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THE 16TH WORLD LAKE CONFERENCE

“Lake Ecosystem Health and Its Resilience: Diversity and Risks of Extinction”
November 7-11th, 2016 Discovery Kartika Plaza Hotel, Bali - Indonesia

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Lake Ecosystem Health and Its Resilience: Diversity and Risks of Extinction
PROCEEDINGS of the 16th World Lake Conference

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Foreword

Water, along with air, has always been the basic part of human's life. Among the water bodies, lakes are of severe impacted ecosystems despite its importance to the surroundings. Lakes confer numerous functional roles that may include defense over flood, recharge and storage of groundwater, biodiversity hot spot and the social economic services. Unfortunately, the alarming signals of lakes being under stress are underway. Contamination and pollution, sedimentation, wetland habitat degradation, alien species invasion, and other anthropogenic activities may have been the major stressors often associated with lake's deterioration. Since the issues on lake's deterioration have been globally emerged, a collected commitment should be engaged to supporting lake sustainability.

The World Lake Conference comes forward as an international forum serving to bridge communication among multi-sectoral parties towards sustainable management in lakes and basins. The 16th World Lake Conference, held from Nov 7th to 11th 2016 in Bali, Indonesia, invited distinguished keynote speakers around the globe; Prof. Takehiko Fukushima from University of Tsukuba, Prof. David Hamilton from GLEON, Prof. Walter Rast from ILEC Japan, Prof. Soontak Lee from IHP UNESCO, Dr. Fauzan Ali (Director of Research Center for Limnology, Indonesian Institute of Sciences) and Mr. Alue Dohong from Peatland Restoration Agency (Indonesia). It was also delightful that we had Governor Mikazuki from Shiga Prefectural Government (Japan) and Governor Hashimoto from Ibaraki Prefectural Government (Japan) to deliver their speeches.

The conference had also been completed nicely by the release of Bali Declaration. Another significant output of the conference is the publication of proceedings. The total papers reviewed and compiled in these proceedings are 83 which were broken up into several thematic sections. The sections comprise (1) climate change and water crisis (2) lake environment under stress and their restoration challenges (3) lake and lake basin management and policies (4) multiple water use purposes (5) water education, ecotourism, culture (6) database and knowledgebase systems, informatics and monitoring technologies (7) biodiversity and conservation (8) ecotechnology and ecohydrology (9) manmade lakes (10) limnology and limnological science fundamentals. Lastly, we acknowledge the creditable efforts and dedications that editors, reviewers and the proceeding team have been put forward.

July 2017

Prof. Gadis Sri Haryani
Chairperson of Scientific Advisory Board

Table of contents

Topic 1. Climate change and water crisis.....	1
CLIMATE CHANGE IMPACTS ON NATURAL RESOURCES AND COMMUNITIES: A GEOSPATIAL APPROACH FOR MANAGEMENT	1
R.N. Samal, A. Ojha, P.K. Mohan, J. Rout	1
Topic 2. Lake environment under stress and their restoration challenges.....	12
THE INCREASE OF FLOATING NET CAGES, AQUACULTURE AREA AND WATER QUALITY IN MANINJAU LAKE, WEST SUMATERA-INDONESIA	12
Hafrijal Syandri, Junaidi, Ainul Mardiah, and Azrita	12
BIO-ACCUMULATION OF MERCURY IN LAKE TALIWANG, WEST NUSA TENGGARA: IMPACT OF TRADITIONAL GOLD MINING	19
Suwarno Hadisusanto, Dwindi Mariska Putri, Dini Dwi Amanda	19
INCREASING HUMAN-ENVIRONMENTAL STRESSES ON CITARUM BASIN IN THE PAST DECADES	23
Eka Fibriantika, Hidayat Pawitan, Robert Delinom	23
HEAVY METALS CONTENT OF SEDIMENT AND MOLLUSC IN LAKE MANINJAU, WEST SUMATERA.....	31
Sigid Hariyadi, Muhamad Suhaemi Syawal, Yusli Wardiatno	31
CHALLENGES IN THE RESTORATION OF LAKE MANINJAU: BRIDGING ACTORS' INTERESTS FOR SUSTAINABILITY	38
Putu Oktavia, Uly Faoziyah	38
TRANSFORMATION OF ZOOPLANKTON COMMUNITIES DUE TO THE LAKES RECOVERY PROGRAMS	47
Olga Derevenskaya, Nafisa Mingazova	47
CHANGES IN THE CHEMICAL ECOLOGY OF BLUE-GREEN ALGAE DURING PERIODS OF ACTIVE GROWTH.....	53
Ikuyo Makino, Yuji Yahagi, Takahiro Nakayama and Atsushi Kobayashi	53
TROPHIC AND POLLUTION STATUS OF JAWAHAR SAGAR IN SOUTHERN RAJASTHAN, INDIA BASED ON WATER QUALITY AND MACROINVERTEBRATE FAUNA.....	59
N. Sarang, L. L. Sharma and H. K. Vardia	59
Topic 3. Lake and lake basin management and policies.....	70
STRATEGY FOR CONSERVATION AND MANAGEMENT OF URBAN LAKES IN MUMBAI	70
Pramad Salaskar; E.V. Muley	70
POTENTIAL TRADE-OFFS BETWEEN CLIMATE CHANGE ADAPTATION AND MITIGATION IN RIVER BASIN SCALE WATER MANAGEMENT.....	77
Tiina Nöges, Peeter Nöges	77
PEOPLE'S ACTIVITIES IN LAKE DANA0, PACIJAN ISLAND, CEBU, PHILIPPINES.....	84
Serapion N. Tanduyan, Genes M. Pasaje, Ricardo B. Gonzaga, Wilfredo G. An0os, Homer Gaciano, Norberto B. Andrade, Eva P. Muaña, Gabriel T. Muaña, Leif Erickson Tampus, Jonar Gonzales, Berenice T. Andriano, Lorenzo B. Andriano and Aderito Gonzales II.....	84

EFFORTS TO IMPROVE WATER QUALITY IN LAKE KASUMIGAURA BY IBARAKI PREFECTURAL GOVERNMENT	97
Kunika Soma, Tatsumi Kitamura, Takeshi Ouchi, Takuo Nemezawa, Hiroyuki Kashimura, Yoshinao Nakazawa and Mieko Kuwana..... 97	
THE GOVERNANCE OF LAKE RAWAPENING: AN INTERORGANIZATIONAL NETWORK ANALYSIS.....	101
Evi Irawan 101	
CAGE CULTURE AND LAKE MANAGEMENT PRACTICES IN LAKE DANA0, SAN FRANCISCO, CENTRAL PHILIPPINES	109
Serapion N. Tanduyan, Berenice T. Andriano and Ricardo B. Gonzaga 109	
IDENTIFICATION OF LAKE SENTARUM'S POTENTIAL ECOSYSTEM SERVICES, SOCIAL AND INSTITUTIONAL PROFILES TO SUPPORT ECOTOURISM DEVELOPMENT (A REVIEW PAPER)	117
Ivana Yuniarti..... 117	
CONFIGURATION OF LAKE TOBA MANAGEMENT BASED ON PRESIDENTIAL REGULATION NO. 81/2014	123
Lukman..... 123	
PROMOTING INTEGRATED LAKE BASIN MANAGEMENT IN LAKE NAKURU WATERSHED, KENYA.....	130
Jackson Akama Raini, Richard Kipsang Rop, Timothy Murithi Kiogora 130	
STAKEHOLDER PARTICIPATORY ROLE IN MALAYSIAN ILBM INITIATIVES RESEARCH PERSPECTIVES	136
Zati Sharip, Saim Suratman 136	
Topic 4. Multiple water use purposes.....	143
MOBILE DRINKING WATER TREATMENT PLANT (TYPE IG5M30) FOR DISASTER EMERGENCY RESPONSE	143
Ignasius D.A. Sutapa, Eka Prihatinningtyas, Eva Nafisyah and Hasan Fauzi..... 143	
Topic 5. Water education, ecotourism, culture	150
PRACTICE OF WATER ENVIRONMENTAL EDUCATION IN KASUMIGAURA WATERSHED BY TSUCHIURA CITY	150
Hiroki Nagamine, Takashi Fujiwara, Kazuhiro Mizuta..... 150	
POTENTIAL IDENTIFICATION OF FLORA AND FAUNA LAKE BUYAN AS BASIS FOR TOURISM DEVELOPMENT STRATEGY BASED ON AQUATIC ECOSYSTEMS.....	160
I Wayan Restu, Gde Raka Angga Kartika, Made Ayu Pratiwi..... 160	
Topic 6. Database and knowledgebase systems, informatics and monitoring technologies.....	167
SWAT APPLICATION TO ASSESS DIFFERENT FERTILIZATION EFFECTS ON WATER QUALITY IN AN AGRICULTURAL WATERSHED	167
Seiko Yoshikawa, Kazunori Kohyama, Yuta Shimizu, Saeko Yada, Kei Asada, Sunao Itahashi, Yasuhiro Nakajima, Sadao Eguchi..... 167	
ESTIMATING LAKE EXTENT AND WATER VOLUME OF FLOODPLAIN LAKES OF KALIMANTAN USING RADAR IMAGES	178
H. Hidayat, D.H. Hoekman, A.J. Teuling, G.S. Haryani, A.J.F. Hoitink 178	

SELF ORGANIZING MAP (SOM) AS CLUSTER MODELLING TOOL OF ALGAL BLOOMS RISK IN MANINJAU LAKE	184
Yuli Sudriani and Astried Sunaryani	184
A LAND COVER MAP ACCURACY METRIC FOR HYDROLOGICAL STUDIES.....	191
Brian Alan Johnson, Isao Endo, Akio Onishi, Milben Bragais, Damasa B. Magcale-Macandog, Emily Skeeihan	191
INVESTIGATION ON RELATIONSHIP BETWEEN LAND COVER AND WATER QUALITY CHANGES IN LAGUNA DE BAY, THE PHILIPPINES, OVER THE 2007-2015 PERIODS	196
Isao Endo, Brian Johnson, Emily Skeeihan.....	196
ASSESSMENT OF HYDROLOGIC ALTERATION WITHIN ECOSYSTEM IN A SAHALIAN SHALLOW LAKE: LAKE GUIERS, SENEGAL	200
Sambou Djiby, Diekkrüger Bernd, Gaye Adama, Gaye Amadou Thierno	200
RELATIONSHIP BETWEEN SPECTRAL OPTICAL PROPERTIES AND OPTICALLY ACTIVE SUBSTANCES (SUSPENDED MATTER) IN LAKE MANINJAU	217
Fifia Zulti, Taofik Jasalesmana, and Tri Suryono	217
18 LAND USE CHANGE ANALYSIS AT SENTARUM CATCHMENT AREA, WEST KALIMANTAN-INDONESIA	222
Iwan Ridwansyah, Kenlo Nasahara and Chikako Nishiyama, Luki Subehi.....	222
A CASE STUDY ON SIMPLE FLOODS OBSERVATION AND MAPPING SYSTEM BY IMAGE INFORMATION	232
Kiyoto Kurokawa	232
DEVELOPMENT OF SPATIAL PREDICTION MODEL TO IMPROVE LAKE WATER QUALITY MANAGEMENT IN KLANG VALLEY, MALAYSIA	240
Bashirah Fazli, Aziz Shafie, Azuhan Mohamed, Nasehir Khan E.M. Yahaya, Suriyani Awang, Azman Mat Jusoh, Normaliza Noordin and Pauziah Hanum Abdul Ghani	240
Topic 7. Biodiversity and conservation	248
HABITATS CHARACTERIZATION FOR IHAN (<i>Neolissochilus</i> sp.) CONSERVATION PLANNING AROUND LAKE TOBA, NORTH SUMATERA, INDONESIA	248
Sekar Larashati, Iwan Ridwansyah	248
AVIFAUNAL AND RIPARIAN VEGETATION COMPOSITION IN AND AROUND THE MUSEUM LAKE IN GOVERNMENT ZOOLOGICAL GARDEN THIRUVANANTHAPURAM, KERALA INDIA	258
Anila. P. Ajayan, Ajit Kumar K G, Anoop Rajamony, Prasannan Krishnankutty, Ravinesh Raveendran	258
FISH DIVERSITY OF THE SINGKARAK LAKE, INDONESIA: PRESENT STATUS AND CONSERVATION NEEDS	270
Ainul Mardiah, Azrita and Hafrijal Syandri	270
THE FISH COMMUNITIES OF ABKHAZIAN LAKES.....	276
Nail Nazarov, R. Mingaliev, Y. Badretdinova, N. Mingazova, R. Dbar, R. Zamaletdinov.....	276
EFFECT OF SEASONAL CHANGES ON SPATIAL DISTRIBUTION OF BACTERIAL PATHOGENS IN TILAPIA (<i>Oreochromis niloticus</i>) IN LAKE BATUR	279
Endang Wulandari Suryaningtyas, Devi Ulinuha.....	279
FLUCTUATING ASYMMETRY USING GEOMETRIC MORPHOMETRICS IN <i>Glossogobius giuris</i> (HAMILTON, 1822) FROM LAGUNA LAKE, PHILIPPINES.....	284
Lorenz J. Fajardo, Ma. Vivian C. Camacho and Pablo P. Ocampo	284

EARLY DETECTION OF ICHTHYOFAUNA ALIEN SPECIES AT GAJAH MUNGKUR RESERVOIR, WONOGIRI, CENTRAL JAVA, INDONESIA	293
Rikho Jerikho.....	293
FECUNDITY OF THREE SPOT GOURAMI (<i>Trichopodus trichopterus</i> PALLAS) IN LAKE LANA O, LANA O DEL SUR.....	296
Maida A. Atomar and Nazma D. Eza	296
GUT CONTENT ANALYSIS OF <i>Puntius tumba</i> TAKEN FROM SELECTED RIVERS OF LANA O DEL SUR, PHILIPPINES	305
Aynie S. Mohammad, Husna A. Dimapalao	305
EFFECTS OF QUALITY AND QUANTITY OF WATER ON MACROINVERTEBRATES IN TEMPORARY STREAM AT HARIPHUNCHAI EDUCATION CENTRE, THAILAND	314
Kitti Moolla and Decha Thapanya.....	314
THE COMPOSITION OF A BENTHIC MACROINVERTEBRATE COMMUNITY IN HANJALUTUNG OXBOW-LAKE: AN ANALYSIS	320
Imroatushshoolikhah, Jojok Sudarso, Yustiawati, Laelasari	320
PHYTOPLANKTON COMMUNITY AT LITTORAL ZONES OF LAKE MATANO IN RELATIONSHIP TO WATER QUALITY	328
Fachmijany Sulawesty	328
EVALUATION OF GENETIC RELATIONSHIP AMONG SELECT SIX FISH SPECIES USING THE PARTIAL FRAGMENT OF MITOCHONDRIAL CYTOCHROME C OXIDASE SUBUNIT-1 GENE (CO1)	337
Arif Wibowo and Tuah Nanda Merlia	337
BIODIVERSITY AND CONSERVATION OF ENDEMIC FISH SPECIES IN SOME LAKES OF SULAWESI	341
Syahroma Husni Nasution.....	341
OCCURRENCE OF WATER-BORNE BACTERIAL PATHOGEN, <i>Aeromonas</i> sp., IN LAKE MATANO, INDONESIA	347
Miratul Maghfiroh, Eva Nafisyah, Nina Hermayani Sadi.....	347
Topic 8. Ecotechnology and ecohydrology	352
LAKE RESTORATION IN INDONESIA: A RISK BASED ECOHYDROLOGY APPROACH.....	352
Gadis Sri Haryani.....	352
ECO-FRIENDLY LARGE-SCALE TESTS TO REDUCE PHOSPHORUS IN RIVER WATER BY ELUTING IRON ION SYSTEM	360
Naozo Fukuda, Toshiya Akasaki, Mikio Sugimoto, Kenkichi Maruyama, Tomohiro Ichikawa, Shigeru Endo, Takeharu Konami.....	360
RESTORING INDONESIAN LAKE BUFFER ZONES USING NATIVE PLANT SPECIES	366
Susi Abdiyani and Evi Irawan	366
ECOHYDROLOGY MANAGEMENT OF LAKE AND WETLAND IN PUTRAJAYA URBAN ECOSYSTEM.....	375
Normaliza Noordin, Akashah Majizat, Zati Sharip, Ahmad Zubir Sopian.....	375
INTEGRATED MULTI TROPHIC AQUACULTURE AS SAFE ENVIRONMENT FOR FISH PRODUCTION IN SMALL RESERVOIRS	388
Djamhuriyah S. Said, Tjandra Chrismadha, Triyanto.....	388

A NEW METHOD TO ESTIMATE CONCENTRATIONS OF PHOSPHOROUS, NITROGEN AND COD IN EUTROPHIC RIVERS	395
Tsuyoshi Kinouchi, Yan Zeng	395
MONOFILAMENT GILLNET AS A CONTROL OF MIDAS CICHLID (<i>Amphilophus citrinellus</i>) AT IR. H. DJUANDA RESERVOIR, WEST JAVA-INDONESIA.....	402
Andri Warsa , Endi Setiadi Kartamihardja, Joni Haryadi, Dimas Angga Hedianto	402
PHYTOTECHNOLOGY APPLICATION TO CONTROL LAKE WATER QUALITY: A PRELIMINARY TRIAL TO USE FLOATING PLANTS FOR CONTROLLING WATER QUALITY IN A SMALL LAKE OF SITU CIBUNTU, CIBINONG, INDONESIA.....	411
Tjandra Christmadha, Tri Suryono, Yayah Mardiaty, Endang Mulyana	411

Topic 9. Manmade lakes.....420

EVALUATION OF FLOOD MITIGATION AND WATER PURIFICATION EFFECT IN URBAN LAKE, JABODETABEK.....	420
Koshi Yoshida, Ami Aminah Meutia, Satoru Itagawa, Hiroko Matsuda	420
EFFECTS OF CHECK DAM ON MACROINVERTEBRATE COMMUNITIES IN HUAI TON KOK WATERSHED, CHIANG MAI PROVINCE, THAILAND	428
Varaphan Marueng, Weerasak Roongruangwongse, Decha Thapanya, Chitchol Phalaraksh.....	428
NITROGEN LOAD INFLOW TO LARGE SCALE RESERVOIRS IN THE CITARUM RIVER BASIN, INDONESIA	434
Yuki Jikeya, Koshi Yoshida, Shigeoya Maeda, Hisao Kuroda	434

Topic 10. Limnology and limnological science fundamentals.....442

TROPIC STATE CHARACTERISATION FOR MALAYSIAN LAKES.....	442
Zati Sharip, Fatimah M. Yusoff, Wan Ruslan Ismail	442
CURRENT STATUS OF LAKE ARAL – CHALLENGES AND FUTURE OPPORTUNITIES	448
N. Aladin, T. Chida, J.-F. Cretaux, Z. Ermakhanov, B. Jollibekov, B. Karimov, Y. Kawabata, D. Keyser, J. Kubota, P. Micklin, N. Mingazova, I. Plotnikov, M. Toman	448
IDENTIFYING SOURCES OF NITRATE IN AN IRRIGATED RICE PADDY WATERSHED, TSUKUBA JAPAN	458
Saeko Yada, Yasuhiro Nakajima, Takeshi Horio, Keiya Inao, Sunao Itahashi, Kei Asada, Seiko Yoshikawa and Sadao Eguchi	458
RELATIONSHIP BETWEEN TROPIC STATES AND NUTRIENTS LOAD IN WATERS SURROUNDING SAMOSIR ISLAND, LAKE TOBA, NORTH SUMATERA	469
Niken TM Pratiwi, Arif Rahman, Sigid Hariyadi, Inna Puspa Ayu, Aliati Iswantari	469
ZOOPLANKTON DIEL VERTICAL MIGRATION IN LAKE LAUT TAWAR, ACEH, INDONESIA ...	476
Dwinda Mariska Putri, Suwarno Hadisusanto	476
WATER QUALITY CHARACTERISTICS IN THE PLANKTOTHRIX DOMINANT YEARS IN SHALLOW LAKE KASUMIGAURA.....	482
Takao Ouchi, Hisao Kobinata, Koichi Kamiya, Keita Nakagawa, Kazuhisa Sugaya and Morihiro Aizaki	482
STUDY ON THE NITROGEN LEACHING MECHANISM FROM AGRICULTURAL LANDS	487
Kuroda Hisao, Lin Xiaolan, Kitamura Tatsumi, Oouchi Takao and Sugaya Kazuhisa.....	487
THE ORIGINAL METHOD OF CLASSIFICATION OF WORLD LAKES BASED ON FORMULAS AND RESULTS OF ITS APPLICATION	491
N.M. Mingazova, A.I. Galeeva	491

THE RELATIONSHIP OF RIPARIAN VEGETATION COMPOSITION WITH RAINBOWFISH ABUNDANCE IN LAKE SENTANI, PAPUA, INDONESIA	500
I Gusti Ayu Agung Pradnya Paramitha, Riky Kurniawan	500
DISTINCTIVE FLUCTUATION IN WATER QUALITY AND PLANKTON COMPOSITION IN THE CENTER OF LAKE KASUMIGAURA, JAPAN SINCE 2001	513
Atsushi Numazawa and Kazuo Okubo	513
THEORETICAL PELAGIC TO BENTHIC PRIMARY PRODUCTION RATIOS IN TWO LAKES WITH CONTRASTING LIGHT CONDITIONS	519
Fabien Cremona, Alo Laas, Toomas Kõiv, Margot Sepp, Peeter Nõges, Tiina Nõges	519
STUDY OF FISHERY LOAD CAPACITY IN SUTAMI AND LAHOR RESERVOIRS, EAST JAVA, INDONESIA	527
Winari, T., Hapsari, D., Windianita, K., Rahman, K.I., Hidayat, F., Ruritan, R.V., Sudaryanti	527
ENVIRONMENTAL FACTORS REGULATING THE DOMINANCE SPECIES OF PHYTOPLANKTON IN LAKE MANINJAU, WEST SUMATERA, INDONESIA.....	536
Sulastrı, Arianto Budisantoso and Sulung Nomosatryo	536
DIAGNOSIS, WATER QUALITY OF TOBA LAKE AND ITS MANAGEMENT.....	549
Tri Retnaningsih Soeprbowati and Sri Widodo Agung Suedy	549
CARBON DIOXIDE AND METHANE ACCUMULATION IN A HIGHLY EUTROPHIC TROPICAL LAKE, INDONESIA.....	557
Cynthia Henny, Arianto B. Santoso, Sulung Nomosatryo	557
EVALUATION OF LAKE WATER QUALITY IN KLANG VALLEY USING MULTIVARIATE STATISTICAL TECHNIQUES	566
Isa Baba Koki, Sharifuddin Md Zain, Low Kah Hin, Hafizan Juahir, Azman Azid	566
WATER QUALITY IMPACT ON FISH CULTURED IN LAKE TUTUD, NORTH SULAWESI, INDONESIA	577
Suzanne Lydia Undap, Reiny Tumbol and Sandra Tilaar	577
WATER QUALITY AND DIVERSITY OF AQUATIC INSECTS IN HIGHLAND AGRICULTURAL AREA, CHIANG MAI, THAILAND	582
Rungpailin Wongphutorn, Manoj Potapohn and Chitchol Phalaraksh	582
PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEDIMENT IN LAKE TEMPE USING MULTIVARIATE ANALYSIS APPROACH.....	586
Siti Aisyah	586
THE SEASONAL OF THERMAL STRATIFICATION AND WATER COLUMN STABILITY OF LAKE MANINJAU, WEST SUMATERA	593
Taofik Jasalesmana, Fia Zulti, Tri Suryono, Arianto Budi Santoso	593
WATER QUALITY ANALYSIS AT SAGULING RESERVOIR	600
Luki Subehi	600
WATER QUALITY ASSESSMENT OF VASTRAPUR & SOLA LAKE OF AHMEDABAD CITY, GUJARAT, INDIA.....	605
Manisha Desai	605
DISTRIBUTION AND DIVERSITY OF DIATOM IN SURFACE SEDIMENTS OF URBAN PONDS IN CIBINONG BOTANICAL GARDEN	612
Aan Dianto, Luki Subehi, Ardo Ramdhani	612

TEMPERATURE EFFECTS ON LEAD TROPHIC TRANSFER WITHIN THE PHYTOPLANKTON – ZOOPLANKTON – NILE TILAPIA/COMMON CARP FOOD WEB: A CASE STUDY FROM THE CIRATA RESERVOIR, INDONESIA	618
Evi Susanti, Nurpilihan Bafadal, TB Benito Kurnani, Sunardi, Cynthia Henny	618
WATER QUALITY STATUS OF SINGARVA LAKE AT AHMADABAD, GUJARAT, INDIA.....	624
Sanjay Vediya.....	624

Topic 2. Lake environment under stress and their restoration challenges

THE INCREASE OF FLOATING NET CAGES, AQUACULTURE AREA AND WATER QUALITY IN MANINJAU LAKE, WEST SUMATERA-INDONESIA

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ABSTRACT

This study was carried out to evaluate the increase of floating net cages, aquaculture area and water quality parameter in Maninjau lake. The results showed that the total floating net cages in the years of 2011 (15,000 units), 2012 (15,860 units), 2013 (16,120 units), 2014 (16,580 units) and 2015 (20,608 units) respectively. The location of floating net cages in Maninjau lake still dominant in littoral area, with distance 25 to 100 meter from the edge of the lake. The aquaculture areas which are used for 20,608 units of floating net cages are 113.7 hectares. Meanwhile, based on the size of fish, stocking density and oxygen used for aquaculture, the needed ideal area is 1416,04 hectares. The water quality around floating net cages showed there was no significant differences ($p > 0.05$) between sampling sites. The results obtained the levels of water transparency was 1.91-1.99 meter, ammonia 0.35-0.65 mg/L, nitrite 0.210-0.254 mg/L and the total phosphorus 0.32-0.80 mg/L, respectively. We conclude that increasing of floating net cages around Maninjau lake is not suitable with aquaculture area which have negative effect to sanity of fish and water quality parameter.

Keywords: Maninjau Lake, floating net cages, aquaculture area, water quality.

INTRODUCTION

Maninjau lake is one of the fifteen lakes in Indonesia which becomes very important priority lake to be saved (Ministry of Environment of the Republic of Indonesia, 2012) because its plays an important role as hydroelectric plants with power 64 MW and the economic value was IDR 71.8 billion/year, tourism IDR 2.15 billion/year, fishing-capture IDR 1.12 billion/year (LIPI, 2009) and aquaculture activity of tilapia dan carp species by using floating net cages is 4,316 units with an investment of IDR 112 billion/year (Syandri, 2003). The total floating net cages in Maninjau lake for tilapia and carp farming always increase in every year. In the year 2001, the total floating net cages was 3,500 units, while in the year 2013 was increase to 16,120 units (Syandri et al., 2014a; Junaidi et al., 2014).

In this decade, the pressure of the environment condition in Maninjau lake not only caused by the increase of floating net cages (Syandri et al., 2014a; Syandri et al., 2016) but also intensive land used in the catchment area (Machbub, 2010) and used that area for settlement and conversion of paddy fields into fish ponds (Government Agam Regency, 2012; Syandri et al., 2014a). That activity caused directly increase of the organic loading in Maninjau lake and also have effect to the decrease of water quality (Henny, 2009; Yusuf et al., 2011; Junaidi et al., 2014; Syandri et al., 2015a) and the diversity of fish species (Dina et al., 2011; Syandri et al., 2014b).

In this work, we examined the used of Maninjau lake for the aquaculture of tilapia (*Oreochromis niloticus*) and carp (*Cyprinus carpio*) in the floating net cages in Agam Regency of West Sumatera Province, Indonesia. We analyze the increase of floating net cages, aquaculture area and some physico-chemical parameters.

METHODS

Study area

The Maninjau lake with a surface area 9,996 hectare is located in Tanjung Raya district of Agam Regency, West Sumatera Province - Indonesia, the geographical position E:00°12'26.63"-S:0°25'02.80" and E:100°07'43.74"-S:100°16'22.48", located at altitude 461.50 meter above sea level. The regional climate is classified as Schmith-Ferguson Climate. This lake has characteristics of climate types A and annually receives an average rainfall 3,490 mm, with two distinct seasonal periods of precipitation: a

dry season that normally extends between April and September, and rainy season from October to March. During this study, the monthly precipitations of the rainy season varied between 120 and 200 mm, and in the dry season between 10 and 50 mm.

Data floating net cages and the aquaculture area

The data of floating net cages was collected from the year 2011 to 2014 from Department of Marine and Fisheries science of Agam Regency, whereas the data in the year 2015 was calculated directly from the field. The calculation of aquaculture area in each village were analyzed based on the stocking density of fish, water temperature (26°C), oxygen used/kg fish/hour (0,7 g O₂/kg fish/ hour), elevation of lake (461 meter above sea level), and the ratio of the oxygen used with the available oxygen in the water body. The amount of oxygen used which generated in one day under normal circumstances with water temperature is 26°C = 16.67g O₂ / m² which consists of photosynthesis 14.33g and 2.34g of air diffusion, to fish oxygen only provided 22% (3.67 g O₂ / m²).

ARCGIS 10.1 programme was used for making aquaculture area maps of floating net cages in Maninjau lake. The data used in this study is a multi-temporal satellite image Landsat TM / ETM + and SPOT image of the 4 during the period from the year 2014 to 2015, DEM SRTM resolution of 17 meter.

The water samples were collected every three months in the year of 2015 in four sites from the lake at 1.0 meter depth: A – *Sungai Batang*; B – *Sungai Tampang*; C – *Bayur*; D – *Koto Kaciek* (Figure 1). The water samples in 2-litre per bottles were maintained at 4°C for up to 24 hours. The following physico-chemical parameters of water was analyzed; temperature, pH, amount of ammonia, nitrite, total phosphorus and dissolved oxygen according to the methods described by APHA (APHA, 1998).

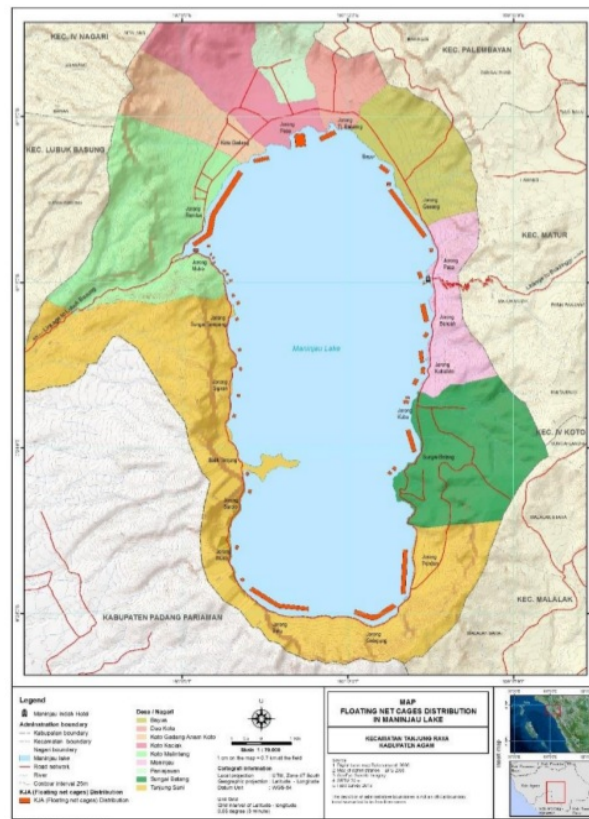


Figure 1. Map of study area in Maninjau lake of Agam Regency-Indonesia

RESULTS AND DISCUSSIONS

The total of floating net cages

The total of floating net cages from the year 2011 to 2015 at Maninjau lake in the district of Tanjung Raya, Agam Regency (**Table 1**).

Table 1. The total of floating net cages in Maninjau lake (units)

No	Village	2011	2012	2013	2014	2015
1	Maninjau	1531	1,743	1,795	1,843	1,597
2	Bayua	2324	2,349	2,425	2,856	4,178
3	Il Koto	816	907	1,050	866	866
4	Koto Kaciek	1013	1,013	1,060	1,260	1,409
5	Koto Gadang	202	202	190	200	200
6	Koto Malintang	2448	3,768	3,850	3,650	3,612
7	Tanjung Sani	5194	4,140	4,000	4,108	5,461
8	Sungai Batang	1472	1,741	1,750	1,797	3,285
	Total	15,000	15,860	16,120	16,580	20,608

Sources : Data in the year 2011- 2014 was secondary data and the year 2015 is the primary data.

If we compared the total floating net cages in the year 2015 with the year 2011-2014, the unit was increased in every year. The increased of floating net cages has positive impact on fish farmers, fish feed traders, fish sales and other labor. According to (Nasution et al., 2011; Syandri et al., 2015a), business of tilapia and carp cultured on the floating net cages in Maninjau lake have positive impact to increase society income in the district of Tanjung Raya, Agam Regency. Meanwhile, that activity have negative impact on the water quality parameter (Henny, 2009; Syandri et al., 2014a; Syandri et al., 2015a; Syandri et al., 2016).

The aquaculture area around floating net cages in Maninjau lake still dominant in littoral area with distance 25 to 100 meter from the edge of the lake. Floating net cages was placed on water depth between 10 to 50 meter. The aquaculture area of floating net cages in *Sungai Batang*, *Tanjung Sani*, *Bayur*, and *Koto Kaciek* village are presented in **Figure 2,3,4,5**, respectively.

The aquaculture areas which are used for 20,608 units of floating net cages are 113.7 hectares. Meanwhile, based on the size of fish, stocking density and oxygen used for aquaculture, the needed ideal area is 1416,04 hectares (**Table 2**).

Table 2. The total floating net cages, aquaculture area in the field and ideal aquaculture area

Village	Floating net cages (units)	Aquaculture area in the field (hectare)	Ideal aquaculture area (hectare)
10 Maninjau	1,597	11.98	109.73
Bayur	4,178	31.34	287.08
Il Koto	866	6.49	59.50
Koto Kaciek	1,409	10.57	96.82
Koto Gadang VI Koto	200	1.60	13.75
Koto Malintang	3,612	27.09	248.20
Tanjung Sani	5,461	40.95	375.24
Sungai Batang	3,285	24.63	225.72
Total	20,608	113.7	1,416.04

Source: Primary survey data, October 2015.

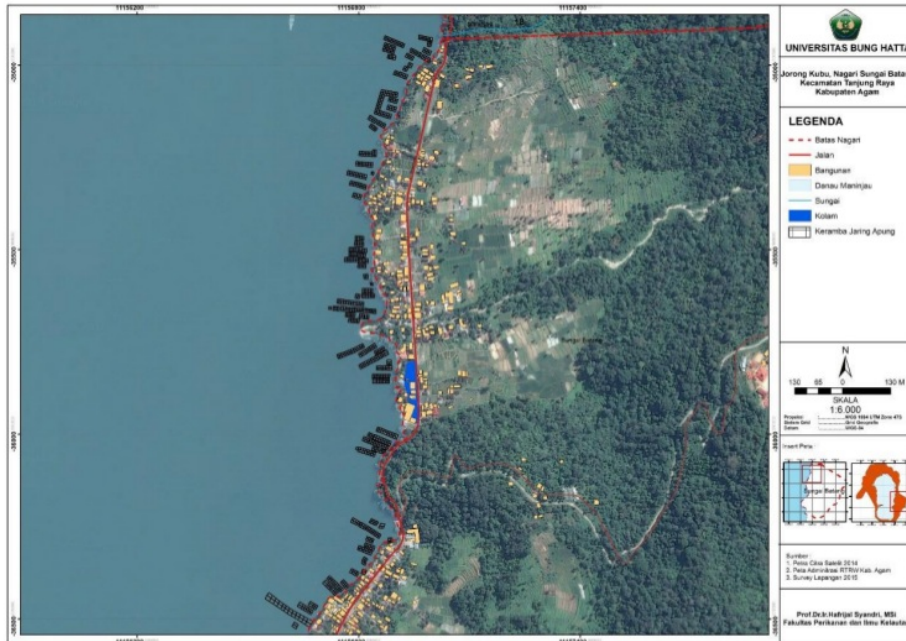


Figure 2. The aquaculture area of floating net cages in *Sungai Batang* village

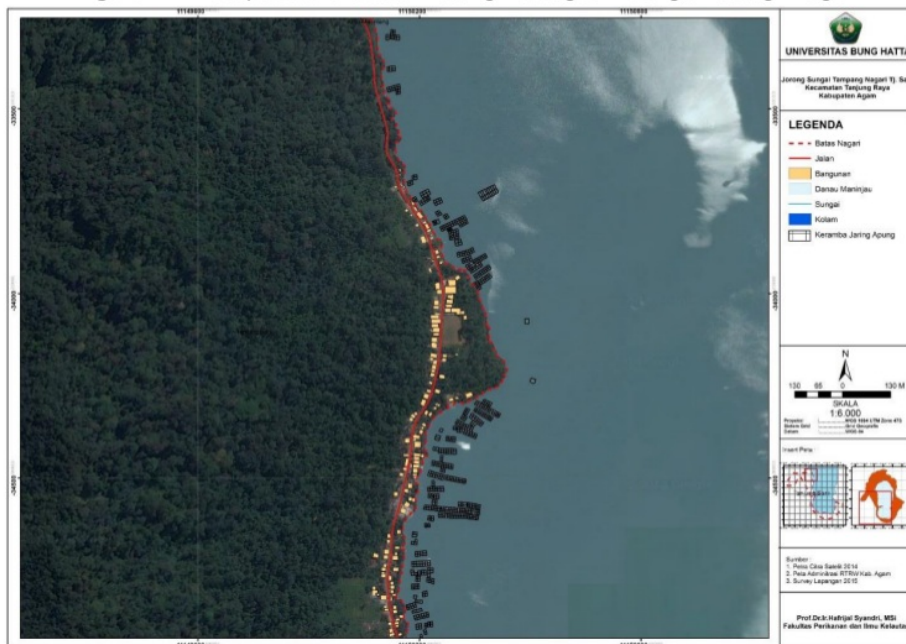


Figure 3. The aquaculture area of floating net cages in *Tanjung Sani* Village

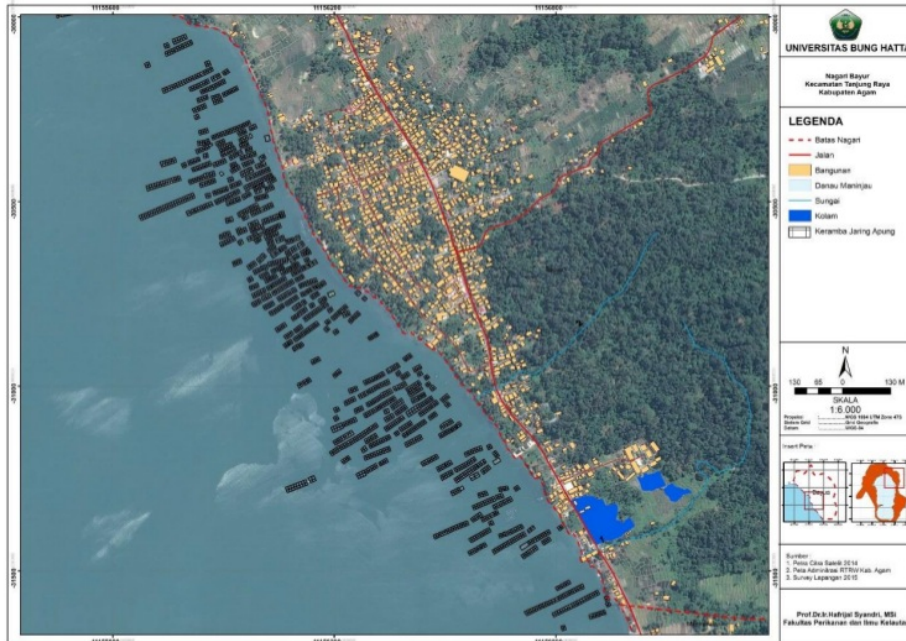


Figure 4. The aquaculture area of floating net cages in Bayur Village



Figure 5. The aquaculture area of floating net cages in Koto Kaciek Village

Water quality parameters in the floating net cages

The results on the physico-chemical parameters of the water samples from the four sampling sites on the fish farm in Maninjau lake are presented in **Table 3**. The average water transparency in all sampling site varied between 1.91 m and 1.99 m. The temperature showed that strong fluctuations over the study periode (**Table 3**), especially in the Bayur site (26-30°C). Throughout the experiment, the amount of

pH, ammonia, nitrite, total phosphorous and dissolved oxygen in Maninjau lake did not showed significantly different between sampling site ($p > 0.05$). The levels of pH varied from 7.29 to 8.10, with the higher means for the dominant of floating net cages (site C and D) (**Table 3**). The ammonia content varied from 0.35 to 0.65 mg/L, with higher means for the site A. The nitrite content varied from 0.210 to 0.254 mg/L, with similar means for all sites. The total phosphorus content ranged from 0.32 to 0.80 mg/L, and the highest concentrations refer to Sungai Tampang, due to many activities around floating net cages. Dissolved oxygen content was slightly varied between sampling sites, with average values between 6.14 and 6.80 mg/L (**Table 3**). The water quality of floating net cages was directly influences the productivity and sanity of fish (Henny, 2009; Syandri et al., 2015a; Syandri et al., 2016). According to Asir and Pulatsu (2008), intensive aquacultural activity causes release the organic waste and soluble inorganic nutrients, such as nitrogen and phosphorus content, which can cause or accelerate eutrophication in natural aquatic systems. Nutrient release (especially nitrogen and phosphorus) consists of dissolved and particulate fraction. The differences water quality parameters is not only between species, but also within species, depend on feeds employed, feeding regimes, culture systems, productivity, sanity of the fish, and environmental parameters of the local area (Gorlach-Lira, 2013; Junaidi et al., 2014; Syandri et al., 2015a; Syandri et al., 2016).

Table 3. Water quality parameters in floating net cages

	Site A	Site B	Site C	Site D
Water transparency (m)				
Mean	1.96	1.98	1.99	1.91
Standart deviation	0.14	0.07	0.10	0.10
Median	1.85	1.98	2.01	1.94
Min-Max	1.80-2.10	1.90-2.08	1.85-2.10	1.90-2.00
Temperature (°C)				
Mean	27.75	28.5	28.25	28.5
Standart deviation	1.25	1.29	1.70	1.29
Median	28.5	28.5	28.5	28.5
Min-Max	26.0-29.0	27-30	26-30	27-30
pH				
Mean	7.72	7.67	7.95	7.86
Standart deviation	0.35	0.33	0.23	0.16
Median	7.59	7.70	7.95	7.92
Min-Max	7.29-8.10	7.30-8.0	7.70-8.20	7.70-8.10
Ammonia (mg/L)				
Mean	0.59	0.41	0.37	0.46
Standart deviation	0.06	0.03	0.02	0.05
Median	0.60	0.41	0.375	0.465
Min-Max	0.50-0.65	0.38-0.45	0.35-0.41	0.40-0.51
Nitrite (mg/L)				
Mean	0.167	0.144	0.232	0.165
Standart deviation	0.017	0.044	0.018	0.047
Median	0.165	0.126	0.233	0.175
Min-Max	0.148-0.190	0.144-0.210	0.210-0.254	0.100-0.210
Total phosphorus (mg/L)				
Mean	0.565	0.716	0.485	0.392
Standart deviation	0.031	0.111	0.050	0.056
Median	0.540	0.705	0.475	0.400
Min-Max	0.53-0.60	0.59-0.80	0.44-0.55	0.32-0.45
Dissolved Oxygen (mg/L)				
Mean	6.307	6.375	6.140	6.805
Standart deviation	0.617	0.302	0.384	0.308
Median	6.41	6.355	5.985	6.66
Min-Max	5.49-6.92	6.07-6.72	5.50-6.45	6.37-7.08

A = Sungai Batang; B = Sungai Tampang; C = Bayur; D = Koto Kaciek

5

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