice after preserving for 45 days of preservation. The H_o is accepted, showing there is no difference between the texture of the skin preserved with coconut midrib ash or the preserved with borax.

The results of the study found to preserve the texture of hair the administration of 100% borax (P1) showed a mean of 2.96, followed by the administration of 50% borax (P3) with an a mean value of 2.93 and the application of ash 100% coconut midrib (P2) a mean value of 2.90. Testing the texture of hair gave an F_{count} value = 0.105 (p> 0.05), showing that all treatments have relatively the same effect on the texture of mice hair after preserving for 45 days. It can be concluded the H_o can be accepted, so there is no difference in the

texture of the hair preserved with coconut midrib ash and those preserved with borax.

The combination of coconut midrib ash and borax (P3) showed a slightly better aroma with a mean value of 2.937, followed by giving P2 (2.925) and P1 (2.912). Testing the aroma obtained F_{count} value = 0.017 ($p > 0.05$), found all treatments had relatively the same effect on the aroma of mice after 45 days of preservation. It can be concluded that H_o is accepted, then there is no difference in the aroma preserved with coconut midrib ash and those preserved with borax.

According to Pakaya et al. (2014) the use of star fruit (*Averrhoa bilimbi* L.) as a natural preservative, tested in concentration (three levels: C1 = 100 mg / ml, C2 = 200 mg / ml and C3 = 300 mg / ml) while the second treatment (T) is the duration of storage (Three Levels: T1 = 0 days, T2 = 15 days and T3 = 30 days). The results showed the presence of bacteria concentrations of 100 mg / ml, 200 mg / ml and 300 mg ml of starfruit (*Averrhoa bilimbi* L.) solution significantly inhibited bacterial growth ($p < 0.01$). For the treatment of storage time 0 days, 15 days and 30 days significantly affected the growth of bacteria ($p < 0.01$), meaning that the longer the dried anchovies, were soaked in star fruit solution, and the higher the concentration the smaller the bacterial growth. Thus, it can be concluded that H1 is accepted, so there are differences in influence between treatments.

CONCLUSION

1. The greatest organoleptic value for texture was for treatment 2 with alcohol with a mean value of 27.44. Then followed by treatment 1 with the administration of coconut midrib ash with a mean value of 27.42, and the smallest result in the control treatment with a mean value of 14.10.

2. The greatest organoleptic value of aroma was treatment 2 was the alcohol with a mean value of 27.50. Followed by treatment 1 with the administration of coconut midrib ash with a mean value of 22.48, and the lowest result was the control treatment with a mean value of 12.70.

3. The largest color organoleptic value in treatment 2 with the administration of alcohol with a mean value of 22.52. Then followed by treatment 1 with the administration of coconut midrib ash with a mean value of 22.36, and the lowest result found in the control treatment with a mean value of 12.88.

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Natural resources management to deliver Sustainable Development Goals (SDGs)

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ABSTRACT

Indonesia is known as a rich natural resources country, but at the same time has a problem of water shortage, soil degradation, pollution, agriculture and forest production, biodiversity conservation, and mineral and energy sustainability. The national natural resources management planning alignment with SDGs programme, particularly the water resources management, afforestation programme, a guide for sustainable management of Indonesia's biodiversity, government and non-government organizations participant in conservation practice, exploring alternative energy sources to reduce dependence on oil, mainstreaming of SDGs into National Development agenda, National Action Plan, and SDGs program for Sub-national level. This program was participated by all stakeholders included government, civil society organizations, philanthropy and business society, academics as well as experts. This literature review paper will discuss about the natural resources management to deliver sustainable development goals programme in Indonesian, with specific and focus topics for water and pollution, soil, land product (agriculture, forest and biological resources), mineral and energy. The objective of this paper was to describe the alignment of the natural resources management planning and SDGs programme as evaluation to improve their implementation in Indonesia. Though the government has already implemented SDGs program but innovative strategic need to be developed.

ABSTRAK

Indonesia dikenal sebagai negara yang kaya sumberdaya alam, tetapi pada saat yang sama menghadapi masalah kelangkaan air, degradasi lahan, polusi, produksi pertanian dan kehutanan, konservasi keanekaragaman hayati, keberlangsungan mineral dan energi. Rencana pengelolaan sumberdaya alam nasional sejalan dengan program SDGs, khususnya terkait pengelolaan air, program perhutanian, pengelolaan keanekaragaman hayati secara berkelanjutan, pemerintah dan para pihak yang berpartisipasi dalam praktek konservasi, eksplorasi energi alternatif untuk mengurangi ketergantungan pada minyak bumi, dan pengarus-utamakaan program SDGs ke dalam agenda pembangunan nasional, rencana aksi nasional, dan program di tingkat wilayah. Program ini diikuti oleh seluruh para pihak, termasuk pemerintah, organisasi masyarakat sipil, masyarakat bisnis dan filantropi, kaum akademisi dan para ahli. Studi Pustaka ini akan membahas tentang pengelolaan sumberdaya alam untuk mencapai program pembangunan berkelanjutan di Indonesia, khususnya tentang masalah air, polusi, produsi lahan (meliputi pertanian, hutan, sumberdaya biologi), mineral dan energi. Tujuan penulisan naskah adalah untuk memberikan gambaran keterkaitan antara rencana pengelolaan sumberdaya alam dan pelaksanaan program pembangunan berkelanjutan, sebagai evaluasi untuk meningkatkan implementasinya di Indonesia. Meskipun pemerintah telah melaksanakan program SDGs, tetapi strategi yang inovatif perlu dikembangkan.

Keywords: *Natural resources, management, SDGs, environment*

INTRODUCTION

Natural resources degradation are serious problem that was taken place in Indonesia and in the world. This problems were exaggerated by the rapid population increase, the excessive consumption of resources, and pollution. The abundant resources of Indonesia are blessing, but at the same time will become disaster if they are not managed wisely.

Indonesia is known as a strategic geographic and rich natural resources country. Indonesia, located between the Pacific Ocean and the Indian Ocean in Southeast Asia has 735.358 square miles area that spread out in over 13.000 islands, with population was estimated 261 million people (Sawe, 2018). The fertile soil, abundant water, and humid climate support the tropical rain forest and biodiversity.

Indonesia contains the most extensive standing rainforests in all of Asia, with an estimated 94 million hectares (232 million acres) of forest cover — an area the size of Nigeria. These trees release oxygen into the air and remove harmful particles. They also absorb gases, like carbon dioxide, that cause changes in our climate. Flora and fauna also attracted the visitors from across the world flock to Indonesia to see its charismatic native species — such as orangutans, Sumatran tigers, Komodo dragons, whale sharks, sea turtles and manta rays. The country's incredible rainforests and coral reefs make it one of the top adventure and dive destinations in the world. Indonesia's lands and waters make the country a major producer of foods that

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Indonesians, as well as people around the world, eat every day: seafood, rice, coffee, cocoa, cassava, peanuts and spices like nutmeg. It is also the world's largest producer of palm oil, an edible vegetable oil found in half of the packaged goods on supermarket shelves (Conservation International Indonesia, 2020). Indonesia also has abundant of natural resources, such as potential deposit hydrographic, mineral and energy.

However, Indonesia has a big problem concerning to increase population very quickly. Despite being blessed with abundant amounts of natural resources, about 11.2% of Indonesia's population lives below the poverty line. Academics around the world studying similar phenomenon across the world in resource-rich countries call this the "natural resource phenomenon." The phenomenon describes the contradictory relationship between a nation's economic performances compared to natural resource wealth. One of the primary contributors to this unique phenomenon is what economists refer to as the "Dutch disease," a phenomenon where the development of a specific sector leads to the decline of other sectors (Sawe, 2018). The country's response to this development will determine the fate of its abundant natural wealth — and the people who depend on it.

The Sustainable Development Goals (SDGs) were conceived at the United Nations Conference on Sustainable Development in 2012, as a set of universal goals designed to expand on the Millennium Development Goals which had been created to confront the environmental, economic, and political challenges facing the world at the end of the 20th century. The roots of the two sets of goals can be traced back to the 1970s and 1980s when, amid increasing concerns about environmental degradation, nations became more aware of the importance of protecting the environment while continuing to follow an economic and social development agenda both nationally and globally (WCED, 1987).

Indonesia was very committed to succeed SDGs programme, that include (1) *Social development* including poverty reduction and hunger, health, education and gender equity; (2) *Economic development* including clean and affordable energy, decent work and economic growth, innovation, industry and infrastructure, reduce inequality, and partnership; (3) *Environmental development* including clean water and sanitation, sustainable cities and communities, responsible consumption and production, climate action, life below water and life on land. The programme was started focuses on achievement in health, food security, sustainable agriculture and education, while the latter focuses on industrial development, innovation, infrastructure, and protection and sustainable use of marine and coastal ecosystem. This literature review paper will discuss about the natural resources management to deliver SDGs programme in Indonesian, with specific and focus topics for water and pollution, soil, land product (agriculture, forest and biological resources), mineral and energy. Aim of paper was to describe the alignment of the natural resources management planning and SDGs programme as evaluation to improve their implementation in Indonesia.

RESULTS AND DISCUSSION

The results and discussion will be divided in the three part, were (1) natural resources potential, (2) natural resources management, and (3) implementation of SDGs programme in Indonesia.

1. Natural Resources Potential

The potential natural resources in Indonesia can be classified as (1) inexhaustible resources with the case study of water and pollution; and (2) exhaustible resources that divided by (a) renewable exhaustible resources with case study of soil, product of land (agriculture, forest and biological resources), and (b) non-renewable exhaustible resources with case study of mineral and energy (Owen, 1985).

Water

Despite of the abundance of water resources potential, the Indonesia's surface water resources have already experienced water shortage during the dry season. The total water demand of the country is currently 1,074 m^{-3} sec^{-1} for irrigation, domestic, municipal and industrial purposes, while the low flow available at the normal climatic year is only about 790 m^{-3} sec^{-1}. This explains that the current water uses is highly constrained by unbalanced condition of demands and the potential availability of water, particularly at point of time during the season of scarcity of the year. Indonesia's population of 207,6 million (2000) is spread over a number of islands. The increasing population in Indonesia is not followed by the equal distribution of population regionally either by province or by island. According to 2000 Population Census, Java Island resided by around 59% of population, which has area of 7% to total area of Indonesia. Meanwhile, Maluku and Papua have 25% of the total area of Indonesia but are inhabited by 2% total Indonesian population. With the current growth rate of 1.66% the population is expected to grow to 280 million by the year 2020. In the past decade urban immigration has resulted in an urban growth of about 5% annually. It is estimated, therefore that by the year 2020 about 52% of the nation's population will live in urban surroundings, compared to 38% in 1995 (World Water Council, 2003).

Though precipitation daily sound, like a lot; nevertheless, a severe water shortage is the most urgent, long-range, environment problem facing some nations in the world (Ja¨germeyr et al., 2017). Water was related to issues of floods, droughts, soil erosion and

sludge production, lack of adequate water storage, watersheds degradation, threats on water availability and sustainability, water quality problems (Fulazzaky, 2014).

Pollution

Pollution can be taken place in the atmosphere, in the soil and water. Major atmospheric pollutants can be a carbon monoxide (CO), oxides of sulfur, hydrocarbons, particulate matter, oxydes of nitrogen, photochemical smog and ozone; Sources of pollutants can come from transportation and industry; Air pollution indirectly effect to climate change. One harmful aspect of air pollution is that it may directly modify the intensity of sunlight, temperature, cloud formation, and the distribution volume, and acidity of rainfall. Moreover, relatively slight rainfall or temperature changes may disrupt the balance of ecosystems by eliminating key plant and animal species.

Anorganic pesticide pollutant effect seriously to ecosystem stability. Some field receive heavy pesticide dosage of solid or solute waste. Solid waste, such as wastepaper, can, bottles, junked cars, tires, plastic and so on. Industrial hazard was can serious effect to groundwater and surface water problem. In undisturbed ecosystems there exist naturally occurring regulatory mechanisms, that keep population levels of a species at a point of equilibrium. However, whenever the original ecosystem becomes restructured by humans, it tends to become simplified, with a resultant disruption of the stabilizing influences of density-dependent regulatory factors. A lot of human intervention that tend to simplify the ecosystem.

Soil

Indonesia mainland has variety of soils, parent materials, landforms, elevations and climates. This condition is the main capitals to produce sustainable agricultural commodities. The utilization of land resources to develop agriculture should consider its potentials in gaining the optimum results. Up to now the agricultural area used for agricultural purposes cover 70.2 million hectares consisting of rice field, upland crop field, yard, plantation, grazing land, trees, and fish pond. Based on the assessment results by Indonesian Agency for Agricultural Research and Development, the land in Indonesia which is potential or suitable for agriculture covers 94 million hectares, comprising 25.4 million hectares of wetland (rice field) and 68.6 million hectares of upland/dryland. There are 30.67 million hectares of the total area which is potential for agricultural extensification comprising of 8.28 million hectares annual wetland agriculture (rice field), 7.08 million hectares annual upland agriculture, and 15.31 million hectares perennial agriculture. Wetland for annual crops covers swampy land with the total of 2.98 million hectares (mainly in Papua) and non swampy land 5.30 million hectares. In Indonesia the potential land as well as available land for agricultural extensification is still sufficient, but by the increasing needs of land for agriculture and non-agriculture, careful utilization is needed. The landuse competition in the future as a consequences to keep national food security and develop bioenergy needs to be overcome. Some efforts that can be done are by increasing the productivity (intensification), correct landuse based-extensification, and developing primary technological innovation (Hidayat, 2009).

Soil role as habitat of micro and macro-organism. The living community of soil organism includes bacteria, molds, protozoa, mites, insect larvae, millipedes, earthworms, burrowing mammals (moles), and so on. The environment with which this soil community interacts is composed of trillions of rock particles, detritus (decaying organic matter), water, gases (oxygen, carbon dioxide, etc.), chemical energy, heat energy, and so on (Rasul, 2016). The activity of living organisms play an important role in soil development. The soil, in turn, is an important factor in the distribution of both plants and animals.

Product of land

Agriculture. As an agricultural country, agriculture became the most important livelihood for the majority of the people of Indonesia. Agricultural land area approximately 82,71% of the total land area. The land is mainly used for rice cultivation. The spread of rice production is still concentrated in Java due to the high productivity and harvested area compared to other islands. Other agricultural production are maize, sweet potatoes, peanuts and soybeans. The production of vegetables, horticultural species include large red onion, scallion, potato, cabbage and carrots. While the production of horticultural types of fruits include mango, durian, oranges, bananas, papaya and barking. Based on the age of plants, plantations in Indonesia is divided into two major groups, namely crops (sugarcane, tobacco, cotton, distance, fragrant lemongrass, patchouli and hemp) and perennial crops (rubber, coconut, coffee, palm oil, clove, nutmeg, wood sweet, vanilla, hazelnut, nut, tamarind, palm, palm, coconut, and sago palm). Most of the plantation cultivation of annual crops (Rio, 2012). Livestock population in Indonesia consists of a large livestock population, such as dairy cows, beef cattle, buffalo, and horses. Population of small ruminants include: goats, sheep, and pigs. While the poultry population consisted of chicken, broiler chicken, broiler chickens and ducks. Among livestock products, which currently has export prospects are processed leather (tanned).

Forest. Based on the function, Indonesia's forests are divided into four types, namely protected forest, production forest, nature reserves, and forest tours. Forestry production in the form of forest wood, well logs, sawn timber and plywood. From the results of these forests, which is currently a mainstay product

Indonesia for export activity is plywood. Physical fact that two-thirds of Indonesia in the form of the sea, the sea's natural resources have huge potential. In addition to containing oil, gas, mineral and marine non-conventional energy, and treasure that has begun to be dug though still limited, the sea also produces fish is estimated at 6,4 million tons per year. Currently the only used about 70%. The development of marine resources and fisheries are grouped in five marine industry, namely the fishing industry, marine energy, mining and industry, maritime industry, including shipbuilding industry, shipping industry (marine transport) and the tourism industry (marine tourism and conservation areas). Today is a mainstay of Indonesian fishery exports are shrimp and tuna (Rio, 2012).

The nation also has the region's largest exploitable tropical forests namely in Papua and Kalimantan which support a healthy timber industry. The rainforests, which are the world's third largest, are home to 29,000 species of plants and 3,000 species of animals. The timber industry has witnessed steady growth since the 1960's with legitimate and illegal loggers targeting specific tree species such as Teak and Meranti which is in high demand due to its reddish easily workable wood that is also considerably lightweight. Vennes and plywood that is produced locally is either consumed locally or exported. The excessive exploitation of forests has led to massive deforestation and substantial environmental degradation. The rate of environmental degradation is further accelerated by government-sanctioned conversion of tracts of forest into agricultural fields (Sawe, 2018).

Biological resources. Indonesia's mega-biodiversity, consisted of Terrestrial area 1.860.359,67 km^2, Marine area 5,8 million km^2, 33 Provinces, approx. 424 cities/districts, Population 218,9 millions (2005), Biodiversity: Mammals 515 species, Reptiles 781 species, Primates 35 species, Aves 1595 species, Amphibia 270 species, Plants (angiospermae, gymnospermae dan pteridophyta) 31,746 species (Nalang, 2003).

The population of any organism will be the result of the interaction of the two antagonistic forces of the environmental resistance (ER) and the biotic potential (BP). The population of an organism is controlled in part by density-independent factors, such as heat, cold, drought and so on; Habitat is the general environment in which an organism lives---its natural home. The habitat of a wild animal provides certain essentials: shelter, food, water, breeding sites (den, nest, or burrow), and a fairly well-defined area called territory, in which an animal has psychological dominance over intruders.

Tropical ecosystems provide a wide and complex range of goods and services to individuals and communities. Environmental valuation includes a diverse and complex set of values that can be conceptualized in a number of ways. Direct-use values: Resources for extraction, water services, recreation and tourism; Indirect-use values: Climate regulation, physical protection; Non-use values: Option value (i.e. willingness to pay), existence value (i.e. value of knowing the resource exits); Intrinsic values: Values not tied to human use. When ecosystems are destroyed or degraded, the impacts on natural resources, biodiversity and ecosystem services can represent huge losses to the state, society and individuals. These diverse environmental values include: direct-use values related to natural resources that can be managed and extracted (e.g. timber, minerals and non-timber forest products) and in direct use values associated with biodiversity and ecosystem services (e.g. hydrological, pollination and climate regulation services, recreation and tourism). Nature also holds intrinsic values and non-use cultural, religious and historical values. When ecosystems are destroyed or degraded, the impacts on natural resources, biodiversity and ecosystem services can represent huge losses to the state, society and individuals (Bryant, 2020; Phelps et al., 2014).

Mineral and energy

Unlike forest, wildlife, fisheries, and even soil, mineral resources are non-renewable exhaustible---they cannot be renewed once they are consumed. The great majority of minerals now used by society have been extracted from earth's crust. Good example are gold, silver, and diamond (carbon). Those mineral compounds are not distributed uniformly. Recently, gasoline supplies became so scarce that thousand of independent dealer throughout the world were force to stop pumping gas. The kind of energy resources are coal, coal gasification, coal liquefaction, oil, natural gas, oil shale, tar sands (Owen, 1985).

The various sources of energy can be conveniently grouped as commercial primary energy resources was included the non-renewable sources of energy or conventional sources of energy are being accumulated in nature for a very long time and can't be replaced if exhausted. Nature gifted resources which are consumed can't be replaced, e.g.: coal, petroleum, natural gas, thermal power, hydro power and nuclear power are the main conventional sources of energy; Renewable sources of energy was included of energy sources, which are continuously and freely produced in the nature and are not exhaustible are known as the renewable sources of energy, e.g.: solar energy, biomass and wood energy, geo thermal energy, wind energy, tidal energy and ocean energy (ICAR, 2020).

The mining sector is one of the largest industries in the country as vast exploited and un-prospected mineral deposits support it. The nation's mineral

resource exports are dominated by natural gas and crude petroleum. Other major mineral exports include coal, nickel, bauxite, gold, tin, and copper. The country's industrial development is also to a large extent based on the domestic processing of mineral wealth. However, most of the minerals are exported in a raw or semi-processed state to some industrialized nations.

The Indonesian abundant natural resources above need to be managed efficiently in order to meet the need of social, economic and environment sustainably.

2. Natural Resources Management

Water resources development

The role Water Resources Development in Indonesia has been put by the ancient generation of Indonesian, highly importance. This had been supported by strong evidence for the case for agricultural water utilizations. This fact would likely remain constant and yet sustainable toward the long-term future. Water resources have played a major role in Indonesian development. Currently, over 5.5 million hectares of agricultural lands have been served with technical irrigation schemes. Parallel with these, another 1.6 million hectares are irrigated under the village irrigation schemes. These involved diversity of either construction or rehabilitation works of about 12,500 diversion structures and 40 reservoirs. Apart from these, Indonesia has also been able to extend water resources utilization progressively to support its 2,200 megawatts of hydropower generation -- which is now encompassed about 20 percent of the nation's electricity generating capacity. Rural and Urban water supply schemes deliver close to 100,000 litres per second of piped drinking water. On top of the above achievement, over 3.3 million out of the 3.4 million hectares of swamplands have been developed and major flood control and drainage projects have been implemented. In addition, nearly 18,000 hectares of fishponds have been developed mostly in Aceh, North Sumatra and Sulawesi. In addition, about 1.96 million hectares of lowlands and urban areas are provided with flood protection infrastructures, compounded with 15 kilometres of coastal structural protections (World Water Council, 2003).

The government of Indonesia has made special efforts on integrated water resources management (IWRM) since the enactment of Law No. 7/2004 on water resources. Guided by this law, the decision makers, managers and operators will always strive to do the right things to implement the strategies, programs and activities to support water management. The law and policies governing the implementation of IWRM are the legal provision for managing water resources in the river basin perspective but have not yet been synchronized effectively. Each ministry in pursuit of its mission has a mandate with responsibility for promoting social, economic, environmental and cultural well-being of communities in the present and for the future. Challenging the IWRM perspective may be the pilot projects need to be done together in order to solve a problem. This perspective seeks inter-ministerial cooperation and coordination to expedite clearances for water management activities. The goal of involvement different ministries is to help identify and implement mechanisms that encourage members to find ways to become involved in analyzing the complexity of implementation projects. Multi-criteria decision analysis is an umbrella approach that has been applied to a wide range of water management situations and helps to frame a group process that made stakeholder preferences explicit and substantive discussions about long-term river management possible (Fulazzaky, 2014).

Soil management

The establishment of plantation forest or natural regrowth was seen to decrease surface runoff and sediment generation and therefore, in principle, de-intensification can provide a solution to on-site and downstream sediment problems. Conventional fallow systems do not seem sustainable given the mounting population pressure, however. Fields are often left fallow for one or two years after three to five cropping seasons in order to regain some degree of fertility. These typically short fallow periods are too short for substantial soil restoration and fodder is often cut on such fields, favouring the establishment of grasses with low nutritional value such as *Imperata cylindrica*. Soil fertility may be restored to some extent by afforestation, depending on the species involved and the 'improved' fallow period. Albizia trees rapidly enhanced soil carbon and nitrogen contents, although the possible consequences for other soil nutrients (potassium, calcium, phosphorus) and soil acidity require more attention. Plantation forest can also provide income through the sale of timber and fuel wood after some years, but potential constraints to afforestation include the lack of rapid benefits, the tree stumps that impede tillage after clear-felling, and the possibility of pest outbreaks. The alternative is to try and simultaneously reduce environmental problems and enhance land productivity through intensification. Although promoted unsuccessfully in the study area in the past, intensification on rain-fed land through agro-forestry (involving fodder crops for stall-fed livestock) still seems viable (van Dijk et al., 2004).

Agriculture. The modern farm is a special type of ecosystem consisting of both natural and human-made components. We shall call it an agroecosystem. The structure of this ecosystem consists of both biotic (farmer, crops, insect pests, and so on) and abiotic (soil minerals, climate, solar energy, and fossil fuels) components which interact. The function of the agroecosystem includes such processes as: plowing,

fertilizer application, photosynthesis, irrigation and soil erosion (Waldron et al., 2017). Unique nature of Indonesian geography, coupled with the lack of transport infrastructure, makes their exploitation challenging. Moreover, a lack of investment, protectionism and an unwieldy regulatory environment are all inhibiting the sector from reaching its full potential. Agriculture has been held back by low productivity, under-investment, unclear property rights on land, ill-advised trade regulations, misplaced support for staples and restrictions on foreign ownership. By pursuing crop diversification, encouraging co-operation between smallholders and large estates and easing constraints on foreign investment, Indonesia could raise its farmers' productivity.

Forest. The forest ecosystem is essentially a community of organisms, the member of which interact with the living and non-living components of this environment. A forest is a complex ecosystem. It is composed of both living (tress, herbs, shrubs, weeds, soil bacteria, fungi, viruses, earthworms, caterpillars, moths, bark beetles, grouse, bear, deer), and non living (water, rock, particles, solar radiation, wind, and so on) components; The forest management must always consider of ecological, social, and legal constraints factors.

Biodiversity and conservation. Conservation is state of harmony between man and the environment. They include the following: *Preservation*, preserving resources from human destruction; *restoration*, repairing the damage, so that the original value and productivity of the resource can be restored; *beneficiation or upgrading a resource*, upgrading of any natural resource such as forest, farmland or fishery; *substitution*, the replacement of a scarce resource with one that is more abundant; *maximization*, refer to the reduction of waste by the most efficient use of a resource that is possible; *reusing ad recycling*, the use and reuse of sewage -contaminated river water throughout urban area; *integration*, the determination of how to maximal value of such a complex of interrelated and interacting resources for society. Our complex and varied of natural environment are dynamic and organic whole. Humans cannot degrade one part of the environment without at the same time harming other parts as well.

A guide for sustainable management of Indonesia's biodiversity was mentioned in Indonesia Biodiversity Action Plan (IBSAP), in 1993. In IBSAP 2003 was formulated a participatory, bottom-up and transparent approach. The regional autonomy and decentralization, need to improve involvement of community in biodiversity management, shift biodiversity management paradigm, new strategy systems and action plan that is more contextual with the current situation (Nalang, 2009).

Management and conservation should be applied according to ecological approach principle. We have defined ecology as the study of the interrelationship that exist between organism and their environment. An understanding of certain basic ecological concept will aid in developing and appreciation not only of the problems facing the conservationist and environmentalist, but also of the policies, strategies,

Table 1. Major Natural Resources, Conservation Issues, Government responsible Agencies and Non-governmental organizations (Bryant, 2020).

Indonesia	
Location	Southeast Asia, archipelago between the Indian Ocean and the Pacific Ocean
National Websites	Indonesian Government Links
Embassy / Chancery in U.S.	2020 Massachusetts Avenue NW Washington D.C. 20036
Agencies responsible for biological inventory and conservation	Ministry of Forestry and Ministry of Environment
Non-governmental organizations concerned with conservation	See "Professional Organization"World Wide Fund For Nature (WWF) Indonesia Programme The Nature Conservancy (TNC) Indonesia Programme World Environment Center (WEC) Conservation Internasional (CI) Indonesia Programme Care Internasional Indonesia Organization Industrial Spiritual and Culture Advancement (OISCA) Asia Westland Bureau (AWB) Canadian University Service Overseas (CUSO) (The) Fort Wayne Zoological Society and Concervation International (FWZS/CI) (The) International Council for Bird Preservation (ICBP) atau Birdlife Sticthing FACE (Forest Absorbing Carbon dioxide Emission) Center For International Forestry Research (CIFOR) (The) Tropenbos Foundation (The) International Crops Research Institute for (the) Semi Arid Tropics (ICRISAT) (The) Gottingen University Centre de Cooperation Internationale en Recherche Agronomique Pour le Development (CIRAD) (The) International Course for Development Oriented Research In Agriculture (ICRA) Indonesian Center for Environmental Law (ICEL)
Major Natural Resources	The natural resources of Indonesia include petroleum, tin, natural gas, nickel, timber, bauxite copper, fertile soil, coal, gold, and silver. In addition, there are vast rain forests, coral reefs and mangrove forests that serve as home to a large variety of plants and animals. Indonesia is known for its Orangutans and Komodo Dragons. There are over 40,000 species of plants and about 6000 species are used by natives in traditional rituals and for herbal medicine.
Major Environmental and Conservation Issues	Forest fires have often been started by plantation owners and the timber industry to clear forest for their activities. In recent years they have burned out of control due to low rainfall and unusual wind patterns caused by El Nino They cause transnational air pollution and destroy huge areas of forest habitat. Indonesian fires blamed on plantations, ENN Daily News -- 8-10-99 ASEAN moves up smog meeting as fires rage, ENN Daily News -- 8-10-99 Indonesia's Forest Fires Pose an Economic Threat Also, there are problems due to commercial deforestation. Efforts are being made to preserve rare animals like the Komodo Dragon. Recently, in 1997 a new species of coelacanth, a fish that was thought to be extinct for 80 million years, was discovered by Mark Erdmann in Sulawesi.

Source: Page compiled by Kyle Lothringer as part of a class project in h90 "The Science of Biodiversity and Conservation" (Peter J. Bryant, Instructor), University of California, Irvine, Irvine, CA 92697, USA.

and regulations by which the problems might be resolved (Owen, 1985). Ecology study structure and function of ecosystem. Principles of ecology, mention (1) *The low of conservation of matter*, although matter can be change from one form to another, it can neither be created nor destroyed by ordinary physical and chemical changes. Although energy cannot be converted and destroyed, it can be converted from one form to another; *Matter and energy laws—Their ultimatum to spaceship earth*, we cannot continue to act as if we rule nature, but we must act as though nature rules us; (2) Whenever energy is converted from one form to another, a certain amount is lost in the form of heat. Photosynthesis is the process by which green plant converts the raw materials carbon dioxide and water to glucose in the presence of sunlight. The green pigment in plant, known as chlorophyll, serves as catalyst in the process (Owen, 1985; Rasul, 2016). The government and some non government organizations were participated in conservation practice, were reported in Table 1.

Mineral and energy management

Fossil fuels have become central to Indonesia's energy policy and its main source of export revenues. Growing environmental concerns, both domestically and internationally, combined with subsiding coal prices and the on-going shale gas revolution, call into question the sustainability of such a strategy. Indonesia should increase its energy efficiency and further develop gas to plug the gap until sufficient renewable energy, especially geothermal, comes on line. Government control over the oil industry via state-owned Pertamina should be gradually reduced. Clarifying, streamlining and publicising simple regulations in energy and minerals, especially regarding land rights and on-shore processing, and removing foreign-ownership restrictions will help bring much needed investment. The pressure on the environment that natural resource exploitation is creating should be addressed by increasing the share of gas and renewables in the energy mix, properly defining property rights and regulations regarding forest land, and implementing a positive implicit carbon price. More resources should be devoted to combating widespread illegal mining and deforestation (Dutu, 2015).

Indonesia possesses vast reserves of coal, mostly steam coal of medium calorific value used for energy production (and some small amounts of lower-end coking coal products). It also possesses huge reservoirs of natural gas and oil, and was until 2009 the only Asian country in the Organisation of Petroleum Exporting Countries (OPEC). In terms of minerals, Indonesia is the world's largest exporter of refined tin and (until recently) nickel ore, and a leading exporter of bauxite, lead, gold and copper. The Grasberg mine in Papua has the world's third-largest copper reserves and the world's biggest gold reserves.

The Indonesian Government is also exploring alternative energy sources to reduce dependence on oil. The renewable energy sources can be defined as captured an energy resource and replaced rapidly by a natural process such as power generated from the sun or from the wind. Alternative energy sources, are gas, coal, hydropower, geothermal, and solar power (Rio, 2012). Nuclear fuel and waste cycle are also alternative energy. Though, their radioactive contamination of the human environment is most likely to occur during the transport of spent fuel for reprocessing and during the transport and disposal of nuclear waste (Owen, 1985). Government currently explore the alternative energy sources, such as biomass based energy or biofuel with ingredients such as oil palm plantation crops, sugarcane, cassava, and distance (Rio, 2012).

Natural resources management is one of the Indonesian development planning that alignment with Sustainable Development Goals program.

3. Sustainable Development Goals (SDGs)

The alignment of Indonesian development planning and SDGs, can be explained that Indonesia has four pillar development, i.e. environment, social, economic, law and governance. Management of natural resources, water security, soil and biodiversity conservation are part of environment goals. For mainstreaming of SDGs into National Development Agenda were implemented through three steps, were (1) SDGs Roadmap as planning document of strategic steps to achieve SDGs 2016-2030, (2) National Action Plan as planning document to achieve SDGs for National Level, (3) Preparing Planning Document to achieve SDGs for Sub-national Level (Yusuf, 2016).

Indonesia is highly committed to implement SDGs. The substance and objective of SDGs (Dinpanah and Lashgarara, 2008; Bich et al., 2020; Shubhra and Palwal, 2019) are in line with "Nawacita" (Indonesia's national development vision), National Long Term Development Plan (RPJPN) 2005-2025 and the National Medium-Term Development Plan (RPJMN) 2015-2019. The same commitment to jointly implement SDGs by all countries in the world is essential to eradicate poverty, promote shared prosperity and improve environmental quality. Issues of poverty, welfare, and environmental quality are common challenges to be faced globally as one planet. Therefore, one of the main necessary conditions to achieve SDGs is an enabling situation that should be created jointly: a global peace, security and stability. Goals, targets, and indicators of SDGs that have been agreed are continuation and expansion of Millennium Development Goals (MDGs) that were implemented in 2000-2015. Indonesia is also highly committed to the 2017 VNR. The theme of 2017 VNR is "*Eradicating*

poverty and promoting prosperity in a changing world". In preparing the VNR, all of the four participation platforms are involved, i.e, government (Minister of National Development Planning, 2017), civil society organizations (Starbird et al., 2016), philantrophy and business society (Sahaa et al., 2018; Lal, 2020), academics and experts (Keesstra et al., 2016; Xiao et al., 2018). To meet the Sustainable Development Goals, the Increasing distribution and connectivity of other regions are one of the Indonesian government programme. The government, aware of each region's potential and comparative advantages, has put connectivity and specialisation to manage natural resources at the heart of the Master Plan for Acceleration and Expansion of Indonesia's Economic Development 2011-2025 (Dutu, 2015).

Although the government has already implemented implemented SDGs to national program; however, some new strategy requires to be implemented to 'localize' the global goals, i.e. (1) optimizing the current technocratic framework of SDGs implementation; (2) establishing guidelines for a sustainable development framework at provincial and district/city level; (3) incorporating insights from civil society, industry, and a range of non-state actors who work on sustainability, establishing a forum for their participation in the SDGs implementation processes; and (4) establishing a policy network to measure the implementation of the SDGs at the national and subnational levels by incorporating the insights of non-state actors (Agussalim et al., 2019). Main challenges of implementing SDGs, are (1) Involvement of all parties in a process to establish mutual trust, (2) Developing database system for aligned indicators as well as indicators that will be developed, (3) Disaggregating of the 241 SDGs indicators by gender, age group, geographic location, income level, disability, and migration status (Yusuf , 2016).

CONCLUSION

The Indonesian government has implemented the natural resources management planning that alignment with SDGs programme, through (1) integrated water resources management program to store water during the rainy season and serve water during the dry season; (2) afforestation programme to prevent runoff, sedimentation and soil erosion; (3) agroforestry and forest management that always consider of ecological, social, and legal factors; (4) a guide for sustainable management of Indonesia's biodiversity was mentioned in Indonesia Biodiversity Action Plan (IBSAB); (5) the government and non-government organizations participated in conservation practice; (6) exploring alternative energy sources to reduce dependence on oil, such as biomass based energy or biofuel with ingredients of oil palm plantation crops, sugarcane, cassava; (7) mainstreaming of SDGs into National Development agenda based on SDGs Roadmap, National Action Plan as planning, and SDGs program for Sub-national level. This program was participated by all stakeholders included government, civil society organizations, philanthropy and business society, academics and experts. Though the government has already implemented SDGs program, but innovative strategic need to be developed.

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The cover page should contain; The title and full mailing address, e-mail address and address of the Lead Author and all additional authors.

Contributing Papers should contain the following sections and be arranged in the following order: Abstract, Introduction, Methods, Results, Discussion, Acknowledgments, Literature Cited. Tables, figures and Plates (including legends), if included, should follow the Literature Cited.

All pages should be numbered consecutively. Do not number section headings or subheadings.

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Keywords: From five to eight pertinent words, in alphabetical order.

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Use an ampersand (&) between author surnames when the citation is parenthetical: (Traeholt & Idris, 2011).

When a citation is not parenthetical, use "and": "Our results agree with the predictions of Wolf and Rhymer (2001)."

For citations with more than two authors, use et al.: (Campos-Arceiz et al., 2011). Do not italicize et al.

List parenthetical citations in alphabetical order and chronologically from oldest to most recent and separate entries with a semicolon: (Campos-Arceiz et al., 2011; Geissman, 2009, 2010).

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"In press" means the cited paper has been accepted unconditionally for publication. Provide the year of publication in the text (Bird, 2010) and in Literature Cited section provide the volume number, and substitute "in press" for page numbers (Bird, I.M. 2010. Nesting success in arid lands. Conservation Biology 24: in press.).

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Campos-Arceiz, A. and R.T. Corlett (2011). Big animals in a shrinking world—studying the ecological role of Asian megafauna as agents of seed dispersal. Innovation 10: 50–53.

Campos-Arciez, A., Larringa, A.R., Weerasinghe, U.R., Takatsuki, S., Pastorini, J., Leimgruber, P., Fernando, P. and L. Santamaria (2008). Behavior rather than diet mediates seasonal differences in seed dispersal by Asian elephants. Ecology 89: 2684–2691.

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Sebaran Mata Kuliah
Program Studi Manajemen Lingkungan Universitas Pakuan

No	Mata Kuliah	SKS	No	Mata Kuliah	SKS
Semester I			**Semester III**		
1	Metodologi Penelitian	3	1	Desain Penelitian	2
2	Isu-isu Kontemporer *Sustainable Development*	3	2	Pengukuran dan Instrumentasi (KKL)	2
			3	Mitigasi Bencana	2
3	Hukum Lingkungan	2	4	Teknik Pengelolaan Limbah *)	2
4	Ekologi dan Ilmu Lingkungan	3	5	Konservasi Energi *)	2
5	Filsafat Ilmu	2	6	Ecotourism *)	2
			7	Pengelolaan DAS *)	2
			8	Desain Pendidikan Lingkungan Hidup *)	2
			9	Konservasi dan Rehabilitasi Lahan *)	2
			10	Etika dan Moral Lingkungan *)	2
Semester II			**Semester IV**		
1	Teknik Analisis Data	3	1.	Tesis	6
2	Sistem Informasi Pengelolaan Lingkungan	2			
3	Manajemen Strategik dan Resiko Lingkungan	2			
4	Manajemen SDA dan AMDAL	3			
5	Kesehatan Lingkungan	3			
6	Bahasa Inggris	Non			
	TOTAL SKS				42

*) Mata Kuliah Pilihan (3 MK)

Dosen Tetap
Program Studi Manajemen Lingkungan
1. Prof. Dr. Isman Kadar
2. Dr. Rita Retowati, M.S.
3. Dr. Yossa ISTiadi, M.Si.
4. Dr. Dolly Priatna, M.Si.
5. Dr. Rosadi, S.P., M.M.
6. Dr. Sri Wahyuni, SE., MP.

Rincian Biaya

No.	Jenis Biaya	Semester 1	2	3	4	Jumlah
1	Pendaftaran	750,000				750,000
2	SPP					
	Gelombang I	6,500,000	2,000,000	2,000,000	2,000,000	12,500,000
	Gelombang II	7,500,000	2,000,000	2,000,000	2,000,000	13,500,000
	Gelombang III	9,000,000	2,000,000	2,000,000	2,000,000	15,000,000
3	SPP	3,000,000	3,000,000	3,000,000	3,000,000	12,000,000
4	SKS	1,950,000	1,800,000	1,650,000	900,000	6,300,000
5	Jas Almamater	500,000	-	-	-	500,000
6	Buku Pedoman & Bimbingan Tesis	-	-	100,000	-	100,000
7	Wisuda				+ PM*)	+ PM*)
	JUMLAH GEL I	12,700,000	6,800,000	6,750,000	5,900,000 + PM*)	32,150,000 + PM*)
	JUMLAH GEL II	13,700,000	6,800,000	6,750,000	5,900,000 + PM*)	33,150,000 + PM*)
	JUMLAH GEL III	15,200,000	6,800,000	6,750,000	5,900,000 + PM*)	34,650,000 + PM*)

Waktu Perkuliahan :
Reguler:
Jum'at Jam 17.00 – 21.00 Perkuliahan:
Sabtu Jam 08.00 – 16.00 *Blended Learning System*

Contact Person:
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