

Biological and Cultural Ecologies: Indigenous Knowledge, Indonesia and IR 4.0

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Abstract

Global concern about the environmental crisis threatening human society has increased rapidly in the last decade. But the sociocultural loss of diverse indigenous languages throughout the world does not attract the same level of attention as Canadian wild fires or a Venice threatened by the sea. In Indonesia, the link between environmental endangerment and the loss of local languages has been well documented. These interlinked crises require efforts to bring together scholars in both the natural and social sciences in order to devise research featuring projects that address the endangerment of local ecologies as well as the languages spoken there. Of course, such projects require outreach to and the involvement of the communities whose environments and languages are threatened. Engaged community members can work with scholars to face this twin crisis with action plans appropriate to the local ecological and language environments.

Keywords: Environment Crisis, Endangered Languages, Local Knowledge, Community Engagement, Ecologies

Introduction

Today we, all of us, are witnessing the environmental crisis that is impacting the seas, the rivers, the forests, the mountains, even the soils of Indonesia. In the context of contemporary, international concern about global ecology, Island Southeast Asia stands out as one of the most highly threatened regions of the world. This environmental crisis has proceeded with and must be linked with the rapid loss of the region's heritage languages. Biological ecology and cultural ecology are interconnected.¹ Indeed, two decades ago, Nettle (1999)

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demonstrated that those areas of the world with the highest biological diversity are also the same areas with the highest language diversity. “Any study of endangered flora and fauna in this region should go hand in hand with the study of endangered languages and dialects” (Collins 2019b).

These interlinked crises underscore the critical relevance of bringing together scholars in the fields of natural and social sciences. What transdisciplinary projects can we identify and agree to undertake that address these parallel and interconnected crises? We must address the fact that “Language endangerment is significantly comparable to—and related to—endangerment of biological species in the natural world” (Krauss 1992:4). Certainly, in the nineteenth century the scientific articulation of modern linguistics was linked to the parallel development of the biological sciences.² Moreover, scholars of the biological sciences were enthusiastic researchers of languages.

Alfred Russel Wallace (1823-1913), co-founder of evolutionary theory, conducted his ground-breaking fieldwork for eight years (1854-1862) in island Southeast Asia, mostly in eastern Indonesia. He collected numerous biological specimens, including 110,000 insects, 7500 shells, 8050 bird skins and 410 mammal and reptile specimens; see Camerini 2002:9; Raby 2001:165). Although Wallace was a pre-eminent scholar of the natural sciences, he also collected language “specimens”. Indeed, he collected fifty-nine wordlists of heritage languages spoken in the archipelago (Wallace 1869:464-493); many of which are no longer spoken.³ The first four of the lexical items collected by Wallace are presented in Illustration 1.

Junaid for inviting him and his colleague Muh. Affan Ramadhana who handled communications.

² Many of the concepts and terms developed in the nineteenth century (and later) for the emerging life sciences were incorporated into linguistics, for example, morphology, innovation, retention, diversification, speciation, reconstruction, extinction, endangered, family tree.

³ Several of the languages that Wallace included in his collected wordlists are cited in Collins 2018, for example the Atamanu language no longer spoken in Awaiya where Wallace worked 150 years earlier.

English.....	BLACK.	FIRE.	LARGE.	NOSE.
1 Malay	Itam.....	Api	Büsar	Idong
2 Javanese.....	Iran	Güni.....	Gedé.....	Irong.....
3 Sasak (Lombok).....	Bidan	Api	Ble	Idong.....
4 Macassar.....	Leling	Pepi	Lompo.....	Kamürong.....
5 Bugis	Malotong	Api	Maraja.....	Ingok.....
6 Bouton	Amáita	Whá	Monghi.....	Oánu.....
7 Salayer	Hitam	Api	Bakéh.....	Kumor.....
8 Tomóre	Moito	Api	Owhosi.....	Hengénto.....
9 Tomohon	Rümdum	Api	Tuwón.....	Ngerun.....
10 Langowan	Wülin	Api	Wanko.....	Ngilung.....
11 Ratahan	Mahitum.....	Pütong.....	Loben.....	Irun.....
12 Belang.....	Mühónde.....	Sülu.....	Musolah.....	Niyun.....
13 Tanawanko	Rümdum	Api	Süla.....	Ngerun.....
14 Kema	Hirun.....	Api	Süla.....	Ngerun.....
15 Bantek	Maitung.....	Pütung.....	Ramoh.....	Idung.....
16 Menado.....	Maitung.....	Pütung.....	Raboh.....	Idung.....
17 Bolang Itam.....	Moitomo.....	Püro.....	Morokaro.....	Djunga.....
18 Sanguir Is.	Maítum.....	Pütun.....	Labo.....	Hirong.....
19 Falibabo Is.	Maitu.....	Pütun.....	Bagewa.....
20 Sula Is.	Miti.....	Api	Ea.....	Ne.....
21 Cajeli.....	Metan.....	Ahu.....	Lehai.....	Nem.....
22 Wayapo.....	Miti.....	Bána.....	Bagut.....	Nien.....
23 Massaratty	Miti.....	Bána.....	Haat.....	Nieni.....
24 Amblaw.....	Kameichei.....	Afu.....	Plaré.....	Neinya téha.....
25 Ternate.....	Kokótu.....	Uku.....	Lamu lamu.....	Nunu.....
26 Tidore.....	Kokótu.....	Uku.....	Lamu.....	Un.....
27 Kaióa Is.	Küda.....	Lütan.....	Lol.....	Usnod.....
28 Batchian.....	Ngóá.....	Api	Rá.....	Hidom.....
29 Gani	Kitkudu.....	Lütan.....	Talalólo.....	Usnut.....
30 Sahoe.....	Kokótu.....	Uhu.....	Lamu.....	Ngünu.....
31 Galela.....	Tatataro.....	Uku.....	Elamo.....	Ngüno.....
32 Liang.....	Méte.....	Aów.....	Nila.....	Hiruka.....
33 Morella.....	Méte.....	Aów.....	Hella.....	Iuka.....
34 Batu-merah.....	Meteni.....	Aow.....	Enda-á.....	Ninura.....
35 Lariki, &c.	Méte.....	Aow.....	Era.....	Iru.....
36 Saparua.....	Meteh.....	Háo.....	Ilahil.....	Iri.....
37 Awaiya.....	Meténi.....	Aousa.....	Iláhe.....	Nua-mo.....
38 Camarian.....	Méti.....	Hao.....	Eráamei.....	Hili-mo.....
39 Teluti.....	Méte.....	Yafó.....	Elau.....	Olicolo.....
40 Ahtiago (Mah.).....	Memétan.....	Yaf.....	Aiyuk.....	Iiin.....
41 Ahtiago (Alf.).....	Meten.....	Wahum.....	Poten.....	Iinum.....
42 Gah.....	Miatan.....	Aif.....	Bobuk.....	Sonina.....
43 Wahai.....	Meten.....	Aow.....	Maina.....	Inóre.....
44 Goram.....	Meta metan.....	Hai.....	Bobok.....	Suwera.....
45 Matabello.....	Meten.....	Efi.....	Leleh.....	Wiramáni.....
46 Teor.....	Miten.....	Yaf.....	Lén.....	Gilinkani.....
47 Ké Is.	Metan.....	Youf.....	Lih.....	Nirun.....
48 Aru Is.	Büré.....	Ow.....	Jinny.....	Djurul.....
49 Mysol (Coast).....	Mülmetan.....	Lap.....	Sala.....	Shong gulu.....
50 Do. (Interior).....	Bit.....	Yap.....	Klen.....	Mot mobi.....
51 Dorey.....	Paisim.....	Voor.....	Iba.....	Snori.....
52 Teto, E.	Metan.....	Hahi.....	Bot.....	Inur.....
53 Vaiqueno, E.	Meta.....	Hai.....	Naiki.....	Inu.....
54 Brissi, W.	Metan.....	Ai.....	Naaik-Bena.....	Panan.....
55 Savu.....	Meddi.....	Ai.....	Moneái.....	Hewonga.....
56 Rotti.....	Ngéo.....	Hai.....	Matua, Malóá.....	Idun.....
57 Allor.....	Mité.....	Api	Bé.....	Niru.....
58 Solor.....	Mitang.....	Api	Belang.....	Irung.....
59 Bájau (Sea Gipsies).....	Lawon.....	Api	Basar.....	Uroh.....

Illustration 1. A sample of the fifty-nine wordlists that Wallace collected during his zoological fieldwork in the archipelago (Wallace 1869:468).

In a parallel transdisciplinary endeavor, the contemporary study of endangered languages must be linked to the contemporary, international concern about global ecology. All of us must realize that linked to the biological heritage of Island Southeast Asia, is its language heritage.

In this brief essay, first, some projects linking language sciences and life sciences will be discussed. In the second part of the paper, the need to undertake future projects in the context of the Industrial Revolution 4.0 will be considered. Projects focused on addressing the linked crises in biological and language ecologies can take advantage of the new technologies of IR 4.0, as well as contribute to improving those technologies. In the conclusion, the breadth and depth of the environmental and cultural crises will be reconsidered.

Culture, Language and The Life Sciences

Ten years ago, at an international seminar of postgraduate directors at Indonesian universities, the designated theme was the role of postgraduate programs in the continuous

development of island society.⁴ One presentation (Collins 2011a) critiqued the manipulation of culture and language in development projects throughout the world. But, because the seminar was organized by Universitas Pattimura in Ambon city in east Indonesia, the paper began by commenting on unplanned, opportunistic development in a village on the same island where the seminar was being held. The focus was on the village of Asilulu, a densely populated littoral village of fishermen and traders on Ambon island's northwest coast approximately 50 km from Ambon city.⁵ See Illustration 2.



Illustration 2. The village of Asilulu on Ambon's northwest coast.

In Collins (2011a), a brief sketch of development over a forty-year period was presented, as follows:

"The images are idyllic and suggest a "traditional" village, picturesque and unchanging. But between 1972 and 2011, many changes have impacted this village, its people and their environment. In the late 1970's the selling price of clove skyrocketed; all the wooded areas within 2-3 kilometers of Asilulu village were removed to plant clove seedlings even on very steep slopes, too close to the sea to be productive. About 10 years later chainsaws became widely used; most of the decades-old durian and mango trees, formerly yielding food and a marketable commodity, became planks. As more cash became available, new houses were built. The live coral below the photo's crystal clear waters was crow-barred out to form house foundations; the pebbles of the beaches were carted away to make cement. When shark oil emerged as a commodity about 15 years ago, all the harmless, unpalatable, bottom-dwelling sharks were driven to near extinction to supply the demand in Ambon city. The same fate befell the crabs and tropical lobsters rarely eaten by Asilulu

⁴ *Peran Program Pascasarjana dalam Pembangunan Masyarakat Kepulauan secara Berkelanjutan,*

⁵ For more information about Asilulu, see the introduction in Collins (2007).

villagers: caught and shipped to the city's restaurants. This photo does not indicate the diesel and gasoline scum on the water, the roads cut out of the woods, the beach built over with a freezer plant to process yellow fin tuna for Japanese markets."

The contrast between the imagined, "traditional" village and its implied unchanging cultural practices with the factual description of an emerging Asilulu of the twenty-first century is undeniable. An untrained observer can enumerate the visible changes in the environmental setting of the village. A trained linguist can try to assess the equally dramatic changes to language praxis in Asilulu.

Access to education as well as improved infrastructure have led to social and economic expectations that have caused changes in the way indigenous languages of Maluku are perceived and used. In Asilulu village, for example, in 1972 and into the 1980's everyone in the village spoke Asilulu. People who married into the village learned the language; parents spoke it to their children. However, today, parents no longer transmit the Asilulu language to their children. Most villagers under the age of 25 or 30 no longer speak the language to each other and have limited comprehension when they are occasionally addressed in their heritage language by their elders. So, while the improvement of the infrastructure in Indonesia has made it easier to conduct language research, the object of the research has changed. In many places we can no longer study robust language use in a range of social settings. Rather, we are looking at stages of obsolescence in which social factors determine language choice. See Collins (2014).

It is true that language shift and language extinction in Maluku have been historically connected to colonial educational and ecological policies (Collins 2003). In the colonial era, the indigenous languages spoken in Christian villages, where, unlike Muslim villages were provided with schools and better overall infrastructure overall, were the most threatened. Indeed, many of those languages are now extinct. However, as suggested above, economic progress achieved in the twentieth century has been impacting language choice and language viability in all socioreligious communities throughout the province, whether in villages that became Christians in the 16th and 17th centuries (Collins 2003, 2012), villages that converted to Christianity only in the twentieth century (Florey 1993, 2001) or in Muslim villages like Asilulu (Collins 2017a) and Tulehu on the east coast of Ambon island, as reported in Musgrave and Ewing (2006) and Musgrave (2005), as well as in Latu and Sepa on the south coast of Seram (Collins 2017b).

In fact, language obsolescence and environmental deterioration are not simply occurring at the same time. It is not a coincidence that linguistic and biological ecologies are simultaneously in decline. Luisa Maffi (2001:3) wrote eloquently about

"... the relationship between language, knowledge, and the environment, of the breakdown of these ties under the pressure of 'modernization,' and of the far-reaching implications of this breakdown for indigenous and other local peoples, and for humans at large."

Environment shapes the languages of the communities who live in that specific ecological niche. Cultural attitudes are shaped through the influence of the ecology. As Wollock (2001:257) suggested: "[T]hese languages have to no small extent been shaped by the environments in which their speakers live and in turn have guided the shaping of environments by those who live in them." Let us return to a question proposed earlier in this essay: What transdisciplinary projects can we identify and agree to undertake that address these parallel and interconnected crises?

In the early years of the twenty-first century, two Indonesians who had recently finished their undergraduate studies at the agricultural faculty of Tanjungpura University (Pontianak, West Kalimantan, Indonesia) arrived at the National University of Malaysia to enroll in an M.A. program focused on linguistics. As agriculture undergraduates, they had studied biology and botany and had written their undergraduate essays about their laboratory experiments. However, they had also worked as field assistants in numerous language research projects in their province.⁶ In their MA theses, each of them combined their training in life sciences as well as their experiences as field workers in linguistics with their lived knowledge of their local epistemologies as members of two different indigenous communities of Borneo.

These two scholars proved that crossing back and forth from linguistics and language study to botany and zoology can be intense and successful. As reported in Collins (2019b):

“In 2009, P. Derani completed his MA thesis that studied a long oral narrative, *Mamakng Bulatn Jadi Macatn*, recorded in the Benawas language of west Kalimantan. His analysis drew on oral literature, linguistics and the nuances and cycles of swidden rice cultivation (agriculture). In 2009 as well, Herpanus submitted his MA thesis, *Etnolinguistik Dayak Desa: Zingiberaceae dan masyarakat*, which studied the various species of zingiber (all plants closely related to ginger) known and used by the Desa ethnic group of west Kalimantan. Using botany, linguistics and anthropology, he collected specimens in villages and the forest to identify the various species of *Zingiberaceae* and worked closely with village elders and shamans to explore the material and spiritual functions of these plants in Desa society. In these two cases, both scholars worked across disciplines to gain new conceptualizations of their data. And in both cases they had to work closely with local community members that spoke these two languages and lived their lives within these cultures.

These two studies provided a preliminary path that can be followed to develop transdisciplinary projects that aim at the linkages between biological and language ecologies. Their studies (Derani 2009, Herpanus 2009) indicate the close and complementary connections across a range of disciplines as well as the importance of collaborating with members of the local community.⁷

In addition, we must recognize an exceptionally well-planned and carefully executed research project that criss-crossed the natural and social sciences, and not only linked these broad academic fields together but also engaged the local communities. From 1991-1997 diverse scholars and community members participated in the Culture and Conservation Research Program in East Kalimantan with funding from the Ford Foundation as part of the Kayan Mentarang Conservation Project of World Wildlife Fund Indonesia. At first the project

⁶ Many of these projects were funded by or sparked by a Southeast Asian Studies Regional Exchange Program Regional Collaboration Grant (2000-2003) on Language and identity in western Borneo. See Collins (2001) for a brief overview.

⁷ Herpanus continued his studies in Malaysia and wrote a doctoral dissertation focused on the impact of social and agricultural practices on the sustainability of indigenous botanical knowledge. In short, as Indonesian internal migration projects (*transmigrasi*) and later palm oil estates overtook the cultural and agricultural practices of a small indigenous community of swidden rice cultivators in West Kalimantan, the recognition of, as well as the terminology and lore about the plants and animals of the adjacent forests have drastically diminished among the younger generation of the indigenous community. This dissertation was revised and published: *Bahasa dan Etnobotani Suku Desa: tantangan perubahan ekologi* (Herpanus. 2014).

was planned as an oral literature project, but this plan was changed significantly to connect with the World Wildlife Fund's project to develop a management plan for the Kayan Mentarang conservation area. Among the laudable characteristics of this project was the comprehensive training program for the project team, including intensive training for "Indonesian, particularly local, indigenous ("Dayak"), researchers in field research techniques" (Eghenter, Sellato and Devung 2003:2). As noted in Collins (2019b):

In 1990–1992 alone there was training "bridging ecology and anthropology, the natural and social sciences". Subsequent field studies (1993–1994) focused on "linguistics and oral literature; land tenure and traditional legal systems; and regional history of societies and the forest.... These were carried out by about thirty scholars and students, most of whom were Indonesian...." In the final phase of the (1995–1997), "[r]ecruiting and training continued to target Dayak researchers from communities in and around the Kayan Mentarang area..." A small team of core researchers and research assistants was formed (Eghenter, Sellato and Devung 2003:3).⁸

From the description above, apparently at an early stage of this project, literature and narratives about land tenureship were emphasized in the program proposal. But as funding was explored and plans proceeded, the project shifted to a program primarily aimed at improving the planning and management of a nature reserve, albeit a project in which oral literature still played a role. The resounding success of this program is reflected in the empowerment of local participants and collaborators who led "conservation and development activities in their own communities" (Eghenter, Sellato and Devung 2003:3).

We have only looked very briefly at three projects that linked natural and social sciences in order to explore the linkages between language and biological ecologies. Indeed, "we linguists need to devise plans to strengthen language diversity through transdisciplinary projects that embrace environmental ecology and the biological sciences. However, we must propose projects in which language revitalization and the empowerment of heritage language communities is the focus of the project" (Collins 2019b). Language, local culture and oral literature should not be mere subsections of larger projects focusing on managing nature reserves and encouraging sustainable development; see Collins (2011a).

Today, it is indisputably clear that we are facing the rapid loss, in fact, the steady destruction, of language and cultural diversity in Indonesia. Let us devise projects in which language maintenance and revitalization are the highest priorities and with which environmental and biological sciences can be connected in order to facilitate the sustainable revival and development of withering heritage languages and the fragile and damaged local environment.

Indigenous Knowledge and IR 4.0

"Industrial Revolution 4.0" is a phrase that has appeared over and over again in national and international conferences in the Southeast Asian region. In the popular imagination, this term is often associated with the increasing automatization, indeed robotization, of industrial production. About five years ago, a team of scholars in Italy undertook a research project in

⁸ This is merely a brief sketch of a complex project. Interested colleagues should refer to Chapter 1, Introduction, written by Eghenter and Sellato to appreciate the intensity of planning, revising and conceptualizing that yielded the successes of the Culture and Conservation Research Program. Eghenter, Sellato and Devung (2003) is available on-line. I am grateful to Prof. Antonia Soriente who directed me to this on-line resource.

order to understand how workers interact with production systems, to explore user experience and to examine the existing technologies that monitor the workers' experiences. As the scholars wrote (Peruzzini et al. 2017:806):

“Industry 4.0 paradigm is based on systems communication and cooperation with each other and with humans in real time to improve process performances in terms of productivity, security, energy efficiency, and cost. Although industrial processes are more and more automated, human performance is still the main responsible for product quality and factory productivity.”

This theme of human-machine interaction and specific inputs from humans is a constant theme in studies of IR 4.0. One of the aspects of IR 4.0, as we shall examine below, is “Big Data”. Friese and Contreras (2016) observed: “Besides the hype about big data, the quest for meaning and the need for human interpretation still exist.” This pointed critique is relevant for all the components of IR 4.0.

As Collins (2019c) noted:

“In automated industries, the role of the workers and the management includes developing, improving and monitoring the production and communication systems. In broader terms, Artificial Intelligence (AI) in interactive video technology, chatbots, virtual reality training programs and other immersive experiences are all interconnected with language and linguistics.”

In a pictorial representation of the nine pillars of the Industrial Revolution 4.0 (Al-Madinah International University 2019), one of those so-called “pillars” was Big Data. In this essay, we briefly examine precisely that component of IR 4.0, namely Big Data and its relevance to the task of linking language and biological environments.

One of the descriptions of Big Data was set forth by De Mauro et al. (2016): “Big Data is the information asset characterized by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value”. In terms of high volume, some authors estimate that any amount of data above 1 terabyte is already considered Big Data. Let us consider the relevance of Big Data to language studies and linguistics as well as explore the relevance of Big Data to the revitalization of threatened languages.

In early 2009, an ambitious proposal to develop an online dictionary for English-speaking students learning the Malay language was approved by the U.S. Department of Education eventually with funding for four years (2009-2013). This project, Online Multimedia Learners' Dictionary of Malay, included a team of computer science specialists and language teachers as well as a group of student assistants. In the original proposal, the team planned to identify and scan Malay language materials in order to develop a corpus of lexical items as the empirical basis of the dictionary. But before work began, the team realized that this would be a time-consuming task that might not reflect the social diversity of contemporary Malay. There was an eureka moment: Why not use Google Search as the corpus for this project? Using Google's authentic and sociologically diverse materials guaranteed an enormous corpus (Collins 2011, 2019b). Indeed, Tharan (2017) estimated that 10-15 exabytes of data can be accessed through Google Search; that amount is almost 10.5 million terabytes. If 1 terabyte is already considered Big Data (see above), using Google as the dictionary's corpus meant relying on Big Data. When the project began in 2009, analytic networks and programs were only beginning to become well-known among corporate users, so human analysis was still essential.

That was almost fifteen years ago. Since then, a variety of analytic tools are now available for big data. Moreover, with respect to the study of Indonesian, at least two major Indonesian language projects undertaken by Indonesia's national language center, Badan Pengembangan dan Pembinaan Bahasa, have produced significant products, for example, the fifth edition of the foremost monolingual dictionary of Indonesian, *Kamus Besar Bahasa Indonesia Edisi Kelima* (in both print and online versions) as well as the fourth edition of the grammar of standard Indonesian, *Tatabahasa Baku Bahasa Indonesia Edisi Keempat*. However, it remains unclear if the editorial teams of either this dictionary or this grammar made use of Google Search or other online sources.

Clearly, relying on Google Search as the corpus for a world language, such as Indonesian/Malay, Japanese, Hindi/Urdu, Spanish and many others, probably is an appropriate decision. Big Data can definitely be accessed and utilized for the study of major languages. The usefulness of resources like Google for the endangered minority languages of Indonesia and other countries is another issue altogether. It is true that many data of endangered languages can be found through Google Search. However, usually there will be no online newspapers, academic studies or government reports available produced using the 'small' heritage languages. Nonetheless, Twitter messages, blogs/vlogs, YouTube, Facebook postings and chats, even advertisements, sometimes appear using the threatened languages of Indonesia. The problem is having an analytic tool that will uncover and disambiguate these data. If these materials do not have a clear label, access might be difficult. There are, however, a few academic sites that store data collected from some endangered languages, notably The Endangered Languages Archive (ELAR), "a digital repository preserving and publishing endangered language documentation materials from around the world. The materials ... are digital, and are freely available" (<https://elar.soas.ac.uk/>).⁹ The Department of Linguistics at the University of Hawai'i has organized Kaipuleohone, a digital language archive managed by the university's library. "Founded in 2008, the archive houses texts, images, audio, and video collected from around the world by linguists, anthropologists, ethnomusicologists, and more. Our collection includes a wealth of photographs, notes, dictionaries, transcriptions, and other materials related to small and endangered languages" (<http://ling.hawaii.edu/kaipuleohone-language-archive/>).

As linguists, it is critical for us to collect data and make those data accessible, perhaps by depositing them in repositories like ELAR and Kaipuleohone, uploading them to YouTube and other social media, or other more localized systems of distribution and access, including print, CDs and regional media sites. Labeling these materials, perhaps by language name for easy access, is critical to distributing these materials, especially for members of the speech communities whose languages have been archived, uploaded or printed.

Linguistic and ethnographic projects in Indonesia that focus, for example, on ethnobotanical data, fish glossaries with illustrations and local ichthyological knowledge, animal trap vocabularies, agricultural practices or many other diverse cultural and language topics require collaboration with specialists in the appropriate fields of natural science, as well as with anthropologists, sociologists and oral literature experts—moreover, with local villagers who can share their on-the-ground expertise. Funding can be sought to organize field

⁹ A perfunctory search of <https://elar.soas.ac.uk/> found materials for six heritage languages of Indonesia: Penan (Kalimantan), Ambel (Raja Empat, West Papua), Maku'a (Timor Leste), Kerinci (Jambi), Rongga (Flores, East Nusa Tenggara) and Ratahan (North Sulawesi).

trips for Indonesian school children to join botanists, linguists and village elders to visit the forests of their localities and learn about plants and their practical and ritual functions, as Herpanus (2014) did in Indonesian Borneo. Similarly, new courses at Indonesian universities can be pioneered to bring students of linguistics and literature to the sea and seaside to learn from ichthyologists and village specialists about the sea resources, the indigenous terminologies and local technologies. Simply making videos of community members speaking their heritage language and interacting with the environment (collecting molluscs on river banks, harvesting durians in their orchards, collecting traditional medical herbs in the forest) and then making those videos available on social media would contribute to strengthening the status and use of endangered languages. These hypothetical projects are transdisciplinary and must include the indigenous villagers whose local epistemology and heritage language expertise are essential.

Conclusion.

More than twenty years ago, Nettle and Romaine (2000:32) pointed out that most of the world's languages are spoken in tropical regions. One of the two great tropical belts of language diversity runs "from South India and peninsular Southeast Asia into the islands of Indonesia, New Guinea and the Pacific." By focusing on some of the languages of Indonesia, sited in the middle of this great belt of language diversity, we chose to test the theory that "... the relationship between language, knowledge, and the environment" is breaking down "...under the pressure of 'modernization.'" (Maffi 2001:3).

First, we discussed the detailed empirical research conducted in Indonesian Borneo (Derani 2009, Herpanus 2009, 2014). Second, this recent research was coupled with decades-long participation and observation among language communities of Seram and Ambon in eastern Indonesia, as documented in Collins (2012, 2018). The contribution of the study presented here lays in the contextualization of the linked crisis of language loss and the endangerment of environmental diversity, precisely in one of the "two great belts of language diversity" (Nettle and Romaine 2000:32). By using both of these methodologies. We found support for Maffi's hypothesis linking linguistic and biological ecologies.

Among the major conclusions of this study, we note the following:

- Loss of biological and language ecologies in Indonesia are connected.
- Scholars of biology and linguistics must devise transdisciplinary projects.
- These projects must include intensive outreach designed to include local communities.
- At the university level, joint courses bringing together language and environmental studies must be developed
- To reach the next generation, there is a need for projects that focus on fieldtrips for school children with scholars and local elders to the remaining pockets of forest so all can learn from indigenous knowledge and nomenclatures.
- Similarly, modern communication technology must be utilized to distribute videos and popular articles about local languages and ecologies.

Recently, the government of Indonesia has committed to a massive investment in creating a new capital city in eastern Borneo, a city being imagined and engineered far removed from today's capital of Indonesia, Jakarta, the colonial metropolis far on the southwestern fringe of the archipelago. Can today's scholars also commit to a shift away from language ideologies mired in colonial disrespect for heritage languages and local ecologies? Diversity (*kebinekaan*) must remain an achievable ideal and aspiration of the nation.

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