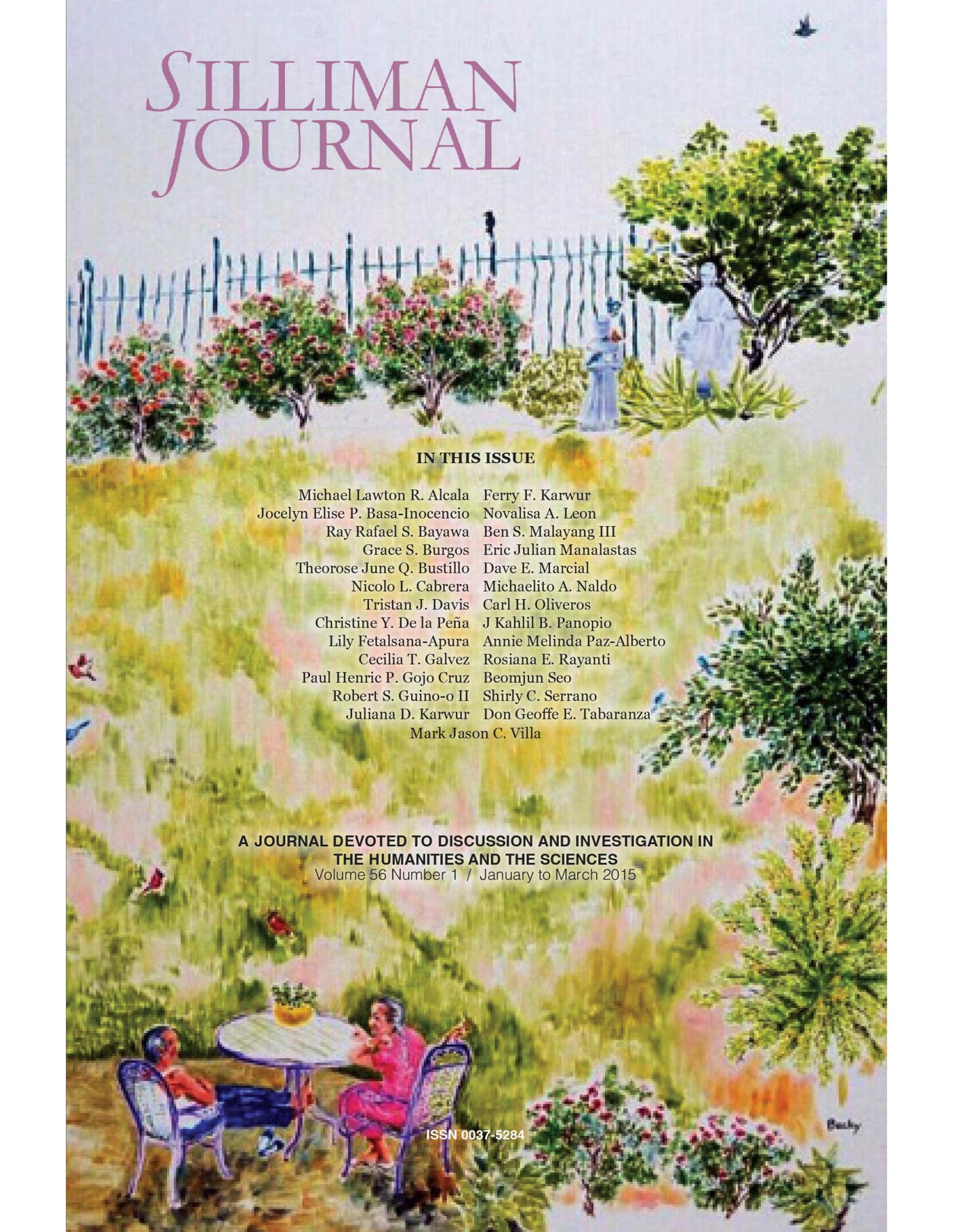


# SILLIMAN JOURNAL



## IN THIS ISSUE

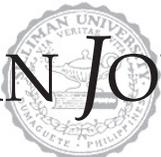
Michael Lawton R. Alcalá	Ferry F. Karwur
Jocelyn Elise P. Basa-Inocencio	Novalisa A. Leon
Ray Rafael S. Bayawa	Ben S. Malayang III
Grace S. Burgos	Eric Julian Manalastas
Theorose June Q. Bustillo	Dave E. Marcial
Nicolo L. Cabrera	Michaelito A. Naldo
Tristan J. Davis	Carl H. Oliveros
Christine Y. De la Peña	J Kahlil B. Panopio
Lily Fetalsana-Apura	Annie Melinda Paz-Alberto
Cecilia T. Galvez	Rosiana E. Rayanti
Paul Henric P. Gojo Cruz	Beomjun Seo
Robert S. Guino-o II	Shirly C. Serrano
Juliana D. Karwur	Don Geoffe E. Tabaranza
Mark Jason C. Villa	

**A JOURNAL DEVOTED TO DISCUSSION AND INVESTIGATION IN  
THE HUMANITIES AND THE SCIENCES**

Volume 56 Number 1 / January to March 2015

ISSN 0037-5284

# SILLIMAN JOURNAL



**Margaret Helen Udarbe-Alvarez**, Ph.D., *Editor*  
**Alana Leilani Cabrera-Narciso**, M.A., *Associate Editor*  
**Ian Rosales Casocot**, M.A., *Production Editor*  
**Nenith P. Calibo**, *Business Manager*

## EDITORIAL BOARD

**Evalyn E. Abalos**, Ph.D.  
**Jose Edwin C. Cubelo**, Ph.D.  
**Dennis T. Solon**, Ph.D.  
**Lorna T. Yso**, M.L.S.  
**Enrique G. Oracion**, Ph.D.  
**Betsy Joy B. Tan**, Ph.D.

## OVERSEAS EDITORIAL BOARD

**Allan B. I. Bernardo**, Ph.D.  
*Department of Psychology, Faculty of Social Sciences, University of Macau  
Taipa, Macau, SAR, China*

**Dennis Patrick McCann**, Ph.D.  
*Research Director, Asian Institute for International Business Ethics—Hong Kong and Rothlin  
International Management Consulting—Beijing*

**Ceres E. Pioquinto**, Ph.D.  
*English Lecturer, HMZ Academy/Dialogica Zug, Baar, Switzerland*

**Laurie H. Raymundo**, Ph.D.  
*Coral Ecologist, University of Guam Marine Laboratory, Mangilao, Guam, USA*

**Lester Edwin J. Ruiz**, Ph.D.  
*Director, Accreditation and Institutional Evaluation,  
Association of Theological Schools in the United States and Canada  
The Commission on Accrediting, Pittsburgh, PA, USA*

**Dr. Margaret Helen Udarbe-Alvarez**, *Chair*



Volume 56 Number 1 ~ January to March 2015

# BOARD OF REVIEWERS



**Evalyn E. Abalos**, Ph.D.

Dean

College of Nursing, Silliman University  
Dumaguete City, Philippines

**Antonio J. Barroga**, Ph.D.

Professor

Department of Animal Science, Central Luzon State University  
Muñoz, Nueva Ecija, Philippines

**Mendiola Teng-Calleja**, Ph.D.

Assistant Professor

Psychology Department, Ateneo de Manila University  
Loyola Heights, Quezon City, Philippines

**Susan May F. Calumpang**, Ph.D.

Scientist I, National Crop Protection Center

College of Agriculture, University of the Philippines at Los Baños  
College, Laguna, Philippines

**Cecilia A. Mercado**, Ph.D.

Dean

School of Computing and Information Sciences, Saint Louis University  
Baguio City, Philippines

**Lester Edwin J. Ruiz**, Ph.D.

Director, Accreditation and Institutional Evaluation

Association of Theological Schools in the United States and Canada

The Commission on Accrediting

Pittsburgh, PA, USA

**Michele Joan D. Valbuena**, Ph.D.

Associate Professor

Department of Psychology, Silliman University  
Dumaguete City, Philippines

**Mae Brigitt Bernadel L. Villordon**, Ph.D.

Assistant Professor

Biology Department, Silliman University  
Dumaguete City, Philippines



# SILLIMAN JOURNAL

Volume 56 Number 1 2015



The SILLIMAN JOURNAL is published twice a year under the auspices of Silliman University, Dumaguete City, Philippines. Entered as second class mail matter at Dumaguete City Post Office on 1 September 1954.

Copyright © 2015 by the individual authors  
and SILLIMAN JOURNAL

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage and retrieval system, without permission in writing from the authors or the publisher.

ISSN 0037-5284

Opinions and facts contained in the articles published in this issue of SILLIMAN JOURNAL are the sole responsibility of the individual authors and not of the Editors, the Editorial Board, SILLIMAN JOURNAL, or Silliman University.

Annual subscription rates are at PhP600 for local subscribers, and \$35 for overseas subscribers. Subscription and orders for current and back issues should be addressed to

The Business Manager  
SILLIMAN JOURNAL  
Silliman University Main Library  
6200 Dumaguete City, Negros Oriental  
Philippines

Issues are also available in microfilm format from

University Microfilms International  
300 N. Zeeb Road, Ann Arbor  
Michigan 48106 USA

Other inquiries regarding editorial policies and contributions may be addressed to the SILLIMAN JOURNAL Business Manager or the Editor at the following email address: [sillimanjournal@su.edu.ph](mailto:sillimanjournal@su.edu.ph).

Or go to the SILLIMAN JOURNAL website at [www.su.edu.ph/sillimanjournal](http://www.su.edu.ph/sillimanjournal)

*Cover and book design by Ian Rosales Casocot*

*Line drawings by Onna Rhea Quizo*

*Cover painting, "Family Portrait" by Rebecca de la Torre, courtesy of the artist.*

*Printing by SU Printing Press, Dumaguete City*

# CONTENTS



- 13 Editorial Notes**  
Margaret Helen F. Udarbe
- 19 Rethinking How We Do Environmental Science**  
Ben S. Malayang III
- 46 Water and Bottom Sediment Quality of Pagatban River in Negros Oriental, Philippines: 30 Years after Mining Closure**  
Robert S. Guino-o II, Michael Lawton R. Alcala, and Jocelyn Elise P. Basa-Inocencio
- 72 Plant Diversity in the Forest Ecosystem of Carranglan Watershed, Nueva Ecija, Philippines**  
Annie Melinda Paz-Alberto, Shirly C. Serrano, Cecilia T. Galvez, and Paul Henric P. Gojo Cruz
- 95  $\beta$ -mannanase enzyme supplementation of grower- finisher pig diets with copra meal**  
Michaelito A. Naldo, Ray Rafael S. Bayawa, and Beomjun Seo
- 108 Cigarette Smoking in Filipino Sexual-Minority Men: Further Evidence of Disparities in the Philippines**  
Eric Julian Manalastas and Nicolo L. Cabrera

**121 The Daily Life of Post-Stroke Patients in Tomohon City, North Celebes, Indonesia**

Rosiana E. Rayanti, Ferry F. Karwur,  
and Juliana D. Karwur

**143 Pedagogical Integration of Information and Communication Technology among Teacher Educators in Central Visayas, Philippines**

Dave E. Marcial

NOTES

**167 Distribution and Early Breeding of Green-Faced Parrot Finches (*Erythrura viridifacies*)**

Tristan J. Davis, Don Geoffe E. Tabaranza,  
Mark Jason C. Villa, J Kahlil B. Panopio,  
and Carl H. Oliveros

**176 Addressing Natural Disasters: A Multisectoral Proactive Approach**

Grace S. Burgos, Christine Y. de la Peña,  
Novalisa A. Leon, and Theorose June Q. Bustillo

REVIEW

**189 On David Bosch's *Transforming Mission: Paradigm Shifts in Theology of Mission***

Lily Fetalsana-Apura

# PUBLICATION GUIDELINES



SILLIMAN JOURNAL welcomes submission of scholarly papers, research studies, brief reports in all fields from both Philippine and foreign scholars, but papers must have some relevance to the Philippines, Asia, or the Pacific. All submissions are refereed.

SILLIMAN JOURNAL is especially receptive to the work of new authors. Articles should be products of research taken in its broadest sense and should make an original contribution to their respective fields. Authors are advised to keep in mind that SILLIMAN JOURNAL has a general and international readership, and to structure their papers accordingly.

SILLIMAN JOURNAL does not accept papers which are currently under consideration by other journals or which have been previously published elsewhere. The submission of an article implies that, if accepted, the author agrees that the paper can be published exclusively by the journal concerned.

Manuscripts of up to 10,000 words, including tables and references, should conform to the conventions of format and style exemplified in a typical issue of SILLIMAN JOURNAL. Documentation of sources should be discipline-based. Whenever possible, citations should appear in the body of the paper, holding footnotes to a minimum. Tables must be held to a maximum of five. Pictures or illustrations will be accepted only when absolutely necessary. All articles must be accompanied by an abstract of 200 words and keywords of not more than ten words, and must use gender-fair language.

SILLIMAN JOURNAL likewise welcomes submissions of "Notes," which generally are briefer and more tentative than full-length articles. Reports on work-in-progress, queries, updates, reports of impressions rather than research, responses to the works of others,

even reminiscences are appropriate here.

SILLIMAN JOURNAL also accepts for publication book reviews and review articles.

Manuscripts should be submitted electronically in one Microsoft Word file (including title page, figures, tables, etc. in the file), preferably in RTF (.rtf). Figures and photos must also be attached to the email in .jpeg. Please send one copy of the manuscript as an e-mail attachment, with a covering message addressed to the Editor: [sillimanjournal@su.edu.ph](mailto:sillimanjournal@su.edu.ph)

The Editor will endeavor to acknowledge all submissions, consider them promptly, and notify the authors as soon as these have been refereed. Each author is entitled to one complimentary copy of the journal. Additional copies are available by arrangement with the Editor or Business Manager before the issue goes to press.

Other inquiries regarding editorial policies and contributions may be addressed to the Business Manager at [nenithpcalibo@yahoo.com](mailto:nenithpcalibo@yahoo.com), or the Editor at [sillimanjournal@su.edu.ph](mailto:sillimanjournal@su.edu.ph).

# SILLIMAN JOURNAL



---

## EDITORIAL NOTES



“The more we get out of the world the less we leave, and in the long run we shall have to pay our debts at a time that may be very inconvenient for our own survival.”

**Norbert Weiner**

*The Human Use of Human Beings*  
(1954)

AS WE TRANSITION from biannual to quarterly publishing, welcome to the first of four issues of *Silliman Journal* for 2015—our 61st year. Although we continue to be a multidisciplinary publication, majority of this issue’s papers are in the natural sciences and they convey to us the rich variety in the work that academic scientists are doing in their respective fields.

This issue begins with “Rethinking How We Do Environmental Science” by Silliman University President Ben S. Malayang III who was invited to participate in the 6th International Conference on Environmental Future on the theme “Interdisciplinary Progress in Environmental Science and Management” held at Newcastle University, UK on 18-22 July 2011. The conference was organized

on the premise that “at this time, 'interdisciplinary' thinking is considered key to solving environmental problems, but it is unclear what this thinking is or would be and how it might be progressed in future.” For this essay, Malayang studied 17 conference papers and discusses interdisciplinarity according to its epistemological bases, methodological possibilities, and emerging challenges and opportunities in environmental science.

In the second paper, biologist Robert Guino-o and colleagues investigate the quality of Pagatban River in Negros Oriental, Philippines, 30 years after the closure of mining operations in its vicinity. According to the authors, conditions have improved, but there are still heavy metals in bottom sediment higher than acceptable levels. Similarly, frequent *SJ* contributor Annie Paz-Alberto and fellow researchers investigate another environmental indicator—plant diversity in the forest ecosystem of a confined area in the Philippines—the Carranglan Watershed in Nueva Ecija, Luzon. The authors found many endangered species (four critically endangered), but there were also three species that could serve as potential biodiversity indicators due to their abundance. Still, many threats to the ecosystem were identified.

These studies are followed by one made by agriculture researcher Lito Naldo and associates who study pig diets, in particular the supplement  $\beta$ -mannanase enzyme supplementation of grower-finisher pig diets with copra meal. The authors say that the Philippines is the top producer of copra around the world, but use of copra meal for pig diets is limited due to its high-level non-starch component that acts as an anti-nutritional factor. Supplementation, therefore, was necessary and found to significantly reduce costs.

Our fifth paper, a team-up of University of the Philippines professor Eric Manalastas and Nicolo Cabrera who is affiliated with Stroger Hospital in Chicago, USA, looks into cigarette smoking among Filipino sexual-minority men. Eric previously discussed cigarette smoking among LGBT Filipino youth (*SJ* 2012 1) and the paper in the current issue provides further evidence of disparities in the Philippine population.

The next paper by Rosiana Rayanti and colleagues deals with post-stroke patients in Tomohon, Indonesia. The authors acknowledge the changes in eating habits and daily activities of the study participants after stroke, and lament the lack of specific programs in Tomohon to help stroke survivors and their families.

The final full-length paper in this issue is by Dave Marcial who investigates the use of information and communication technologies among teachers at higher education institutions in Central Philippines. Dave has found that teachers are familiar with ICTs, in general, but are not really taking advantage of them in instruction.

### Notes Section

There are two contributions to our notes section—the first is from Tristan Davis and colleagues who observed and studied the distribution and early breeding of Green-Faced Parrot Finches (*Erythrura viridifacies*), recorded at multiple locations in the Philippines, but never previously located on the island of Mindoro. However, sightings on this island were first reported in 2013, and the observations are here documented. In addition, Silliman University faculty and doctoral students from the College of Nursing chime in with proposals for the academe and local government on disaster preparedness, given the Philippines' environmental vulnerability.

### Review Section

Our lone book review in this issue is by the religious studies professor, Lily Apura. She critiques David Bosch's *Transforming Mission: Paradigm Shifts in Theology of Mission*. Although this is a 1991 publication, Lily insists it continues to be relevant and applicable, particularly for inclusion in an issue filled mostly with science research, because, as she says "Bosch brings together a comprehensive body of knowledge gleaned from human and natural sciences, and combines this with biblical and theological learning, coming up with an incisive analysis of mission covering two centuries of Christian history." Lily adds: Bosch's "prior knowledge of scientific research theories particularly that of Thomas Kuhn, and his readings in theology and Christian history (Hans Kung) led him to view the various ways of thinking and doing mission in terms of paradigms."

### Acknowledgments

I would like to thank our numerous contributors and reviewers for the papers in this issue. Indeed, the work of academics is never

confined to the classroom, and this is especially true for those who accept the comprehensive role of academics to include research and extension.

Concern for our environment is not a new advocacy; climate change is not a new buzzword. In 1953, the American naturalist and photographer Edwin Way Teale, said “The long fight to save wild beauty represents democracy at its best. It requires citizens to practice the hardest of virtues—self-restraint.” A few years later, author and critic Marya Mannes (1958) also cautioned “The earth we abuse and the living things we kill will, in the end, take their revenge; for in exploiting their presence we are diminishing our future.”

**Margaret Helen F. Udarbe**

*Editor*





---

# RETHINKING HOW WE DO ENVIRONMENTAL SCIENCE

**Ben S. Malayang III**  
Silliman University, Philippines



This paper examines 17 reviews of various philosophical, conceptual and methodological issues and experiences with environmental interdisciplinary work. These were presented and read in the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management, held in Newcastle University, UK, July 18-22, 2011. The 17 reviews are examined for indications of the current progress and direction of the development of interdisciplinary approaches to environmental research and governance. The implications of interdisciplinarity to sustainability (or how environmental interdisciplinarity contributes to improving the geospheric, biospheric and ethnospheric well-being in our planet) are drawn from the reviews.

---

**KEYWORDS:** environmental science, interdisciplinary, epistemology of interdisciplinarity, methodology of interdisciplinarity, experiences on interdisciplinarity, sustainability

---

## INTRODUCTION

THE SCOPE OF human appreciation of “environmental problems” can range from being very local and immediate—like waking up one day and realizing that there are no more robins singing outside our window (Carson, 1962) to very global and remote—like worrying over melting glaciers in places we have not been to and on how it signals changing conditions on earth (Intergovernmental Panel on Climate Change, 2007).

In turn, public demand for environmental knowledge cuts across a range of disciplinary domains. It can be confined to one discipline such as chemistry (e.g., how heavy metals contaminate table wines; Naughton & Petróczi, 2008) or extend to many disciplines (such as demography, marine biology, forestry, hydrology, political science, agronomy, geography, economics, anthropology and sociology) to understand and do something about marine pollution, fishery collapse, or deforestation (Fisher & Chen, 2011; Ommer, 2011; Lele & Kurien, 2011). It can extend to even wider domains like piecing together scientific and traditional knowledge on how life and geochemical processes occur across different cultural, economic and political systems, to much better understand and respond to present threats to biodiversity and human survival on earth (Millennium Assessment, 2005).

Public demand for comprehensive environmental knowledge has inspired scientists (and practitioners of other knowledge-generating traditions<sup>1</sup>) to reconsider and rethink how we produce and put together environmental knowledge to produce wider aggregates of useful and correct views of contemporary environmental events (Trompf, 2011).

The task is not simple. Questions abound, such as how far can we go into piecing environmental knowledge together without losing the verifiability and truth value of its composites? How can a bit of environmental knowledge be mixed with other bits without eroding their individual and collective credibility? Does scale of knowledge integration matter?

This paper examines 17 reviews on interdisciplinarity that touch on different aspects of the epistemological basis and methodological possibilities of interdisciplinary environmental

---

<sup>1</sup> This paper recognizes that there are many knowledge-generating practices other than science. Many references have been made on “local” or “traditional” knowledge that do not necessarily practice or include the methods of science. This paper focuses on science.

science. Some of the reviews discuss lessons learned from experiences in doing it. Some talks of how interdisciplinarity links with sustainability (or to how earth systems [our geosphere] are able to continue supporting life systems [biosphere] and human well-being and ways of life [ethnosphere]). The object of the paper is to draw some indications, not to summarize them, of the stage and progress of current rethinking of environmental science as a disciplinary, multidisciplinary and interdisciplinary enterprise. The references in these reviews to the *epistemology*, *methodology*, and *experiences* with interdisciplinary studies and other environmental works are grouped into these three topics.<sup>2</sup>

### EPISTEMOLOGICAL BASIS OF INTERDISCIPLINARITY

Western theories of knowledge link modern sciences to Classical Greek roots. The link runs along how knowledge is to be understood (or on what it is) and how it is obtained. Two theories stand out: Platonic Idealism and Aristotelian Empiricism. Initially, they were viewed as being opposed over the nature of knowledge and on how knowledge is obtained. But as Western philosophy moved on forward, the two were eventually combined into a single view of science as a process that obtains knowledge from both “ideas” (Platonic) and “verifiable experiences” (Aristotelian).

Science has since proved a powerful influence on the economy and culture of many nations and societies, particularly in the West, which had used it as an engine for intellectual and material progress. It has been regarded as among the major factors for the West’s “rise” to global dominance (McNeil, 1963). Its stress on “objectivity” (which allows for acquiring knowledge independent of what might be preferred by otherwise intimidating institutions such as the State or the Church), and its ability to produce useful technologies, inevitably set science as an epistemological icon in contemporary society, in most parts of the world.

---

<sup>2</sup> For the purpose of this paper, “epistemology of interdisciplinarity” refers to theories and notions of knowledge (and on how knowledge is gained or lost) used to provide a basis for validating (or invalidating) interdisciplinarity. “Methodology of interdisciplinarity” refers to how interdisciplinarity is (or can be accepted to be) validly done. “Experiences on interdisciplinarity” refers to how interdisciplinarity has been attempted and the lessons learned from the attempt.

## The Western Tradition of Classifying Knowledge Into Disciplines

To Trompf (2011), the “burgeoning acquisition of information on the workings, scope and diversities of the cosmos” marks Europe’s intellectual legacy that has been mainly rooted on science. And Frodeman (2011) noted that the rapid accumulation of western knowledge is associated with the science and research traditions of European academia.

But “burgeoning” knowledge requires that they be organized into sensible categories. This gave rise to disciplines and the early departmentalization of knowledge production and knowledge delivery in many western schools. Trompf (2011) pointed out that the rapid acquisition and accumulation of knowledge in Europe had “put serious pressure on 19th century European intellectuals to classify branches of human knowledge.” That’s apparently what happened.

Frodeman (2011) described the “deep roots” of classifying knowledge in European academia “going back to Antiquity.” This, he said, “brought coherence to [European] academic programs through the centuries.” He cited the Kantian, Humboldtian and Cartesian traditions of European education and how they had led to classifying knowledge along related lines and areas of interests (that is, by “discipline”). For his part, Trompf (2011) saw Europe’s practice to organize knowledge along “more ‘rational,’ ‘scientific’ and ‘secular’ principles of order” as being “a mark of European modernity.” He saw the value of ordering “subject-areas and disciplines intelligently, or assess them for apparent degrees of certitude.”

Disciplinary specialization, however, suffers from a serious deficiency: it has limited immediate reach and relevance when taken in relation to wider and broader interlocking concerns of peoples and societies. Its stress on internal validity and on factual details appears mismatched with how many more people today would rather prefer knowledge that has high external validity and direct relevance to a broad range of their concerns. Frodeman (2011) and Trompf (2011) cited limits of specialization. Frodeman (2011) said that modern information technology, neoliberal education, and the demand for accountability challenge disciplines to widen their analytical range. He agreed but on another tack. He saw

the “tensions between positivistic and holistic styles” in science pointing to a need “to discover some synthesizing principle by which all the distinctive methods of approaching the world might be viewed in interrelationship.”

### **The Need for Integrating Disciplines**

There seems to be two compelling reasons for achieving interdisciplinarity in environmental science. The first is the complexity of human-nature dynamics that require many perspectives to better understand them. Pretty (2011), Ostrom and Cox (2011), Tacconi (2011), Fisher and Chen (2011), Ommer (2011) and Christie (2011) discussed large socio-ecological and socio-cultural systems as settings of interlocking resource and social issues. They are large units of analyses that are beyond the usual boundaries of disciplines. Pretty (2011) described how “emergent human cultures have shaped and in turn been shaped by local ecosystems” and elaborated on how the vulnerability of these systems involves disruptions of livelihoods, governance institutions, resources, and cultural traditions. Understanding these requires many disciplines. He cited research mixing physical and social sciences to address conservation and resilience in these systems. This is echoed by Ostrom and Cox (2011) who stressed that effective resource and environmental governance requires “knowledge and perspectives from scientific disciplines that are frequently isolated from each other.” Tacconi (2011) and Acevedo (2011) cited the need for “synergies” of disciplines to better understand resource and environmental governance and food security issues. Acevedo (2011) gave examples of interdisciplinary research work in agriculture and environment and how they lead to increasing food productivity. Fisher and Chen (2011), Ommer (2011), and Christie (2011) discussed people-resource issues across continental coasts and oceans and how they are best understood with information derived from an integration of science disciplines and non-science knowledge systems. Hecht (2011) referred to the “multiplicities of political ecologies, policies, politics, science and technologies” that need to be understood in unity in order to better understand forest conversions and dropping deforestation rates in Brazil.

The second reason for interdisciplinarity is that sciences have been expanding in reach and range of knowledge domains.

Spangenberg (2011) cited how sustainability science, as a discipline, involves “integrated assessments and interdisciplinarity” and is composed of many basic disciplines. It “can be subdivided into the more traditional, disciplinary based science for sustainability.” It represents, he said, “a new step in the evolution of science.” Beder (2011) described how environmental and ecological economics have progressed towards environmental interdisciplinarity and offer perspectives on complex ecological and social problems that improve our “understanding of the real world.”

Integrating discipline-generated knowledge and fusing knowledge systems can be pivotal to effectively addressing present-day environmental concerns.<sup>3</sup> This was pointed out by Ostrom and Cox (2011), Ommmer (2011), Christie (2011), Pretty (2011), Spangenberg (2011), Fisher and Chen (2011), Tacconi (2011), Beder (2011), and Acevedo (2011). Some of the concerns have global dimensions including biodiversity loss, climate change, food security, and environmental conflict and justice. They need to be told in interdisciplinary stories and perspectives because they are often seen by people and policy makers as single unities rather than as being a composite of different events.

### **Barriers to Integration**

Although many might desire integration, three barriers stand in the way of its adoption. First, academics, in general, prefer to work within clear disciplinary boundaries. This is for perhaps two reasons: accountability and productivity. Trompf (2011) discussed how there had been an intensification of public demand for knowledge workers to be accountable over what they do. If this is to be, it would seem better that workers confine themselves within clearly set boundaries of disciplinary responsibility. Beder (2011) described how environmental economics kept to within its disciplinary boundaries even if it expanded its reach and applications. This suggests, at least perhaps to Beder, that expanding a discipline could be an option, instead of integration.

The second barrier lies in the difficulty of translating integrated

---

<sup>3</sup> Frodeman referred to “interdisciplinary approaches to education and research” which he defined as “the integration of different disciplinary approaches and discipline-based methodologies.” A similar notion of “interdisciplinary research” was used by Acevedo. It is in this sense that disciplinary and knowledge “integration” is understood and used in this paper.

knowledge into effective environmental actions. People tend to view environmental problems in more local scales. They act local. And so, even if integration might improve our understanding of ecological events, Beder (2011) noted that it still has to “overcome political and social barriers to translating that understanding into widespread implementation of effective environmental measures.” One social inhibitor of integration can be the “false dualism” mentioned by Pretty (2011). It is the tendency to place superior value to particular sources of knowledge (e.g., science over local knowledge). This thwarts integration. Another is the “disciplinary biases” noted by Fisher and Chen (2011).

The third barrier is the inherent difficulty of integration. What would be its basis and its “synthesizing principle” which Trompf (2011) claimed is essential for integrating “distinctive methods of approaching the world”? Or what would be the “purpose of research” that Spangenberg (2011) said is a feature of interdisciplinarity in the case of sustainability science? How might it be done? What methodological challenges are to be overcome? These questions need to be resolved (with wide acceptance) before interdisciplinary integration in environmental science could gain ground.

### **Bases for Interdisciplinary Integration**

Reyers, Roux, & O'Farrell (2011) discussed how “disciplinary divides” may be bridged. They distinguished “multidisciplinarity” and “interdisciplinarity” based on earlier works by Jantsch (1972), Max-Neef (2005) and Lengwiler (2006). The two concepts stem from a notion of a “continuum of disciplines” that starts with “disciplinarity” (or “about the monodiscipline and represents specialization in isolation”). It extends to “multidisciplinarity” which “represents more than one discipline being studied or applied without actually integrating the disciplines”, or “cooperation [among certain disciplines] with low degree of exchange between the disciplines”). The continuum ends with “interdisciplinarity” which involves “cross-disciplinary cooperation feeding back into disciplinary knowledge.”

To Reyers et al. (2011), interdisciplinarity is couched in a four-level “knowledge hierarchy.” In this hierarchy, “all levels of the hierarchy are coordinated on the basis of an over-all purpose.”

- The first level is the “empirical.” It encompasses “the basic life, earth, social and human sciences which use logic as their organizing language and usually claim objectivity” (see Jantsch, 1972). Here, “multidisciplinary cooperation between several empirical disciplines” can occur, creating what are referred to as “interdisciplines.”
- The second level is the “pragmatic”. It “uses the language of cybernetics, the science of regulation and control, as its organizing language” (see Jantsch, 1972). This level encompasses the “applied or sectoral interdisciplines like forestry, engineering and architecture which are informed by the underlying empirical disciplines, while at the same time providing them with direction and coordination” (see Max-Neef, 2005). At this level, “vertical cooperation and coordination required by pragmatic interdisciplines demands close collaboration between empirical- and pragmatic-levels practitioners equivalent to an interdisciplinary research program of universities, research institutions and sectoral agencies jointly generating knowledge and understanding.”
- The third level is the “normative.” This level “uses planning as its organizing language and deals with the design of social systems including policy, planning and law.” At this level, “humans shape their own and the earth’s future” (see Jantsch, 1972).
- The fourth level is the “purposive” (or “the level of meaning”). It “introduces values into the interdisciplinary structuring of the normative disciplines below.” The “organizing language at this level should be anthropology at its most profound” which, in Jantsch (1972), refers to “the science of creating an anthropomorphic world where humans can survive changing environments.”

Reyers et al. (2011), suggested that interdisciplinarity occurs when knowledge freely flows between “interdisciplines” within and across tiers of the knowledge hierarchy. If correct, this offers one epistemological basis for interdisciplinary integration in environmental science.

But there are other possible bases for integration. One is the

inherent nature of environmental problems that often pertain to how humans live and survive in certain settings. This was pointed out in a number of the reviews. But for Pretty (2011), it offers a basis for research approaches that “connect knowledge with action” intended to “produce optimal outcomes for both nature and culture.”

Another is the close complementation of certain disciplines that lend to their more easily linking their research. Beder (2011) cited how ecological economics which “incorporate the research of economists, ecologists, philosophers and social scientists” create a basis for interdisciplinarity.

Trompf (2011) has referred to how “planetary survivalism in the present time has pushed environmental science center-stage as a pivotal activity encouraging interdisciplinary collaboration.” This suggests that having a common environmental concern can be a basis for integration.

Some other bases for integration may emerge in the future. Frodeman (2011) said that certain pressures on discipline-focused knowledge will eventually lead to “the integration of disciplinary approaches and discipline-based methodologies.” Disciplinary responses to the pressures can result to the development of new theories that justify integration.

Acevedo (2011) referred to different levels of production that requires interdisciplinary approaches and which can push for developing new interdisciplinary theories and methodologies.

## **METHODOLOGICAL POSSIBILITIES FOR INTERDISCIPLINARITY**

Several of the reviews discussed methodological issues of interdisciplinarity. They comment on processes and procedures for conducting interdisciplinary research.

### **Methodological Assumptions on Interdisciplinarity**

The interplay of social and ecological dynamics associated with environmental concerns requires methodologies that facilitate understanding them in ways that cut across traditionally-delineated disciplines. This was pointed out or was alluded to in several of the reviews:

- In the case of marine contaminants, Fisher and Chen (2011) said that understanding them “requires the identification of environmental variables that influence ecological and human effects, the ability to predict spatial and temporal occurrences, and development of integrative interdisciplinary and mechanistic models for predicting their occurrences and severity.”
- Christie (2011) laid out reasons why “disciplinary theories and methods to support interdisciplinary and integrated ocean and coastal management policies and implementation should conform to a perspective that ocean management is a societal activity with diverse goals ideally informed by interdisciplinary information.”
- Ommer (2011) pointed out that understanding fishery collapse in Canada will require delving into “complex interdependent social and environmental issues” that requires “interdisciplinary applied work.”
- Lele and Kurien (2011) described tropical forest research as “a quintessential interdisciplinary research problem straddling the social-natural divide.”
- Tacconi (2011) discussed how forest change studies need to involve “research integrating economic, political, social, and environmental aspects” because they “cannot be satisfactorily addressed by single disciplines.” This is also pointed out by Acevedo (2011) in the case of food security and global change studies.
- Ostrom & Cox (2011) discussed a “panacea problem” which refers to the “tendency to adopt oversimplified institutional prescriptions like government or private ownership to ‘solve’ environmental and conservation problems.” They review works being done “to move beyond this panacea” and using “multiple levels of analysis in a diagnostic framework, applied with a diversity of scientific perspectives and methodologies.”
- Agrawal & Benson (2011) said that “different strategies to govern resource commons produce effects that can be assessed

along different dimensions, in terms of the (a) ecological and social sustainability of the resource system, (b) contributions to the livelihoods of those who rely on these resources, or (c) equity in the allocation of benefits." These strategies, they pointed out, require "systematic understanding" to explain how they play out under different governance situations.

There is a wide recognition in the reviews that methodology is a critical element in interdisciplinary environmental work, mainly because of the complexity of nature-culture dynamics involved in creating environmental situations. It is this complexity that makes it reasonable to assume that interdisciplinary methods (and methodologies) facilitate systematically coordinated research processes that accommodate and are hospitable to diverse disciplinary methods.

### **Doing and Facilitating Interdisciplinarity**

As a concern in interdisciplinary work, methodology encompasses the aspects of properly doing it in a way that is valid and correct, and giving robust theoretical legitimacy to its procedures. Several of the reviews point to four factors that are crucial to doing interdisciplinary work: [1] its theoretical bases; [2] its techniques; [3] its organization; and [4] its support systems.

**Theory.** The theoretical basis of interdisciplinary methods gives them validity and legitimacy, just as in all research work. But interdisciplinary methodology is presently a complex issue among researchers. Lele & Kurien (2011) cited "differences in implicit values, theories and epistemologies across disciplines" that are often a challenge to interdisciplinary forest research. This difficulty is also alluded to by Agrawal and Benson (2011) who lamented the lack of a theory linking equity and benefits in resource commons that otherwise facilitate interdisciplinary assessments of resource governance outcomes.

But while the value of theory is recognized, only three of the reviews actually suggest some possible theoretical underpinnings for interdisciplinary methods. These are Reyers et al. (2011) who suggested that "interdisciplines" and hierarchies of knowledge can be a basis for integrating knowledge; Ostrom and Cox (2011) who described multi-tiered analysis as a valid tool for systematically obtaining knowledge from different sources; and Berkes (2011)

who explained how participatory learning processes can be a method to acquire valid information.

**Technique.** Doing interdisciplinary work requires creative ways to facilitate collaboration among different researchers and sources of information. Several of the reviews describe (or suggest) certain techniques to do this.

- Ostrom and Cox (2011) proposed adopting a diagnostic method founded on a framework of “socio-ecological systems” (SES). Citing Anderies, Janssen, & Ostrom (2004), they, too, saw SES as ‘social systems in which some of the interdependent relationships among humans are mediated through interactions with biophysical and non-human biological units.’ SES thus provides an analytical framework to diagnose how “several primary classes of entities” influence each others’ behaviors when “embedded in a social, economic, and political setting and in related ecosystems” (McGinnis, 2010). Multi-tiered diagnostics requires a systematic identification of entities that determine and affect environmental outcomes occurring within and across different levels of a socio-ecological system.
- Berkes (2011) described an approach featuring “learning by doing” that stresses “user participation and feedback learning.” He points to “deliberation, visioning, building social capital, trust and institutions, capacity building through networks and partnerships, and action-reflection-action loops for social learning” as a valid way to bring about multi-level interdisciplinarity in resource governance.
- Spangenberg’s (2011) reference to reflexivity and applicability as features of the “science of sustainability” alluded to a technique along similar principles elaborated by Ostrom and Cox (2011) and Berkes (2011).
- Tacconi (2011) suggested an interdisciplinary technique involving the usual hypothesis testing in science. He referred to how “empirical research needs to include testing hypotheses arising from theoretical developments, assessment of policy uptakes, and new exploratory research.” The procedure for doing this is the same as those in most science disciplines but the hypotheses to be tested are formulated from different

aggregations of knowledge using “mixed methods” of research. Such hypotheses may be generated presumably from fusing knowledge in the manner described by Reyers et al. (2011) and Pretty (2011), or from experiences on SES and learning loops described by Ostrom and Cox (2011) and Berkes (2011). Experiences on inter-cultural resource governance like what Filer (2011) described in the case of Papua New Guinea, or on coastal resource management and global networks of marine protected areas like those discussed by Ommer (2011) and Christie (2011), can also form the bases for formulating these “aggregated” hypotheses.

- Acevedo (2011) suggested modeling as a tool and technique to encourage interdisciplinary research.

**Organization.** Technique is one thing, but organization is another. The way researchers and knowledge workers are made to work together is crucial in interdisciplinary work. Ommer (2011) cited sensitivities, values, ego, willingness to work with others, and interpersonal skills as being keys to the success of a large coastal study involving researchers from many disciplines. How the researchers are organized and who among them is made to work with another, facilitate or impede success. Fisher and Chen (2011) noted that an “appropriate organizational structure” facilitates multivariate analyses of marine contamination.

There are perhaps two aspects about organization that play important roles in interdisciplinary success: purpose and people.

- Beder (2011) emphasized purpose. He suggested that researchers be organized around a common concern. He talked of researchers tackling different aspects of broad theoretical and policy issues in environmental and ecological economics being fruitful only if they work around a common theme.
- Christie (2011) stressed people and who are involved in the work. He referred to “self reflexive and multidisciplinary research teams” and how this is a factor in the success of interdisciplinary coastal conservation work.

**Support systems.** Fisher and Chen (2011) talked of the role and value in interdisciplinary work of “core facilities that can be

used to support different collaborating teams.” They can facilitate or erode collaboration. This implies, too, that funding is critical. An interdisciplinary team is often large and interdisciplinary work is an intricate cogwheel of tasks and schedules. Facilities and funds are heavy constraints on them.

Other reviews have cited the roles of networks, institutions and clarity of goals. They facilitate interdisciplinarity by widening the circle and extent of intellectual, organizational and funding support for it (Acevedo, 2011; Beder, 2011; Berkes, 2011; Christie, 2011; Lele & Kurien, 2011; Ommer, 2011; Ostrom & Cox, 2011; Pretty, 2011; Spangenberg, 2011).

## EXPERIENCES WITH INTERDISCIPLINARY WORK AND LESSONS LEARNED

Several reviews describe experiences with environmental interdisciplinary work and the manner they addressed the epistemological and methodological issues of interdisciplinarity. They point to two lessons learned from these experiences: [1] there are key factors to its success; and [2] it is difficult to do.

### Experiences

A number of the reviews allude to both epistemological and methodological issues as core concerns in interdisciplinary work. But the experiences they describe are about overcoming the barriers to integration and less on how they built up a theoretical basis for it. The legitimacy of the interdisciplinary work, it seems, is lodged on the assumption that having more people with different expertise and points of view coming together to look at complex environmental issues, is logically valid and appropriate.

Two ways are described on how barriers were overcome. One is by how people work together, and the other is about the tools being used to do the work.

**People.** Ommer (2011) gave an example of this. She described scientists and knowledge workers with otherwise different disciplinary backgrounds appealing to a shared purpose, a high sense of professionalism, and good interpersonal skills, to successfully undertake a complex research project. Interdisciplinary work was facilitated by good teamwork, not much by adhering to a shared

epistemological point of view or methodological preferences. Other reviews point to a similar approach: different experts looking at marine conservation issues (Christie, 2011); researchers from many disciplines looking at forests and forest changes (Agrawal & Benson, 2011; Hecht, 2011; Lele & Kurien, 2011; Tacconi, 2011); and natural and social scientists collaborating to understand different aspects of global changes and food security (Acevedo, 2011). This is a “quilting” of methods, as it were, and is deemed a correct (and presumably valid) research approach. Scientists and experts with diverse methodological orientations and toolkits are made to come together to bring into a common environmental concern their different perspectives on it. Each expert and researcher uses a method that they find appropriate. There is no stress on researchers needing to first agree on a common theory of knowledge or a common methodological orientation. Beder (2011) described interdisciplinarity in environmental and ecological economics and how they have advanced even if their practitioners diverge on their epistemological roots and methodological orientations.

**Tools.** Ostrom and Cox (2011) and Berkes (2011) described the use of certain analytical tools and learning processes to facilitate interdisciplinarity. They allow for different disciplinary methods to come together to “fuse” learning. Diversity of disciplinary methods is assumed and is welcomed, but rather than taken as an impediment to interdisciplinarity, the different methods are taken as sources of knowledge that can be processed using a “synthesizing” analytical procedure. The procedure, if done right, could produce more comprehensive information on a research topic. It is not pointed out that researchers and participants in these processes shall need to agree first on an epistemological or methodological theory of interdisciplinarity before these tools and processes can be used.

The experiences on interdisciplinarity described in the reviews so far are more about how it was done in ways that seem logical and reasonable enough. There is no mention of experiences in constructing epistemological and methodological theories to validate interdisciplinarity, or which generated these theories.

## Lessons Learned

The reviews identify four factors behind successful interdisciplinary exercises, and four reasons why they are difficult

to do.

**Factors of interdisciplinary success.** Fisher and Chen (2011) found that successful interdisciplinary work was linked to three factors: scientists were working around common “analytical cores or public ‘outreach’ cores”; scientists were organized into interdisciplinary groups; and funding was specifically committed to support collaborative endeavors. Other reviewers found “pressures” to disciplines as another factor.

- **Common Core.** Ommer (2011) said that when scientists from different disciplines are made to work together, it would be crucial that they have a “shared vision or concern.” A shared vision can be a game changer because it “captures the synergies that are the huge reward in research of this kind and holds researchers together.” He added common method, language, training and organization and a factor that, like funding, has something to do with incentives for scientists to work together. This is the matter of “equitable ways to publish results.”

The factor of a “common core” is alluded to in the other reviews. Acevedo (2011) referred to “common goals” of interdisciplinary teams and Spangenberg (2011) pointed out that a common “purpose of research” and “reflexivity and applicability” are features of interdisciplinarity. Ostrom and Cox (2011) cited the importance of a common research aim “that facilitates the accumulation of empirical data on both social and biophysical variables at multiple levels of aggregation.” Christie (2011) agreed with this point that shared “worldviews” among those involved in interdisciplinary ocean studies is a key factor to “improve our ability to interpret scientific conclusions.” In the case of Papua New Guinea, Filer (2011) saw interdisciplinarity as being facilitated by a common place of concern.

- **Organization.** The factor of organization is pointed out in three reviews as being not only about how scientists work together but also about who are involved in the work. They stress the value of having a wide compass of knowledge workers engaged in interdisciplinary research. Pretty (2011) cited the need to involve different sources and practitioners of traditional knowledge. Berkes’ (2011) stress

on “common learning” is shared by Lele & Kurien (2011) who referred to “engagement in a common sphere” and “shared learning and building of common frameworks” involving different stakeholders to a common resource, as essential to interdisciplinary forest research.

- **Funding.** Interestingly, other than Fisher and Chen (2011), none of the other reviews specifically mentions funding as a critical factor to interdisciplinary environmental work. But virtually all the reviews imply that funding is critical. Interdisciplinary work involves many people doing many things and attending to many areas of concern (Beder, 2011; Berkes, 2011; Christie, 2011; Lele & Kurien, 2011; Ommer, 2011; Ostrom & Cox 2011). Funding is therefore a critical concern. What is particularly important is that funding is committed to interdisciplinary work, said Fisher & Chen (2011). This is a point that might be grounded on the fact that most funding agencies desire to have clear returns to their investments and disciplinary outputs tend to be more precisely describable than the more nebulous outcomes of collaborative research. Funding can easily swing toward supporting disciplinary research.

Funding implies incentives. Consequently, it can be surmised that in the same basket with funding, incentives (salaries, job security, standing among peers, and professional advancement through publications) are among the factors of successful interdisciplinary work.

- **Pressures.** Three reviews cite pressures on disciplines as a key factor in interdisciplinary success. Lele & Kurien (2011) pointed out that “the pressure for more rigour and more integration... from outside of academia” can lead to more interdisciplinary work. “Quality and rigour,” they said, “should not be defined purely internally, in terms of logical connections between theory, hypothesis and evidence. They should also be defined externally as rigour in identifying the most pressing problems, as rigour in defining them in socially relevant and normatively transparent ways, and rigour in examining one’s own representation of the ‘other’.” The pressure for this kind of rigor encourages interdisciplinary collaborations.

Tacconi (2011) implied the same pressures on researchers in forest policies. They face pressures to provide a comprehensive

basis for different policy options, which require that they go beyond the natural sciences and incorporate into their analyses knowledge products and perspectives from political and other social sciences. This is because “the inclusion of governance factors in the analysis and development of policies aimed at reducing deforestation and promoting a transition to reforestation are fundamental to the success of those policies.”

Hecht (2011) pointed to “new institutional framings, ideologies, political decentralization, globalization and an expanded arena for new social movements and civil society” as external contexts of forest transitions. To achieve rigor in transitions research, these contexts need to be integrated in the analyses of forest cover change. It is a pressure that cannot be ignored in forest cover change studies in Brazil.

### Difficulties of Interdisciplinary Work

But the reviews indicate that interdisciplinary research work is not easy. Four reasons are pointed out: [1] it takes time to get it going; [2] it takes many to do it, and do it together; [3] it requires many tools to do it; and [4] then there is politics.

**Takes time.** Ostrom & Cox (2011) find that “enabling scholars from multiple disciplines to share a common framework for diagnosing the sources of diverse environmental problems will take time and effort within a dedicated research programme.” Berkes (2011) found the same difficulty in adaptive co-management. It takes time to get it to get it going.

**Involves many.** Interdisciplinary research requires many scientists and knowledge workers coming from different knowledge perspectives to work together well (Ommer, 2011). To do this, they need to have a wide appreciation of their different knowledge tacks, sources, and epistemological orientations (Agrawal & Benson 2011). Pretty (2011) cited the difficulty of linking disciplines and knowledge systems because it requires from their practitioners “a concomitant effort to appreciate, protect, and support cultural diversity.”

**Involves many tools.** Agrawal & Benson (2011) and Acevedo (2011) said that interdisciplinary research requires complex analytical tools. These tools can constrain and inhibit interdisciplinary collaboration. They include both quantitative and qualitative tools which means that interdisciplinary researchers

should be able to use (or be at least familiar and comfortable with) both tools.

**Politics.** Perhaps a significantly intractable dampener of interdisciplinary undertakings is the effects of politics on collaborative research. Beder (2011) said that “knowledge alone, no matter how refined and comprehensive, is insufficient to overcome the power of vested interests.” Powerful groups may choose to adopt a policy over another on the basis of what suits their interests. They would tend to be selective on which research they will support (and which ones they will kill).

A similar point is elaborated by Filer (2011) who noted that interdisciplinary debates have had a long and rich history in Papua New Guinea. Yet they have no direct and significant influence on current environmental policy in the country because “indigenous society-environment relationships” are presently the ones dictating policy, more than science.

Trompf (2011) said that “environmental scientists always need to take stock of the socio-political contexts in which interdisciplinary action takes place.” It can do or undo an otherwise useful research work.

## IMPLICATIONS TO SUSTAINABILITY

Trompf (2011) said this about specialization and interdisciplinarity:

The trouble is so much specialization impresses itself on researchers that they will naturally be suspicious of interdisciplinarians, who seem to have bitten off more than their fair share. Even though interdisciplinarity is sorely needed to solve complex problems, and by now a small academic industry is devoted to it (Weingart & Stehr, 2000), a likely future holds that solutions will have to come with collaborations of specialists; and even such collaborators, wherever they are, will have to operate between the competing pressures of academy, politics, industry and independent activists (Cromwell & Levine, 2007).

To Trompf (2011), the obvious links between environmental interdisciplinarity and sustainability center on the complexity

of biospheric and ethnospheric interactions that keep life going on earth. Understanding them requires analytical approaches that cut across disciplinary boundaries, and which overcome the competing pressures that he cited. A number of the reviews refer to the complexity he cited, as this occurs across different ecological settings:

- In the case of agriculture, Acevedo (2011) cited the extensive dynamics between biodiversity, agricultural productivity and ecosystem services. He said that interdisciplinary models can lead to designing effective strategies for sustainable food production. He referred to an “eco-agricultural approach” to shaping strategies that improve productivity that are “wildlife-friendly” and promotes biodiversity conservation alongside raising food outputs. He claimed that “biodiversity at the landscape level is key to sustain both agricultural production and the provision of ecosystem services” (see Brussaard et al., 2010). Because they are closely linked, it is necessary that “agricultural and natural areas are jointly managed to produce ecosystem services” (see also Scherr & McNeely, 2008).
- Forestry features very close links between nature and culture. Lele and Kurien (2011), Tacconi (2011), and Hecht (2011) described the biological and social complexity of forest ecosystems so that multi-, cross-, and interdisciplinary approaches would better facilitate understanding myriad human and natural events that affect their sustainability.
- In the case of oceans and coasts, Fisher and Chen (2011) described the fate and severity of marine contaminants being driven by both natural and social influences. Interdisciplinary approaches facilitate more accurate and comprehensive determination of their movements and shape responses to the threats they pose to the sustainability of ocean ecosystems and services. This is echoed by Ommer (2011) and Christie (2011) who explained that because of the complex human-nature dynamics occurring in marine ecosystems, research on them is best done using interdisciplinary approaches.

The reviews that look at large and complex socio-ecological systems (Agrawal & Benson, 2011; Beder, 2011; Berkes, 2011;

Ostrom & Cox, 2011; Pretty, 2011; Reyers et al., 2011; Spangenberg, 2011) point to sustainability being hinged on fully appreciating intricate nature-culture dynamics. They give these reasons:

- Values, philosophy and ethics shared by a community dictate the manner and extent that they use environmental assets like land (Reyers et al., 2011); these need to be understood as related influences on sustaining the assets.
- In order “to build a new research programme on the sustainability of complex SES,” said Ostrom and Cox (2011), “dialogue between scientists of different disciplines, as well as between scientists and practitioners, under the auspices of an applied science of sustainability” would be necessary.
- Sustainability, Spangenberg (2011) suggested, is couched in intricate human-nature interactions. Interdisciplinary appreciation of these interactions is crucial to laying “a robust basis” for sustainability.
- Cultures are complex systems encompassing beliefs, meanings and world views; livelihoods, practices and resource management systems; knowledge bases and language; and institutions, norms and regulations (Pretty, 2011). These connect communities to their environments. The “cultural continuity” of a community and the sustainability of its resource base are linked to how they are properly understood.
- Society and resource systems are constantly in flux. And the flux can cut across different tiers of ecological and social structures. Thus, to Berkes (2011), decentralization, learning-as-participation, adapting, and capacity-building would be crucial to sustaining resources and resource governance systems. These cannot occur without a multifaceted appreciation of these fluxes.
- For Beder (2011), environmental policy which addresses sustainability issues has broad and intricate economic contexts. Achieving sustainability will require the interweaving of many disciplines from both the natural and social sciences. A failure in interdisciplinarity can lead to shortcomings of

policy that, in turn, erode sustainability.

- Policies generate multiple outcomes (Agrawal & Benson, 2011). Interdisciplinary approaches can lead to better ways of combining them and so, presumably, to also ensuring sustainability.

What the reviews seem to be saying is that complexity begs interdisciplinarity. Trompf (2011) cited the fields of economics and ecology that have had long histories of interdisciplinarity. Their success in producing considerable interdisciplinary knowledge (which to Trompf is the “universitas” of knowledge), has contributed to influencing human behaviors that in turn had affected the sustainability of environmental systems (see also Polunin & Burnett, 1993).

### **CONCLUSION: EMERGING CHALLENGES AND OPPORTUNITIES FOR INTERDISCIPLINARITY IN ENVIRONMENTAL SCIENCE**

There is general recognition that there is value to interdisciplinarity. The reviews show why and how it facilitates comprehensive and intricate (and so, perhaps, more correct) appreciation of complex human-nature interactions. But there remain three serious challenges to interdisciplinarity:

- First is *epistemological*. Its theoretical foundations still need further work. There are conceptual constructs of knowledge that might justify and validate interdisciplinarity (Frodeman, 2011; Ostrom & Cox, 2011; Reyers et al., 2011; Trompf, 2011), but they seem not much in terms of giving interdisciplinarity firmer intellectual and conceptual moorings or bases for developing a distinctive philosophy and epistemology of interdisciplinarity. There also remains the question of these constructs gaining wide acceptance across disciplines and practitioners of different knowledge systems.
- Second is *methodological*. Interdisciplinary methods and methodologies are still scant. The reviews show that interdisciplinarity is being done more by gathering disciplines

together and providing researchers that otherwise have different toolkits and methodological orientations, with a basis for them to collaborate on a common problem. There appears to be not much being done on actually constructing a body of theories and procedures that facilitate the acquisition of interdisciplinary knowledge that has clearly assured internal and external validities, and which allow for replicability. Frodeman (2011) put it this way: "The age of disciplinary knowledge may be ending, but we do not yet know the true shape of interdisciplinarity."

- Third is *institutional*. There is lingering hesitance among discipline-trained researchers to be involved with it. The value of interdisciplinarity might be widely accepted, but it will be difficult and will take much effort and time to convince researchers to subjugate their disciplinary traditions to a new one in which disciplines play less starring roles. And, too, the providers of support facilities and funds might be less attracted to the involved processes and engagement of large numbers of people and the long gestation periods that often characterize interdisciplinary work.

In spite of the challenges, however, there are opportunities for promoting and strengthening environmental interdisciplinarity. The reviews suggest three:

- There is rising awareness of it and willingness to do it among scientists and knowledge workers within and outside science. It is considered relevant and appropriate for understanding and responding to complex environmental dilemmas that presently threaten human survival and sustainability. The reviews indicate a rising recognition by science scholars and practitioners that these dilemmas require interdisciplinarity.
- There is an intensifying public demand for it. People, policy-makers, priests, politicians and power brokers are hungering for knowledge products that can give them a broader sense of environmental threats to life and property, and which can give them a better handle of closely intertwined issues affecting life systems. A number of the reviews cite the close links between interdisciplinary research and public policy. They note how

these are getting more extensive and intense.

- Scholars and science practitioners are recognizing the limits of disciplines. Discipline-oriented research is being recognized as having a limited reach when set against the breadth of contemporary environmental dilemmas. The reviews hint of a rising suspicion (if not already a realization) of a “Kuhnian anomaly” (Kuhn, 1962) in the relevance of traditionally-bounded disciplines to address present-day environmental concerns. It would seem that, in a word, a growing number of adherents of disciplinal sciences might now be reconsidering Robert Frost’s line, “Good fences make good neighbors.”

In brief, the 17 reviews indicate that [1] interdisciplinarity is something we are better off doing in the face of the multi-dimensional, multi-locational, multi-scalar and multi-level complexity of our current environmental dilemmas and prospects for sustainable well-being; [2] it can be done (and in fact is being done); but, [3] we have yet to build up a wider consensus within and outside the science and knowledge-building communities, including the public, on theories and methods that justify, validate, and give credibility to interdisciplinarity.

We know we need it, and although we are doing it and are quite clear about why we do it, we are still really unsure of what it is and how to do it.

## ACKNOWLEDGEMENTS

I wish to thank the ICEF for its invitation for me to participate in the 6th International Conference on Interdisciplinary Progress in Environmental Science and Management. Thanks also to Dr. Rebecca R. Jelliffe for her helpful editorial comments.

## REFERENCES

- Acevedo, M. (2011.) Interdisciplinary progress in food production, food security and environmental research. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Agrawal, A. & Benson, C. (2011.) Common property theory and resource

- governance institutions: Strengthening explanations of multiple outcomes. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Anderies, J., Janssen, M. & Ostrom, E. (2004.) A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society* 9(1), 18.
- Beder, S. (2011.) Environmental economics and ecological economics: The contribution of interdisciplinarity to understanding, influence and effectiveness. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Berkes, F. (2011.) Devolution of environmental and resource governance: Trends and future. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Brussaard, L., Caron, P., Campbell, B., Lipper, L., Mainka, S., Rabbinge, R., Babin, D., & Pulleman, M. (2010.) Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture. *Current Opinion in Environmental Sustainability* 2(1-2), 34-42.
- Carson, R. (1962.) *The silent spring*. Boston: Houghton Mifflin.
- Christie, P. (2011.) Creating space for interdisciplinary marine and coastal research: Five dilemmas and suggested resolutions. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Filer, C. (2011.) Interdisciplinary perspectives on historical ecology and environmental policy in Papua New Guinea. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Fisher, N. & Chen, C. (2011.) Interdisciplinary approaches for addressing marine contamination issues. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Frodeman, R. (2011.) Interdisciplinary thinking and academic sustainability: Managing knowledge in an Age of Accountability. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Frost, R. (1915.) Mending wall. Retrieved from <http://www.poemhunter.com/poem/mending-wall>

- Hecht, S. (2011.) From eco-catastrophe to zero deforestation? Interdisciplinary, politics, environmentalisms and the decline of clearing in Amazonia. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Intergovernmental Panel on Climate Change. (2007.) *Fourth assessment report. World Meteorological Organization and the United Nations Environment Programme*. London: Cambridge University Press.
- Jantsch, E. (1972.) Towards interdisciplinarity and transdisciplinarity in education and innovation. *Interdisciplinary Problems of Teaching and Research in Universities*. Paris: OECD.
- Kuhn, T. (1962.) *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Lele, S. & Kurien, A. (2011.) Interdisciplinary analysis of the environment: Insights from tropical forest research. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Lengwiler, M. (2006.) Between charisma and heuristics: four styles of interdisciplinarity. *Science & Public Policy* 33, 423-434.
- Max-Neef, M. (2005.) Foundations of transdisciplinarity. *Ecological Economics* 53, 5-16.
- McGinnis, M. (2010.) Building a programme for institutional analysis of social-ecological systems: A review of revisions to the SES framework. [Working Paper.] *Proceedings of the Workshop in Political Theory and Policy Analysis*. Bloomington, IN: Indiana University.
- McNeil, W. (1963.) *The rise of the West: A history of the human community*. Chicago: University of Chicago Press.
- Millennium Assessment. (2005.) *Ecosystems and human well-being*. Washington, DC: Island Press.
- Naughton, D. & Petróczi, A. (2008.) Heavy metal ions in wines: meta-analysis of target hazard quotients reveal health risks. *Chemistry Central Journal* 2008, 2:22 doi:10.1186/1752-153X-2-22.
- Ommer, R. (2011.) "Coasts under stress": A Canadian case study of interdisciplinary methodology. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Ostrom, E. & Cox, M. (2011.) Moving beyond panaceas: A multitiered diagnostic approach for social-ecological analysis. *Proceedings of the 6th International*

- Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Pretty, J. (2011.) Interdisciplinary progress in approaches to address social-ecological and eco-cultural systems. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Polunin, N. & Burnett, J. (Eds.). (1993.) *Surviving with the biosphere*. Edinburgh, UK: Edinburgh University Press.
- Reyers, B., Roux, D., & O'Farrell, P. (2011.) Can ecosystem services lead ecology on a transdisciplinary pathway? *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Scherr, S. & McNeely, J. (2008.) Biodiversity conservation and agricultural sustainability: towards a new paradigm of 'ecoagriculture' landscapes. *Philosophical transactions of the Royal Society B: Biological Sciences* 363(1491), 477-494.
- Spangenberg, J. (2011.) Sustainability science: A review, an analysis and some empirical lessons. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Tacconi, L. (2011.) Developing environmental governance research: The example of forest cover change studies. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.
- Trompf, G. (2011.) The classification of the sciences and the quest for interdisciplinarity: A brief history of ideas from ancient philosophy to contemporary environmental science. *Proceedings of the 6th International Conference on Environmental Future, on Interdisciplinary Progress in Environmental Science and Management*. UK: Newcastle University.

---

# WATER AND BOTTOM SEDIMENT QUALITY OF PAGATBAN RIVER IN NEGROS ORIENTAL, PHILIPPINES: 30 YEARS AFTER MINING CLOSURE

Robert S. Guino-o II

Michael Lawton R. Alcalá

Jocelyn Elise P. Basa-Inocencio

Center for Tropical Conservation Studies, Biology Department,  
Silliman University, Dumaguete City, Philippines



Anthropogenic activities threaten the ecological functions and services of rivers. In particular, Pagatban River in Negros Island, Philippines experienced these threats as massive fish kills happened from 1979 to 1983 as a result of mine tailing pollution. This study explores the water quality of Pagatban River after three decades of post-mining operation. A one year longitudinal design was employed to monitor 17 water parameters in three study sites within a 15.81 kilometer stretch of Pagatban River. Water quality parameters of the river between seasons and across sites were analyzed using Kruskal-Wallis One-way Analysis of Variance. These parameters were also compared with national and international standards for water quality. Results revealed that total water volume, width of river, water volume per site, temperature, total suspended solids, phosphate ( $\text{PO}_4\text{-P}$ ) and total *coliform* varied significantly between seasons. Meanwhile, width of river, water volume, velocity, depth of river, salinity and nitrate ( $\text{NO}_3\text{-N}$ ) showed significant differences across sampling sites. Furthermore, the heavy metals in the waters of Pagatban River were below the detectable

limit of 0.01 mg/L, however, the bottom sediments from the river mouth and river banks showed high levels of heavy metals that ranged from 0.1 mg/kg – 242.8 mg/kg. Although the general water quality of Pagatban River can be classified as Class C which is suited for aquaculture use, the amount of heavy metals in its bottom sediments is not compatible with any fishery activities in the area. In conclusion, this study confirms that the water quality of Pagatban River has improved significantly over the last three decades but its bottom sediment quality still has heavy metals that are 200 to 5,000 times higher than the acceptable levels.

---

**KEYWORDS:** heavy metals, mine tailing, Pagatban River, Negros Oriental, total coliform, water quality

## INTRODUCTION

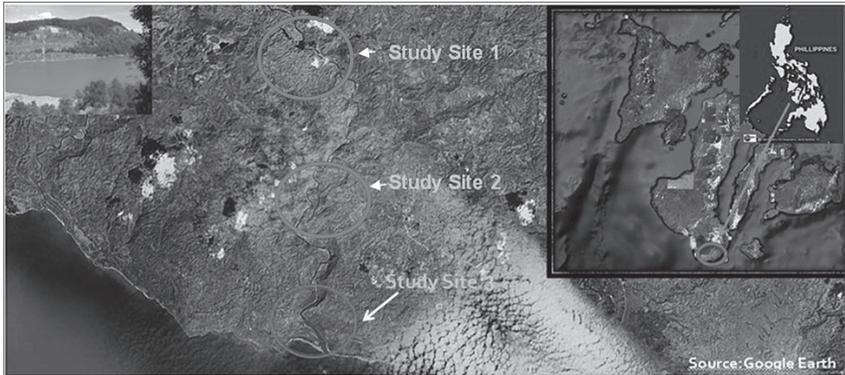
RIVER ECOSYSTEMS ARE among the endangered ecosystems because of unregulated human activities that imperil them. There are three anthropogenic threats that rivers in Asia face today, namely: [1] degradation of river basins due to deforestation, [2] Infrastructure developments that disrupt the functioning of biological ecosystems, and [3] river pollution (Dudgeon, 1992; Qiao et al., 2011). Deforestation has also been identified as the major cause of suspended sediment load and massive flooding in rivers. In cases of extreme siltation, species decline and disappearances are expected when habitats of aquatic organisms are altered. Meanwhile, infrastructure developments that regulate the flow of rivers such as levees, dikes, dams and canals have been known to disrupt fish breeding migration patterns. Estuaries in China are among the most turbid in the world with an annual terrestrial sediment load of 1,600 million tons that are largely caused by dredging, oil and gas explorations and many others (Wang, Wang, Guan, & Guo, 2011). Furthermore, river pollution in Asia is characteristically dominated by domestic wastes particularly fecal pollution (median coliform count of 10,000 l<sup>-1</sup>) rather than industrial effluents except for Malaysia where river pollution was attributed to tin mining (Barril & Tumlos, 2002; Dudgeon, 1992; Malayang, Briones, & Catalan, 2002). Philippine rivers and streams, likewise, suffer from varying degrees of environmental disturbances from waste dumping as cities and municipalities expand (UNEP-IETC Report, 2009).

Studies conducted in Pagatban River on Negros Island between 1979 and 1981 indicated copper and zinc levels of 0.017-0.057 mg/L and 0.014-0.273 mg/L, respectively (Lowrie et al. as cited in Alcalá, 1999). These were attributed to discharges from the mining company that operated in the area. Decimation of ecologically important species and persistent fish kills were observed in Pagatban River during that time (Alcalá, 1984). No rehabilitation activities were recorded after the mining company closed down in 1984. Previous studies on the water quality of Pagatban River served as an important baseline data for comparison after three decades without mining activities. This river marks the boundary between Bayawan City and the Municipality of Basay; it receives the effluents from the open pit mining area.

The aim of the study was to compare the water quality of Pagatban River of Negros Island between seasons and across sites after three decades of post-mining activity. Seventeen water parameters were measured covering physico-chemical and biological aspects. From these water data, comparisons were made with international water quality standards set by US EPA (1986) and WHO (2011). Comparisons to the previous water data of Pagatban River (Alcalá, 1999; Rosario, 1999) were also conducted to verify any improvement or further deterioration of its water quality. Results of this study will be useful for the identification of its water classification and appropriate usage based on the existing guidelines as provided by the Department of Environment and Natural Resources of the Philippines.

## MATERIALS AND METHODS

Pagatban River is located in southern Negros separating the municipality of Basay and Bayawan City. The river has an average width ranging from 63 m to 78 m. The study area covered an approximate length of 15.81 kilometers and was divided into three sampling stations designated as upstream (Barangay Naghalin in Basay), midstream (Barangay San Miguel in Basay), and downstream (Barangay Pagatban in Bayawan). Upstream (Study Site 1) has a rugged terrain and is highly elevated. This was accessed by land transportation while midstream and downstream (Study Sites 2 and 3, respectively) were accessed using a motorized canoe.



**Figure 1.** Map of Pagatban River, Negros Oriental showing the location of study sites. **Site 1: Upstream—Bgy. Naghalin, Basay:** Upper Upstream (Sitio Tigbayawan)—9.48573°N, 122.70893°E, Middle Upstream (Sitio Cabigtian)—9.48166°N, 122.71122°E, Lower Upstream (Sitio Cubi)—9.48063°N, 122.71181°E. **Site 2: Midstream—San Miguel, Basay:** Upper Midstream (Sitio Aya-aya)—9.41316°N, 122.71457°E, Middle Midstream—9.42133°N, 122.71214°E, Lower Midstream—9.41996°N, 122.71231°E. **Site 3: Downstream—Bgy. Pagatban, Bayawan:** Upper Downstream—9.38647°N, 122.71458°E, Middle Downstream—9.38844°N, 122.71251°E, Lower Downstream—9.38601°N, 122.71408°E. Upper left inset is the water-filled open pit copper mine that drains into the river.

Water sampling from the study sites was conducted during the dry season from February to May 2010 and the wet season from August to November 2010. Data validation through a community dialogue was conducted in November 2011 while intermittent water sampling continued until January 2012 on selected parameters. Water samples were obtained from every site in three replicates using 350-ml water bottles. The samples were stored in an ice box and were analyzed *in situ* through a make shift laboratory and later brought to the Chemistry and Biology Departments of Silliman University for further laboratory analyses. The analyses comprised of seventeen water parameters, namely: pH, temperature, dissolved oxygen, salinity, color, width, depth, total *coliform*, nitrate, phosphate, total suspended solids, velocity, volume per site, total volume, lead, copper, and zinc. Seventy two (72) measurements per parameter were conducted throughout the sampling period with the exception of the heavy metals: lead (Pb), copper (Cu), and zinc (Zn) measured twice every season for the water samples and once every season for the bottom sediments samples. The data on heavy metals were compared to the previous data of Alcala (1999) and Rosario (1999) to determine variations in concentrations across time.

The following methods were used to measure the water parameters: pH meter for water pH, thermometer for subsurface water temperature, ocular approximation using *sechi disk* for water color; Winkler titration, refractometer and vacuum filtration (GFC filter) methods for dissolved oxygen, salinity and total suspended solids, respectively. Furthermore, Cadmium Reduction method was employed to analyze nitrate (NO<sub>3</sub>-N); Ascorbic Acid colorimetric method for total phosphate (PO<sub>4</sub>-P) determination; aerobic plate count using EMB culture medium for the bacterial determination of total *coliform*; and flame atomic absorption spectrophotometry (AAS) for the analysis of heavy metals. River velocity was determined using a floater which was made to travel a known distance divided by the time spent to travel the said distance. Water volume per sub-site was calculated using the formula  $R = \text{width (m)} \times \text{depth (m)} \times \text{velocity (m/sec)}$ . The formula used for the total water volume was  $Q = R_1 + R_2 + R_3$  (Umali & Cuvin, 1988) where  $R$  is the flow volume at study sites 1, 2 and 3.

Descriptive statistics such as mean, minimum, maximum, standard deviation, and standard error were used for the analyses of physico-chemical and total *coliform* data. Normality in the data distribution was established using Shapiro-Wilk's test. The Kruskal-Wallis One-way Analysis of Variance was used to compare the means of the water parameters between sampling seasons and across sampling sites an alpha level of 0.05.

## RESULTS

### Physical Parameters of Pagatban River Between Seasons

The mean water temperature differed significantly between seasons (mean temperature during dry season = 31.03 °C; mean temperature during wet season = 28.53 °C;  $p$  value = 0.054) (Table 1). Although the water velocity did not differ significantly, the water volume per study site ( $R$ ) and total water volume ( $Q$ ) varied significantly between seasons (mean  $R$  during dry season = 19.43 m<sup>3</sup>/s; mean  $R$  during wet season = 33.76 m<sup>3</sup>/s;  $p$  value = 0.025; mean  $Q$  during dry season = 58.26 m<sup>3</sup>/s; mean  $Q$  during wet season = 110.84 m<sup>3</sup>/s,  $p$  value = 0.021). The color of the river water during the dry season was dominantly clear green but murky brown during the wet season. The mean width of Pagatban River

showed significant differences between seasons (mean width during dry and wet seasons = 63.06 m and 77.94 m, respectively;  $p$  value = 0.000). However, the mean depth of the river did not show significant variation between the seasons (mean depth during dry season = 1.24 m, mean depth during wet season = 1.28 m,  $p$  value = 0.169). Lastly, total suspended solids (TSS) differed significantly between seasons (TSS during dry season = 45.74 mg/L; TSS during wet season = 105.94 mg/L;  $p$  value = 0.001).

### **Chemical and Biological Parameters of Pagatban River Between Seasons**

The pH level of Pagatban River did not differ significantly between dry and wet seasons (mean pH during dry months = 7.29; mean pH during wet months = 7.07;  $p$  value = 0.141). Dissolved oxygen (DO) levels did not vary significantly between seasons (mean DO during dry months = 9.26; mean DO during wet months = 9.76;  $p$  value = 0.096). Similarly, the salinity levels did not significantly vary between seasons (mean salinity during dry months = 0.105; mean salinity during wet months = 0.097;  $p$  value = 0.070). Meanwhile, total nitrate ( $\text{NO}_3\text{-N}$ ) level of Pagatban River showed no significant variations (mean  $\text{NO}_3\text{-N}$  during dry months = 0.077 mg/L; mean  $\text{NO}_3\text{-N}$  during wet months = 0.12 mg/L;  $p$  value = 0.608). Total phosphate level ( $\text{PO}_4\text{-P}$ ), on the other hand, differed significantly between seasons (mean  $\text{PO}_4\text{-P}$  during dry months = 2.57 mg/L; mean  $\text{PO}_4\text{-P}$  during wet months = 0.44 mg/L;  $p$  value = 0.001). The levels of heavy metals in the water of Pagatban River were below the limit of detection set by the analysis, thus, lead (Pb), copper (Cu) and zinc (Zn) were < 0.010 mg/L, < 0.032 mg/l and < 0.017 mg/L, respectively. However, the bottom sediments found at the river bank showed high heavy metal content. Composite sample analyses revealed that lead (Pb) level was 5.8 mg/kg, copper (Cu) was 242.8 mg/kg and zinc (Zn) was 41.8 mg/kg. Lastly, the level of total coliform varied significantly between seasons where mean total *coliform* during dry season was 1,867 cfu/mL and 18 cfu/mL during the wet season ( $p$  value = 0.04).

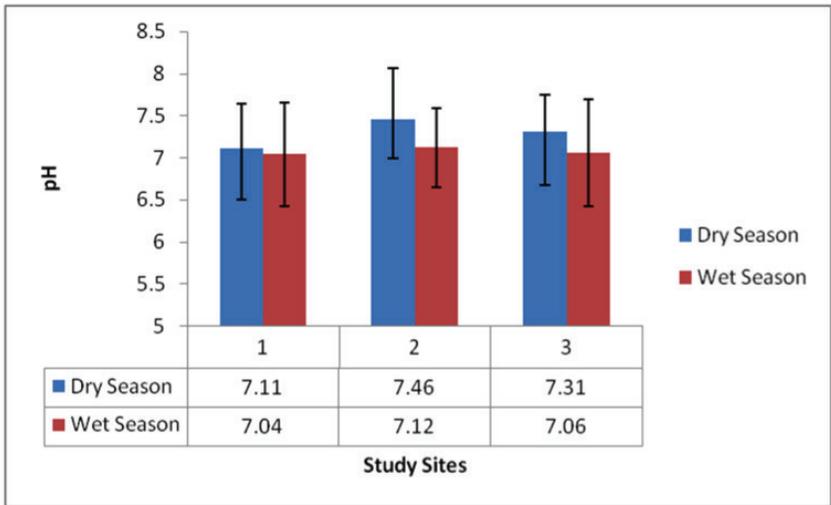
### **Water Parameters Across Study Sites**

The mean pH values of Pagatban River indicated neutral values of above 7 (Figure 2). The midstream area showed the highest

**Table 1.** Physico-chemical and total coliform parameters of Pagatban River between dry and wet seasons (n=72/parameter; n=12/heavy metal in water; n=2/heavy metal in bottom sediments)

Parameters	2010 DRY SEASON					2010 WET SEASON				
	Fresh water Std.	Max	Min	Average	S.E. (±)	Max	Min	Average	S.E. (±)	p value
pH	6.5-8.5	6.43	8.20	7.29	0.08	7.80	6	7.07	0.09	0.141
Temp. (°C) max. rise	3	34.20	26.20	31.03	0.34	30.10	26	28.53	0.11	0.054
D.O. (mg/L)	5	12	4	9.26	0.27	11.20	8	9.76	0.11	0.391
Salinity (g/L)	—	1	0	0.11	0.04	0.30	0	0.10	0.02	0.070
Width (m)	—	132	22	63.06	6.88	137	31	77.94	7.13	0.000
Depth (m)	—	4.17	0.35	1.24	0.16	4.47	0.47	1.38	0.13	0.169
Velocity/site (m/s)	—	0.77	0.07	0.25	0.02	1.24	0.07	0.40	0.05	0.060
R (m <sup>3</sup> /s)	—	67.84	4.69	19.43	3.09	80.97	12.78	33.76	6.08	0.025
Q (m <sup>3</sup> /s)	—	85.79	38.64	58.26	3.30	125.75	95.62	110.84	7.10	0.021
NO <sub>3</sub> -N (mg/L)	10	0.20	0.008	0.08	0.008	0.86	0.02	0.12	0.03	0.608
PO <sub>4</sub> -P (mg/L)	0.20	4.87	1.764	2.565	0.294	1.81	0.07	0.44	0.06	0.001
TSS (mg/L)	30	220	0	45.74	10.24	167.20	11.2	105.94	5.32	0.001
Coliform (cfu/mL)	—	58,667	0	1,867	1,569	90	0	18	4.69	0.040
Pb in water (mg/L)	0.05	—	—	<0.018	—	—	—	<0.010	—	—
Cu in water (mg/L)	1.0	—	—	<0.018	—	—	—	<0.032	—	—
Zn in water (mg/L)	5.0	—	—	<0.036	—	—	—	<0.017	—	—
Color	—	—	—	b-c	—	—	—	b-c	—	—
Pb in soil (mg/kg)	0.025	—	—	5.8	—	—	—	<1.00	—	—
Cu in soil (mg/kg)	0.045	—	—	242.80	—	—	—	222.40	—	—
Zn in soil (mg/kg)	0.090	—	—	41.80	—	—	—	51.40	—	—

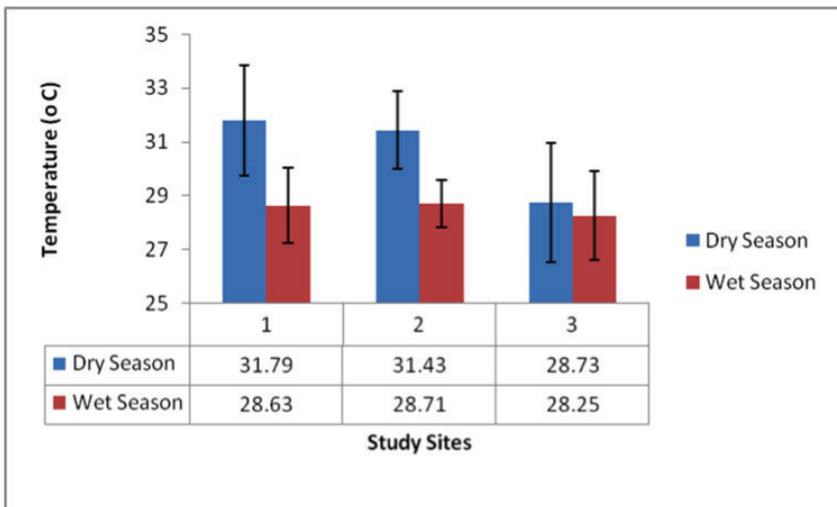
Freshwater standard is based on DENR DAO 34-90, US EPA and WHO; temp= temperature; DO= dissolved oxygen; R= water volume/study site; Q=total water volume; NO<sub>3</sub>-N=nitrate; PO<sub>4</sub>-P=phosphate; TSS=total suspended solids; Pb=lead; Cu=copper; Zn=zinc; b-c=brown to clear green; \*p value in **bold** font indicates statistical significance; p value in regular font indicates non-significance



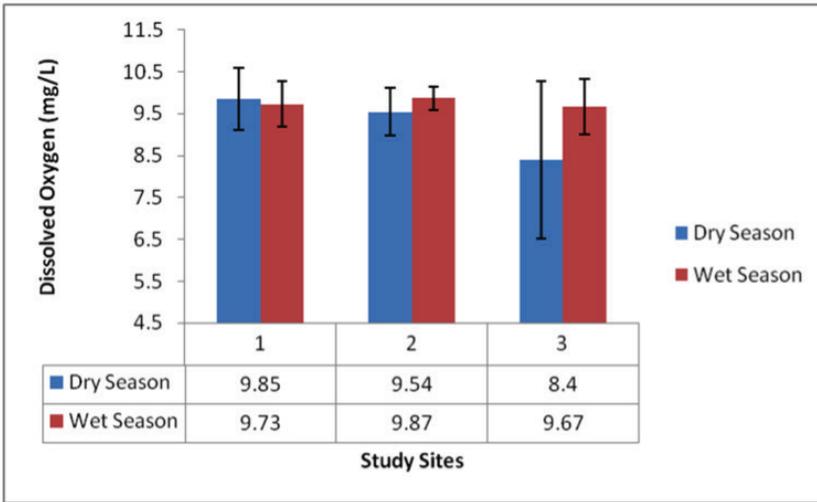
**Figure 2.** Mean water pH of Pagatban River across study sites and between seasons.

mean pH values of 7.46 and 7.12 during dry and wet seasons, respectively. The mean pH did not vary significantly across the three study sites ( $p$  value = 0.488).

The highest mean water temperature was recorded at the upstream area during the dry season with an average of



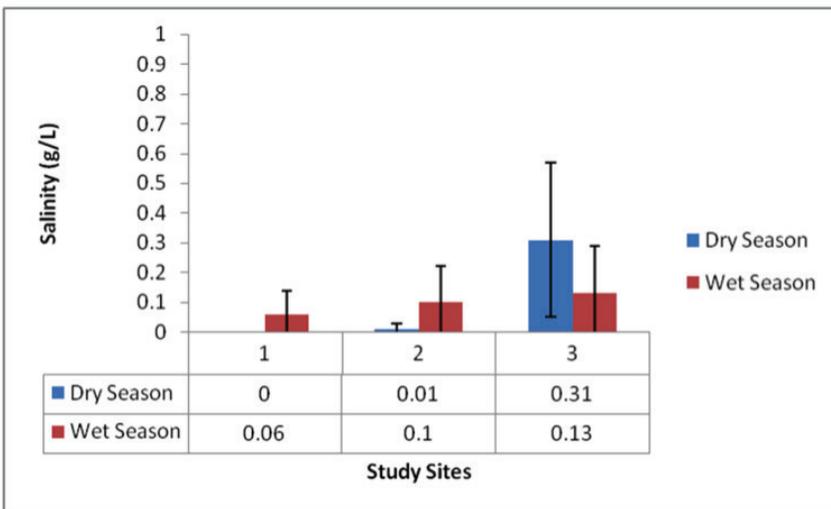
**Figure 3.** Mean water temperature of Pagatban River across study sites and between seasons



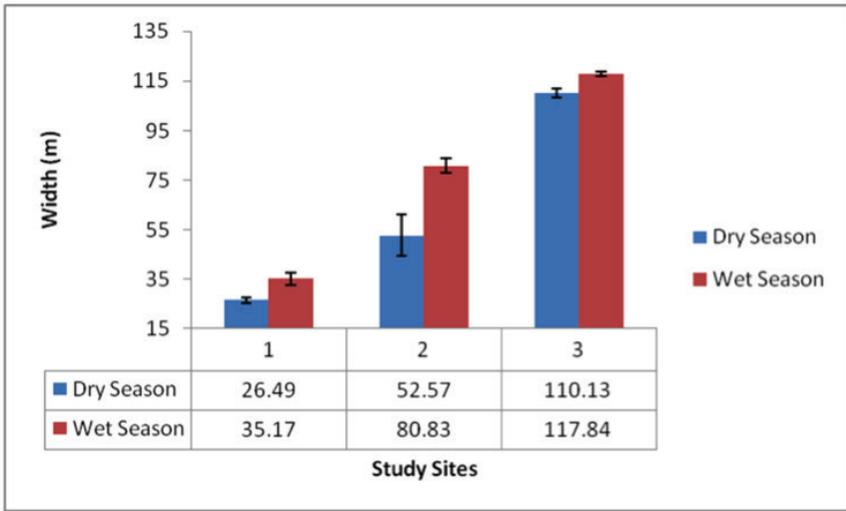
**Figure 4.** Dissolved oxygen levels of Pagatban River across study sites and between seasons

31.43°C while lowest mean water temperature was recorded at the downstream area during the wet season with an average of 28.25°C (Figure 3). There was no significant difference of the mean water temperature across the three sites (*p* value = 0.414).

The mean dissolved oxygen (DO) values of Pagatban River



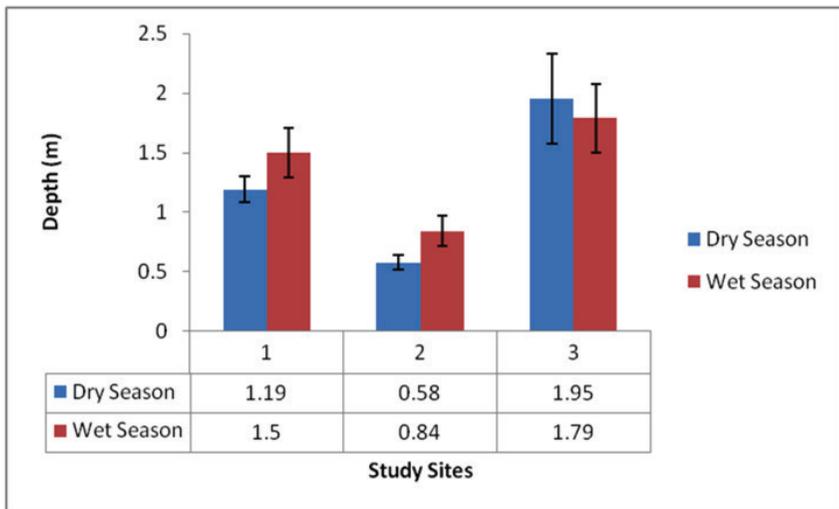
**Figure 5.** Mean salinity levels of Pagatban River across study sites and between seasons



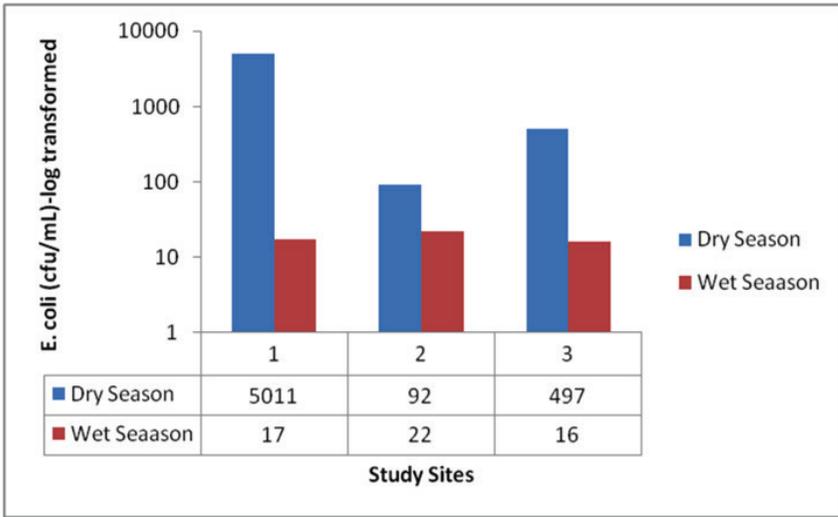
**Figure 6.** Mean width of Pagatban River across study sites and between seasons

remained above 8 mg/L between seasons and across study sites (Figure 4). There was no significant difference of the DO levels across the three study sites.

The mean salinity values throughout the study sites ranged from 0 g/L to 0.31 g/L. The highest salinity values were consistently observed at the downstream area which averaged to 0.31 g/L and



**Figure 7.** Mean depth of Pagatban River across study sites and between seasons



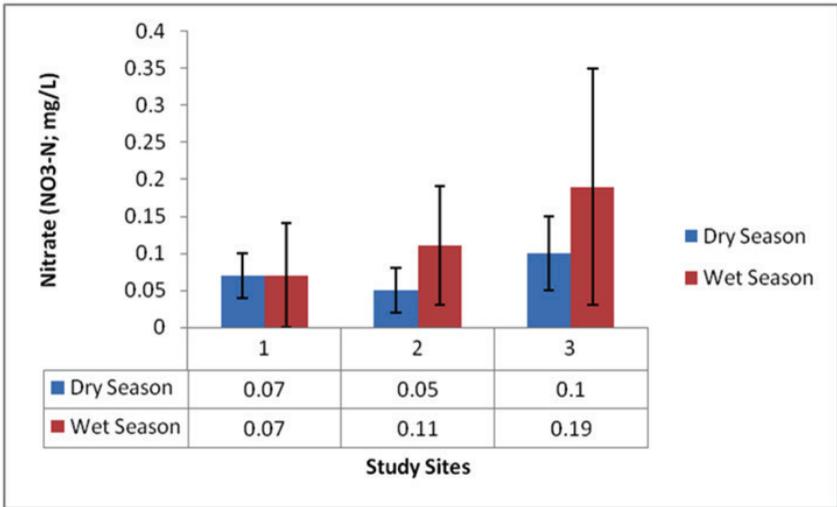
**Figure 8.** Levels of total coliform in Pagatban River across study sites and between seasons

0.13 g/L during the dry and wet seasons, respectively (Fig. 5). The lowest average salinity of 0 g/L was recorded in the upstream area during the dry season. The mean salinity varied significantly across the three study sites ( $p$  value = 0.002).

The highest mean width and depth values were recorded in the downstream area between seasons and across the study sites. The average width and depth of the downstream area during the dry season were 110.13 meters and 1.95 meters, respectively, whereas the average width and depth during the wet season were 117.84 meters and 1.79 meters, respectively. Both parameters varied significantly across the three study sites ( $p$  value = 0.000 for width and depth, respectively).

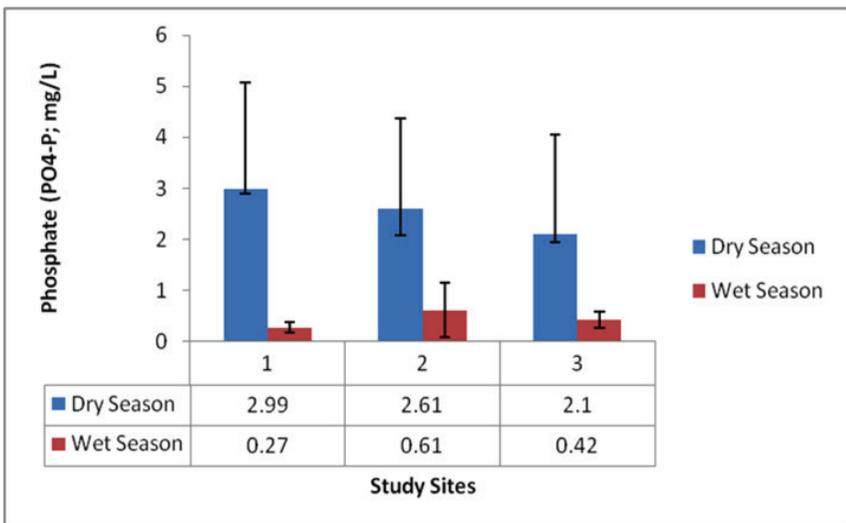
The total *coliform* bacteria which serve as an indicator of biological pollution in the river was highest during the dry season specifically at the upstream area which averaged to 5,011 cfu/mL. Over-all, coliform levels were low during the wet season which ranged from 16 cfu/mL to 22 cfu/mL. Although the levels varied significantly between seasons ( $p$  value = 0.04; Table 1), no significant difference was observed across the study sites ( $p$  value = 0.43).

Nutrient level of the river such as nitrate ( $\text{NO}_3\text{-N}$ ) was highest at the downstream with an average of 0.10 mg/L and 0.19 mg/L during dry and wet seasons, respectively. All nitrate values

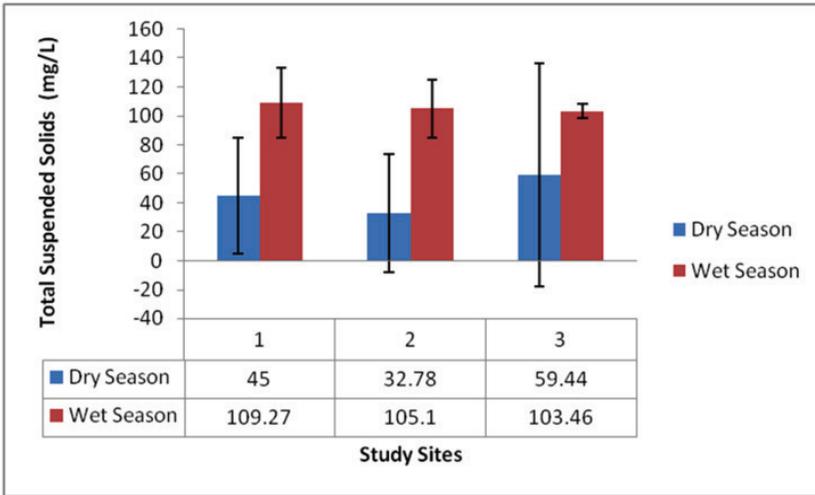


**Figure 9.** Nitrate concentrations of Pagatban River across study sites and between seasons

were below the maximum permissible limit but was observed to be lowest in the upstream. There was a significant difference in the nitrate levels across the three study sites ( $p$  value = 0.047). In contrast, the phosphate ( $\text{PO}_4\text{-P}$ ) level was highest at the upstream which averaged to 2.99 mg/L during the dry season



**Figure 10.** Phosphate concentrations of Pagatban River across study sites and between seasons

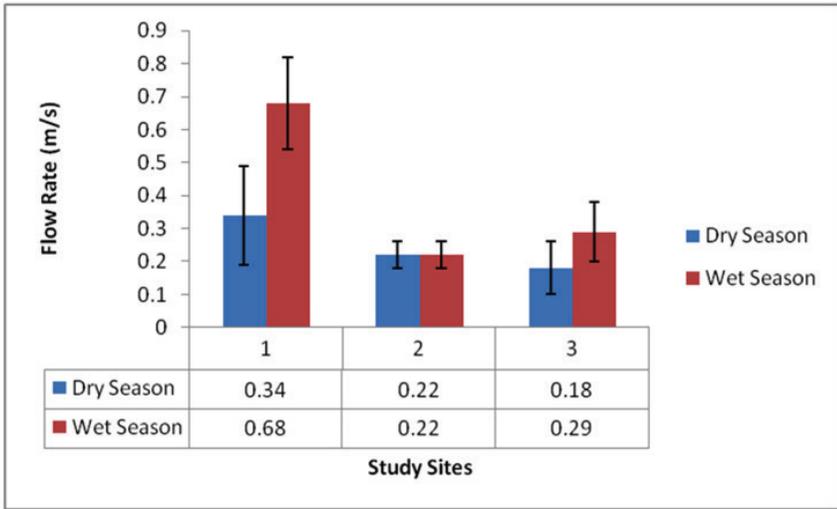


**Figure 11.** Total suspended solids of Pagatban River across study sites and between seasons

and was lowest at the downstream which averaged to 2.1 mg/L. During the wet season, the phosphate levels decreased across the three study sites and ranged from 0.27mg/L to 0.61 mg/L. All phosphate values were above the maximum permissible limits set by national and international water quality standards. Phosphate levels did not have significant differences across the study sites ( $p$  value = 0.749), however, there was a significant difference between seasons (Table 1). Over-all mean phosphate levels were more than 10 times higher than permissible limit of 0.2 mg/L for recreational water.

The total suspended solids (TSS) levels in Pagatban River were very high during wet season throughout all study sites which ranged from 103.45 mg/L to 109.27 mg/L. The water quality was most turbid between the months of August and November which coincided with the wet season. During the dry season, the TSS was highest at the downstream with an average of 59.44 mg/L. There was no significant difference of the TSS levels across the three study sites ( $p$  value = 0.390) but a significant difference between seasons was recorded (Table 1).

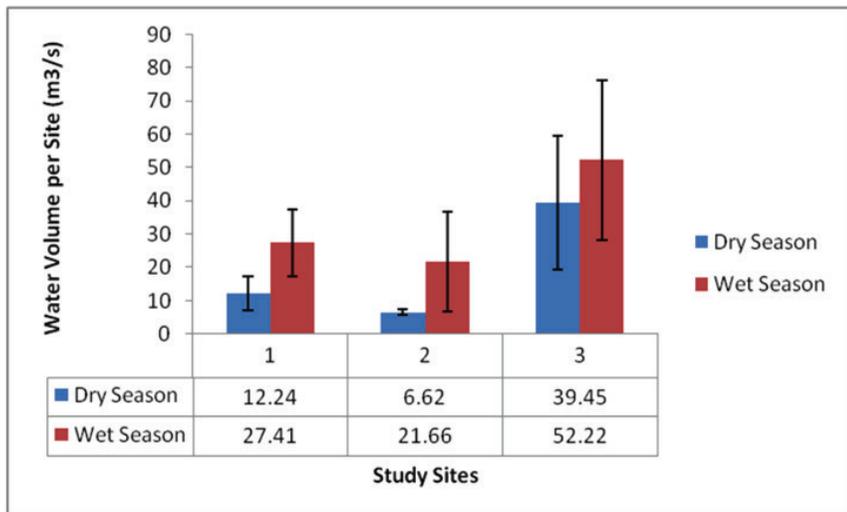
In terms of water velocity per site, the highest values were recorded at the upstream during dry and wet seasons which averaged to 0.34 m/s to 0.68 m/s, respectively. There was a significant difference of the water velocity across the three study



**Figure 12.** Water velocity of Pagatban River across sites and between seasons

sites ( $p$  value = 0.000) but none between seasons (Table 1).

Finally, water volume (R) was highest at the downstream between seasons and across sites which averaged to 39.45 m<sup>3</sup>/s and 52.22 m<sup>3</sup>/s during dry and wet seasons, respectively. The lowest water volume was recorded at the midstream which averaged to



**Figure 13.** Water volume (R) of Pagatban River across study sites and between seasons

6.22 m<sup>3</sup>/s during the dry season. There was a significant difference of the water volume across the study sites ( $p$  value = 0.000) but none between seasons (Table 1).

Significant differences of the water parameters of Pagatban River between seasons and across sites were established by Kruskal-Wallis Analysis of Variance. Of the thirteen parameters analyzed between dry and wet seasons, seven differed significantly, namely: temperature, width, flow volume/site ( $R$ ), total flow volume ( $Q$ ), phosphate ( $PO_4$ -P), total suspended solids ( $TSS$ ) and total coliform levels (Table 1). Six differed significantly across sites (Table 2), namely: salinity, width, depth, nitrate ( $NO_3$ -N), water velocity, and flow volume per site ( $R$ ). The total volume ( $Q$ ) was not included in the Kruskal-Wallis Analysis of Variance because  $Q$  was the sum of the water volume ( $R$ ) in the three study sites and comparison was not plausible;  $Q$  could, however, be compared between dry and wet seasons. Water pH and dissolved oxygen (DO) were the only parameters of Pagatban River that did not vary significantly between seasons and across study sites using the same test. The rest of the parameters may vary either as an effect of season or sites or a combination of both.

Heavy metals such as lead (Pb), copper (Cu) and zinc (Zn) in the waters of Pagatban River were below the detectable limit of 0.01 mg/L (Table 3). These levels were also below the maximum permissible limit set by the Department of Environment and Natural Resources. However, the heavy metals in the sediments of Pagatban River particularly those located at the river banks in all study sites showed high levels of heavy metals that ranged from <1 mg/kg to 242 mg/kg. These portions of the river where the samples were taken showed a characteristic grey color on the surface and a deep yellow-orange color below the surface.

## DISCUSSION

Tropical rivers are characterized by temporal and spatial variations due to the interplay of season, river basin lithology, vegetation, slope, and land use. In the studies of Dudgeon (1992; 2000), tropical Asian rivers were characterized as having high temperature, low water volume and low suspended solids during dry season with inverse levels during the wet months. Similarly, Philippine rivers were characterized with seasonal variations as noted in

Table 2. Mean Values and Standard Deviations of Selected Water Parameters Across Sites

Parameters	Dry Season		Wet Season		P value
	Upstream	Midstream	Downstream	Upstream	
pH	7.11(+.53)	7.46 (+.60)	7.31(+.44)	7.04 (+.61)	0.488
Temp.(oC)	31.79(+2.04)	31.43(+1.44)	28.73(+2.22)	28.63(+1.41)	0.414
D.O.(mg/L)	9.85(+.74)	9.54(+.57)	8.40(+1.88)	9.73(+.54)	0.080
Sal. (g/mL)	0.00(+.00)	0.01(+.02)	0.31(+.26)	0.06(+.08)	<b>0.002</b>
Width (m)	26.49(+1.3)	52.57(+8.4)	110.13(+1.8)	35.17(+2.5)	<b>0.000</b>
Depth (m)	1.19(+.11)	0.58(+.06)	1.95(+.38)	1.50(+.21)	<b>0.000</b>
Coliform (cfu/mL)	5011(+9948)	92(+121)	497(+657)	17(+30)	0.430
NO <sub>3</sub> (mg/L)	0.07(+.03)	0.05(+.03)	0.10(+.05)	0.07(+.07)	<b>0.047</b>
PO <sub>4</sub> (mg/L)	2.99 (+2.08)	2.61(+1.75)	2.10(+1.95)	0.27(+.10)	0.749
TSS (mg/L)	45.00(+40)	32.78(+41)	59.44(+77)	109.27(+24)	0.390
velocity (m/s)	0.34 (+.15)	0.22(+.04)	0.18(+.08)	0.68(+.14)	<b>0.000</b>
R (m <sup>3</sup> /s)	12.24(+5)	6.62(+1)	39.45(+20)	27.41(+10)	<b>0.020</b>

Temp.= temperature; DO = dissolved oxygen; Sal. = salinity; NO<sub>3</sub>=nitrate; PO<sub>4</sub>=phosphate; TSS=total suspended solids; R = water volume/site; \*p value in **bold** font indicates statistical significance; p value in regular font indicates non-significance

Table 3. Comparative Analysis of Heavy Metals in the Water and Bottom Sediments of Pagatban River

	Lowrie, <i>et al.</i> as cited by Alcala, 1999	Rosario, 1999	Guino-o, <i>et al.</i> [this study]	Maximum Permissible Limit WHO	Maximum Permissible Limit DENR
Pb in water (mg/L)	—	—	<0.010 - <0.018	0.05	0.05
Cu in water (mg/L)	0.017-0.057	<0.01	<0.018 - <0.032	1.0	0.05
Zn in water (mg/L)	0.014-0.273	—	<0.017 - <0.036	5.0	—
<b>Maximum Permissible Limit EPA</b>					
Pb in sediment (mg/kg)	—	—	<1- 5.8	0.025	
Cu in sediment (mg/kg)	—	—	222.4 - 242.8	0.045	
Zn in sediment (mg/kg)	—	—	41.8-51.4	0.090	

several studies (Carumbana, 2002; Linaugo, Turbanos, Pacalioga, Patiluna, & Menes, 2010; Olaguer, Mendoza, Pakingking, & Yamamoto, 2010). In this particular study, seven of the 13 water parameters showed significant variations between dry and wet seasons. Specifically, the mean values of temperature, width, water volume per site ( $R$ ), total water volume ( $Q$ ), phosphate ( $PO_4\text{-P}$ ), total suspended solids ( $TSS$ ) and total *coliform* varied significantly between seasons. Furthermore, significant variations across study sites were observed for salinity, width, depth, nitrate ( $NO_3\text{-N}$ ), velocity and water volume per site. The results also show an apparent decline of the water quality of this river in relation to national and international water standards. Moreover, excessive water volume resulted to severe flooding of the entire river during the wet season causing drowning incidents of farm animals and people; destruction of houses along the river banks, and damage to agricultural crops as reported by the residents to the local government units. Poor forest cover oftentimes causes severe flooding during the wet season; in Negros Island the remaining primary forest cover is four percent of its land area (ESSC, 1999). Flooding is a common event in many areas of this island.

Among the water parameters of Pagatban River that draw critical attention are the high mean values of the following parameters: [1] Phosphate ( $PO_4\text{-P}$ ), [2] Total *coliform*, [3] Heavy metals in the sediments, and [4] Total suspended solids. Study results revealed that phosphate levels increased 15 times higher than the maximum permissible limit of 0.2 mg/L during the dry season and two times higher than the permissible limit during the wet season. Anthropogenic activities that lead to high phosphate levels include the use of commercial fertilizers in the nearby sugarcane farms of Pagatban whose peak use fall during the dry months of February to May. Agricultural farming in the areas of Basay and Bayawan, where the river cuts across, contributes to chemical runoffs (e.g., phosphate, nitrate) during rainy weather. Processes that cause these include sub-surface nutrient leaching, soil erosion, effluents released from sugar mill washings of sugar cane or farm equipment. However, phosphate readings seemingly decrease during the wet season due to the diluting effects of heavy rains and river flooding. This pattern in nutrient influx which was also observed in the studies of Dudgeon (1992) and Carumbana (2002) confirms that river ecology is significantly affected by the

seasonality of land discharges. Furthermore, the same studies indicated that monsoonal rains tend to dilute the levels of nutrients in the rivers while the dry season, particularly during El Niño phenomenon tend to concentrate them. Interestingly, the Yang Tze River in China does not follow this pattern; it experiences peak nitrogen, phosphorus and bicarbonate loadings during the flood season (Wang, Wang, Guan, & Guo, 2011). In this particular case, spatial variations and other environmental factors may play significant influence than just seasonal variation insofar as phosphate and nitrate are concerned.

Secondary contributors to the high phosphate levels of Pagatban River are laundry washing and bathing activities by the nearby residents. Soaps and detergents contain phosphates and sulfates that can increase the phosphate load of a water body (Molles, 1999, p. 509). Previous studies in Jalaur River in Panay, Naungan River in Leyte, and Bago River in Negros Occidental, and (Guino-o, 2005; Borlongan, Golez, & Lorque, 2010; Linaugo, Turbanos, Pacalioga, Patiluna, & Menes, 2010) have documented that rivers tend to be used as receptacles for wastewater from industries, domestic households and agriculture. In the study of Fang (2000), phosphate is generally a limiting factor in the environment, however, discharges of raw sewage, disposal of detergents from domestic households can lead to phosphate overloading in an aquatic system.

The indicator species for biological pollution in freshwater bodies is the *coliform* bacteria. The total *coliform* level was generally higher in the dry season than in the wet season. It was also highest in the upstream as compared to midstream and downstream. The variations in the levels of *coliform* bacteria across the three study sites can be attributed to the response of the residents to the presence of the research team. During the first month of the sampling period, water buffalos were commonly found in the upstream area of the river near the sampling sites but were no longer present during the succeeding months. Lower levels of coliform bacteria may have been observed during the wet season due to the diluting effects of heavy rain and flooding. Most households in the upstream and midstream areas did not have access to sanitary toilets as well, thus, open defecation is practiced in these areas. Although the total *coliform* levels did not show significant differences across the study sites, this study confirmed that Pagatban River was contaminated with *coliform* bacteria at a

level above the maximum permissible limit during the dry season.

The levels of heavy metals in the waters of Pagatban River were low with values ranging from  $< 0.010$  mg/L to  $< 0.036$  mg/L compared with the data of Rosario (1999) and Lowrie and colleagues (as cited by Alcala, 1999) which ranged from  $< 0.010$  mg/L to  $0.273$  mg/L. This reflected a  $-87\%$  variance from previous level indicating that heavy metals in the waters of Pagatban River have been diluted after three decades without mining activity. According to US EPA water quality guideline (1986, p. 477), however, copper levels at  $0.006$  mg/L is already lethal to the blue mussel and is known to cause hepatic toxicity and gastrointestinal disorder. Lead (Pb) at the level of  $0.1425$  mg/L is lethal to amphipods and can cause adverse neurological development, impaired renal function, hypertension and infertility among animals. In this study, the over-all findings revealed that heavy metals in the waters of Pagatban River were below the maximum permissible limit set by DENR and WHO (2011). However, the bottom sediments or soil samples taken from the river banks across the three study sites showed high levels of heavy metals which ranged from  $< 1$  mg/kg to  $242.8$  mg/kg. Heavy metals in the water of this river appear to be very low but they are concentrated in the river substrate through time. This observation can be attributed to the mine tailings from the mining activities in Basay dating back to the 1980s which led to the mass killing of the aquatic organisms in this river. The present heavy metals in the bottom sediments of Pagatban River—lead (Pb), copper (Cu), zinc (Zn)—were found to exceed the maximum limit set by EPA which were  $0.025$  mg/kg,  $0.045$  mg/kg and  $0.090$  mg/kg, respectively. Thus, lead (Pb) in Pagatban River was 200 times higher than the permissible limit; while copper (Cu) and zinc (Zn) were 5,000 times and 600 times higher than the permissible limits, respectively. Based on the water quality of Pagatban River, it can be classified as Class C water which is suited for aquaculture, however, the amount of heavy metals in its bottom sediments is still not compatible with any fishery activities in the area.

After 30 years of no-mining activities in the nearby areas of Pagatban River, chemical analyses confirmed that heavy metal contamination still persists in its bottom sediments, thus posing an environmental threat. This finding has implications to the food web, and food chain in the aquatic ecosystem. Heavy metal contamination affects all food trophic levels from smallest

microbenthos to the top predator in the food web in the process of biological magnification. The work of Power (1990) demonstrated that certain fishes act as keystone species in food webs in rivers where their presence exerts a strong effect on the structure of the communities they inhabit. When the threshold level for heavy metal is reached, it causes mortalities not only to the keystone species but also to other biological species in the food web of the river. In Pagatban River, there is a reason to believe that invertebrates may be contaminated with heavy metals and therefore must be protected along with the other species so as not to repeat a mass decimation of aquatic organisms as what happened in the past. As a safety precaution, fishery resources of Pagatban River must be analyzed for heavy metal contamination since the residents of Pagatban and the neighboring areas are dependent on these resources as food.

Total suspended solids or TSS, an indicator of the amount of sediment in a river system, in Pagatban was found to be two times higher than the maximum permissible limit of 50 mg/L during wet season. However, the mean TSS level during the dry season was lower than the permissible limit. Significant difference of the TSS levels between dry and wet seasons was recorded but no significant difference across study sites. The high values of TSS during the wet season can be linked to several factors such as increased water volume, velocity, and subsequent soil erosion from heavy rains and turbulent water mixing during typhoons. Sediments from the upstream and upper midstream areas were also collected by the mid-catch basin of the lower midstream site which eventually reached their way to the downstream.

## CONCLUSION AND RECOMMENDATIONS

The general water quality of Pagatban River is classified as Class C water except for its phosphate, total coliform, heavy metals in the sediments, and total suspended solids where the latter exceeded the maximum permissible limits set by national and international environmental agencies. Significant seasonal variations were observed in the following water parameters: width, water volume per site, total water volume, total suspended solids, total *coliform*, temperature, and phosphate ( $\text{PO}_4\text{-P}$ ). Significant site variations were noted in the following water parameters: velocity, width,

water volume per site, salinity, nitrate ( $\text{NO}_3\text{-N}$ ), and depth. Although the heavy metals in the waters of Pagatban River were below the detectable limit set by the analyses, the very high levels of heavy metals in its sediments do not compliment with any fishery activity such as the propagation and growth of fishery resources.

In order to sustain and improve the water quality of Pagatban River in Negros Oriental, Philippines, the following recommendations are proposed:

1. Full implementation of the Clean Water Act of 2004 (RA 9275) at the barangay level of the local government units which prohibits the dumping of wastewater into creeks, rivers and marine waters without undergoing treatment processes. The same law mandates all local government units (LGUs) to share in the management and improvement of the water quality within their territorial jurisdictions. Pagatban River is a shared river between the City of Bayawan and the Municipality of Basay, thus, a co-management scheme between the two local government units is a wise step in the over-all management of this river. The establishment of a river monitoring system by the local government unit is also suggested to operationalize the Clean Water Act. Furthermore, it is suggested that the monitoring results will be reported during the monthly meeting of the barangay for proper management.
2. Due to the large volume of water that runs through Pagatban River during the wet season, a flood warning system is suggested for the local government units to consider in their future plan of action. The effects of flooding have been reported by the residents of Pagatban to be more destructive in the past three years. A flood warning system will promote safety to people's lives and properties in the nearby areas of the river.
3. Clandestine operation of small-scale mining in the side of Basay area has to be stopped by the concerned local government units at the level of the barangay in order to protect its water quality and accompanying biodiversity. The improved river quality of Pagatban River after three decades of no mining in its nearby area will be lost if mining activity

is allowed at any scale. Pagatban River should be protected from any type of pollution because it is an identified fishing ground of economically-important fishes particularly in the downstream area. Fishery resources of Pagatban River must be analyzed for heavy metal contamination since the residents of Pagatban and the neighboring areas are dependent on these resources as food.

4. River bank stabilization technologies have to be adopted along Pagatban River. Appropriate technologies that can be considered by the local government units include rip-rapped dikes and gabions (e.g., rock-filled wire baskets) in the downstream of the river, mangrove planting in the estuaries, restoration of riparian vegetation in the midstream and upstream with indigenous Philippine flora (vetiver grass *Vetiveria zizanioides* coupled with geotextile from coconut) and the continuing reforestation of the Bayawan-Basay watershed by the Provincial DENR of Negros Oriental. The downstream was the widest among the three sites of the river and this will continue to widen if river bank stabilization strategies are not implemented. River bank erosion and siltation will also be addressed when these technologies are implemented thereby improving the over-all health of Pagatban River and the ecosystems near it.
5. The implementation of ecological sanitation programs by all barangays near Pagatban River is recommended in this study. Strategies such as “zero open defecation” program can be realized when a barangay provides adequate numbers of communal toilets in the area. Dumping of industrial, domestic, and agricultural wastes into the river will not happen when barangays have accessed to a sanitary landfill, compost area and regulated communal dumpsite as provided by RA 9003 (Ecological Solid Waste Management Act of 2000).
6. The continuing linkage of the local government unit with non-governmental organizations to address environmental issues such as river biodiversity, conservation and management is a practical step in sustaining initiatives for a healthy freshwater ecosystem. For instance, local government units can tap the services of the academe with capabilities for water analysis in

monitoring a river system. This can be implemented through a service learning program where the expertise of the academe is put into practical use and at the same time address the need for the exposure of students to good environmental practices.

## ACKNOWLEDGMENTS

The authors would like to thank the Commission on Higher Education (CHED) for the research funding; Dr. Angel C. Alcala and Dr. Orencio D. Lachica of the CHED Zonal Research Center at Silliman University, Dumaguete City for their invaluable support; Mayor German P. Saraña of Bayawan City for the logistics support in going to the upstream area; Bridgitt P. Villordon for the help in the sample collection; Dr. Lita M. Cadeliña for the initial comments on the manuscript; Degilla family and our local partners in the different barangays for their help. This paper was awarded First Place in the poster competition during the National Convention of the Federation of Institutions for Marine and Freshwater Sciences (FIMFS) in Tagbilaran City, Bohol, Philippines on November 11, 2011.

## REFERENCES

- Abal, E.G., Bunn S.E. & Dennison, W.C. (2005). Healthy waterways healthy catchment: Making the connection in SE Queensland. Brisbane, Australia.
- Alcala, A.C. (1976). *Philippine land vertebrates*. Manila, Philippines: New Day.
- Alcala, A.C. (1984). *Animal extinctions in a Philippine estuary*. Unpublished manuscript. SUAKCREM Library, Silliman University, Dumaguete City.
- Alcala, A.C. (1999). Death of a river. *Journal of Environment, Energy and Minerals* 11(3): 22-27.
- Barril, C.R. & Tumlos, E.T. (2002). Water quality trends and trophic state assessment of Laguna de Bay, Philippines. *Aquatic Ecosystem Health & Management*, 5(2), 115-126.
- Borlongan, I.G., Golez, N.V. & Lorque, F. (2010). Physico-chemical assessment of the Jalaur river system, Iloilo, Philippines. *Silliman Journal*, 51(1), 224-246.
- Carumbana, E.E. (2002). Taxonomy, abundance and distribution of fishes in the Agos River, Central Sierra Madre, Luzon, Philippines. *Asia Life Sciences* 11(1), 29-58.
- Chiu, Y., Santos, L. & Juliano, R. (1988). *Management and operation of intensive prawn farms*. UP Aquaculture Society, UP Visayas publication.

- Clean Water Act 2004 (RA 9275). Philippines.
- Department of Water Resources Quality Assurance/Quality Control Program—California (1995). Compilation of sediment and soil standards, criteria, and guidelines.
- Dudgeon, D. (1992). Endangered ecosystems: A review of the conservation status of tropical Asian rivers. *Hydrobiologia*, 248, 167-191.
- Dudgeon, D. (2000). The ecology of tropical Asian rivers and streams in relation to biodiversity conservation. *Annual Rev. Ecol, Evol, and Syst.* 31, 239-263.
- Ecological Solid Waste Management Act 2000 (RA 9003). (Phils.).
- ESSC. (1999). *Decline of the Philippine forest*. Makati, Philippines: Bookmark.
- Fang, T.H. (2000). Partitioning and behaviour of different forms of phosphorus in the Tanshui estuary and one of its tributaries, Northern Taiwan. *Estuarine, Coastal and Shelf Science*, 50, 689-701.
- Giessmann, H. (2003). River consultation report. Retrieved from <http://www.idi.or.jp/report>
- Guino-o, R. (2005). *Sustainability of Naungan River in Ormoc City, Philippines*. [Unpublished MS Thesis.] Miriam College, Quezon City.
- Linaugo, J.D., Turbanos, F.M., Pacalioga, J.O., Patiluna, M.L., & Menes, C.C. (2010). Physico-chemical and bacteriological assessment of Bago river, Negros Occidental. *Silliman Journal*, 51(1), 21-40.
- Malayang, B.S., Briones, N.D., & Catalan, Z.B. (2002). Policy options to encourage community support for the sustainable development of Philippine lakes: Insights from Laguna de Bay. *Aquatic Ecosystem Health & Management*, 5(2), 147-154.
- Molles, M.C. (1999). *Ecology concepts and application*. USA: McGraw-Hill.
- Newkirk, G. (1996). Sustainable coastal production systems: A model for integrating aquaculture and fisheries under community management. *Ocean and Coastal Management*, 32(2), 69-83.
- Olaguer, I.M., Mendoza, S.A., Pakingking, R., & Yamamoto, A. (2010). Seasonal changes and coliform load of Jalaur River, Province of Iloilo, Panay Island, Philippines, *Silliman Journal*, 51(1), 247-264.
- Power, M.E. (1990). Effects of fish on river food webs. *Science*, 250, 811-814.
- Qiao, L.L., Wang, Y.Z., Li, G.X., Deng, S.G, Liu, Y., & Mud, L. (2011). Distribution of suspended particulate matter in the northern Bohai Bay in summer and

- its relation with thermocline. *Estuarine, Coastal and Shelf Science* 93, 212-219.
- Rosario, E.A. (1999). *Final management plan of the Bayawan-Basay watershed in Negros Oriental*. Dumaguete City: DENR-PENRO.
- Tsai, C.K. (1989). Water quality management. Proceedings of the Southeast Asian shrimp farm management workshop. American Soybean Association, Singapore, 140 pp
- UNEP-IETC Report. (2009). *Large scale treatment of domestic waste water*. Retrieved from [www.unep.or.jp/ietc/publication](http://www.unep.or.jp/ietc/publication).
- US EPA (1986). *Quality criteria for water*. Washington, DC: Office of Water Regulations and Standards.
- Wang, X.H., Wang, H., Guan, W. & Guo, Z. (2011). Dynamics of Chinese muddy coasts and estuaries: An introduction. *Estuarine, Coastal and Shelf Science*, 93, 171-172.
- WHO, (2011). *Guidelines for drinking water quality* (4th edition).

---

# PLANT DIVERSITY IN THE FOREST ECOSYSTEM OF CARRANGLAN WATERSHED, NUEVA ECIJA, PHILIPPINES

**Annie Melinda Paz-Alberto**

Institute for Climate Change and Environmental Management  
and Department of Biological Sciences, College of Arts and Sciences,  
Central Luzon State University  
Science City of Muñoz, Nueva Ecija, Philippines

**Shirly C. Serrano**

Institute for Climate Change and Environmental Management  
Central Luzon State University  
Science City of Muñoz, Nueva Ecija, Philippines

**Cecilia T. Galvez**

Science City of Muñoz, Nueva Ecija, Philippines

**Paul Henric P. Gojo Cruz**

University of Los Baños  
College, Laguna



Forests are home to 50-90% of the Earth's species providing food, wood, fiber, energy, raw materials, industrial chemicals, and medicine. Biodiversity is a vital part of the earth's capital, preserving the plant's genes, species, and ecosystems hence, biodiversity conservation should be a priority. This study assessed plant diversity in Carranglan, Nueva Ecija, Philippines to determine the exploitation and conservation status of its forest ecosystem. Plants were collected, preserved, described, identified and classified. The number and distribution of each species of plants were noted for diversity assessment. Data were gathered using quadrat sampling method with ten pre-selected stations: five were located at Barangay Gen. Luna and five were at Barangay Burgos. There were a total of 292 different plant species in the area, under 91 families with families Moraceae, Myrtaceae, Araceae, and Rubiaceae as most represented. Trees, shrubs and vines are the most common, with some ferns, mosses, herbs, grasses, sedges, and epiphytes. Shannon's Diversity Index showed that the study areas exhibited very high diversity.

There were 25 plants found to have been part of the International Union for the Conservation of Nature (IUCN) Red List of 2013. Four species of these belonging to the genus *Shorea* were listed as critically endangered, two of which are endemic to the Philippines. Near threatened, endangered, threatened, vulnerable, and plant of least concern were recorded. Twenty four endemic plants, 15 introduced plant species and four invasive plant species were also recorded. Three species, namely *Oncosperma horridum* (Griff.) Scheff., *Dinochloa luconiae* (Munro) Merr. and *Radermachera gigantea* (Blume) Miq. could serve as potential biodiversity indicator species in both of the study areas due to their high number of individuals, frequency, and abundance. Threats to the Carranglan Forest ecosystem include fires, timber poaching, *kaingin* practices, soil erosion, and small-scale mining.

---

**KEYWORDS:** diversity, plants, watershed, biodiversity indicator, degradation

## INTRODUCTION

THE CARRANGLAN WATERSHED (CW) in Central Luzon covers a total area of 97,318 ha of which 4, 023ha comprise the water reservoir. It lies at 15°44' to 16°88' north latitude and 120°36' to 122°00' east longitude (Lasco, Cruz, Pulhin, & Pulhin, 2010). The Caraballo mountain ranges border the watershed in the north while the southern portions are bordered by the Sierra Madre mountain ranges.

The CW experiences two pronounced seasons: dry from December to April and wet for the other months. The annual average rainfall is 1,766.5 mm (Saplaco, Bantayan, & Cruz, 2001; NPC, 1995 and 1997, as cited in Lasco et al., 2010). Temperature ranges from 23.21°C to 33.71°C, with an average annual humidity of 83.37% (NPC 1995 and 1997, as cited in Lasco et al., 2010). The topography of CW ranges from level, undulating and sloping, up to steep hilly landscapes. These landscapes are often dissected by narrow, flat-bottomed valleys formed by streams running in these mountains. The soils in these mountains were products of the weathered materials from volcanic activities and diorite. The major soil textures are silty clay loam, clay loam, and clay.

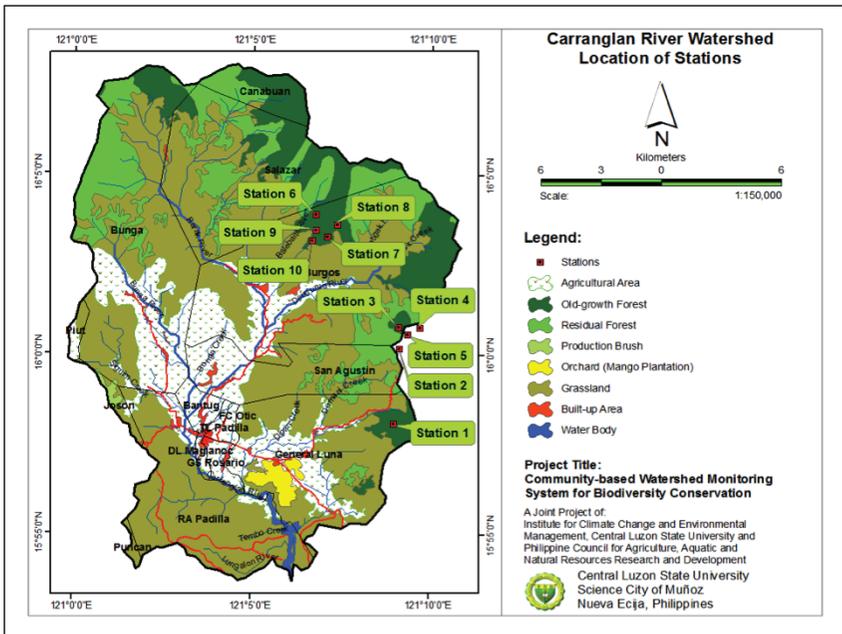
Biodiversity refers to the variety of life in all its forms found on earth. It has to be conserved because it leads to a stable and balanced

ecosystem, underpinning for agriculture and forestry, source of medicine, natural service for vegetative cover, recreational, aesthetic, ecotourism, scientific, and commercial values (Alberto, 2005). Likewise, natural plant biota serve to maintain air quality as they fix CO<sub>2</sub>, release O<sub>2</sub>, and help to assimilate other air pollutants by absorbing considerable solar radiation and, by releasing water vapor through transpiration, they moderate temperature and help maintain climate (Cunningham & Cunningham, 2007).

Duelli and Orbist (2003) state that biodiversity indicator is a linear correlate to the entity or aspect of biodiversity under evaluation. Biodiversity indicators represent three value systems such as conservation (protection and enhancement of rare and threatened species), ecology (ecological resilience and ecosystem functioning based on species diversity) and biological control (diversity of antagonists of potential pest organisms). Biodiversity indicators could be used as quantifiable environmental factors in scientific research.

Threatened species lists are designed primarily to provide an easily understood qualitative estimate of risk extinction (Possingham, et al., 2002). There are four ways by which these lists could be used, namely [a] to set priorities for resource allocation for species recovery; [b] to inform reserve system design; [c] to constrain development and exploitation; and [d] to report on the state of the environment. However, there are limitations on the use of threatened species lists. According to Possingham, et al. (2002), threatened species lists are inappropriate to use for resource allocation because resources for conservation are limited. The use of threatened species as surrogates for biodiversity is also limited because most invertebrate animals and nonvascular plants are not included in any threatened species lists. Moreover, these lists can lead to the illogical outcome that developments with small impacts might be curtailed by a listed species but those developments with large impacts on one or more nonlisted species can proceed with no mitigation requirements. The threatened species lists might also increase threats to a species. In addition, threatened species lists might have limited value as indicators of change in the state of the environment because of uneven taxonomic treatment, variation in observational effort, and the changes in the lists reflect change in knowledge of status rather than change in status itself (Possingham, et al., 2002).

The study was conducted to assess the diversity of plants in the



**Figure 1.** The ten study sites at Carranglan Watershed.

Carranglan Watershed, to identify the endemic and introduced/invasive plants species, to determine the ecological/economic roles/functions of plants in the forest ecosystems, to identify biodiversity indicators and to determine the sources and impact level of environmental problems in the forest ecosystem.

## METHODOLOGY

### Study Sites

Forested areas from two barangays, General Luna and Burgos in Carranglan, Nueva Ecija (Figure 1) were selected as study areas. Barangay Gen. Luna has a total land area of 9,406.02 ha. The forested area encompasses 6,078.47 ha with 206.50 ha of bodies of water. Open spaces and grassland occupy 650.48 ha (CENRO-Muñoz, 2001). These areas are often cultivated and serve as pasture for animals. The mountains of Barangay Gen. Luna exhibit varying steepness—from flat to very steep—and numerous streams. The

upper parts of the forested area are dominated by large trees with many small shrubs and vines. Some portions are dominated by tall grasses and large ferns.

Barangay Burgos has a total land area of 9,745.47 ha of which 4,428.28 are forested. Bodies of water (e.g., major rivers and falls) comprise 419.26 ha. Grasslands are present starting from the foot up to about half of some mountains. The surveyed mountain has a steep to very steep terrain. The soil is rocky to clayey. Large trees, shrubs, bamboo and vines are present in the study areas.

### The sampling areas

A total of ten stations were established at Carranglan Watershed equally distributed between Barangay Gen. Luna and Barangay Burgos. Selection of the stations and quadrats were guided by digitized maps. Each station contained ten preselected quadrats measuring 10m x 12m. A total of 12,000 sq. m. of the primary and old-growth forest located within Barangay Gen. Luna and Barangay Burgos was surveyed in Carranglan Watershed. These areas have rocky and clayey terrain with elevation range from 500-1000 meters above sea level and most of them have steep terrain. Several small streams and large rivers are present in the area. Water from these areas are utilized as sources of potable water and irrigation. The rivers emptied into Pantabangan Hydroelectric Dam.

### Data gathering, documentation and collection of samples

The local name, habit, number of individual plant per species and the quadrats where they were present were gathered and recorded from 2011-2013. The data were used to compute for the various ecological parameters such as frequency and dominance, among others using the following formulas (Smith & Smith, 1998):

#### 1. Percentage Occurrence

$$\text{Percentage Occurrence} = \frac{\text{No. of Stations where sp. occurred}}{\text{Total No. of Stations}} \times 100$$

#### 2. Frequency Distribution (F)

$$F = \frac{\text{No. of quadrats where the species occurred}}{\text{Total No. of Quadrats}}$$

### 3. Relative Frequency (RF)

$$RF = \frac{\text{Frequency of 1 species}}{\text{Total Frequency}} \times 100$$

### 4. Density = Number of individuals of a species per area sampled

$$D = \frac{\text{No. of Individuals}}{\text{Total Area Sampled}}$$

### 5. Relative Density (RD)

$$RD = \frac{\text{Density of a species}}{\text{Total Density of all Species}} \times 100$$

### 6. Dominance (Do)

$$\text{Where: } Do = \frac{\sum ni (ni - 1)}{N (N - 1)}$$

### 7. Relative dominance (RDo)

$$RDo = \frac{\text{Dominance of 1 species}}{\text{Total Dominance}} \times 100$$

### 8. Importance Value Index (IVI) = RF + RD +RDo

### 9. Shannon Diversity Index

$$H' = \sum pi \ln pi$$

Where:  $H'$  = Shannon index of diversity  
 $pi$  = proportion of species from the total species  
 $\ln$  = natural logarithm

## 10. Biodiversity Indicator Value (Dufrene & Legendre, 1997)

$$\text{IndVal}_{ij} = A_{ij} \times B_{ij} \times 100$$

Where:  $A_{ij}$  =  $N_{ij} / N_i$  \ N individuals i  
 $A_{ij}$  = the average amount of the species i in zone j (abundance)  
 $N_i$  = mean values for species i in all zones

$B_{ij}$  =  $S_{ij} / S_j$  \ N sites i  
 $B_{ij}$  = no. of sites in zones j where species i is present (frequency)  
 $S_j$  = number of sites in zone j

Information on uses of the plants recorded and associated beliefs, if any, were also gathered. The plants were photographed in their natural habitat. In case of very tall trees whose leaves are not observable due to their height and the understory trees that obscure viewing, bark of young individuals were photographed instead. Samples were collected to aid in identification and also preserved as herbarium specimens and archived at the Biodiversity Museum of the Institute for Climate Change and Environmental Management, Central Luzon State University. As much as possible, parts with reproductive organs were collected. Small shrubs, ferns, mosses and herbs were collected whole. Specimens were also categorized based on the IUCN Red List of Threatened Species (2013).

### Sources and Levels of Impact of Environmental Degradation of the Terrestrial Ecosystems

The condition of the ecosystem was assessed through ocular inspections. The checklist on the sources and impact level on environmental degradation of forest ecosystems (Alberto, 2005) was utilized. There are four levels of impact in each source of environmental degradation; a value was assigned for each level. The level of impact is estimated based on the percentage of impact/damage in the study area. The checklist was rated using the values 1-4 by a minimum number of ten evaluators from the CENRO, Department of Environment and Natural Resources, Central Luzon State University, and PCAARRD, DOST to determine the present condition of the forest ecosystem. Respondent answers were averaged and a scale (Table 1) was used to interpret the scores

for impact level on environmental degradation of the ecosystem.

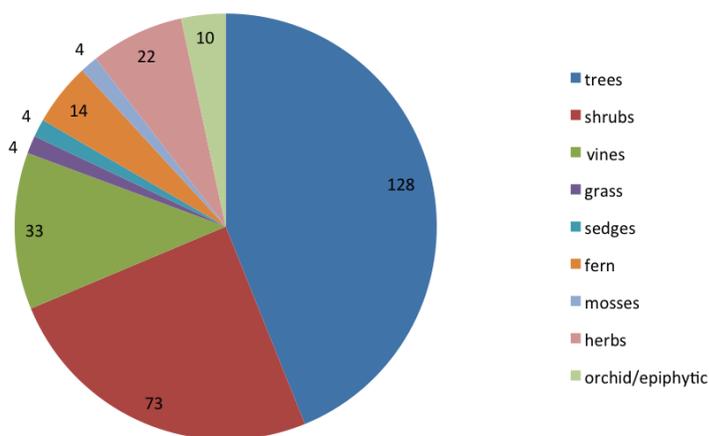
Table 1. **Impact Level Scale Values.**

Scale	Impact Level
1.01 – 1.75	No Significant Impact
1.76 – 2.50	Small Impact
2.51 – 3.25	Moderate Impact
3.26 – 4.00	Major Impact

## RESULTS

### Assessment of Flora in Carranglan Watershed, Nueva Ecija, Philippines

A total of 292 plants were observed from all the stations surveyed at the Carranglan Watershed—165 and 163 in Brgy. Gen. Luna and Brgy. Burgos, respectively. Thirty-six species were present in both study areas. The plants were classified under 91 families. Family Moraceae, Myrtaceae, Araceae and Rubiaceae were the most represented families with more than nine representative species each. The flora observed were mostly trees, shrubs, and vines. Likewise, herbs, grasses, sedges and mosses were also observed in the study areas (Figure 2).



**Figure 2.** Plant types present in Carranglan Watershed.

The six species of plants found to occur in all the stations surveyed were *Philodendron lacerum* (Jacq.) Schott., a tree; “biakal” [*Dinochloa luconiae* (Munro) Merr.], a grass species; “yantok” (*Pinanga aculate* Porte ex Lemaire), a shrub; “yantok” [*Oncosperma horridum* (Griff.), Scheff.], a tree; “white lauan” [*Shorea contorta* (Vid.) Merr. and Rolfe], a tree; and *Pueraria lobata* (Willd.) Ohwi, a vine.

Medium-sized to large trees were harvested as sources of timber such as the “Tuai” (*Bischofia javanica* Blume.). Thirty-three (trees) are sources of high to medium quality timber [e.g. “Red Lauan” (*Shorea negrosensis* Foxw.)]. Medicinal and ornamental plants were also common such as “Pakong Gubat” (*Pityrogramma calomelanos* L.) and “Dapo” (*Asplenium nidus* L.), respectively. Other plants were used for handicraft such as “Bamban” [*Donax cannaeformis* (G. Forster) K. Schum.] and as roping materials like “Yantok” (*Calamus usitatus*); forage for animals such as “Jalakjak” (*Cyrtococcum patens* (L.) A. Camus), sources of edible fruits like “Pahatan” (*Mangifera altissima* Blanco), and some can be source of dyes such as “Taluto” (*Pterocymbium tinctorium* (Blco.) Merr.). Some species like *Dendrocnide luzonensis* (Wedd.) Chew secretes irritating chemicals.

Shannon’s Diversity Index showed that Carranglan Watershed has very diverse flora, with a value of 3.68. Each station surveyed also showed very high diversity. Station 5 located at Brgy. Gen. Luna recorded the highest diversity with a total of 101 species (Table 2.)

### Ecological status of plants present in CW

Twenty-five plants from Carranglan Watershed have been listed in the IUCN Red List (2013). Their ecological status was also determined. Three species under the genera of *Shorea*; two of which are endemic to the Philippines, are listed as critically endangered. *Dipterocarpus gracilis* (Blume) was also listed as critically endangered. During the survey, these species recorded low number of individuals. These trees are source of good quality timber, thus these are targeted by loggers (Table 3, Figure 3.)

Twenty-five species are also found to be endemic to the Philippines. Other plants recorded from Carranglan are endemic to Southeast Asia. Ten species are non-native to the Philippines. Four of these are ornamentals; two were planted as crops (*Coffea*

Table 2. Diversity Indices of Plants Observed in the Ten Stations of Carranglan Watershed.

Station	No. of Species	No. of Individuals	Diversity Index	Interpretation
Station 1	69 species	803	3.583	Very high diversity
Station 2	87 species	836	3.866	Very high diversity
Station 3	94 species	1039	3.521	Very high diversity
Station 4	91 species	825	3.798	Very high diversity
Station 5	101 species	773	4.142	Very high diversity
Station 6	97 species	1134	3.203	High diversity
Station 7	93 species	898	3.686	Very high diversity
Station 8	77 species	667	3.627	Very high diversity
Station 9	92 species	696	3.875	Very high diversity
Station 10	93 species	846	3.746	Very high diversity
<b>AVERAGE</b>			<b>3.68</b>	<b>Very high diversity</b>

Table 3. Critically Endangered, Endangered, Vulnerable, Near-threatened, and Least Concerned Species Observed in Carranglan Watershed Based on IUCN 2013.1

Species	Ecological Status
<i>Dipterocarpus gracilis</i> Blume	Critically endangered
<i>Hopea malibato</i> Foxw.	Critically endangered
<i>Parashorea malaanonan</i> (Blco.) Merr.	Critically endangered
<i>Shorea contorta</i> (Vid.) Merr. and Rolfe	Critically endangered
<i>Shorea negrosensis</i> Foxw.	Critically endangered
<i>Shorea polysperma</i> (Blco.) Merr.	Critically endangered
<i>Mangifera decandra</i> Ding Hou	Endangered
<i>Aglaiia macrocarpa</i> (Miq.) Pannell	Near threatened
<i>Dimocarpus longan</i> ssp. <i>malesianus</i> var. <i>schinatus</i> Leenh.	Near threatened
<i>Agathis philippinensis</i> Warb.	Vulnerable
<i>Artocarpus treculianus</i> Elm.	Vulnerable
<i>Canarium luzonicum</i> (Blume) A. Gray	Vulnerable
<i>Cinnamomum mercurioi</i> Vid.	Vulnerable
<i>Mangifera altissima</i> Blanco	Vulnerable
<i>Pterocarpus indicus</i> Willd	Vulnerable
<i>Vitex parviflora</i> A.L. Juss.	Vulnerable
<i>Actinodaphne pruinosa</i> Nees.	Least concern
<i>Aphananis polystachya</i> (Wall) R.N. Parker	Least concern
<i>Caesalpinia sappan</i> L.	Least concern
<i>Calophyllum inophyllum</i> L.	Least concern
<i>Calophyllum soulattri</i> Burm. F.	Least concern
<i>Canarium asperum</i> Benth.	Least concern
<i>Canarium littorale</i> Blume, Bijdr.	Least concern
<i>Dacryodes costata</i> (Bern.) H.J. Lam	Least concern
<i>Knema glomerata</i> (Blco.) Merr	Least concern

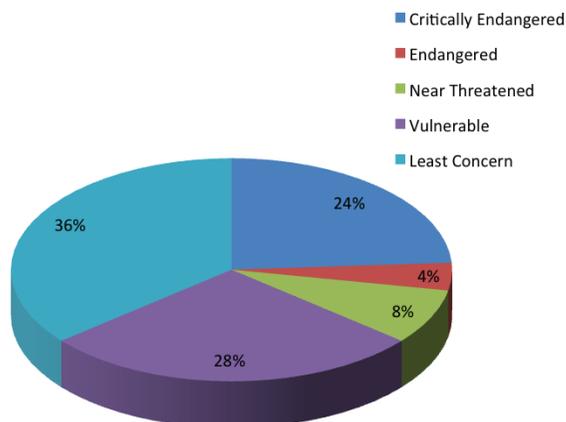
Table 4. Endemic, Introduced/Invasive Plants in Carranglan Watershed

Species	Habit	Ecological Status
<i>Hopea malibato</i> Foxw.	Tree	Endemic (Philippines)
<i>Shorea contorta</i> (Vid.) Merr. and Rolfe	Tree	Endemic (Philippines)
<i>Shorea polysperma</i> (Blco.) Merr.	Tree	Endemic (Philippines)
<i>Agathis philippinensis</i> Warb.	Tree	Endemic (Philippines)
<i>Mangifera altissima</i> Blanco	Tree	Endemic (Philippines and Southeast Asia)
<i>Aglaonema commutatum</i> Schott.	Herb	Endemic (Philippines and Southeast Asia)
<i>Alocasia heterophylla</i> (Presl.) Schott.	Herb	Endemic (Philippines)
<i>Carmona retusa</i> (Vahl.) Masam	Shrub	Endemic (Philippines and Southeast Asia)
<i>Caryota mitis</i> Lour.	Palm	Endemic (Philippines and Southeast Asia)
<i>Dendrocinide luzonensis</i> (Wedd.) Chew	Shrub	Endemic (Philippines)
<i>Doryopteris ludens</i> (Wall. ex Hook.) J. Sm.	Fern	Endemic (Philippines and Southeast Asia)
<i>Ficus balete</i> Merr.	Tree	Endemic (Philippines)
<i>Ficus nota</i> (Blco.) Merr.	Tree	Endemic (Philippines and Southeast Asia)
<i>Ficus pseudopalma</i> L.	Tree	Endemic (Philippines)
<i>Macaranga grandifolia</i> (Blco.) Merr.	Tree	Endemic (Philippines)
<i>Medinilla pendula</i> Merr.	Shrub	Endemic (Philippines)
<i>Melicope triphylla</i> (Lam.) Merr.	Tree	Endemic (Philippines and Southeast Asia)
<i>Oncosperma horridum</i> (Griff.) Scheff.	Tree	Endemic (Philippines and Southeast Asia)
<i>Pandanus luzonensis</i> Merr.	Tree	Endemic (Philippines)
<i>Pinanga maculata</i> Porte ex Lemaire	Shrub	Endemic (Philippines)
<i>Pinanga philippinensis</i> Becc.	Shrub	Endemic (Philippines)
<i>Piper interruptum</i> Opiz. var. <i>loheri</i> (C. DC.) Quis.	Vine	Endemic (Philippines and Southeast Asia)
<i>Spathiphyllum commutatum</i> Schott.	Herb	Endemic (Philippines and Southeast Asia)
<i>Syzygium calubcob</i> (C.B. Rob.) Merr.	Tree	Endemic (Philippines)
<i>Begonia imperialis</i> Lem.	Herb	Introduced
<i>Chamaecranthium venosum</i> M.B.F. ex Wassh. & L.B. Sm.	Herb	Introduced
<i>Philodendron lacerum</i> (Jacq.) Schott.	Epiphyte	Introduced

(CONTINUED TO NEXT PAGE...)

Table 4. Endemic, Introduced/Invasive Plants in Carranglan Watershed (CONTINUED...)

Species	Habit	Ecological Status
<i>Coffea arabica</i> L.	Tree	Introduced
<i>Coffea canephora</i> Pierre ex Frehn.	Tree	Introduced
<i>Gliciridia sepium</i> (Jacq.) Steud	Tree	Introduced
<i>Leucaena leucocephala</i> (Lam.) de Wit.	Tree	Introduced
<i>Philodendron microstictum</i> Standl. & L.O. Williams	Epiphyte	Introduced
<i>Pileostigma malabaricum</i> (Roxb.) Benth.	Tree	Introduced
<i>Pueraria lobata</i> (Willd.) Ohwi	Vine	Introduced
<i>Tectona grandis</i> L. f.	Tree	Introduced
<i>Chromolaena odorata</i> (L.) R.M. King & H. Robinson	Shrub	Introduced, Invasive
<i>Cyperus iria</i> L.	Sedge	Introduced, Invasive
<i>Mikania cordata</i> (Burm. f.) B.L. Rob.	Vine	Introduced, Invasive
<i>Urena lobata</i> Linn.	Shrub	Introduced, Invasive



**Figure 3.** Ecological status of species found in Carranglan Watershed.

*arabica* L. and *Coffea canephora* Pierre ex. Frehn.). There were also three introduced tree species observed at Brgy. Burgos. These trees were planted to reforest the lower part of one of the mountains surveyed (Table 4).

Invasive species are organisms that thrive in new territory where they are free of predators, diseases and resource limitations that may have controlled their population in their native habitats (Cunningham & Cunningham, 2007). The populations of these species grow so large in numbers that they are able to out-compete native species for valuable resources (Pancho & Obien, 1995). Four invasive species—*Chromolaena odorata* (L.) R.M. King & H.E. Robins, *Cyperus iria* L., *Mikania cordata* (Burm. f.) B.L. Rob. and *Urena lobata* Linn.—were observed in some of the stations. These plants were common in grassy area and forest boundaries of the mountains and some individuals were also observed within the forest.

### Biodiversity indicators

A species could be a biodiversity indicator species. It can be one of a species whose presence indicates the presence of a set of other species and whose addition or loss from an ecosystem leads to major changes in abundance or occurrence of at least one species or a species whose presence indicates human-created abiotic conditions. It can also be like dominant species that provides much of the biomass or number of individuals in an area or one

that indicates a particular environmental condition. In addition, an indicator species is a sensitive species that can serve as early warning indicator of environmental changes or species that reflects the effects of a disturbance regime or efficacy of efforts to mitigate disturbance effects (Lindenmayer, Margules, & Botkin, 2000).

Of the 165 species recorded from Barangay Gen. Luna, five species had an indicator value of more than 60%; two species belong to family Arecaceae (*O. horridum* and *P. maculata*); one is a species of bamboo (*D. luconiae*) and two species are trees (*R. gigantea* and *P. luzonensis*). Moreover, four species of plants out of the 163 recorded in Brgy. Burgos showed more than 60% indicator values. Three species—*O. horridum* (Griff.) Scheff., *D. luconiae* (Munro) Merr., and *R. gigantea* (Blume) Miq.—could serve as potential biodiversity indicator species in both the study areas (Table 5).

These species are considered as indicators of biological diversity due to the high number of individuals, frequency, and abundance (Dufrene & Legendre, 1997). These species were usually present in the areas surveyed with large number of individuals, either living close together or growing in wide areas.

Table 5. **Biodiversity indicators species present in Carranglan Watershed<sup>1</sup>**

Area	Species	Indicator value (%)
Brgy. Gen. Luna	<i>Oncosperma horridum</i> (Griff.) Scheff.	86.46
	<i>Dinochloa luconiae</i> (Munro) Merr.	79.27
	<i>Radermachera gigantea</i> (Blume) Miq.	73.02
	<i>Pinanga maculata</i> Porte ex Lemaire	71.66
	<i>Pandanus luzonensis</i> Merr.	66.08
Brgy. Burgos	<i>Radermachera gigantea</i> (Blume) Miq.	75.68
	<i>Mangifera indica</i> L.	72.15
	<i>Dinochloa luconiae</i> (Munro) Merr.	72.03
	<i>Oncosperma horridum</i> (Griff.) Scheff.	67.55

<sup>1</sup> Species with 60% indicator value is a biodiversity indicator (Dufrene & Legendre, 1997)

Table 6. **Major Sources of Environmental Degradation at Carranglan Watershed.**

Sources	Impact value	Interpretation
Fires	2.92	Moderate impact
Kaingin/shifting cultivation	2.76	Moderate impact
Illegal logging/timber poaching	2.69	Moderate impact
Mining	2.67	Moderate impact
Soil erosion/silt run-off	2.66	Moderate impact
Quarrying	2.18	Small impact
Wildlife hunting	2.13	Small impact
Introduced species	1.37	No significant impact

1.00–1.75 = No significant impact      1.76 – 2.50 = Small impact  
2.51 – 3.25 = Moderate impact      3.26 – 4.00 = Major impact

### Threats to plant biodiversity

Seven sources of environmental degradation in Carranglan Watershed were observed and evaluated (Table 6). Five of these showed moderate impacts on the diversity of the forest ecosystems in Carranglan Watershed which include fires, kaingin/shifting cultivation, timber poaching/illegal logging, mining, and soil erosion. Quarrying had small impacts while introduced species had no significant impact in the Carranglan Watershed.

## DISCUSSION

According to Pulhin et al. (2006), the Carranglan Watershed is comprised of 4,023 ha of water reservoir and the climate largely falls under the Philippine Climatic Type I with two pronounced seasons, namely, dry from December to April and wet the rest of the year. The average monthly temperature recorded is at 23.21 °C to 33.71 °C and the average annual relative humidity is 83.37%. The topography of the watershed is characterized by complex land configuration and mountainous, rugged terrain. It ranges from nearly level, undulating and sloping, to steep hilly landscapes. Its soils originated mostly from weathered products of meta-volcanic activities and diorite. Surface soil textures are silty clay loam and clay loam to clay. There are four types of soils in the watershed, namely Annam, Bunga, Guimbaloan, and Mahipon

(Saplaco et al., 2001). These soil types are recommended for trees and forest crops. The major land use types found in Carranglan Watershed are forests, open grasslands and reforestation sites. Due to the physical factors present in Carranglan Watershed, the forest ecosystems are favorable to have good growth for trees and other plants hence, the result of the diversity assessment study is still very high.

Most of the plants observed in the stations were trees, shrubs, and vines. Several herbs, grasses, sedges and mosses were also seen in the study areas. Overall there were 128 tree species, 73 shrubs, 33 vines, four grass species, four sedges, 14 fern species, four mosses, 22 herbs, and 10 orchid/epiphytic species found in the study areas. However, there were six species of plants found to occur in all the stations that were surveyed: *Philodendron lacerum* (Jacq.) Schott., “biakal” [*Dinochloa luconiae* (Munro) Merr.], “yantok” (*Pinanga maculata* Porte ex Lemaire), “yantok” [*Oncosperma horridum* (Griff.) Scheff.], “white lauan” [*Shorea contorta* (Vid.) Merr. and Rolfe] and *Pueraria lobata* (Willd.) Ohwi.

*Philodendron* are rainforest species that grow and develop more during the rainy season. In nature, most *Philodendron* species live on the trunks or branches of trees and do not need soil to survive. A *Philodendron* species' roots are designed to collect rain water during the wet season and suffer through the dry season. But even in the dry season a *Philodendron* sp. can collect enough water from the humidity around their exposed roots to survive (Lucas, n.d.).

*Philodendron lacerum* grows as either an epiphyte (ep-a-FIT) or a hemiepiphytic species. An epiphyte is a species that grows upon the side of branches of a tree as a result of a seed being placed in the tree in the droppings of a bird, animal or bat. A hemiepiphyte (hem-a-EPA-fit) normally begins life as a seed that has fallen to the ground and then climbs the host tree. Hemiepiphytes may also be epiphytic (a plant that begins life on the branch of a tree) and then drop roots to the soil that become firmly established (Lucas, n.d.).

“Biakal” [*D. luconiae* (Munro) Merr.] is a true and climbing bamboo found throughout the Philippines and this plant is a natural component of secondary and disturbed secondary forest at low to medium altitudes. In virgin forests, these plants are found as rare climbers primarily due to the limited light brought about by the closed canopy (PCARRD, 2006).

*Pinanga maculata* Porte ex Lemaire is a solitary medium-sized

palm growing to 4-5m tall with purplish/brown crownshaft. The leaves are large with irregular spaced leaflets, dark green above with large irregular areas of lighter green (Tiger stripes). This is an attractive endemic palm found in the primary forest in the Philippines from low to high altitudes. The juvenile plant is attractive because of its mottled leaves and the mature plant is elegant in form (Vaile, 2014a).

*Oncosperma horridum* (Griff.) Scheff. is found growing wild in lowland forests in the Philippines and indigenous to Indo-China and Malesia ecozone. It is a slender, tall and clustering palm native to rainforests that can reach to about 700m. Its stem is covered in black and downward pointing spines with pinnate leaves (Vaile, 2014b).

*Shorea contorta* (Vid.) Merr. and Rolfe is a large tree found in the lowland seasonal semi-evergreen dipterocarp forest. It is endemic in the Philippines and now considered to be a critically endangered plant based on the IUCN Red List of Threatened Species version 2014.3 (as cited in Ashton, 1998). The white lauan can reach up to a height of about 30-50m. It has brown to nearly black bark, although it can look grey when exposed to bright sunlight. The upper part of the trunk may have distinct longitudinal ridges. This tree belongs to the dipterocarp family, a group of important timber trees that dominate the lowland forests in the Philippines.

However, it is very interesting to note that an introduced species or an invasive plant is already present in all the stations surveyed in the Carranglan Watershed. This plant is the *Pueraria lobata* (Willd.) Ohwi or called "kudzu," a native of Japan. Kudzu is a perennial, trailing or climbing vine of the legume family (DCR—VNPS, n.d.). Dark green leaves, starchy fibrous roots, and elongated purple flowers with a fragrance reminiscent of grapes readily identify this aggressive vine. Rarely flowering, kudzu stems and roots spread out in all directions from root crowns, with new plants beginning every one to two feet at stem nodes. This dense packing of kudzu can result in tens of thousands of plants occupying a single acre of land. Kudzu leaves are hairy beneath, often tri-lobed, and in groups of three on the vine. The  $\frac{1}{2}$  to  $\frac{3}{4}$  inch purple flowers are pea-like in shape and are produced on plants exposed to direct sunlight. Kudzu fruits, present in October and November, are hairy, bean-like pods that produce only a few viable seeds in each pod cluster. It is thought that some seeds can

remain dormant for several years before they germinate. During the peak growing season in early summer, this prolific vine can grow at a rate of a foot a day, easily covering and choking trees and understory vegetation.

A hardy opportunist, kudzu grows in a variety of habitats and environmental conditions, but does best on deep, well-drained, loamy soils. Almost any disturbed area is suitable habitat for this vine. Roadsides, old fields, vacant lots and abandoned yards are all prime spots for new kudzu growth. Where it grows, kudzu has the ability to out-compete and eliminate native plant species for sunlight, moisture, and soil nutrients, thereby upsetting the natural diversity of plant and animal communities. Its extremely rapid growth rate and habit of growing over objects threatens natural areas by killing native vegetation through crowding and shading, and can seriously stifle agricultural and timber production. Because of its hardy nature and lack of natural enemies, kudzu is able to colonize diverse habitats and achieve a widespread distribution (DCR—VNPS, n.d.). This plant can destabilize trees by its weight (up to 400 lbs) and either tips them over or cracks their branches or trunks (Noah, n.d.). *P. lobata* has negative effects on crop production, forestry production and the natural environment, as it smothers existing flora. Once introduced into an area, it is difficult to control or eradicate (EMPP, 2007).

Management and control of this invasive plant should be done before it could affect and harm the endemic and native plant species in the forest ecosystems of Carranglan Watershed. Results reveal that this plant has no significant impact yet in the forest ecosystems of the Carranglan Watershed but in time if no management action will be made this invasive plant can lead to loss of diversity of plants in the watershed.

Biodiversity indicators are quantitative data to measure aspects of biodiversity, ecosystem condition, ecosystem services and drivers of change. They also help us understand how biodiversity is changed over time and space (UNEP—WCMC, n.d.). Biodiversity indicators are those species whose presence or absence affects the biodiversity of a particular area. They can serve as important sources of food for the other species and they can serve as indicators of habitat/ecosystem conditions. Species with more than 60% biodiversity indicator values are considered as biodiversity indicator species.

In this study, three species, *O. horridum* (Griff.) Scheff., *D.*

*luconiae* (Munro) Merr., and *R. gigantea* (Blume) Miq. could serve as potential biodiversity indicator species in both the study areas. The presence of these species is important in determining the habitat/ecosystem condition and the disturbances experienced in the area. The absence of these species may mean that the area is disturbed or is not in good condition anymore. The absence of these species, too, may indicate that the biodiversity in the forest ecosystem is already changing. Hence, biodiversity indicators may form an essential part of monitoring and assessment to give the status of biodiversity in the area.

A number of environmental conditions posed threats to the forest ecosystems in Carranglan. Fires, shifting cultivation and illegal logging or timber poaching, mining and soil erosion showed high values with moderate impacts on the forest ecosystems.

Fires were common especially during the dry season. Often the grassland areas and areas near *kaingin* are the main sources of fires. Fires are also rampant in areas where tall grasses and pine trees co-exist. According to CENRO-Muñoz (2001), these fires are either caused accidentally (e.g. lightning) or intentionally to give way to new *kaingin* areas.

Lands near the foot of the mountain and even in higher areas were used for cultivating vegetables such as beans and eggplants. The soil in these areas is often exposed after harvest season making them vulnerable to soil erosion and landslides during rainy season. Evidence of timber poaching was also observed. There was a time when freshly cut timber was observed in the mountains of Brgy. Burgos. According to the residents, it is legal to cut trees if it is only used for personal use (i.e. for house construction). Wildlife hunting also posed small impact on the forest ecosystem especially in the forested areas in Brgy. Burgos. During the duration of the fieldwork in that area, numerous traps or "silo" were observed. Many of these were newly set-up with fresh bait such as banana. Forest fowl or "labuyo," monitor lizards, wild pigs, deer, and civet cats were the most common animals caught by the people near the area.

Other sources of environmental degradation include mining and quarrying (the operation has ceased according to DENR), soil erosion, and introduced species.

## CONCLUSIONS

Carranglan Watershed has a very diverse flora. The flora present has a lot of economic importance but some are already evaluated as critically endangered such as *Shorea sp.* and *Dipterocarpus gracilis* (Blume). Three species—*O. horridum* (Griff.) Scheff., *D. luconiae* (Munro) Merr., and *R. gigantea* (Blume) Miq.—could serve as potential biodiversity indicator species in the forest ecosystems of Barangays General Luna and Burgos. Anthropogenic activities are the main contributors in the degradation of the forest ecosystem. Fires, shifting cultivation (*kaingin*), illegal logging/timber poaching, mining and soil erosion posed moderate threats to the forest ecosystems of Carranglan. The effects of quarrying such as habitat loss and sedimentation to the lower part of the river posed threats to the forest ecosystem while the presence of introduced species has no significant impact yet in the Carranglan Watershed.

## RECOMMENDATIONS

The research team recommends further studies on the flora of the other areas not surveyed during the duration of the study. These include the forest areas in other mountains present in both barangays. These areas were not surveyed due to their inaccessibility, far distance, and safety issues of the field researchers. It is also recommended that intensive survey on the economic uses of the plants be done with interviews on the local community. Collection of samples is better done during months when trees are most likely to bloom (November to January). This is to make sure that identification of plants will be easier. Moreover, studies on the impact of invasive species should be conducted in the Carranglan Watershed to verify the extent of growth and distribution as well as damage on the endemic and native trees in the watershed. Results could be used as guide in the establishment of ecological tourism spot for forest ecosystems in Central Luzon.

## ACKNOWLEDGMENTS

The authors would like to thank the following: PCAARRD-DOST for the funding support; CENRO-Muñoz for the secondary data they shared; military detachments of the respected barangays for ensuring the safe passage of the research team; and, the National Museum of the Philippines for the identification of several species.

## REFERENCES

- Alberto, A. (2005). *Biodiversity*. Muñoz, Nueva Ecija, Philippines: Environmental Management Institute, Central Luzon State University.
- Ashton, P. (1998). *Shorea contorta*. *The IUCN Red List of Threatened Species. Version 2014.3*. Retrieved from [www.iucnredlist.org](http://www.iucnredlist.org).
- City Environmental and Natural Resources Office-Muñoz. (2001). *Existing land use allocation per barangay*.
- Cunningham, W.P., & Cunningham, M.A. (2007). *Principles of environmental science: Inquiry and application* (4th Ed.). Singapore: McGraw-Hill Education.
- Department of Conservation and Recreation and Virginia Native Plant Society. (n.d.). *Invasive alien plant species of Virginia*. Retrieved from [www.dcr.virginia.gov/natural\\_heritage/documents/fspulo.pdf](http://www.dcr.virginia.gov/natural_heritage/documents/fspulo.pdf)
- Duelli, P., & Obrist, M.K. (2003). Biodiversity indicators: The choice of values and measures. *Agriculture Ecosystems and Environment*. Retrieved from [www.science-direct.com](http://www.science-direct.com)
- Dufrene, M., & Legendre, P. (1997). Species assemblages and indicator species: The need for a flexible asymmetrical approach. *Ecological Monographs*, 67(3), 345-366.
- European Mediterranean Plant Protection (EMPP). 2007.
- International Union for the Conservation of Nature Red List of Threatened Species Version*. (2012). Retrieved from <http://www.iucnredlist.org>
- Lafrankie, J. Jr. (2010). *Trees of tropical Asia: An illustrated guide to diversity*. Philippines: Black Tree.
- Lasco, R.D., Cruz, R.V., Pulhin, J.M., & Pulhin, F.B. (2010). *Assessing climate change impacts, vulnerability and adaptation: The case of Pantabangan-Carranglan Watershed*. Los Baños, Philippines: World Agroforestry Center, College of Forestry and Natural Resources, University of the Philippines at Los Baños.

- Lindenmayer, D.B., Margules, C.R., & Botkin, D.B. (2000). Indicators of biodiversity for ecologically sustainable forest management. *Conservation Biology*, 14.
- Lucas, S. (n.d.). *The exotic rainforest*. Retrieved from [www.exoticrainforest.com/Grow%20or%20Growing%20Philodendrons.html](http://www.exoticrainforest.com/Grow%20or%20Growing%20Philodendrons.html)
- Noah, B. (n.d.). *Kudzu, Pueraria lobata*. Retrieved from <http://sites.google.com/a/rsu5.org/invasive/message/kudzu-pueraria-lobata>
- Pancho, J.V., & Obien, S.R. (1995). *Manual of rice field weeds*. Muñoz, Nueva Ecija, Philippines: Philippine Rice Research Institute.
- Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. (2006). *Philippine climbing bamboos: A potential resource for the furniture and handicraft industry*. Los Baños, Laguna: PCARRD.
- Possingham, H.P., Andelman, S.J., Burgman, M.A., Medellin, R.A., Master, L.L., & Keith, D.A. (2002, November). Limits to the use of threatened species lists. *Trends in Ecology and Evolution*, 17, 11.
- Pulhin, J.M., Peras, R.J.J., Cruz, R.V.O., Lasco, R.D., Pulhin, F.B., & Tapia, M.A. (2006, October). Vulnerability of communities to climate variability and extremes: Pantabangan-Carranglan Watershed in the Philippines. *AIACC Working Paper No. 44*. University of the Philippines at Los Baños.
- Saplaco, S.R., Bantayan, N.C., & Cruz, R.V.O. (2001). *GIS-based ATLAS of selected watersheds in the Philippines*. Philippines: Department of Science and Technology, Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (DOST-PCARRD) & University of the Philippines-Los Baños, College of Forestry and Natural Resources, Environmental Remote Sensing and Geo-Information (UPLB-CFNR-ERSG).
- UNEP-WCMC. (n.d.). *Biodiversity indicators*. Retrieved from [www.unep-wcmc.org/biodiversity-indicators\\_77.html](http://www.unep-wcmc.org/biodiversity-indicators_77.html)
- Vaile, E. (2014). *Oncosperma horridum*. Retrieved from [www.palmpedia.net/wiki/Oncosperma\\_horridum](http://www.palmpedia.net/wiki/Oncosperma_horridum)
- Vaile, E. (2014). *Pinanga maculata*. Retrieved from [www.palmpedia.net/wiki/Pinanga\\_maculata](http://www.palmpedia.net/wiki/Pinanga_maculata)

---

# $\beta$ -MANNANASE ENZYME SUPPLEMENTATION OF GROWER-FINISHER PIG DIETS WITH COPRA MEAL

**Michaelito A. Naldo**

College of Agriculture, Silliman University, Dumaguete City, Philippines

**Ray Rafael S. Bayawa**

Kerry Ingredients & Flavours Thailand Ltd., Bangkok, Thailand

**Beomjun Seo**

CTCBIO Inc., Songpa-gu, Seoul, Korea



The use of copra meal in pig diets is limited due to its high level of non-starch polysaccharides (NSP) particularly  $\beta$ -mannans, which act as anti-nutritional factor causing gut viscosity and consequently poor nutrient digestibility. Supplementation of  $\beta$ -mannanase enzyme to corn-soybean based diets has been found to improve the performance of growing pigs. This study investigated the effect of adding  $\beta$ -mannanase enzyme to grower-finisher pig diets with different levels of copra meal. Five hundred growing pigs (24.52 kg mean BW) were randomly allotted to eight (8) dietary treatments, in a two-stage feeding program namely grower (first 4 weeks), and finisher (succeeding 9 weeks). The first experimental diets in both grower (CM10) and finisher (CM20) stages containing 10 and 20 percent copra meal respectively were not supplemented with  $\beta$ -mannanase enzyme. The next experimental diets in the grower (CM10+MAN) and finisher (CM20+MAN) stages contain the same level of copra meal as in the first but were supplemented with 400 IU of  $\beta$ -mannanase per kg. A third set of experimental diets in the

grower (CM15+MAN) and finisher (CM25+MAN) stages had higher levels of copra meal at 15 and 25 percent respectively, and were also supplemented with 400 IU of  $\beta$ -mannanase per kg. The fourth and last set of experimental diets for the grower (CM10+ME100) and finisher (CM20+ME100) stages contained the same level of copra meal as the first but had additional 100 kcal/kg of metabolizable energy compared to the other experimental diets. Body weight gain, feed intake, and feed per gain in the grower and finisher stages as well as for the whole duration of the study were taken and computed. No significant difference in weight gain was found among treatments in all stages but overall, diets supplemented with  $\beta$ -mannanase enzyme had significantly lower feed intake ( $P < 0.05$ ) and consequently better feed conversion. This study demonstrates the possibility of reducing cost by adding  $\beta$ -mannanase enzyme to diets with high levels of copra meal.

---

**KEYWORDS:** copra meal,  $\beta$ -mannanase enzyme, feed intake

## INTRODUCTION

THE PHILIPPINES IS the top producer of copra in the world at more than 2.7 million metric tons in 2010 alone (Corpuz, 2010). As the raw material in the extraction of coconut oil, copra's major by-product is copra meal, which can be used as a raw material in grower-finisher and breeder (adult) pig diets. However, the use of copra meal in pig diets is limited due to its high fiber content and the presence of high levels of the non-starch polysaccharide (NSP) called  $\beta$ -mannan, which acts as an anti-nutritional factor causing gut viscosity and consequently poor nutrient digestibility. The economic benefits of using higher levels of copra meal in pig diets can be huge for the Philippine swine industry when considering the cheap cost of copra meal in the Philippines.

A few research studies have shown that supplementation with exogenous  $\beta$ -mannanase enzyme has improved the growth performance of newly-weaned and growing-finishing pigs by releasing extra metabolizable energy from diets containing high levels of soybean meal, which contains moderate levels of  $\beta$ -mannan, the same NSP found at high levels in copra meal. No study has been done to determine if the same  $\beta$ -mannanase

enzyme can also work on pig diets with significant levels of copra meal as it did on soybean meal-based diets.

## REVIEW OF LITERATURE

$\beta$ -mannans are non-starch polysaccharides found in some plant cell wall either as glucomannans or galactomannans. The glucomannans are comprised of  $\beta(1-4)$ -linked glucose and mannose units, while galactomannans consists of a  $\beta(1-4)$ -linked mannan backbone substituted with single units of  $\alpha(1-6)$ -linked galactose (Choct, 1997). On a dry matter basis, copra meal contains 25-30%  $\beta$ -mannan as both pure and galactomannan (Sundu, Kumar, & Dingle, 2006).

$\beta$ -mannans have been found to be deleterious to pig performance, compromising weight gain and feed conversion (Rainbird, Low, & Zebrowska, 1984; Nunes & Malmlof, 1992). This deleterious effect of  $\beta$ -mannan is associated with the viscous nature of all NSP's, their physiological and morphological effects on the digestive tract and the interaction with the microflora of the gut. The mechanisms include altered intestinal transit time, modification of the intestinal mucosa, and changes in hormonal regulation due to a varied rate of nutrient absorption (Choct, 1997). It is the inability of pigs to digest the  $\beta(1-4)$  glycosidic bonds in  $\beta$ -mannans due to the lack of the specific enzyme  $\beta$ -mannanase which causes this.

One of the first studies done on the use of pure  $\beta$ -mannanase on pig diets was by Pettey, Carter, Senne, & Shriver in 2002. They worked on a pure  $\beta$ -mannanase enzyme product fermented from *Bacillus lentus* to find out its effect on diets for weanling and growing-finishing pigs. For growing-finishing pigs, they fed sixty pigs (22.5 kg BW) with either a corn-soybean meal based (negative) control diet, the control diet with 2% soybean oil added to increase metabolizable energy (ME) by 100 kcal/kg (positive control), and the control diet with additional 0.05%  $\beta$ -mannanase enzyme product. After feeding the pigs until around 109 kg BW, they observed that addition of  $\beta$ -mannanase increased ADG compared to both the negative control diet and the positive control diet (with added soybean oil). They also observed that pigs fed the positive control diets and  $\beta$ -mannanase had similar feed efficiency. This led them to suggest that  $\beta$ -mannanase may

provide the equivalent energy of 100 kilocalories per kilogram (kcal/kg) of feed.

It was only last year when a study to confirm the work of Pettey, et al. (2002) was done by Bass, Frank, Johnson, Maxwell, & Lee (2010) at the University of Arkansas, using a pure  $\beta$ -mannanase enzyme from *Bacillus* sp. WL-1. In their feeding trial, a total of 140 grower pigs (65 lb body weight) were fed a 3-phase corn-soybean based diet either with a negative control (NC), the NC diet supplemented with 200,000 IU of  $\beta$ -mannanase (MAN2), the NC diet supplemented with 400,000 IU of  $\beta$ -mannanase (MAN4), and with a positive control diet (PC) which is the NC diet containing additional 45.4 kcal/lb (100 kcal/kg) of metabolizable energy from tallow. Pigs fed the PC diets had a 4.1% higher overall average daily gain and 8.5 lb additional body weight at the end of the study compared to pigs fed the NC diet. Diets supplemented with  $\beta$ -mannanase (MAN2 & MAN4) had a lower feed intake in phase 1, phase 2, and over-all, and a lower feed per gain at each level of  $\beta$ -mannanase addition during phase 1 and overall. Although Bass et al. (2010) could not show that  $\beta$ -mannanase supplementation can improve grower-finisher pig performance similar to adding 100kcal/kg of energy in the diet, as shown by Pettey et al. (2002), they were able to show an improvement in energy utilization in pigs fed  $\beta$ -mannanase.

To date, no work has been done to confirm the studies of Pettey et al. (2002) and Bass et al. (2010) using grower-finisher pigs fed diets containing copra meal. For the interest of the swine raising and feedmilling industries in the Philippines where copra meal is a cheap and available feed raw material, a study is needed to find out if significant amounts of metabolizable energy can be extracted from  $\beta$ -mannanase supplemented pig grower and finisher diets containing copra meal.

## MATERIALS AND METHODS

### Animals

Five hundred cross-bred, growing pigs, with a mean weight of 24.52 kg, were randomly allotted to 20 equal groups, with each group randomly allotted to 20 pens of similar size. These pens were randomly allotted to four dietary treatments, each treatment

having five replicates. Each pen with 25 pigs was considered as one experimental unit.

## Experimental Diets

Eight experimental diets were formulated and fed in two stages. The first four iso-nitrogenous diets were fed for the first four weeks, the grower stage; while the other four iso-nitrogenous diets were fed on the succeeding nine weeks, the finisher stage.

In the grower stage, the negative control diet, called CM10, is a grower diet containing 10% copra meal. The next experimental diet (CM10+MAN) is the same diet as CM10 but supplemented with 400 IU of  $\beta$ -mannanase per kg. The next experimental diet (CM15+MAN) is a grower diet containing 15% copra meal supplemented with 400 IU of  $\beta$ -mannanase (CTCZyme) per kg. The last diet, considered the positive control diet (CM10+ME100) is the same diet as CM10 but with the metabolizable energy (ME) content increased by 100 kcal/kg. Diets CM10, CM10+MAN, and CM15+MAN are all iso-caloric. A summary of the experimental diets in the grower stage can be seen in Table 1.

Table 1. **Summary of Experimental Diets in Grower Stage.**

Experimental Diet	Formulation
CM10 (Negative Control)	Grower Diet with 10% Copra Meal
CM10+MAN	Treatment 1 Diet + 400 IU $\beta$ -mannanase
CM15+MAN	Grower Diet with 15% Copra Meal + 400 IU $\beta$ -mannanase
CM10+ME100 (Positive Control)	Treatment 1 Diet + 100 kcal/kg of metabolizable energy

In the finisher stage, the negative control diet, called CM20 is a finisher diet containing 20% copra meal. The next experimental diet (CM20+MAN) is the same CM20 diet but supplemented with 400 IU of  $\beta$ -mannanase (CTCZyme) per kg. The next experimental diet (CM25+MAN) is a finisher diet containing 25% copra meal supplemented with 400 IU of  $\beta$ -mannanase (CTCZyme) per kg. The last diet, considered as the positive control diet (CM20+ME100), is the same CM20 diet but with the metabolizable energy (ME) content increased by 100 kcal/kg. CM20, CM20+MAN, and

CM25+MAN are all iso-caloric. A summary of the experimental diets in the finisher stage can be seen in Table 2.

Table 2. **Summary of Experimental Diets in Finisher Stage.**

Experimental Diet	Formulation
CM20 (Negative Control)	Finisher Diet with 20% Copra Meal
CM20+MAN	Treatment 1 Diet + 400 IU $\beta$ -mannanase
CM25+MAN	Finisher Diet with 25% Copra Meal + 400 IU $\beta$ -mannanase
CM20+ME100 (Positive Control)	Treatment 1 Diet + 100 kcal/kg of metabolizable energy

The  $\beta$ -mannanase enzyme product (CTCZyme) used comes from the fermentation of *Bacillus* sp. WL-1 and is the same enzyme used by Frank et al. in 2009. It was provided by CTCBIO Inc. of Seoul, Korea. All experimental diets did not contain any antibiotic as growth promotant or in-feed medication.

## Data Collection

Initial and final body weights, and feed intake (consumption) per pen, during the grower and finisher stages as well as for the whole duration (overall) of the trial were recorded. Body weight gain per pen was computed based on the recorded initial and final body weights. Based on the feed consumption and weight gain data, the feed conversion ratio (feed per gain) of each pen was computed. The incidence, date and weight of all mortality if any were also recorded. Weight gain of pigs that died before the end of the feeding trial was included in the computation of FCR per pen.

## Statistical Analysis

Treatment effect on body weight gain and feed per gain per pen was determined using Analysis of Variance (ANOVA). Differences among treatment means were considered significant at P values  $<0.05$ . When found significantly different, a t-test would be conducted to determine which particular treatment mean differed from the others (P $<0.05$ ).

Table 3. Mean Performance of Pigs Fed the Four Dietary Treatments<sup>1</sup>

Parameters	Dietary Treatments				P Value <sup>2</sup>
	CM10/CM20	CM10+MAN/ CM20+MAN	CM15+MAN/ CM25+MAN	CM10+ME100/ CM20+ME100	
Body weight gain per pen, kg					
Grower stage	515.80	504.40	517.72	524.70	0.565
Finisher stage	1,122.30	1,078.90	1,073.98	1,128.20	0.611
Overall	1,638.10	1,583.30	1,591.70	1,652.90	0.539
Feed intake per pen, kg					
Grower stage	1,362 <sup>a</sup>	1,266 <sup>ab</sup>	1,170 <sup>b</sup>	894 <sup>c</sup>	.001
Finisher stage	3,720 <sup>a</sup>	3,672 <sup>ab</sup>	3,552 <sup>b</sup>	2,082 <sup>c</sup>	5.26E-15
Overall	5,082 <sup>a</sup>	4,938 <sup>b</sup>	4,722 <sup>c</sup>	2,976 <sup>d</sup>	6.23E-13
Feed per gain					
Grower stage	2.64 <sup>a</sup>	2.52 <sup>ab</sup>	2.26 <sup>b</sup>	1.71 <sup>c</sup>	0.002
Finisher stage	3.33 <sup>b</sup>	3.42 <sup>a</sup>	3.31 <sup>a</sup>	1.85 <sup>b</sup>	5.4E-09
Overall	3.11 <sup>ab</sup>	3.12 <sup>a</sup>	2.97 <sup>b</sup>	1.81 <sup>c</sup>	1.08E-09

<sup>1</sup> A total of 500 grower pigs with a mean weight of 24.52 kg were used at the beginning of the 13-week study (25 pigs per pen, 5 pens per treatment, 4 treatments). Grower stage (first 4 weeks) used iso-nitrogenous diets among four treatments, and finisher stage (next 9 weeks) also used iso-nitrogenous diets among four treatments. Grower stage CM10 diet had 10% copra meal without  $\beta$ -mannanase. Grower stage CM10+MAN diet had 10% copra meal with 400 IU of  $\beta$ -mannanase. Grower stage CM15+MAN diet had 15% copra meal with 400 IU of  $\beta$ -mannanase. Grower stage CM10+ME100 diet had 10% copra meal but was 100 kcal/kg higher in metabolizable energy compared to the other treatments. Finisher stage CM20 diet had 20% copra meal without  $\beta$ -mannanase. Finisher stage CM20+MAN diet had 20% copra meal with 400 IU of  $\beta$ -mannanase. Finisher stage CM25+MAN diet had 25% copra meal with 400 IU of  $\beta$ -mannanase. Finisher stage CM20+ME100 diet had 20% copra meal but was 100 kcal/kg higher in metabolizable energy compared to the other treatments.

<sup>2</sup> Data were analyzed using ANOVA with 2 factors, where 1 factor is the pen or replicate (considered as blocking factor) and the other is the treatment. Means within a row without a common superscript letter are significantly different ( $P < 0.05$ ).

## Time and Place of Study

Feeding trial for this study was done at Tecolu Farms in Calinan, Davao City from March to May 2011.

## RESULTS

Table 3 shows the mean performance of pigs fed the four experimental diets and the corresponding P values from the ANOVA.

### Grower Stage

At the end of the grower stage, all pigs had a mean body weight of 45.59 kg. Body weight gain during the grower stage was not significantly different among treatments although pigs on the positive control diet (CM10+ME100) had the highest body weight gain.

However, feed intake in the grower stage was significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diet (CM10+ME100) consuming significantly the least amount of feed. Pigs on the negative control diet (CM10) consumed the most followed by pigs on CM10+MAN although not significantly different. Pigs on CM15+MAN had the next lower feed intake consuming significantly lesser than pigs on CM10 but not significantly lesser than pigs on CM10+MAN.

As a result of the significantly different feed intake among treatments in pigs during the grower stage, feed per gain was likewise significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diet (CM10+ME100) giving the significantly lowest feed consumption per gain in weight of 1.71. As in feed intake, pigs on the negative control diet (CM10) had the highest feed per gain followed by pigs on CM10+MAN and then pigs on CM15+MAN. Feed per gain of pigs on CM10+MAN was not significantly lower than pigs on the negative control diet (CM10) and was not significantly higher than pigs on CM15+MAN, which had a significantly lower feed per gain than pigs on the negative control diet (CM10).

## Finisher Stage

At the end of the finisher stage, all pigs had a mean body weight of 92.95 kg. As in the grower stage, body weight gain during the finisher stage was not significantly different among treatments with pigs on the positive control diet (CM20+ME100) having the highest body weight gain.

Similar to the grower stage, feed intake during the finisher stage was likewise significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diet (CM20+ME100) consuming the significantly least amount of feed. Pigs on the negative control diet (CM20) consumed the most followed by pigs on CM20+MAN although not significantly different. Pigs on CM25+MAN had the next lower feed intake consuming significantly lesser than pigs on the negative control diet (CM20) but not significantly lesser than CM20+MAN.

As in the grower stage, feed per gain during the finisher stage was likewise significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diet (CM20+ME100) giving the significantly lowest feed consumption per gain in weight of 1.85. However, feed per gain of pigs on the negative control diet (CM20), CM20+MAN and CM25+MAN did not differ significantly.

## Overall

When combining both grower and finisher stages, overall body weight gain was not significantly different among treatments with pigs on the positive control diets (CM10+ME100/CM20+ME100) showing the highest body weight gain.

Overall feed intake was significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diets (CM10+ME100/CM20+ME100) consuming the significantly least amount of feed. Pigs on the negative control diets (CM10/CM20) had the significantly highest feed intake, followed significantly by pigs on CM10+MAN/CM20+MAN, and then followed significantly by pigs on CM15+MAN/CM25+MAN.

Due to the significant difference in overall feed intake, overall feed per gain was significantly different among treatments ( $P < 0.05$ ) with pigs on the positive control diets (CM10+ME100/CM20+ME100) giving the significantly lowest feed consumption

per gain in weight of 1.81. It is interesting to note however, that pigs on CM15+MAN/CM25+MAN had a significantly lower overall feed per gain compared to pigs on CM10+MAN/CM20+MAN. Although not significantly different, this is also true in both the grower and finisher stages.

## DISCUSSION

Contrary to the findings of Pettey et al. (2002), body weight gain of pigs was not increased significantly when given  $\beta$ -mannanase supplemented diets or the positive control diets (with additional 100 kcal/kg of ME), although pigs given the positive control diets gave the numerically highest body weight gain in the grower and finisher stages as well as overall.

An increase in dietary energy concentration is usually associated with a reduction of voluntary feed intake (Noblet, 2006). The decreasing trend in feed intake observed among pigs from those consuming the negative control diets (CM10/CM20), followed respectively by  $\beta$ -mannanase supplemented diets with increasing copra meal level (CM10+MAN/CM20+MAN and CM15+MAN/CM25+MAN) could only be explained by an increasing dietary energy concentration. The increasing level of  $\beta$ -mannans available for degradation by  $\beta$ -mannanase enzyme in these diets could have been the source of additional mannose (monosaccharide) moieties available for energy use.

Bass et al. (2010) also observed this declining feed intake when they increased  $\beta$ -mannanase supplementation from 0 to 200,000 IU, and 400,000 IU per ton. In their study however, it was the level of supplementation that was increased, while the amount of substrate remained the same.

Pettey et al. (2002) described a similar decrease in feed intake among pigs when 100 kcal/kg of ME from soybean oil was added to the diet. Bass et al. (2010), on the other hand, did not observe this when 100 kcal/kg of ME from tallow was added. In this study the 100 kcal/kg ME added to the positive control diets came from coconut oil. The different properties of the oil/fat used in these three studies might explain why pigs performed differently in the positive control diets.

Tallow contains almost equal amounts of saturated (52.1%) and unsaturated (47.9) fatty acids, 88% of which are long-chain

(with more than or equal to 16 carbons). Soybean oil contains predominantly unsaturated (84.9%) fatty acids, 95.1% of which are long-chain (with more than or equal to 16 carbons) like tallow. Coconut oil, unlike tallow and soybean oil contains predominantly saturated (91.9%) fatty acids, 75.5% of which are medium-chain fatty acids (with 10 to 14 carbons) (NRC, 1998). Unlike long-chain fatty acids, medium-chain fatty acids supply a quick source of energy when supplied in the diet, because they have a smaller molecular size, and thus are hydrolyzed and absorbed faster in the intestinal mucosa (Back & Babayan, 1982). Medium-chain fatty acids leave the intestinal mucosa by the portal venous system whereas long-chain fatty acids follow the lymphatic system, thus medium-chain fatty acids reach the liver more rapidly. Furthermore in the liver, medium-chain fatty acids cross the double mitochondrial membrane very rapidly because unlike long-chain fatty acids, they do not require the presence of carnitine to cross the mitochondrial membrane. (Bremer, 1980). It is inside the mitochondria where fatty acids undergo  $\beta$ -oxidation to produce acetyl-Coa which subsequently enters the Krebs cycle to produce energy in the form of ATP.

The unique metabolic pathway taken by the medium-chain fatty acids in coconut oil could be the reason why Cera, Mahan, & Reinhart (1989) observed that coconut oil had the highest apparent fat digestibility compared to corn oil and tallow in pigs 4 weeks post-weaning. Pigs fed coconut oil also had a higher weight gain than those fed tallow or corn oil. Corn oil also contains predominantly long-chain fatty acids. Using newly weaned pigs (4.9 kg BW), Li, et al. (1990) compared coconut oil with soybean oil and several coconut and soybean oil combinations. They observed that from 0 to 35 days post weaning, pigs fed coconut oil alone had higher ADG and better feed efficiency.

The feed intake of pigs fed the positive control diets in this study cannot be compared to the feed intake of pigs fed the positive control diets in the study of Pettey et al. (2002) and Bass et al. (2010) because the type of oil used to provide the additional 100 kcal/kg of ME was different. Furthermore, the strategy of using coconut oil to provide additional energy to the positive control diet may have affected feed intake not as a result of the additional 100 kcal/kg ME but due to the unique metabolic pathway taken by its medium-chain fatty acids during digestion and metabolism. Future studies which seek to determine the effect of increasing

the energy concentration of feed should not use coconut oil as a source of additional energy.

## IMPLICATIONS

This study has shown that  $\beta$ -mannanase enzyme supplementation of pig diets with high levels of copra meal reduces feed intake but is able to maintain growth rate, consequently improving feed conversion.  $\beta$ -mannanase enzyme supplementation therefore allows the possibility of using higher levels of copra meal in pig grower and finisher diets for the purpose of reducing feed cost while maintaining growth performance.

## ACKNOWLEDGMENT

This study was funded by CTCBIO Incorporated, a South Korean food and feed additive company with headquarters at Sambo Bldg. 2F, 296 Jungdae-ro, Songpa-gu, Seoul, 138-858, Korea, in cooperation with their Philippine distributor, Equalivet Incorporated, located at 18 Betty Go Belmonte St., New Manila, Cubao, Quezon City, Philippines.

## REFERENCES

- Back, A. C. & Babayan, V.G. (1982). Medium-chain triglycerides: An update. *Am. J. Clin. Nutr.* 36, 950.
- Bass, B.E., Frank, J.W., Johnson, Z.B., Maxwell, C.V., & Lee, J.H. (2010). Effect of dietary mannanase supplementation on pig growth performance. *University of Arkansas Animal Science Department Report 2010*, 80-81.
- Bremer, J. (1980). Carnitine and its role in fatty acid metabolism. *Trends Biochem Sci.* 2, 207-9.
- Cera, K.R., Mahan, D. C., & Reinhart, G. A. (1989). Apparent fat digestibilities and performance responses of post-weaning swine fed diets supplemented with coconut oil, corn oil or tallow. *J Anim Sci*, 67, 2040-2047.
- Choct, M. (1997, June). Feed NSP—Chemical structure and nutritional significance. *Feed Milling International*, 13-26.
- Corpuz, P.G. (2010). Philippines oilseeds situation and outlook. Global Agricultural Information Network. Retrieved from [http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Oilseeds%20and%20Products%20Annual\\_Manila\\_Philippines\\_5-18-2010.pdf](http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Oilseeds%20and%20Products%20Annual_Manila_Philippines_5-18-2010.pdf)

- Li, D.F., Thaler, R.C., Nelssen, J.L., Harmon, D.L., Allee, G.L. & Weeden, T.L. (1990) Effect of fat sources and combinations on starter pig performance, nutrient digestibility and intestinal morphology. *J Anim Sci*, 68, 3694-3704.
- Noblet, J. (2006). Nutrition of the growing pig: adaptation of diet characteristics to animal and environment conditions. *American Soybean Association International Marketing Southeast Asia. Swine Nutrition & Management: Technical Report Series 2006*, 60-68.
- National Research Council. (1998). *Nutrient requirements of swine* (10th Ed.). Washington, D.C.: National Research Council.
- Nunes, C.S. & Malmlof, K. (1992). Effects of guar gum and cellulose on glucose absorption, hormonal release and hepatic metabolism in the pig. *British Journal of Nutrition*, 68, 693-700.
- Petty, L.A., Carter, S.D., Senne, B.W., & Shriver, J.A. (2002). Effects of beta-mannanase addition to corn-soybean meal diets on growth performance, carcass traits, and nutrient digestibility of weanling and growing-finishing pigs. *J Anim Sci*, 80, 1012-1019.
- Rainbird, A.L., Low, A.G., & Zebrowska, T. (1984). Effect of guar gum on glucose and water absorption from isolated loops of jejunum conscious in growing pigs. *British Journal of Nutrition*, 52, 489-498.
- Sundu, B., Kumar, A., & Dingle, J. (2006). Response of broiler chicks fed increasing levels of copra meal and enzymes. *International Journal of Poultry Science*, 5(1), 13-18.

---

# CIGARETTE SMOKING IN FILIPINO SEXUAL-MINORITY MEN: FURTHER EVIDENCE OF DISPARITIES IN THE PHILIPPINES

**Eric Julian Manalastas**

University of the Philippines Diliman & George Washington University

**Nicolo L. Cabrera**

John H. Stroger, Jr. Hospital of Cook County



Empirical studies in lesbian, gay, bisexual, and transgender (LGBT) health have documented significant disparities in risk behaviors and health outcomes across sexual orientation and gender identity. One such disparity lies in tobacco use. Surveys based on representative samples (Jabson, Farmer, & Bowen, 2014; Manalastas, 2012; Tang et al., 2004) as well as meta-analyses (Lee, Griffin & Melvin, 2009; Marshal et al., 2008) indicate that gender and sexual minorities generally have disproportionately higher rates of smoking than heterosexuals. This paper builds on previous research in the Philippines that presented initial evidence for cigarette smoking disparities among sexual-minority youth (Manalastas, 2012). We examine this issue again using a different nationally representative sample of Filipino men. Analysis of archival data from the National Demographic and Health Survey showed evidence for disparities in tobacco use based on sexual-minority status. Current smoking was disproportionately higher among sexual-minority men (67%) than heterosexual men (54%). Filipino sexual-minority men also began smoking significantly earlier—about a year—than heterosexual men.

No differences in smoking volume was found—both sexual-minority and heterosexual Filipino male smokers smoked an average of 10-11 sticks a day. The findings point to one important disparity in Filipino LGBT health risks: the need to address the disproportionately higher uptake of tobacco use, one of the leading preventable causes of morbidity and mortality in the world, among sexual-minority Filipino men.

---

**KEYWORDS:** cigarette smoking, tobacco use, health disparities, sexual minority men, LGBT health

RESEARCH ON LESBIAN, gay, bisexual, and transgender (LGBT) health has documented significant disparities in health risk behaviors and outcomes across sexual orientation and gender identity (Bogart, Revenson, Whitfield, & France, 2014; IOM, 2011). One particular disparity lies in what is considered by the World Health Organization as one of the leading preventable causes of morbidity and mortality: cigarette smoking. Robust evidence from the past two decades point to disproportionately higher rates of cigarette smoking among sexual minority men and women in the US and other countries, compared to the heterosexual population (Lee, Griffin, & Melvin, 2009; Lee, Blosnich, & Melvin, 2012).

In this paper we build on prior work in the Philippines that presented first evidence for cigarette smoking disparities among sexual minority young women ages 15 to 24, but not among young men (Manalastas, 2012). We begin with a short review of the current literature in global LGBT health on cigarette smoking, followed by a focus on the tobacco use situation in the Philippines. We present a secondary analysis of archival data for an expanded age range of Filipino men, including young and older adults, to examine disparities in cigarette smoking for sexual minority Filipino men. Implications for global LGBT health and LGBT health in the Philippines in particular are discussed.

### **Cigarette Smoking in Sexual Minorities**

Lesbians, gay men, and bisexual people smoke more than the heterosexual population. Research from 1987 to the 1990s initially documented this disparity, though these earlier studies were limited by a reliance on small convenience samples (Ryan, Wortley,

Easton, Pederson, & Greenwood, 2001). As interest in this aspect of LGBT health grew, more evidence based on larger, representative samples accumulated indicating that higher rates of cigarette smoking could be found among sexual minorities (Jabson et al., 2014). Researchers have documented these findings among sexual minority adolescents (e.g., Corliss et al., 2014; Rosario et al., 2014), emerging adults (e.g., Blosnich & Horn, 2011), and older adults (e.g., Fredriksen-Goldsen, Kim, Barkan, Muraco, & Hoy-Ellis, 2013) as well as across a wide array of research designs and analytic strategies including longitudinal designs (e.g., Corliss et al., 2013; Newcomb, Heinz, Birkett, & Mustanski, 2013), diary methods (Pachankis, Hatzenbuehler, & Starks, 2014), multilevel ecological modelling (Hatzenbuehler, Jun, Corliss, & Austin, 2013), and path analysis (Balsam, Beadnell, & Riggs, 2012). The general pattern also appears to be robust across different measures of cigarette smoking (Lee et al., 2012; Marshal et al., 2008). And although data on gender-minority populations are lacking (IOM, 2011), there is some evidence of similar disparities among transgender and genderqueer individuals (Clarke & Coughlin, 2012).

The overall theme in this rapidly growing body of literature is that lesbian, gay, bisexual, and likely also transgender individuals are at higher risk for the harmful effects of cigarette smoking. Indeed some studies now show evidence that sexual minority populations may have higher odds of ARIs (acute respiratory illnesses) such as strep throat infection, sinus infection, asthma, and bronchitis (Blosnich, Jarrett, & Horn, 2010) as well as higher CVD (cardiovascular disease) risk (Hatzenbuehler, McLaughlin, & Slopen, 2013), in part due to higher rates of tobacco use.

### **Intersectionality: Who—and Where—Are These “LGBT” Smokers?**

Despite the strong evidence for risk behavior disparities related to cigarette smoking along sexual minority status, one limitation of the current body of literature is its geographic bounds: nearly all the published studies, at least those in peer-reviewed publications, come from LGB and heterosexual samples in the United States. According to the analytic perspective of intersectionality (Cole, 2009), a key question to ask when posing questions about the experiences, including health risk experiences, of social groups such as lesbian, gay, and bisexual people is “Who is included

within this category?" This analytic test, the first of three proposed by Cole (2009) as a means to sensitize researchers interested in addressing intersectional questions, draws attention to diversity within categories, including those subpopulations who may be systematically underrepresented or glossed over in the literature. This raises the question of how well sexual minority youth and adults who live in the USA with its particular sociocultural, historical, and legal contexts represent the health situation for sexual minority youth and adults overall. We argue that this issue is in large part an empirical matter that can be addressed by examining LGBT and other sexual and gender minority populations across different cultures and nation-states, beyond the borders of the USA.

The project of global LGBT health knowledge, especially on cigarette smoking disparities, has begun, led by researchers interested in unpacking the category of "LGB people" beyond "LGB people in the USA." Researchers internationally have now collected evidence for higher cigarette smoking based on sexual orientation in Canada (Clarke & Coughlin, 2012), Sweden (Lindström, Axelsson, Modén, & Rosvall, 2014), Mexico (Ortiz-Hernández, Gómez Tello, & Valdés, 2009), China (Berg et al., 2011; Yu et al., 2013), and in the Philippines (Manalastas, 2012). This paper contributes to this international body of literature by extending previous findings from the Philippines that show cigarette smoking disparities for sexual minority Filipinos versus the general population.

### **Cigarette Smoking in the Philippine Context**

According to the World Health Organization (2011), tobacco use in its most common form of cigarette smoking is "the gender-linked behavior with the greatest public health significance" (p. 1). In developing countries in Southeast Asia, tobacco use is a highly gendered health risk behavior—men's rates for smoking are triple or even quadruple the rates for women (Morrow & Barraclough, 2003).

In the Philippines, where the tobacco-farming industry plays a considerable cultural and economic role, cigarette smoking is much higher among men than women. The best available evidence comes from the 2009 Philippines Global Adult Tobacco Survey (GATS), a nationally representative survey of Filipinos ages 15

years and older administered by the government's Department of Health and National Statistics Office, with support from the WHO and the US Centers for Disease Control and Prevention. Data from a multi-stage geographically clustered sample of 9,705 Filipinos indicate large gender disparities: men (48%) smoke more than women (9%). More Filipino men smoked daily (38%) than women (7%). The average age of initiation into cigarette smoking was 17.4 years for men, earlier than for women (19.1 years). And among current smokers, men reported higher average smoking volume (11.3 sticks per day) than women (7.0 sticks per day). Across multiple measures of cigarette smoking, men in the Philippines smoke more.

Unfortunately data on sexual orientation were not collected in the GATS, so analysis of LGB disparities was not possible. Applying the first heuristic intersectional question of who are included in this category of "Filipino men," an analysis was conducted using data from the 2003 Young Adult Fertility and Sexuality Survey (YAFS3), a nationally representative survey of Filipino young adults ages 15 to 24 (Manalastas, 2012). Because YAFS3 included items on sexual behavior and romantic relationships, disaggregation on sexual minority status was possible. Findings from this study indicated that young sexual minority women in the Philippines were more likely to be smokers (24%) than their heterosexual counterparts (17%) and to smoke at higher volumes (5.2 versus 3.9 sticks per day). Smoking prevalence was much higher among Filipino gay, bisexual, and other young men who had sex with men (71%), though not significantly different from heterosexual men (69%). No differences in smoking volume was found (sexual minority men and their heterosexual counterparts smoked averages of 7.8 and 7.6 sticks per day, respectively). On the other hand, Filipino sexual minority men reported having their first cigarette at a younger age (mean of 15.8 years), significantly earlier than their heterosexual male counterparts (mean of 16.2 years). Overall, this initial investigation into cigarette smoking among LGB youth in the Philippines indicated similar disparities as found in the US literature and elsewhere, especially for sexual minority young women.

## **Problem**

The present study aimed to replicate and extend the previous

findings on sexual minority cigarette smoking in the Philippines using a different, but likewise nationally representative, dataset with an expanded age sample of Filipino men. In particular, we sought to determine whether gay, bisexual, and other men who have sex with men in the Philippines have disproportionately higher rates of cigarette smoking than their heterosexual counterparts.

## METHOD

### Dataset

The National Demographic and Health Survey (NDHS) is an interview-based structured survey conducted by the Philippine National Statistics Office (NSO). The NDHS is a survey whose original intent is to collect national data for calculating demographic rates, analyze factors and trends in fertility, measure levels of contraceptive knowledge and practice, collect data on knowledge of sexually transmitted infections including HIV/AIDS, and provide information on overall Filipino physical and sexual health. For this paper, we used the publicly accessible archived men's data from the 2003 NDHS; this is the first and last time data collected from Filipino men (subsequent NDHS surveys in 2008 and in 2012 were focused exclusively on women respondents, with no data on sexual orientation collected). The men's questionnaire was administered to 5,009 Filipino men ages 15 to 54 years old eligible for interview, with 4,776 successfully surveyed (response rate of 95%).

### Variables

Sexual orientation was assessed in the NDHS dataset using a one-item sexual behavior measure that asked respondents if they had ever had sex with another man (yes or no). Filipino men who answered yes to this question were classified as sexual minority men (5.16% of the total analytic sample); this sexual behavior measure is the second most common operationalization of sexual minority status in the health literature after self-identification (Blosnich, Lee, & Horn, 2013; Young & Meyer, 2005) and is the only available one in the NDHS dataset. Three items assessed

tobacco use among respondents: (1) self-identification as a current cigarette smoker, (2) number of sticks smoked in the past 24 hours, and (3) age of initiation into cigarette smoking.

## RESULTS

About half of Filipino men (54.6%) reported being cigarette smokers. Contrary to what was previously found in a young adult sample from the Philippines but consistent with the global LGBT health literature, there was a significant disparity in smoking prevalence along sexual orientation. Disproportionately more sexual minority men reported smoking (66.7%) than their heterosexual counterparts (53.9%),  $\chi^2(1) = 15.3, p < .001$ .

In terms of early initiation into smoking, Filipino sexual minority men began smoking cigarettes about one year earlier than heterosexual men, a finding consistent with previous results in the young adult study. Age of initiation into smoking for gay, bisexual, and other men who have sex with men was 16.32 years,  $SD = 3.69$  (95% CI = 15.82 - 17.01) while heterosexual counterparts first tried cigarettes at mean age of 17.32 years,  $SD = 4.12$  (95% CI = 17.22 - 17.54),  $t(3928) = 3.36, p < .001$ .

No differences in smoking volume was found, as in the previous study. Both sexual-minority and heterosexual Filipino male smokers smoked an average of 10 to 11 sticks, or about half a pack, in the past 24 hours preceding data collection.

## DISCUSSION

Analysis of nationally representative Philippine archival data showed evidence for disparities in men's cigarette smoking along sexual-minority status. Disproportionately more Filipino sexual minority men were currently smoking than heterosexual men. They also began smoking significantly earlier—about a year into their teenage years—than heterosexual counterparts. No differences in smoking volume was found; both sexual minority and heterosexual Filipino male smokers smoked about half a pack of cigarettes in the past day before the survey.

These results corroborate and extend previous findings in both the global LGBT health literature and in a previous study

of young adults in the Philippines—that significant disparities exist for sexual minorities in cigarette smoking, one of the leading preventable causes of morbidity and mortality in the world (Bogart et al., 2014; IOM, 2011; Manalastas, 2012). More specifically, the findings in this analysis contribute to the body of empirical evidence that gay and bisexual men and other men who have sex with men are at higher risk for cigarette smoking—in the United States, Canada, Sweden, Mexico, China, and the Philippines.

The next step after establishing the prevalence of LGBT health problems like tobacco use and the existence of LGBT health disparities is to investigate the causal pathways that lead to such disparities (Blosnich et al., 2013). A number of factors have been proposed by US researchers for LGBT disparities in cigarette smoking. These include: [1] anti-LGBT stigma, both at structural and individual levels (Hatzenbuehler et al., 2013; Pachankis, Hatzenbuehler, & Starks, 2014), [2] social norms in LGBT social spaces that promote cigarette smoking (Holloway et al., 2012), [3] distress and mental health problems that are mistakenly perceived to be alleviated by tobacco use (Jabson et al., 2014; Newcomb et al., 2013; Rosario, Schrimshaw, & Hunter, 2011), and [4] targeted marketing of LGBT communities by the tobacco industry (Balsam et al., 2012). Future investigations in the Philippines and other developing countries can look into these potential factors, in order to tease out cross-culturally shared as well as culturally specific pathways to LGBT smoking disparities. In particular, examining the cultural contexts of anti-LGBT stigma in the Philippines and its possible links to risk behaviors like cigarette smoking may be a fruitful starting point. Though being gay is not criminalized in the Philippines as in neighboring Southeast Asian countries like Singapore or Malaysia, no national laws exist that protect sexual minority Filipinos from anti-LGBT discrimination in education, employment, housing, or health care (UNDP, USAID 2014). There is no legal recognition of same-sex partnerships, and moral exclusion of LGBT individuals, communities, and families is not uncommon in this predominantly Roman Catholic developing country.

## Limitations

As with all secondary analysis of archival data, there are a number of limitations in the current paper; here we identify four. First,

sexual minority status was measured using only a single item sexual behavior question that asked respondents if they have sex with other men. Such single-indicator measures tap only into one aspect of sexual orientation and may not fully capture sexual minority respondents, including those who are not sexually active (Korchmaros, Powell, & Stevens, 2013). Second, the current data did not differentiate between gay and bisexual men, nor look into more culturally indigenous conceptualizations of sexual orientation in Philippines society like the category of *bakla* (Garcia, 2013). Third, current cigarette smoking was measured using a relatively straightforward self-report item that asked if a respondent currently smoked or not, without specifying what “current smoker” means; future researchers should consider adopting standardized definitions of current smoking for greater comparability, such as the US Centers for Disease Control and Prevention definition (*i.e.*, having smoked at least 100 cigarettes in one’s lifetime and smokes every day or on most days). Fourth, it is unknown how smoking disparities have increased, decreased or remained the same in the years following the original NDHS data collection; an important next step is to integrate sexual orientation data collection tool in current research on cigarette smoking in the Philippines.

### **Implications for Practice and Policy**

Evidence for higher prevalence of cigarette smoking among Filipino gay, bisexual, and other men who have sex with men should prompt medical practitioners working with sexual minority male patients to include routine screening for cigarette smoking and its associated cardiovascular, respiratory, and other consequent diseases. This is especially important as research elsewhere suggests that gay men themselves may not perceive cigarette smoking to be a significant health concern, especially compared to HIV infection and sexual health (Groves, Ventuneac, Rendina, Jimenez, & Parsons, 2013).

In terms of policy and programs, the present findings join more general evidence in the Philippines that public health interventions for cigarette smoking would do well to incorporate both a gender and a sexuality lens. Cigarette smoking is higher for Filipino men than women and highest for Filipino sexual minority men. Public health messaging by the Philippine Department of Health

and curricular inclusion of lessons on the problem of tobacco use by the Department of Education can include information about how cigarette smoking disproportionately affects some Filipinos more than others, including sexual minorities. Inclusion of sexual orientation and gender identity items in the Philippines Global Adult Tobacco Survey is likewise critical in order to provide more nuanced data on Filipino LGBT smoking (including tobacco-related expenditures, second-hand smoke exposure, and quitting). Finally, reduction and cessation interventions that specifically target LGBT communities and are tailored to their needs, contexts, and concerns have been found to be useful and more effective than one-size-fits-all approaches (Dickson-Spillmann, Sullivan, Zahno, & Schaub, 2014); such interventions may compliment broader government-led initiatives to address the serious but neglected problem of cigarette smoking by LGBT and non-LGBT people in the Philippines.

### AUTHORS' NOTE

A previous version of this paper was presented at the 2014 Annual Scientific Conference of the Philippine Population Association. We thank Alyssa Zucker of George Washington University's LGBT Health Policy and Practice Programme as well as an anonymous reviewer for comments and feedback. Correspondence may be sent to Eric Manalastas, Department of Psychology, Lagmay Hall, University of the Philippines Diliman, Quezon City, Philippines 1101, or email: ejmanalastas@kssp.upd.edu.ph

### REFERENCES

- Balsam, K. F., Beadnell, B., & Riggs, K. R. (2012). Understanding sexual orientation health disparities in smoking: A population-based analysis. *American Journal of Orthopsychiatry*, 82(4), 482-493.
- Berg, C. J., Nehl, E. J., Wong, F. Y., He, N., Huang, Z. J., Ahluwalia, J. S., & Zheng, T. (2011). Prevalence and correlates of tobacco use among a sample of MSM in Shanghai, China. *Nicotine & Tobacco Research*, 13(1), 22-28.
- Blosnich, J. R., & Horn, K. (2011). Associations of discrimination and violence with smoking among emerging adults: Differences by gender and sexual orientation. *Nicotine & Tobacco Research*, 13(12), 1284-1295.
- Blosnich, J., Jarrett, T., & Horn, K. (2010). Disparities in smoking and acute respiratory illnesses among sexual minority young adults. *Lung*, 188, 401-

407.

- Blosnich, J., Lee, J. G. L., & Horn, K. (2013). A systematic review of the aetiology of tobacco disparities for sexual minorities. *Tobacco Control, 22*, 66-73.
- Bogart, L. M., Revenson, T. A., Whitfield, K. E., & France, C. R. (2014). Introduction to the special section on lesbian, gay, bisexual, and transgender (LGBT) health disparities: Where we are and where we're going. *Annals of Behavioral Medicine, 47*, 1-4.
- Clarke, M. P., & Coughlin, J. R. (2012). Prevalence of smoking among the lesbian, gay, bisexual, transsexual, transgender and queer (LGBTQ) subpopulations in Toronto—The Toronto Rainbow Tobacco Survey (TRTS). *Canadian Journal of Public Health, 103*(2), 132-136.
- Cole, E. R. (2009). Intersectionality and research in psychology. *American Psychologist, 64*(3), 170-180.
- Corliss, H. L., Rosario, M., Birkett, M. A., Newcomb, M. E., Buchting, F. O., & Matthews, A. K. (2014). Sexual orientation disparities in adolescent cigarette smoking: intersections with race/ethnicity, gender, and age. *American Journal of Public Health, 104*(6), 1137-1147.
- Corliss, H. L., Wadler, B. M., Jun, H., Rosario, M., Wypij, D., Frazier, A. L., & Austin, S. B. (2013). Sexual-orientation disparities in cigarette smoking in a longitudinal cohort study of adolescents. *Nicotine & Tobacco Research, 15*(1), 213-222.
- Dickson-Spillmann, M., Sullivan, R., Zahno, B., & Schaub, M. P. (2014). Queer quit: A pilot study of a smoking cessation programme tailored to gay men. *BMC Public Health, 14*, 126-133.
- Fredriksen-Goldsen, K. I., Kim, H., Barkan, S. E., Muraco, A., & Hoy-Ellis, C. P. (2013). Health disparities among lesbian, gay, and bisexual older adults: Results from a population-based study. *American Journal of Public Health, 103*(10), 1802-1809.
- Garcia, J. N. (2013). Nativism or universalism: Situating LGBT discourse in the Philippines. *Kritika Kultura, 20*, 48-68.
- Grov, C., Ventuneac, A., Rendina, H. J., Jimenez, R. H., & Parsons, J. T. (2013). Perceived importance of five different health issues for gay and bisexual men: Implications for new directions in health education and prevention. *American Journal of Men's Health, 7*, 274-284.
- Hatzenbuehler, M. L., Jun, H., Corliss, H. L., & Austin, S. B. (2013). Structural stigma and cigarette smoking in a prospective cohort study of sexual minority and heterosexual youth. *Annals of Behavioral Medicine, 47*, 48-56.
- Hatzenbuehler, M. L., McLaughlin, K. A., & Slopen, N. (2013). Sexual orientation

- in cardiovascular biomarkers among young adults. *American Journal of Preventive Medicine*, 44(6), 612-621.
- Holloway, I. W., Traube, D. E., Rice, E., Schrager, S. M., Palinkas, L. A., Richardson, J., & Kipke, M. D. (2012). Community and individual factors associated with cigarette smoking among young men who have sex with men. *Journal of Research on Adolescence*, 22(2), 199-205.
- IOM (Institute of Medicine). (2011). *The health of lesbian, gay, bisexual, and transgender people: Building a foundation for better understanding*. Washington, DC: The National Academies Press.
- Jabson, J., M., Farmer, G. W., & Bowen, D. J. (2014). Stress mediates the relationship between sexual orientation and behavioral risk disparities. *BMC Public Health*, 14, 401-409.
- Korchmaros, J. D., Powell, C., & Stevens, S. (2013). Chasing sexual orientation: A comparison of commonly used single-indicator measures of sexual orientation. *Journal of Homosexuality*, 60, 596-614.
- Lee, J. G. L., Griffin, G. K., & Melvin, C. L. (2009). Tobacco use among sexual minorities in the USA, 1987 to May 2007: A systematic review. *Tobacco Control*, 18, 275-282.
- Lee, J. G. L., Blosnich, J. R., & Melvin, C. L. (2012). Up in smoke: Vanishing evidence of tobacco disparities in the Institute of Medicine's report on sexual and gender minority health. *American Journal of Public Health*, 102(11), 2041-2043.
- Lindström, M., Axelsson, J., Modén, B., & Rosvall, M. (2014). Sexual orientation, social capital and daily tobacco smoking: A population-based study. *BMC Public Health*, 14, 565-574.
- Manalastas, E.J. (2012). Cigarette smoking among lesbian, gay and bisexual Filipino youth: Findings from a national sample. *Silliman Journal*, 53(1), 71-87.
- Marshal, M. P., Friedman, M. S., Stall, R., King, K. M., Miles, J., Gold, M. A., Bukstein, O. G., & Morse, J. Q. (2008). Sexual orientation and adolescent substance use: A meta-analysis and methodological review. *Addiction*, 103(4), 546-556.
- Morrow, M., & Barraclough, S. (2003). Tobacco control and gender in Southeast Asia. Part 1: Malaysia and the Philippines. *Health Promotion International*, 18(3), 255-264.
- Newcomb, M. E., Heinz, A. J., Birkett, M., & Mustanski, B. (2013). A longitudinal examination of risk and protective factors for cigarette smoking among lesbian, gay, bisexual, and transgender youth. *Journal of Adolescent Health*, 54, 558-564.

- Ortiz-Hernández, L., Gómez Tello, B. L., & Valdés, J. (2009). The association of sexual orientation with self-rated health, and cigarette and alcohol use in Mexican adolescents and youths. *Social Science & Medicine*, 69, 85-93.
- Pachankis, J. E., Hatzenbuehler, M. L., & Starks, T. J. (2014). The influence of structural stigma and rejection sensitivity on young sexual minority men's daily tobacco and alcohol use. *Social Science & Medicine*, 103, 67-75.
- Rosario, M., Corliss, H. L., Everett, B. G., Reisner, S. L., Austin, S. B., Buchting, F. O., & Birkett, M. (2014). Sexual orientation disparities in cancer-related risk behaviors of tobacco, alcohol, sexual behaviors, and diet and physical activity: Pooled Youth Risk Behavior Surveys. *American Journal of Public Health*, 104(2), 245-254.
- Rosario, M., Schrimshaw, E. W., & Hunter, J. (2011). Cigarette smoking as a coping strategy: Negative implications for subsequent psychological distress among lesbian, gay, and bisexual youth. *Journal of Pediatric Psychology*, 36(7), 731-742.
- Ryan, H., Wortley, P. M., Easton, A., Pederson, L., & Greenwood, G. (2001). Smoking among lesbians, gays, and bisexuals: A review of the literature. *American Journal of Preventive Medicine*, 21(2), 142-149.
- Tang, H., Greenwood, G. L., Cowling, D. W., Lloyd, J. C., Roeseler, A. G., & Bal, D. G. (2004). Cigarette smoking among lesbians, gays, and bisexual: How serious a problem? (United States). *Cancer Causes and Control*, 15, 797-803.
- UNDP, USAID. (2014). *Being LGBT in Asia: The Philippines country report*. Bangkok: United Nations Development Programme.
- Young, R. M., & Meyer, I. H. (2005). The trouble with "MSM" and "WSW": Erasure of the sexual-minority person in public health discourse. *American Journal of Public Health*, 95, 1144- 1149.
- Yu, F., Nehl, E. J., Zheng, T., He, N., Berg, C. J., Lemieux, A. ., Lin, L., Tran, A., Sullivan, P. S., & Wong, F. Y. (2013). A syndemic including cigarette smoking and sexual risk behaviors among a sample of MSM in Shanghai, China. *Drug and Alcohol Dependence*, 132, 265-270.
- World Health Organization (2009). *2009 Philippines Global Adult Tobacco Survey Country Report*. Retrieved from [http://www.who.int/tobacco/surveillance/2009\\_gats\\_report\\_philippines.pdf](http://www.who.int/tobacco/surveillance/2009_gats_report_philippines.pdf)
- World Health Organization. (2011). *Gender, health, tobacco, and equity*. Retrieved from <http://www.who.int/tobacco/publications/gender>

---

# THE DAILY LIFE OF POST-STROKE PATIENTS IN TOMOHON CITY, NORTH CELEBES, INDONESIA

**Rosiana E. Rayanti**

Nursing Science Program, Faculty of Health Sciences, Satya Wacana Christian  
University  
Salatiga, Central Java Indonesia

**Juliana D. Karwur**

Department Head of Education, Tomohon City, North Celebes, Indonesia

**Ferry F. Karwur**

Faculty of Health Sciences, Satya Wacana Christian University  
Salatiga, Central Java Indonesia



Stroke, in this case paralytic stroke, is a sudden paralysis caused by a brain injury. As a result of paralysis, post-stroke patients will have physical, psychological and social limitations that affect their quality of life. As a consequence, patients need help from others, especially from their family to go through their daily activities. This study aimed to show the prevalence and characteristics of post-stroke patients and describe their daily life pattern of activities in Tomohon City, Indonesia. Data were collected through in-depth interviews with observations from five participants of family members who had experienced stroke. Results of this study indicated changes in the life of post-stroke patients in terms of their daily activities, eating habits, and family communication patterns. As a result of physical weakness the daily life of the five participants was limited only to home activities. Food preference and consumption were also affected. Both participants and caregivers perceived that the emotional sensitivity they had developed and the changes in terms of family roles frequently led to misunderstandings between the patients and the caregivers.

---

**KEYWORDS:** daily living pattern, stroke, Indonesia

## INTRODUCTION

STROKE IS A paralysis that results in a disturbance of cerebral function (focal or global) and lasts for more than 24 hours, and may cause death caused by vascular disorders (Truelsen, Begg, & Mathers, 2000). The result encompasses disorder function in cognitive, physical, socio-emotional and/or communication aspects affecting daily activity in the long term (Miller et al., 2010). Approximately 50 million stroke survivors worldwide must overcome the physical, cognitive disorder, and emotional deficits; 25-74% of these patients need assistance partially or depend completely on caregivers for daily life activities (Miller et al., 2010). The Riset Kesehatan Dasar (Research of Basic Health) of Indonesia in 2007 listed stroke as the first cause of death in all ages (Departemen Kesehatan Republik Indonesia [Department of Health of Indonesia], 2009). The prevalence of stroke in Indonesia in 2008 was 8.3% with 6% diagnosed by the health worker (Badan Penelitian dan Pengembangan Kesehatan [Department of Research and Health Development], 2008).

North Sulawesi was ranked as the fourth province in national stroke prevalence with 8.5% based on clinical diagnosis (Dinas Kesehatan Provinsi Sulawesi Utara [North Celebes Provincial Health Department], 2009). The top three provinces in terms of stroke prevalence are NAD (10.4%), Riau (10.1%), and Jakarta (9.4%). Compared to the average national prevalence which was 6%, the prevalence of stroke was higher in North Sulawesi. Also, the percentage of stroke symptoms in North Sulawesi reached 10.4%, which indicates a higher mean compared to the national average which was only 8.3% (Dinas Kesehatan Provinsi Sulawesi Utara [North Celebes Provincial Health Department], 2009).

Tomohon, 23 km from the provincial capital of North Sulawesi, Manado, had a prevalence of 4% of stroke based on the clinical diagnosis. This number was below the average prevalence of North Sulawesi, which was 8.5%. However, when compared to the number of those who have the symptoms of stroke, the prevalence of Tomohon was 11%, slightly higher than the 10.4% average prevalence of North Sulawesi (Dinas Kesehatan Provinsi Sulawesi Utara [North Celebes Provincial Health Department], 2009).

According to Van Eeuwijk's study in 2005, majority of the patients in Tomohon, Tahuna and Manado had post-stroke

paralysis and weak movements caused by hyperuricemia. Consequently, they were depending on others with daily life activities such as washing of clothes, dressing, taking a bath, and eating. Van Eeuwijk's (2005) study focused on long-term care of elderly who suffered due to the weakness of the body caused by aging and/ or several illnesses.

### **Prevalence and Description of Stroke (and Related Diseases) in Tomohon City**

The Head of the Tomohon Health and Social Department informed that there was a total of 222 post-stroke patients in 7th Tomohon Health Center, of which 209 patients were with ischemic stroke and 13 patients with hemorrhagic stroke in the year 2010. Based on the Tomohon Health and Social Department's record, the stroke profiles were categorized as Blood Vessel Disease and Hypertension. The data on hypertension provided clues about the possibility of stroke prevalence in Tomohon. North Celebes Provincial Health Department (2009) reported that hypertension had the highest rank among 10 major diseases in Tomohon (41.6%). Hypertension was ranked first (33%) of 10 major diseases in the Health Centers<sup>1</sup> (Dinas Kesehatan dan Sosial Kota Tomohon [Department of Health and Social of Tomohon], 2011). Similarly, hypertension ranked first as the most prevalent disease for inpatients (22%) and ranked second for outpatients (16.5%)<sup>2</sup> at Bethesda Hospital and Gunung Maria Hospital (Dinas Kesehatan dan Sosial Kota Tomohon [Department of Health and Social of Tomohon], 2011).

A visit to 7 Health Centers namely Kakaskasen, Lansot, Taratara, Matani, Tinoor, Pangolombian, and Rurukan was conducted. The results showed a total of 51 post-stroke patients in 7th Tomohon Health Center during January to June 2011. Majority were 65 years old or older (62.7%), were female (58.8%), had ischemic stroke

---

<sup>1</sup> The 10 top diseases are hypertension, acute respiratory tract infections, tonsillitis, gastritis, musculoskeletal system diseases, upper respiratory tract infection, allergic skin diseases, skin infections, diarrhea, and lower respiratory tract infection.

<sup>2</sup> The dominant diseases of in-patients are dyspepsia, typhoid, heart disease, diabetes mellitus, urinary diseases, dengue fever, sepsis, and tuberculosis. While the dominant diseases of outpatient are acute respiratory tract infections, hypertension, refractive disorders, diarrhea and gastritis, dyspepsia, skin diseases, diabetes mellitus, cataracts, typhoid, and ear diseases.

(94.1%), had hypertension (70.5%), and had children as caregivers (80.3%). Three post-stroke patients had recurrent stroke resulting to hemorrhagic stroke. Forty-nine out of 51 patients with post-stroke had one or more related disease diagnosed by physician, in terms of hypertension, hyperlipidemia, hyperuricemia, diabetes mellitus, heart disease, and lung complications. Most of them had weak left (21.4%) and right (37.2%) side of the body. The others had weak body movement including weak limb or hand muscle, left-sided facial nerve paralysis, difficulty swallowing, slurred speech, and hyper salivation. However, there was one patient with no physical limitations. Also, there were three patients with no data about their physical post-stroke condition.

The physical limitation made the patients dependent on others. Their daily activities were limited, mostly around the house. Moreover, social interaction became less.

## Stroke Treatment

Post-stroke treatment that patients undergo in Tomohon is varied. Generally, stroke patients directly go to the hospital. Then they are referred to a neurologist, do regular physical exercises with a physiotherapist, or choose other alternative treatments. *Ceragem* has been a popular alternative treatment in Tomohon for the past five years. It makes use of long distance beam infrared passing through jade to a certain body point in order to accelerate blood circulation and chemical processes in the body. Post-stroke patients have learned to exercise their body in *Ceragem*.

Tomohon Health and Social Department and two hospitals have made effort to manage stroke. Two Hospitals in Tomohon have provided infrastructure facilities and specialists of neurology for stroke treatment. Unfortunately, the health centers do not have the same facilities as the hospital. Only one of seven health centers, namely Tara-tara Health Center has complete supporting facilities for post-stroke rehabilitation. In addition, physiotherapist, nurse, and physician have also collaborated to address post-stroke patients' needs. Physiotherapists provide physical exercise, perform infrared radiation, and conducted educational awareness on stroke treatment. Nurses provide direct care to post-stroke patients while doctors do so in curative phase. Tomohon Health Department has an active role in stroke treatment on preventive action and promotion programs, namely

URSILA (program for elderly), PERKESMAS (community health care), SUMAPUT (control nutrient input and prevention against cardiovascular disease), and exercise activity and health promotion programs collaboration with the church.

However, several obstacles hindered the implementation of post-stroke rehabilitation process. There were two obstacles that prevented post-stroke patients to avail of Tomohon's medical program. One obstacle was the unavailability of someone who could accompany patients to visit the health center for routine check-up. Second, patients' family members lacked information on stroke treatment.

The people who are with the post-stroke patients most of the time, particularly caregivers, are affected by the stroke. The local context and background culture can influence the interaction pattern of post-stroke patients and caregivers. It is therefore important to identify the daily life of post-stroke patients and their caregivers within the context of a particular culture and locality. This paper assessed the daily life pattern of patients with post-stroke in Tomohon City which included the prevalence and characteristics of post-stroke patients and the daily life activities pattern of post-stroke patients in Tomohon City, Indonesia.

## METHODOLOGY

The study used a qualitative-descriptive method. It was conducted in June to July 2011 in Tomohon City. There were two stages used in determining the sample. First, an interview with the physiotherapist, who did home care for post-stroke patients at health centers, was conducted. There were 11 post-stroke patients who qualified and met the characteristics of the participants: those who were not hospitalized, did not have poor prognosis, did not have cognitive and linguistic impairment, and have been taken care of by family members for more than six months. Second, interview and direct observation were conducted on 11 post-stroke patients. Five participants were chosen. The others were not selected due to the following reasons: 1 patient had inability to recall past events; 1 patient did not have stroke as the CT-scan showed no ischemic or infarct tissue in the brain; 1 patient had difficulty speaking (dysphagia); 1 patient was not taken care of by a family member; 1 patient was hospitalized at Bethesda GMIM

Hospital, and the other one was taken care of by family members who work as farmers until 6 pm everyday which made it difficult to meet the caregivers.

The five participants had undergone neurological assessment and in-depth interview. Neurological assessment included [1] the cerebral function in mental status, intellectual functioning, language skills, logical thinking, emotional status, perception and motor skills; [2] the cranial nerves assessment, nervous I-XII; [3] the motor system balance and coordination, and Romberg test; [4] the sensory system of tactile sensation, pain and temperature, vibration and proprioception, which feels the sensation of position and integration; and [5] the status of the reflexes—triceps reflex, biceps reflex, brachioradialis reflex, patellar reflex, achilles reflex and response babinski.

Information obtained during the interview with the participants included [1] health profile (the impact of post-stroke, health-related problems, stroke type, recurrent stroke, stroke factors, caregivers, and stroke treatment); and [2] patterns of daily life (daily activities, eating habits, and family communication pattern between the participants and their caregivers). Interview was also conducted with caregivers and physiotherapists in order to create triangulation. Post-stroke rehabilitation in Health Centers Tomohon focused on physical exercise prepared by a physiotherapist. Physiotherapists recorded the health status of the post-stroke patients.

The participants were Mr. A (45 years old), Mrs. B (55 years old), Mrs. C (78 years old), Mrs. D (73 years old) and Mrs. E (72 years old) (see Table 1). Each participant had specific characteristics: [1] Mr. A (45 years) suffered from recurrent stroke and had emotional sensitivity. Based on the assessment neurology, Mr. A had dysphagia and could not hold emotion when questioned about his feelings towards his illness; [2] Mrs. B was depressed after her husband's death. Mrs. B had two jobs and worked hard until she did not have enough time to take rest; [3] Mrs. C had stroke and suffered over the past 10 months, and it was the shortest time compared to the other patients; [4] Mrs. D had never been hospitalized; and [5] Mrs. E fully depended on others in carrying out daily activities.

The data obtained were analyzed through open coding then categories were created. Abstractions were explained by using descriptive approach. Interview transcriptions were analyzed

until no new information was observed.

## RESULTS

### Study Participants' Profile

In-depth interview was done with five study participants (Table 1), three of whom were of working age (45-65 years old) and two, older adults (over 65 years old). Three participants had family members with stroke and degenerative diseases as follows: Mr. A's parents had diabetes mellitus and his sisters had stroke; Mrs. B's father and sister had stroke; Mrs. C's family had hypertension, diabetes mellitus, and stroke; Mrs. D and Mrs. E did not have family history of disease.

Extreme fatigue and too much burden were the major factors that triggered the onset of stroke as reported by the study participants. Three of the five participants claimed that stroke was triggered by fatigue while one said it was due to fatigue and too much burden, and one said it was due to too much burden. Two participants worked hard and did not have enough time to take rest (*e.g.*, Mr. A was a truck driver while Mrs. B was a hair stylist and tailor). Mrs. E was tired from traveling between cities within a week. Furthermore, Mrs. B was stressed after her husband died. She used her time to work. Mrs. D was depressed caused by her daughter who could not marry her partner even if they had already 3 children. They have different religion so her partner's mother was against their relationship.

### Eating habits

Observed and interviewed with the Head of Tomohon Health and Social Department, physicians, nurses, physiotherapists, study participants generally consume red meat, saltwater fish, and alcoholic drinks. This is supported by the fact that almost every Saturday and Sunday, they have a party serving all meals namely, pork, dog meat, bat and white rat meat, tuna fish, and vegetables.

Mr. A's eating habits changed after his stroke attack. When he suffered first stroke attack, he lost appetite and could only finish half of the food served. After recovering from the first attack, he felt better and was then able to finish one or more food served. He

Table 1. Profile of Study Participants in Tomohon City, Indonesia (N=5).

Initials	Highest educational attainment	Health history in last 10 years	Family health history	Kind of stroke	Trigger of stroke onset according to client	Length of suffer with stroke	Physical impact after stroke
Mr. A (45 years)	Junior High School	Recurrent stroke, HTN, and hyperlipidemia	Stroke and DM	Ischemic stroke	Fatigue	5 years	Slurred speech, hyper salivation and left-sided hemiparesis
Mrs. B (55 years)	Junior High School	Stroke, HTN, and hyperlipidemia	Stroke and HTN	Ischemic stroke	Burdened and fatigue	5 years	Right-sided hemiparesis
Mrs. C (78 years)	Junior High School	Stroke, HTN, and hyperlipidemia	Stroke, HTN, and DM	Ischemic stroke	Fatigue	10 months	Right-sided hemiparesis
Mrs. D (73 years)	Elementary School	Stroke, HTN, and hyperlipidemia	None	Ischemic stroke	Burdened	3 years	Right-sided hemiparesis
Mrs. E (72 years)	Senior High School	Stroke and HTN	None	Ischemic stroke	Fatigue	3 years	Right-sided hemiparesis

ate twice per day except when he was taking the medicine that made him eat thrice daily. He said:

*I ate more than 1 kg of pork. I loved to eat pork and drink saguer before I had the first stroke. I consumed 7-8 bottles of saguer [an alcoholic palm sap from Palm Sugar plant (Arenga pinnata)], 1 bottle of cap tikus [traditionally distilled saguer], and ate lots of durian before. After the stroke, the doctor advised me to limit the meat consumption, so I ate more vegetables, usually boiled vegetables and grilled fish, fish with soup and sometimes fried fish. I love to eat fish with spicy sauce but it's too oily so I prefer grilled fish. I also quit smoke. (Mr. A, age 45)*

Mrs. B consumed a lot of pork or dog meat, rice, and oily food. After she got stroke, she was worried about her weight. She decided to go on diet and limit food consumption. She ordered food through catering. Her daughter sometimes cooked for her. The menu was rice, food with sauces, *gohu* (typical food of Tomohon, with the half-ripe papaya, water, salt, red sugar, ginger and chili). She consumed pork once a week. She stated:

*I loved to eat dog meat (RW) and pork that is why I had stroke. After the stroke, I only consumed small serving of pork per week. The doctor said I have to maintain my cholesterol and sugar level because sometimes my cholesterol and sugar level are low. I am too worried with my blood pressure, but the doctor said I have to eat so I can have energy. As for the daily food, I have catering and when I got bored of the menu, my daughter cooks for us. I prepare for my own breakfast in the morning. Boiled and fried vegetables with sauce and rice are my usual food. I take 12.5 mg of captopril every morning and consumed traditional herb and vitamins after the breakfast. (Mrs. B, aged 55)*

Mrs. C rarely consumed fried food because she had high blood cholesterol. Before, she consumed rice, pork and oily food. Also she drank 1 cup [1 *grem* in the local] of *cap tikus* (traditional distilled *saguer*) per day. After the stroke attack, she controlled her diet. She was able to eat half of the food served and drank two glasses of water per day. She seldom drank water because she was afraid that she needed to urinate often. In addition, her diaper was replaced only at 3 pm and 6 pm. She felt uncomfortable with

a wet, full diaper. Her daily menu was porridge for breakfast, fried fish/vegetable stewed or boiled without sauce for lunch and dinner. She said:

*I am able to finish one half of the meal served. I have high cholesterol, so I limit the consumption of fried food. In the morning, I eat porridge while in noon I eat fried or boiled fish and boiled vegetables. After the stroke, I don't have much appetite anymore. I decided to limit the consumption of oily food even without the advice from doctor. I drink cap tikus a bit only so I can feel a bit warm. I only drink 1 bottle of coke and that was before my sickness. (Mrs. C, aged 78)*

Mrs. D consumed rice or potatoes, boiled vegetables and fish. She also drank 1-2 bottles of *saguer* per day. She ate thrice per day. Her menu was cassava, boiled vegetables, and fish. She could finish her served food. Sometimes, she consumed snacks like boiled potatoes or bananas between breakfast and lunch. She did not consume fried food and pork. She was an occasional alcoholic drinker with maximum of two glasses but after the stroke, she quit. She stated:

*I eat saltwater fish and vegetables, but I do not really like fish so I only eat some part of it. I eat rice for breakfast until dinner. When I got bored with rice, sometimes I change it with cassava. I can finish one serving; I usually eat fish and cassava. Sometimes I only eat two tablespoon of rice then I changed it with boiled banana and vegetables. In the past, I consumed 1-2 glass of *saguer* but I quit after I got stroke. I do not smoke, even before the stroke. (Mrs. D, aged 73)*

Mrs. E also loved to eat red meat, especially pork and oily food. She ate thrice daily. She consumed fried banana, fried cassava, or cookies between meals. However, she was able to finish only a quarter of the food served. Her daily menu after the stroke was rice, fish and vegetables. She said:

*I enjoyed eating pork before but for now I only ate vegetables, mostly boiled vegetables. I eat three times a day. After my breakfast sometimes I eat snack. At 3 pm I usually eat cookies, fried cassava, or fried banana. Also, I sometimes have snack in*

*the evening. I do not have food restriction. I mostly eat a quarter of the meal served and I am used to it. (Mrs. E, aged 72)*

## Daily Activities

Post-stroke condition leads participants to depend on caregivers to go through their daily activities. This condition results in emotional instability between study participants and their caregivers. In addition, daily activity is disturbed, *i.e.*, limited social activities only around the house.

Mr. A stopped working as a truck driver because he had slurred speech and hyper salivation and left-sided hemiparesis. He spent his day by doing physical exercises at *Ceragem* therapy and spiritual activities in his neighborhood. After undertaking physical exercises, he was able to walk and speak although not in a normal manner. He woke up before 5 am and visited *Ceragem* which is located about 1 km away from his house. After finishing the *Ceragem* treatment at 5 am, he walked around the house and slept until 7 am. He woke up again at 8 am for breakfast. He had lunch at 2 pm and then watched TV. He walked in the afternoon around the house or sat in front of the house, and slept at 9 pm. He attended spiritual worship and activities in his neighborhood every week. He narrated:

*I woke up before 5 am and start walking to Kakaskasenas. The exercise there starts at 5 am. After undergoing the Ceragem exercise, I like to sing, shout and talk. I can speak a little bit better now. I go to Ceragem everyday. Sometimes I sleep at around 8 AM after the breakfast. I have lunch at 2 pm and after that I just watch TV until dinner and then sleep. These are my daily activities—eat, sleep and exercise. We have family gathering once or twice a week, usually every Thursday or Sunday. (Mr. A, aged 45)*

Mrs. B was a tailor and a hair stylist. She also stopped working and just stayed at home. On Saturdays, she woke up at 3:30 am because she had to go to church for Worship. On weekdays, she woke up at 7 am, and then she drank water, 12.5 mg of captopril, the extract of avocado/sour soup leaf, vitamin B1 and B5, and traditional medicine *soman* (herbal medicine). After that, she took a hot shower, had breakfast, sat down and watched television

in the afternoon. She slept at 3 am after watching TV series. She used a walking stick to help her move around the house. She was able to attend the spiritual activity around the neighborhood. Furthermore, she interacted with neighbors or people in church. Her daughter used Mrs. B's living room as a salon, so she had many visiting customers to interact with. She stated:

*Every Saturday, I wake up early because I join the early Morning Prayer at 3:30 am. We go to church at 4 or 4:30 am. In other days, I wake up at 7 am and do some body stretching. After breakfast, I watch TV until evening. I could not take a nap in the afternoon. I join the other program or social gathering if the place is near my house. If I am not sick, I want and will join every program. (Mrs. B, aged 55)*

Mrs. C only stayed in the house. She woke up at 4 am, and then washed her face. She had to wait for someone else to replace her diapers and clean her body. Mrs. C was assisted by her daughter for that need. Yet, the daughter only stayed in the house on working days. She had to go back to Manado every weekend. She has a family in Manado. Therefore, Mrs. C's family paid a caregiver who is from the extended family to take care of Mrs. C during the weekend. Mrs. C's diaper was regularly changed at 3 pm and 6 pm. After she took shower in the morning, replaced her shirt and, ate breakfast, she spent her time watching television. Then, she took a nap although she could not sleep well. She had lunch at 1 pm; the food was prepared by her son. After that, she watched TV. The caregiver cleaned her body at 4 pm, then she watched TV, had dinner and slept at 9 pm. She felt lonely. In the past, she joined Christian Worship activities, but after she had stroke, she just stayed at home. She rarely did exercises, only movements like walking to turn on or off the lights in front of the house within more or less five meters. She claimed she had stiffness in her right hand and feet caused by rarely exercising. She said:

*Someone helps me to walk, take a bath and defecate in bathroom. There are family members who assist me in doing that. I don't drink too much water because no one will help me change the diaper and it is uncomfortable if the diaper is full especially in the middle of the night. I wake up at 4 am every morning, and*

*then wash my face and change the diaper with the help of the helper. My son would prepare the breakfast. When I watch TV sometime I feel asleep for 15-45 minutes. No one accompanies me for exercise, so after I wake up I go to the front house, open the door and turn on/off the light. (Mrs. C, aged 78)*

Mrs. D woke up at 4 am and cooked. She slept at around 9 pm. She cooked and cleaned the house, pulled out the grass in the yard, but could not wash the dishes. Her hand felt pain if exposed to water. She joined the *Ceragem* therapy and did exercise at home. She walked to the *Ceragem* therapy. She trained her arm strength by hanging both of her arms on the rope hanging from the ceiling; she put her arms up and down the rope for 200 times a day. After that, she was able to join the Christian worship or activities around her neighborhood. Mrs. D looked healthier compared to the other study participants. She expressed:

*I am able to do some daily activities like cooking, cleaning the house and getting rid of grass in the front yard but I cannot wash the dishes. When my hand touches the water, I feel pain in my right hand. Same thing happens when I wake up in the morning due to the cold temperature. I can feel a bit pain on my right hand. I wake up at 4 am and sleep at 9 pm. I asked my son to hang ropes on the ceiling; something looks like a small swing on the ceiling so I can exercise my hand. I can walk by myself and join the social gathering near my house. (Mrs. D, aged 73)*

Since she suffered a stroke, Mrs. E spent most of the time lying on a bed. She could not join the Christian worship in the Church or the other activities outside. She was not able to wake up alone and got exhausted easily. Her husband helped her to wake up from the bed and changed the sleep positions. She woke up at 7 am and sat in the living room. After that, she slept for a while and woke up for breakfast. Her activity only includes sitting in the living room or sleeping. She spent most of her time on the bed inside her room. She was an active person before she suffered stroke. Before, she was a PKKA member (women's association in the neighborhood) and church chorister. She visited her grandchildren in Manado and Bitung City several times. The exhaustion of long holiday trip triggered the onset of her stroke. She stated:

*I wake up at 5 am and sleep after watch TV in evening. I follow Sunday morning worship at home and sleep again after the worship. I wake up when I hear the children are going to school and meal time. Children usually go to school at 7 am. When I feel tired, I go to my bedroom. (Mrs. E, aged 72)*

### **Family Communication Patterns between Study Participants and Their Caregivers**

Family communication patterns between the participants and caregivers were affected by many factors. The main factor was emotional sensitivity. Physical, psychological, social, and emotional weakness occurred between the study participants and their caregivers. It posed ineffective communication between them. Family communication patterns indicate the quality of the relationship and interaction between the study participants and their caregivers. In-depth interviews and observations were conducted on both parties.

Mr. A's self-image has changed after the stroke. He felt low esteem because he was dependent on others especially Mrs. S (55 years old), his wife. He was not able to support his family financially. The eldest son supported Mr. A's family needs. Mrs. S also worked to meet the family's need. Although Mr. A could not speak clearly, the wife always tried to understand and accompany him. Her tasks were cooking, preparing food, washing clothes, and giving medication. They liked to talk about their four children and four grandchildren. One time, they had a misunderstanding because Mrs. S did not listen and ignored the wishes of Mr. A. She delayed to do Mr. A's request. Then, Mr. A was angry and refused to talk to her. As a result they quarreled and slept separately for a week. When interviewed, Ms. S was careful in answering the questions. She looked towards her husband and answered softly. It appeared that Mrs. S was afraid to express her opinion in front of her husband. Mr. A seemed to have developed a temper. He confessed:

*When I had the first stroke, I get angry easily. No one can speak harsh word, for I will get mad. But it changed especially when I have recurrent stroke. I could not hold my feelings. When I watch TV, I was easily influenced by the TV series. If I watch the fight scene, I will get excited and angry also, and when I watch*

*the sad scene I will cry immediately. Sometimes, my wife does not respond to me immediately. When I scold her, she does not pay attention. Sometimes I can't be better just because of my emotion. One time we slept in different rooms because she did not listen to me. It could happen for a week. (Mr. A, aged 45)*

Mrs. B tried to accept her situation after stroke. When talking about her illness, she looked disappointed. Mrs. SDM (31 years old), the first daughter, was her caregiver. Mrs. SDM complained about her mother's condition after stroke. However, she still took care of Mrs. B including spoon-feeding, replacing diapers, washing the clothes, and cleaning the house. They loved to tell jokes to each other and discussed home or salon daily. Almost every day, they also had argument. Mrs. B was burdened and stressed with her physical limitation and her daughter was burdened with household problems. Mrs. B was upset because Mrs. SDM quit college. She got pregnant and had to get married. Therefore, they quarreled almost every day. One time, they had misunderstanding and did not talk to each other. However, one of them would budge and they got along again after the quarrelling. She expressed:

*My daughter got married because she was pregnant. She stopped from school. She and her husband often fight even in front of the parents. I do not want [to] intervene with their problems so I just go to my bedroom. My daughter and I often quarrel. But she is my daughter and I still love her. I do not like to keep my emotion and I prefer to express my emotion. When we argue, it only lasts for a day and the next day everything becomes normal. (Mrs. B, aged 55)*

Mrs. C felt lonely. Before, she joined many activities outside, but after she suffered stroke, she had stayed at home. She did not have friends who accompanied her. Her caregivers were her fourth son (41 years old) and second daughter (53 years old) who took care of the housework. Family member's role had changed and made them more sensitive. Her son, Mr. D did household task. He went to the market, prepared food, and turned off the lights. Her daughter, Mrs. Y's task was to change diaper and clean Mrs. C's body. Mrs. C became angry at little things, like when Mr. D forgot to turn off the lights or he did not immediately

come when called. Mr. D was burdened with these tasks. He felt that the tasks were for women. On the other hand, Mrs. Y did not have much time to take care of Mrs. C. She has a job as a teacher. Although they lived together, they rarely had conversation. Even Mr. D admitted attempting to start a conversation but was ignored by Mrs. C. The caregivers talked to Mrs. C while they helped her eat, turn off lights, or help Mrs. Y bathe Mrs. C. This situation led Mrs. C to frequently quarrel with her caregivers and would not eat at mealtimes. She said:

*After the stroke, I get mad easily even for a little thing. People usually say to me "do not be grumpy, Grandma." I have many thoughts since I got sick. I live with two children and household task is not easy. I have several rooms for rent; it means I have to oversee the rooms. I am changed because I keep on thinking of my sickness and condition. I could not go out due to walking problem. Also, I seldomly talk with my son, some simple questions like is the food ready? Have you eaten? It is not like other mother and son conversation. We are not like mother and son. Last time, he did not answer me when I was calling him. I got mad and so [did] he. I do not like to talk to him. Sometimes, he did things that are not important. I reminded him but he did not care. (Mrs. C, aged 78)*

Mrs. D became more sensitive and had low self-esteem because of her physical limitations. Her caregivers were Mr. AK (69 year-old-husband) and Mrs. A. (25 year-old adopted daughter). Mr. AK's tasks were to accompany her and bring water for domestic use while Mrs. A's tasks were cooking, preparing food, washing the clothes, and cleaning the house. Mrs. D considered it a burden to request help from the caregivers. Hence, their relationship was not good. Mrs. D only talked with them about house condition or Mrs. A's children. She was disappointed by the caregivers. Mr. AK was always angry when she asked help to get water and Mrs. A gave less attention to the children. Mrs. D kept her disappointment and burden for a long time due to Mrs. A's problem. She was not married although she had three children from her partner. Mrs. D chose to keep her sadness related to her relationship with the caregivers. She stated:

*Honestly, my daughter is not married. The mother of her*

*partner promises to get them married. However, even until they already have 3 children, they are still not married. They have different religions. So I am always distracted with this thing. I really want them to be married officially. They have to think seriously of the future of their children. I am also burdened when I have to ask my husband to [get] the water from the well. My husband has hypertension and he got mad easily so I just keep it to myself, because it is useless to tell him. (Mrs. D, aged 73)*

Mrs. E depended completely on others. Mrs. E spent most of the time lying on a bed. Her caregiver was her husband, Mr. YK (72 years old). His tasks were to accompany her for daily conversation, help her do body exercise, and bring her for check-up at the hospital. Their daughter who lived in the same neighborhood helped them clean the house, wash clothes and prepare meals. Being always together, the couple is endeared to the neighbors. They did not like to quarrel. One time, Mr. AK did exercise even Mrs. E prohibited him because he was sick. As a consequence, he got sicker and Mrs. E did not talk to him. They did not talk to each other for several days, and they chose to keep the problem. She expressed:

*Our neighbors said they never heard us fighting. We know every couple has different opinion and tendency to argue on something. When we have argument, one of us would budge so we never fight. (Mrs. E, aged 72)*

## DISCUSSION

Stroke commonly happens to older adults with the age ranging from 55-85 years old particularly to those whose family have history of stroke and the mortality rate doubled in each year (Goldstein et al., 2006). In addition, they have one or more degenerative diseases including hyperlipidemia and hypertension which are the major risk factors of stroke (Goldstein et al., 2006). The occurrence of stroke in older adults is higher than those who are in their productive age because of the physical deterioration and weakened immune system that make them more vulnerable to degenerative disease that may lead to stroke (Nugroho, 2008). The main reasons for stroke in the productive age is unhealthy

lifestyle such as smoking, irregular exercise, unhealthy diet, and stress (Supriyono, 2008; Sitorus, Hadisaputro, & Kustiowati, 2009).

Women tend to have higher chance of stroke in postmenopausal period. This is related to the estrogen in the female body, which may reduce the risk factors of stroke in postmenopausal phase (Rossouw et al., 2002; Wassertheil-Smoller, Hendrix, Limacher, Heiss, & Kooperberg, 2003). Men have a greater potential to suffer a stroke at a young age therefore the survival rate is also higher, while women in their old age will have less chance to survive (Reeves et al., 2008; Roger et al., 2010).

Most patients have ischemic stroke than hemorrhagic stroke (National Heart, Lung, and Blood Institute, 2006). The prevalence of ischemic stroke in Western countries is 87% and the rest is hemorrhagic stroke (Roger et al., 2010).

In Asian countries with low consumption of animal protein, high in saturated fat and cholesterol, the risk of stroke increases (Sauvaget, Nagano, Hayashi, & Hamada, 2004). Gariballa (2000) stated that a balanced consumption of fruits, vegetables especially beans and limited consumption of saturated fats can prevent recurrent stroke. Smoking and consumption of alcoholic beverages are associated as stroke risk factors, therefore post-stroke patients are advised to quit smoking and drinking alcoholic beverages. Furthermore, stress can trigger stroke by atherosclerosis process, increased cardiac output, increased blood pressure, improve blood sugar, muscle tissue damage, infertility, inhibition of the inflammatory reaction, growth suppression, and suppression of immunity (Carr & Shepherd, 1998).

A caregiver's role is very important in addressing the daily needs of post-stroke patients. Miller et al, (2010) reported that majority of stroke patients who survive and continue to live in the community need help from their caregivers related to their physical limitation including hemiplegia, hemiparesis, ataxia, dysarthria and dysphagia (Smeltzer & Bare, 2009). However, caregivers are affected by the changes of the post-stroke patients condition particularly their personalities (Benny, Aldy, & Darulkutni, 2008). These changes have effects particularly on family communication pattern in terms of self-image, physical and emotional conditions, physical environment, the role of the social environment, body language and intelligence as effective

communication factors (Lunandi, 1987). The changing of these factors leads to the ineffective communication that triggers the occurrence of misunderstanding between the post-stroke patients and their family members.

## CONCLUSIONS AND RECOMMENDATIONS

The study showed that the data of stroke in Tomohon City was covered by physiotherapist in Primary Health Care. In Tomohon Health and Social Department, the data was classified into Vascular Disease and Hypertension group. Consequently, the health programs in Tomohon Health and Social Department refer to clients with vascular disease and hypertension only. There is no specified health program for stroke patients and their caregivers. The change of stroke patients affects the patient and their families and both parties have to deal with it.

Tomohon Primary Health Care should conduct specified health programs for stroke patients and their families. Seminars or trainings are needed for family members about their roles and function and the stroke effect on the patient and family members. They should well understand about their significant roles in supporting stroke survivors.

A holistic rehabilitation team is needed in Tomohon City. It should be a collaboration between multidisciplinary disciplines, composed of physicians, nurses, physiotherapist, speech therapists, occupational specialists, social workers, and family members of stroke patients. It should use family-centered approach. The health practitioners must involve family members in any health services during home care service so that the family members become independent to take care of the patient.

This study utilized the data from seven Tomohon primary health care centers, excluding the data from two hospitals in Tomohon, GMIM Bethesda Public Hospital and Gunung Maria Hospital in the second half of 2010. Further research using quantitative method to seek the bigger scope of stroke prevalence and family members' roles during stroke rehabilitation process is needed in Tomohon City.

## ACKNOWLEDGMENTS

The researchers would like to thank Asst. Prof. Ronelaine B. Picardal as an English Editor and Tomohon Health and Social Department for the guidance and support on the research.

## REFERENCES

- Badan Penelitian dan Pengembangan Kesehatan [Departement of Research and Health Developmpt]. (2008). *Riset Kesehatan Dasar (RISKESDAS) 2007: Laporan Nasional 2007*. Jakarta: BPPK Departemen Kesehatan Republik Indonesia.
- Benny, M.S., Aldy S. R., & Darulikutni, N. (2008). Hubungan antara perubahan kepribadian pasca-stroke dengan ansietas dan depresi pada pengasuh. Medan: Departemen Neurologi Fakultas Kedokteran Universitas Sumatra Utara. *Majalah Kedokteran Nusantara*, 41(1). Retrieved from [http://repository.usu.ac.id/bitstream/123456789/18514/1/mkn-mar2008-41%20\(7\).PDF](http://repository.usu.ac.id/bitstream/123456789/18514/1/mkn-mar2008-41%20(7).PDF)
- Carr, J.H., & Shepherd, R. B. (1998). *Neurological rehabilitation: Optimizing motor performance*. Oxford: Butterworth-Heinemann.
- Depertemen Kesehatan Republik Indonesia [Department of Health of Indonesia]. (2009). *Profil kesehatan Indonesia 2008*. Jakarta: Kepala Pusat Data dan Informasi RI.
- Dinas Kesehatan dan Sosial Kota Tomohon [Department of Health and Social of Tomohon]. (2011). *Profil Kesehatantahun 2010*. Tomohon: DINKES Tomohon.
- Dinas Kesehatan Provinsi Sulawesi Utara [North Celebes Provincial Health Department]. (2009). *Profil kesehatan Provinsi Sulawesi Utara Tahun 2008*. Balai Data, Surveilans dan Sistem Informasi Kesehatan: Sulawesi Utara.
- Gariballa, S. E. (2000). Nutritional factors in stroke. *Br J Nutr*, 84(1), 5-17.
- Goldstein, L.B., Adams, R., Alberts, M.J., Appel, L.J., Brass, L. M., Bushnell, C.D., Culebras, A., DeGraba, T.J., Gorelick, P.B., Guyton, J.R., Hart, R.G., Howard, G., Kelly-Hayes, M., Nixon, J.V., & Sacco, R.L. (2006). Primary Prevention of Ischemic Stroke: Guideline from the American Heart Association/ American Stroke Association/Stroke Council. *Circulation* 28, 114 (22):e617
- Lunandi. (1987). *Komunikasi Mengena: Meningkatkan Efektivitas Komunikasi Antar Pribadi*. Yogyakarta: Kanisius.
- Miller, E.L., Laura, M., Lorie, R., Richard, D.Z., Tamilyn, B.Y., Patricia, C., Sandra, A.B. (2010). Comprehensive overview of nursing and interdisciplinary rehabilitation care of the stroke patient: 207 scientific statement from the American Heart Association. *Stroke*, 41:2402-2448.

- NHLBI [National Heart, Lung, and Blood Institute]. (2006). *Incidence and prevalence: 2006 chart book on cardiovascular and lung diseases*. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute.
- Nugroho, Wahjudi. (2008). *Keperawatan Gerontik & Geriatrik* (Edisi 3). Jakarta: EGC.
- Reeves, M.J., Bushnell, C.D., Howard, G., Gargano, J.W., Duncan, P.W., Lynch, G., Khatiwoda, A., & Lisabeth, L. (2008). Sex differences in stroke: Epidemiology, clinical presentation, medical care, and outcomes. *Lancet Neurol.* 7, 915–926.
- Sitorus, R.J., Hadisaputro, S., & Kustiowati, E. (2009). *Faktor-faktor risiko yang mempengaruhi kejadian stroke pada usia muda kurang dari 40 tahun (studi kasus di rumah sakit di Kota Semarang)*. Semarang: Universitas Diponegoro.
- Rossouw, J.E., Anderson, G.L., Prentice, R.L., LaCroix, A.Z., Kooperberg, C., Stefanick, M.L., Jackson, R.D., Beresford, S.A., Howard, B.V., Johnson, K.C., Kotchen, J.M., & Ockene, J. (2002). Risks and benefits of estrogen plus progestin in healthy postmenopausal women: Principal results from the women's health initiative randomized controlled trial. *JAMA*, 288, 321–333.
- Sauvaget, C., Nagano, J., Hayashi, M., & Yamada, M. (2004). Animal protein, animal fat and cholesterol intakes and risk of cerebral infraction mortality in the adult health study. *Stroke*, 35(7), 1531-7.
- Smeltzer SC, & Bare BG. (2009). *Brunner and Suddarth's textbook of medical of medical surgical nursing* (12th ed.). Philadelphia: Lippincott Willian & Wilkins.
- Supriyono, M. (2008). *Faktor-faktor risiko yang berpengaruh terhadap kejadian penyakit jantung koroner pada kelompok usia <45 tahun (studi kasus di RSUD dr. Kariadi dan RS Telogorejo Semarang)*. Semarang: Universitas Diponegoro.
- Truelsen, T., Begg, S., & Mathers, C. (2000). *The global burden of cerebrovascular disease*. Retrieved from [http://www.who.int/healthinfo/statistics/bod\\_cerebrovascularstroke.pdf](http://www.who.int/healthinfo/statistics/bod_cerebrovascularstroke.pdf)
- Roger, V.L., Go, A.S, Lloyd-Jones, D.M., Adams, R.J., Berry, J.D., Brown, T.M., Carnethon, M.R., Dai, S., De Simone, G., Ford, E., Fox, C.S., Fullerton, H.J., Gillespie, C., Greenlund, K.J., Hailpern, S.M., Heit, J.A., Ho, M.P., Howard, V.J., Kissela, B.M., Kittner, S.J., Lackland, D.T., Lichtman, J.H., Lisabeth, L.D., Makuc, D.M., Marcus, G.M., Marelli, A., Matchar, D.B., McDermott, M.M., Meigs, J.B., Moy, C.S., Mozaffarian, D., Mussolino, M.E., Nichol, G.E., Paynter, N.P., Rosamond, W.D., Sorlie, P.D., Stafford, R.S., Turan, T.N., Turner, M.B., Wong, N.D., & Wylie-Rosett, J. (2011). Heart disease and stroke statistics 2010 update: A report from the American Heart Association. *Circulation*, 30, 121(12):e260
- Van Eeuwijk, P. (2005). When social security reaches its limits: long-term care of elderly people in urban Indonesia. In R. Büchel, A. Derks, S. Loosli,

S. Thüler. (Eds.), *Exploring social (in-)securities in Asia*. Bern: Institut für Sozialanthropologie, 74-90.

Wassertheil-Smoller, S., Hendrix, S.L., Limacher, M., Heiss, G., & Kooperberg, C.; WHI Investigators (2003). Effect of estrogen plus progestin on stroke in post-menopausal women: the women's health initiative: A randomized trial. *JAMA*, 289:2673-2684.

---

# PEDAGOGICAL INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY AMONG TEACHER EDUCATORS IN CENTRAL VISAYAS, PHILIPPINES

**Dave E. Marcial**

College of Computer Studies, Silliman University  
Dumaguete City, Negros Oriental, Philippines



Information and communication technology (ICT) changes the way education is delivered. ICT highly supports student-centered environment. This paper examines the level of pedagogical integration of ICT among teacher educators in Central Visayas, Philippines. The study used a survey questionnaire based on the National ICT Competency Standard for Teachers. A total of 383 responses from 76 private and public higher education institutions were included in the analysis using weighted mean and chi-square. The study reveals that the level of pedagogical integration of ICT among the teacher educators is moderate. The result implies that the teacher educators are familiar with the pedagogical operations of ICT but have not experienced the actual implementation of it. The level of competency in the pedagogical integration of ICT is affected by age, status, institution, and number of years in teaching. Teacher educators from private higher education institutions (HEIs) have a higher competency level than those who are affiliated from public HEIs. Those who have a desktop, Smartphone and a laptop computer with Internet accessibility have a higher competency

level than those who have not. From the data it can be said that the pedagogical integration of ICT among teacher educators is at the learning level only.

---

**KEYWORDS:** descriptive, educational technology, ICT in education, pedagogy, Philippines, teacher education

## INTRODUCTION

THE WEBSITE *Teaching Teachers for the Future* has made the observation that information and communication technology (ICT) changes teaching and learning. It changes the way teachers teach, and students learn; it transforms pedagogy. Collaborative and interactive teaching strategies require a new method of pedagogy like the ICT integration in teaching and learning (Cox et al., 2003). Likewise, Kollias & Kikis (2005) suggested a pedagogical-independent definition of ICT-related pedagogical innovations in schools. They stated that “pedagogic innovations in the use of ICT in schools are those activities where innovation agents integrate existing or new ICT-related pedagogic theories, knowledge, processes and/or products in schools.” They cited that pedagogical practices include: promoting active learning, providing students with competencies and technological skills, stimulating students in collaborative and project-based learning, providing students with customized instructions, addressing issues of equity for students, “breaking down the walls” of the classroom, and improving social cohesiveness and understanding. ICT is a knowledge construction tool helpful in achieving authentic and realistic problem-based approaches to teaching and learning (Prestridge, 2012).

However, there are many challenges and barriers to integrating ICT in the classroom. These barriers include cultural, behavioral, technical, and financial aspects (Samire, 2012). Marcial (2012) ranked the following obstacles of ICT integration as encountered by teachers in higher education: [1] limited number of Internet-connected PCs in the faculty room; [2] inadequate number of electronic audio and visual equipment; [3] limited bandwidth that results to slow internet connection for online activities; [4] inadequate number of computers available in the faculty room;

[5] lack of knowledge and training in using the available e-learning tools; [6] not enough time to develop e-learning materials for classroom instruction; [7] get used to and contented with the traditional mode of instruction; [8] afraid to use computers and other electronic equipment; and [9] unavailability of software applications installed in the computer for faculty use.

Globally, the study of ICT in the classroom is well-researched most especially in the developed countries. On the same manner, studies from developing countries contribute equally significant results in the integration of ICT in education. Moreover, several studies in the Philippines also reported that ICT impacts teaching and learning. However, few know of these studies that focused on the pedagogical integration of ICT among teacher educators in the central part of the Philippines.

This paper presents a supplemental discussion about the ICT competence in the teacher education program in Region 7 particularly on the pedagogical integration of ICT. Specifically, this paper describes the level of competence in relation to the pedagogical use of ICT among teacher educators in Central Visayas, Philippines. It also explains the relationships between the respondent's demographic profile such as sex, age, status, type of institution, number of years in teaching, highest educational attainment and the level of ICT competency in operations and concepts. Likewise, it also presents the relationship between the respondent's technology ownership of a desktop, Smartphone, tablet, and a laptop and the ICT competency level in operations and concepts as perceived by the respondents. Lastly, the paper presents the relationship between Internet accessibility and ICT-pedagogical use.

## RELATED LITERATURE

The well-studied framework about pedagogy and technology is the Technological Pedagogical Content Knowledge (TPACK). As defined in its website [tpack.org], "TPACK is a framework that identifies the knowledge teachers need to teach effectively with technology" (Figure 1). The TPACK framework is an extension of the Shulman's idea of Pedagogical Content Knowledge. It has seven components that include content knowledge, pedagogical knowledge, technology knowledge, pedagogical content

knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. On the website, it explains

At the heart of the TPACK framework, is the complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). The TPACK approach goes beyond seeing these three knowledge bases in isolation. TPACK also emphasizes the new kinds of knowledge that lie at the intersections between them, representing four more knowledge bases applicable to teaching with technology: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and the intersection of all three circles, Technological Pedagogical Content Knowledge (TPACK).

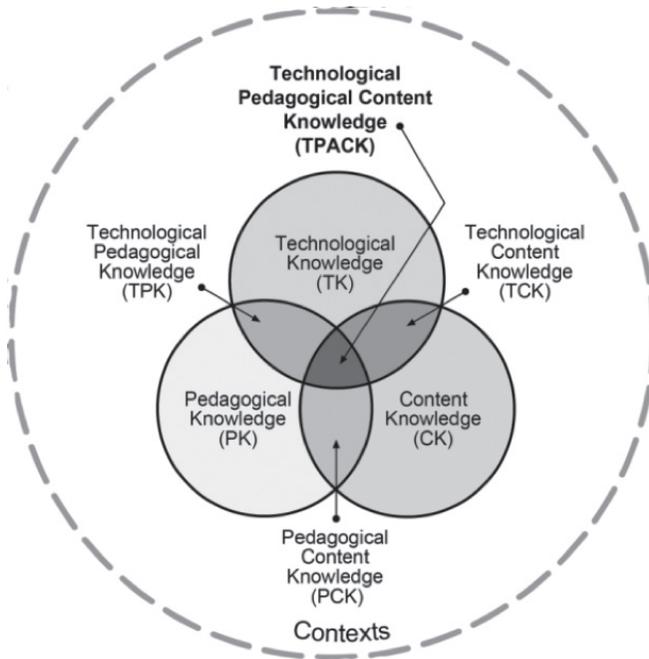


Figure 1. **Technological Pedagogical Content Knowledge (TPACK) Model.** Reproduced by permission of the publisher, © 2012 by tpack.org

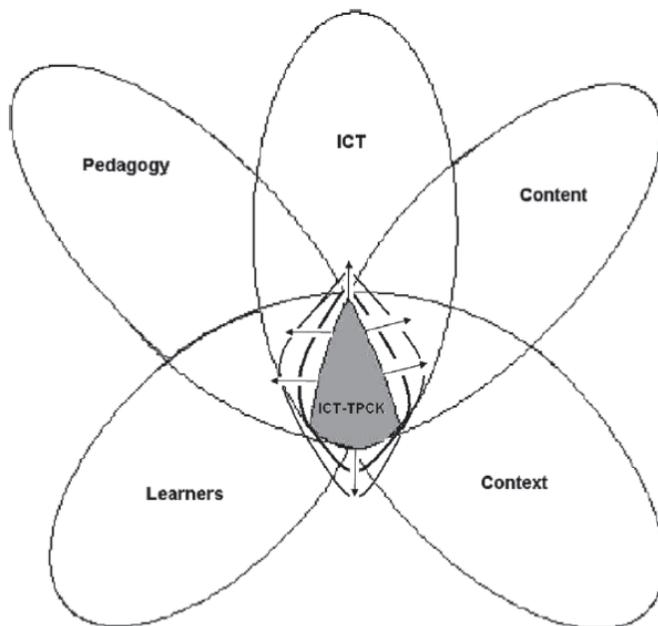


Figure 2. **ICT-TPACK**. Adapted from Angeli and Valanides (2009), p. 157.

Furthermore, TPACK framework is a generative framework helpful to pre-service teachers. It guides pre-service teachers' preparation to integrate ICT into classrooms teaching and learning (Chai, Koh, Tsai, Lee, & Tan, 2011). As a strand of TPACK, ICT-TPCK was introduced by Angeli and Valanides (2009) (Figure 2). They described ICT-TPCK as "the ways knowledge about tools and their affordances, pedagogy, content, learners and context are synthesized." They explained that topics that are difficult to be understood by learners or hard to be presented by teachers could be taught more effectively with technology. Hennessy et al. (2007) concluded that the use of ICT allows students to engage in "What If" explorations. However, field experience with educational technology courses are vital components in the design and implementation of technology-integrated lessons. It was found that both variables could significantly influence pre-service teachers' ability to combine content, pedagogy and technology (Mouza, Karchmer-Klein, Nandakumar, Ozden, & Hu, 2014).

The Bangkok website of UNESCO (2011) has declared that "the use of ICT can contribute to a movement towards constructive teaching approaches, and constructive teaching processes can

lead to greater use of ICT in education.” The UNESCO ICT framework explained that “the former approach is the traditional method while the latter refers to a way of teaching that demands a redefinition of the traditional teacher-student relationship.” This method is adapted by Trinidad (2003) explaining that this shift from having a teacher-centered to learner-centered environment is not easy, and it entails a long and rigorous process. Shown in table 1 is a comparison between the types of pedagogy, and teacher-centered and learner-centered environments.

Table 1. **Teacher-centered and Learner-centered Learning Environment.**

	<b>Teacher-centered learning environments</b>	<b>Learner-centered learning environments</b>
Classroom activity	Teacher-centered. Didactic.	Learner-centered. Interactive.
Teacher’s role	Fact teller, primary source of information, content expert, and source of all answers.	Collaborator, mediator, mentor, coach, sometimes co-learner and knowledge navigator. Gives students more options and responsibilities for their own learning.
Student’s role	Passive recipient of information, reproducing knowledge, learning as a solitary activity.	Active participant in the learning process, producing and sharing knowledge, participating at times as expert, learning collaboratively with others.
Instructional emphasis	Facts, memorization, and accumulation of facts.	Relationships, inquiry, and invention. Transformation of facts.

CONTINUED TO NEXT PAGE...

Table 1. **Teacher-centered and Learner-centered Learning Environment.** (CONTINUED...)

	<b>Teacher-centered learning environments</b>	<b>Learner-centered learning environments</b>
Concepts of knowledge	Quantity, comprehension, and accumulation of facts.	Quality of understanding, application, synthesis, and evaluation.
Demonstration of success	Norm-referenced	Criterion-referenced
Assessment	Multiple-choice items, exams, and essays	Portfolios and performance or product-based assessment
Technology use	Drill and practice, rote learning, presenting via PowerPoint	Communication, access, collaboration, expression, sharing of data, and e-learning

Adapted from Sandholtz, Ringstaff, and Dwyer (1997) and UNESCO (2011), as cited in Trinidad (2003), p. 99.

Among the popular technologies in a learner-centered learning environment is the e-learning. E-learning is broadly inclusive of all forms of ICT in teaching and learning. Because of this, e-learning evolves according to its composition and delivery method. Some of the common terms of e-learning includes multimedia learning, technology-enhanced learning, technology-rich learning environments, computer-based instruction, computer-based training, computer-assisted instruction or computer-aided instruction, Internet-based training, web-based training, online education, virtual education, virtual learning environments, mobile-learning, and digital educational collaboration. These names vary according to pedagogical perspectives or learning theories. Among these are social-constructivist, and Laurillard's Conversational Model including Gilly Salmon's five-stage model, cognitive, emotional, behavioral, and contextual perspective. For Mayes & de Freitas (n.d.), e-learning can be viewed in three broad theoretical perspectives: associationist, cognitive, and situative.

Emerging pedagogical trends that geared towards a student-centered environment are open learning, increased sharing of power between the professor and the learner, and increased use of technology (Ontario Online Learning Portal, n.d.). The portal

describes ICT integration's role as not only to deliver teaching, but also to support and assist students and to provide new forms of student assessment. Further, pedagogy is becoming complex and dynamic like learning analytics. Kanwar (2014) showed two examples of learning analytics; these are predictive systems and recommender systems. Both systems require sophisticated computer programming. Computerized pedagogical planners (Olimpo et al., 2010), outcomes-based education planners and makers, web-based service-learning systems among others are now changing the landscape in pedagogy.

The UNESCO ICT Competency Standards for Teachers also address six components of the educational system. It is essential to note that the Standards do not merely focus on ICT skills. Rather, they include training in ICT skills as part of a comprehensive approach to education reform that includes: policy, curriculum and assessment, pedagogy, the use of technology, school organization and administration, and teacher professional development. It can be noted that UNESCO (2011) defined three approaches of ICT competency in pedagogy. These are *integrate technology*, *complex problem-solving*, and *self-management*. Described in the UNESCO ICT CST, *integrate technology* approach refers to the changes in pedagogical practice that involve the integration of various technologies, tools, and e-content as part of a whole class, group, and individual student activities to support didactic instruction. *Complex problem-solving* approach includes collaborative problem- and project-based learning in which students explore a subject deeply and bring their knowledge to bear on complex, everyday questions, issues, and problems. The *self-management* approach is described as that phase when students are working in a learning community in which they are continuously engaged in creating knowledge products and building on their own and each other's knowledge base and learning skills.

Similarly, the Philippines has its own competency standard. Formulated by the Commission on Information and Communication Technology, the National ICT Competency Standard for Teachers, also known as NICS-Teachers came out in 2006. The national standard defines the competency outcomes, and the supporting knowledge and skills needed to deploy ICT in performing the job roles related to teaching. NICS-Teachers is supported by various public and private interest groups that seek to improve pre-service and in-service trainings of teachers on

the use of ICT in education. References of NICS-Teachers include ISTE NETS-S and IFIP Curriculum-Professional Development of Teachers. NICS-Teachers consists of four elements such as skill set standard that describes the key area of competency, a descriptor that describes the covered skills set, statements that describe the outcome in terms of the key areas of competence, and indicators that determine the actions the individual would take to manifest scope of competence. Most importantly, NICS-Teachers consists four domains of skill set. One of the domains is pedagogical integration that includes competencies related to the use of technology in the components in instruction processes. These processes are [1] planning and designing effective learning environments and experiences supported by technology; [2] implementing, facilitating and monitoring teaching and learning strategies that incorporate a variety of ICT to develop and improve student learning; and [3] assessing and evaluating student learning and performances. The pedagogical domain in NICS-Teachers has six competency standards. Digital tools specified in the standard include databases, spreadsheets, concept mapping tools, communication tools, data analysis tools, slide presentations, multimedia tools, email, Web 2.0, computer-based assessments and evaluation, and online repositories (NICS-Teachers, n.d.).

## METHODOLOGY

### Design and Environment

The study implemented a descriptive-correlative approach and utilized a survey method. The study was conducted in all recognized higher education institutions (HEIs) offering any teacher education programs in the four provinces in Region 7, Philippines. Teacher education program refers to degree programs such as Bachelor of Science in Secondary Education and Bachelor of Science in Elementary Education offered in public and private HEIs. All private and public HEIs including community colleges were included (Table 2). The respondents of the study are all full-time faculty teaching any professional or specialization courses of teacher education program in the provinces of Bohol, Cebu, Negros Oriental and Siquijor.

## Respondents

All HEIs offering teacher education programs in Region 7 were considered. A total enumeration of respondents was employed. The identification of HEIs was based on the list given by CHED Region 7 office, dated January 31, 2013. Table 2 shows the summary of the number of HEIs offering teacher education programs in the region.

Table 2. **Summary of HEIs Offering Teacher Education Program in Region 7.**

Type of HEIs	Bohol		Cebu		Negros Oriental		Siquijor		Total	
	f	%	f	%	f	%	f	%	f	%
Public	7	35.00	17	27.42	9	42.86	1	25	34	31.78
Private	13	65.00	45	72.58	12	57.14	3	75	73	68.22
<b>Total</b>	<b>20</b>	<b>100.00</b>	<b>62</b>	<b>100.00</b>	<b>21</b>	<b>100.00</b>	<b>4</b>	<b>100</b>	<b>107</b>	<b>100.00</b>

A total of 76 out of 107 HEIs participated during the administration of the survey (Table 3). All schools in Bohol and Siquijor participated in the investigation. In Negros Oriental, 12 out of 21 schools from Negros Oriental participated and included in the analysis of the study. Five HEIs in Negros Oriental are no longer offering teacher education program as listed in CHED's database. Some HEIs in Negros Oriental did not return the questionnaires. In Cebu, 40 out of 62 HEIs were included in the analysis of the study. There were filled out questionnaires from two schools rejected due to the qualifications of the persons who answered the survey tool. Some Cebu schools opted not to participate in the study, and some did not return the questionnaires after several days of extension. In total, responses from 23 (30.26%) public and 53 (69.74%) private HEIs were included in the study.

Table 3. **Summary of HEIs participated in the Study.**

Type of HEIs	Bohol		Cebu		Negros Oriental		Siquijor		Total	
	f	%	f	%	f	%	f	%	f	%
Public	7	35.00	12	19.35	3	25.00	1	25	23	30.26
Private	13	65.00	28	45.16	9	75.00	3	75	53	69.74
<b>Total</b>	<b>20</b>	<b>100.00</b>	<b>40</b>	<b>100.00</b>	<b>12</b>	<b>100.00</b>	<b>4</b>	<b>100</b>	<b>76</b>	<b>100.00</b>

## Instrument

The instrument used in data gathering to accomplish the specific objectives of the study was a survey questionnaire. Questions related to ICT competencies in teacher development were based on the Philippine's National ICT Competency Standards for Teachers. Respondents were asked to evaluate the level of their competency according to the five-point Likert scale choices: 1—poor (don't know anything about it); 2—fair (just read from a book/heard it from others); 3—good (has the ability to explain and discuss the task but has not experienced the actual process); 4—very good (has the ability to perform and carry out the task but needs the help, advice, and guidance from an expert); and 5—excellent (has the ability to perform and carry out the task proficiently without the help of an expert). The questionnaire was drafted based on national and integration competency standards. Then, a test-retest among 23 qualified testers was conducted to measure the reliability of the instrument. These testers are full-time faculty in Silliman University College of Education teaching in the high school department. They were chosen because they have similar teaching attributes with the respondents. The testers were randomly selected in coordination with the college dean. Administration of the test-retest was conducted in two (2) weeks by distributing the hard copy of the questionnaire. Using statistical software, the test-retest answers were processed. Items that were not significant either at 0.01 or 0.05 levels were removed.

## Administration and Statistical Treatment

The survey administration process was done in two distribution periods. In total, 383 responses were accepted and included in the analysis coming from 76 private and public HEIs in the four provinces. Filled-out questionnaires from unqualified respondents were rejected, including those questionnaires that were mostly unanswered. In this case, 40 survey questionnaires were rejected. The statistical tools employed in the data processing were the weighted mean for measuring the competency level and chi-square for testing the relationships.

Table 4. ICT Competency Level in Pedagogical Domain.

Pedagogical Skills	Bohol	Cebu	Negros Oriental	Siquijor	Total
	( $\bar{x}$ ) Description				
Making students use databases, spreadsheets, concept mapping tools and communication tools, etc.;	(2.52) Fair	(2.89) Good	(2.63) Good	(2.57) Fair	(2.65) Good
Encouraging students to do data analysis, problem solving, decision making, and exchange of ideas;	(2.81) Good	(3.10) Good	(3.04) Good	(2.93) Good	(2.97) Good
Using appropriately slide presentations, videos, audio and other media in the classroom;	(3.15) Good	(3.40) Very Good	(3.34) Good	(3.43) Very Good	(3.33) Good
Teaching students to use various multimedia materials for the reports and class presentations;	(3.06) Good	(3.40) Very Good	(3.32) Good	(3.07) Good	(3.21) Good
Using various synchronous and asynchronous communication tools (email, chat, white boards, forum, blogs);	(2.80) Good	(3.18) Good	(3.01) Good	(2.86) Good	(2.96) Good
Facilitating cooperative learning and exchange of ideas and information;	(3.25) Good	(3.41) Very Good	(3.35) Good	(3.14) Good	(3.29) Good
Using electronic means of administering quizzes and examinations;	(2.60) Good	(2.79) Good	(2.74) Good	(2.64) Good	(2.69) Good
Analyzing assessment data using spreadsheets and statistical applications;	(2.69) Good	(2.79) Good	(2.72) Good	(2.36) Fair	(2.64) Good

CONTINUED TO NEXT PAGE...

Table 4. ICT Competency Level in Pedagogical Domain. (CONTINUED...)

Pedagogical Skills	Bohol	Cebu	Negros Oriental	Siquijor	Total
	(x) Description	(x) Description	(x) Description	(x) Description	(x) Description
Exploring the use of electronic assessment tools like on line testing, submission of projects via email or on line facilities;	(2.65) Good	(2.83) Good	(2.72) Good	(2.29) Fair	(2.62) Good
Setting up online databases or repositories of student works.	(2.46) Fair	(2.54) Fair	(2.57) Fair	(2.21) Fair	(2.45) Fair
Aggregate Mean	(2.80) Good	(3.03) Good	(2.94) Good	(2.75) Good	(2.88) Good

## RESULTS AND DISCUSSION

### Competency Level of ICT Pedagogical Integration

Table 4 is the level of ICT competency of the respondents in relation to the pedagogical integration. This domain includes competencies related to the use of technology in the teaching instruction as listed in NICS-Teachers. The respondents perceived themselves to have “good” competency in terms of the pedagogical integration of ICT with a total mean of 2.88. Specifically, the data showed that the capability of setting up online databases or repositories of student works was rated fair in all provinces with  $\bar{x} = 2.21$  in Siquijor,  $\bar{x} = 2.46$  in Bohol,  $\bar{x} = 2.54$  in Cebu and  $\bar{x} = 2.57$  in Negros Oriental. Bohol teachers perceived also that they have a fair level of competency in making students use databases, spreadsheets, concept mapping tools and communication tools ( $\bar{x} = 2.52$ ). Cebu teachers perceived themselves to be very good at facilitating collaborative learning and exchange of ideas and information ( $\bar{x} = 3.41$ ), using appropriately slide presentations, videos, audio and other media in the classroom ( $\bar{x} = 3.40$ ), and teaching students to use various multimedia materials ( $\bar{x} = 3.40$ ). Teachers from Siquijor perceived themselves to be very good also in using slide presentations, videos, audio and other media in the classroom ( $\bar{x} = 3.43$ ). However, they have many fair levels of pedagogical competencies such as skills in making students use databases, spreadsheets, concept mapping tools and communication tools ( $\bar{x} = 2.57$ ), analyzing assessment data using spreadsheets and statistical applications ( $\bar{x} = 2.36$ ) and exploring the use of electronic assessment tools like online testing, submission of projects via email or online facilities ( $\bar{x} = 2.29$ ).

The result implies that teacher educators in the region can interpret and discuss ICT pedagogically, but have not experienced the actual pedagogical infusion of ICT. Specifically, the result suggests that the respondents have not used communication and data analysis software in their teaching and have not acquired the full potential of using communication software. One website pointed out that “the availability of communicating (and learning) through the Internet has brought phenomenal resources into the lives of anyone connected to it.” The website further described that online communication tools are used in order “to bring ‘experts’ into the classroom, to collaborate with other classrooms across

the globe, to connect with guest readers, [to] address the learning styles of their digital-age students, as well as [use] research-based 'best practices'." Among the most common synchronous web-based communication tools that is being utilized in the classroom, is Skype. Teachers must take advantage of this tool.

Likewise, the result entails that the respondents can discuss but have not experienced applying data analysis software to develop students' higher order thinking skills and creativity. It can be noted that data analysis software is a computer program to inspect, clean, transform, and model data with the goal of highlighting useful information, suggesting conclusions and supporting decision making. Data analysis software is commonly used in business, science, and social science domains. This fact may be the reason that the teacher educators have a moderate level of pedagogical integration in their teaching.

Further, the result also entails that the respondents can interpret, but have not experienced performance tasks for students to locate and analyze information and to use a variety of media to clearly communicate results. It may imply that the respondents have not used a variety of presentations and multimedia software. Research shows that the use of presentation software provides pedagogic benefits in the classroom. Nouri and Shahid (2008) suggested that the use of presentation software such as MS PowerPoint improves students' attitudes toward the instructor and course presentation. They also asserted that MS PowerPoint presentations may improve short-term memory depending on the topic discussed and the students' preferred presentation style. On the other hand, the use of video impacts education in three key concepts: interactivity with content, engagement, and knowledge transfer and memory (Zanetis, 2012). Further, Learningshrew's website cited several studies about the advantages of video-sharing in education. These include [1] video-sharing can be more engaging, enjoyable and motivating than other educational tools (Kay, 2012); [2] video instruction led to statistically-measurable better knowledge when tested than a pamphlet, as well as being more enjoyable (Armstrong et al., 2011); [3] video-sharing puts the students in control of when and where they access the information, and allows them to repeat all or part of the learning as needed (Hill & Nelson, 2011); [4] video-sharing widens access to education; [5] video makes possible the idea of the "Flipped Classroom"; and [6] video can generate data which can then be

extremely helpful in determining educational approaches.

Moreover, the result also suggests that the respondents are familiar, but have not experienced conducting open and flexible learning environments to support collaborative learning. It entails that the respondents are not integrating Web 2.0 tools into their teaching. In the report of an independent Committee of Inquiry into the impact on higher education of students' widespread use of Web 2.0 technologies in UK, Web 2.0 (or Social Web technologies) is described as "technologies that enable communication, collaboration, participation and sharing." Examples of Web 2.0 include social networking sites, blogs, wikis, folksonomies, video sharing sites, hosted services, web applications, and mashups. On the other hand, *cooltoolsforschools.wikispaces.com* categorized Web 2.0 according to its academic use. Web 2.0 tools include presentation tools, collaborative tools, research tools, video tools, slideshow tools, audio tools, image tools, drawing tools, writing tools, music tools, organizing tools, converting tools, mapping tools, quiz and poll tools, graphing tools, creativity tools, widgets, and file storage & web pages. Simões & Gouveia (2008) asserted that "Web 2.0 services allow the harnessing of the power of groups." They recommended that higher education should promote open and participatory ICT architectures so that students could use and produce their content. One of the most popular Web 2.0 sharing tools is Slideshare. Teachers must take advantage of this tool.

Notably, the result suggests that the respondents are aware, but have not experienced using electronic assessment and evaluation tools that are interactive and adaptable to the diverse learners. Scalise & Gifford (2006) asserted that computer-based assessment offers "powerful scoring, reporting and real-time feedback mechanisms." Higher education institutions must develop an assessment-centered e-learning system for improving student learning effectiveness (Wang, 2014).

### **Relationships between ICT Pedagogical Competency Level and the Respondent's Demographic and Technological Profile**

There are many factors that affect effective pedagogical integration of ICT. Kreijns, Van Acker, Vermeulen, & Van Buuren (2013) revealed that the proximal variables attitude, subjective norm, and self-efficacy towards ICT learning materials were significant

predictors of teachers' intention to use ICT learning materials. They added that attitudes, subjective norm, and self-efficacy mediated the effects of the three distal variables on intention: previous use, perceived knowledge and skills, and colleagues' usage of ICT learning materials. They recommended persuasive communication and skills based training as appropriate interventions. In the same manner, Liu (2011) concluded that constructivist teaching with technology to enhance student achievement could influence teacher beliefs and practices.

The results of chi-square computation for determining if significant relationships exist between the pedagogical integration of ICT and demographic profile among the respondents (Table 5) shows that there is a significant relationship between the pedagogical integration of ICT and the respondent's age ( $\chi^2 (8, N = 383) = 36.20, p < .01$ ). Age category is based on Erikson's stages of development, such as young adulthood (19-40), middle adulthood (41-65), and maturity (66-death). Like the existing literature, this study reveals that the young adult teachers garnered highest mean ( $\bar{x} = 3.12$ ) of pedagogical integration of ICT and the mature teachers getting the lowest ( $\bar{x} = 2.06$ ). The study also shows that there is a significant relationship between the pedagogical integration of ICT and the respondent's status ( $\chi^2 (8, N = 377) = 22.50, p < .01$ ). Unmarried respondents are higher in terms of the level of ICT competency ( $\bar{x} = 3.24$ ). Similarly, the data also shows that type of institution is correlated with the level of pedagogical integration of ICT ( $\chi^2 (4, N = 377) = 11.20, p < .05$ ). Respondents coming from the private schools are better ( $\bar{x} = 3.05$ ) in their pedagogical use of ICT compared to those who are coming from the public schools ( $x = 2.84$ ). There is a strong evidence of significant relationship between the respondent's number of years in teaching and level of pedagogical integration of ICT ( $\chi^2 (16, N = 383) = 49.00, p < .01$ ). Interestingly, respondent's sex and highest educational attainment are not significantly related to the level of competency in the ICT-pedagogy integration.

In the same manner, the results of chi-square computation for determining if significant relationships exist between the pedagogical integration of ICT and respondent's technology ownership (Table 6) shows that there is strong evidence of significant relationship between the pedagogical integration of ICT and the respondent's ownership of desktop ( $\chi^2 (4, N = 383) = 26.50, p < .01$ ). Pedagogical integration of ICT is also affected also

**Table 5. Relationships Between ICT Pedagogical Competency Level and the Respondent's Demographic Profile**

ICT Pedagogical Competency Level and...	$\chi^2$ Value	P value	df	Remarks
Sex	2.27	0.687	4	Not Significant
Age	36.20	0.000	8	Significant
Status	22.50	0.004	8	Significant
Type of institution	11.20	0.024	4	Significant
No. of years in teaching	49.00	0.000	16	Significant
Highest educational attainment	7.00	0.537	8	Not Significant

by smartphone ownership ( $\chi^2$  (4, N = 383) = 17.40,  $p < .01$ ) and laptop ownership ( $\chi^2$  (4, N = 383) = 15.50,  $p < .01$ ). Respondents who have computers like desktop ( $\bar{x} = 3.18$ ), smartphone ( $\bar{x} = 3.17$ ) and laptop ( $\bar{x} = 3.14$ ) have higher competency compared to those who have not ( $\bar{x} = 2.53$ ), ( $\bar{x} = 2.79$ ) and ( $\bar{x} = 2.65$ ). Further, internet accessibility is also a factor that may affect the pedagogical use of ICT in teaching and learning. Respondents with internet access at school have higher levels of pedagogical use of ICT ( $\bar{x} = 3.04$ )

**Table 6. Relationships Between ICT Pedagogical Competency Level and the Respondent's Technology Ownership.**

ICT Pedagogical Competency Level and...	$\chi^2$ Value	P value	df	Remarks
Desktop ownership	26.50	0.000	4	Significant
Smartphone ownership	17.40	0.002	4	Significant
Tablet ownership	7.50	0.112	4	Not Significant
Laptop ownership	15.50	0.004	4	Significant
Internet accessibility in the school	15.30	0.004	4	Significant

compared to those who do not have ( $\bar{x} = 2.33$ ). On the other hand, tablet ownership has no correlation with the pedagogical integration of ICT. This can be argued that the respondents have no idea on how tablet computers support mobile learning as a new pedagogy in teaching and learning.

## SUMMARY AND CONCLUSIONS

The pedagogical integration of ICT in relation to the teacher's skills domain is rated moderate, and it is at the learning level only. The level of competency in the pedagogical integration of ICT is affected by the respondent's age, status, institution, and number of years in teaching. It is noted that teacher educators from private HEIs have a higher competency level than those who are affiliated with public HEIs. Those who have a desktop, Smartphone and a laptop with internet accessibility have a higher competency level than those who do not own these gadgets.

ICT does not guarantee positive pedagogical benefits. Understanding pedagogical principles underlying the use of ICT in education is the key to innovation (Correa, Losada & Karrera, 2010). Pedagogical use of ICT in education is coupled with many theoretical and learning perspectives. Teachers must evaluate its usage and integration carefully while keeping in mind that ICT in teaching and learning is not all about the latest and the most advanced technology. They need to be proactive and responsive to their teaching strategies in order to support, guide and facilitate learning (Cox et al., 2003). They must keep in mind that ICT should be coupled with content and pedagogy.

## RECOMMENDATIONS

It is highly recommended that in-house ICT skills enhancement training for teacher educators be regularly conducted. Training providers should refer to any existing competency standards like UNESCO ICT CST, ISTE Standards-T, NICS-Teachers. They should carefully customize the standards to make it scalable and adaptable to the school. However, they should also include recent skills like those considered as 21st century tools. Most importantly, teachers must seriously immerse themselves in innovative

teaching that create student-centered learning environment.

## ACKNOWLEDGEMENTS

The funding support provided by the Commission on Higher Education through the Philippine Higher Education Research Network (PHERNet), facilitated by Silliman University through Research and Development Center is gratefully acknowledged. The research expertise of Dr. Enrique Oracion and the involvement of Dr. Pablito de la Rama are very much appreciated. The assistance of Jeambe Rendal and Kristel Puno, as well as the coordination of Ms. Mitzi Fortich, Ms. Dawn Iris Calibo and Dr. Jonathan Etcuban is deeply appreciated. The same appreciation is also given to all the field assistants and enumerators namely: Rose Ann Digal, Ma. Hazel Pantoja, Melissa Tamayo, Rosie Namoc, Mary Ann Caliao, Aahron M. Dinauanao, Cynthia S. Abellanosa, Venancio B. Fernandez, Rafael Calvo, Fritzie D. Skinner, Marites C. Melendres, Glenn A. Arnado, Robbie Austen Vailoces, Lyviendo Dales, Ramcer Dy Teves, Sheila Garcia, and Edit Albit. We are very grateful also to all school heads for accommodating us during the survey.

## REFERENCES

- Angeli, C., & Valanides, N. (2009, January). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, 51(1), 52, 154–168. doi:<http://dx.doi.org/10.1016/j.compedu.2008.07.006>
- Chai, C.S., Koh, J.H.L., Tsai, C., & Tan, L.L.W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education*, 57, 1184–1193. doi:10.1016/j.compedu.2011.01.007
- Communication Tools. (n.d.). *21 Things for the 21st Century Educators*. Retrieved from <http://www.21things4teachers.net>
- Correa, J., Losada, D., & Karrer, I. (2010). ICT policies in schools and their effect on pedagogical innovation in Spain: The Amara Berri Basque School case study. *Procedia Social and Behavioral Sciences*, 9, 44-47. doi:10.1016/j.sbspro.2010.12.113
- Cox, M., Webb, M., Abbott, C., Blakeley, B., Beauchamp, T., & Rhodes, V. (2003). *ICT and pedagogy: A review of the research literature*. Retrieved from [https://wiki.inf.ed.ac.uk/twiki/pub/ECHOES/ICT/ict\\_pedagogy\\_summary.pdf](https://wiki.inf.ed.ac.uk/twiki/pub/ECHOES/ICT/ict_pedagogy_summary.pdf)

- Hennessy, S., Wishart, J., Whitelock, D., Deaney, R., Brawn, R., la Velle, L., & Winterbottom, M. (2007, January). Pedagogical approaches for technology-integrated science teaching. *Computers & Education*, 48(1), 48, 137–152. doi:<http://dx.doi.org/10.1016/j.compedu.2006.02.004>
- Kanwar, A. (2014, June 19). *Universities in an era of open education*. Manila, Philippines.
- Kollias, A., & Kikis, K. (2005). Pedagogic innovations with the use of ICTs: From wider visions and policy reforms to school culture. *Future Learning*. Retrieved from <http://www.publicacions.ub.es/refs/indices/06319.pdf>
- Kreijns, K., Acker, F. V., Vermeulen, M., & Van Buuren, H.. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior*, 29, 217–225. doi:<http://dx.doi.org/10.1016/j.chb.2012.08.008>
- Liu, S.-H. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education*, 56, 1012–1022. doi:10.1016/j.compedu.2010.12.001
- Marcial, D. E. (2012). The familiarity and degree of integration of e-learning tools into the teaching instruction of non-information technology faculty at a Philippine university. *Silliman Journal*, 53(1), 88-128.
- Mayes, T., & de Freitas, S. (n.d.). JISC e-learning models desk study. *Review of e-learning Theories*. Retrieved from [http://www.jisc.ac.uk/uploaded\\_documents/Stage%2020Learning%20Models%20%28Version%201%29.pdf](http://www.jisc.ac.uk/uploaded_documents/Stage%2020Learning%20Models%20%28Version%201%29.pdf)
- Mouza, C., Karchmer-Klein, R., Nandakumar, R., Ozden, S.Y., & Hu, L. (2014, February). Investigating the impact of an integrated approach to the development of preservice teachers' technological pedagogical content knowledge (TPACK). *Computers & Education*, 71. doi:<http://dx.doi.org/10.1016/j.compedu.2013.09.020>
- National ICT Competency Standard (NICS) for Teachers. (n.d.). *Commission on Information and Communication Technology*. Retrieved from <http://www.ncc.gov.ph/nics/files/NICS-Teachers.pdf>
- Nouri, H., & Shahid, A. (2008). The effects of PowerPoint lecture notes on student. *The Accounting Educators' Journal*, 18, 103 -117. Retrieved from [www.aejournal.com/ojs/index.php/aej/article/viewFile/99/69](http://www.aejournal.com/ojs/index.php/aej/article/viewFile/99/69)
- Olimpo, G., Bottino, R., Earp, J., Ott, M., Pozzi, F., & Tavella, M. (2010). Pedagogical plans as communication oriented objects. *Computers & Education*, 55, 476-488. doi:10.1016/j.compedu.2010.02.011
- Ontario Online Learning Portal for Faculty and Instructors. (n.d.). A new pedagogy is emerging... and online learning is a key contributing factor. Retrieved

from <http://contactnorth.ca/trends-directions/evolving-pedagogy-0/new-pedagogy-emergingand-online-learning-key-contributing>

- Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & Education*, 58, 449-458. doi:10.1016/j.compedu.2011.08.028
- Samire, M.K. (2012). To review the barriers of ICT application in Payam Noor University of Mazandaran from professors and student point of view. *Procedia—Social and Behavioral Sciences*, 47, 180-184. doi:10.1016/j.sbspro.2012.06.635
- Scalise, K., & Gifford, B. (2006). Computer-based assessment in e-learning: A framework for constructing “intermediate constraint” questions and tasks for technology platforms. *The Journal of Technology, Learning, and Assessment*, 4(6). Retrieved from <http://ejournals.bc.edu/ojs/index.php/jtla/article/view/1653/1495>
- Simões, L., & Borges-Gouveia, L. (2008). Web 2.0 and higher education: Pedagogical implications. Proceedings of the 4th International Barcelona Conference on Higher Education. Barcelona: GUNI-Global University Network for Innovation. Retrieved from <http://www.guni-rmies.net>
- Trinidad, S. (2003). Working with technology-rich learning environments: Strategies for success. In M. Khine & D. Fisher (Eds.), *Technology-rich learning environments: A future perspective* (pp. 97-113). World Scientific Publishing Co. Pte. Ltd.
- UNESCO. (2011). *ICT competency framework for teachers*. Retrieved from <http://unesdoc.unesco.org/images/0021/002134/213475E.pdf>
- Wang, T.H. (2014). Developing an assessment-centered e-learning system for improving student learning effectiveness. *Computers & Education*, 73, 189–203. doi:<http://dx.doi.org/10.1016/j.compedu.2013.12.002>
- Zanetis, A.D. (2012, March). The impact of broadcast and streaming video in education. Cisco Systems Inc. Wainhouse Research, LLC. Retrieved from <http://www.cisco.com/web/strategy/docs/education/ciscovideowp.pdf>

NOTES





---

DISTRIBUTION AND EARLY BREEDING OF  
GREEN-FACED PARROT FINCHES  
(*Erythrura viridifacies*)

Tristan J. Davis  
Chandler, Az, USA

Don Geoff E. Tabaranza  
Mindoro Biodiversity Conservation Foundation, Inc., Alabang, Muntinlupa,  
Philippines

Mark Jason C. Villa  
Wild Bird Club of the Philippines, Manila, Philippines

J Kahlil B. Panopio  
Haribon Foundation, Quezon City, Philippines

Carl H. Oliveros  
University of Kansas Biodiversity Institute and Department of Ecology and  
Evolutionary Biology, Lawrence, KS, USA



## INTRODUCTION

THE GREEN-FACED PARROT Finch *Erythrura viridifacies* is a poorly known member of the Family Estrildidae endemic to the Philippines. Of the 10 to 13 currently recognized parrot finches (*Erythrura*), two other species occur within the Philippines: the widely-distributed Tawny-breasted Parrot Finch *Erythrura hyperythra* and the Mindanao endemic Red-eared Parrot Finch *Erythrura coloria*. The Green-faced Parrot Finch has been recorded from multiple locations on Luzon, two locations on Negros, and one location each on Panay and Cebu (Collar, Mallari, & Tabaranza, 1999; Paguntalan & Jakosalem, 2008); the species has never been recorded from the relatively large island of Mindoro. As with its congeners, the Green-tailed Parrot Finch seems to be eruptive and semi-nomadic in abundance and is apparently closely tied to presence of bamboo; higher concentrations are reported when

bamboo is in flower (Payne, 2010).

In 2013, the authors encountered the Green-faced Parrot Finch independently during three separate inventories on the island of Mindoro, which is geographically located between the other islands where the species had already been recorded. These sight and specimen records represent the first report of the species for Mindoro. Specimens obtained strongly suggest that the species breeds prior to attaining full definitive plumage.

## MINDORO RECORDS

All records of Green-faced Parrot Finch occurred in Occidental Mindoro within the Sablayan Prison and Penal Farm property on the central west part of the island (Figure 1).

1. March 4, 2013—Sablayan Prison and Penal Farm; Siburan; on trails near rest houses. MJCW saw at least four adult birds in association with flowering bamboo.

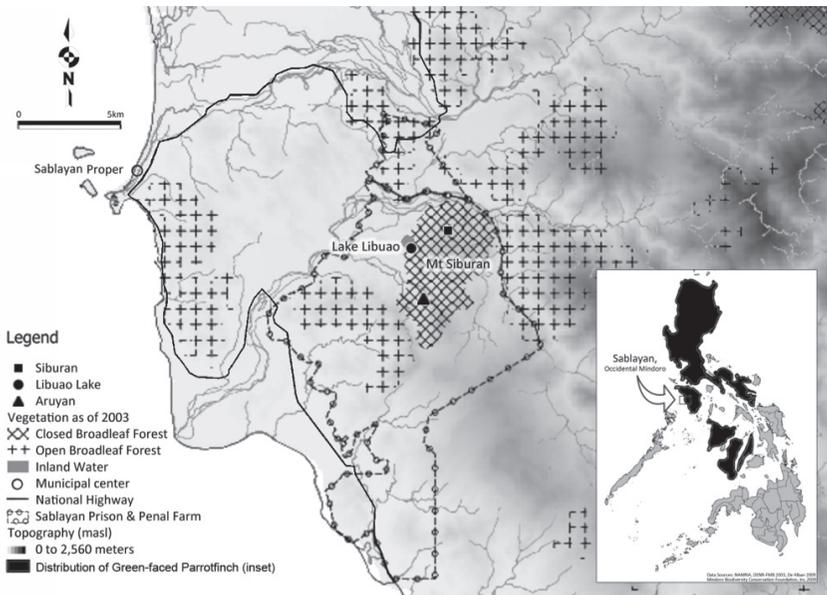


Figure 1. **Map of central Occidental Mindoro showing localities of Green-faced Parrot Finch records. Inset shows current known distribution of the species.**

Table 1. Sex, Age, Breeding, and Gonad Information From Specimens of Green-faced Parrot Finch.

KU Accession No.	Locality	Date	Sex	Skull Ossification	Bursa	Gonads (mm)	Plumage
122353	Aruyan, Bamboo patch	11 July	Male	100%	None	5.5x4	Immature
122355	Aruyan, Bamboo patch	11 July	Female	100%	None	5x3, 1.5 (ova), 3 (oviduct)	Immature
122356	Aruyan, Bamboo patch	13 July	Female	100%	None	8x6, 3 (ova)	Adult
122352	Aruyan, Old growth forest	14 July	Female	5%	None	5x3, 1.5 (ova)	Immature
122354	Aruyan, Old growth forest	15 July	Male	0% (unossified)	2 mm dia.	7.5x4	Immature
122357	Aruyan, Old growth forest	16 July	Female	0% (unossified)	3 mm dia.	8x8, 15 & 7 (ova)	Immature
122372	Libuao, second growth forest	18 July	Female	25%	None	15x8, 8 (unshelled egg)	Immature

2. May 16, 2013—Sablayan Prison and Penal Farm; Siburan. JKP and a local guide, Archie Gutierrez, saw a pair of adult birds.
3. July 11–16, 2013—Sablayan Prison and Penal Farm, Aruyan (120.916E, 12.787N), 200m. University of Kansas (KU) and Mindoro Biodiversity Conservation Foundation ornithology team (TJD, CHO, DGEF) obtained six specimens (KU 122353–1223557) captured in 12 m length mist nets placed in and near bamboo patches in tall old growth forest (Table 1).
4. July 18, 2013—Sablayan Prison and Penal Farm, Libuao Lake (120.897E, 12.818N), 170m. University of Kansas and Mindoro Biodiversity Conservation Foundation ornithology team (TJD, CHO) obtained one specimen (KU 122372) captured in a net in secondary forest near inland lake.

### ABUNDANCE AND DISTRIBUTION

Existing data indicate that, similar to other species of *Erythrura*, Green-faced Parrot Finch is nomadic, and its presence is highly correlated with flowering bamboo (Evans & Fidler, 1990; Collar et al, 1999; Payne, 2010). Both sight records support this pattern as the birds observed in March and May at Sablayan were found associated with flowering bamboo.

During the KU expedition that found Green-faced Parrot Finches at Sablayan in July 2013, all seven specimens were captured in mist nets. Most individuals captured at the Aruyan camp were from nets placed in or within 200m of extensive patches of bamboo within the hill forest. The lone capture at the Libuao Lake camp was from a net at the edge of secondary forest with only scattered bamboo. Despite multiple days searching in the habitat where we netted the seven individuals by experienced field ornithologists, no other individuals were seen; there was extremely low bird activity, including very limited vocalizations by normally vocal components of the avifauna. This similarly made locating individuals of most species in the dense habitats at Sablayan extremely infrequent during our stay. Regular captures of small numbers of birds seem to support the observation that the population is not permanent, is dispersed at this time of the year, and is highly nomadic, especially for first year juveniles.

That more juveniles were captured in July 2013 may indicate that first-year birds disperse rapidly after fledging to occupy suitable habitat and/or take advantage of temporary resources.

As a result of these new Mindoro records, the Green-faced Parrot Finch is much more widespread than known only a few decades ago. The range of this species now spans five of the larger islands in the Philippine archipelago (Philippine island size rank in land mass measured in km<sup>2</sup> in parentheses [Dickinson et al. 1991]): Luzon (1), Negros (3), Panay (6), Mindoro (7), and Cebu (9). These islands also form the northern and western line of major islands in the chain; with the Mindoro records, there is no longer a gap in the geographical distribution among islands (Figure 1, inset).

It is possible that further research on other large islands in the archipelago adjacent to islands where the Green-faced Parrot Finch is now known (Samar, Leyte, Bohol) will demonstrate the species is even more widely distributed. The largest Philippine island from which the Green-faced Parrot Finch is unknown is Mindanao. Although Green-faced Parrot Finch may occur on this island, it may be replaced there by Mindanao's endemic Red-eared Parrot Finch that occurs in similar habitat at higher elevations; nonetheless, Green-faced Parrot Finch should be searched for there at elevations below 1000m where no Parrot Finch has yet been recorded (Kennedy, Gonzales, Dickinson, Miranda, & Fisher, 2000).

Despite the presence of flowering bamboo, the only other *Erythrura* known from Mindoro, the Tawny-breasted Parrot Finch, was not recorded at our sites. However, our study sites may have been too low in elevation to document the species (Kennedy et al. 2000).

## PLUMAGE AND BREEDING

Green-faced Parrot Finches are sexually monomorphic with only very minor differences between adult males and females (Payne, 2010). Juvenile plumage is typically described as similar to adult females, but paler and with the under parts buff (Evans & Fidler, 1990; Payne, 2010). Of the two sight records of multiple individuals from March and May 2013, all birds observed were clearly in an adult plumage. However, of the seven specimens collected in July



Figure 2. **Adult and immature plumage of Green-faced Parrot Finch. Note uniform green under parts and longer tail in adult female (L) and shorter tail and buff under parts sharply demarcated from green lower throat/upper breast in juvenile (R).**

2013, all but one—an adult female—were in the very distinctive juvenile plumage; additionally, we found the immature plumage to be quite distinct from the adult female plumage with the latter more closely matching the adult male plumage (Figure 2). As can be seen in Table 1, immature plumage occurred irrespective of skull ossification (ranged from 0–100% ossified) or presence of a bursa (only two with measurable bursas of 2mm and 3mm).

Little has been published on the breeding ecology of Green-faced Parrot Finches in the wild. Collar et al. (1999) inferred at least some breeding take place in May based on gonad development (males with enlarged gonads; females with undeveloped gonads). While Payne (2010) indicated the breeding season appears to be March–April and males perform a courtship similar to a congener. It is unclear whether they were referring to wild or captive birds because the remainder of their information on breeding specifically refers to data from captive birds.

Breeding Green-faced Parrot Finches in captivity has been relatively unsuccessful with several attempts failing to produce even one clutch (Morly, 1984; Evans & Fidler, 1990). Currently,

this species seems to be one of the rarest of the grass finches in aviculture.

At least two female (ovary > 5mm long, ova larger than 1mm diameter) and one male (testes 7.5x4mm) specimens are in immature plumage but appear to be actively breeding based on gonad condition, including one female with an unshelled egg in its oviduct (Table 1). Based on the gonad development, it is clear that immature *Erythrura* at least attempt breeding prior to attaining definitive adult plumage characteristics (fully pneumatized skulls, lack of bursa, as well as adult plumage).

Data on early breeding of members of *Erythrura* are limited, and refer almost exclusively to captive birds. Evans & Fidler (1990) cited several instances of early breeding for members of the genus, but never mentioned that they did so while in immature plumage; at least in one case, breeding in captivity was more successful with younger birds (under 12 months). Savage (1897) found a pair of young birds that were supposedly a pair, but did not indicate they had ever been bred successfully.

Captive immatures are usually removed from adult birds early on and not presented with resources that may stimulate breeding (nest material, nest boxes, soft food, etc.); some breeders have had several species of *Erythrura* breed successfully when at least one member of the pair was in immature plumage (Scott Golden, Rich Dozaba, pers. comm.). Golden also indicated that immature birds rarely paired with other immature birds; pairs would be made up of one adult and one immature bird. In these instances, a sex imbalance may influence pairing with immatures. The Gouldian Finch *Erythrura gouldiae* is relatively well-known in aviculture for both retaining their immature plumage longer than other parrot finches and for breeding prior to attaining adult plumage when given the opportunity (Dozaba, pers. comm.).

McRae (2014) indicated that Tricolored Parrot Finch *Erythrura tricolor* attains adult plumage in two to four months and have reproduces successfully in captivity at six months of age. Nicholson (1950) also indicated Red-headed Parrot Finch *Erythrura cyanovirens* attained adult plumage at four months. Data from captive species of *Erythrura* all indicate adult plumage is reached at an age of between four and six months (Rich Dozaba verbally; Scott Golden, Graham Lee, *in litt.*).

Although it is unknown exactly how old the immature birds we collected on Mindoro were, it may be that Green-faced Parrot

Finch retains juvenile plumage characters longer than congeners, thus increasing the probability of breeding while in immature plumage.

Because the availability of one of the primary food resources (bamboo seeds) of Green-faced Parrot Finch is unpredictable and local, early breeding may be adventitious when such resources are temporarily abundant. In these scenarios, pairs may double or triple clutch in a single favorable season providing a glut of immatures available for subsequent pairing. Scott Golden (pers. comm.) also surmised based on his experience with captive *Erythrura* that an excess of adults may promote indiscriminate pairing with immatures.

Our analysis demonstrates the importance of specimen data when studying breeding in birds where condition of the gonads can only be determined internally. More data on breeding of the poorly known *Erythrura viridifacies* in the wild is needed.

## ACKNOWLEDGEMENTS

We wish to thank the Department of Environment and Natural Resources MIMAROPA office, PENRO Occidental Mindoro and CENRO Sablayan, for facilitating permits; the Sablayan Prison and Penal Farm and Sablayan municipality for permission to work in the area; local guides and our Philippines field crew for assistance in field; and, Mark Robbins for useful comments on this manuscript. Rich Dozbaba, Scott Golden, and Graham Lee provided valuable information on captive parrot finches. Fieldwork in the Philippines was supported by a US National Science Foundation Grant to R. Brown and R. Moyle (DEB 0743576).

## REFERENCES

- Collar, N.J., Mallari, N.A.D., & Tabaranza, B.R. (1999). *Threatened birds of the Philippines; The Haribon Foundation/Bird Life International Red Data Book*. Makati City: Bookmark.
- Evans, S., & Fidler, M. (1990). *Parrot finches: The aviculturist's guide*. London: Blanford.
- Kennedy, R.S., Gonzales, P.C., Dickinson, E.C., Miranda, H.C. Jr., & Fisher, T.H. (2000). *A guide to the birds of the Philippines*. UK: Oxford University Press; reprinted 2012.
- McRae, G. (2014). The Tanimbar, Tri-coloured or Forbes parrotfinch (*Erythrura*

- tricolor). Retrieved from <http://www.finchsociety.org/cfa/tanimbar/tanimbar.htm>
- Morley, I. (1984). Experiences with the Green-faced Parrot Finch. *The Grassfinch*, 8, 108–110.
- Nicholson, N. (1950). Breeding of Red-headed Parrot Finches. *Avicultural Magazine*, 56, 249–252.
- Paguntalan, L.M.J., & Jakosalem, P.G. (2008). Significant records of birds in forests on Cebu Island, Central Philippines. *Forktail* 24, 48–56.
- Payne, R.B. (2010). Family *Estrildidae* (waxbills). In J. del Hoyo, A. Elliott, & D.A. Cristie (Eds.). *Handbook of the birds of the world, Vol. 15, Weavers to new world warblers*, pp. 234–377. Barcelona: Lynx Edicions.
- Savage, E. (1897). Parrot finches. *Avicultural Magazine* 3, 166–167.

---

# ADDRESSING NATURAL DISASTERS: A MULTISECTORAL PROACTIVE APPROACH

Grace S. Burgos  
Christine Y. de la Peña  
Novalisa A. Leon  
Theorose June Q. Bustillo

College of Nursing  
Silliman University, Dumaguete City, Philippines



It is not uncommon for the Philippines to experience natural disasters particularly typhoons. According to the Intergovernmental Panel on Climate Change (2001) "changes in climate not only affect average temperatures, but also extreme temperatures, increasing the likelihood of weather-related natural disasters." Natural disasters are unstoppable occurrences in the Philippines. Adaptation by considering it as a "way of life" compels the necessity for preemptive measures by having a feasible and sustainable disaster preparedness plan.

---

**KEYWORDS:** disaster, disaster preparedness, mitigation, cultural awareness, cultural sensitivity

## INTRODUCTION

DISASTERS HAVE BEEN defined as "ecologic disruptions, or emergencies of a severity and magnitude resulting in deaths,

injuries, illness, loss of livelihoods, infrastructures and facility destruction that cannot be effectively managed by routine procedures, or resources and will require outside assistance” (Veenema, 2006). For health care providers, disasters are defined by their impact on the health of the people and on health care services.

Nurses are often considered the health care personnel who will be deployed as first responders, direct care providers, on site coordinators of care, information providers or educators, mental health counselors and triage officers when disaster comes (WHO, 2009). In as much as the nursing workforce constitute the largest group of health care providers, their readiness and willingness to respond to disasters and engage in preparedness and recovery activities will be significant in creating and assisting the community to be more resilient against disasters (Chan et al., 2010).

Indeed, nurses play a major role in any disaster preparedness and it is just but imperative that they be equipped with the basic knowledge on disaster science, and the five areas of focus in emergency and disaster preparedness: preparedness, mitigation, response, recovery, and evaluation (Veneema, 2006). It was revealed that a lack of accepted competencies and gaps in education make it difficult to recruit nurses prepared to respond to a disaster and provide assistance in an effective manner (Chan et al, 2010; WHO, 2009).

As a result, the International Council of Nurses (ICN) and World Health Organization jointly devised a Framework of Nursing Disaster Competencies that define nurses’ role in disasters, as well as serve as a guide in the development of training and education. Some schools in China adapted this competency in the undergraduate level but offered this as a continuing education for graduate students. The post training assessment proved student’s increased knowledge on disaster preparedness as well as in the willingness and desire to help when disaster occurs.

Meanwhile, ICN explicitly defined its position on disaster preparedness as follows:

- Assisting countries in planning and integrating disaster prevention and reduction within the existing machinery and strategies and devise contingency plans for disaster prone areas to have better and easier access to alternative health care

services.

- Encourage National Nurse Associations (NNAs) to develop and support regulatory framework allowing and assisting nurses to meet regulatory requirements in a timely manner when providing nursing care to affected areas.
- Lobby development banks and international financial institutions to incorporate disaster preparedness and mitigation in their aide programs.
- Promote dissemination and access to knowledge, information, training and technology.
- Develop, encourage, and support international networks.
- Support international coordination relief efforts to reduce duplication of services.
- Support NNAs in their work to mitigate the impact of natural disasters.

Disaster preparedness and management is not solely the responsibility of the medical responders nor of the nursing workforce, but is a multi-sectoral concern in all levels. Societies do have the capability to take measures to protect the vulnerable population and reduce the risk and improve the condition of those affected by the disasters. An organized and coordinated effort from the different sectors in the community such as family units, academe, local, regional and national government, community, health sectors, mass media, and international organizations mitigates the serious outcome of disasters.

Disasters seek no boundaries and even developed countries such as the United States (US) and Japan had their share of disasters. The US suffered from the devastating effect of Hurricane Katrina in all angles in 2005. Survivors were displaced to different places including Houston, Texas. Katrina's tragedy was compounded by human negligence of ignoring an old levee system. Slow response following the disaster resulted in the high loss of lives and properties. Many residents disregard initial warnings to evacuate, putting a severe strain on rescue operations.

The rescue and recovery efforts following Katrina became highly politicized, with federal, state and local officials “pointing fingers at one another” (Zimmerman, 2012).

In 2011, Japan’s earthquake and tsunami during and after evacuation, revealed that many people died unnecessarily due to lack of education and skepticism of warnings. Delayed evacuation and non-evacuation were significant in influencing life loss and lives of emergency responders or other community members (Fraser, Leonard, Matsuo, & Murakami, 2012). Disaster management involves preparing, supporting, and rebuilding society when natural or human-made disasters occur not only at the local level but also at the regional and national levels especially when the local level gets paralyzed by the disaster itself (Wilson et al., 2008).

In October of 2013, Bohol experienced an earthquake of 7.2 magnitude resulting in devastation of historical, religious infrastructure but more importantly loss of lives. A month after that, super typhoon Yolanda (Haiyan) ravaged the Visayan region with its unprecedented devastation particularly in Tacloban. An estimate of more than 6,000 perished while leaving thousands of individuals wounded and homeless. Chaos was obvious on the ground, with the local and national level leaders pointing fingers at each other, which delayed rescue and recovery efforts including the distribution of relief goods and services. Allow me (Grace) to share my personal experience in witnessing the effects of this disaster and things I learned from the experience.

Eight days after Yolanda, my husband and I initially sent five pairs of boots, gloves and masks for workers to use to remove debris and dead bodies in a local hospital in Tacloban. Reflecting that I [could] do more and believing that I [could] be of help having the emergency nursing experience in the US, I volunteered to travel with One Rescue team of Dumaguete to render medical/nursing services to Tacloban taking with me medications to be donated. As we travelled through Abuyog, Leyte, it was obvious that people lost their houses and livelihood. But the worst one was in Tacloban City. Obviously, noise was both on and off land. C-130 planes taking out patients and passengers out of Tacloban, choppers dropping relief goods, trucks with military personnel providing water to

the survivors, international health organization setting up field hospital tents, and government/private trucks throwing debris and burying dead bodies.

Amidst all these, I decided not to be overwhelmed by emotion but to be functional instead. I joined the medical doctors from St Luke's Manila and Médecins Sans Frontières (MSF), functioning as a triage nurse and interpreter. There were some challenges that we encountered as a team. Health administrators in a local hospital in Tacloban were not aware of existing health services in the event patients need higher level of care. Cultural awareness was shared to the French medical team by educating the team about Filipino customs and health seeking behaviors and practices. With the bridging of cultures ongoing, patient care was not delayed.

There was another perspective that was challenged. The ethical standard of practice of respecting patients' privacy was raised by the French against Philippine media taking photographs of patients without consent. [The] media then was educated on the value of respecting privacy as a standard of practice to uphold.

## Disaster Preparedness in all Levels

After reviewing several academic journals and discussing various disaster experiences, we have come up with the following position statements:

**Family.** Family members should discuss different natural disasters as well as devise and practice an evacuation plan. We support the idea that the family, as a basic unit of society, should discuss disaster preparedness. Family units are the first to be affected during disasters. We recommend that family units should make an effort to help themselves first, instead of relying on someone. Families should be familiar with the location of evacuation centers, pay attention to directives, and follow instructions when ordered to evacuate; organize a kit with food provision, clothes, medicines and important documents before disaster strikes. Families should take evacuation instructions seriously.

**School/Universities/Academe.** Schools should be required to incorporate topics on disaster preparedness in all levels in their

curriculum. Institutions should have an evacuation plan that should be practiced at least two or three times a year. Disasters seek no time schedule when it occurs, therefore they can happen during school hours. Administrators and student representatives should be encouraged to participate in learning activities involving disaster preparedness. Students and faculty alike should possess basic knowledge on disaster preparedness. Nursing students must be prepared for possible disasters at the individual, family, and nursing program levels. If the faculty are not well prepared for disasters, students are assumed to be the same (Schmidt et al., 2011). Simulation skills can be utilized.

**Community.** Communities are encouraged to participate and coordinate with local government units with regard to disaster preparedness including identifying hazardous areas, evacuation routes and centers. Public education and awareness on disaster preparedness through barangay or town hall meetings should be a must. Proper and accurate information dissemination should be relayed. Mandatory evacuation should be enforced when needed especially those residing in the shoreline. Local governments should provide transportation to those who cannot travel on foot (using vehicles would promote risk of traffic congestion and hampering rescue efforts) and designate safe evacuation centers. Directory with hot line telephone numbers should be made available for the people to access in case of questions.

**Health sectors.** There should be creation of an interdisciplinary task force comprised of medical doctors, nurses, social workers, psychologists, firefighters, paramedics, and engineers who will be deployed in times of disasters. Providing proper training through simulation and skills enhancement should be required. Funding should be provided by the government with the cooperation of non-government units for those who want to be trained. We recommend obtaining continuing education credits on disaster preparedness. Local nursing associations such as the Philippine Nurses Association (PNA) should lobby with the Philippine Regulation Commission to include this as a requirement for license renewal (as well as to include global health issues such as communicable diseases and bioterrorism). All nurses in particular should have basic understanding of disaster science specifically on preparedness, mitigation, response, recovery and evaluation. Nurses must possess skills that will allow them to respond to large scale disaster and mass casualty events (Veenema, 2006). Health

institutions should require department heads to be available and functional in assisting patients or workflow. Administrators should be familiar with the existing services available during disasters for easy referral and to avoid delay.

**Government/non-government sectors.** Government and non-government sectors must design a clear organizational infrastructure at local, regional and national levels that will create guidelines necessary to best prepare and handle natural disasters and their aftermath. We recommend a defined procedure or command responsibility when the local level fails or cannot function. In the case of Yolanda, local government officials of Tacloban who were the first responders were also the victims. Politicizing the disaster should not be tolerated and perpetrators should be held accountable because it delays relief efforts such as what happened during Typhoon Yolanda. Government and private establishment should be required to train and educate employees on disaster preparedness.

**Mass Media.** People in the media, whether television or radio should have accurate and pertinent information when educating the public on disaster and preparedness. There should be responsible reporting that includes using clear, simple, and understandable lay terms when forecasting or delivering disaster situations. The media should coordinate with local, regional and national government units when conveying disaster awareness and preparedness information. Included should be previous historical account or information on the devastation brought by natural disasters on possible affected areas. Tacloban and other affected areas were once hit by strong typhoons in 1897 and 1912, and coincidentally images of the devastation on those years surfaced only during the aftermath of Yolanda. Probably, if these images were presented earlier, they would have served as resourceful tool in creating awareness and prompted an organized evacuation.

**Global responsibility.** Despite international preparation for these types of disasters, obvious chaos on the disaster site and decision protocols illuminate a need to create more efficient systems for disaster preparedness and response, especially with regard to global health security (Stone, 2013). The World Health Organization (WHO) or the United Nations Organization (UN) should extend assistance to developing countries such as the Philippines to create policies on disaster preparedness and provide

opportunities for learning enhancement through international forum or conference on disaster preparedness. Forums and conferences not only should address disaster preparedness as a way of life, but include issues related to natural disaster such as global warming and how to prevent and mitigate its effect on the people and the environment globally.

We encourage and support ICN advocacy on using Framework of Disaster Competencies to enhance education and awareness on disaster preparedness. We will engage ourselves with international networks such as international disaster conferences and wish to be allowed to have access to information, training, and skills acquisition.

## CONCLUSION

We can never stop disasters from happening and it would be impossible and absurd to assume zero casualty. To those injured after the disaster, rapid response to their needs with the best tools we have and modern medicine practitioners should be provided. The effective response we provide are basically the result of having the people around who have appropriate knowledge and training at the right time, who are willing to assist and provide care and who have the adequate supplies of medicines, vaccines, and diagnostic equipment such as those of the MSF and the Australian tent hospital in Tacloban during the aftermath.

Future landfall of typhoons in populated areas in the Philippines cannot be prevented, but people living in prone areas can be evacuated safely to designated evacuation centers. Societies by all means can take measures to lessen the risks and vulnerability by having adequate planning and preparation while having the ability to preserve and restore the lives of those who are caught in the disaster (Bissell & Pinet, 2004).

A workshop held in Manila January 26-30, 2015 sponsored by the United States Assistance of International Development (USAID), World Food Programme (WFP), and The Logistic Institute of Asia-Pacific at National University of Singapore (TLUI -AP) emphasized the need to improve coordination and cooperation between the different sectors. This effort will enhance the collective capacity of communities to improve the effectiveness and efficiency of humanitarian logistics operations

during disaster cycle.

Disaster preparedness and mitigation for natural disasters is an important goal, and should be way of life, but becomes unattainable when there is no serious commitment, coordination, accountability, and implementation of these measures. Implemented measures should also be evaluated for their strength, weakness, and areas to improve in order to achieve a more organized, sustainable and resilient community when another natural disaster strikes.

## REFERENCES

- Bissell, R., Pinet, L. (2004). Evidence of the effectiveness of health sector preparedness in disaster response. *Family & Community Health*. Retrieved from [www.ncbi.nlm.nih.gov/pubmed/15596966](http://www.ncbi.nlm.nih.gov/pubmed/15596966)
- Chan, S.S., Chan, W., Cheng, Y., Fung, O.W.M., Lai, T.K., Leung, A.W.K., Leung, L.K., Li, S., Yip, A.L.K., & Pang, S.M.C. (2010). Development and evaluation of an undergraduate training course for developing International Council of Nurses Disaster Competencies in China. *Journal of Nursing Scholarship*, 42(4), 405-413. Retrieved from [www.ncbi.nlm.nih.gov/pubmed/21091623](http://www.ncbi.nlm.nih.gov/pubmed/21091623)
- Fraser, S., Leonard, G.S., Matsuo, I., & Murakami, H. (2012). Tsunami evacuation: Lesson from the Great East Japan earthquake and tsunami of March 11th 2011. *GNS Science Report*. Retrieved from <http://www.civildefencegovt.nz/memwebsite.nsf/Files/TsunamiEvacuationLessonsFromTheGreatEastJapan>
- International Council of Nurses. (2010). Nurses and disaster preparedness. Retrieved from [www.icn.ch](http://www.icn.ch)
- Schmidt, C.K., Davis, J.M., Sanders, J. L., Chapman, L., Cisco, M.C., & Hady, A. (2011). Exploring nursing students: Level of preparedness for disaster response. *Nursing Education Perspective*. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/22235694>
- Stone, L. (2013). A typhoon of global health concerns: Natural disaster preparedness and response. *Global Health Governance*. Retrieved from <http://blogs.shu.edu/ghg/2013/12/10/a-typhoon-of-global-health-concerns-natural->
- Veneema, T.G. (2006). Expanding educational opportunities in disaster response and emergency preparedness for nurses. *Nursing Education Perspective*. Retrieved from [www.ncbi.nlm.nih.gov](http://www.ncbi.nlm.nih.gov)
- Wison, S.A., Temple, B.J., Milliron, M.E., Vasquez, C., Packard, M.D., & Ruby, B.S. (2008). The lack of disaster preparedness by the public and its effect on the

---

communities. *Internal Journal of Rescue & Disaster Medicine*. Retrieved from [ispub.com/URDM](http://ispub.com/URDM)

World Health Organization (2009). *ICN framework of disaster nursing competencies*. Geneva, Switzerland: WHO.

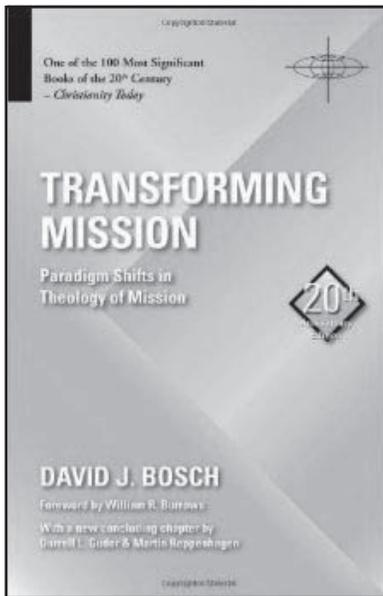
Zimmermann, K.A. (2012). Hurricane Katrina: Facts, damage & aftermath. *Live Science*. Retrieved from <http://www.livescience.com/22522-hurricane-katrina-facts.html>



REVIEW







# TRANSFORMING MISSION: PARADIGM SHIFTS IN THEOLOGY OF MISSION

David J. Bosch

Maryknoll/New York: Orbis, 1991. (587 pp.  
including indexes)



*Review by Lily Fetalsana Apura*

BOSCH BRINGS TOGETHER a comprehensive body of knowledge gleaned from human and natural sciences, and combines this with biblical and theological learning, coming up with an incisive analysis of mission covering two centuries of Christian history. His prior knowledge of scientific research theories particularly that of Thomas Kuhn, and his readings in theology and Christian history (Hans Kung) led him to view the various ways of thinking and doing mission in terms paradigms.

Defined as “the entire constellation of beliefs, values, techniques,... shared by the members of a given community” (185, citing Kuhn), paradigms, as Bosch believes, serve as theoretical framework through which people perceive reality. Following Hans Kung’s paradigmic periodization of Christian history, Bosch presents a comprehensive analysis of historical

mission paradigms. He asserts that this approach is justified, in that theologians in each epoch generally share a common frame of reference about God, humans and the world.

By way of example, he cites common frame of reference (paradigm) for doing mission in the postmodern era (188-9):

1. The realization that the earth's resources are dwindling and that life is possible only in as much as such resources last.
2. The loss of dominance by the Christian West, and the fact that those under its sway are challenging it and are resisting its control.
3. The failure of technological progress to bring about a better world, and instead gave those who have access to it means for power and wealth, and capacity for unprecedented violence and mass destruction.
4. All over the world, those oppressed and exploited are rising in resistance against dominating powers and constructs.
5. The sense of disappointment and despair brought by the failure of the enlightenment to bring about promised progress anchored on what humans can achieve, and the realization of dominating function of Western knowledge.
6. Christians are realizing that there will always be other religions and Christianity cannot claim to stand above all.
7. Secularization of what used to be Christian West has led to the loss of faith and the traditional values necessary for human society.

There is no turning back however to the good old days when life was simple and faith seemed uncomplicated. For though scientific theories are provisional, scientific progress is undeniable. Following Kuhn's suggestion, Bosch explains that knowledge and research do not move progressively to the best and final solution but "by way of revolutions" (184). The process starts as pioneering studies begin to debunk accepted view, and begin to think of new ways of seeing and doing things in

view of the emerging problems. As the “new” paradigm grows and generates new knowledge, it matures and “in the context of an extraordinary network of diverse social and scientific factors,” gains more subscribers and “eventually the original, problem-ridden paradigm is abandoned” (184, citing Kuhn). But old paradigms do not completely disappear these may still be perpetuated by certain groups, or it can be “rediscovered” as in the case of Augustine and Luther who rediscovered the book of Romans (186). At other instances people adhere to differing paradigms at the same time.

Applied to mission, Bosch clarifies that the norms and sources of his proposed paradigm shift “can only be carried out on the basis of the gospel and because of the gospel, never... against the gospel.” The gospel must according to him be related “not only to the present and the future, but also to the past, to tradition, to God’s primary witness to humans (191f.). He states, “theology must undoubtedly always be relevant and contextual (200-203), (but)...this may never be pursued at the expense of God’s revelation in and through the history of Israel and, supremely, the event of Jesus Christ (203-206). Thus Bosch defines mission at the end of the book as “the participation of Christians in the liberating mission of Jesus..., wagering on a future that verifiable experience seem to belie... the good news of God’s love, incarnated in the witness of a community, for the sake of the world” (519).

Suggesting with Martin Hengel that mission in fact gave rise to theology, Bosch asserts that theology emerged from the necessity of doing mission (15). In this regard, Bosch gives a lucid overview of mission in Matthew, Luke-Acts, and Pauline letters. Common among the three interpretations of the Gospel is the priority Jesus gave to his mission among the Jews as he proclaimed the realization of their longed for salvation. Though confined to the Jews, Jesus left the door open for salvation to the Gentiles who were the readers of Luke-Acts. Here the writers clearly pointed solidarity and hospitality of the new community who served as witness to the work of God’s spirit among them. It was Paul who interpreted Jesus’ resurrection the universality of the Gospel, thus zealously proclaiming God’s offer of salvation to the Gentiles.

From a persecuted minority religion, Christianity won converts from the literate class, and by the second century and what for Jews was the Messiah was understood as the Lord. As God and Gospel came to be understood in Greek philosophical

thoughts, the church came to be identified with power except in the East where the church as a minority served as a bastion of what is good in Christianity.

In the Medieval times Augustine brought out the necessity of individual appropriation of God's universal offer of salvation, but the ecclesiastical structure became so dominant that it led to what Bosch termed: "ecclesiaticization of salvation" — that is salvation only in direct connection with the Roman Catholic Church. This was countered by the reformation insistence on *justification by faith* based on the premise of what God has done in Christ. Yet the theme of divine sovereignty, according to Bosch led to passivity in mission and the reformation stress on correct doctrine led to an intellectual but emotionally detached faith. Though the Kingdom of God was rightly understood as the "here and now," and evangelism was replaced by development, the apocalyptic element of faith was neglected. Hence the practice of Christianity that came with the enlightenment was highly rationalized with a misplaced belief on the capacity of human beings and of science to bring about the realization of a better world. Bosch states, "(T)he objectivist framework imposed on rationality...led to disastrous reductionism and hence to stunted human growth"(353). He believes that rationality has to be expanded to include the "will" which a function of religion, and, in the case of Christianity the place for a "chastened and humble witness to the ultimacy of God in Jesus Christ" (355).

Bosch believes that the prevailing historical determinism based on the law of cause and effect can be countered by apocalypticism, "the belief that things can be different, that it is not necessary to live by old established patterns..." (356). This he claims "both (as) a theological and sociological category" is a source of hope especially among the poor. He says, "(T)he notions of repentance and conversion, of vision, of responsibility, of revision of earlier realities and positions, long submerged by suffocating logic of rigid cause and effect thinking, have surfaced again and are inspiring people who have long lost hope, at the same time giving a new relevance to the Christian mission" (356).

Bosch proposes Christian commitment to a "fiduciary framework" with humility and self-criticism (360). In a time like ours, Christians must stand firm in their "conviction and commitment" as the Body of Christ and commit to the mission of building communities that will serve as a witness to the power

and work of God in saving people and in bringing about a *new heaven and new earth*.

This becomes clearer as he states in connection with mission and dialogue, "(W)e know only in part, but we do know. And we believe that the faith we profess is both true and just, and should be proclaimed. We do this, however, not as judges or lawyers, but as witnesses; not as soldiers, but as envoys of peace; not as high-pressure salespersons, but as ambassadors of the Servant Lord." (488).

Gleaning insights from the New Testament paradigms, the way mission has been done in the past, and presently among different Christian traditions, and, taking into consideration the postmodern context, Bosch seeks to recapture the apocalyptic nature of the gospel which he hopes would invigorate the church's spirituality and zeal for doing mission.

Finally he asserts that all the six *Christological salvific events* should always be a part of our proclamation, that we always witness to the "*incarnate, crucified, resurrected, ascended Christ, present among us in the Holy Spirit and...who will consummate history*" (518) soon.

The strength in Bosch mission treatise is that he was able to use current epistemological studies in analyzing mission in history especially its application in the modern period. Bosch agrees with Thomas Kuhn's critique of scientific methods as widely accepted, and human sciences have affirmed the implausibility of pure objectivity. Knowing this, he refrains from issuing magisterial statements (though his work is hailed as a magisterial treatise on mission), and therefore is able to speak of the postmodern situation. But Bosch stands firmly on the Christian tradition. He has a positive view of differing traditions and theologies, and he finds link for them either in the New Testament or in the emerging context of interpretation—an evidence of genuine openness. He, in no way minimizes differences but insists that polarities though uncomfortable must be affirmed, as those are parts of the whole of the church historically and universally.

Bosch in his work is able to draw broad ranging views and ways of doing mission in a way that they cohere and belong together. His book in itself is a demonstration of the paradigm he proposes. But in a time when knowledge has become so specialized, can an ordinary Christian or even a pastor involved in the day to day mission, be expected to have a good grasp of the

complexities involved in the mission of incarnating the gospel? Bosch's work is appreciated best among the academics and those who subscribe to postmodern ways of thinking. Those who still dwell in the good old days when certainty and objectivity can be presumed, will find Bosch's proposition relative and provisional. Those who deny the postmodern distrust of absolute certainty, will find his construct wanting. What he proposes is a postmodern paradigm after all. In a way Bosch modeled his mission stance in the book—a humble attestation, and witness to what “one knows to be true.”

### **ABOUT THE REVIEWER**

Lily Fetalsana Apura is a faculty member of the Religious Studies Department of Silliman University.





SILLIMAN JOURNAL

Volume 56 Number 1 2015

---

**BEN S. MALAYANG III**

Rethinking How We Do Environmental Science

**ROBERT S. GUINO-O II, MICHAEL LAWTON R. ALCALA,  
AND JOCELYN ELISE P. BASA-INOCENCIO**

Water and Bottom Sediment Quality of Pagatban River in Negros Oriental,  
Philippines: 30 Years after Mining Closure

**ANNIE MELINDA PAZ-ALBERTO, SHIRLY C. SERRANO, CECILIA T. GALVEZ,  
AND PAUL HENRIC P. GOJO CRUZ**

Plant Diversity in the Forest Ecosystem of Carranglan Watershed, Nueva Ecija,  
Philippines

**MICHAELITO A. NALDO, RAY RAFAEL S. BAYAWA, AND BEOMJUN SEO**

$\beta$ -mannanase Enzyme Supplementation of Grower-Finisher Pig Diets  
with Copra Meal

**ERIC JULIAN MANALASTAS AND NICOLO L. CABRERA**

Cigarette Smoking in Filipino Sexual-Minority Men: Further Evidence of  
Disparities in the Philippines

**ROSIANA E. RAYANTI, FERRY F. KARWUR, AND JULIANA D. KARWUR**

The Daily Life of Post-Stroke Patients in Tomohon City, North Celebes, Indonesia

**DAVE E. MARCIAL**

Pedagogical Integration of Information and Communication Technology  
Among Teacher Educators in Central Visayas, Philippines

**NOTES**

**TRISTAN J. DAVIS, DON GEOFFE E. TABARANZA, MARK JASON C. VILLA,  
J KAHLIL B. PANOPIO, AND CARL H. OLIVEROS**

Distribution and Early Breeding of Green-Faced Parrot Finches (*Erythrura  
viridifacies*)

**GRACE S. BURGOS, CHRISTINE Y. DE LA PEÑA, NOVALISA A. LEON,  
AND THEOROSE JUNE Q. BUSTILLO**

Addressing Natural Disasters: A Multisectoral Proactive Approach

**REVIEW**

**LILY FETALSANA-APURA**

On David Bosch's *Transforming Mission: Paradigm Shifts in Theology  
of Mission*

**ON THE COVER**

*Family Portrait*  
Rebecca dela Torre