

# ABSTRACT BOOK



## THE 16<sup>TH</sup> WORLD LAKE CONFERENCE

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

Organized by:



Ministry of  
Environment and Forestry



Ministry of  
Public Works and Housing



Indonesian Institute of  
Science



United Nations Educational, Scientific  
and Cultural Organization



Asia Pacific Centre for  
Environment



Bali Provincial Government



Bali Provincial University



International Lake Environment  
Committee

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# Letters of Welcome

Dear colleagues,

I would love to sincerely welcome all the delegates with the brightest smile and embracing arms extending our earnest Indonesian greeting 'Selamat Datang'. It is an invaluable verity that I see many come to our conference with joy and contented heart despite the weariness you might have felt after long hours of flights or miles you have gone through. I thank you for the efforts and supposedly, we can serve you at best here, in Bali.

Bali is the island of enchanting beauty. It is the sanctuary where the Mother Nature bestows ideas and inspirations. Our intention is to get together the scientific side and the calming nature. And Bali is the perfect place for this rendezvous. Our scientific committee together with the local organizing committee have avidly arranged the scientific program for the conference and we do hope that everyone learns this to be prolific and beneficial opportunity.

This year's theme of the 16th World lake Conference is Lake Ecosystem Health and Resilience: Diversity and the Risk of Extinction. It has become our commitment, as the human beings and the ones who exploit the nature; lakes in particular, to sustain the balance and self-reflect that a lot have been going on with our lakes and that most of them are silently suffering. Actions may have been kicked off but that is not about it. 'Are actions sufficient to recover the grieving lakes?', 'Do we need improvements on our actions?', 'How long will it take for the accomplishment?' are of the lingering questions that need to be answered. Open discussions and sharing experience are encouraged during the conference although three-day schedule may seem so short for multifaceted issues.

In regards to the abstract submissions, we are pleased to know that the total number exceeds 250 submissions in which those for oral presentations are 171 and 89 are engaged for posters. Oral presentations are divided into four stream rooms for three days. Whereas the poster showcase is scheduled twice at the designated timeframe.

Lastly, I would like to acknowledge our hard-working friends from the committees who have been so enthusiastic in ensuring the details of the conference. I do appreciate the whole lot you have worked on and look forward to the successful conference.

*Terima kasih.*

Sincerely yours,

**Prof. Gadis Sri Haryani**

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# Keynote Speakers

## **LIMNOLOGY AND THE EFFORT TO FACE ITS PROBLEMS**

Fauzan Ali

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The field of limnology has been evolving with the integration of the ecosystem, which now comprises lakes catchment area, reservoir, rivers and wetlands. As such, all-encompassing studies to understand the structure and the function of inland ecosystem in Indonesia have been encouraged. Also, there is an increasing obligation towards the needs to conceive and maintain the ecological balance of inland water ecosystem which was subjected to massive pressure in recent times. Indonesia is listed among the 12 megadiversity countries, ranked the second in the world (the first in Asia) in the number of freshwater fish species. Moreover, there are 840 lakes, 735 ponds and 162 dams in Indonesia, covering about 21,000 km<sup>2</sup> of area, retaining approximately 500 km<sup>3</sup> of water volume and providing both ecological and economic services. Recently, there is an increasing need to conserve and maintain the ecological balance of inland water system which are subjected to massive pressure. In addition, the problem of biodiversity crisis in limnetic systems is at the worst among that in other natural systems. To identify the reason for the crisis in limnetic environments, and to conduct better conservation and management, we must urgently collect the information about the status quo of limnetic environments through appropriate environmental monitoring.

Keyword: Biodiversity, Limnology, Ecosystem, Conservation

## **INTEGRATED MANAGEMENT OF LENTIC AND LOTIC WATER SYSTEMS: APPLICATION TO INDONESIAN PRIORITY LAKES**

**Walter Rast, Chair, ILEC Scientific Committee and**

**Director of International Watershed Studies, Texas State University**

Lakes, reservoirs and wetlands comprise our planet's major lentic (standing or pooled) water systems on our planet, containing the vast majority of the readily-accessible liquid freshwater on its surface. Although Integrated Water Resources Management (IWRM) has become the mantra in global water discussions and in national water programs, it is becoming increasingly clear this approach does not adequately address the unique features of lentic water systems (large volume; long water retention time; integrating nature; complex dynamics) within many water management schemes. The sustainability of the wide range of life-supporting ecosystem services provided by these lentic water systems is threatened by this deficiency. Subsequent experience suggests Integrated Lake Basin Management (ILBM), infused within the IWRM concept, provides a valuable complementary approach to watershed management. The Indonesian National Conservation Policy has recognized its value with its ILBM-based approach to assessing and managing its priority lakes. At the same time, a lake basin actually represents a linked system of nested and interacting lentic and lotic (flowing) water systems. This reality expands the ILBM concept to a broader Integrated Lentic-Lotic Basin Management (ILLBM) framework. There are examples for application of this broader approach within the context of the Indonesian priority lakes activities, with both scientific and management implications.

## PASSING OUR BOUNTIFUL LAKES TO THE NEXT GENERATION WITH LOCAL EFFORTS

Taizo Mikazuki

Governor of Shiga Prefecture

I would like to express my joy at the opening of the 16th World Lake Conference in Bali, and extend my gratitude to Indonesian Government and those responsible for their efforts in organizing this conference. Shiga Prefectural Government proposed this World Lake Conference about 30 years ago, with the hope that government officials, researchers and citizens from regions that have lakes could meet together and discuss issues regarding the lakes. The 1st World Lake Conference was held in Otsu City in Shiga in 1984. Since then, the conferences have been held in many countries around the world and attended by around 20,000 people in total. This 16th World Lake Conference is being held in Southeast Asia for the first time, with the theme, "Lake Ecosystem Health and Its Resilience: Diversity and the Risk of Extinction." Amidst concerns that lake environments around the world are getting worse, I expect that our discussions will be beneficial for future initiatives in participating countries. Shiga is home to Lake Biwa, the largest lake in Japan, which supplies water for 1,450 million people. Historically, Shiga's citizens, government, and researchers have collaborated on efforts addressing environmental problems in Lake Biwa, including the occurrence of freshwater red tides. We are continuing our efforts for the lake with initiatives such as the Lake Biwa Comprehensive Conservation Plan, Mother Lake 21 Plan and the Law for the Conservation and Restoration of Lake Biwa. Regions with precious water resources, such as lakes, play an important role in the world and shoulder a great deal of responsibility. I would like to call upon this year's participants to continue their efforts towards lake conservation. Beginning on the local level in regions with lakes, I hope we can expand our efforts and contribute to the solution of water problems around the world.

## **SUSTAINABLE WATER MANAGEMENT WITH AP-HELP AND IWRM**

Soontak Lee

Yeungnam University, Republic of Korea President, International Hydrologic Environmental Society (IHES) Governor, World Water Council

In many years of the world, growing human populations are rapidly depleting available freshwater supplies. During the 20th century, the global human population increased fourfold to more than six billion. Water withdrawn from natural freshwater ecosystem increased eightfold during the same period. Facing an ominous specter of increasingly severe water shortages in many areas of the world, water managers and leaders are exploring strategies for managing water resources sustainably. This quest for sustainability centers on managing human uses of water as well as maintaining healthy freshwater ecosystems for future generations in the 21st century.

The sustainable management as a new paradigm since 1992 is to manage water supply and demand in an integrated way, taking into consideration both socio-economic requirements and the intrinsic capabilities and limitations of ecosystems to support, over the long-term, a particular suite of human activities. Furthermore, ecologically sustainable water management protects the ecological integrity of affected ecosystems while meeting intergenerational human needs for water and sustaining the full array of other products and services provided by natural freshwater ecosystems. Ecological integrity is protected when the compositional and structural diversity and natural functioning of affected ecosystems is maintained.

As the sustainable water management, the HELP(Hydrology for the Environment, Life and Policy) was implemented as a cross-cutting programme of the IHP-VII and VIII and is to deliver social, economic and environmental benefit to stakeholders through sustainable and appropriate use of water by directing hydrological science towards improved integrated catchment management basins and aims to address key water resources security issues in the field and to integrate them with policy and management needs.

Secondly, the Integrated Water Resources Management(IWRM), a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems is also implemented for the sustainable water management through the establishment of good understanding of sectoral perspectives.

The HELP also provides scientific research results for the implementation of IWRM through the processes such as; IWRM guidelines as a user-friendly and cooperative approach that will invite each water sector to fruitfully participate and cooperate in improving water quality and quantity in a river basin; and the river basin approach is being recognized as a comprehensive basis for managing water resources more sustainably and will thus lead to social, economic and environmental benefits. Furthermore, AP-HELP(Asia Pacific-HELP) can play important roles in developing holistic sustainable solutions for the SDGs and needs to respond to the priorities and needs of Member States under IHP-VIII focused on six knowledge areas.

It is required to develop IWRM strategies with HELP approaches and reflect the strategy into National Water Resources Plan and needed for advanced technologies and methods for basinwide IWRM and Sustainable Water Management.

## **LAKE RESTORATION IN NEW ZEALAND, WITH IMPLICATIONS FOR LAKES GLOBALLY**

David Hamilton<sup>1\*</sup>, Kevin Collier<sup>1</sup>, Chris McBride and Clive Howard-Williams<sup>2</sup>

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Lake restoration requires an enabling context, including policies and funding to support the restoration process, time series monitoring to separate intrinsic (natural) variations from effects of management interventions, and clear end points that provide an expected time course of improvement in key variables. Examples of each of these requirements are provided in the context of lake restoration in New Zealand, where there has been active use of a range of physical and chemical methods. By contrast, restoration using biological manipulation is uncommon in New Zealand, whereas inadvertent introductions of exotic species (e.g., fish such as koi carp and catfish, or macrophytes such as hornwort or oxygen weeds), have had deleterious impacts on lake water quality. Some general findings of these case studies are that (i) restoration must be tailored to individual lakes because of different stressors, connectivity and levels of natural resilience, (ii) degraded lakes often have high levels of resilience that necessitate more extreme restoration measures, (iii) sediment and nutrient legacies (i.e., bottom-sediment pools) may require specific management to effect short-term improvements, and (iv) addressing catchment sediment nutrient inputs and connectivity is fundamental to successful restoration and enables longevity and effectiveness of in-lake actions. Restoration must also build in future challenges; the intersection of land use intensification and climate change, as well as increased globalisation, are likely to necessitate even greater vigilance for lake management programmes and may mean that a greater number of lakes will fail to meet water quality targets without concerted management actions.

## **LAKE ENVIRONMENTS UNDER STRESS AND THEIR RESTORATION CHALLENGES**

Takehiko Fukushima

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Lakes are facing multiple kinds of stresses on their environments e.g. effluent increase in point and non-point sources, artificial alteration of basin, excessive water use, invasion of alien organisms, global climate change, change in people's concern, etc. In this presentation, two topics on lake environmental changes in Southeast Asian tropical regions are focused. First, the spread of cyanobacterial blooms and/or macrophyte is demonstrated in several shallow polymictic lakes using the analysis on satellite images. Lake Tonle Sap in Cambodia shows a clear increase trend in the area covered by cyanobacterial bloom and its influence on fish catch and fish species richness should be discussed. In contrast, the areas covered by macrophyte are expanding in Indonesian shallow lakes, e.g. Lakes Limboto, Tempe, resulting in damages in lake use. Second, the upwelling of dissolved oxygen (DO) deficit waters in several Indonesian deep lakes (Lakes Maninjau, Singkarak, Toba, Matano, Batur and Buyan and Cirata Reservoir) is indicated based on the published reports and our field surveys. The upwelling rates and areal hypolimnetic oxygen depletion rates are increased in recent decades compared with those in the period before the decades. Most probably, meromictic characteristics result in the upwelling regardless of lake tropic levels and it is predicted that the DO deficit layer will reach and pass over the thermocline in near future partly accelerated by global warming. Thus, the mass death of fish is expected and has already occurred in a few lakes when relatively strong wind blows. Urgent challenges for their restoration are necessary particularly on regular monitoring, prohibition of excessive fish culture, injection of oxygen-rich waters, withdraw of oxygen-deficit waters, adaptive management of lake water use, etc.

Keywords: Stress on lake, cyanobacterial bloom, macrophyte coverage, upwelling of dissolved oxygen deficit water, meromictic, mass death of fish, global warming, restoration challenges

## **MULTIPLE WATER USE PURPOSES**

Nazir Foad

Peatland Restoration Agency, Indonesia

# Main Paper Speakers

## LAKE AND LAKE BASIN MANAGEMENT AND POLICIES IN BALI

Ni Luh Kartini

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Bali small island has four lakes located in the highlands into reservoir water flowing underground into 9 districts of the city in Bali. Lake basin caldera in Bali is the result of ancient volcanic eruptions. Position Batur lake basin, Beratan, Bulian, Tamblingan very distinctive because the landscape is closed (confined) in the science of hydrology called confined basin. Confined basin means not river flow in and out of the lake. Lakes exist in Bali since Rice and agricultural system in Bali starting in upper reaches 678. Subak is upstream of the lake..The King gives subsidies to people making the field (tax free), proved that taking care of Ulun Danu each lake from Castle (royal). Lake management policies there needs to be involvement and active role of local communities affected by this danau.Hal 1) internal factors (physical, motivation, community interests that exist around the lake); 2) external factors (facilitators, media, profits, time and quality companion). Rescue ecosystem of the lake in bali with the implementation of tri hita karana. Tri Hita Karana is three relationships reason for happiness, 1. Man's relationship with God (Parhyangan), 2. Man's relationship with man (Pawongan), Human 3.Hubungan an environmental deng (Palemahan). Bali Lake guarded by customs and religious ceremonies regularly. Lakeside village is responsible for managing the lake from the religious ceremony while from the management authority is the authority of the Central Government. Of the four lakes in Bali Tamblingan lake is still only sustainable for a very strong traditional institutions. members of traditional institutions have always taught about the lake is the temple, the temple of the forest if there are disturbing the lake means no survivors.

Keywords : Lake, management, policies, tri hita karana

## BIODIVERSITY AND CONSERVATION OF SOUTHEAST ASIAN LAKES

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Southeast Asian countries are rich in lakes either natural or man-made lakes. Indonesia alone has 521 natural lakes and more than 600 reservoirs. The lakes are not only beautifulwith panoramic views which attract international tourists, but also a natural supermarket. The hydrological cycle in the tropical Asia, has brought high precipitation to Southeast Asian region. The ecoregion has one of highest lake biodiversities in the world. Two distinct seasons are recorded, the dry and wet months. In the wet months, most lakes are overflow. The colonization of floating aquatic weeds such as *Eichhornia crassipes*, *Salvinia molesta*, *Azolla pinnata*, and *Pistia stratiotes* have shallowing the lake depths. Submerged weeds such as *Hydrilla verticillata* and *Ceratophyllum demersum* have spoilt the lake bottom benthic ecosystem. The colonization of wild *Mimosa pigra* population has brought massive problems to the lake especially on utilization fishing activities. The cage cultures using the highly prized hybrid tilapia *Oreochromis niloticus* are widely practised in most lakes. The Irrawaddy dolphin (*Orcacella brevirostris*) is one of the widely distributed aquatic mammal in Southeast Asia coastal zones and large rivers such as Irrawaddy in Myanmar, Mekong in Cambodia and Mahakam in Kalimantan. Tonle Sap in Cambodia is a largest seasonally inundated freshwater lake in Southeast Asia. It is connected to Mekong river through 200 km Tonle Sap river. This lake is a place for migratory birds. The local communities have utilized this lake as a resource area. Perhaps the lake is functioning as a resource area.

## **LAKE RESTORATION IN INDONESIA: A RISK BASED ECOHYDROLOGY APPROACH**

**Gadis Sri Haryani**

**Research Center for Limnology**

**Indonesian Institute of Sciences**

Lakes are the last frontier in survival and resilience of our society in that they provide us with more than just precious fresh water resources and other ecosystem services, but the health of Lake Ecosystem would reflect how we value our present civilization and future wealth of our descendants. What may commonly be misperceived is that lakes in many respects are not part of rivers, e.g. the longer retention time, different geological histories, many lakes have no rivers, and the presence of thermocline as well,

15 lakes in Indonesia have been considered to be in their critical stage and they suffered from a range of direct and indirect anthropogenic as well as the aggravating climate change impacts. Attempts to address some ecosystem deterioration in a number of lakes in Indonesia by introducing ecohydrological and ecotechnological measures will be described in this paper.

This paper will eventually highlight the restoration within the light of risk and future uncertainties impacts reduction at the center of our sustainable lake management, in which ecohydrology remains at the core of seamless reconciliation between development and aquatic environmental conservation efforts.

## **WATER ENVIRONMENTS UNDER STRESS IN CHANGING CLIMATE: ECOHYDROLOGY AND ECOTECHNOLOGY SOLUTIONS**

**Hidayat Pawitan**

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Water environments under stress in changing climate is obvious from environmental degradations, water, climate and anthropogenic changes related to disasters that include land subsidence and modified river morphology and downstream floodings. Despite relatively very high water security status in terms of water quantity, Indonesia is facing serious challenges to continuity and access to good water quality, especially in urban and developing areas. Case in the Greater Jakarta-Citarum basins supported with large cascaded reservoirs will be briefly presented with simple water balance analysis indicating the critical conditions between the competing water uses. Apparent seasonal and spatial patterns changes of water environments in the Greater Jakarta basins could be recognized from water quality information due to population density, anthropogenic activities and land use changes that represent substantial ecohydrology issues. River basin management considering upstream and downstream interactions, groundwater and coastal development and management issues required good governance regulating respected stakeholders. Ecohydrology and ecotechnology offer science based solutions that need to be promoted further with ecoefficiency indicators to boost sustainability of the Greater Jakarta-Citarum water system.

Keywords : environmental degradations, ecoefficiency indicators, governance, water security, Jakarta basins.

## **ECOTECHNOLOGY IN WETLANDS RESTORATION: A CASE STUDY OF RESTORING DEGRADED PEATLAND AREA IN CENTRAL KALIMANTAN, INDONESIA**

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Water is a vital necessity for all living organisms (flora and fauna). Most of the surface fresh water reserves on Earth are found in lakes (87%), Swamps (11%) and the rivers (2%). But in Indonesia, the majority of surface fresh water reserves are located in the peat swamps of Sumatra, Kalimantan and Papua (> 1 trillion m<sup>3</sup>), in the lake about 100 billion m<sup>3</sup> and in big rivers around 1.4 billion m<sup>3</sup>. Peatland ecosystem can also be categorized as a "lake" as 80-90% of its volume contains water (Suhardjo dan Dreissen, 1975), but filled up with organic matters which accumulated since thousands years ago and therefore stored lots amount of carbon. In the ex-Mega Rice Project located in central Kalimantan, started in 1995, about 1,4 million Ha of peatland area was dissected with primary-secondary- tertiary canals, which totally about 4,500 km long. These canals have caused repeated peatland fire, as much of its water drained into the river and peatland became dry in the dry season or even much dryer during the el\_Nino that makes peatland very susceptible to fire. In order to reduce peatland fire, also its ghg emission, Wetlands International Indonesia has rewetted such dried peatland using appropriate and low cost eco-technology, where many of the existing canals were blocked (dammed) using local materials, and above the dams, indigenous peatland tree species were planted. By blocking such canal, not only the peatland became wet and insusceptible to fire and carbon emission can be reduced, but at the same time, the blocked canals revealed to trap many fish species that can support the local community livelihoods.

Keywords: peatland, carbon, ghg emission, drainage canals, peat fire and blocking of canals provided multiple benefits to nature and local community

## **REWETTING AND PALUDICULTURE AS A SOLUTION TO REHABILITATE DEGRADED PEATLAND IN INDONESIA- LOCAL KNOWLEDGE, COMMUNITY AND LOCAL ECONOMY**

Kosuke Mizuno

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The tropical peat swamp forest ecosystem is one of the most biodiverse ecosystems in the world and provides a wide range of goods and services that are of vital importance, both locally and globally. Due to their physical characteristics, tropical peat swamp forests have been difficult to utilize, and therefore spared from development for a long time. However, the tropical peatlands started to be developed on a large scale since 1980's. Drainage associated with plantation development of fast-growing trees and oil palm has led to a decrease in groundwater table levels and the drying of peat swamp forests, resulting in an increase of carbon dioxide (CO<sub>2</sub>) emissions by peat decomposition, and frequent fires. Rewetting and Paludiculture on the rewetted peatland is a solutions to the current crisis of peat degradation and fire/ haze. The study will show the paludiculture activities that are suitable for the rehabilitation of tropical degraded peatland, especially in Riau Indonesia. Paludiculture is sustainable livelihood options with conserving and rehabilitating peatlands. Livelihood activities include agroforestry, such as the combination of indigenous peat swamp tree species and pineapples, sago, commercialization of non-timber products and fisheries. The paludiculture will develop based on the local knowledge, local economy, and value-chain to the domestic and international markets. This study shows the two cases of paludiculture, one is a sago planting at the Kepulauan Meranti District, and another is a peatswamp indigenous tree planting at the Bengkalis District, Riau Province, Indonesia.

## **GENERATING A LONG-TERM DATABASE FOR INDONESIAN LAKES FROM LANDSAT SATELLITE DATA**

Bunkei Matsushita<sup>1</sup>, Setiawan Fajar<sup>2,3</sup>, Luki Subehi<sup>3</sup>, and Takehiko Fukushima<sup>1</sup>

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A long-term database is crucial to monitor and understand the amount and quality of water bodies as well as their biogeochemical processes in order to achieve an effective management and a sustainable use of water resources. However, routinely monitoring a water body is not easy for local and national governments with meager financial resource especially in developing countries. It is thus lack of the long-term database that can be used by policy makers and environmental managers for evaluating a water body. On the other hand, with the progress of remote sensing techniques, it has been possible to provide synoptic observations for water bodies at frequent intervals and relatively low cost. In this presentation, we will introduce our JSPS-LIPI (Japan Society for the Promotion of Science – Lembaga Ilmu Pengetahuan Indonesia) Joint Research Program, which has an objective to generate a long-term database for Indonesian lakes from Landsat satellite data. The database includes water surface area and shape, secchi disk depth, concentrations of total suspended matter and chlorophyll-a since 1980s. Challenges for the database generation from satellite images are also discussed.

Keywords: remote sensing, database, Landsat, Indonesian lakes

## **IMPACT OF CAGE AQUACULTURE ON PROLONGED LAKE EUTROPHICATION AND FREQUENT LAKE HYPOXIA: LAKE MANINJAU, INDONESIA**

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Lake Maninjau has been exploited for cage aquaculture since 1990s. During the 1990s and 2010s, increased inputs of organic waste and nutrients from fish feed waste and feces degraded lake water quality, induced prolonged eutrophication and reduced hypolimnetic oxygen levels. Massive fishkill first recorded was in 1998 followed by cyanobacteria blooms. The lake is a tectono-volcanic type of lake in which produced fair amount of sulfide in the anoxic hypolimnion. The lake is weakly stratified and therefore it is very sensitive to changes in meteorological conditions. Storm with strong winds, which induce vertical mixing, could lead to lake hypoxia with sulfide odorous surface water. Fishkill incidence has been reported due to this phenomenon. Since 2008 lake has been highly eutrophic and enduring hypolimnetic hypoxia, which cause more frequent fishkill. We compile and synthesize past and recent research to address prolonged eutrophication and frequent hypoxia in Lake Maninjau due to impact of uncontrolled cage aquaculture in Lake Maninjau. We document past and recent trends in key parameters determining prolonged eutrophication and lake hypoxia and examine their likely ecological impacts. Long-term study (2001- recent) reveals increase trends in nutrient concentrations as total nitrogen and total phosphorus, chlorophyll-a and solids concentrations as suspended solids. Increase inputs of nutrients induces changes in dominant type of phytoplankton from Chrysophyta (diatom) to Chlorophyta (green algae) in 2005 - 2007 and to Cyanophyta (toxic blue green algae) from 2007 to recent. Changes in the highest concentrations of sulfide related depth to the upper hypolimnion layer might cause shifting oxycline to the upper water column up to < 8 m depth (epilimnion layer), which increases the thickness of hypolimnetic hypoxia (DO < 2 mg/L). Rough estimation indicates that 97% of lake volume has been in anoxic conditions. Lake hypoxia also has impacts on fish community where it does not only reduce the types of fish and benthic fauna present but also reduce its productivity. To improve lake water quality to a mesotrophic requires reduction in nutrient and organic loads which means removing most of fish cages out of lakes. However, the complexity of the problems due to economic value of cage aquaculture makes it harder to impose any regulation on reducing fish cage number or even on banishing any cage in lakes. We set good ecosystem lake water quality criteria and provide potential approaches to achieve those water quality criteria targets for Lake Maninjau to reduce risk of prolonged eutrophication and frequent lake hypoxia.

Keywords: Eutrophication, lake hypoxia, water quality, tropical lake

## EFFECTS OF SALTWATER INTRUSION IN CHAO-PHRAYA RIVER AND MITIGATION MEASURES

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Drought has caused many problems in lower Chao Phraya River basin for the recent years. With the lack discharge released from the north, this caused the problem of saline water from the sea intruded into Chao Phraya River and made the water appropriated for both consuming and agricultures. Unfortunately, the saline water could intrude into the river with a vast distance, more than 100 kilometers from the river mouth, where it reached the Bangkok Metropolitan raw water supply intake stations and also passed many agricultural areas. This caused damages to Bangkok Metropolitan water supply system and high value crops; such as orchids and durians. To keep the saline water far away from the significant places, adequate amount of discharge related to the sea level have to be released from the reservoirs in the upstream of Chao Phraya River. Then, the water budget balance between water to counter the saltwater and irrigated water for farmers became a curious issue among the people in Chao Phraya River basin; especially during the drought season. This study aims to investigate the damages of saltwater intrusion in Chao Phraya River by simulations and questionnaires, and to summarize the possible mitigation measures in the short and long term plans. This could be a guideline for preventing the saltwater intrusion in the future.

Keywords: Saltwater intrusion, Chao-Phraya River, Reservoir Management, Drought

## **BIOGEOCHEMICAL AND GEOMICROBIOLOGICAL INVESTIGATIONS ON FERRUGINOUS SEDIMENT OF LAKE TOWUTI, SULAWESI, INDONESIA**

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Lake Towuti is a tropical 200 m deep tectonic lake seated in ophiolitic rocks and surrounded by lateritic soils. Its location on Sulawesi, Indonesia, renders Lake Towuti's sediments prime recorders of paleoclimatic changes in the tropical Indo-Pacific Warm Pool. The tropical climate and the lateritic weathering of the (ultra)mafic catchment of the Malili Lakes system cause a strong flux of iron(oxy)hydroxides to the lake, which are effectively trapping all available phosphorus in the water column, thereby driving the water column towards severely nutrient-limited conditions. The strong iron flux results in ferruginous sediments that support microbial communities that are utilizing a range of metalliferous substrates as electron donors. However, due to anoxia in the deepest parts of the stratified water column and the sediment, metal reduction processes lead to a release of adsorbed phosphate, allowing for increasing biological activity. From May to July 2015, the Towuti Drilling Project (TDP) carried out a drilling campaign at Lake Towuti and recovered over 1000 m of sediment drill cores from three sites with maximum penetration depths of 133, 154, and 174 m below lake floor, respectively. Initial sedimentological data indicate that at least 800 ky of sedimentation history were recovered. Two biogeochemical pilot campaigns were carried out prior to drilling to obtain a detailed picture of the surface sediment and to optimize the analytical procedures for the peculiar sediment composition. By analyzing cores from sites above and below the oxycline we found that biogeochemical processes in the sediment can be linked to differences in bottom water redox conditions

Ferruginous sediments likely support microbial communities, which can utilize a range of metalliferous substrates. Although microbial activity decreases dramatically below the water-sediment interface and with increasing sediment depth, even this low activity can have an appreciable impact on both sediment composition and biogeochemical cycles over long time periods. In addition, iron minerals are also suspected to strongly adsorb DNA. Upon cell lysis, nucleic acids are released into the surrounding water and sediment and partitioned between sorption to reactive Fe surfaces and uptake or degradation via microbial metabolisms. Binding to metal oxides and colloids could result in preservation and persistence of eDNA in the lacustrine record, providing a valuable archive of genetic information. However, since metal-reducing bacteria have the capacity to solubilize structural Fe and utilize adsorbed nutrients, the sediment-bound eDNA should not be totally recalcitrant and could serve as a labile organic substrate for sedimentary microbes. Its concentrations should then depend on the complex interplay between these processes. Lake Towuti provides the opportunity to examine microbial populations in an iron-dominated and sulfate-poor ecosystem with dynamic redox conditions and infer sorption and diagenetic processes arising from subsurface microbial activity.

In order to investigate the relationship between biogeochemistry and microbial processes in these iron-rich anoxic sediments, we retrieved short sediment cores from Lake Towuti in 2013 and 2014 at three different depths. The sediment was analyzed for pore water geochemistry, total cell counts and potential sulfate reduction rates (SRR) as well as extra- and intracellular DNA (iDNA). These data provide a background for geomicrobiological and biogeochemical analysis of the long (>100 m) drill cores that were retrieved during the ICDP (International Continental Scientific Drilling Program) Towuti drilling campaign in spring/summer 2015 and which were analyzed with the same techniques in order to provide a concise dataset.

Changes in redox chemistry, whether they are related to climate or in-lake processes, appear to lead to variations in burial of OM, as well as electron acceptor availability and metal speciation in the sediments. When considering a lacustrine sedimentary record over geologic timescales, long-term shifts between oxic and anoxic conditions and vice versa appear to be the main control factors for the distribution of electron acceptors and OM availability and therefore control metabolic activity of the subsurface biosphere.



# Oral Abstracts

# Oral Abstracts

Tuesday, November 8<sup>th</sup>, 2016

Room A, Topic 3 Lake and Lake Basin Management and Policies

## **RANKING TRANSBOUNDARY LAKE THREATS: A GLOBAL-SCALE ASSESSMENT**

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A Transboundary Waters Assessment Programme (TWAP) was undertaken to determine the status of, and the threats to, transboundary lakes and reservoirs, rivers, aquifers, large marine ecosystems and the open ocean, both to establish a global-scale knowledge base and to rank the threats to these various water systems. The lakes component of this global-scale assessment focused on 206 priority transboundary lakes and reservoirs. Based on GIS-based spatial analysis techniques, and consideration of the characteristics of their drainage basins, the relative lake threats were expressed in terms of Human Water Security threats and Biodiversity threats. As a group, the African transboundary lakes merit the greatest attention from the perspective of relative threats, and the need for management interventions, followed by lakes in Asia and South America. Another major finding was that the interpretation of the relative threat ranks was fundamentally dependent on the perspective of those using the ranking results, with many ranks changing significantly when different filtering criteria or alternative weights were applied in the threat ranking calculations. The assessment results also demonstrated that an accurate, meaningful risk classification required consideration of a range of interacting scientific, socioeconomic and governance issues. To this end, the value of Integrated Lake Basin Management (ILBM) in future assessments, as a complement to Integrated Water Resources Management (IWRM), also is discussed. A final conclusion was an urgent need for the international water community to undertake knowledge base development focusing on transboundary lakes, as well as their linkages with other lentic and lotic water systems.

Keywords: lakes, transboundary, assessment, governance, management

## **PEOPLE'S ACTIVITIES IN LAKE DANAOS, PACIJAN ISLAND, CEBU, PHILIPPINES**

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Pacijan Island was blessed to have Lake Danao as the largest and cleanest lake throughout Region 7 and one of the tourist destinations in Camotes islands. The study on people's activity was made to find out their effects to the lake as well as their nature, problems and solutions. Actual interview with the respondents and visits in the lake Danao and workplace of the respondents was using an interview guide to gather data throughout the barangays surrounding the lake namely, Northern Poblacion, Sta. Cruz, Cabunga-an, Esperanza, Union and Campo. Results as to capture fisheries shows that pole and line dominates as the fishing gadget throughout the six barangays followed by spear fishing, fish pots, drag seine and gillnet. Fishes caught are tilapia, mudfish, freshwater catfish, climbing perch, therapon, shrimps and goby. Aquaculture activities were only done by the BFAR-7 and D.A- Municipal Office. Post harvest processing of caught fishes were drying, frying, pickled, stewed, broiled and tinola. Agricultural activities are planting corn, rice, coconut, cassava, vegetables and cow and chicken raising. Recreational activities and business includes the construction and operation of White Lake Park, bike trail, and sakanaw. Conservation and sustainability of Lake Danao as an aquatic site involves Lake Danao Clean-up, cleaning the area and tree planting. Problems encountered are stealing of caught fish in fishpots, restricting fishing, using gillnets becomes a problem because fishing is the major livelihood of the people. Soli-soli weavers have no specific areas for gathering the raw materials. Rainy season becomes their problem because the soli-soli is not thoroughly and immediately dried resulting to poor quality of the product. Perceptions as to the conditions of the lake show that during summer months water is shallower and during rainy days the water is very deep. Crocodiles, leeches and land turtles are already gone and replaced by therapons. Species of birds are diminishing due to disturbance and hurting of birds which were stopped for the last 10 years. The space for the lake becomes large because the inhabitants cleaned the lake.

Keywords: Lake Danao, People's activities, Cebu, Philippines

## **SUSTAINABLE MANAGEMENT OF LAKES WATER'S SYSTEMS AND THE NEED FOR AN ECOSYSTEM APPROACH AND A COMPREHENSIVE INTEGRATION OF WATERS BODIES**

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Recent completed transboundary water assessment programme has indicated that lakes and other lentic water systems provide wide range of ecosystem services, comprising, resource provision services (drinking water supply, agricultural irrigation, fisheries, recreation, transportation, hydropower generation); regulating services (flood and drought mitigation, self-purification, climate mediation, shoreline ecotone buffering, diverse food-chains) and cultural and recreational services (including aesthetics, spiritual, anthropogenic, and historical values). Those wide range of services that benefit directly to people have become the focus of intense research and policy interest over the past decade. Such assessment has indicated as well that, in order to assess comprehensively the sustainable management of lake basins and lake water systems, one needs to fully consider interactions and integration of overall inland water systems, including lakes and reservoirs, rivers and wetlands, aquifers and in many instances coastal waters. In fact, the complexity of water systems drainage basin should lead to a more comprehensive approach for a sustainable management and governance of lake basins. Indeed the step by step methodology of target and indicator 6.6.1 of SDG Goal 6 which main focus is, by 2020, to: "ensure availability and sustainable management of water and sanitation for all" includes the need to protect and restore in a comprehensive way all those water-related ecosystems, namely rivers, inland waters, wetlands, aquifers and lakes. Considering the global sustainable development agenda as a whole, reaching such target by 2020 will surely constitute one of the major challenges the world will have to face in order to successfully achieve most of the 2030 Agenda targets.

## **ECOSYSTEM HEALTH REPORT CARD: A TOOL FOR EFFECTIVE TRACKING OF THE ECOSYSTEM HEALTH OF CHILIKA LAKE AND ITS BASIN**

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Chilika Lake a Ramsar site, is situated along east coast of India, was in a degraded condition till late 1990's. Lake was restored successfully in 2000 by Chilika Development Authority (CDA) with an ecosystem approach. CDA adopted "Ecosystem health report card" as a monitoring tool to track the health of the lake and its basin. Ecosystem health report card is a transformative assessment that compares scientific and environmental data with thresholds and are delivered to a wide audience in a simple format for better understanding and appreciation. The health of the lake was assessed, taking into consideration 10 indicators organized into three broad indices i.e. (a) Water quality (b) Fisheries and (c) Biodiversity. For water quality (i) water clarity, (ii) DO (iii) total chlorophyll; for biodiversity (i) bird (ii) dolphin (iii) benthic faunal diversity (iv) phytoplankton diversity and for fisheries (i) total catch (ii) size (iii) diversity, had been taken in to account. Desired conditions (thresholds) for each indicator was arrived at based on available guidelines, current scientific knowledge, historical data and trends based on which score was given to each indicator at the scale 1-10. The individual grades were calculated for all three indices; water quality, fisheries and biodiversity. Overall, Chilika Lake scored a "B" for ecosystem health based on performance of water quality, fisheries, and biodiversity indices during 2012 and 2014. The report card is produced every two years. Considering its effectiveness, it is adopted as a management tool for effective tracking of ecosystem health of Chilika Lake and is being replicated in other wetlands in Asia.

Key words: Ecosystem health report card, Ramsar site, water quality, biodiversity, fisheries, Chilika lake

## QUESTIONING NEGOTIATED APPROACH IN MANAGING MULTI-PURPOSED LAKE MANINJAU

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Lake Maninjau offers picturesque green landscape to tourist across the world before fish farm invaded the lake. For the past ten years the number of fish farming using Floating-net- cage (FNC) in Maninjau skyrocketing to more than 20.000 unit in the area of 99.5 km. With the total value production of USD 2.1726 billion, the fish farming activity has been claimed success in generating economy of fish farmer's income. However, the environmental impact of overly used Lake is cautiously being overshadowed by the economic pressure to the lake. Negotiations and strategic management largely failed to lessen the environmental degradation. To address issues mentioned above, research method has combined quantitative and qualitative approach to shaping suitable recommendation to each party (Government, Community, and Civil Society). By employing quantitative approach (choice modeling), there are four scenarios offered to the community surrounding the lake (4 Nagari/Villages as samples). Community likely to pledge into two different opposite poles: business as usual or zoning the FNC to a particular area of the lake. A qualitative approach has shown that main challenge is to create an institutional environment that will enable all stakeholders to participate in the management of water resources in a continuous learning process. One of the methods for solving water resource management is Negotiated Approach (NA). These efforts promote negotiations as processes in which participants can reach an understanding of and resolve problems based on their shared common interests, rather than as bargaining processes in which individual participants defend their positions and interests. Thus, this paper will discuss two main issues: A) will NA able to contribute in managing Lake Maninjau with all the complexity within the Lake's utilization? B) in what way the four scenarios offered will support NA in Lake Maninjau?

Keywords: Negotiated Approach, Lake Maninjau, Fish Farming, Water Resource Management

## THE GOVERNANCE OF LAKE RAWAPENING, INDONESIA : AN INTER-ORGANIZATIONAL NETWORK ANALYSIS

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Lake governance is an inherently complex process. Much of literature dealing with lake governance, however, relates to the limnological sciences and the technological dimensions. There is an increasing need to understand the multi-stakeholder governance arrangements that emerge from the cross-scale nature and multifunctional role of lake. This study aims to examine networks between actors that either directly or indirectly influence the sustainability of Lake Rawapening in Indonesia. The data were collected using a questionnaire and semi-structured interviews of 60 organizations, ranging from local resource users and village leaders, to governmental agencies, universities and NGOs. Results show that there is no organization that coordinates the various lake

resources related activities at the lake catchment scale. Furthermore, an important result is that municipal governmental agency play a crucial role linking otherwise disconnected actors. Instead of imposing institutional arrangements, it is more promising to identify and build on existing inter-organizational network structures. Social network analysis can help to identify existing social structures and points for interventions to increase the problem solving capacity of the governance network.

Keywords: Lake governance, watershed, social network analysis, Indonesia

## **VALUATION OF ECOSYSTEM SERVICE OF THE LAGUNA LAKE BASIN : EROSION CONTROL AND FLOOD WATER RETENTION**

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The Wealth Accounting and Valuation of Ecosystem Services (WAVES) is a global partnership program initiated by the World Bank in 2014. It aims to promote sustainable development by ensuring that accounting for natural resources and the services provided by the ecosystems are mainstreamed into development planning. One of the two pilot test sites in the Philippines is the Laguna Lake Basin where lies the largest and most economically important lake in the Philippines. Based on the framework of the System of Environmental and Economic Accounts (SEEA) approved by the UN Statistical Commission (UNSC), a pilot ecosystem accounts was developed which includes a land account containing land cover and changes; a water account providing information on water quantity; an ecosystem condition account indicating water quality, changes in bathymetry and sediment loading; an ecosystem production account looking at the flow of ecosystem services like fishery production, water supply, flood retention and soil erosion regulation. This paper focuses on two ecosystem services: erosion control and floodwater retention capacity, which is also referred to as flood control service, and their significance on the ecological integrity of the lake. Erosion control is defined as the amount of sedimentation avoided because of the vegetation cover. This was calculated by comparing the erosion and sedimentation rates in the lake that would have taken place without vegetation cover with the actual erosion and sedimentation rates. Major land cover changes in the basin using satellite images were analyzed for the period 2003-2010. Closed forest decreased by 35% while built-up areas increased by 116%. There was rapid urbanization and industrialization in the lake region in particular in the northwest, western and southern portions of the watershed.

Keywords: This section should contain maximum 5 words that are written in 10 font size and separated with commas.

## **ASSESSMENT OF ECOSYSTEM HEALTH STATUS OF LOKTAK LAKE – THE LARGEST FRESH WATER LAKE IN NORTH EAST INDIA**

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The lake's ecosystem is an essential resource for human survival. They provide a number of ecosystem services which are essential for mankind. The increasing human activity has degraded these resources through modifications resulting in physical, chemical and biological features. This will severely affect the human socioeconomic and later collapse of the lake ecosystem. Considering the above issues, the main objective of the present study is to assess the Loktak lake ecosystem health in order to identify the main driving forces for deterioration of the lake. The methodology of the study includes studying the factors, including socioeconomic, climatological, land use/land cover changes, status of biodiversity, water quality, pesticides level and human health risk assessment. The result identified that the lake is under severe pressure from anthropogenic activity leading to alternation in land use pattern, increase in regional climate leading to hydrology variation, increase level of pollution and pesticides load resulting in higher chance of disease to human and animal due to the consumption of the polluted water. This will also affect the flora and fauna of Keibul Lamjao National Park, the only floating national park in the world located in the southern part of the Loktak where a number of important species including highly endangered *Rucervus eldii eldii* has its only habitat. The outcome of this study provide the overall health status of the Loktak lake and the data from this study will be useful for implementation of news schemes and policy for restoration and sustainable management of the Loktak lake.

Keywords: Ecosystem health, Socioeconomic, *Rucervus eldii eldii*, Loktak, Sustainable management

## STRATEGIES FOR CONVERSION OF ABANDONED QUARRIES TO LAKES FOR LAND USE AND FISHERIES -- CASE STUDIES

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Once quarrying is over, it gives the problems for the land use for the area, as they are not suitable for vegetation purposes. However, flooding of that quarry may change the land use, if it is converted to lake. Under the Resource Management Act (RMA) 1991, it is one of the permitted activity unless specifically controlled under the regional plan. Flooding of that quarry does not take water from a stream or discharge it to a stream but it does divert groundwater. As quarries typically have steep sides and are likely to have substantial water depth when full, the Health and Safety Act (HSA), 1992 requires it to be fenced or other appropriate safety measures to be implemented according to the intended use. The water quality in the flooded quarry will depend on the morphometry of the excavated pit i.e., is it a relatively shallow river gravel extraction site with a large surface area to volume ratio, or is it an open-cast coal mine or rock or mineral extraction quarry which has been sunk deep into the ground to follow a specific rock or mineral load and/ or what is the proposed use of the lake once the quarry has been flooded. Because these flooded quarries have groundwater as their primary water source and they are likely to be surrounded by pastoral farm land, the water in the lake is nutrient enriched. A no. of case studies is conducted in the different mining fields. It is observed that the plant material remaining in the quarry when it filled are decomposed and the bottom water oxygen levels are very low. The low oxygen in the bottom waters are exacerbated when the water column thermally stratifies. The decomposition processes associated with residual coal in a flooded coal mine may release chemical contaminants (e.g., boron) which could leak back into the groundwater contaminating the downslope streams and aquifers. Design considerations to minimize these effects include terracing the littoral zone to provide suitable substrate for growing marginal wetland plants and emergent macro-phytus as a buffer zone around the lake edge. Intercept drains are installed to prevent surface runoff from adjacent land and roads entering the lake. Stock exclusion fences are erected around the lake. Within the lake, onsiderations are given to install aerators to keep the water column mixed. In a lake where the surface area dimensions are nearly uniform, an air-bar aerator are less efficient that an enclosed rising plume device which draws the bottom water to the surface before dispersing it laterally. These aerators are destratification devices which need to be in operation as soon as the lake begins to stratify in spring. By artificial means through chemical treatment these waters are made to be non-toxic so that the hygienic conditions can be maintained. It is observed that because of enriched mineral content in the water the growth rate for different types of different types of fishes, crabs, prawns are appreciable. This man-made lakes not only solves the utilization of lands but also solves the crisis of fishes.

## **AN OPERATIONAL FRAMEWORK TO EVALUATE ECOSYSTEM SERVICES AND DISSERVICES IN A BIOSPHERE RESERVE INTEGRATING LOCAL INSIGHTS**

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Colloquially the evaluation of ecosystem services (ES) and ecosystem disservices (EDS) for various ecosystems at different scales is completed using top-down approach with economic valuation methods such as market price or cost based. Reasons for this predominance could lie in first, the attractiveness of applying preset evaluation frameworks in which the aforesaid methods are commonly referred and second, our suspect that unless monetized, benefits will be ignored. However, the integration of the concept into real decision making has never been up to our prospects. Within the limited success stories reported, a number of challenges have been unveiled, one of which relates to the need of complementing the evaluation with local insights from stakeholders given the ultimate beneficiaries of studies being these local people. In light of addressing this issue, we propose a conceptual framework to evaluate ES and EDS with consideration of empirical knowledge from stakeholders. Within the scope of this manuscript, some highlighted results from the application of the framework to locate, quantify, and assess endemic ES and EDS of U Minh Thuong Biosphere Reserve in Vietnam's Mekong delta were briefly presented. The proposed framework, through the case study, has proved to be operational by being able to elucidate not only the values of ES and EDS but also how they are intuited by stakeholders.

Keywords: Ecosystem Services and Disservices, Biosphere Reserve, Mekong Delta

## **EFFORTS TO IMPROVE WATER QUALITY IN LAKE KASUMIGAURA BY THE IBARAKI PREFECTURAL GOVERNMENT**

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Lake Kasumigaura is the second largest lake in Japan and a million people lives Kasumigaura watershed. Lake Kasumigaura is expected to support economic development of Ibaraki and the metropolitan area as precious water resources. However, the economy developed caused deterioration of lake water quality. Therefore, Ibaraki Prefectural Government has placed Lake Kasumigaura water purification at important prefectural administration and has formulated Lake Kasumigaura Water Quality Conservation plan for 30years. The plan consist of various efforts i.e. Household Wastewater Management, Livestock Waste Management, Agricultural Measures, etc. Ibaraki Prefecture make Prevent Eutrophication in Lake Kasumigaura ordinance was established in 1982(reformed the Ordinance to Water Conservation in Lake Kasumigaura in 2007). The ordinance focused on the idea of reducing the amount of nitrogen and phosphate in the wastewater and included a ban on the use and sale of phosphorus detergent and the strict wastewater standards for the factories. In 2005, Ibaraki Kasumigaura Environmental Science Center was established to conduct the conservation of rivers and lakes, as an opportunity which the Governor propose its establishment during the 6th World Lake Conference held in Ibaraki prefecture in 1995. Moreover, to be a financial source to conserve lake Kasumigaura project, Ibaraki Prefectural Government introduced a local tax called 'Forest and Lake Environment Conservation Tax' in 2008. As a result of these efforts, economy and population have been growing up whereas Lake Kasumigaura water quality remains on the same level recent years.

Keywords: Lake Kasumigaura, Water Quality Conservation plan, Eutrophication in Lake Kasumigaura ordinance, Ibaraki Kasumigaura Environmental Science Center, Forest and Lake Environment Conservation Tax

## Room B, Topic 10 Limnology and Limnological Science Fundamentals

### DIATOMS, WATER QUALITY OF TOBA LAKE AND ITS MANAGEMENT

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Toba Lake is one of the biggest lakes in the world: 1,130 km<sup>2</sup> wide, 529 meter depth; and 4,311,58 km<sup>2</sup> of total catchment area. There is Samosir Island in the centre of lake. 19 rivers are enter to the lake but only has 1 outlet i.e. Asahan River. The main functions of Toba Lake are for hydroelectricity power, resource for drinking water, transportation, tourism, and irrigation. The town development in Toba Lake side and Samosir Island had induced water quality deterioration. This research was done to study the diatoms and water quality of Toba Lake and its management. Water samples were taken for diatoms and water quality analysis. Identification of diatoms was done using microscope with 1,000 magnification. Based on this research, the main problem of water quality in Toba Lake was heavy metals lead (Pb) and copper (Cu) that exceeded water quality criteria for all class. Based on total nitrogen (1.085-2.03 mg/L) Toba Lake was in the state of mesotrophic – hypereutrophic. Whereas based on total phosphorous (0.37-0.42mg/L), in the state of hyperetrophic, whereas based on chlorophyll-a in the state of hypereutrophic. pH in Toba Lake was exceeded 7, therefore *Falacea pygmaea* was found in Toba Lake, as well as several *Denticula* species.

Keywords : Toba Lake, diatoms, water quality, hyper-eutrophic, *Falacea*, *Denticula*

### PALAEOLIMNOLOGY FOR ECOSYSTEM ASSESSMENT IN TROPICAL AND TEMPARATE FLOODPLAIN LAKES

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The ecological balance of many shallow floodplain lakes has been altered in recent decades through the modification of hydrology and fluxes of pollutants. Palaeolimnology (sediment core analyses) allows reconstruction of lake ecological conditions before and after major anthropogenic impacts which often pre-date the implementation of lake monitoring programmes. Here we present sedimentary data from three contrasting floodplain sites in tropical (Tasik Chini, a shallow flood pulse wetland in Peninsular Malaysia), continental (Dongting Lake, Yangtze Delta in China) and temperate (Attenborough wetlands complex of small artificial ponds in the UK) regions to demonstrate how palaeolimnology can be applied to assess the causes and consequences of changes in floodplain lake ecosystem structure and associated ecosystem services. We used a range of geochemical/ isotopic and physical analyses to reconstruct past changes in these sites. In tropical Tasik Chini, the combined impacts of land use conversion to oil palm during the 1980s and subsequent regulation of the lake in 1995 to raise water levels have increased sediment infilling rates, and increased allochthonous carbon processing in the lake basin. In Dongting Lake, the construction of the Three Gorges Dam in the 1990s has increased the retention of organic biota and algal remains in sediments of this lake. Ponds in Attenborough wetland complex show hydrological connectivity has a strongly influences the prevalence of bloom-forming cyanobacteria. The long-term and integrative overview provided by palaeolimnology shows how ecosystem services such as the provision of high quality water and carbon sequestration have been influenced over recent decades.

Keywords: wetlands, algal pigments, stable isotopes, sediment cores, shallow lakes

## **WATER QUALITY CHARACTERISTICS IN THE PLANKTOTHRIX DOMINANT YEARS IN SHALLOW LAKE KASUMIGAURA**

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The cyanobacterial blooms in lakes cause serious problems in the world. The most common bloom in eutrophic lakes occurs in the epilimnion. On the other hand, the bloom of Planktothrix, one of the filamentous cyanobacteria, appears in the dysphotic zone because it prefers low irradiance and temperature compared with other phytoplankton. In Lake Kasumigaura, the bloom of Planktothrix suspensa occurred during winter and spring from 2007 to spring 2011. Lake Kasumigaura, located in Ibaraki Prefecture in the eastern part of Japan, is hypereutrophic, large (the second largest lake in Japan), relatively shallow (average depth of 4 m), and polymictic lake. In this study, we analyzed characteristics of water quality in the *P. suspensa* dominant years (2007-2010) by comparing with the other years (2012-2015). The average of bio-volume of hytoplankton in the former years was larger than that in the latter years. This is the reason why chemical oxygen demand (CODMn) was high in the former years (average of 9.7 mg L<sup>-1</sup> at lake center, whereas average of 7.6 mg L<sup>-1</sup> in the latter years). Total phosphorus concentration peaks were observed in spring and summer in the former years, but only in summer in the latter years. The average of transparency in the former years was 0.7 m, and 0.9 m in the latter years. The change of irradiance condition seems to affect in occurrence of the *P. suspensa* bloom.

Keywords: filamentous cyanobacteria, Planktothrix suspensa, Lake Kasumigaura, shallow, water quality characteristics

## **WATER QUALITY ASSESMENT OF VASTRAPUR & SOLA LAKE OF AHMEDABAD CITY, GUJARAT, INDIA**

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The water bodies are facing a severe threat of pollution all over the world. To ensure fresh water availability from the local water sources has become a big challenge. The main objectives of this paper are to assess water quality of these lakes situated in the city. This paper discusses the water quality of two small, an artificial lake situated in Western part of Ahmedabad. Both lakes are considered artificial as a recreational resource. The purpose of the survey was to collect information concerning use and value of water quality improvements. During January-2011 to December -2012 Water samples were collected from aforesaid both lakes and analyzed at monthly interval. The analysis was carried out for the parameters like Temperature, pH, color, odour, Dissolved Oxygen (D.O), Biochemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D), Chloride, Nitrate, Sulphate, Calcium, and Magnesium. The study report discusses about the analysis of the lake water quality and suggests the means to improve the lake water. It was observed that due to presence of impurities in the lake there are many different parameters like DO, COD, Chloride, Total Hardness, ph, and Alkalinity was found to be increased during summer season and have got diluted during rainy season. So these kind of changes would affect the aquatic environment like increase in nitrogen content would result in eutrophication naturally which leads to decrease in the oxygen content level. The study report discusses about the analysis of the lake water quality and suggests the means to improve the lake water quality.

Key words: water pollution, water quality, Sola lake, Vastrapur lake, Eutrophication

## REGIME SHIFT OF PLATEAU SHALLOW LAKE DIANCHI (ENCLOSURE EXPERIMENTS IN CAOHAIBAY AS AN EXAMPLE)

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Due to eutrophication and climatic changes, cyanobacterial blooms seem to be increasing in a growing number of freshwater ecosystems all around the world. Two alternative stable states exist in shallow lakes: acrophyte dominated clear state and phytoplankton dominated turbid state. More and more people pay attention to looking for effective method for regime shift in eutrophic water body in recent years. We did the situ field experiment using the different size enclosure in Lake Caohai, a part in Lake Dianchi. As large *Microcystis* colonies were founded the main contributing to the algae biomass and have a great influence on the biomanipulation using cladoceran *Daphnia*, an effective microfiltration method was applied to removal larger size of *Microcystis* colonies before the biomanipulation experiments. Then the combined methods by biomanipulation using cladoceran *Daphnia* and re-establishing submerged macrophyte were applied. The results showed that the chlorophyll content can be decreased to 50 µg/L or less when abundance of *Daphnia magna* exists by using the combined method. Secchi depth was increased from 40 cm to more than 80 cm. It is implied that the *Daphnia magna* may plays a regulatory role to induce a clear water state in shallow hypertrophic lake. However, it is not obvious of regulation of *Daphnia magna* on higher algal biomass or large *Microcystis* colonies in eutrophic water body. The corresponding relation data between the characteristics of algal bloom and the *Daphnia magna* density can give some guidance in biomanipulation.

Key word: Regime shift, Plateau shallow Lake, Cyanobacterial blooms control, Biomanipulation, submerged macrophyte

## TROPHIC STATUS ASSESSMENT OF TADLAC LAKE IN LOS BAÑOS, LAGUNA PHILIPPINES USING PHYTOPLANKTON AND ZOOPLANKTON

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Tadlac Lake was heavily used for aquaculture until massive fish kill occurred in the lake during December 1999 to February 2000 as its annual overturn happened. Laguna Lake Development Authority (LLDA) and Barangay Fisheries Aquatic Resource Management Council (BFARMC) rehabilitated the lake via banning of aquaculture in the lake. This study seeks to provide an information regarding the lake's trophic status since there is no available data regarding the trophic status of the lake 15 years after rehabilitation. The phytoplankton and zooplankton community, abundance and some physico-chemical parameters were analyzed from October 2014 to January 2015. Five stations in littoral zone and two stations in limnetic zone were selected. Samples for zooplankton was collected using vertical hauling while for phytoplankton, horizontal hauling was used in littoral zone and vertical hauling for limnetic zone. A total of 14 species were recorded throughout the sampling period. For phytoplankton, Chlorophyta was the most abundant group with relative abundance of 58%, followed by Bacillariophyta (35%) and Cyanophyta (7%) while for zooplankton, Rotifera was the most abundant group (83.93%) followed by Copepoda (14.60%) and Cladocera (1.47%). In terms of mean abundance (MA) and relative abundance (RA) for phytoplankton, the highest is *Melosira* (MA= 51,815, RA= 34.887%), followed by *Coelastrum* (MA= 31,107 RA= 20.944%) and *Eudorina* (MA= 27,147 RA= 18.277%). While for zooplankton group, the highest is *Brachionus forficula* (MA= 2,864; RA= 25.23%), followed by *Bdelliod sp. 1* (MA= 1,742; RA= 15.34%) and *Brachionus havanaensis* (MA= 1,427; RA= 12.57%). Abundance of these plankton species indicates that the lake is still experiencing eutrophication. Moreover, the algal pollution index, saprobity index and zooplankton wetland index result showed that the lake is eutrophic with moderate organic pollution.

Keywords: trophic status, phytoplankton, physico-chemical parameters, algal pollution index, saprobity index.

## RELATIONSHIP BETWEEN TROPHIC STATES AND NUTRIENTS LOAD IN WATERS SURROUND SAMOSIR ISLAND, LAKE TOBA, NORTH SUMATRA

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Lake Toba as the largest lake in Indonesia is fast developed in fish aquaculture, tourism, agriculture, and human settlement. These activities will produce organic and inorganic materials that will affect water quality and can cause eutrophication. Some indicators of eutrophication in Lake Toba are nutrients increasing and trophic states changing. The aim of this study was to analyze the effect of nutrients load to the trophic states in waters surround Samosir Island, Lake Toba, North Sumatera. This study was conducted at 23 stations around Samosir Island. Water samples were taken for water quality, nutrient (P and N), and phytoplankton analysis. Data analyses were conducted for nutrients load, trophic states, and spatial distribution mapping of those and dominant species of phytoplankton. Result showed that P and N load in waters surround Samosir Island mainly sourced from floating cage aquaculture and land activities. P and N load from floating cage aquaculture activity was higher than land activity. Those P and N load had increased P and N concentration in waters surround Samosir Island. The P and N concentration showed high trophic states (eutrophic). Biological trophic states index (Nygaard) also showed that waters surrounds Samosir Island have already in eutrophic states. This was strengthened by high abundance of Anabaena (Cyanophyceae) that indicates eutrophic condition.

Keywords: Lake Toba, nutrients, phytoplankton, trophic states

## TROPHIC STATE CHARACTERISATION FOR MALAYSIAN LAKES

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This study investigates the trophic conditions and water quality of three selected lakes of different trophic namely Dayang Bunting Lake (oligotrophy-mesotrophy), Subang Reservoir (mesotrophy-eutrophy) and Sembrong Reservoir (eutrophy-hyper eutrophy) with the objective to characterize a trophic classification for Malaysian Lake. The study assess the various environmental variables including chlorophyll-a, total phosphorus, total nitrogen, dissolved oxygen, pH, turbidity and transparency. Our results showed a low transparency in all lakes which ranged from 0.2 to 3.7 m. Dayang Bunting Lake has the highest transparency, salinity and conductivity among the lakes. Mean concentration of chlorophyll-a was below 10 µg/L while mean secchi depth transparency exceeded 3.0 m indicating oligotrophic-mesotrophic environment. TP concentrations were lowest compared to other lakes. Sembrong Reservoir has the highest turbidity and chlorophyll-a, and lowest transparency among the lakes. Mean concentration of chlorophyll-a in this reservoir exceeded 25 µg/L, indicating eutrophic to hyper-eutrophic environment. The physical-chemical properties of Subang reservoir, such as turbidity, transparency, dissolved oxygen and nitrate, are in between the two lakes. TSI differences indicated both Subang and Sembrong reservoirs are non-phosphorus limited while Dayang Bunting Lake is phosphorus limited. Sembrong Reservoir is dominated by Aphanizomenon and Oscillatoria spp while Subang Lake is dominated by green algae. The most common algae in Dayang Bunting Lake are dinoflagellates and diatom. Using linear regression of the data, a new trophic state classification was proposed for Malaysian lakes.

Keywords: eutrophication, Malaysia, trophic state

## LIMNOLOGICAL MONOGRAPH OF LONAR LAKE, INDIA

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The main objectives of the present study are, to identify the Bio-Geographical area of Lonar Crater and the lake basin inside it is need to protect and conservation of the ecological wonder in India. This require to recommend a monitoring mechanism that can review and guide the process of comprehensive conservation measures. Effective measures therefore can be suggested only by detail knowledge of Biological Diversity and knowing the data of present status of rare, endangered and threatened (RET) species, endemic and vulnerable species of crater ecosystem. Environmental education to create awareness in community so as to get their involvement for the conservation of Biodiversity of Lonar Lake and identification of appropriate legal status to be accorded to the identified area is the another objective. These objectives are related to current perceptions of key environmental challenges that may accordingly evolve over time: to investigate ecosystem of Lonar lake, to know composition of flora and fauna, to know ecological aspects, sub ecosystems and their inter relationship, find out causes of degradation of Lonar Lake, to find out effective conservation of a critical ecosystem and its resources, to evaluate ecological issues, pollution level and reasons, to know impact of human interventions, and to inculcate the judicious and sustainable use of lake and its resources. This will appeal to Ramsar Treaty and Government of India for the conservation of Lonar Lake. The methods followed-Different locations were selected as sites for the study of ecological zones as the monograph is concerned to study of ecological aspects of all kind of organisms living in the lake. Various Limnological parameters were studied by using standard methods. For the assessment and comprehensive conservation measures of the ecological, geographical and archeological aspects, local stakeholders and controlling authorities were consulted. The microbial fauna, zooplanktons, phytoplanktons, Macroinvertebrates, Avian diversity are studied since ten years but recent data of previous three years i. e. 2013-2016 will be discussed. The study reveals that Lonar lake is an inland saline water body of the salinity is due to carbonates only and is 10g./L. The microbial flora and fauna includes only the salt tolerant species of planktons. Though salty the water is not hard. The lake is in peril as it declining in salinity gradually. Human interventions, increasing load of pollutants in the form of fertilizers and pesticides in agriculture at the alluvium of the crater leading it towards Eutrophication.

Keywords: Lonar lake, Wet-land, Eutrophication.

## ZOOPLANKTON DIEL VERTICAL MIGRATION IN DANAU LAUT TAWAR, ACEH

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Danau Laut Tawar located in tropical sub-alpine area, light intensity high throughout the year with low air temperature. Watershed supplied high sediment input during rainy season. Floating karamba and domestic wastes supplied nutrients. Zooplankton diel vertical migration (DVM) are distinct in each lake. Environmental factors are playing role in driven zooplankton DVM, also competition and predation. The aim of this research is studying zooplankton DVM pattern and biological-physical factors drives it in Laut Tawar Lake, Aceh. Sampling took place in centre of lake using water sampler on March and June 2015. Sampling perform three times a day, before dawn at 03.00 WIB, before culmination at 11.00 WIB, and after sun sets at 20.00 WIB. Samples collected in 0, 1, 3, 5, 8, 15, 30 and 60 meters with 5 replications. Physico-chemicals factor measured are secchi depth, air temperature, vertical water temperature, DO, CO<sub>2</sub>, nitrate and phosphate. Zooplankton in Laut Tawar shows temporal DVM. Zooplankton didn't perform DVM in March while they shown strong DVM in June. Zooplankton DVM in Danau Laut Tawar driven mostly by the presence of predators. March is Depik (*Rasbora tawarensis*) last month of spawning season. Zooplankton density increased on June after spawning season end. Rise of zooplankton density caused decrease of phytoplankton density. Copepods can reach 30 m to avoid predators. Weak DVM shown by Rotifers. They compete with Cladocerans for food thus avoiding the same depth as Cladocerans.

Keywords: trophic cascade, cascade migration, tropical subalpine lake, temporal diel vertical migration

## DRIVING FACTORS AFFECTING DYNAMICS OF PHYTOPLANKTON FUNCTIONAL GROUPS IN ERHAI LAKE

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Dynamics of phytoplankton functional groups during 2013 to 2015 were investigated in lake Erhai, a large plateau lake in Southwest of China. Species (or genus) which relative biomass abundances more than 10% were included in 16 functional groups. The concurrent frequency of Tz、T、M、P functional groups is highest, but the seasonal dynamics of phytoplankton functional groups are different during 3 years. In 2013, the occurrence sequence of dominant functional groups was Tz-P- M/T-M, while in 2014, the occurrence sequence was Tz-P- Y-M- T-Tz, and in 2015, the occurrence sequence was Tz-P- Tz-T- Tz. Heavy cyanobacterial blooms of *Microcystis* were occurred in September and October in 2013. Compare to 2013, the biomass contribution of functional groups P increased and functional groups M decreased in summer and autumn in 2014, and the biomass contribution of functional groups Tz increased and M decrease significantly in summer and autumn in 2015. The possible driving factors, such as total phosphorus, total nitrogen, ammonia nitrogen, permanganate index, water temperature, transparency, pH, DO, rainfall, radiation were also studied. Temperature, radiation, nutrients from heavy runoff pollution may be the key factors.

Keywords: functional groups; Lake Erhai; cyanobacterial blooms

## **SPECIAL SESSION**

### **MANAGING LAND-USE SYSTEM IN THE CATCHMENT AREA OF UPPER SEKAMPUNG WATERSHED IN SUMATRA-INDONESIA**

Introduction to the Session: Bustanul Arifin (Professor, University of Lampung, Indonesia)

Sekampung Watershed in Lampung, Sumatra-Indonesia covers over 484 thousand hectares and 8 districts and municipalities, stretching from Upper Sekampung in the District of Tanggamus to Lower Sekampung in the District of East Lampung. Sekampung is the main watershed in the Province, serving as major food baskets, such as rice, maize, cassava, other secondary crops, and fishery products and centers of major agricultural export commodities such as coffee, cocoa, palm oil, coconut, etc. However, the current land use system, especially in the catchment area has led to land degradation in the watershed, where 49 percent of land area is degraded, 34 percent potential to degrade and 17 percent non-degraded. The average rate of soil erosion is 67.5 ton per hectare per year, higher than the 25 ton per hectare tolerable soil loss. This session examines the management of land-use system in the catchment area of Upper Sekampung, as it will affect significantly the ecosystem health and resilience of the watershed. Non-sustainable land use system will increase ecological risks, posing serious threats to the livelihood deterioration of the poorer segment of rural and suburban people in the Province. Such ecological risks have caused significant impacts on soil and water quality, agricultural production and productivity, food and water supply on which public health heavily depends. Four presenters from Indonesia and Japan will discuss more in-depth from social-economic to bio-physical dimensions of the theme. Dr. Hanung Ismono examines the economics of coffee agroforestry system in Upper Sekampung Watershed that serves as conservation strategy in the catchment area. Professor Irwan Sukri Banuwa extends the arguments of multiple-crops modeling of coffee farming system in Upper Sekampung that contributes to diversified income sources and sustainable resource management. Dr. Hiroaki Somura analyzes the relationship between land use system of catchment area and water quality in Batu Tegi Dam of Sekampung Watershed, as most farmers do not apply chemical fertilizer and pesticides excessively. Dr. Slamet Budi Yuwono examines sustainable water resources management in Way Betung, Lower Sekampung Watershed, and introduces the mechanism of payment for ecosystem services from water users in the downstream as beneficiaries to land-users in the upstream as service providers. Finally, Professor Ryohei Kada will summarize the session and deliver a concluding note on interdisciplinary approach in managing environmental risks in Sekampung Watershed of Sumatra, Indonesia.

### **THE ECONOMICS OF COFFEE AGROFORESTRY SYSTEM IN UPPER SEKAMPUNG WATERSHEDS**

Hanung Ismono (Associate Professor, University of Lampung, Indonesia)

(co-authored with Bustanul Arifin, Ryohei Kada, Katsuya Tanaka)

This study examines the economics of coffee agroforestry system in Upper Sekampung Watersheds, conducting a thorough household survey, by interviewing 408 coffee farmers in two sub-districts of Pulau Panggang and Pugung in the watershed. The study employs farm-economic analysis and compares the economic performance of coffee agroforestry in different land-use systems in the study sites. Farmers in the study sites have adopted coffee agroforestry system for a while using shaded fruit trees and multi-strata coffee system to secure household income and to contribute to conservation practices in the catchment area of the watershed. Average coffee production in Upper Sekampung is 394 kg/ha, which is far away below the national average of 645 kg/ha, mostly due to traditional farming practices and simple processing techniques. Coffee crops remain profitable in the watershed, but ample opportunities could be explored to improve the coffee yield and quality to fulfill increasing demand for coffee. Agroforestry system has provided additional income sources, mostly from tree species, shown by significant higher B/C ratio than the coffee farm only. Supply chain certification programs have attempted to create price premiums at the farm level, where Rainforest Alliance and 4C certificates have been around in the study sites for about 5 and 2 years respectively. Farm gate price of coffee closer to the premium market price has more short-term attention from coffee farmers in the study sites, although environmental risks are higher. The study calls for more empowerment programs for coffee farmers to improve coffee yield and coffee quality, for example by adopting selected red-cherry picking, green-washing and dry processing of the post-harvest handling.

## **MULTIPLE-CROP MODELING OF COFFEE FARMING SYSTEM IN UPPER SEKAMPUNG**

Irwan Sukri Banuwa (Professor, University of Lampung, Indonesia)  
(co-authored with Melya Riniarti)

This study analyzes multiple-crop modeling of coffee-based farming systems in Upper Sekampung watershed, by comparing coffee monoculture (UT1), multiple-crop modeling of farming system of coffee and pepper (UT2), farming system of coffee, pepper, and banana (UT3), farming system of coffee, pepper, and cocoa (UT4), and farming system of coffee, pepper, banana, and cocoa (UT5). The study observes bio-physical conditions in great detail, land capability classes of the multiple-crop of the farming system, and analyzes the sustainability of the above-mentioned farming systems using soil erosion indicators, farm-income generated from the system, and its ability to support the household livelihood in the study area. The results show that the existing monoculture coffee in Upper Sekampung does not perform sustainable farming indicators. The rate of soil erosion in Upper Sekampung is extremely high, ranging from 52.5 to 452 ton per hectare year on the slope of 15 percent or higher, far greater than the local tolerable soil loss of 38.7 ton per hectare per year. Average farm income generated from coffee-based farming system is quite low, ranging from Rp 6.9 to 16.2 million per year, much lower from minimum decent living (KHL) of Rp 18 million per year. Multiple-crop coffee-based farming systems show more sustainable farming indicators, where more complex coffee-farming system (UT5) show the most optimal indicators compared to others. Combination of modern agricultural inputs in multiple-crop of coffee-based farming system of UT5 could reduce the erosion rate down to 2.9 to 27.1 ton per hectare per year and generate farm income nearly Rp 20 million per year, which is above the minimum decent living standard. This study strongly recommends the protected zone of Upper Sekampung should be designated for conservation area, and not recommended for agricultural development.

## **ON THE RELATIONSHIP BETWEEN LAND USE SYSTEM OF CATCHMENT AREA AND WATER QUALITY IN BATU TEGI DAM OF THE SEKAMPUNG WATERSHED**

Hiroaki Somura (Assistant Professor, Shimane University, Japan)  
(co-authored with Slamet Budi Yuwono)

This study reports the progress research on relationship between land use system of catchment area and water quality in Batu Tegi Dam of the Sekampung Watershed in Lampung. Coffee farmers in the catchment of Upper Sekampung Watershed generally do not apply excessive chemical fertilizers and pesticides, resulting in low coffee yield and their farm income. However, different land-use system has different pattern of agricultural input application, causing different water quality in the main river and some sub-rivers in the study area. Land use systems that are prone to soil erosion and land degradation, such as coffee monoculture and intensive food crop farming, have major impact on water quality due to sedimentation process and some contamination incidence. Land use systems that are more sustainable such as coffee agroforestry with shaded tree of fruit crops and timber crops have minor impact on water quality. Some other patterns of correlation between land-use system and water quality in Batu Tegi Dam will also presented in the analysis, especially in the main Sekampung river and Sangharus river.

## **SUSTAINABLE WATER RESOURCES MANAGEMENT IN WAY BETUNG, LOWER SEKAMPUNG WATERSHED**

Slamet Budi Yuwono (Associate Professor, University of Lampung, Indonesia)  
(co-authored with Irwan Sukri Banuwa)

The study examines the impact of land use change in Way Betung Watershed on the capacity of water resources supplier of Bandar Lampung City, and estimate the economic value of Way Betung water resources. Way Betung watershed serves as one important network of Sekampung Watershed and the most potential water resources supplier for the City of Bandar Lampung, particularly for potable regional water company (PDAM) in the Provincial Capital. An integrated bio-physical and economic model was employed to examine the impact of land-use changes. A demand function of willingness to pay (WTP) was adapted to estimate the annual economic value of water resources in the watershed. The results shows that the drivers of land use changes in the Way Betung watershed include: (1) increasing annual run off coefficient, (2) the maximum daily discharge (Q max), and (3) decreasing daily minimum discharge (Q min), as (5) increasing fluctuation of river discharge. Total annual economic value of water resources of Way Betung watershed was Rp 101.1 billion per year and the total willingness to pay value for the rehabilitation of Way Betung watershed was Rp 1.5 billion per year. These estimates were derived from public clean water sector, tourism, water mineral companies, households and paddy field farmers in the upstream portion of the watershed. The study recommends some scenarios of water resources development, by simulating the erosion level and run-off and potential economic consequences for the future. The best scenario for sustainable water resources of Way Betung watershed includes forest cover as much as 30 percent of the watershed and alley cropping on mixed farming system. This development will reduce the erosion to lower than the tolerable soil loss (TSL) and decrease the fluctuation of monthly run off from 64.7 to 30.9. Finally, association of water users is willing to pay the rehabilitation costs in the catchment area of watershed.

### **SUMMARY OF THE SESSION**

## **INTERDISCIPLINARY APPROACH IN MANAGING ENVIRONMENTAL RISKS IN SEKAMPUNG WATERSHED**

Ryohei Kada (Professor, Shijonawate Gakuen University, Japan)

The collaborative research between Indonesian researchers and Japanese researchers on such important theme of managing land-use system in the catchment area of Upper Sekampung Watershed in the Province of Lampung in Sumatra-Indonesia has revealed some insights that an interdisciplinary approach is really needed in managing environmental risks in Sekampung Watershed of Sumatra. Since the watershed is really important for the people's livelihood in the province, non-sustainable land-use system significantly affects the ecosystem health and resilience of the watershed. An interdisciplinary approach of such complex problems would result in better managing the ecological risks through integrated natural resource management, especially since agricultural production and food security remain important issues in Indonesia, either at the household, landscape or regional levels.

Policy changes and advocacy are needed to provide alternatives for farmers' decision on land-use systems and crop rotations to manage ecological risks and to ensure the level of profitability of agroforestry systems in the watersheds. Such integrated approach of social sciences and natural sciences shall generate better recommendations for community-based risk communication and early warning system of ecological risks. This could also contribute to better farming practices that could ensure sustainable resources management, agricultural production and livelihood consequence at the landscape and regional levels. Involving local community in such a complex task could also contribute to the improvement of social capital and effectiveness of stakeholders' networking for co-design of integrated natural resource management. This community-based trans-disciplinary approach could be more effective and sustainable for natural resource management. An important key for policy advocacy in the future is by building up partnership the above mentioned tasks with locally organized leaders and major stakeholders involved in land use changes affecting ecological risks at the landscape and regional level.

## Room C, Topic 7 Biodiversity and Conservation

### RESPONSES OF PHYTOPLANKTON STRUCTURE COMMUNITIES IN THE XIANGXI RIVER TO THE REGULATION OF THE THREE GORGES RESERVOIR

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Xiangxi River is a typical tributary of the Three Gorges Reservoir (TGR) and was influenced significantly by the regulation of the TGR. In order to get insight into the variation of phytoplankton communities in the Xiangxi River and its responses to the hydrologic regime of the TGR, annual investigation in situ was conducted. The results indicated that the hydrologic regime of the TGR was divided into four stage: water releasing stage (Feb.- June), low water level stage (June – Sept.), water impounding stage (Sept. – Nov.) , high water level stage (Nov. – Next Feb.). A total of 67 species belonged to 7 phyla were identified, including 32 Chlorophyta, 15 Bacillariophyta, 10 Cyanobacteria, 5 Pyrrophyta, 4 Chrysophyta and 1 Cryptophyta species. The perennial common species were cryptomonas ovate, Cyclotella meneghiniana and Melosira granulata (Ehr.) Ralfs. The seasonal predominant species were including Peridiniopsis niei., Ceratium hirundinella, Pandorina morum, Eudorina sp. and Microcystis aeruginosa. the succession order was the following: cryptophyta, pyrrophyta and bacillariophyta (Mar.—April) -- Chlorophyta (May) -- Cyanobacteria (June - Sept.) – bacillariophyta (Sept.-Nov.) – cryptophyta (Dec. – Feb.). Total biomass of phytoplankton was 0.53 -233.57 µg/L expressed as Chl a concentration, the peak value was appeared in spring (May). Algal cell density varied from  $0.29 \times 10^6$  ind /L to  $206.85 \times 10^6$  ind /L, the peak value was observed in the summer. Significant positive correlation between phytoplankton communities and water level was proved. It was concluded that the regulation of reservoir could determine the characteristics of phytoplankton community in its tributary.

### DISTINCTIVE FLUCTUATION IN WATER QUALITY AND PLANKTON IN THE CENTER OF LAKE KASUMIGAURA, JAPAN SINCE 2001

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Lake Kasumigaura is a wide, shallow maritime lagoon lake in which the water is artificially desalinated to be utilized effectively for tap water, irrigation and industry. The water is highly eutrophicated and its improvement has been an urgent matter for some time. We have scientifically monitored the water quality and plankton periodically at six monitoring points since 2001 in citizen activities. We experienced outbreaks of Bosmina, high transparency in early summer and a massive microcystis bloom in midsummer, 2011 after the Great East Japan Earthquake and the subsequent radioactive cesium pollution from the accident in the Fukushima nuclear power plant in March. We propose that the outbreak of Bosmina grazing diatoms and green algae in early summer caused the increment of transparency, resulting in a massive proliferation of microcystis in midsummer. However the causalities from this abrupt outbreak of Bosmina are uncertain. It was observed that water fleas including Daphnia and Cyclops became scarce during the white turbidity period, 2002~2006. White turbidity in the lake water inhibits the photosynthesis by phytoplankton, resulting in a decrement in primary production, including the population of zooplankton and the fishery catch. While COD values also decreased, the inorganic nitrogen and phosphorus values were relatively high during the white turbidity period. Since 2012, a restoration of transparency has brought about relatively high COD values probably because of the proliferation of phytoplankton. Through these experiences we have learned again the importance of transparency for the productivity and health of our lake eco-system.

Key words: water quality, plankton, transparency, productivity

## **FISH DIVERSITY OF THE SINGKARAK LAKE, INDONESIA: PRESENT STATUS AND CONSERVATION NEEDS**

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Singkarak lake is one of the priority lake in Indonesia who need to be save in terms of fish production and source of income for many fishermen living. This study has been conducted from January to April 2016. While aim of the study revealed the existing of fish species and their composition along with diversity and conservation needs. The results of present investigation reveal the occurrence of 19 fish species belonging to 5 orders, 8 families and 15 genera. Among the collected species, order Cypriniformes was the most dominant consist of 42.10%, followed by order Perciformes 21.05%, order Siluformes 10.52%, and order Tetraodontiformes and Synbranchiformes 5.26%, respectively. Among 19 species, bilih (*Mystacoleucus padangensis*) in Singkarak lake was categorized only one species in the world and have economi value to society. The fish status is endangered now, due to over fishing by gillnet and liftnet. Futhermore, needs to be conservation regarding the mess size and the total fishing gear used in Singkarak lake.

Keywords : Singkarak lake, diversity, conservation, economic value

## **PROTOZOAN GRAZING IN A SHALLOW EUTROPHIC LAKE: COMPARISON BETWEEN LITTORAL AND PELAGIAL**

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We studied the protozoan grazing rates in a shallow eutrophic lake and made a comparison between two different habitats: littoral and pelagial. Studies were carried out in Lake Võrtsjärv and lasted from April to July. Grazing by protozooplankton was measured by in situ feeding experiments with fluorescent microspheres (diameters of 0.5  $\mu\text{m}$  for picoplankton, and diameters of 3  $\mu\text{m}$  and 6  $\mu\text{m}$  for nanoplankton). Our study revealed that the lowest grazing rates in pelagial coincided with the corresponding highest grazing rates in littoral. We also studied the metazooplankton seasonal dynamics and larval fish feeding on zooplankton. The possible cascading effects and their influence on the microbial loop will be discussed in more detail.

Keywords: protozoa, grazing, littoral, larval fish

## **A BEHAVIOURAL STUDY OF GOLDEN APPLE SNAIL *Pomacea canaliculata* AT TROPICAL LAKE WITH SPECIAL REFERENCE TO CHENDEROH RESERVOIR, MALAYSIA**

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A survey on the egg deposition behaviour of golden apple snail *Pomacea canaliculata* was conducted at Chenderoh Reservoir, Perak. The distribution of *P. canaliculata* and their mediums for egg deposition at the lake were recorded. The egg deposition mediums ranged from the aquatic plants, rock, boat and human instruments. Since *P. canaliculata* is native to South America and extremely macrophytophagous; feeding on submersed and floating higher plant, the number of egg clusters on the aquatic plants was counted to examine the preferred plant species for egg deposition by *P. canaliculata*. The egg clusters were then collected for hatching test. Findings showed that *P. canaliculata* were found to lay eggs on the stems and leaves of aquatic plants with 44% occurrence compared to the other hard medium such as boat, rock and fish cage and also on the emerged bamboo pile which recorded 14% occurrence for each medium. A total of 65% of the eggs were deposited on the stem and 35% of the eggs were deposited on the leaves of the aquatic plants. *Phragmites australis* (41%) from Poaceae family was the most preferred plant for egg deposition whereas the least preferred plant for egg deposition was *Neptunia oleracea* (3%) from Fabaceae family. Based on the results, there was no significant difference ( $p > 0.05$ ) in percentage of hatched egg between the submersed and non-submersed test. The incubation period of egg to hatch was approximately 14 days upon the hardening of the calcium shell. In addition, the percentage of the egg to hatch is about 60% even though the egg was immersed in the water. As *P. canaliculata* is considered to be in the top 100 of the "World Most Invasive Alien Species", therefore, the studies on its behaviour are needed in order to reduce the economic loss especially in the agriculture sector and also for a healthier lake environment.

Keywords: *Pomacea canaliculata*, Chenderoh Reservoir, invasive, aquatic plant, egg deposition

## **AVIFAUNAL AND RIPARIAN VEGETATION COMPOSITION IN AND AROUND THE MUSEUM LAKE IN GOVERNMENT ZOOLOGICAL GARDEN THIRUVANANTHAPURAM, KERALA INDIA**

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This study considers with species composition, diversity and IUCN threat status of avifaunal population along with an ear marked riparian vegetation in and around the lentic ecosystem inside the Government Zoological Garden, Thiruvananthapuram Kerala. Of the total 60 bird species identified during the study period February 2013 to July 2015, 88% (S=53) are resident breeders and 23% (S=14) are winter migrants. The order Passeriforms shows an exceptional gradient of species diversity with 26 species (43%). 17% (S=8) of the total 46 plant species belongs to the family Poaceae followed by Araceae and Lecythydaceae. Nesting ground of Oriental darter (*Anhinga melanogaster*), a near threatened species enlisted in the IUCN Red List ignites the indispensability of biodiversity conservation and effective resource management. The Thiruvananthapuram zoo which is located at the heart of the city acts as a buffering zone for the captured, exhibited and native avian fauna. Maximum number of bird species was observed in winter season as compared to the summer and monsoon. Highest numbers of birds were recorded during the month of November (n=423) and lowest in August (n=193) which may be due to availability of food and favorable climatic conditions for nesting, roosting and boosting for most of the bird species in winter season. This watery ecosystem and the surrounding vegetation is an abode of diverse fauna which emancipates the global concept of conservation and ecological duty, even if it is being landscaped at the heart of the overcrowding city. The distribution of birds shows the status of this aquatic ecosystem.

Keywords: Avifauna, Kerala, Zoological garden, Riparian Vegetation, Oriental darter

## **FLUCTUATING ASYMMETRY USING GEOMETRIC MORPHOMETRICS IN *Glossogobius giuris* (HAMILTON, 1822) FROM LAGUNA LAKE, PHILIPPINES**

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The study investigated the pattern of asymmetry in white goby, *Glossogobius giuris*, a native and an economically important fish which is of declining population in Laguna Lake, Philippines. Fish samples (N=118) were obtained from two predominantly agricultural sites (Bay and Santa Cruz) in the East Bay and from a reference site, where gobies were reared in tanks. Nineteen anatomical landmarks were digitized on fish images and were subjected to an advanced tool for shape asymmetry (Symmetry and Asymmetry in Geometric Data (SAGE) version 1.04). Procrustes two-way mixed model ANOVA revealed significant levels of both directional and fluctuating asymmetries (FA) between sexes and among populations. Fluctuating asymmetry, the small, random differences between the left and right sides of a bilaterally symmetrical organism, is widely reported as a measure of developmental stability and as an early-warning tool in monitoring the health of aquatic ecosystems. Results of this study imply that deviations from perfect symmetry may be attributed to both genetic and environmental stressors. Overall FA variations based from two major principal components were high in wild populations. Findings may indicate the contributory effects of environmental conditions associated with anthropogenic pressures on the developmental stability of goby populations.

Keywords: fluctuating asymmetry, white goby, Laguna Lake, geometric morphometrics, SAGE

## **TOWARDS SUSTAINABLE FISHERIES IN LAKE LANA O, THE PHILIPPINES: FOCUS ON THE DWINDLING ENDEMIC CYPRINIDS POPULATION**

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Sustainable fisheries is the management and conservation of the natural aquatic resources base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. In Lake Lanao, Lanao del Sur Province, Southern Philippines, sustainable fisheries had been practiced hundreds of years ago as evidenced by the fishing practices of the M'ranaw people. However, advancing civilization and foreign dominations had influenced many of these practices, eventually resulting in unsustainable patterns of development. Moreover, modern fisheries, even as it had been enormously successful in extracting abundant harvest from aquatic habitats had harmed the ecosystem, and destroyed the economic and social well-being of the rural communities. For the present paper, critical issues such as open access, overfishing, and other anthropogenic stress, amongst others, that had led to a declining endemic cyprinids population are presented. One study carried out exemplifies one of these issues. Common indicators that fisheries managers can use to detect overfishing and fishing pressure on these prized species are discussed. Responsive action agenda to the problems confronting the endemic cyprinids are also proposed. These agenda hope for proper management and conservation of these resources ensuring food security to the M'ranaw people.

Keywords: Sustainable Fisheries, Endemic Cyprinids, Fisheries Management, Anthropogenic Stress, Food Security

## **A BASIC IDEA OF GUIDELINES FOR CONTROLLING SUBMERGED MACROPHYTE OVERGROWTH TO BENEFIT ECOSYSTEM AND BIODIVERSITY**

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The growth of submerged macrophytes expanded rapidly after 1994, especially in the South Basin of Lake Biwa, and since that time long-term chlorophyll a concentration has been decreasing, suggesting a so-called “ecological regime shift” is occurring. Since 2002, their overgrowth has caused harmful impacts such as oxygen depletion at the lake bottom and/or lentic algal blooms, as well as having detrimental effects on fisheries, navigation, and the scenic value of the lake. The local government, Shiga Prefecture, has been cutting and removing macrophytes to reduce the damage and to conserve the lake ecosystem.

In this study, we investigated the biomass of macrophytes in the South Basin and calculated the biomass for the purpose of recycling. According to long-term records the maximum biomass in a year has varied between 500-18,000 dry-t since 1936 and between 3,000-18,000 dry-t over the last 20 years. The macrophytes grow by approximately 2,000 dry-t per month from May to September. The local government harvested 500 dry-t per year from 2011-2014, which is only 3-15% of the total biomass. However we do not know how much volume is appropriate for sustainable harvesting. It is important to take care of the overall ecosystem balance as well as to control macrophytes. Therefore, we observed benthic animals, epi-fauna and periphyton while controlling macrophytes volume. We will suggest a benchmark macrophyte biomass amenable to scientific analysis taking into consideration the ecosystem and biodiversity. This study will provide a basic idea of the guidelines for macrophyte management in lakes.

Keywords: biodiversity, species richness, submerged macrophytes, South Basin of Lake Biwa, harvesting submerged macrophytes

## **SPECIES DIVERSITY OF FINFISHES AND CRUSTACEANS OF BUGUEY LAGOON**

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Buguey Lagoon is significantly a productive inland water along wetlands of Cagayan which is one of the priority biodiversity conservation areas. Despite of its significance to municipal fisheries, only limited studies have been carried out along species diversity. This study investigated the species composition, relative abundance and diversity of finfishes and crustaceans. Sampling was carried out twice a month from June to November 2015 at three sites/barangays. Species composition revealed 55 species caught of which 43 finfishes classified belong to 10 orders and 31 families. Crustaceans like shrimps (6) and crabs (6) belong to 1 order and 4 families. Order Perciformes and Decapoda constitutes 52.72 % and 21.81 % of the total order diversity respectively. The community was dominated by Family Portunidae comprising 83% and Gobiidae 13% of the species richness/total familial diversity. *Portunus pelagicus* is the most dominant among the crab species in terms of relative abundance of crustaceans. *Ambassys gymnocephalus* and *Penaeus indicus* have the highest species abundance. The exotic *Litopenaeus vannamei* an aquaculture commodity in ponds was caught for the first time in this inland water. Simpson's Reciprocal Index shows that in every fishing operation more than 3 finfishes and 2 crustaceans were caught. Diversity index were higher in finfishes  $H = 2.08$  than crustaceans  $H = 1.02$  but both show good results to the study. Thus, suggesting that this lagoon would provide sustainable livelihood if managed appropriately.

Keywords: species composition, relative abundance, diversity index, shrimps, crabs

## **LEGISLATION AND STAKEHOLDERS' INVOLVEMENT IN CONTROLLING INVASIVE ALIEN SPECIES IN LAKE BIWA, JAPAN**

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Lake Biwa, the largest and oldest lake of Japan, inhabited by more than 2,000 species of animals and plants including some 60 endemic species, has provided a variety of ecological services with local society and residents. However, its rich and unique biodiversity has been deteriorated and threatened by invasions and proliferation of not a few invasive alien species, exemplified by North American predatory fishes (largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus*) and South American amphibious weeds (alligator weed *Alternanthera philoxeroides* and water primrose *Ludwigia grandiflora* ssp. *hexapetala*). Intensive removal of alien fishes by commercial fishermen has been carried out since 1984 when the population of largemouth bass started to explode within the lake, whereas volunteering removal of alien amphibious weeds was initiated in 2007 when another alien weed Senegal tea plant *Gymnocoronis spilanthoides* was first found in the lake. To activate the control of invasive alien species, national and local legislation has played an important background role through authorization of governmental financial support and facilitation of public participation. Here, I will review the cases of collaborative efforts for controlling fish and amphibious weeds that are highly invasive.

## **Room D, Topic 5 Water Education, Ecotourism, Culture KABATA**

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Harie District, Takashima City, is located on the northwestern shore of Lake Biwa. This district is well endowed with clean water, which is flowing from springs originate in underflow water of the Ado-river and groundwater from the Hira mountains. This clean water is called as "shozu (pure water)" and many of the approximately 160 houses there have a feature unique to the area known as "kabata" (literally, edge of a river) whereby residents make use of these springs in their daily lives. Being aware of the importance of the water being as the common property of the entire area, the Committee of Harie Shozu Village, a community-based organization which local residents form, conducts activities to preserve the water environment and provides visitors with guided tours which create profits. The District annually accepts almost 10,000 visitors including the ones from the foreign countries. Being highly recognized as one of the most successful cases of ecotourism in Japan, the Committee won Grand Prize at 9th Ecotourism Awards co-organized by Ministry of the Environment, Japan, and the Japan Ecotourism Society in 2013. In addition, Harie District has been designated as "Important Cultural Landscape Sites" by the Agency for Cultural Affairs, Japan and submitted an application as "Lake Biwa and its Surrounding Waters: The Water Heritage of Prayers and Lifestyle" and this was approved in 2015 as "Japan Heritage".

Keywords: Kabata, Community-Based Organization, Ecotourism, Japan Heritage, heratware Approaches

## **LOCAL VOLUNTEER GROUP ACTIVITY IN TAKASHIMA CITY, JAPAN**

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Lake Biwa cleaning crops

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Takashima City (located in the northwestern part of Shiga Prefecture, Japan) has been quenched since ancient times with fresh water from the underflow or spring water from mountains and forest area. The highest quality and most low temperature current has been flowed into the Lake Biwa (the largest lake in Japan) from Takashima's many underground veins and rivers without cease (the amount of which is equal to approximately 40% of the water in the Lake Biwa which provides drinking water with 13.5 million peoples in Kansai area). Although Takashima is described as very beautiful scenery, the garbage in the mass consumption times thrown by the people can be seen in the Lake Biwa lakefront. Under such circumstances, the 654 cherry blossom trees planted every 6 km of lakeshore in Takashima, have been once spoiled but achieved flowering reproduction wonderfully by the activity of local volunteer group. Furthermore, we have started volunteers "Lake Biwa cleaning crops" since 2011 and started cleaning activities around the cherry trees and lakefront area. It continues well more than five years mainly on a middle and early old age generation and enjoying morning natural walking, health maintenance and talking with the persons from 8:00 to 10:00 in the morning of every Tuesday. We started with a few persons and now grew up more than ten person's group activity. We continue our activity, even it's a small one, for not only the Lake Biwa but also the human awareness of the importance of maintain the global environment including lakes and reservoirs.

Keywords: Flowering reproduction, local volunteer group, cleaning activities, human awareness, heartware approaches

## **THE LAGUNA DE BAY ECOSYSTEM HEALTH REPORT CARD: AN ASSESSMENT AND COMMUNICATION TOOL FOR STAKEHOLDERS**

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The Laguna Lake Development Authority, in collaboration with the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), published the first Laguna de Bay Ecosystem Health Report Card in 2016. This was funded by the UNEP/GEF project on Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-based Pollution in support of the Global Nutrient Cycle. It is designed to provide a better understanding of the current ecosystem health and to serve as a simple communication tool to the stakeholders. Two sets of indicators were used, i.e. water quality (nitrate, phosphate, chlorophyll a, dissolved oxygen, biochemical oxygen demand and total coliforms) and fisheries (zooplankton, population of native species, and catch per unit effort), which were monitored from 2004 to 2013. They were evaluated in terms of compliance to the National Water Quality Criteria for Class C waters (Fisheries), which is the classification of Laguna de Bay. The numerical scores were then transformed into the equivalent grade in five colors, wherein green is the highest grade and red is the lowest grade. The fisheries indicators were calculated as ratios or percentage that are then combined for each bay. Based on the 10-year data, the ecosystem health of Laguna de Bay scored a passing mark of 76% or a C- in water quality and a failing mark or an F in Fisheries. These were influenced by the high concentration of phosphate, high chlorophyll a, abundance of invasive species, low population of calanoids and low fish catch per unit effort.

Keywords: ecosystem health, communication tool, indicators, score

## **COMMUNITY PARTICIPATION IN INTEGRATED SUSTAINABLE ENVIRONMENTAL MANAGEMENT OF LAKE BINDUSAGAR: FAMOUS NATURAL HERITAGE OF INDIA**

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Bindusagar, situated in the city of Bhubaneswar, India, a very old important natural heritage site under stress. It is a holy lake latitude-20.24 0 , longitude-85.83 0 having great religious historical significance. The lake area is 3 x 10 4 square meter & depth is more than 5mts. It is not only an old worship place, but it also controls major socio economic; cultural activities of large number of people. It harbors various types of flora & fauna. More than five thousand people mostly priests, live around the lake. They earn day to day living using the lake resources. Over the years the lake has suffered from degradations like, siltation, eutrophication, weed infestation, water quality changes. After detailed study, an integrated sustainable environmental management plan has been prepared with community mobilization & participation to address the above mentioned environmental degradation. Methods: A detailed primary socio-economic study was conducted by Rapid Rural Approval (RRA). Participatory Rural Appraisal (PRA) methods. Detailed analysis of water quality parameter & soil analysis were carried out. Findings- From the results it was observed that the water is in highly eutrophic condition resulting in huge weed infestation. The inlets & outlet for water circulation is choked, are to be renovated for better water circulation. The water use pattern was mostly responsible for eutrophic condition. Therefore, an Integrated Sustainable Environment Management plan has been prepared with community mobilization & participation to address Restoration Challenges.

Key words: Bindusagar, Stress, Integrated, Community Management.

## **WATER EDUCATION: AN AWARENESS CAMPAIGN IN SCHOOL IN TRIBAL BELT OF WESTERN PART OF INDIA**

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On site experiment was conducted in 2015-16 on adopted residential tribal school students located deep in the forest of western part of India. For years together, the students of this school were drinking natural untreated spring and well water usually contaminated by E.coli which was further linked with burden of diarrial infection, Regular hospitalizations Anaemia, poor class attendance and academic performance. The dropout percentage was significant for all classes. After studying the negative impact, we designed and implemented safe drinking water plant for all in-house students with hand wash station. The E.Coli free drinking water was provided to all in scientific way. Water education films were screened and awareness programs were conducted for their parents too by organizing their school visits. Majority of parents are residing nearby hamlets and show their complete dependence on slow flowing river and small water bodies existing in forest as a main source of drinking water. These water sources are the true causal factors for early child morbidity and mortality in this tribal belt. The community participation was also involved for water education to reduce child mortality. Results obtained in one span of years study were amazing. There were no health complains nor hospitalizations, Anaemia and stress in girls was drastically reduced, dropout percentage was almost zero and class attendance was excellent. We concluded that if safe clean drinking water is provided to residential tribal school children supported with excellent class room coaching, their academic performance can easily compete with urban students to enter in main stream of education.

Keywords: Tribal, *E.Coli*, Morbidity, Mortality, Anaemia

## **NATIONWIDE COOPERATION OF UNIVERSITY STUDENTS IN REMOVAL OF INVASIVE AQUATIC WEED IN LAKE BIWA, JAPAN**

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Water primrose *Ludwigia grandiflora* ssp. *hexapetale*, an alien aquatic weed from South America was first found in 2009 and have continued expanding in Lake Biwa, Shiga prefecture, thereafter. Its initial coverage was only 142m<sup>2</sup>, but it reached some 2,000 times as large as 270,000m<sup>2</sup> within 6 years through its explosive growth. Because of an amazing ability to propagate and regenerate, negative influences on ecosystems are worried about, such as competitive exclusion of native plants, degradation of habitats, and obstacles in operation of commercial fisheries. We, IVUSA (International Volunteer University Student Association) are the pioneers to remove water primrose in April 2013, and organized large-scale removal events by more than 1,000 students from universities all over Japan in September 2014 and 2015. As a total, we carried out 29 removal events in which a total of 4,668 persons were participated including administrative officers, regional environmental organizations, commercial fishermen, and local residents. As much as 270 tons of water primrose was successfully removed, thereby. In addition, we have extended our connections and regional relations to other environment-oriented groups, local residents, fisheries cooperatives, and local governments of prefecture and cities. We have actively and continuously tried to raise regional awareness of the problem through a variety of exhibitions, presentations, and communications through SNS. We made "Banakin-kun", a symbolic mascot character of water primrose to enhance public relations.

Keywords: Water primrose *Ludwigia grandiflora* ssp. *hexapetale*

## **A NEW WATER CULTURE CONCEPT "TIRTA BUDAYA SITU"**

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For increasing the quality of life of Jabodetabek residents, it is urgent to enhance the functions of urban lake and their surroundings. The research found that there is a need to organize the relationship between residents, local government and private sector. Based on our research results, a new water culture called the "Tirta Budaya Situ" is promoted. With a new water culture, community will feel needs from the urban lake, and they will protect and maintain urban lake and environment. This is a new approach to maintain urban lake where Central Government could not handle and Local Government has no authority to manage, the community role is defined and enhanced. In "Tirta Budaya Situ", the system of urban lakes certification is created. Community, local government and private sector will work together to apply for the certificate to the Ministry of Environment, and maintain and enhance the functions and services of urban lake. Urban lake which has certificate of "Tirta Budaya Situ", will be proud of the local community. Thus, encourage community to concern with urban lake at their area. Situ or reservoir which has certificate of "Tirta Budaya Situ" has a variety of functions and residents surrounding the lakes will be deeply involved in the maintenance and enhance preservation. Through "Tirta Budaya Situ" Certification, we hope that community, local government and private sector will be active in the urban lake utilization and management, so that the urban lake will not be abandoned or damaged.

Keywords: urban lake, Jabodetabek, local community, water culture, certification.

## **EVALUATING INDICATORS FOR USE IN REPORT CARDS FOR LAKE ECOSYSTEM HEALTH**

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Ecosystem health report cards are effective tools for environmental management and science communication. They are designed to effect changes in management and policy and influence behavior. Report cards are successfully being used in iconic watersheds in the USA (Mississippi River and Chesapeake Bay) and Australia (Great Barrier Reef) and have been used for the first time in two lake ecosystems in Asia - Chilika Lake (India) and Laguna Lake (Philippines). The process promotes community participation by bringing together decision-makers, managers, scientists, stakeholders, and resource-users to develop a conceptual framework for their ecosystem. This framework identifies the values of the ecosystem and the different threats that it is faced with. It also defines the goals and major aspects of each goal that should be evaluated over time by nominating potential ecosystem indicators that address these goals. Indicators are more often selected from available monitoring data that are collected by a specific agency. However, there is an emerging trend and demand for the inclusion of socio-economic indicators. While report cards are inherently diverse and place-based, similar indicators can be adapted by a particular ecosystem. In this study, we evaluate the use of different biophysical, ecological, socio-economic and other emerging indicators specific for a Lake ecosystem. With consideration to the importance of incorporating local knowledge and community values in the report card process, we develop a framework to help stakeholders determine what suite of indicators and possible thresholds they can use in developing their own Lake Ecosystem Health Report Cards.

Keywords: Lake ecosystem health, report cards, indicators

## **CAPACITY BUILDING OF LAKE TOBA ECOSYSTEM MANAGEMENT BASED ON SOCIO CULTURAL**

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Lake Toba is one of the natural resources and environment in Samosir District, North Sumatera and the largest lake in Indonesia which is already known as one of tourist the attractions. Currently preservation of function is threatened due to the pressure of unsustainable development. This study aims to formulate a capacity development strategy for sustainable Lake Toba ecosystem management through the identification of traditional wisdom and its relation to environmental management in Samosir, socio-economic and socio cultural analysis and in relation to the preservation of the Lake Toba ecosystem, the analysis of capacity Lake Toba ecosystem management. The method used is explanatory research by conducting surveys, Focus Group Discussion (FGD) and SWOT analysis. Research results indicate that socio-economic and socio cultural conditions is categorized as good. Overall condition of ecological wisdom is categorized as good. The environmental damage of Lake Toba ecosystem can be divided into Toba lake water pollution due to floating net cages activities and domestic waste, hotels and restaurants waste and environmental damage such as deforestation, illegal logging and sand mining. Conditions of pollution and damage in the area of the Lake Toba ecosystem in bad categories. Society and government capacity in Managing Lake Toba Ecosystems in sufficient category The strategy resulting from the SWOT analysis can be implemented into a variety of programs.

Keywords : capacity building, socio economic, socio cultural, ecological wisdom

## **IMPACTS OF PARTICIPATING MEASURES FOR REDUCTION OF ALIEN FISHES IN LAKE BIWA**

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Since alien fishes were found in Lake Biwa on 1960s, environmental and economic problems broke out in the lake. Shiga prefectural government have carried out eighteen political measures for reduction of alien fishes: some grant for fishers for extermination alien fishes, research for efficient extermination of alien fishes, ordinance to prohibit release of alien fishes to the lake and so forth. As these measure's outcome, amount of exterminated alien fishes has been assessed by prefectural government. However, the impacts on recreational fishers' mind to participate extermination of alien fishes are unknown yet. We investigated recreational fisher's recognition and observance level of no-release rule and their cooperation mind in extermination of exotic fishes by a questionnaire. As a result, we revealed that: (i) fishers who knew the no-release rule had long fishing career and caught many largemouth bass; (ii) fishers who kept the no-release rule were older than forty years old and their fishing point was near the box for dump alien fishes. In addition, fishers who didn't keep the rule came from outside Shiga prefecture and their fishing point was not near the box for dump alien fishes; (iii) fishers who used the box for dumping alien fishes caught many bluegill and their fishing point was near the box for dump alien fishes.

Keywords: common resource management, policy assessment, alien species, citizen's participation, Lake Biwa

## **BOTTOM UP TOURISM DEVELOPMENT: THE EMERGENCE OF COMMUNITY BASED TOURISM IN RECENT DEVELOPMENTS OF BALI TOURISM**

**Darma Putra**

**Udayana University**

In the last two decades there has been a growing number of villages in Bali that show their serious efforts to manage the natural and cultural potentials of their area as tourism attractions. By doing so, the villages have the opportunity to be part of the tourism economy. This is something that has been widely enjoyed by locals and national entrepreneurs or multinational corporations. This paper discusses the emergence of community participation in recent development of tourism in Bali. It focuses on three questions which are (a) why does community participation in the tourism sector has been so late, (b) how do they manage their natural and cultural resources, and (c) does their participation in tourism development contribute to a model of community based tourism (CBT), if yes what type of CBT have they implemented? In order to provide a clear picture, the paper discusses tourists attractions managed by two different villages in Bali, which are Tanah Lot Temple in South-West Bali and Pandawa Beach in South Bali. The paper concludes that community participation in managing tourism attractions are not given by authority but, as in the case of Tanah Lot, the community had to protest through demonstration in order to get their right. The two cases show that Balinese communities have the professional capacity to manage tourism attraction in their area and use the income from the tourism sector to support financial need of the community through the channel of existing customary village organisation (*desa adat*), thus make it a typical Balinese model of CBT.

## **SPECIAL SESSION – HEARTWARE THEME**

### **“HEARTWARE”: A TYPOLOGICAL ANALYSIS AND PROSPECTIVE INTEGRATION INTO “ILBM”**

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The concept of “heartware” (e.g., common appreciation of historical, cultural, anthropological and even religious implications) aspect is beginning to be recognized as important as “software” (the government rules and regulations and the stakeholder participation) and ‘hardware’ (structural and non-structural interventions involving technology and instrumentation) aspects in river-lake basin management. The proposed presentation will discuss a provisional synthesis of the exploratory surveys of existing river-lake basin management experiences, in which the importance of shared values among people with regard to such “heartware” has emerged as the essential glue uniting the scientific, socio-cultural and political dimensions. The survey was participated by various lake basin management research groups and projects from India, Japan, Malaysia, Nepal and the Philippines with additional workshop inputs received from various Bangladesh, Indonesia, Mexico and Pakistan. The presentation will also bring forth how the implicit importance of “heartware” may be more explicitly integrated into the ILBM Platform Process, a river-lake basin governance improvement approach having been promoted globally over the past decade. The project has been technically and financially supported by Ministry of Education, Sports, Culture, Science and Technology through Research Center for Sustainability and Environment, Shiga University, and the government and people of Shiga Prefecture through ILEC.

Keywords: ILBM, Heartware, Knowledgebase, Experience Sharing, Ecosystem Service

## **COMMUNITY-BASED SHARED VALUE AS THE HEARTWARE DRIVER FOR INTEGRATED LENTIC LOTIC BASIN MANAGEMENT**

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This paper explores the case for using “community-based shared values” as a potential driver for the heartware aspect of governance in Integrated Lentic-Lentic Basin Management (IL 2 BM). This policy approach was originally inspired from the Japanese experience - and the paper investigates whether a similar strategy can be adapted in the Malaysian context. The insights will be gained through a literature review of the subject, plus our 3.5 years experiment in testing the application of the Heartware concept with watershed communities at the Selangor River and Lake Varsity (within the campus of University of Malaya) respectively. The study confirmed the availability of a range of community-based shared values that are promising to drive the heartware for integrated watershed management in the local Malaysian context. However, most of these shared values are either declining in its appreciation or nostalgic in nature – and its value for IL 2 BM could not be realized if it is not proactively re-enriched, activated and creatively mobilized by the local communities and key stakeholders of the watershed. We propose that a conscious application of the heartware approach could tap into the care/humanistic dimension of shared agency which can then create a more reflective and adaptive policy environment for the IL 2 BM cyclic platform process.

Keywords: Community-based shared value; Heartware; Integrated Lentic-Lentic Basin Management; Governance

## **“THE HEARTWARE ASPECT FOR STRATEGIC PLAN OF TONLE SAP AUTHORITY”**

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Tonle Sap Authority (TSA) was established by the Royal Degree NS/RKT/0609/705 dated on 29th June 2009. TSA is the national independent institution with its mandate to manage and coordinate the overall activities in the Tonle Sap Great Lake and related region, direct adviser and providing recommendation to the Royal Government of Cambodia. In particular, the present pressure of the development, population growth, inequality use of beneficiaries, and poverty of the people relying on these natural resources have been making the ecosystems of Tonle Sap be jeopardized and at risk of threats of overexploitation. The main threats are population growth, overfishing, wildlife, flooded forest encroachment, illegal fishing activities, climate change, pollution and water quality, variation in hydrology regime etc. After recently attending a seminar on the concept of "Heartware" governance and management of the lake and basin, which initiated the experience of Japan seen as a good theory should be more aware and learn to be more comprehensive. I hope that the meeting WLC16 will gain many new experiences and especially the idea of "Heartware" a matching basis to the context of Cambodia on the principle of river basin management.

Keywords: The Heartware and Tonle Sap Strategic Plan.

## **FORMATION, MAINTENANCE, TRANSFORMATION OF HEARTWARE: EXPERIENCES IN LAKE BIWA**

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There has been a focus on the use of “heartware” concept for Integrated Lake Basin Management (ILBM). In many fields, heartware, along with hardware and software, is recognized as an important element to construct effective governance structure. A dam, for example, is hardware, while its operating rules are software. These two are, however, often not good enough. Heartware, such as people’s wisdom and culture, is usually needed to complement the whole system. This paper will discuss how heartware is formed, maintained, and transformed through the experience in Lake Biwa, Japan. As a case study, we will review what happened personal water crafts (PWC) were introduced to the lake in 1990s. In many western countries, there should be certain boating etiquettes, which may not be written in the official regulations, but are still important for the boaters to respect each other and the environment. Japan, on the other hand, was relatively weak in such a healthy culture for pleasure boating. The result was chaotic: they cut trees to launch their boats, run around nearby the shores which created noise and air pollutions, and caused deadly accidents and so on. The first part of our paper will look closely the cause of this chaos. Then, the second part will discuss the way to address the issues based on hardware, software, and heartware approaches. We will also refer to a prefecture’s environmental education project “Uminoko”, a floating school project for every fifth graders in the end.

## URBAN LAKES: IDENTIFYING HEARTWARE APPROACHES FOR DHAKA CITY

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The term 'Heartware' refers to traditions, values and emotional connections, with respect to lakes and rivers. Water bodies in Bangladesh have traditional, cultural, economic and spiritual values and are considered sacred. With the advent of modernization, our past connections with lakes and rivers have been eroding. Although there have been attempts to restore and protect urban lakes by various government and non-government agencies, these initiatives have largely focused on structural and legal reforms. Human sentiments and people's connection to lakes and their influence on decision making about the wise-use of lakes have not really been explored in Dhaka. This paper seeks to understand the connections between human emotions and how they can influence the management of lakes. The objective of the research is to identify the 'heartware' approaches for urban lakes in Dhaka City. A combination of research tools have been deployed for the purpose of collating information: namely, review of existing literature and interviews with the users of the lakes in various capacities. The insights about people's values and emotional linkages to urban lakes in Dhaka city identified through the research pave the way for sustainable planning and use of the natural resources. The key findings or suggestions put forth by the respondents such as meaningful engagement of people through education and awareness can be applied for strengthening efforts geared towards conservation of urban lakes in Dhaka, as well as other parts of the country and the region.

Keywords: Heartware, Urban Lakes, Dhaka City, Education, Awareness

Wednesday, November 9<sup>th</sup>, 2016

Room A, Topic 3 Lake and Lake Basin Management and Policies

### STRATEGY FOR CONSERVATION AND MANAGEMENT OF URBAN LAKES IN MUMBAI

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Studies on impact of massive urban development on the trophic status of water bodies in Mumbai have been carried out for two years. Water quality characteristics with reference to various physico-chemical and biological parameters in Powai Lake, Vihar Lake, Bhawan's Pond, and Rain Water Harvesting (RWH) Pond located in the vicinity of Maharashtra Nature Park, Sion, Mumbai reveal deterioration of water quality due to impact of various anthropogenic activities leading to changes in the trophic status of these water bodies. Water Quality characteristics and trophic status of Powai Lake indicate it as a hyper-eutrophic. The lake is fully infested with water hyacinth as well as blooms of blue green algae *Microcystis aeruginosa*. Primary productivity studies on Vihar Lake reveal that the lake is least productive and characterized by high transparency, low plankton volumes, and low respiratory rates. RWH pond and Bhawan's Pond are relatively more productive than Vihar lake. Plankton volumes and respiratory rates were higher and transparency was less in both the water bodies. In contrast to the Vihar lake, plankton was abundant and respiratory rates were very high in RWH Pond and Bhawan's Pond. Systematic efforts for monitoring of water quality of these water bodies through Naushad Ali Sarovar Samvardhini are strongly recommended so as to evolve strategic planning and action plan for conservation and management of these water bodies through stake holder and community participation.

Keywords: Sarovar Samvardhini, Community participation, Water Quality, Trophic status, Urban lakes, Mumbai

### POTENTIAL CROSS-SECTORIAL TRADE-OFFS IN RIVER BASIN SCALE WATER MANAGEMENT

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The carbon balance of aquatic and terrestrial ecosystems is tightly linked with cycles of other nutrients, first of all with nitrogen and phosphorus, and with the CNP stoichiometry in food webs. All these processes are sensitive to climate change and transform as a result of global trends. Climate change affects nutrient and carbon losses from terrestrial ecosystems and their loads into aquatic ecosystems. For mitigating nutrient losses/loads, river basin management should plan better matching of nutrient supply with plant demand. Climate change mitigation measures aim at reducing greenhouse gas emissions while adaptation measures should reduce the vulnerability of societies and ecosystems to adverse effects of climate change. In respect of water resources and ecological status of water bodies, the two approaches are often disconnected that, instead of synergies, can create trade-offs between them. It is well-known that large-scale biofuel production increases water demand and contamination, hydro-electric power plants fragmentise the river ecosystem integrity and affect biodiversity, dams and water reservoirs can emit additional greenhouse gases, and seawater desalination as a drought combating measure accelerates energy consumption. It is much less known that even reforestation, wetland reconstruction, or creating buffer strips, usually considered as win-win measures, may locally become antagonistic to other adaptation and mitigation measures. Careful spatial planning should avoid trade-offs between mitigation and adaptation, and make it possible to combine the reduction of vulnerability with mitigation of greenhouse gas emissions. Environmental impact assessment and strategic environmental assessment should be applied to analyze the environmental effects of proposed measures.

Keywords: water, river basin management, climate change, nutrients, cross-sectorial tradeoffs

## **ESTABLISHMENT OF ENVIRONMENTAL CONSERVATION PLATFORM OF TONLE SAP LAKE**

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Tonle Sap Lake is one of the world's most precious freshwater ecosystems, serving crucially important functions to Cambodian society. However, this ecosystem is experiencing drastic changes due to pollution, overfishing, shifts in land use, human activities in adjacent river basins, regional climate change, and impacts from the Mekong River. Given such environmental and societal concerns, we have initiated a project to investigate the unique system of Tonle Sap Lake and its surrounding basins to develop a hydraulic/water quality model (water environment analytical tool) for the lake and propose environmental conservation plans focusing on the assessment of environmental health and ecological risks. Making use of this analytical tool, we will propose water environment conservation plans that will maintain environmental health and alleviate ecological risks, taking into account factors such as population growth, land use change, and other relevant environmental stresses. This project also aims to establish the Tonle Sap Water Environmental Platform (TSWEP) through which researchers, administrative organizations, and citizens can collaborate and co-design regarding measures for conserving the lake environment. The TSWEP is open to any persons and organizations eager to initiate and to promote conservation acts on the lake. By combining the aforementioned analytical tool with the Tonle Sap Water Environmental Platform, we aim to contribute to the sustainable development of Tonle Sap Lake as well as the Mekong River Basin. This project is currently being implemented together with the Tonle Sap Authority, the Ministry of Environment, and the Ministry of Water Resources and Meteorology of Cambodia.

Keywords: Tonle Sap Lake, Mekong River Basin, Water quality model, Environmental conservation, Tonle Sap Water Environmental Platform.

## **TOWARD THE ADAPTIVE WATERSHED GOVERNANCE TO ENHANCE BIODIVERSITY-DRIVEN NUTRIENT CYCLING AND HUMAN WELL-BEING**

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Technological innovations in the use of nutrients to produce food contributed to the great global increase in population, life expectancy, and economic prosperity experienced in the twentieth century. Overexploitation of nutrient resources, however, causes disturbance of natural biogeochemical cycles, accounting for serious eutrophication in many watershed ecosystems around the world. Such nutrient imbalances are a main driver of biodiversity loss on a global scale, leading to deterioration of its ecosystem functions and services. It is now recognized that nutrient imbalances and biodiversity loss are prevalent throughout the planet, posing a risk to sustainable human development. In order to solve these problems related to nutrient imbalances and to ultimately ensure sustainable social-ecological systems, we have to enhance nutrient recycling on watershed scales. Under such a background, we aim to facilitate cross-linkage of the multi-level governance, in which governments and researchers with a systemic view intend to solve nutrient imbalance-derived issues on the regional and global scales, while civilians want to solve social and environmental issues in the context of their life and livelihood. For such watershed governance to be successful, local and scientific knowledge must be shared and integrated by a variety of stakeholders to reconcile conflicts and interests emerging on different scales. Here I will develop a framework for the adaptive watershed governance with the case study in the Lake Biwa Watershed, in which civilians are empowered for biodiversity conservation, resulting in enhancement of their well-being, while scientists show how biodiversity enhances nutrient recycling through their conservation activities.

Keywords: Nutrient imbalance, Biodiversity, Transdisciplinary science, Human well-being

## **IDEAS AND SUGGESTION FOR ECOLOGICAL ENVIRONMENT PROTECTION OF FRESH MACROPHITIC LAKE – KELUKE LAKE**

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Keluke Lake, located in Qaidam Basin of Tibet plateau, belongs to fresh macrophitic lake which is disturbed by human. The lake and its wetlands have the significant function of ecological security in eastern part of Qaidam Basin. National and local governments have paid much attention to the protection of ecological environment of lakes. However, Keluke lake is still facing several problems including worsen water quality and deteriorated ecological environment, especially the decrease of the submerged plants area, which resulted from the increased population in the upper reaches, the rapid developments of industry, agriculture, tourism, and the fishery breeding. The lake ecological security is under threats.

In order to improve the water quality or ecological environment state, and avoid “taking measures after polluting”, this study took the safeguard of ecological security in Keluke Basin as the target, the “ecological-oriented, the source control and pollutant decrease, the improvement of ecological environment quality, and maintenance of ecological environmental security” as the strategic orientation, and this study explored the method of ecological environment protection, which was suitable for the characteristic of the lake in Tibet plateau. The The engineering proposal of the social and economic regulation, land and water resources regulation, the prevention and control of pollution source and ecosystem conservation were implemented aggressively in Keluke Lake basin, and long-term protection mechanism was constructed gradually to protect and improve the nature ecological function or natural capacity of recovery in Keluke Lake to become the typical case of ecological environment protection for lakes in Tibet plateau.

Keywords : Tibet plateau, Qaidam Basin, Keluke Lake, ecological security

## **THE SUSTAINABLE DEVELOPMENT PROJECT AROUND LAKE VICTORIA WITH WATER, ECOLOGICAL SANITATION AND AGRICULTURE**

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African rural communities need comprehensive development models that could solve the problems of infrastructure such as safe drinking water supply, proper hygiene and sanitation, and food security. Nippon International Cooperation for Community Development (NICCO) with the support of Kyoto University implemented the comprehensive development project over seven years in amount about 1.5 million US\$ for about 11,000 people in three districts of Malawi, which consisted of seven elemental programs such as (A) agriculture, (B) grain storage, (C) reforestation, (D) measures for infection, (E) human resource development, (F) water supply and (G) ecological sanitation (ECO-sanitation). Upon the successful results of Malawi, NICCO started a new project in Kenya from 2015, which will expand target communities around Lake Victoria aiming for water pollution control of the costal zones.

Keywords: ecological sanitation, agriculture, water supply, Malawi, Kenya

## **ASSESSMENT OF ANTHROPOGENIC PRESSURES ON THE VISOVAC LAKE, CROATIA – STEPS TOWARDS IMPROVED PROTECTION AND MANAGEMENT**

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Lakes are highly vulnerable aquatic ecosystems which are exposed to ever-increasing anthropogenic pressures, such as population growth and land-use change. Accurate and timely assessment of anthropogenic pressures in lake watersheds is therefore a key prerequisite for their environmental sustainability and management. The problem of environmental protection is especially pronounced in conservation areas such as national parks. The aim of this study was a comprehensive analysis of the main factors influencing biogeochemistry and environmental quality of the Visovac Lake, Croatia. The Visovac Lake is situated in the Krka National Park, an unaltered karst area of exceptional natural value, which has been intensively used for regional drinking water supply as well as for recreation and tourism activities with about 1 million visitors per year. The study was conducted by focusing on anthropogenically-enhanced eutrophication and input of various toxic contaminants as the two major processes which may lead to the deterioration of the environmental quality of the lake. The investigation comprised a systematic assessment of water and sediments samples, based on a number of parameters, including basic hydrographic properties, eutrophication-related parameters, concentration of major and trace elements as well as a suite of natural and xenobiotic organic contaminants. Periodic hypoxia/anoxia events in the bottom layer during the lake stratification indicated that eutrophication poses the potential threat to the lake quality, while the concentration of anthropogenic contaminants in water and sediment was comparatively low. However, increasing trends in recent years, associated probably with the growth of tourist activities, indicated the need for continuous monitoring.

Keywords: eutrophication, anthropogenic inputs, trace elements, organic contaminants, Visovac Lake

## **SUMMARY OF EFFORTS TO MAINTAIN THE WATER ENVIRONMENT QUALITY OF THE LAKE FUXIAN, CHINA**

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The Lake Fuxian is the biggest deep freshwater lake in China, occupying 9.16 percent of the fresh water resources of the whole country. It had great water quality and was known as "Plateau Pearl" in honor. However, with the recent local rapid economic development on tourist and agriculture industry, the water environment appeared progressively deterioration. For maintaining the healthy water environment of the lake, a system framework of watershed pollution control, including the comprehensive analysis of the pollution driving forces, calculating Water Environmental Carrying Capacity of the lake, specific implementation of Five-Projects of water pollution control, and enhancing the ability of watershed management and environmental monitoring capacity, has been carried out. So far, above efforts was contributed a lot for maintaining the great water environment quality of the Lake Fuxian. This paper makes a systematic introduction to the system framework of watershed pollution control, and moreover the some major engineering effects after being widely carried out. It hopes this summary could be the next step protection experiences for the Lake Fuxian and used for reference to the protection of other related lakes in China even all over the world.

Keywords: Lake Fuxian, Watershed pollution control, Protection experiences, Engineering effects

## THE EFFORT FOR THE CONSERVATION AND RESTORATION OF LAKE BIWA IN SHIGA, JAPAN

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The initial push towards restoration of the water quality of Lake Biwa came from housewives who took a leading role in initiating a public movement to make the switch from synthetic detergents to organic soap in 1970's while fresh water red tides were observed. It was called Soap Movement and Shiga prefectural government established an ordinance which prohibits the use of the synthetic detergents in response to the movement. Besides those efforts, by constructing sewerages and laying down the regulation concerning industrial waste water, its water quality has improved to a certain level. However, there are still many problems regarding eco-system such as the decrease of endemic species and the increase of the invasive species, and the outgrowth of waterweed. Although Shiga government made the Lake Biwa Comprehensive Conservation Plan (Mother Lake 21 Plan) in 2000 and has promoted individual initiatives in several areas, it revised the plan completely to take countermeasures to the current problems. The revised plan aims at the comprehensive measures taking water catchment of Lake Biwa as one whole system, with a key phrase, consideration to the connection and its progress is being checked by Mother Lake Forum, which is formed by various parties such as the government, citizens, NPOs, researchers and companies. In 2015, the Law for the Conservation and Restoration of Lake Biwa was implemented by the Japanese national government. Based on the law, with the support from the national government, Shiga government will take various initiatives for the lake.

Keywords: Soap Movement, the Lake Biwa Comprehensive Conservation Plan (Mother Lake 21 Plan), Consideration to the Connection, the Law for the Conservation and Restoration of Lake Biwa

## Room A, Topic 7 Biodiversity and Conservation

### BIODIVERSITY AND DISTRIBUTION OF ICHTHYOFAUNA IN LAKE MATANO, SOUTH SULAWESI

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Lake Matano is one of the ancient lakes in Sulawesi. One fauna unique in Sulawesi is ichthyofauna. The aim of study to express biodiversity and distribution of ichthyofauna and know the habitats life in Lake Matano. The study was conducted in Lake Matano at five stations in April and August 2015 namely Lawa River, Nuha, Petea, Pantai Impian, and Pantai Kupu-kupu. Samples were collected using experimental gillnet with mesh sized  $\frac{3}{4}$ ; 1;  $1\frac{1}{4}$ ;  $1\frac{1}{2}$ ; 2; 2,5; and 3 inches. The sample ichthyofauna done for two hours each station. The result showed that 17 species were found which consist of 13 endemic species and red listed by IUCN and four exotic species. The three species form genus *Glossogobius*, three species from genus *Paratherina*, seven species from genus *Telmatherina*, and four alien species of the carp (*Cyprinus carpio*), louhan, gourami (*Trichopodus trichopterus*), and tilapia (*Oreochromis niloticus*). The total number of fish highest found on *Telmatherina antoniae* at the Petea station (outlet of the lake) and the Pantai Impian. Composition of fish highest in April and August found on fish *T. antoniae* were 53% and 47%, respectively. Exotic species who became invasive was louhan that were found in Nuha station. In general the whole range of water quality in each station still requirements of fishing activities. Considering ichthyofauna that were found in Lake Matano dominated by endemic fish, we need to careful when will do introduction new species into these waters, because it will be decreased even extinct of endemic fish in this lake.

Keywords: Biodiversity, distribution, ichthyofauna, Lake Matano

## THE FISH COMMUNITIES OF ABKHAZIAN LAKES

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The aim of this work are research and assessment of the fish community's status of the Abkhazian lakes with different anthropogenic pressing. In the work following tasks have been: study of the species composition of the lake's fish fauna, assessment of species diversity of fish communities with the aid of standard indexes, analysis of the environmental groups of fish communities in lakes. The material collected by fishing on lakes using fishnet with length of 3 m and a mesh size of 5 mm. Assessment of species diversity indices were carried out by Margalef-, Menhinik- and Shannon-indexes. The study as a part of the fish communities of lakes Skurcha, Ritsa, Mayak was found 16 fish species of 4 units (gasterosteiformes, cephaloformes, carpiformes, perciformes). Among the studied lakes the highest rates of species richness and diversity observed in the lake Skurcha. Skurcha get the lowest rates of species richness. By confinement fish community to the type of food on the Skurcha marked: benthophages (60%), planktophages (30%), detritophages (10%). Lake Mayak fully represented by benthophages. The lake Ritsa marked planktophages (60%) and benthophages (40%). In lake Skurcha rheophilic fish (60%) and limnophilic fish (40%), rheophilic fish (100%) lives on the lake Ritsa, on lake Skurcha lives limnophilic fishes (100%). By confinedness to the habitat on the lakes of Skurcha and Ritsa fish community represented by demersal fish (50%) and pelagic fish (50%). The lake Ritsa live only demersal species (100%).

Keywords: ichthyofauna of Abkhazia, fish communities, biodiversity

## ROTIFER COMPOSITION AND BIODIVERSITY IN TROPICAL MESOTROPHIC AND EUTROPHIC LAKES

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Zooplankton is one of the biotic constituents for the structure and function of freshwater lake ecosystem. Rotifers, one of the common group of freshwater zooplankton are usually considered to be useful indicators of water quality due to their high population turnover rates. This study was conducted to evaluate the rotifer composition and abundance in relation to different trophic status of the lakes in order to identify potential rotifer species as bioindicators of lake trophic status. Bimonthly sampling were carried out in Sembrong Lake and Putrajaya Lake from April 2015 to February 2016. Duplicate zooplankton samples were collected vertically and preserved for identification and enumeration. Physico-chemical parameters were measured in situ using YSI multi-parameter. A total of 32 species of rotifers were identified consist of 11 families, Asplanchnidae, Brachionidae, Filinidae, Flosculariidae, Gastropodidae, Hexarthridae, Lecanidae, Mytilinidae, Synchaetidae, Testudinellidae, and Trichocercidae. Putrajaya Lake had the higher ( $p < 0.05$ ) density of rotifers with the total mean density of  $239393.11 \pm 12974.75$  ind  $m^{-3}$  while, the lower total mean density recorded in Sembrong Lake ( $158676.57 \pm 8461.40$  ind  $m^{-3}$ ). Rotifer diversity was higher ( $p < 0.05$ ) in Sembrong Lake ( $1.9 \pm 0.02$ ) compared to Putrajaya Lake ( $1.50 \pm 0.03$ ). The Canonical Correspondence Analysis (CCA) scores indicated that the abundance of *Brachionus forficula*, *B. sericus*, *Filinia opoliensis*, *F. terminalis*, *Keratella tropica*, *Pompholyx complanata* and *Trichocerca similis* was related to eutrophic condition, whereas *Anuraeopsis fissa*, *B. angularis*, *B. caudatus*, *B. quadridentatus*, *K. cochlearis*, *K. tecta*, and *T. cylindrica* was related to mesotrophic condition. This suggests that the trophic state of a lake determines the rotifers community structure.

Keywords: Rotifers, species diversity, indicator species, trophic status

## **IMPACT OF EXOTIC FISH REMOVAL ON BIOTA IN A LAGOON LINKED TO LAKE BIWA**

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Lake Biwa, the largest and oldest lake in Japan, has many endemic species and traditional fisheries. In this lake, two invasive exotic fish, piscivorous largemouth bass *Micropterus salmoides* and omnivorous bluegill *Lepomis macrochirus*, which were introduced from North America increased remarkably in the 1980s. Consequently, native aquatic organisms have decreased conspicuously. But in recent years, owing to the removal of these exotic fish by fisherman for decades, it seems that these exotic fish have been decreasing their populations gradually. The purpose of this study is to confirm that the decrease of the exotic fish populations leads to the restoration of the native biota. Methods Since 2003, we removed these exotic fish and monitored the change of biota in Sonenuma-lagoon which is a lagoon linked to Lake Biwa via only a narrow and shallow channel. Because Sonenuma-lagoon (0.2km<sup>2</sup>) is much smaller than Lake Biwa (670 km<sup>2</sup>), the changes of the biota are likely to be detected more rapidly and easily than for Lake Biwa. We removed exotic fish by netting and fishing until 2007. Since 2008, we have mainly used electro-fishing boat (EFB) which discharges into the water. Findings Owing that EFB was efficient to capture mature largemouth bass, its decrease has become clear since around 2012. From around the same time, increasing populations of native fish and crustaceans have been clearly detected. On the other hand, decrease of the bluegill population has not been detected. The results of this study showed that removal of piscivorous largemouth bass is effective in restoring native biota.

Keywords: largemouth bass, bluegill, exotic fish, biota, electro-fishing

## **REVIEW OF CONSERVATION PRACTICES ON LAKE TANA, ETHIOPIA**

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Soil erosion is a widespread primary factor degrading fertile lands within Ethiopia, causing an estimated loss of two billion tons of fertile soils, and reducing the agricultural GDP by 2.3% a year. To remedy this problem as well as introduce measures to mitigate the effect of Climate Change, the International Fund for Agricultural Development and the Ethiopian Government have put in place the Community Based Integrated Natural Resources Management Project in March, 2010. The project is being implemented in 27 Woredas or administrative districts, of the Lake Tana Watershed, the area drained by Lake Tana, the source of the Blue Nile, and connected rivers. The conservation efforts under the project focus on convincing communities to allocate and respect no-grazing and no-tillage protected areas, developing their interests in conservation activities through regional learning exchanges and trainings. In addition, cash crops are used to create common Funds to drive conservation practices. Through learning exchanges with communities that have successfully rehabilitated severely degraded lands in the Tigray region in the North of Ethiopia, communities have been able to view the positive impacts of conservation activities. After the exchange, their perception of conservation activities has changed. Members are enthusiastic to share their newly gained knowledge and mobilize people in their own Kebele (local district) through a Watershed management committee to devise an action plan, and undertake sustainable land management practices. This includes women's participation and they are now almost equally participate in soil and watershed conservation activities. By the end of the seven year project, 1,040 hectares of degraded lands will be revived by planting suitable tree species and 1,293 of community forests will be protected to revitalize watersheds in 27 Woredas within the Lake Tana Basin. Engaging people in forest and watershed committee's has created synergies to enhance collective action for conservation efforts.

Keywords: Conservation, lake, management, practices, Tana.

## PREFERENCE OF MICROALGAE AS PLANKTONIC OR PERIPHYTIC COMMUNITY IN CILEUNGI KARSTIC SINKHOLES, WEST JAVA, INDONESIA

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Karstic sinkholes in Cileungsi Karst formed as consequences of lime mining activity. Sinkholes filled by water through hydrological process and subsequently inhabited by microorganisms, such as microalgae. This research was conducted to determine microalgae preference as planktonic or periphytic community in karstic sinkholes that influenced (site 1) and uninfluenced (site 2) by anthropogenic activities. Preference analysis was conducted using  $\alpha$ ,  $\beta$ ,  $\gamma$  diversity and PCA. Diversity analysis result showed that  $\alpha$  periphyton ranged from 18-23 and  $\alpha$  plankton ranged from 11-37. Furthermore,  $\gamma$  periphyton was 24 and  $\gamma$  plankton was 37. There was nestedness phenomenon based on the value of  $\beta$  ( $\beta_{cc}$  supported by  $\beta_{richness}$ ). In site 1, periphytic microalgae nested to planktonic microalgae. In site 2, planktonic microalgae nested to periphytic microalgae. Based on PCA, there were 16 genera of phytoplankton, 16 genera of periphyton, and 5 switchover genera in site 1, and there were 3 genera of phytoplankton, 21 genera of periphyton, without switchover genera in site 2. Microalgae prefer to live as periphytic community in anthropogenic uninfluenced karstic sinkholes, and prefer as planktonic community in anthropogenic influenced karstic sinkholes.

Keywords: karstic sinkholes, microalgae, periphyton, plankton,  $\alpha$   $\beta$   $\gamma$  diversity

## PREVALENCE OF TREMATODE METACERCARIAE IN CYPRINOID FISH FROM NONG LUANG WETLAND, CHIANG RAI PROVINCE, THAILAND

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A study of prevalence rate of trematode metacercariae was determined in cyprinoid fish collected from Nong Luang Wetland, Chiang Rai Province, Thailand in May 2016. A total of 120 freshwater fish of 8 species were examined by dissection techniques. Then fish samples were digested with 100% pineapple juice instead of Pepsin. Subsequently, the digested materials were rinsed through the grading sieves mesh and examined for metacercariae using stereo microscope. The overall prevalence rate of metacercariae in cyprinoid fish was 10% (12/120), predominantly in *Puntius brevis* (5%), *Anematichthys repasson* (2.5%), *Luciosoma bleekeri* (1.66%), *Rasbora tornieri* (0.83%), *Labiobarbus siamensis* (0.0%), *Barbodes gonionotus* (0.0%), *Osteochilus vittatus* (0.0%) and *Puntius orphoides* (0.0%), respectively. *Centrocestus caninus metacercariae* was found in the highest number and unidentified species of metacercariae, respectively. These results indicate that eating raw freshwater fish represents a risk for acquiring fish borne zoonotic trematode infection in Nong Luang Wetland, Chiang Rai Province, Thailand.

Keywords: prevalence, Trematode, Metacercariae, Cyprinoid fish, Nong Luang Wetland

## EFFECT OF SEASONAL CHANGE ON SPATIAL DISTRIBUTION OF BACTERIAL PATHOGENS IN TILAPIA (*Oreochromis niloticus*) IN BATUR LAKE

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The aquaculture production of tilapia in Batur Lake is decreasing due to infection of some potential pathogenic bacteria. Bacterial infection happen in Tilapia immune system weakens, causes of water quality changes and seasonal changes. Disease by pathogenic bacteria causing damage to the skin, flesh, gills and internal organs. The spread of bacterial diseases in fish are generally very fast and can lead to a very high mortality in fish that attacked, so the loss caused by this disease is quite large. While the infected fish will lead to cuts in the meat, resulting in lower selling prices. The aim of the research was to determine the seasonal distribution of pathogenic bacteria present in tilapia samples collected from farming locations in Batur Lake. Tilapia (*Oreochromis niloticus*) samples were collected from five floating net cages in Batur Lake. Three fish samples were taken from each station with fish sized ranged from 100-200 g. Identification of bacteria was conducted by using Gram staining method while the observation of colors and shapes of the cells were performed using a microscope at 1000 magnification. Finally the bacteria were inoculated using a streak plate technique on SSA (Salmonella Shigella Agar), EMBA (Eosin Methylene Blue Agar) and TCBS (Thiosulphate Citrate Bile Salt Sucrose). The results showed that the seasonal change affects the spatial distribution of pathogenic bacteria tilapia. Type of pathogenic bacteria in the dry season is more varied than the rainy season. In the dry season there are 5 types of potentially pathogenic bacteria that cause the disease are *Aeromonas*, *Streptococcus*, *Salmonella sp*, *Shigella sp* and *E.Coli* while in the rainy season there are 2 types of pathogenic bacteria is *Pseudomonas alcaligenes* and *Aeromonas salmonicida*.

Keywords: *Oreochromis niloticus*, seasonal change, spatial distribution, potential bacteria pathogenic

## ZOOBENTHOS OF LAKES OF REPUBLIC OF ABKHAZIA UNDER VARIOUS TROPHIC, SPATIAL AND SALINITY CONDITIONS

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Republic of Abkhazia has been rarely investigated due to the wars that undergone on its territory. Therefore, any studies on biodiversity of republic's lakes provide unique information. Laboratory of Water Ecosystem Optimization has inspected biodiversity of republic's lakes for several years. Samples of zoobenthos were collected from 9 lakes which diverse by location, trophic status and salinity. Zoobenthos was represented by 98 organisms belonging to 8 classes. Most of the organisms of zoobenthos were represented by insects and gastropods. Amphibious insects contribute to more, than 60% of organisms of zoobenthos found. The biggest amount of organisms of zoobenthos was found in Skurcha Lake (36 species). In addition, zoobenthos biodiversity has changed significantly over the period of long-term study on the Skurcha Lake. Lake has experienced transformation processes, such as lake desalination. This has been achieved via channel that has been digged from Kodor River with freshwater. Therefore zoobenthos biodiversity vary, some of the species belong to freshwater systems while other belong to estuary ecosystems. Biggest biodiversity of zoobenthos organisms observed in the littoral zones of lakes. Rheophilic species were found at the confluence with rivers. Oligochaeta was the only class observed at large depths.

Keywords: zoobenthos, oligochaeta, desalination, invertebrates

## **A PRELIMINARY STUDY OF ZOOPLANKTON DISTRIBUTION IN BUKIT MERAH LAKE, PERAK, MALAYSIA**

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A preliminary study on zooplankton distribution was conducted in Bukit Merah Lake, Perak, Malaysia with the aim of providing baseline information on zooplankton community structure in relation to physico-chemical characteristics. Zooplankton were collected by filtering 40 L of lake water for each sample using 35 µm mesh plankton net. A total of 49 taxa were recorded from the three main groups of freshwater zooplankton, made up of 34 Rotifera, 13 Cladocera and 2 Copepoda. The study revealed that the lake was dominated by *Keratella cochlearis*, *Trichocerca sp.*, *Polyarthra sp.*, *Bosminopsis deitersi* and *Diaphanosoma sp.* Zooplankton abundance shows a strong positive correlation with temperature measurement ( $r = 0.872$ ) and a weak negative correlation with conductivity ( $r = -0.158$ ) and total dissolved solid ( $r = -0.173$ ). There was a significant difference of zooplankton abundance among the six sampling stations. Based on the findings, it could be concluded that the zonation of the sampling stations and environmental conditions of the lake was greatly affected the distribution and abundance of zooplankton at all sampling stations.

Keywords: zooplankton, Bukit Merah Lake, Rotifera, Cladocera, Copepoda

## **Room B, Topic 10 Limnology and Limnological Science Fundamentals**

### **CARBON DIOXIDE AND METHANE ACCUMULATION IN A HIGHLY EUTROPHIC TROPICAL LAKE, INDONESIA**

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Accumulation of carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) has been estimated in a highly eutrophic Lake Maninjau (West Sumatera, Indonesia) in 2009 and in the recent years. The lake has been exploited for cage aquaculture for more than two decades. The lake receives high inputs of not only nutrients (Nitrogen (N) and Phosphorus (P)) but also organic carbon (C). Accumulation of carbon in the lake bottom has caused steadily sulfides production in the hypolimnion waters. As results, the lake oxic-anoxic line has been shifting gradually from the depth of 40 m in 2006 to 10 – 20 m depth in recent years increasing the thickness of anoxic hypolimnion. Deep profile water samples were collected at two sites of lake (one is the master deep station and another one is on the shallower area of the cage aquaculture). CH<sub>4</sub> was determined from the headspace of the crimp-sealed vials by using gas chromatography (Agilent Technologies) and CO<sub>2</sub> concentration were calculated from alkalinity data and pH. The lake condition reflects the CO<sub>2</sub> and CH<sub>4</sub> accumulation. Concentration of CO<sub>2</sub> increases from 0.1 mmol L<sup>-1</sup> in 2009 to about 0.63 mmol L<sup>-1</sup> in 2016 in the anoxic bottom waters, which contain a total accumulation of 45.8 tons CO<sub>2</sub> in 2009 and to a high total accumulation of 227.2 tons of CO<sub>2</sub> in 2016. Biogenic CH<sub>4</sub> accumulates to high concentrations (up to 1.5 mmol L<sup>-1</sup>) in deep anoxic hypolimnion waters, which contain a total of 158.5 tons CH<sub>4</sub>. No substantial increase has been observed on the concentrations of CH<sub>4</sub> from 2009 to 2015. There is no sign of inhibition of methane production in the presence of sulfides. The lake acts as a CO<sub>2</sub> sink with flux of around  $-3 \text{ mmol m}^2 \text{ d}^{-1}$  however the lake emits around  $4.9 \text{ mmol m}^2 \text{ d}^{-1}$  of CH<sub>4</sub>. Although the lake acts as CO<sub>2</sub> sink, the accumulation of CO<sub>2</sub> and CH<sub>4</sub> in the bottom water is substantially high. The lake is weakly stratified with anoxic hypolimnion where the other study has shown that the lake experiences complete mixing to a depth of 60 m several times in a year depending on the weather causing lake hypoxia. Henceforth elevated CO<sub>2</sub> and CH<sub>4</sub> in the bottom water could escape during the lake mixing. Elevated CO<sub>2</sub> and CH<sub>4</sub> emission from the lake can make significant contribution to global climate change.

Keywords: Carbon dioxide, methane, emission, eutrophic, tropical lake

## IDENTIFYING SOURCES OF NITRATE IN AN IRRIGATED RICE PADDY WATERSHED, TSUKUBA, JAPAN

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The objective of this study is to identify sources of  $\text{NO}_3^-$  in river water using  $\delta^{15}\text{N}_{\text{NO}_3}$  and  $\delta^{18}\text{O}_{\text{NO}_3}$  in an irrigated rice paddy watershed where irrigation water is supplied from outside of the watershed as well as the upstream mountain area. The study was conducted in a rice paddy watershed which covers 9.9 km<sup>2</sup> in the southern part of Mt. Tsukuba, Ibaraki, Japan. We determined  $\delta^{15}\text{N}_{\text{NO}_3}$  and  $\delta^{18}\text{O}_{\text{NO}_3}$  of  $\text{NO}_3^-$  for river water, mountain stream, foothill stream, irrigation water, and drainage water every other month. Stable isotopes were analyzed by isotope-ratio mass spectrometer (IRMS) after converting  $\text{NO}_3^-$  to  $\text{N}_2\text{O}$  by the denitrifier method. Analysis of  $\delta^{15}\text{N}_{\text{NO}_3}$  and  $\delta^{18}\text{O}_{\text{NO}_3}$  of  $\text{NO}_3^-$  from this watershed showed that the decrease in  $\text{NO}_3^-$  concentration in the mainstream river water occurred mainly because of the mixing of nitrate from different sources (foothill stream water and drainage water) during irrigation period. Our data suggested that denitrification is a lesser contributor to the decrease in  $\text{NO}_3^-$  concentrations in this watershed, because enrichment of isotopic transformation (positive relationship between  $\delta^{15}\text{N}_{\text{NO}_3}$  and  $\delta^{18}\text{O}_{\text{NO}_3}$ ) with decreasing  $\text{NO}_3^-$  concentration was not apparent. Different hydrological components suggest that  $\text{NO}_3^-$  in the mainstream river water in this watershed consisted mainly of mountain stream-derived  $\text{NO}_3^-$  during the non-irrigation period. The research highlights that the  $\delta^{15}\text{N}_{\text{NO}_3}$  and  $\delta^{18}\text{O}_{\text{NO}_3}$  of  $\text{NO}_3^-$  can be used as a powerful tool, in order to evaluate nitrogen cycling in a watershed-level agricultural field where irrigation water is supplied from outside of the watershed.

Keywords: Agriculture, Irrigation, Nitrate, Stable Isotope, Watershed

## STUDY ON THE NITROGEN LEACHING MECHANISM FROM AGRICULTURAL LANDS

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In Lake Kasumigaura basin, agricultural production value is the top class in Japan. As a result, agricultural non-point source loads measures have become a big problem. It is an object to clarify the mechanism of the nitrogen pollution. In Hokota river basin, there are many cultivation, such as melons and tomatoes and strawberries that use a large amount of nitrogen fertilizer. In addition, livestock is also very large. Therefore, livestock compost is produced in large quantities, large amounts of compost is thought to be fertilizer to farmlands. As a result, the total nitrogen concentration of Hokota river has been increased to about 10mgL<sup>-1</sup> was observed. This case was similar to the results of measurement of the nitrogen pollution spring water by compost put in the past. Therefore, although nitrogen fertilizer reduction was intended for chemical fertilizers, it was found to cause nitrogen contamination over an extended period of time even organic fertilizers. Moreover, we were core boring the farmlands subsoil until 10m, and analyzed the nitrogen component. Therefore, it was found that it is necessary to solve the three mechanisms shown below as nitrogen pollution mechanism of agricultural simultaneously. 1) Reduction of "the total input nitrogen" (the total amount of chemical fertilizers and organic fertilizers), 2) Reduction of "the necessity nitrogen leaching" (minimum required soil residual nitrogen content for the crop harvest), 3) Countermeasure of "the accumulated nitrogen" (inorganic nitrogen content which is present in less than or equal to about 1m subsoil).

Keywords: Nitrogen pollution, non-point source load, the total input nitrogen, the necessity nitrogen leaching, the accumulated nitrogen

## **EVALUATION OF LAKE WATER QUALITY IN KLANG VALLEY (MALAYSIA) USING MULTIVARIATE STATISTICAL TECHNIQUES**

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Lakes are major sources of water for human consumption and domestic uses in Malaysia, but suffered deterioration in water quality due to anthropogenic activities. This paper studied Physico chemical parameters and heavy metals distribution in five lakes at Klang Valley Malaysia, to evaluate its quality status and possible sources of the identified pollutants for their preservation and continuous utilization. The analyzed parameters were Electrical Conductivity (EC), Dissolved Oxygen (DO), pH, Biological Oxygen Demand (BOD), Ammoniacal Nitrogen (AN), Total Dissolved Solid (TDS), and Suspended Solid (SS), and metals include Cd, Mn, Pb, As, Fe, Ca, Na, and Mg. The levels of these parameters were compared to Malaysia's national water quality standard. The chemometric tools applied were Principal component analysis (PCA) and Hierarchical cluster analysis (HCA). The PCA was applied to identify decreased number of four principal components (PC). The PC1 was strongly loaded with Mn, BOD and AN, while PC2 was strongly loaded with As, Fe and Na. HCA classified the sample sites into three clusters, and the results showed variations in degree of pollution due to oxygen consuming organic pollutants which can be attributed to the domestic sewage and waste water, and other anthropogenic sources. The lakes were classified as the most polluted, polluted and less polluted with respect to influence of organic and metal pollutants. There is a need to monitor the lakes to prevent further deterioration. Proper lake management and environmental law enforcements will assist in maintaining a healthy lake ecosystem.

Key words: Klang Valley, Lake, Pollution, water quality, Chemometric.

## **WATER QUALITY IN COASTAL WETLAND AND ITS IMPACTS ON MACRO FAUNA AT GULF OF KACHCHH, GUJARAT, INDIA**

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Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs. They also support numerous species from various groups including microbes to mammals. Physical and chemical features such as climate, topography, geology, nutrients, and hydrology help to determine the life forms inhabiting in wetlands. Coastal wetlands of Gulf of Kachchh is itself a unique for its semi-arid climate with extremely low rainfall, high variability in seasonal temperature, high rate of evaporation and high salinity with the tidal amplitude. The present study deals with the investigation on birds and macro fauna abundance in coastal wetlands with reference to the water quality. Total 76 species of birds including 54 migratory and 22 resident birds, 34 macro invertebrate species were recorded in different zone responding to the water quality at different zone of coastal wetland of Gulf of Kachchh. Study depicted that the water qualities shows significant impact on the faunal abundance; several parameters like, salinity, temperature, DO, phosphate, nitrogen are negatively correlated while the elements such as pH, sulphate, BOD, calcium, magnesium showed positive correlation with the faunal abundance and activities and found to be vary by wetland zone. The study reveals that macro fauna like birds and benthic invertebrates can be used as key indicator to know the status of coastal wetlands and apply for the rapid monitoring.

Key words: coastal wetland, rapid monitoring, indicator, macrofauna

## **WATER QUALITY IMPACT ON FISH CULTURED IN LAKE TUTUD IN NORTH SULAWESI, INDONESIA**

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Lake Tutud is a lake and is located in North Sulawesi, Indonesia. The estimate terrain elevation above seal level is 390 metres. Latitude: 1°2'40.56" Longitude: 124°41'49.55". We determined the current condition of the water quality of Lake Tutud in terms of physical and chemical parameters in a fish farming locations on Lake Tutud of Tombatu village waters. Determination of sampling points at each station is placed vertically at three predetermined points from the guard house toward the front of the net, the distance between one point to the next point was  $\pm 15$  m; whereas for the analysis of water quality parameters was done using an HORIBA water quality meters' type U-536. Determination points were done by purposive sampling which refers to the physiographic location wherever possible in order to represent or describe these waters. The research was carried out for 6 months and was done in 3 stages, morning, afternoon and evening. For direct measurement (in situ) was performed once a week at the three points which included parameters pH, temperature, conductivity, DO, Oxidation reduction potential, turbidity, TDS, depth and GPS. Findings, generally, the result of water quality analysis at the aquaculture still in the water quality standard PP No.82 of 2001.

Keywords: Water Quality, Lake Tutud, Aquaculture

## **ORIGINAL CLASSIFICATION METHOD LAKES IN THE WORLD USING A FORMULA AND RESULTS OF APPLICATION**

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In world practice, there are many classifications of lakes, based on the use of 1-2 parameters. The aim of the present study was to develop a new method of classification of lakes and identifying opportunities for its application. During large-scale studies of lakes in different regions of the world original way to classify of lakes the authors was developed. The method allows to classify each lake on the feature set using special formulas. The structure formulas contain geographical, hydrological, hydro-chemical and hydro-biological indicators. Each indicator is denoted by a specific letter. Each feature is indicated by the numeral index. The set of indicators and signs gives a certain formula. With the help of this method and formulas was carriers the typing and classification of lakes for several regions of the world. For Russia, the inventory of lakes in Kazan Republic of Tatarstan was held. The study of 180 lakes showed that the main type of city lakes are small floodplain lakes, with increased salinity, eutrophic trophic status. In the Republic of Mari El (Russia) has an inventory of more than 100 lakes. Here, among the lakes of karst origin meets a wide variety of types. With the use of this method are classified as lowland lakes Abkhazia (Caucasus), some lakes in Italy (Trazimeno) and Turkey (Iznik, Yuzla). During the testing of the method it is proved that it can be used both to refer to the individual lakes (identification of the formula), and for large-scale typing in the regions, with the identification of belonging to one or another type.

Keywords: Lake classification, method of classification , lake

## **Room B, Topic 2 Lake Environment Under Stress and Their Restoration Challenges**

### **INFLUENCE OF DISSOLVED OXYGEN CONCENTRATION CHANGE ON MUSTY ODOR PRODUCTION BY ACTINOMYCETES**

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Musty odor in drinking water has been a worldwide problem. There are two typical musty odor compounds, geosmin and 2-methylisoborneol, both of which are produced as secondary metabolites by some filamentous cyanobacteria and actinomycetes existing in freshwater environment. However, environmental factors affecting their musty odor production have not yet been fully studied. Dissolved oxygen (DO) changes in aquatic environment could play a role in stimulating geosmin production by actinomycetes in the sediment. In this study, to clarify the effect of different DO concentration on geosmin production, *Streptomyces coelicolor* A3(2), a geosmin-producing actinomycete, were cultured for 3 days under different initial DO concentrations (0-8 mg/L). In order to explain the putative influence of temporal DO change, A3(2) were also incubated under DO 0 mg/L for 1 or 3 days first, and then incubated under DO 8 mg/L for another 3 days. As a result of the experiment under different initial DO concentrations, the highest geosmin production of the single cell level was recorded under DO 2 mg/L, indicating that DO 2 mg/L condition may facilitate geosmin production. However neither A3(2) growth nor geosmin production were observed below DO 0.4 mg/L. As a result of the experiment of temporal DO change, A3(2) growth and geosmin production occurred when incubated under DO 8 mg/L after incubated under DO 0 mg/L for 1 or 3 days, indicating that A3(2) has been active in anoxic environment for 3 days. Our results proved that geosmin production by *S. coelicolor* A3(2) could be affected by DO condition.

Keywords: musty odor problem, geosmin, actinomycetes, dissolved oxygen concentration

### **ENVIRONMENTAL CHANGE AND ECOLOGICAL RESILIENCE: SEDIMENTARY EVIDENCE FROM CRATER LAKES IN THE PHILIPPINES**

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Many earth processes are thought to be sensitive around threshold values of key environmental variables. Knowing how these control variables have varied over time and how environmental conditions have responded to the variations, and in particular tipping points across which conditions show a high rate of change for a given alteration in stimulus, is important to our understanding of environmental change. In order to better project future environmental changes at policy-relevant geographic scales, relationships have been sought at the regional scale between environmental control and response variables. Regional and local scales of analyses also enable inclusion of indices of human development to ensure that widely differing levels of resource use are not over-looked in any analysis of how to mitigate anthropogenic impacts. This presentation focuses on research on crater lakes in a particularly dynamic (environmentally) part of tropical east Asia – Luzon, the largest of the archipelago of islands that form the Philippines. The research is using lake sediments as a basis for an ecologically meaningful perspective in which current environmental change is placed within the context of natural variability over timescales of hundreds and thousands of years. The Philippines is generally considered highly vulnerable to a range of environmental change phenomena. Variations in important environmental control and response variables, reconstructed from sedimentary evidence and calibrated using data from investigations of present-day ecology and water quality at the same sites, are being used to establish environmental resilience and the extent to which anthropogenic impacts are exceeding natural variability.

Keywords: Climate change, palaeolimnology, pollution, regime shift, volcanic lakes

## **TRANSFORMATION OF ZOOPLANKTON COMMUNITIES DUE TO THE LAKES RECOVERY PROGRAMS**

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Studies were carried out on three lakes in Kazan (Russia). The lakes were severely polluted due to sewage revenues of industrial enterprises. In 1984-1995 two lakes measures to restore water quality have been met. Measures included the removal of industrial waste water to the treatment plant, the bottom of the cleaning of contaminated sediment, creating a temporary flowage, landscaping shores. Water quality in lakes has improved considerably. We investigated changes in zooplankton communities during the measures, after their completion, as well as 20 years later. We have found that the response of zooplankton to reduce pollution manifested in the increase in the number of zooplankton species, amount of dominant species, abundance and biomass. In the Lake L. Kaban increased share of Cladocera, in the lake M.Kaban - Copepoda and Cladocera. Enhanced development of these groups of zooplankton caused corresponding changes in taxonomic indicators based on the ratio of the values of abundance and biomass of zooplankton major groups, saprobic index. Follow-up of the lakes showed that the preserved sufficiently high anthropogenic load in 15- 20 years require repeated remediation.

Keywords: zooplankton, restoration, lake, community

## **THE INFLUENCE OF TILAPIA CAGE CULTURE ON PHYSICO-CHEMICAL PARAMETERS AT DIFFERENT DEPTHS OF TEMENGOR RESERVOIR, MALAYSIA**

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Aquaculture industry has risen with the increase in human population and its function as a major protein source provider. With a surface area of 15,200 ha, Temengor Reservoir, Malaysia was selected for a large scale aquaculture for highly prized hybrid tilapia *Oreochromis niloticus*. The commercial tilapia hybrids fetch a high value in freshwater fish market and subsequently reaching an international market. Based on previous studies, aquaculture activities could deteriorate the surrounding environment due to water discharge from the cage containing high concentrations of nutrients and suspended solids. Since there are no previous documentations on the impact of fish cage culture on water quality of Temengor Reservoir, hence this study was conducted by examining several physical and chemical parameters in the immediate vicinity of fish cages and at some distances away at different depths of Temengor Reservoir. Monthly sampling was conducted at 13 sampling stations from April 2014 to March 2015. In this study, water samples were collected at depths of 0m, Secchi depth, 5m, 10m and 15m. Physical parameter readings were taken in-situ. The results revealed that water temperature did not differ among stations while dissolved oxygen and pH values were slightly lower at the stations with fish cages. The presence of fish cages significantly increased the concentration of nitrate-nitrogen, ammonia-nitrogen, orthophosphate and chlorophyll a. Apparently, the nutrient concentrations were relatively higher near to cages and decreased slightly at sampling points more distant from the cages ( $p < 0.05$ ). Based on the findings, the water quality dynamics in this area was not pronounced and has not led to any deterioration of environmental health so far. Moreover, the depth of this reservoir has diluted the concentration of the nutrients resulting in low concentrations of nutrients as compared to other previous studies conducted in other areas. The data obtained from this research can be utilised as baseline data for reference by other scientists in terms of ecological management and conservation related to aquaculture activities.

Keywords: Temengor Reservoir, tilapia cage culture, physical and chemical parameters, lake depths

## **BIOACCUMULATION OF COPPER (CU) IN ORGANS OF *Oreochromis Niloticus* AT BUYAN AND TAMBLINGAN LAKE BALI**

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The research aimed to study the degradation of Buyan and Tamblingan lake using ecological approach by investigating the potential and impact of copper (Cu) on freshwater ecosystem. Nile Tilapia (*Oreochromis niloticus*) weighted 200 g and 20 cm body-long was introduced and exposure in each lake. Bioaccumulation of copper (Cu) was analyzed in muscle and liver using Atomic Absorbance Spectrophotometer (AAS) in 0, 15 and 30 days of exposure. The result showed that the bioaccumulation of copper (Cu) range from  $2,04 \times 10^{-3} \mu\text{mol g}^{-1}$  to  $45,92 \times 10^{-3} \mu\text{mol g}^{-1}$  in muscle and  $9,34 \times 10^{-3} \mu\text{mol g}^{-1}$  to  $22,18 \times 10^{-3} \mu\text{mol g}^{-1}$  in liver in three station of each lake. Fluctuation of heavy metals accumulation in muscle and liver is due to internal mechanism respond by exogenous metals metabolism. This result describe that copper (Cu) has higher concentration in comparison with Indonesia government policy in both lake. These circumstances because the differences of environmental disturbance. Buyan has higher disturbance such as deforestation for industry, the using of organic fertilizer or pesticides and agro-tourism.

Keywords: Copper (Cu), *Oreochromis niloticus*, Bioaccumulation, Buyan; Tamblingan.

## **CHARACTERISTICS OF WATER BLOOMS IN THE THREE GORGES RESERVOIR**

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Three Gorges Reservoir (TGR) is the biggest river-type deep reservoir in the world. After the TGR's impoundment, more than 170 tributaries became the typical bay in its mid-downstream, where water blooms occurred frequently in spring and summer annually. The backwater area was the sensitive area for water bloom and different type of water bloom could be observed, such as dinoflagellates bloom, Cryptomonas bloom, diatom bloom, green algal bloom and cyanobacteria bloom, et al.. Information on occurring mechanisms of water blooms in the new reservoir (TGR) is very important to forecast and prevent water bloom. After 12 year's investigation, a distinct spatial heterogeneity was the characteristics of the water bloom distribution. Though water bloom occurred in the backwater area, different type of water bloom could be observed in different bay at the same time, even in the same tributary. On the other hand, different tributaries showed significant different variation of predominant species and the algal biomass. The spatial features of water bloom was the consequence of accelerated eutrophication process and the changes of hydrodynamics after the TGR's impoundment. Significant seasonal succession of water bloom was observed, dinoflagellates bloom and cryptomonas bloom were appeared in spring, diatom bloom was observed in the late spring and early summer, green algal bloom occurred in the early summer, cyanobacteria bloom was founded in summer and the early autumn. Temperature and light intensity was the driving force in the succession of water blooms in TGR.

## **CHALLENGES IN THE RESTORATION OF LAKE MANINJAU: BRIDGING ACTORS' INTERESTS FOR SUSTAINABILITY**

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Lake Maninjau, situated in Kabupaten Agam West Sumatera, has a lot of strategic functions ranging from ecological to socio-economic for the surrounding areas. However, the lake condition in the last decades shows progressive environmental damage caused by extensive fish cultivation, pollution from domestic uses and degradation of the catchment areas. This condition if left unchecked, threatens not only Maninjau biodiversity but also threaten the ability of the lake to sustain the social and economic life of the surrounding community. The management of Lake Maninjau has become the interests of various parties, including local people, governments, environmental activists, and investors. Unfortunately, these interests are often not aligned, giving rise to conflicts. Broadly speaking, potential conflicts of interest in the management of Lake Maninjau is between economic interests and environmental interests. Therefore, to provide input for decision making related to quality improvement efforts and management of Lake Maninjau, this paper aims to identify the main problems of the lake management by using stakeholder mapping. Specifically we (i) highlight the challenges in the restoration of the lake from stakeholders perspectives and (ii) describe the alternatives in bridging actors interest for the successful lake management. This study offers one potential approach in the management of the lake in Indonesia.

Keywords: Maninjau, local knowledge, stakeholder mapping

## **THE DIFFERENCE OF TRIGGERS INDUCING ALGAL BLOOMS BETWEEN PLAIN AND PLATEAU EUTROPHIC SHALLOW LAKES**

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Excessive nutrient loads alter aquatic ecosystem structure and often leads to harmful algal blooms. However, the possible difference of who drive the algal blooms under the eutrophic lakes with different elevations is not clear. Here the goal was to determine if distinct triggers inducing algal blooms occur in plateau and plain eutrophic lakes. A dataset of 643 eutrophic lakes derived from National Lakes Assessment in 2007 conducted by U.S. Environmental Protection Agency were employed. Self-organizing map (SOM) was used to classified and characterized the spatial pattern of environmental variables. Two structural equation models (SEM) were developed to identify the triggers and analyze the dynamic response of algae. The results demonstrated solar ultraviolet was the trigger inducing the algal blooms in plateau eutrophic lakes, while the trigger was water temperature in plain eutrophic lakes. The findings could provide implications for deeply deciphering the eutrophication mechanism and reserving the detrimental effects of eutrophication.

Keywords: Eutrophication, Self-organizing map, Structural equation model, Solar ultraviolet radiation, Temperature

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

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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.

## **RADIOACTIVE CONTAMINATION AND FISH HEALTH IN LAKES WITHIN THE CHERNOBYL ZONE: 30 YEARS AFTER ACCIDENT**

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During 1998-2015 we studied dynamics and bioavailability of the main dose-forming radionuclides in components of lake ecosystems as well as effects of long-term radiation exposure on fish within the Chernobyl exclusion zone (CEZ). Despite the absence of significant changes in the population structure, as well as a small number of external morphological disorders and malignant neoplasms in fish, we determined an increase in abnormalities of the axial skeleton, histopathology of liver, gills and gonads, as well as significant changes in the peripheral blood of fish. Drawing attention the high rate of red cells aberrations and abnormalities in blood of fish from lakes within the CEZ in comparison with reference lakes. It can testify to certain mutagenous of environment and possible display of radiation-induced genetic instability of fishes in condition of chronic radiation impact. The increased levels of erythrocyte damages in 4-12 times for pray fish and in 7-15 times for predatory fish were higher in comparison with fish from the reference lakes. Hereby the long-term radiation exposure of fish in lakes within the CEZ causes reactions, showing the damage of important biological systems. The special significance may acquire cytogenetic and genetic effects resulting from disorders of the genome stability with high probability of appearance in the form of increased mutation rates, decreased fertility and loss of the most sensitive species. Cumulative radiobiological processes can last for many generations allowing currently assume the possibility of incomplete realization of the long-term effects of irradiation.

Keywords: Chernobyl exclusion zone, lake ecosystems, fish, radioactive contamination, radiation-induced effects.

## **CREEPING WATER-PRIMROSE THREATS AKANOI BAY WHICH INSIDE THE LAKE BIWA THE RESERVOIR OF KANSAI REGION**

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The Akanoi bay is the one of the most invade water pollution area in the lake biwa, the largest lake in Japan. The akanoi bay is inlet that had biodiversity therefor it had many living things inhabit until 1960s. In 1996, we organized the NPO called Akanoi Biwako Environmental Citizen's Initiative to restore the water environment of this area. Spontaneously Invasive foreign species named water primrose are discovered in 2009 in Lake Biwa and it starts growing rapid speed. Then we started project to remove these water primrose with resident, fishery associations, students, and companies. Continuing this operation, with government and administration, we obtain an evaluation as the model case in Shiga prefecture the Kansai region.

Keywords: water-primrose , npo , lake biwa , akanoi bay

## **Room C, Topic 1 Climate Change and Water Crisis**

### **CLIMATE CHANGE IMPACT ON WATER QUALITY OF PHEWA LAKE, NEPAL**

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Water quality of Phewa lake has been identified as potentially vulnerable to climate change. In a sub-temperate climate like western region of Nepal, there will be changed in the spatial and temporal distribution of temperature and precipitation due to climate change which in turn will increase both the intensity and frequency of extreme events like droughts and floods. Climate change has several impact on water quality of Phewa Lake because of depletion of oxygen level and thermal stratification. The prime objective of this research is to analyze impact of climate change on water quality Phewa Lake through CE-QUAL- W2 simulation model. The model parameters were calibrated by field data collected during 2002–2007, and verified against observations made during 2007–2011. The projected temperature and precipitation data for the near- and long-term future were downscaled to regional and daily scales, and used to simulate the projected changes in water quality through the validated model. This lake is tectonic nature so the stratified random sampling technique was adopted at sampling time. The results indicate that rising temperatures will significantly lower the water quality in sub-tropical climate region through greater thermal stability and dissolve oxygen stratification, resulting in reduced dissolve oxygen concentrations in deeper layers of the lake and increased release of phosphorus and nitrate nitrite from sediments. Dissolve oxygen is decreasing from 9.5mg/l to 6mg/l in mean annual in summer season. Average annual surface water temperature is going up by 2.2 percentage. This flux in phosphorus in the hypolimnion may not support algal growth in the epilimnion during summer. However, nutrients are projected to increase throughout the lake, since it is well-mixed in late fall/winter. If the presence of nutrients is high, the prolonged growing season will increase the expected frequency of algal blooms. Phewa Lake is mesotrophic to eutrophic status. Most of the chemical parameters shows negative result. The ecosystem of Phewa Lake was worst if depletion rate of oxygen would be continued in future.

Keywords: Climate change, lake, water quality, dissolve oxygen

## **CLIMATE CHANGE IMPACTS ON NATURAL RESOURCES AND COMMUNITIES: A GEOSPATIAL APPROACH FOR MANAGEMENT**

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Climate change causes environmental depletion which became threats to the global economy. The health and productivity of ecosystems underpins agriculture, stable ecosystems are the foundation for livelihood and food security. The objective of the study is to propose adaptation measures using geospatial technology for conserve the natural resources and improve the livelihood of the local community from climate change scenario. Planning & decisions on policies and programs are required for natural resource management need to be based on broad citizen participation and the engagement of rural communities. The adaptation measures will help the planning system to regulate the development for the natural resources and socio-economic environment. The major natural resources in the environment are land and water which destroyed by human interference and also for climate change. With the use of geospatial technology the various thematic maps are prepared, which are helpful for the site suitability analysis for preparation of land & water management action plan and also socio-economic development. The study area is one of the micro watershed of Ansupa lake catchment under Cuttack district of Odisha, India. To reduce the impact of climate change on natural resources and livelihood, some adaptation measures have been proposed i.e. for afforestation 68.9ha., gap plantation 13.94 ha, agrohorticulture 389.62ha, for farm pond, renovation of existing pond for pisciculture and dockery etc. 11.33 ha., for land management and 5 nos. of bore well, 8 nos. dug well, 51 nos. LBS / check dam, 4 nos. WHS etc. for water management.

Keywords: Climate, Geospatial, natural resource, LBS, WHS

## **THE APPLICATION OF SEDIMENTARY PIGMENTS FOR UNDERSTANDING LAKE ECOSYSTEM RESPONSE TO CLIMATE CHANGE AND HUMAN IMPACTS IN SOUTHEAST AUSTRALIAN CATCHMENT**

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The western volcanic plains of Victoria, Australia are characterised by a large number of permanent and intermittent saline and freshwater lakes. These lakes have been subjected to a large number of palaeolimnological studies mainly using pollen, diatoms, ostracods and carbonates to reconstruct climate variability in the western region of Victoria. Reconstructed climate change in those studies has shown a close relationship between salinity, lake water levels and climate variability and change in Western Victoria; however, changes in the functioning of aquatic ecosystems in response to climate variation and catchment modification since European settlement have not been adequately examined. This study presents the reconstruction of past algal productivity changes over a long time-scale prior and post European settlement from sedimentary pigments. Through using this biomarker preserved in lake sediments, changes in lake ecosystem productivity, in association with key climatic and catchment environment parameters can be inferred, hence enabling the insights of how aquatic ecosystems have responded to climate change and human pressures.

Keywords: eutrophication, lake response, productivity, cyanobacterial pigments, land use impacts

## **LIVING BY THE WATERSIDE: HUMAN ADAPTATION TO GLOBAL WARMING DURING THE HOLOCENE CLIMATIC OPTIMUM IN CHINA**

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We have been engaged in the Sino-Japanese Joint Research on Neolithic cultures in Zhejiang Province, China for more than ten years. The aim of the project is to analyze the ecofacts from archaeological sites in order to elucidate the conditions of the natural environment and the subsistence and diet patterns of people at the time. This report deals with the causal relationship between the climatic change during the Holocene and the beginning of the way of living by the waterside. In Eastern China, over the course of the Early Holocene, the temperature steadily rose toward the Climatic Optimum. Although various sea level curves for the area have been presented, the collective view on the date for the peak is around 6,000 BP or a little earlier. The warming was also accompanied with humidification. The deciduous forests and semi-arid grasslands that distinguished the Late Pleistocene changed into vast inland lakes and swamps. The Kuahuqiao site, Zhejiang Province is the type site of the Kuahuqiao culture and is dated back to the first half of the sixth millennium BC. The ground surface of the site is only 4 m above sea level. It is rich in ecofacts which show high dependency on wetland resources. Especially remarkable among the excavated objects at the site are a wooden ladder and a dug-out canoe that belong to the oldest of their kind in the world. The ladder is a type made of a tree trunk with triangular notches for steps. This hints at the existence of pile dwellings at this site. It is likely that the dug-out canoe and ladder were invented as a pre-adaptation for successfully moving into the wetland environments of the lowlands which had unstable, fluctuating water tables. During the fifth millennium BC (Hemudu culture), adaptation to the wetland settings established. It is clear that they had already begun rice cultivation, based upon evidence of abscission scar at the base of carbonized rice spikelet. The presence of agricultural implements, hoes, or spades made of wood and mammal scapulae also supports this assumption. However, neither paddy fields nor irrigation facilities have been found. It is necessary to emphasize that they had a broad-spectrum subsistence strategy highly dependent on lacustrine resources and the rice cultivation was only a part of it and it took another millennium to establish the ancient civilization (Liangzhu culture) based on rice cultivation.

Keywords: China, Climatic Optimum, Kuahuqiao culture, Hemudu culture, Tianluoshan site

## **SOURCE AND SINK OF CO<sub>2</sub> AND TROPHIC SWITCHOVER IN THE CHILIKA LAKE, INDIA**

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Chilika Lake, one of the largest lake in the world and the first Ramsar site in Asia was studied to understand the carbon dynamics with respect to spatial as well as temporal scale. In the present study, the CO<sub>2</sub> was calculated as a difference of pCO<sub>2</sub> of water and air considering other factors such as solubility coefficient and gas transfer velocity of CO<sub>2</sub>. The monthly data of relevant parameters from 30 stations spreading over the Lake collected during march 1999 to march 2016 (17 years) was analysed normalizing through necessary correction factors to avoid methodological variability with respect to time. The pCO<sub>2</sub> and CO<sub>2</sub> flux recorded to have a significant spatial as well as temporal variability. The study reveals that the inter-seasonal variability leading to trophic switchover mostly attributed to the pattern of rainfall, riverine discharge and extent of seawater mixing. The Lake found to maintain four different ecological zones with respect to environmental characteristics. The spatial variability (in respect to different zones) of pCO<sub>2</sub> and CO<sub>2</sub> flux mostly controlled by presence/absence of vegetation and total carbon distribution in the Lake. Inhibition in primary productivity due to turbidity (by wind induced bottom sediment churning), decomposition of macrophytes and lowering of pH by mixing of riverine freshwater was responsible for the trophic switchover in the several regions of the Lake. The long-term monitoring of such parameters proved to be an effective tool to understand the behavior of an ecosystem with respect to trophic status and its controlling factors.

Keywords : CO<sub>2</sub> flux, pCO<sub>2</sub>, vegetation, Riverine discharge, Trophic status

## **RISE IN WATER LEVEL OF LAKE ENRIQUILLO, DOMINICAN REPUBLIC**

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Lake Enriquillo is the largest of the Antilles with a surface area of approximately 265 square kilometers and its water level at approximately 44 meters below sea level. The lake is hypersaline. Its salinity normally fluctuates between 80 and 110 ppt. As of 2004 a continued rise in the level of its water was observed, taking its fastest growth since late November and early December of 2007, when the southwest of the Dominican Republic was affected by the tropical storms Noel and Olga. This caused the salinity of the lake to significantly decrease at 20 ppt in 2013. During its history Lake Enriquillo has experienced fluctuations in its water level, but the concern of this process has been its rapid and continuous growth. By 2012 the surface area of the lake was over 350 square kilometers. Recent satellite images have shown a decrease in the area of the lake. In this study, we use seismic data, geophysical methods, satellite imagery, and meteorological data to investigate the possibilities of neotectonics influences over the water level rise of the lake. A Ground Penetrating Radar was used to monitor the water level around the lake, and seismic data from the region were analyzed and compared with the precipitation of the study site. Preliminary results indicate that neotectonics has not influenced in the water level rise of the lake.

Keywords : Lake Enriquillo, hypersaline, precipitation, neotectonics

## **ESTONIAN CLIMATE AND WATER - TRYING TO GUESS THE FUTURE**

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Estonia located at the Baltic Sea coast is a flat country rich in water resources. Five percent of Estonia is covered by lakes. Long-term periodic changes in atmospheric circulation patterns, such as described by the North Atlantic Oscillation winter index, are the strongest signals of meteorological forcing reflected in the structure and functioning of aquatic ecosystems in Estonia. Since the 1960s, the rate of surface water temperature increase is 0.4 °C per decade in lakes and double of that in the coastal sea as a result of changing wind patterns pushing warm surface water to Estonian coast. It is not expected that in the coming decades the effects of long-term trends in the mean values of climatic forcing factors, such as temperature, wind speed or the amount of precipitation, on aquatic ecosystems will be statistically distinguishable from the effects of periodic changes or impacts of direct human pressures. It is more likely that indirect pressures arising from human adaptational responses to climate change (such as elevated water abstraction for agriculture, production of energy crops or building of flood defense infrastructures) will have a greater impact on water quality and aquatic ecosystem integrity. In general, Estonia is a safe place by its nature. In spite of that, the frequency of extreme events and related disasters, such as storm surges, coastal floodings, summer heat waves, droughts, forest and peat fires is likely to increase that may require application of specific adaptation measures.

Keywords : climate change, lakes, rivers, coastal waters, North Atlantic Oscillation, adaptation

## **Room C, Topic 6 Database and Knowledgebase Systems, Informatics, and Monitoring Technologies**

### **WEB APPLICATION FOR EXAMINING CLIMATE DATA OF GLOBAL LAKE BASINS: CGLB USING ILEC'S WORLD LAKE DATABASE**

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A newly developed web application, Climates of Global Lake Basins (CGLB), combines existing datasets and interactively displays geographical, hydrological, and climatological information for hundreds of lakes around the world. The listed lakes in this web application is based on the World Lake Database provided by the International Lake Environment Committee. CGLB also provides photographs containing vegetation information by as well as quasi-real time monitoring of lake water levels using satellite altimetry provided by U.S. Department of Agriculture. CGLB can interactively create and animate time series of climatological data in a one-dimensional or two-dimensional (geographical) form. These functions are useful for education, expedition planning, and scientific research. As an example of the application's use, links between water levels in Kenya's Lake Turkana and sea surface temperature (SST) and regional precipitation were tested by time-lag correlation analysis. Precipitation showed no significant correlation with the lake water level for time lags of 0, 1, and 2 months. This suggests that variation in land-surface hydrological processes are key to the interannual variability in water levels in the lake. In contrast, SST in the central tropical Pacific was strongly correlated with the lake water level for all time lags. No significant correlation was found between the lake water level and SST in the Indian Ocean adjacent to Kenya, although significant correlations were found between regional precipitation and SST in the Indian Ocean.

Keywords: global lakes, lake information, climate, web application, Lake Turkana

### **PRIMARY PRODUCTIVITY IN LAKE GENEVA: A VIEW FROM SPACE DURING A DECADE**

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Lakes are the hot spots in the global carbon cycle, and therefore are key elements as climate change regulators; and the productivity of the lakes has a marked importance in the estimation of their ecological state and for predicting their development in the future. However, in situ approaches are not suited to the reliable measurement of primary production at large scales. Combining satellite data with model calculations allows monitoring the state of lakes in space and time, providing a new perspective for lake primary production studies. In this study the primary production was modelled for a large, deep and stratified Lake Geneva in Switzerland using MERIS image archive for 2002-2012. We used a semi-empirical model that estimates primary production as a function of photosynthetically absorbed radiation and quantum yield of carbon fixation. The necessary input parameters of the model (concentration of chlorophyll a, downwelling irradiance, and the diffuse attenuation coefficient) were obtained from MERIS products. Our results show that spatial variability in primary production cannot be neglected in large lakes. One or two measuring points are inadequate to obtain an overview of the dynamics of the productivity of the lake or the evolution of a large lake. How have been the overall trends in productivity and has the spatial changes over time been uniform across the lake? The primary production maps show us the temporal and spatial changes in lakes for a decade, which is impossible to achieve with a common in situ monitoring.

Keywords: lakes, primary production, modeling, MERIS, remote sensing

## SWAT APPLICATION TO ASSESSING DIFFERENT FERTILIZATION EFFECTS ON WATER QUALITY IN AN AGRICULTURAL WATERSHED

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To study the desirable balance of agriculture and water conservation, SWAT (Soil and Water Assessment Tool) was applied to estimate water, sediment(SS), and nutrient movements, and to assessing effects of different fertilizations on water quality in an agricultural watershed leading to the Lake Kasumigaura, Japan. The study area is Sakura River basin of 335 km<sup>2</sup> including 29% of rice fields and 20% of upland fields. The DEM, land use data, and soil data were used for model construction, and meteorological data, soil-profile properties data, irrigation water supplying data, and a general crop management were used for model configuration. Domestic discharge such as water, SS, Org-N, NO<sub>3</sub>-N, Org-P, and Min-P were assumed to constantly flow out from each sub basin in proportion to its urban area. For model calibration and validation, daily stream water flow, and SS, T-N, T-P, NO<sub>3</sub>-N, Ortho-P concentrations measured a few times a month at a downstream observatory station were used, and 3 years (2000~2002) were assigned to the warm-up, 3 years(2003~2005) to the calibration, and the following 3 years (2006~2008) to the validation. By simulations with adjusting several parameters, good estimations for daily stream water flow and SS with R<sup>2</sup>>0.6, E<sub>NS</sub> (Nash-Sutcliffe efficiency coefficient)>0.6, and reasonable estimations for Org-N, Org-P, and NO<sub>3</sub>-N with R<sup>2</sup> from 0.3~0.8 and E<sub>NS</sub> from 0.1~0.4 were attained. By introducing improved fertilizations (smaller and more frequent fertilizations with about 10% decreased N-amount) to paddy, upland, and pasture fields, equal or greater crop yields and mitigated NO<sub>3</sub>-N discharge by 21% were estimated.

Keywords: SWAT,nutrient discharge,fertilization, water quality

## MONITORING LAKE WATER QUALITY CHANGES WITH TIME SERIES OF SATELLITE DATA

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Using of satellite data allows extending lake monitoring from point measurements to the whole lake and improving the frequency of sampling significantly. On the other hand, most lakes are optically complex waterbodies. Meaning that the standard remote sensing products do not perform well there. The objective of our study was to test which processors/algorithms allow us to use MERIS satellite archive for monitoring water quality in one of the largest (3555 km<sup>2</sup>) lakes in Europe, Lake Peipsi, and analyze the changes taken place during the 2002-2011 period. MCI proved to be the best index for phytoplankton biomass (chlorophyll-a) retrieval. This allows us to monitor the chlorophyll-a over the whole lake and increase the sampling frequency significantly (e.g from 2 annual samplings in Russian part of the lake to more than 40). This data reveals interesting trends in lake water quality. OLCI, a follow-up mission of MERIS, was launched on Sentinel-3A in the beginning of 2016 and similar 3B will be launched in 2017. Funding of the Sentinel missions is guaranteed until 2029 meaning that there will be frequent (daily) and long lasting data flow allowing to monitor processes in lakes. MERIS and OLCI have 300 m spatial resolution allowing to monitor only large lakes. Sentinel 2A with 10 m spatial resolution was launched in 2015 and with two sensors in orbit (2017) it will allow to study also very small lakes with quite high frequency (every second day at the latitude of Estonia) increasing the role of remote sensing in lake studies and monitoring significantly.

Keywords: Remote sensing, lakes, water quality.

## **MEROMIXIS IN DEEP MINE PIT LAKES – SIMULATING PERSISTENCE OF STRATIFICATION**

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Water quality in future mining lakes strongly depends on their thermal and chemical stratification. High salinity groundwater inflow accumulating in the deepest parts of the lake tend to generate a permanent stratification, a monimolimnion. Turbulence generated by wind action and convective mixing during cooling periods in autumn and winter can, on the long run, dissolve an existing chemocline, thus, releasing any material accumulated in the monimolimnion into the water column. Here we simulate the entrainment process using a vertical, one-dimensional hydrodynamic model driven by meteorological conditions as found in the mining districts of eastern Germany and Western Australia, respectively. The model is initialized with chemocline depth and salinity of the monimolimnion and forced by hourly meteorological data. Simulation periods are of the order of a century. Modifying climate input data and lake conditions allows us to quantify the timescale of persistence of meromictic conditions for different scenarios. The analysis of ~10000 lake simulation runs shows a consistent pattern of overturn in meromictic post mining lakes after several years or decades whenever there is no additional saline inflow maintaining the permanent stratification. Air temperature and the prevailing attenuation coefficient – or turbidity – of the water column will largely determine the persistence of meromixis. The results of this simulation approach allow to quantify the mixing behavior of future mine pit lakes based on lake bathymetry, expected chemocline depth and salinity under different climate conditions.

Keywords: mining, monimolimnion, chemocline, lake model.

## **LAND USE CHANGE ON SENTRAUM CATCHMENT AREA, WEST KALIMANTAN-INDONESIA**

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Lake Sentarum (800 km<sup>2</sup>) is one of 15 national priority lakes in Indonesia. The lake consists of several floodplain lakes, so it makes a large seasonal changes in area and depth between rainy and dry seasons. Lake Sentarum, included in the list of Ramsar Sites, is the largest and the most important part of the wetland ecosystem in Asia since 1994. Sentarum Catchment Area (4000 km<sup>2</sup>) is directly adjacent to national boundary of Malaysia, and currently Indonesian government is improving the economy in border areas. Economic growth will trigger the land demand for residential areas and cultivation. Therefore, it is important to identify land use changes that will have impacts on hydrological characteristics and floodplain ecosystem of the lake. Currently the land use changes in the catchment arise quickly, especially in forests loss and development of oil palm plantations. The purpose of this study was to analyze the land use changes in Sentarum Catchment Area. The identification of land use changes was using supervised classification method. Data utilized were Landsat-5 (2001) and Landsat-8 (2013). Analysis of land use changes used cross tabulation methods to compare both of land use data series. Results of the analysis showed the land use in 2013 was still dominated by forests with area of 2,320 km<sup>2</sup> (56.6%) after decrease of 143 km<sup>2</sup> for 12 years, while settlement area still only 4.9 km<sup>2</sup> (0.1%) which was a result of increase of 3.8 km<sup>2</sup>. Major changes occurred in the development of oil palm plantations which covers 280 km<sup>2</sup> and the majority comes from the area originally covered by forests (140 km<sup>2</sup>).

Keywords : Lake Sentarum, land use, catchment area, classification

## **DAM OPERATION MODEL AIDED FOR ASSESSMENT OF WATER AND SEDIMENT CYCLES AT NEWLY CONSTRUCTED CASCADE REGULATED DAMS: CASE STUDY IN THE UPPER NAKDONG RIVER BASIN, KOREA**

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Recently, the K-Water (Korean governmental company for water resources) has constructed two cascade dams: Youngju Main Dam and Youngju Sediment Control Dam in the Upper Nakdong River basin (495 km<sup>2</sup>), Korea. The sediment control dam was built 8-km in the upstream of the main dam. Beside for flood control and hydropower supply purposes, the other main function of these two dams is for water quality improvement through sediment control and management such as trapping, flushing, etc. However, many of NGO have complained the dam construction impacts on hydro-ecology of the dam downstream due to insufficient of sediment supply from the upstream. Additionally, no previous studies were carried out enough such that eco-hydrologists concerned on the assessment of the effect of sediment control dam developments. Therefore, this research was intended for quantification of water and sediment cycles at the Youngju dam basin. Dam operation models for water and sediment control in coupling with A distributed Catchment-scale Soil Erosion Model (C-SEM) have been developed and tested. Herein, the dam operation rules proposed by K-Water were successfully formulated in integration with a reservoir sediment-water balance equation. The results shown that the model could reasonably well used for estimating water and sediment cycles in response to various water level condition of dams. Furthermore, the developed model provides fundamental information in planning sediment management strategies for sustainable development of the Youngju dam basin.

Keywords: dam operation, soil erosion, water and sediment cycles, Youngju Dam

## **SYSTEMATIC ANALYSIS OF INLAND WATER QUALITY USING DATACUBE CONCEPTS**

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Water quality and ecosystem health of inland systems are important for the sustainable development of these important ecosystems. The UN-Water agency recognized that there are many challenges in undertaking improvements in water quality or ecosystem health and monitoring their changes over time. Quantitative use of satellite remote sensing data for the synoptic assessment of these vulnerable resources has been shown to be cost effective and beneficial for agencies responsible for water quality management. Multi-temporal Landsat data acquired from the Australian Geoscience Data Cube (AGDC) when combined with optical modeling approaches, enables for the generation of consistent time-series analysis of inland water quality data and products. From this data, water quality variables such as total suspended matter, algal concentrations and the light environment of the water column (vertical attenuation of light) can be retrieved. When integrated with ESA's Copernicus' Sentinel data, the AGDC will provide analysis-ready data for Australia and the South East Asian region. In particular, Sentinel 2A and 3A data has been shown to greatly increase the accuracy of chlorophyll retrievals in comparison to Landsat data, and has great potential for large scale monitoring of eutrophication and associated health risks in inland waters. The Australian Government has signed an agreement with the European Union in regards to the Copernicus mission, and its technical agencies are keen to promote an approach supporting the objectives of Copernicus, ensuring that Australia and the region can benefit from this data. This presentation will demonstrate a framework and product delivery system for quantitative estimation of inland water quality parameters across a range of different optical water types.

Keywords: Copernicus data hub, optical modelling, multi-temporal, remote sensing, water quality

## **ESTIMATION OF THE LAKES OPTICAL PROPERTIES FROM SENTINEL 2 AND SENTINEL 3 SATELLITES FOR ECOLOGICAL AND MANAGERIAL APPLICATIONS**

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New satellite sensors that provide data over Earth free have been launched by European Space Agency under programme Copernicus during last two years. Sentinel 2 and 3 provide spectral, spatial and temporal resolution that would allow use of these data to monitor optically complex waters of lakes. However the variation of lakes waters colour over globe is very large- from dark brown humid rich to crystal clear transparent, and these lakes locate in very varying geographical heights and in climate conditions. Main factors influencing to the optical water type are dissolved organic carbon in water, phytoplankton biomass and amount of suspended sediments. Additional factor is also spectral atmospheric transparent that affects the satellite signal. We provide classification of lakes based on satellite data into five optical type and link these types with possible ecological classification, show the main areas where the classification needs complementary sub-classes, adaption to quickly changing environmental conditions or climatic conditions.

Keywords: Remote sensing, ecological situation, lakes management

## **COUPLING OF GIS AND HEC-HMS FOR FLOOD DISCHARGE HYDROGRAPH ESTIMATION IN A PROPOSED RESERVOIR (CASE STUDY: SINDANGHEULA RESERVOIR)**

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Understanding the rainfall-runoff process and flood discharge hydrograph characteristics in reservoir's catchment is really important particularly for designing spillway. Designing the dimension of spillway must consider the return period flood that driven by storm event or extremely rainfall condition to meet risk and safety factor analysis of Sindangheula Reservoir that will be build in the near future. This paper presents application of HEC-HMS and geographic information system (GIS) to estimate flood discharge hydrograph characteristics in a proposed Sindangheula Reservoir. The SCS unit hydrograph and SCS-Curve Number model were used to determine transformation method between rainfall and runoff process that produce a flood discharge hydrograph in the outlet of the Sindangheula reservoir. The hydrological and GIS data of the study catchment such as: reservoir's catchment deliniation, schematic diagram of reservoir's catchment, digital elevation model (DEM), landuse, hydrology soil group and curve number calculation were processed by using ArcGIS 10.1 and its extension, ArcHydro tools and HEC-GeoHMS as input models to HEC-HMS. The result of this research describes the application of GIS and HEC-HMS such as: its capability, reliability, and limitation for estimating flood discharge in a reservoir for designing spillway.

Keywords: GIS, HEC-HMS, HEC-GeoHMS, Flood Discharge Hydrograph, Sindangheula Reservoir

## **ASSESSMENT OF HYDROLOGIC ALTERATION IN A SAHALIEN SHALLOW LAKE WITHIN ITS ECOSYSTEM; LAKE GUIERS, SENEGAL**

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During the last three decades, climate change, increasing population, changing patterns of water demand has pressurized Lake Guiers' water resources. To address these challenges, Senegalese authorities turned to the construction of dams along Lake Guiers and its tributaries. In this study we assess Lake Guiers hydrologic alteration in order to build greater understanding of flow regimes and facilitate informed resource management decisions on environmental flows. 35 years of daily streamflow data records in Lake Guiers were investigated to determine the Indicator of Hydrologic Alteration (IHA). Two times series (pre-dams and post-dams periods) were considered. The Range of Variability Approach (RVA) was used to quantify the modification of the IHA by comparing the requences within three fixed intervals. Dams and sluices profoundly affect the hydrologic conditions in the Lake Guiers. They reduced high monthly variability of discharges, increased the range of daily discharges, altered the timing of high and low flows, and changed the timing of the yearly maximum and minimum flows. Comparing with that in the pre-impact period, hydrologic features demonstrated obvious changes during the post-impact period. The flow magnitude was smaller and the frequency of low flow events decreased during all months; and the maximum flows and minimum flows increased. The number of high flow events and annual base flow 50% exceedance presented increasing trend. Annual median rate of change appeared as a decreasing trend. Base flow remains low both in pre and post impact. These changes have greater impacts on the water quality and the environmental flow.

Keywords: Streamflow, environmental flow, Indicator of hydrologic alteration, Lake Guiers, Senegal.

## **DEVELOPMENT OF SPATIAL REGRESSION MODEL TO IMPROVE LAKE WATER QUALITY MANAGEMENT IN MALAYSIA**

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Water quality of lentic ecosystem is highly dependent on upstream processes and activities in the catchment area. Thus, integrated watershed management approach is necessary in order to effectively manage the lake water quality. Given the lentic nature of lakes with long retention time and complex response dynamics, it is an arduous task to comprehend types and strengths of pollutions that would impact the water quality status and the responses by the biological communities. The existing traditional evaluation practice of lake water quality that is based upon a quick assessment without considering seasonal succession will never be accurate. Thus, limited information could affect decisions in making effective strategies to overcome water quality deterioration which escalates with time. In addition, established water quality index based on a few fixed parameters may not be sufficient to address problems in different lake types. Hence, consolidating GIS spatial analyst with statistical analysis in one platform as a foundation for the proposed development of water quality prediction model will provide the lake management a supporting tool that will meet the existing sustainable development and water resource management policy. The developed model is incorporated with both statistical and spatial analysis of linear multi-regression using ARC-GIS 10.3. The visualisation output would guide lake managers to prioritise on the areas that require attention. This paper discussed the conceptual framework of the developed water quality prediction model. The model development processes and preliminary findings is also highlighted.

Keywords : Integrated management, GIS, prediction model, water quality.

## Room D, Topic 8 Ecotechnology, Ecohydrology

### USING SUBMERGED VEGETATION AND CHLOROPHYLL A DEFINE THE ALTERNATIVE STABLE STATES OF A SHALLOW LAKE, BAIYANGDIAN, CHINA

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Alternative stable states of shallow lakes explain the process of ecological degradation or recovery. Baiyangdian, the largest freshwater lake in northern China, was separated by artificially dug and raised platform fields into small or medium-sized ponds which are connected by navigation channels. The pollution of the western ponds were heavier than the eastern ponds, since more than 100,000 inhabitants concentrated in the western bank and western platform fields of the lake, and also the inflow is from the western rivers. Defining the alternative stable states of the pond communities is necessary for the appropriate ecological restoration from pond to pond. Based on the data of submerged macrophytes and water qualities of 70 sites along a rough gradient of eutrophication from west to east, the adaptabilities of the plant species to the pollution were ranked from their relationship with water qualities. The Charophytes dominated community which accompanied with *Utricularia vulgaris* L indicates a clear state of water, alternately a *Potamogeton pectinatus* L dominated community or no vegetation indicates a turbid state. The ratio of chlorophyll *a* (ug/ml) to the biomass of submerged vegetation (kg/m<sup>2</sup>) (Chla/BSV) has two turning points (1, 5) along the Chla gradient and suggests that Chla/BSV <1 cover with clear state while Chla/BSV >5 with turbid state.

Keyword : Alternative stable states, Shallow lakes, Submerged vegetation, Chlorophyll a, Baiyangdian Lake

### ECOTECHNOLOGY FOR URBAN WATER SECURITY (A CASE STUDY OF INDRADHNUSHYA CENTER, PUNE- THE NAWATECH INITIATIVE)

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Modern Urban development demands large quantity of freshwater which generates tremendous pressure on depleting fresh water resources. The prime feature of the urban water cycle is the maximization of recycling and reuse of treated wastewater for various non-consumptive and consumptive applications to lessen the pressure on freshwater resources. In the urban catchment, the water balance can be achieved using various technological options with standardized management procedures to ensure supply of good quality water. Under NaWaTech, an initiative of European Union and Department of Science and Technology, Government of India, project Eco-Filtration Bank treatment system, designed by Shrishti Eco-Research Institute is installed at Indradhnushya Environment Center, established by the Municipal Corporation of Pune (Maharashtra, India). Ambil stream passing by the Indradhanushya Environment Center premises has non-monsoon flow about 70–100 MLD (though in monsoon 300 MLD) is contaminated with sewage till confluence with Mutha River. Eco-filtration Bank (EFB) system proposed for the treatment of stream water is comprised of Screen, Intake well, Soil Scape Filtration and Treated water pond. About 50 cu m / day water from the stream is tapped to yield 40 cu m/day clean water for irrigation of public gardens and toilet flushing at public places. This system demonstrates the utilization of contaminated stream water for non-consumptive uses thereby reducing the pressure on freshwater demand. Ecotechnology provides low maintenance, natural technologies for reuse and recycle of the waste water generated by urban settlements. These cost effective technologies reduces space foot print, carbon foot print, and energy foot print leading to sustainable urban development and urban economics.

Key word : NaWaTech, Ecotechnology, Eco-filtration Bank, Soil Scape Filter,

## **IMPACT OF ECO-RESTORATION OF CHILIKA LAKE THROUGH HYDROLOGICAL INTERVENTION ON FISHERIES OUTPUT AND SALINITY DYNAMICS**

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Chilika is the largest brackish water lake in Asia situated on the east coast of India. It is the first Indian Ramsar site of international importance for its rich biodiversity, rich fisheries resources, a million of migratory birds and several rare and endangered species of which Irrawady dolphin is the flagship animal of the Lake. After passing through an eco-degradation phase for several years, hydrological intervention with opening of a new lake mouth was carried out in 2000 for restoration of the Lake. Regular monitoring of fishery yield and water quality were carried out before hydrological intervention to generate baseline information for the pre-restoration period. The post-restoration monitoring of fisheries output and salinity dynamics during post-restoration period (2001-2002 to 2013-2014) indicated spectacular enhancement in fisheries output and salinity dynamics. Collection and estimation of fish catch statistics from the lake employing the systematic sampling technique with landing centre approach during the pre- & post-restoration period embodied the positive impact of eco-restoration. The average annual fisheries output during 13 years of post restoration period (12137.14 t) registered an increase of 595.24 % in comparison to the pre-restoration yield (1745.75 t) during 1999-2000. The average annual salinity (8.5 ppt) during 1999-2000 (pre-restoration period) was increased to average annual salinity of 11.5 ppt, registering an increase of 35.29 %.

Keyword : Chilika Lake, hydrological intervention, eco-restoration, fisheries output, Salinity dynamics.

## **ECO-FRIENDLY LARGE SCALE TESTS TO REDUCE PHOSPHEROUS IN RIVER WATER BY ELUTING IRON ION SYSTEM**

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A large scale verification tests were performed. The purpose was the reduction in phosphorus in river water using technique of eluting iron ion bodies and to suppress generation and water purification phytoplankton in the rivers flowing into Lake Kasumigaura, Ibaraki Prefecture, Japan. The system that was consisted of three processing 25 m<sup>3</sup> tanks as 10m<sup>3</sup>, 10m<sup>3</sup> and 5m<sup>3</sup> were developed based on a rolling drum cartridge system in order to elute Fe<sup>2+</sup> continuously. The amount of treatment water was 100-300m<sup>3</sup> per day and the volume 384kg of eluting iron ion body was referred from a middle scale verification test of 3m<sup>3</sup> single processing tank and laboratory column experiments. The reduction rate of PO<sub>4</sub>-P of treatment raw water recorded 31-47% relative to the quantity of flow. That means we achieved the targeted value of reduction over 30% of PO<sub>4</sub>-P by series of experiments. These experiments found that it is important a deposition process to reduce PO<sub>4</sub>-P and TP under gentle velocity of treatment flow. pH and DO of the treated water to be discharged into the river was a value that fully satisfy the environmental regulations value. It aims in the future a better cost balanced system construction by eluting iron ion effectively.

Keywords: large scale verification tests, reduction of phosphorus, eluting iron ion, river water purification, suppress generation of phytoplankton

## **FISH CRADLE PADDY FIELD PROJECT**

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Fish cradle paddy field project aims to maintain agricultural productivity while restoring paddy field environments where fish can spawn and breed. Until the mid-1960s, farmers had great difficulty growing rice in paddy fields around Lake Biwa, due to flooding caused by fluctuating water levels in Lake Biwa and work in wet paddies using paddy field boats. Meanwhile, Paddy fields, warm and rich in the plankton on which fish feed, were ideal spawning and breeding sites for lake fish. From the mid-1960s, land consolidation projects were promoted, resulting in increased productivity and improved agricultural management. Conversely, to convert wet paddy fields into dry paddy fields, drainage canals were made deep, fish was difficult to go upstream at a rice paddy. Therefore, Shiga Prefecture is promoting the "Fish cradle paddy field project" by which to maintain agricultural productivity while restoring paddy field environments where fish can spawn and breed. Install fish-ways (fish ladders) with a series of steps that reach the level of paddy fields so that water level of the drainage canal is level with the paddy field surface, fish coming from Lake Biwa can enter paddy field and spawn. Hereby, restoration of the local ecosystem is expected to increase environmental awareness among local residents, revitalize the local community and stimulate development of brand agricultural produce as eco-friendly brand rice.

Keywords: local ecosystem, environmental awareness, local community, heartware approaches.

## **A NEW METHOD TO ESTIMATE CONCENTRATIONS OF PHOSPHOROUS, NITROGEN AND COD IN EUTROPHIC RIVERS**

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A new method was proposed to estimate the concentration of total phosphorous (TP), total nitrogen (TN) and chemical oxygen demand (COD) in eutrophic river streams as an alternative to the conventional rating method (LQ method). The method was formulated and parameterized based on the water quality data obtained from a number of water samples collected from six rivers flowing into the Lake Kasumigaura. For estimating TP and COD, the ratio of particulate phosphorous (PP) and particulate COD (PCOD) to the total constituents (PP/TP and PCOD/COD, respectively) was represented as a function of concentration of suspended sediments (SS). Furthermore, the ratio of constituent per unit weight of SS is represented by a function of SS with a correction factors depending on the ratio of particulate components (PP/TP and PCOD/COD). These equations are combined to calculate TP and COD with observed SS as an only input variable. For TN, we proposed a method to estimate dissolved nitrogen (DN) from the monitoring of Nitrate (NO<sub>3</sub>-N) and particulate nitrogen (PN) from SS. The estimated concentrations of TP, TN and COD well agreed with those observed with the root mean square error (RMSE) less than that calculated from the rating method. It was concluded that using monitored SS, NO<sub>3</sub>-N and the flow rate, we can obtain reliable information regarding the concentration and load of TP, TN and COD in the eutrophic streams.

Keywords: Estimation Method, Concentration, Total Phosphorous, Total Nitrogen, COD, Suspended Sediment

## **CONSTRUCTED WETLAND FOR SEWERAGE TREATMENT FOR MULTIPLE WATER USE TO AVOID POLLUTION AT BHUBANESWAR**

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Domestic sewerage at Bhubaneswar, India, contains a lot of polluted matters, which pollute air, water & soil. Literature survey revealed that though a number of methods are available for sewerage treatment yet use of Environmental compatible bio-technology methods are rather scanty in literature. Therefore constructed wetlands, using bio-technology method, called Phytoid technology, has been developed & patented by NEERI, CSIR organization at Nagpur, INDIA, is being implemented for Sewerage Treatment at Bhubaneswar City, INDIA. This city is being developed as number one Smart City of India. The main objective is to use this technology, which will not only avoid pollution, but the treated water can be used for other multiple usable purposes in a sustainable way with minimal maintenance. Sewerage Treatment Plant, module having constructed Wetlands, and different small chambers like screening/floating chamber. Sedimentation cum anaerobic baffled settler tank, constructed wetlands called Phytoid chamber & also called equalization tank containing eco friendly bacteria over it planted beautiful flowering plants, the roots of which reach the surface of water inside the chamber. Finally, the treated water is pumped out for multiple analyzed for pH, BoD, D.O and other parameters before treatments and after treatment. It does not require electric power for operation and minimal maintenance. The results after treatment by such process meet Indian Pollution Control Board norms and is odourless, colourless and pollution free. It can be used for Agriculture, Horticulture and gardening and many other purposes but not useful for drinking purposes.

Keywords: Constructed, wetland, sewage, multiple water use, pollution

## **CHALLENGES IN RAW WATER QUALITY, A CASE STUDY IN PUTATAN WATER TREATMENT PLANT**

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This paper discusses how Maynilad was able to achieve its service obligation to the West Zone Concession Area of Metro Manila, Philippines despite having a very challenging raw water source. The then lone water source Angat Dam and its designed water distribution network can hardly manage the demand of growing population and rapid urbanization of the company's service area. Demand is further elevated with the majority of expansion in the south portion of the concession area. In 2010, Maynilad constructed a membrane-type water treatment plant with 100 million liters per day (mld) capacity, the very first of its kind and volume in the country. It draws water from Laguna Lake - a new source with unpredictable raw water quality. This paper will discuss in detail how Maynilad applied appropriate engineering solutions to its water quality challenge.

Keywords: Laguna Lake, Maynilad, Philippines

## **EVALUATION OF INTRODUCING PLANKTON FEEDER MILKFISH (*Chanos chanos*) TO UTILIZE THE ABUNDANCE OF PLANKTON AT THE EUTROPHIC DJUANDA RESERVOIR IN WEST JAVA, INDONESIA**

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Since 2008 the milkfish (*Chanos chanos*) were introduced in Djuanda Reservoir. The introducing fishes aimed to take advantage of natural food such as plankton that were abundant at the *eutrophic* reservoir and to increasing fishery production. This study aimed to evaluate introducing plankton feeder based on the food and feeding habit of milkfish. The study was conducted in December 2009-February 2010 at 4 stations representing the reservoir condition. Fish caught by experimental gillnet with the mesh sizes from 1-2.5 inches approximately every 10 days. Analyses of fish stomach content were determined to describe feed intake, dietary overlap and prey preferences. The results showed that the main food of milkfish based on Index of Preponderance were phytoplankton (35.2-56.42%), zooplankton (12.22-42.8%) and others (10.92-34.99%). The domination foods from the phytoplankton were Cynophyceae (10.05-31.12%) and from zooplankton were Copepods (3.33-27.79%). The difference of the food consumption by the fishes at three size classes of fish length and between location was statistically no significant ( $p>0.05$ ). The dietary overlap between three size classes of fish length estimated 0.60-0.98. From the electivity index knew that no difference food electivity based on proportion of positive and negative food selected value. The food and feeding habit of milkfish followed the availability of plankton as its food on the water.

Keywords: plankton feeder, milkfish, *Chanos chanos*, eutrophic and Djuanda reservoir

## **MOBILE DRINKING WATER TREATMENT PLANT (TYPE IG5M30) FOR DISASTER EMERGENCY RESPONSE**

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Emergency conditions due to floods, landslides and droughts cause shortages of clean water and drinking water to meet daily needs. These conditions require immediate solution to provide clean water and drinking water to the people in the disaster area. This research activity aims to develop mobile drinking water treatment system beeing capable for processing of marginal raw water into drinking water in the affected areas, in order to help people in the region to access water they need. Development of systems URC-IPAMB Type IG5M30 is an important step to address the needs of water services in the disaster areas, especially floods. URC-IPAMB Type IG5M30 has been completed and the results of operating system and installation testing were satisfied. The quality of water produced has met the standard. Some adjustments and system improvements URC-IPAMB Type IG5M30 still needed in order to optimalize the installation function.

Keywords: mobile plant, operating systems, water quality, clean water, RO system

## **DEVELOPMENT OF UNESCO ECOHYDROLOGY DEMOSITE CARD FOR INTEGRATED CATCHMENT MANAGEMENT OF PUTRAJAYA LAKE AND WETLAND, MALAYSIA**

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UNESCO Ecohydrology Demonstration Sites have launched in 2010 focused on "an integrated understanding of biological and hydrological processes at a catchment scale in order to create a scientific basis for a socially acceptable, cost-effective and systemic approach to the sustainable management of freshwater resources in a variety of ecosystems and climatic zones". UNESCO Ecohydrology Demosite Cards were introduced in 2015 as low cost advanced methodology for mitigation impacts from molecular to catchment scale. Hence, all UNESCO Ecohydrology Demosites came out with their own Demosite card as self-assessment for its current development and achievement related to Ecohydrology implementation in their respective areas. For Putrajaya Lake and Wetlands whereas a UNESCO Ecohydrology Demonstration Site in Malaysia since 2010 and categorized as Operational Demosite out of 32 Demosites in the world and the only Operational Demosite in Southeast Asia, a demosite card on Integrated Catchment Management of Putrajaya Lake and Wetland, Malaysia is developed. The development of this card were taking into account the current status of Putrajaya Lake and Wetlands Ecohydrology management by using relevant data and information needed which collected from various sources virtually or directly in collaboration with local stakeholders in Putrajaya. All data gathered were compiled and arranged into specific Demosite Card template developed by UNESCO. The Demosite Card developed for Putrajaya Lake and Wetlands has shown that major issue contributing to the reduction of the environmental condition in Putrajaya is water pollution, which related to elevated level of pollutants from upstream inflow to the lake that need a serious and systematic management approach and control in order to sustain the catchment area of Putrajaya. The ecohydrological approach that combining the need of the ecosystem into the overall planning, approval, monitoring and enforcement jurisdiction of the city development and the human activities in this catchment area, significantly having a direct impact to the Putrajaya Lake. A number of monitoring and surveillance conducted in this area has shown very positive signs of interesting habitat development and ecosystem enhancement. Water quality is needed to remain in a good condition for allowing water related activities conducted in the lake.

Keywords: Ecohydrology, Demosite Card, Integrated Catchment, Management, Lake, Wetland, Putrajaya.

### RIPARIAN VEGETATION AND ITS RELATIONSHIPS WITH RAINBOW FISH OF LAKE SENTANI, PAPUA

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The relationship between riparian vegetation and ornamental fish in Lake Sentani (140° 23'-140° 50' S and 02° 35'-02° 41' E) was studied. This research was conducted from September until October 2014 through survey method in 3 stations. The survey recorded a total of 30 species within 17 families. *Imperata cylindrica* (L.) Beauv. (Cogongrass) was found as the most abundant species during the survey. Jaifuri was the station with the most species (20 species) and the most abundant of riparian vegetations (304 individuals). The rainbow fish found in the stations were barred rainbow fish (*Chilaterinna fasciata*) (45 individuals) and red rainbow fish (*Glossolepis indicus*) (837 individuals). Dondai was the station with the most abundant of rainbow fish (595 individuals). Both of barred rainbow fish and red rainbow fish found in Dondai station. The result of this study calls for critical consideration for efficient riparian vegetation conservation as a habitat of rainbow fish in the lake because the number of species recorded is lower than expected.

Keywords: riparian vegetation, rainbowfish, Lake Sentani

### DOES EUTROPHIC LAKE PROMOTE GREENHOUSE GAS SINK ?

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Globally, inland waters are known to emit a significant amount of greenhouse gases, namely carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>), to the atmosphere. The net emissions of these gases are largely associated with organic carbon decomposition in the system. Lakes and reservoirs also bury a substantial amount of carbon in the sediment which undergoes remineralization producing dissolved organic and inorganic carbon. Both CO<sub>2</sub> and CH<sub>4</sub> are generated in such process too and are returned back to the water column. Eutrophic lakes, on the other hand, were estimated to sink atmospheric CO<sub>2</sub> due to their high autotrophic activity, and thereby contribute to high organic carbon deposition in the sediment. Despite the important of lakes in regulating global carbon balance, few process-based estimates of emissions from lakes have been undertaken. Here we calculate CO<sub>2</sub> and CH<sub>4</sub> emissions in a small, eutrophic monomictic lake (Okaro, New Zealand) using a mass balance model based on concentrations measured monthly over a one-year period. To support model computations, sediment porewater concentrations of CO<sub>2</sub> and CH<sub>4</sub> and water column profiles of temperature, dissolved oxygen and chlorophyll *a* were collected. We also measured organic carbon content in bottom sediment of the lake to derive estimates of the effects of sediment accumulation and diagenesis on carbon burial, and to provide insights into net accumulation of sediment carbon. On an annual basis, we calculated that CO<sub>2</sub> is released to the atmosphere at a rate of 4 mmol m<sup>-2</sup> y<sup>-1</sup>. Although mostly being up taken to sustain high rates of phytoplankton productivity, CO<sub>2</sub> is emitted as a pulsed release during the onset of lake mixing in winter in which its emission is calculated up to 54.9 mmol m<sup>-2</sup> d<sup>-1</sup>. At that particular time, CH<sub>4</sub> is released in a large amount as well. Up to 6.6 mmol m<sup>-2</sup> d<sup>-1</sup> of CH<sub>4</sub> is calculated emitted from the lake in winter in addition to the monthly average of ~0.1 mmol m<sup>-2</sup> d<sup>-1</sup>. Based on these calculations, the total annual greenhouse gas emission rate (CO<sub>2</sub> and CH<sub>4</sub> combined) from Lake Okaro is 8.8 mol CO<sub>2</sub>-eq m<sup>-2</sup> y<sup>-1</sup> (~0.39 kg CO<sub>2</sub>-eq m<sup>-2</sup> y<sup>-1</sup>) in which that is about half of the average emission from global lakes. Our calculation revealed that although accumulating a high rate of organic carbon (2.3 mol m<sup>-2</sup> y<sup>-1</sup>) in the sediment, only a small portion of that carbon is permanently buried (0.8 x 10<sup>-3</sup> mol m<sup>-2</sup> y<sup>-1</sup>). Most of the accumulated carbon is experiencing remineralization which can be associated with CO<sub>2</sub> and CH<sub>4</sub> production in the sediment, and may potentially be released to the atmosphere during the mixing. This study suggests that eutrophic lakes with high rates of primary production may act as a source of greenhouse gases rather than a sink due to their high rate of organic carbon remineralization in the sediment.

Therefore, knowing that inland waters are dominated by small water bodies with surface areas of <1 km<sup>2</sup> in which they are prone to eutrophication, the role of eutrophic lakes is critical in regulating global carbon cycle.

Keywords: Greenhouse gas emissions, carbon dioxide, methane, global carbon cycle, eutrophic lakes

## **STUDY OF FISHERY LOAD CAPACITY IN SUTAMI-LAHOR RESERVOIR USING CLOROFIL-A AND ZONING METHODS**

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Sutami and Lahor reservoir is the largest man made reservoir in East Java Province with multiple function, which one of them is for aquaculture. Fishery activities with floating net, trawl, and fishnet separator in Sutami and Lahor reservoir held by society nearby the bay along the reservoir. Those activities are also created waste that create higher pollutant load in reservoir. Study of fishery load capacity in Lahor and Sutami Reservoir held with Chlorofil-a method and intended to preserve the benefits of water resources sustainability. The calculation of Chlorofil-a concentration in unit (mg/m<sup>2</sup>) will produce distribution of fisheries potential in each reservoir. The right system to manage fisheries scatter-catch with zoning system, which means divided the territorial waters based on their physical and biological to organize the reservoir fisheries pattern based on reservoir priority function. Sutami and Lahor Reservoir divide into Dangerous Zone, Conservation Zone, Commercial Operation and Free Zone. The result shown the average potential of fishery potential in Sutami Reservoir in range of 73,18 - 166,85 ton/year with fisheries production in Sutami Reservoir in a number of 42,76 ton/ year. The average potential of Lahor Reservoir in range of 10,70-16,64 ton/ year and the fisheries production Lahor Reservoir in a number of 351 ton/ year.

Keywords: Sutami-Lahor Reservoir, Fishery, Chlorofil-a, Zoning

## **PELAGIC TO BENTHIC PRIMARY PRODUCTION RATIOS IN TWO LAKES WITH CONTRASTING LIGHT CONDITIONS**

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Pelagic primary production of phytoplankton and benthic primary production of periphyton were modelled in two small lakes of Estonia (north-east Europe). Although located only 500 m apart from each other, the water color and light attenuation of these two lakes differed markedly. Secchi depth in the clear-water lake was 4.5 and only 0.5 m in the dark-water, total phosphorus was, respectively 15 µg L<sup>-1</sup> and 28 µg L<sup>-1</sup>. We employed a process-based model whose inputs were morphometric, light, and dissolved organic carbon parameters obtained from in situ measurements. The model calculated primary production with a time step of 10 minutes, and a spatial resolution of 10 cm, from sunrise to sunset and from surface to lake bottom. While in the clear lake, the primary production of periphyton and phytoplankton were almost equal, in the dark lake only phytoplankton contributed to whole-lake primary production because of the stronger light attenuation in the water column. The hypsometric profiles differed dramatically between the two lakes. The clear lake had deep, U-shaped curve with high production at all depths in the morning but no increase afterwards; on the other hand, the dark lake production curve was increasing in midday but declined rapidly below the surface. The model we employed was a useful tool for sorting between systems where primary production was light- or nutrient-limited.

Keywords: DOC, light, nutrients, production, periphyton

## INFLUENCES OF MACROPHYTES ON SPATIAL VARIATION OF PHOSPHOROUS SPECIES IN SEDIMENT OF THE CHILIKA LAGOON

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The Phosphorous(P) cycle of the lagoon is mostly influenced with decomposition and regeneration process macrophytes and the exchange between benthic and pelagic compartment. However, the P species variation greatly influenced over time and space depending up on the environmental characteristics. In order to explore the variability of P species in respect to sediment quality and macrophytes, the Asia's largest brackish water lagoon 'Chilika' was studied during 2013. Samples were collected from 15 stations covering four sectors (Sourthen sector(SS), Northen sector(NS), Central sector(CS) and Outer channel(OC)) of the lagoon. Organic carbon was positively correlated with water temperature, which indicated that vegetation biomass was a major factor for controlling the water temperature of Chilika lagoon. The Spatial distribution of bioavailable phosphorous showed that rooted vegetated area of the lagoon released less quantity of phosphorous to the overlying water, Hence, the bio available P concentration observed to maintain an opposite trend with respect to biomass of rooted vegetation. Sediment particle size distribution strongly affected the spatial variation of P species, as indicated by a significant correlation between them. Fe/TP value in rooted vegetated sediments was higher than those of non rooted vegetated of the Lagoon. The rank order of P species in Chilika sediment based on concentration were; loosely-P(L-P)<aluminum-bound P(Al-P)<iron-bound(Fe-P)<organic P (Org-P)<calcium-bound P (Ca-P). There was a significant negative correlation between Ca-P and Org-P, which showed that the converting the Ca-P to soluble and Higher Org-P as a result of P-speciation due to the presence of vegetation area.

Keywords: Phosphorus speciation., Sediment, Macrophyte, Chilika Lagoon

## ECOSYSTEM RESILIENCE: THE ROLE OF MICROALGAE BASED NUTRIENT RECYCLING

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Big but shallow lake water are subject to simultaneous exposure from several anthropogenic stressors, such as pollutants and nutrients and resultant effects come out as bloomed micro algal growth, known as eutrophication, destroying the ecosystem. This kind of problem facing worldwide, which has created a great attention to the researcher. So, protecting the lake to become eutrophicated and managing the risk has become a novel research and new challenges to the lake researchers. Building a nexus between nutrient enrichment condition and basic ecosystem services from the lake a microalgae based nutrient recycling can play a vital role towards ensuring the resilient ecological system in a lake community. A co-benefit of producing alternative renewable energy and the carbon sequestration has been suggested by the present investigation using subcritical water (SCW) treatment. The system is considered to be less energy intensive and more environmental friendly, in which we get three kind of product; upper most part is lipid, which can be converted to biodiesel, liquid phase, in the middle, contains different N and P species which can be a direct source of nutrients for N and P and in the bottom, the solid phase can be used as soil conditioner or organic fertilizer. To achieve the goal of our research, the behaviors of microalgae biomass in subcritical water treatment have been observed through detailed studies. Optimization for operational conditions of SCW for efficient recovery of nutrients are analyzed and found the potentialities to make the lake ecosystem a resilient.

Key words: Lake Ecosystem, Resilient, N and P nutrients, Subcritical water, Microalgae

## **CALCULATING METAL BACKGROUND LEVELS OF SEDIMENTS FROM TAIHU LAKE, A LARGE AND SHALLOW LAKE IN CHINA: AN APPROACH BASED ON SEDIMENT STRATIFICATION**

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This paper presents an attempt to reach natural background levels of metals in sediments from large and shallow lake, being strongly influenced by wind-induced waves and currents. The core sediment profiles from Taihu Lake were classified into four layers, namely "fluid mud layer", "pollution layer", "interlayer", and "nature layer". The nature layer was defined as the background layer by systematically analyzing the concentrations of metals in each layer to determine the background values of metals. To correct for the grain-size and mineralogy effect, vanadium appeared to be the most appropriate choice among the different candidates we tested for normalization. After the samples standing outside the 95% prediction limits with vanadium were eliminated, we used mean values to characterize background concentrations of metals, namely 30.35, 32768.58, 62.30, 43.90, 448.61, 27828.60, 13.40, 20.58, 18.81, 53.28, 6.41, 59.59, 0.26, 144.12, and 20.76 mg/kg for Li, Al, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Sr, Cd, Ba, and Pb, respectively.

Keyword: Taihu Lake, background concentration, sediment, metal assessment, normalization

## **CURRENT STATUS OF LAKE ARAL – CHALLENGES AND FUTURE OPPORTUNITIES**

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The Aral Sea was the fourth largest lake in the world before 1960. However, it is now split into four separate parts and water bodies on isolated bays fed mainly by collector-drainage waters (Jiltirbas, Sarbas, etc.) because of excessive upstream irrigation water withdrawals from the two main influent rivers, the Syr Darya and Amu Darya. The resulting rapid increase in salinity has caused a dramatic decrease in the lake biodiversity and loss of fishery. Only a small part of the indigenous biota has survived. The regression of the Aral Sea has also had profound socioeconomic and human impacts on the lake riparian populations. Accordingly, it is encouraging to note the reversal of the degradation of the Northern (Small) Aral Sea after the creation of a dike at Berg's Strait in 1992. Although this first dike was washed out in 1999, it was replaced with a new structurally-sound dike in 2004-2005. The water level in the Northern Aral has increased several meters and its salinity has returned to levels that can sustain the pre-1960 ecosystem. The biodiversity also has been somewhat rehabilitated, and the commercial fisheries have revived. The remnants of the hyperhaline Southern (Large) Aral unfortunately continue their retreat and salinization. The Large Aral contains no fish species, and almost all the invertebrate species have been lost. To stabilize the Aral Sea to its present state would be very difficult, if not impossible, in the foreseeable future. However, a partial restoration of its separate parts is possible. Plans for further rehabilitation of the Small Sea and possible restoration of some parts of the Southern (Large) Aral Sea are discussed. In fact, the Aral Sea has experienced a number of water level declines and subsequent recoveries over the last 10 millennia.

Keywords : Aral Sea, biodiversity, fauna, salinity

## ENVIRONMENTAL FACTORS REGULATING THE DOMINANCE SPECIES OF PHYTOPLANKTON IN LAKE MANINJAU, WEST SUMATERA, INDONESIA

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Together with the occurrence of algal bloom high concentration of nutrient are always associated with eutrophication in lakes. However, direct links between nutrient composition and the dominant phytoplankton taxa in eutrophic lakes are often limited. Using canonical correspondence analysis (CCA), we elucidated phytoplankton assemblage and the associated nutrient and other environmental variables in a highly eutrophic Lake Maninjau, West Sumatera, Indonesia. Subsurface water samples were collected at 7 study sites in April and July 2009, April 2014, August 2015 and March 2016 to determine species composition and distribution of phytoplankton and physico-chemical parameters including Secchi depth, temperature, conductivity, dissolved oxygen (DO), pH, ammonium (NH<sub>4</sub><sup>+</sup>-N), Total nitrogen (TN), Phosphate (PO<sub>4</sub><sup>-</sup>-P) and Total phosphorus (TP). Succession in the assemblage was observed in August 2015 where the dominance of cyanobacteria was replaced by diatoms and dinoflagellates. Cyanobacteria taxa of *Anabaena* sp., *Cylindrospermopsis raciborskii* and *Microcystis* sp. were associated with TN, ammonia and TN/TP ratio, while *Planktolyngbya* sp. and *Chroococcus* sp. was related to TP, temperature, and pH. Dinoflagellate bloom of *Ceratium hirudinella* was linked with phosphate concentration. Our results confirm that changes in nutrient compositions may have implications for the dominance of taxa in phytoplankton assemblage.

Keywords: canonical correspondence analysis, nutrients, cyanobacteria, eutrophication.

## HEAVY METALS CONTENT OF SEDIMENT AND MOLLUSC IN LAKE MANINJAU, WEST SUMATERA

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Some evidence indicates that Lake Maninjau has been suffering from pollution in the last decade due to increasing activities either in the catchment area or in the lake waters. The aim of the research was to determine the stage of pollution of the lake through observation of Pb, Cd, Hg, Cr, and Fe content in the sediment and molluscs in some river mouths entering to the lake. The three times observations were conducted from March to September 2015 in seven (7) river mouths of Lake Maninjau. Sediment and molluscs of each location were sampled for metals content analyses. Some water quality characteristics were also observed. The molluscs are *Corbicula moltkiana*, *Melanooides* sp., and *Anodonta woodiana*. The metals content of the sediment were Pb: 0.004-11.230 mg kg<sup>-1</sup>; Cd: 0.005-0.019 mg kg<sup>-1</sup>; Hg 0.0006-0.0590 mg kg<sup>-1</sup>; Cr: undetected (<0.004 mg kg<sup>-1</sup>); and Fe: 1.173-3.573 mg kg<sup>-1</sup>. While the metals content in the molluscs were Pb: 0.002-4.170 mg kg<sup>-1</sup>; Cd: 0.013-1.032 mg kg<sup>-1</sup>; Hg: 0.0004- 0.1062 mg kg<sup>-1</sup>; Cr: 0.040-0.098 mg kg<sup>-1</sup>; and Fe: 0.040-0.948 mg kg<sup>-1</sup>. The content of lead (Pb) and cadmium (Cd) in the lake sediment and molluscs (*C. moltkiana* and *A. woodiana*) were considered high or polluted. The lake water quality in the 7 stations seemed to be quite turbid with high content of nitrogen and phosphorus.

Keywords: heavy metals, Maninjau, mollusc, sediment

## UNDER ICE AND EARLY SPRING ECOSYSTEM METABOLISM IN TWO CONTRASTING LAKES

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Lake Nohipalo Valgõjärv and Lake Nohipalo Mustjärv are two small waterbodies (7 ha and 22.2 ha respectively) in southern Estonia. Valgõjärv is an oligotrophic light-colored (Secchi depth 4.5 m) soft-water ( $\text{HCO}_3^- < 80 \text{ mg L}^{-1}$ ) and shallow (max depth 12.5 m; mean 6.5 m) lake. Mustjärv, which is only 500 m away, represents a dystrophic dark-colored (Secchi depth 0.48 m) soft-water, shallow (max depth 8.9 m; mean 3.9 m) system. Both lakes were equipped with Onset HOBO dissolved oxygen (DO) and water temperature/light loggers in late autumn to capture high-frequency changes of measured parameters in several depths over the winter period until spring (end of May). Ice cover started in both lakes at the same time but lasted one week longer in Nohipalo Valgõjärv. Using continuous data of DO, irradiance, and water temperature we estimated winter- and spring-period net ecosystem production (NEP), community respiration (CR) and gross primary production (GPP) for both investigated lakes. Studied lakes acted strongly as net heterotrophic waterbodies in winter and under-ice periods, caused by the light limitation which turned the GPP close to zero. Both lakes had a slight increase of their CR after ice break-up. Lake Nohipalo Mustjärv stayed strongly heterotrophic also in spring, while in Lake Nohipalo Valgõjärv GPP started to increase steadily after the ice break-up leading to a more balanced metabolic state at the end of the measurement period.

Keywords: lake metabolism, contrasting small lakes

Thursday, November 10<sup>th</sup>, 2016

**Room A, Topic 6 Database and Knowledgebase Systems, Informatics, and Monitoring Technologies**

**A LAND COVER MAP ACCURACY METRIC FOR HYDROLOGICAL APPLICATIONS**

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Land cover (LC) has a significant impact on the water quality/water quantity of nearby lakes and rivers, so LC maps are often required as input data for hydrological models. The accuracy of a classified LC map (or LC change map) can affect the accuracy of hydrological modeling results, but because LC maps are usually not produced specifically for hydrological studies, the commonly-used LC map accuracy metrics (e.g. overall accuracy or Kappa coefficient) may not be the most relevant. In this study, we proposed a new metric for LC map accuracy assessment, calculated as the root-mean-square-deviation (RMSD) of the estimated (i.e. mapped) and "ground truth", or reference, runoff curve numbers (CN) at randomly-sampled pixel locations. The new metric, CN-RMSD, directly assesses the accuracy of the runoff estimates in a classified LC map, and its benefit over the traditional LC accuracy assessment metrics is that it more heavily weights LC classification errors that cause greater errors in estimated runoff. Ground truth CN data can be collected much in the same way as ground truth data is collected for the traditional accuracy metrics, e.g. by field surveys or visual interpretation of high resolution remote sensing images, although the use of ancillary data sets (e.g. a soil map) can further improve the accuracy of the ground truth CN values. As a practical demonstration, we compare the calculations of map accuracy given by CN-RMSD, Overall Accuracy, and Kappa Coefficient for a LC map and a LC change map of the Laguna de Bay area of The Philippines.

Keywords: remote sensing, stormwater runoff, SCS curve number, accuracy assessment, hydrological modeling

**ESTIMATING WATER CLARITY FOR INDONESIA LAKES USING LANDSAT IMAGERY**

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Recently, many lakes are degraded due to the anthropogenic activities and or global climate change. One key parameter for evaluating water quality is the water clarity or Secchi Disk Transparency (SDT). It is not easy to perform a routine water quality measurement because very time-, labor and cost consuming. As a result, we are suffering from lack of available data for evaluating water quality change from past to now and even in the future. We need a method with relatively low cost but higher accuracy to fill the data gap. Remote sensing has a potential to meet the above requirements. Comparing to the other satellites, Landsat has the longest continuous mission for earth observation. Accordingly, the main objective of this research is to develop a general model to estimate water clarity for Indonesian lakes using a time-series Landsat images. In situ SDT measurements collected from 2011 to 2016 (ranging from 0.03 m to 18.6 m) and corresponding reflectance extracted from Landsat images were used for model calibration. The other in situ SDT measurements collected in 1992 or 1993 and corresponding Landsat images were used to validate the developed model. As a result, the model calibration and validation show determination coefficients of 0.86 (with averaged relative error of 50.2%) and 0.44 (with averaged relative error of 74.4%), respectively. A long-term change of lake water clarity from 1990 to 2016 will be produced using the developed model.

Keywords: water clarity, remote-sensing, Landsat, water quality

## **INTEGRATION OF SELF ORGANIZING MAP (SOM) AND FUZZY LOGIC AS MODELLING FOR ANALYSIS OF ALGAL BLOOMS RISK IN MANINJAU LAKE**

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Maninjau Lake is a vital water resource for West Sumatera province, providing a home to aquatic species and has been used for hydropower plant, irrigation, tourism and fisheries. At the same time, Maninjau Lake suffered a catastrophic eutrophication by algal blooming for several years. It caused mass death of fish and reduce the water quality. The process of algal blooms mechanism in Lake was very complex with uncertainty in space and time. This study integrated two methods using Self Organizing Map (SOM) and Fuzzy Logic (FL) to quantify the algal blooms risk with uncertainty condition. SOM has advantages for information extraction without prior knowledge (unsupervised) and the efficiency of pattern, classification, clustering and visualization. FL is a powerful method for dealing with uncertainty problems, especially risk analysis and assessment. On-site monitoring data of water quality from 2013 - 2014 in 11 stations in Maninjau Lake were used in rainy and dry season. Algal blooms in Maninjau Lake were classified into four categorized: no bloom, light bloom, moderate bloom, severe bloom. The result showed that most of the Maninjau Lake characteristics for algal blooms risk are light bloom to severe bloom. The method provides an approach to estimate algal blooms risk under uncertainties. Findings indicate that the higher status of eutrophication, the lower accuracy that was achieved for and most severe bloom outbreaks occurred in rainy season.

Keywords: Algal bloom, Risk uncertainty, SOM, Fuzzy logic, Maninjau Lake

## **MAPPING LAKE WATER QUALITY PARAMETERS WITH SENTINEL-2 MULTISPECTRAL INSTRUMENT IMAGERY**

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The importance of lakes and reservoirs leads to the high need for monitoring lake water quality both at local and global scales. Satellite remote sensing is the only feasible way to monitor lakes when we have global questions under investigation, or when water quality over large regions has to be monitored with reasonable frequency. The aim of the study was to test suitability of Sentinel-2 Multispectral Imager's (MSI) data for mapping different lake water quality parameters. In situ data of chlorophyll *a* (Chl *a*), water colour, coloured dissolved organic matter (CDOM) and dissolved organic carbon (DOC) from 9 small and 2 large lakes were compared with band ratio algorithms derived from Sentinel-2 Level-1C and atmospherically corrected (Sen2cor) Level-2A images. The height of the 705 nm peak was used for estimating Chl *a*. The suitability of the commonly used green to red band ratio was tested for estimating the CDOM, DOC and water colour. We were able to show that there is good correlation between band ratio algorithms calculated from Sentinel-2 MSI data and lake water parameters like Chl *a* ( $R^2 = 0.83$ ), CDOM ( $R^2 = 0.72$ ) and DOC ( $R^2 = 0.92$ ) concentrations as well as water colour ( $R^2 = 0.52$ ). The in situ dataset was limited in number, but covered reasonably wide range in optical water properties. These preliminary results allow us to assume that Sentinel-2 will be a valuable tool for lake monitoring and research, especially taking into account that the data will be available routinely for many years, the imagery will be frequent, and free of charge.

Keywords: remote sensing, Sentinel-2, lakes, water quality

## MONITORING OF LIMBOTO LAKE WATERS QUALITY DURING THE PERIOD 2015-2016 USING MULTI-TEMPORAL LANDSAT 8 DATA

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Limboto Lake is a lake with flood plain type that located in the Gorontalo province, Indonesia. The lake is facing problems with shrinkage and siltation, water hyacinth uncontrolled spreading, and water quality degradation, so the lake is included in 15 priority lakes that should be saved. In this research, the quality changes of Limboto lake waters during the period 2015-2016 were monitored and analysed using multi-temporal Landsat 8 data for supporting the national program of lake rescue. Sun geometric correction and atmospheric correction using Dark Object Subtraction were done to maintain the pixel values consistency in multi-temporal data. Furthermore, water hyacinth identification, water lake surface delineation, water cover classification and total suspended solid (TSS) extraction were done sequentially. Lake water quality changes were analyzed by comparing the changes in lake water surface area, water hyacinth distribution and TSS concentration. The results showed that the quality of Limboto lake waters was affected by material coming from the catchment area and the seasons. The areas of lake water surface and water hyacinth decreased and TSS increased in October 2015 during the dry season, but the areas increased and TSS decreased in July 2016 during the wet season. TSS concentrations were high all the time and water hyacinth area covered more than 40% of the lake area.

Keyword: lake waters quality, Landsat 8, lake water surface, water hyacinth, TSS

## NUMERICAL SIMULATION OF THE VERTICAL MIGRATION OF CYANOBACTERIA IN LAKES

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The buoyancy of cyanobacteria with gas vesicles is determined mostly by photosynthesis and respiration. The interplay between vertical mixing, irradiance and vertical mobility requires careful mathematical and numerical modelling for yielding the correct vertical distribution of cell mass. We simulated the vertical distribution of *Microcystis aeruginosa* and *Planktothrix rubescens* by modelling the changes in specific weight of cell material through the Fokker-Planck equation implemented in our numerical one-dimensional vertical (1DV) model for lakes. This 1DV model is forced by wind, air temperature, relative humidity, cloud cover and solar irradiance. Turbulence is modelled by the k- $\epsilon$  turbulence closure including damping by temperature stratification such as by thermoclines in lakes. The 1DV-model has a sub-program for simulating the vertical transport and entrainment by air-bubble plumes and the model is extended with a simplified oxygen balance including the oxygen-production by *Planktothrix rubescens*. Compared to the 200-1000  $\mu\text{m}$  large colonies of *Microcystis aeruginosa* the filaments of *Planktothrix* have an equivalent hydraulic diameter of just 40  $\mu\text{m}$ . With the 1DV-model we demonstrate the consequences of size in terms of vertical migration, depth of concentration and oxygen production similar to Walsby's more simplified approach. For *Planktothrix rubescens* we compare their depth of maximum concentration to observations from 2010 to 2014 in the Swiss Lake Hallwil, including the vertical distribution of oxygen.

Keywords: Lake, migration, cyanobacteria, plume, oxygen

## **RELATIONSHIP BETWEEN LAND COVER CHANGES AND WATER QUALITY CHANGES IN LAGUNA DE BAY, THE PHILIPPINES, OVER THE 2007-2015 PERIOD**

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In this study, we assessed the relationship between land cover change and changes in water quality in the Laguna de Bay area of the Philippines. Land cover changes occurring between 2007 and 2015 were mapped using a combination of optical (Landsat-7/-8) and synthetic aperture radar (ALOS Palsar-1/-2) satellite imagery, and time-series water quality data from 5 different stations situated in the Laguna lake were obtained from the Lake Laguna Development Authority website. To study the effects of land cover changes on water quality at these 5 different stations, the lake and its surrounding watershed area was first subdivided into 5 non-overlapping zones based on the generation of Thiessen polygons. Then, in each of these 5 zones, regression modeling was performed to assess the correlation between the changes in land cover (annual % changes of "built-up", "cropland", and "tree" land cover types) and the change in water quality parameters. In future work, we plan to use the regression modeling results to predict some potential impacts of future land cover changes in each zone as well as in the entire Laguna de Bay area.

Keyword : land cover change, water quality, watershed, eutrophication, ecosystem services

## **ESTIMATING LAKE EXTENT AND WATER VOLUME OF FLOODPLAIN LAKES OF KALIMANTAN USING RADAR IMAGES**

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Lakes hold about 80% of global liquid surface freshwater and encompassing crucial contributors to biodiversity. In time of increasing water demand and climate uncertainty, establishing fundamental patterns of natural variability of water resources including those in lakes is vital. Currently, storage capacity of tropical lakes is rarely reported due to the lack of data. In this contribution we use radar images from the Phase Array Synthetic Aperture Radar (PALSAR) with a pixel spacing of 75 m for the years 2007 through 2010 and lake level data to estimate lake extent and to quantify the volume of floodplain lakes in the Mahakam (East Kalimantan) and the Kapuas (West Kalimantan) lakes region. From flooded pixels we obtain areas of lakes inundation. Area of floodplain lakes is following seasonal inundation pattern as a result of variable rainfall rate; we use rainfall estimates from the Tropical Rainfall Measuring Mission for this analysis. The period of the Mahakam lakes depth measurements was coincided with part of PALSAR data acquisition dates. Therefore, we are able to derive a depth-area relationship that is used to estimate lake's water levels beyond our measurement period. Correlation analysis reveals that depth of the lakes is well-correlated with two-month moving average of areal rainfall. We obtained a linear depth-rainfall relation that was applied to approximate depth of the Kapuas lakes. An estimate of total volume of lakes is derived from total area of flooded pixels and lake's depth. Within the study period, the highest estimated total volume of water in the Mahakam lakes is 6.5 billion m<sup>3</sup> during the PALSAR data acquisition on 4 May 2007, while that of the Kapuas is about 3 billion m<sup>3</sup> during the PALSAR data acquisition on 8 April 2009.

Keywords: Floodplain lakes, inundation; water level, volume estimation, radar.

## **SENSING, SIMULATING, PREDICTING ALGAL BLOOMS IN INLAND WATERS**

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Water quality in inland waters is worldwide declining due to changes in land-use and climate change, recurring algal blooms by e.g. toxic cyanobacteria species are widespread. Such potential harmful algal blooms impact ecosystem services, harm aquatic ecosystem health and limit recreational and cultural water uses. Predicting and managing algal blooms traditionally requires continuous monitoring and data analysis for individual waterbodies which is limited by cost and accessibility. Novel techniques are necessary to step up from local to regional or global forecasting of algal blooms. Earth observation data can be used to gather water quality data even in remote locations with high spatial and temporal resolution, citizen science can help to close local monitoring gaps, aquatic ecosystem models are available to simulate algal blooms based on generally available drivers like meteorology and inflows, and sophisticated prediction tools exist drawing from historical knowledge and current drivers. Predictive capability allows for issuing timely alerts on upcoming threats minimizing risks to public health and reducing business failure. In a historical context they allow for cause-effect analysis of previous blooms and thus help improving management options for the future. Here we give an overview of current techniques for sensing, simulating and predicting harmful algal blooms in lakes and reservoirs on a local, regional and global scale. Example applications for lakes in Europe and Australia show the potential of modelling algal blooms under historical and future climate conditions.

Keywords: Earth observation, CyanoHAB, cyanobacteria, hydrodynamics, remote sensing.

## **VOILÀ, SCHRODINGER'S CAT - NON-EQUILIBRIUM ECOLOGY FOR ADAPTIVE MANAGEMENT: THE CASE OF PULICAT LAGOON, SOUTHEAST INDIA**

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Coastal lagoons are vulnerable to sudden high-impact climatic events, for example, unprecedented floods due to super-cyclonic formation. Such short-term natural events introduce acute, high-impact disturbances or stresses to lagoon ecosystems capable of altering the ambient regimes in various ways. Events like the dessication of lake bed signal longer, unforeseen periods of stress that may go unnoticed in shorter time-spans of monitoring. Any change to trophic status can be temporary or permanent under different disturbance thresholds or ecosystem resiliencies towards geohazards. Exploring adaptive ecosystem management under this perspective dictates that the time has come to let the new Schrodinger's cat – the concept of non-equilibrium ecology of coastal systems – literally “out of the bag”. Non-equilibrium ecology has been established to be quite essential to understand the interactive effects of disturbances as sources of ecosystem states in terrestrial ecosystems, but less applied to coastal lagoons. However, this method can provide crucial information on ecosystem behavior for pursuing adaptive management strategies towards resource management of lagoonal ecosystems. Using data from paleoenvironmental investigations as well as from the recent past, the non-equilibrium ecological responses of Pulicat lagoon (an urban backyard lagoon near Chennai) to high-impact events like the impact of super-cyclones, the 2004 Indian Ocean tsunami, and the 2015 South India flood event is discussed. Multiple palynological, environmental and biological proxies will be used to illustrate non-steady state changes and disturbance regimes. Using the disturbance legacy of the ecosystem, the present work hopes to highlight important post-disturbance pathways influencing the ecological functions of the lagoon.

Keywords: Coastal lagoon, non-equilibrium ecology, disturbance regimes, disturbance legacy, post-disturbance pathways, Pulicat.

## **Room B, Topic 2 Lake Environment Under Stress and Their Restoration Challenges**

### **TRACE ELEMENTS AS INDICATORS OF ENVIRONMENTAL PROCESSES AND ANTHROPOGENIC PRESSURE ON PROTECTED MARINE LAKES**

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The Mljet National Park, Adriatic sea, Croatia, founded in 1960, is one of the first established marine protected areas in the Mediterranean. Its most famous phenomenon are two karstic seawater lakes, known as Small and Great Lake. They are unique for their geological formation, hydrography and water dynamics, and water chemistry resulting in whitening events, but also for their specific biological community including scyphozoans and corals. These unique natural values require strict protection from anthropogenic pressures, in particular from growing tourism. In this work, we applied multielemental analysis of trace elements in undisturbed sediment cores to investigate the origin of sediments, the diagenetic processes in recent sediments and the paleoredox history of the lakes in order to provide a basis for the assessment of recent trends in anthropogenic influence on this vulnerable system. Typical fingerprint of trace elements in sediments suggested the surrounding soil as the main provenance of lake sediments and indicated limited input of the material from the open sea. Different trace elements were used as authigenic mineral formation, paleoredox and pollution indicators. It was demonstrated that Sr could be used as a proxy indicating authigenic formation of aragonite mud sediments. Distributions of the redox sensitive elements Mo, Tl, U and Cd were used to identify changes in redox conditions in the investigated lakes caused by environmental changes in the system over the last century. Elements having anthropogenic origin (Zn, Cu, Pb, Sn, Bi), including organotin compounds, were used to demonstrate increasing pollution over the past 40 years.

Keywords: sediment, trace elements, indicators, Mljet lakes, Adriatic sea

### **DETERMINATION OF MERCURY IN FISH FROM GANDOMAN AND SOOLEGHAN LAGOONS: POTENTIAL LIMITS FOR HUMAN CONSUMPTION**

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Concentrations of mercury in four freshwater fish species from Gandoman and Sooleghan Lagoons, west Iran, were determined by Cold Vapor Atomic Absorption Spectrometry. Concentrations of mercury in muscle of 60 fish ranged from 21 to 31  $\mu\text{g kg}^{-1}$  (mean=26.2  $\mu\text{g kg}^{-1}$ ). Statistical analysis showed no statistical relationship between mean mercury concentration and fish species, although concentration of mercury in different seasons and habitats was statistically different ( $p < 0.05$ ). The obtained results indicated that fish from Gandoman and Sooleghan Lagoons have concentrations well below the maximum permissible levels of mercury according to international standards. Estimates of the health risks associated with consumption of Hg contaminated fish are presented according to daily (kg/d) and monthly (meals/month) limits for the 3 to 75-year-old population demographic. According to the results, maximum allowable fish consumption rate ranged between 233 and 321 g/day and 31 and 43 meal/mo for an adult person with mean 71.5 kg body weight in the studied area.

Keywords: Mercury, Fish, Gandoman Lagoon, Sooleghan Lagoon.

## **BIOACCUMULATION OF METHYL MERCURY IN LAKE TALIWANG, WEST NUSA TENGGARA: IMPACT OF TRADITIONAL GOLD MINING**

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Traditional gold mining in Taliwang used to flow their waste directly to environment. Traditional gold mining separate gold from it rock using mercury. Danau Taliwang recently suffered from mercury pollution and high sedimentation. Organisms live in lake accumulating mercury in their body. The aim of this research is studying the amount of bioaccumulation in plankton, fishes, and sediments, and measuring water quality of Danau Taliwang. Sampling took place in Danau Taliwang, West Nusa Tenggara on February 2016. There were four species of fishes taken: Nila (*O. niloticus*), Gabus (*C. striatus*), Belut (*M. albus*) and Betok (*A. testudineus*). Sediments and plankton collected in inlet area, utilization area and outlet area. Water quality measured while collecting sediment samples. Water quality measured were secchi depth, basin depth, water temperature, pH, DO, CO<sub>2</sub> and alkalinity. Methyl mercury in organisms was analyzed using mercury analyzer in LPPT UGM, only hepar were analyzed. The highest methyl mercury bioaccumulation is in Betok's hepar, there were 204,6 µg/Kg. Gabus has 38,4 µg/Kg, Nila 9,3 µg/Kg, and Belut (*M. albus*) 1,3 µg/Kg. High concentration of mercury in Betok is because it's feeding habits. Betok is omnivorous fish, it likes to stir sediment to find food. The highest methyl mercury concentration in sediment is in inlet area, there was 9,46 µg/Kg. Methyl mercury concentration lower in utilization and lowest in outlet area. It because traditional gold mining found most around inlet area. Water quality showed Danau Taliwang DO is very low. It shows high rate of decomposition due to sedimentation

Keyword : polluted lake, sedimentation, tropical lake

## **TROPHIC AND POLLUTION STATUS OF JAWAHAR SAGAR IN SOUTHERN RAJASTHAN, INDIA BASED ON WATER QUALITY AND MACROINVERTEBRATE FAUNA**

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Jawahar Sagar reservoir is the third reservoir in the series of Chambal valley projects, located 29 Km up stream of Kota Barrage and 26 Km downstream of Rana Pratap Sagar dam, across the river Chambal. Water Quality was analyzed for the period of one year (November: 2004 to November: 2005). Water of Jawahar Sagar indicated alkaline condition ( pH 7.6 in winter to 8.8 in summer). The water temperature was warm (18.5°C in winter to 32.0°C in monsoon). On the basis of water quality and especially depth of visibility of Jawahar Sagar could be categorized as "moderately eutrophic". Nitrate nitrogen values in Jawahar Sagar indicated 'Mesotrophic' status whereas orthophosphate levels in the Jawahar Sagar may be considered a sign of eutrophic status. Jawaha Sagar reservoir could be categorized as 'moderately hard' water based on hardness. In addition to water quality, benthic biodiversity of macroinvertebrates were also studied as bioindicator species for pollution status. From Jawahar Sagar 29 species of macroinvertebrates have been recorded Among macroinvebrates most dominant five benthos were *Melanoides tuberculata*, *Chironomus* larvae, *Bellamya bengalensis*, *Lymnaea acuminata* (Gracilior) and *Goniobasis virginica* in the littoral zone in the decreasing order. The total number of macroinvertebrates depicted by various species of benthos ranged from 858 to 1188 (No./m<sup>2</sup>) in Jawahar Sagar. The macrobenthic community showed dominance of molluscs at Jawahar Sagar probably due to congenial environmental conditions and availability of choice substratum. Organic pollution indicator *Lymnaea acuminata*, *Chironomus* larvae, *Limnodrilus hoffmeisteri* and *Indoplanorbis exustus* fairly domained in Jawahar Sagar reservoir.

Keywords: Water quality, Pollution, Macroinvertebrates, Bioindicator, Jawahar Sagar Reservoir Rajasthan.

## **INCREASING HUMAN-ENVIRONMENTAL STRESSES ON JATILUHUR RESERVOIR IN THE PAST DECADES**

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The study site is the Jatiluhur Reservoir – Downstream area of the Citarum Basin. The study focus concerns the impacts of economic development in the past decades related to food production and availability of water resources in the study area that have undergone significant changes creating severe human-environmental stresses. The study approach and analysis were based on observed hydrologic data to reveal simple water balance of the basin and the long term trends due to changing environment that further be related to food production capacity in the past decades. Some discussions on necessary management options were then given to deal with the sustainability issue by introducing the crop-water productivity strategy as means to ensure efficient use of available resources.

Key findings on long term trends of decreasing rainfall of 28.3 mm/year that correspond to the increasing river discharge of 13.8 mm/year, indicated deterioration of the basin environment with increasing runoff coefficient in the past decades. On the demand side the basin is characterized by increasing population and the needs to support Jakarta water supply that require to increase food production under deterioration environment. Therefore some basin management strategy need to be implemented as suggested.

Keywords: Human-environmental stresses, land and water degradation, food production, crop-water productivity strategy.

## **ALGAL BLOOM IN LAKE ERHAI — THE ROLES OF BIOLOGICAL INVASION, EUTROPHICATION AND CLIMATE CHANGES**

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Deterioration of aquatic ecosystem and algal bloom are serious problems occurring in many lakes worldwide, and eutrophication was frequently considered as one of the most important causations. In this study, we analyzed the long-term changes in aquatic ecosystem, with the emphasis on algal bloom in Lake Erhai, a lake with water surface area of 250 km<sup>2</sup> and mean water depth of 11 m (maximum depth 21 m) in the subtropic Yungui Plateau in southwestern China. The lake had clear water, occasional slight algal bloom and oligo- to mesotrophic status before 2002, and then changed to a turbid water state, with unoccasional heavy algal bloom and eutrophic status since 2003. We found that the biological invasion of alien fishes and climate changes in terms of warming temperature, water level fluctuation and inlake water retention, in addition to the eutrophication, had contributed to the changes of the ecosystem in Lake Erhai. The results highlight the complicate managements of aquatic ecosystem in face of a warming world in the future.

Key words: Aquatic ecosystem, algal bloom, eutrophication, climate change, biological invasion

## IS ABIOTIC FACTORS MAIN DRIVING FORCE FOR CYANOBACTERIAL BLOOM OCCURRENCE?

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Cyanobacteria blooms represent a meaningful environmental and public health issue for freshwater and coastal systems. These events are frequently explained by an interaction of environmental factors, such as high nutrients loads, high temperature and water column stability. More recently, the role of climate change events to promote cyanobacteria dominance has been also evaluated. Besides screening environmental factors that govern fluctuations in the whole group, understanding the occurrence of different eco-strategies and/or species-specific responses is important due to their relation with the functioning of aquatic ecosystems and with the variation in the potential toxicity. In spite of many bloom forming species sharing important traits, a high diversity of intraspecific genotypes is usually observed during a bloom development as well as on spatial distribution of cyanobacteria population. This diversity can interfere on environmental preferences, which affect their occurrence. It is already demonstrated for populations of *Cylindrospermopsis raciborskii* and *Microcystis aeruginosa*, the two most common cyanobacteria species on cyanobacterial bloom. Cyanobacteria are also subject to the effect of biotic factors by interactions with components of the planktonic community, such as predation, parasitism and allelopathy. However, the driving forces behind clonal dynamics are still poorly understood. Besides, the role of cyanotoxins is still an open question and the evolution of toxicity among species and strains is practically unknown. In this presentation, these aspects will be shortly reviewed and the importance of studies to improve our knowledge about the complex matrix of factors involved with cyanobacterial bloom dynamics will be emphasize.

Keywords: cyanobacteria bloom, environmental factors, biological factors

## EUTROPHICATION DEVELOPMENT AND CONTROL TECHNOLOGY OF PLATEAU LAKE—LAKE ERHAI

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As China's social, economic development and population increase, Lake Eutrophication is more and more serious. In order to research complete technology system of Lake Eutrophication control and governance, China government has launched Major Science and Technology Program for Water Pollution Control and Treatment, in 2006. Core objective of this program is to provide technology support for China's water pollution control. Lake Erhai was enrolled in the main watershed special study in 2007. Through pollution source investigation and analysis, treatment technology research and evaluation, demonstration project construction, a set of pollution control technology and solution system suitable for China's western underdeveloped areas is expected to be put forward. Because of nitrogen and phosphorus mainly from rivers into the Lake Erhai, how to reduce pollutant load of rivers into lake, especially reduce nitrogen and phosphorus nutrient concentration of rivers into the lake and the bay, has been the focus of the research content. During years of 2007 to 2014, research group formed a set of five-class system for nitrogen and phosphorus reduction engineering and ecological restoration. The engineering system was launched in Luoshi River watershed that is one of main rivers into the North Lake Erhai, in the form of demonstration project construction. The project brought good results. Compared with 2006, TN, TP and main pollutants concentration in Luoshi River estuarine water decreased obviously. Pollutant concentration decreased by 66% (TP) and 66% (TN) respectively, slashing rivers pollutant load into the lake.

Keywords: Eutrophication, Lake Erhai, Control Technology, Non-point Pollution

## ASSESSMENT OF CYANOTOXINS IN SEDIMENTS AND WATER AT LAGUNA DE BAY PHILIPPINES USING ELISA AND qPCR

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This paper presents the result of the assessment conducted at Laguna de Bay, Philippines specific to the occurrence of cyanotoxins in surface water and sediments. Laguna de Bay is among the large lakes in Asia from which population in various areas around the lake depend their domestic water supply. Some households in several communities rely their everyday living from fishing at the lake. Cyanobacterial bloom in Laguna de Bay has been reported several times and caused the water distributed to the nearby cities to have a peculiar taste and odor. However, quantitative assessment and determination of the type of cyanobacteria present in the lake have not been carried out hence this study was conducted. This will aid in providing information for bioremediation options. Cyanobacteria like *Microcystis aeruginosa* pose serious problems to drinking water and the public health due to its cyanotoxins. Long-time exposure to cyanotoxins would affect the health of public, and thus reliable detection and quantification of the algae species are challenging in Laguna de Bay. Portable enzyme-linked immunosorbent assay (ELISA) was used to detect cyanotoxins. Cell number in the water samples was determined by portable quantitative real-time PCR (qPCR) to distinguish whether cyanobacteria species in Laguna de Bay is toxic or non-toxic, and odorous or non-odorous.

Keywords: *Microcystis aeruginosa*, Laguna de Bay, cyanobacterial bloom, sediments

## Room C, Topic 5 Water Education, Ecotourism, Culture

### PHYTOPLANKTON COMMUNITY DYNAMICS AS BIOINDICATORS TO ASSESS AQUATIC ECOSYSTEM HEALTH: A CASE STUDY OF A TROPICAL RESERVOIR

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Phytoplankton community structure in relation with water quality conditions in Mengkuang Reservoir, Penang, Malaysia was studied to determine its suitability as a tool to characterize lentic ecosystem health. In this study, sampling was carried out in three stations in limnetic zone from surface to bottom in August 2005 to July 2006. The results showed that total phytoplankton density have a clear pattern of vertical distribution. Mean phytoplankton density was 28603 individual/L at the surface water and 14092 individual/L at the bottom. Other than *Staurastrum apiculatum* and *Staurastrum* which were dominant throughout the water column, the upper and bottom layers were also dominated by *Glenodinium lenticular* and *Lyngbya sp.*, respectively. Shannon-Wiener diversity index were 3.69 and 3.7 bits/individual, while evenness were 0.58 and 0.66 at the surface and bottom, respectively. Biological attributes of this reservoir were examined for vertical water quality characteristic by calculating Saprobic index. Saprobic index showed that both layers were in class III β of water pollution (moderately polluted). This study therefore showed that phytoplankton community is a reliable indicator to assess water quality characteristics in a tropical reservoir.

Keywords: Phytoplankton, community structure, vertical distribution, water quality

## **POLLUTION OF LEVEL PENJALIN RESERVOIR PAGUYANGAN SUB DISTRICT BREBES REGENCY DETERMINED FROM THE PLANKTON COMMUNITY STRUCTURE**

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This study aimed to determine water quality of Penjalin Reservoir, to know plankton community structure (abundance, diversity and dominance), and to determine the level of water pollution at each station in Penjalin Reservoir based on its plankton diversity. This study used a survey at six stations namely the inlets, the center, the pier and the outlet of reservoir. Sampling was done 3 times and 4 weeks interval each. Water quality was analyzed descriptively based on quality standard criteria in PP no. 82 of 2001. Plankton community structure that consisted of abundance, diversity and dominance were analyzed descriptively based on the criteria of Shannon-Wiener's diversity index and Simpson's dominance index. Determination of pollution level at each station was based on the diversity index which then analyzed descriptively based on water quality criteria. The results showed that water quality of Penjalin Reservoir was fairly good since it possessed the value under quality standard in PP no. 82 of 2001. The abundance of plankton ranged from 4970.30 to 12923.37 ind.l<sup>-1</sup>. The most abundant species was Tetraedon minimum. Diversity index (H<sup>39</sup>) ranged from 3.28 to 3.55 and dominance index ranged from 0.04 to 0.07. Based on its diversity index, pollution level in Penjalin Reservoir was categorized as unpolluted water.

Keywords: community structure, level of pollution, reservoir

## **EVALUATION OF FLOOD MITIGATION AND WATER PURIFICATION EFFECT IN URBAN LAKE, JABODETABEK**

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As rapid population increase and economic growth, land use was drastically changed from agricultural land to urbanized built-up area especially in outer edge of Jakarta Metropolis. In addition, degradation of water environment in Jakarta became severe. For example, recently, severe flood occurred in Jakarta city in almost every year (2012, 2013, 2014) and water quality level in rivers flowing through Jakarta Metropolis became worse because only 3.0% of living households connected wastewater treatment system. According to JICA feasibility reports, several flood controlling facilities or wastewater treatment plants were planned to construct, however settlement of living people relocation and land expropriation was very difficult in highly populated region. In this study, we focused on multi-functionality of urban lakes (situ and waduk) which is naturally or artificially developed. In Jakarta, about 1000 urban lakes were existed before, however number of them decreased around 300 until now. Reduction of urban lakes will accelerate the degradation of water environment in Jakarta, because urban lakes have multi-functionality for keeping water environment in suitable condition. Therefore, to conserve those lakes in adequate condition and in sustainable, quantitative evaluation of multi-functionalities were quite important in the view point of water purification and flood control in this region.

Keywords : lake water environment, land use change, GIS, JAVA, Jakarta

## **WATER POLLUTION LOAD CAPACITY AND RESERVOIR ZONING AS AN ATTEMPT TO MAINTAIN THE SUSTAINABILITY FUNCTION OF WADASLINTANG RESERVOIR**

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Wadaslintang dam is a multipurpose dam located in Wonosobo regency, Central Java Province, Indonesia, which raw water used for various purposes, such as water supply for irrigation, hydropower, domestic, industry, fisheries and tourism. Degradation of water quality in Wadaslintang reservoir besides caused by pollution from catchment area (household waste, livestock and agriculture), also caused by aquaculture using floating net. The number of floating nets in Wadaslintang reservoir currently is 546 units with various type and size. Study of water pollution load capacity and reservoir zoning has been done as an effort to control water pollution in Wadaslintang reservoir. Water pollution load capacity of reservoir is the limits of reservoir ability to receive input pollutant load that does not exceed the limits required or meet quality standards. While reservoir zoning is an attempt to exploit the reservoir space by determining the functional limits in accordance with potential resource, pollution load capacity and ecological processes that aim to maintain the reservoirs function. The study reveals that total pollutant load (phosphate/P) that takes into Wadaslintang reservoir from those two sources approx. to 407.97 tons/year, causing hyper-eutrophic conditions in Wadaslintang reservoir with levels of phosphate estimated about 283.25 mg/m<sup>3</sup>. Based on pollution load capacity, morphometric and bathymetry, Wadaslintang reservoir is divided into five zones, namely sanctuary fisheries zone, riparian zone, utilization zone (fisheries and aquaculture), tourism zone and danger zone. This paper will discuss measures to control water pollution in Wadaslintang reservoir by determining pollution load capacity and introducing reservoir zoning.

Keywords: reservoir, water pollution control, reservoir zoning

## **IDENTIFICATION OF LAKE TOBA POTENTIALS TO SUPPORT GEOPARK TOBA CALDERA DEVELOPMENT**

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Lake Toba Area in North Sumatra, Indonesia, is declared as a National Geopark of the Republic of Indonesia with a theme of Supervolcano and uniqueness as the largest Quaternary Tectonic-Volcano in the world. Based on research, The Toba Caldera area was formed as a result of Toba Super Volcano eruption with an intensity of >8 VEI which affect globally. Last eruption happened on 74.000 years ago and formed Samosir Island as a geological phenomenon. This eruption affected a six-years of darkness through the whole earth. It is the largest Quartery Caldera in the world and therefore is a significant world heritage. Therefore, its stakeholders confidently registered Toba Caldera to Global Geopark Network UNESCO as one of geopark. UNESCO defined geopark as a geological area, including the specific features of the geologically significant, rare or in the form of beauty which also has ecological value, archaeological, historical and cultural to local economic development through conservation, education and tourism. Based on its uniqueness on geological area both on the lake, land and watershed, on Sumatra Island and Samosir Island, the author set the research goal as an identification of any potentials of Lake Toba to support the development of Geopark Toba Caldera. To reach the goal, the author used qualitative method by doing some depth interview to key stakeholders, literature researches and observation. The findings are Lake Toba may support Geopark Toba Caldera development as a water supply, energy supply, tourism attraction and transportation network.

Keywords : potentials, Lake Toba, support, geopark, development

## **ROLE OF WATER USER ASSOCIATIONS IN ENSURING WATER SECURITY OF UGANDA**

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Water user associations (WUA) can be defined as a cooperative group of individual water users who come together voluntarily to undertake water-related activities for their mutual benefit. WUAs form a tier in the decentralized water resources management structure, serving as an important link between the Catchment Management Committee and catchment-level Stakeholder Forum and water user groups, handpump committees and individual water users. WUA's may also assist in compliance with and enforcement of relevant regulations and permits. WUAs may also participate in and contribute to the resolution of conflicts arising between competing water uses, interests or practices. The objective was to find out the role WUAs in ensuring water security of Uganda. The activities of the associations in 4 river catchments in Uganda where these have been formed were considered. Analysis was made of the contributions of these associations in the management of water resources and their development. It was found out that 75% of the Committees had contributed tremendously to the conservation and proper use of water resources, 15% had not been successful while 10% were inactive. However overall WUAs are important in ensuring water security of the country. It is therefore recommended that the entire country embraces this shift so that WUA Associations are established in all river catchments across the country.

Keywords: Water User Associations, Catchment Management Committee, water resources.

## **PRACTICE OF WATER ENVIRONMENTAL EDUCATION IN KASUMIGAURA WATERSHED BY TSUCHIURA CITY**

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Lake Kasumigaura is a symbol of Tsuchiura city, and supports the lives of its 140,000 citizens. The city is situated along the western shore of the lake with inflowing 56 rivers and the lakesides are rich in diversity. However, the lake has been giving citizens negative impression including offensive odors caused by putrid aoko (water blooms) and debris in and around the lake. Therefore the citizen has been concerned about water environment as familiar issue for a long time. As regards to the river, Tsuchiura city started water quality observation in 1970s and these 20 years' BOD data shows that water quality has been improved from 3.8mg/L in 1995 to 2.0mg/L in 2015 measured at Sakura river's monitoring point. The city has been carrying out practical water environmental education for purposes of creating awareness of familiar water environment and experience at first hand even for the citizens inhabiting off-site waterfront. The three major education themes are to Know, to Touch and to Communicate. The poster shows some Tsuchiura city's programs that provide elementary school students opportunity for learning good place and water environment including 'Sakura-rivers Eco-Adventure tour'.

Keywords : Lake Kasumigaura, Water environmental education, Packtest, Sump water-River water-Lake water, water cycle, Household water

## FORESHORE REPRODUCTION AND UTILIZATION ACTIVITIES BY COMMUNITY

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Since the establishment of Kasumigaura Citizen's Association in 1996, we performed many activities that raise public awareness for improving water quality aiming to swimmable lake water such as the environmental education and symposiums on Kasumigaura Lake. We investigated the role of the sandy beach that was existed once in Kasumigaura Lake, particularly about the function, the utilization and the formation mechanism. We confirmed that it is very important to reclaim the sandy beach. After we examined several places proposed for sandy beach regeneration, we selected the land where the old Ministry of Construction (the existing Ministry of Land, Infrastructure, Transport and Tourism) developed for the foreshore in Kasumigaura Lake shoreline. This development was performed as one of the activities that promote water quality when the 6th World Lake Conference had held in Ibaraki prefecture in 1995. But after the construction, reeds and weed grew thick and it became difficult to enter the foreshore. We held environmental event and raised participants who live in the Kasumigaura basin for the foreshore cleaning. We mowed weed and picked large amount of trash for several years. As a result, the comings and goings of the person were enabled and were able to secure the space where a sandy area can be seen. Our purpose is not only to make this reclaimed foreshore as "Satohama" which anyone can utilize freely but also to maintain the beach clean. Hereafter we hold events that serve as an environmental education and carry out the periodical maintenance of the foreshore.

Keywords : Citizen activity, Foreshore reproduction, Environmental education

## Room D, Topic 8 Ecotechnology, Ecohydrology

### MITIGATION OF FERTILIZER RUNOFF BY USING TERRESTRIAL ALGAE

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Objective: To create a technical measure against nonpoint pollution. Methods: Microalgae, which show photosynthetic growth on the surface of sand-silt-fertilizers mixtures, were chosen to be tested. After such screening, the cells were cultured in an inorganic liquid medium. The algae were collected, and inoculated onto the soil in vitro or outdoors lawn field. After algal growth, the surface layer in the topsoil was collected, sieved with 2-mm mesh, and chlorophyll a content was determined in the ethanol fraction extracted from the soil. Reduction of nitrogen (N) and phosphorus (P) content in the soil by the algal growth was estimated from the difference of chlorophyll a level between the values of before and after the inoculation. Findings: Fertilizer runoff into aquatic systems leads to eutrophication. There are few measures against the nonpoint pollution. We focused on the fact that some microalgae utilize the inorganic nutrients in the upper surface of the topsoil. Some algae utilized the nutrients of inorganic fertilizer and of manures in the soil for their photosynthetic growth. Among them, terrestrial *Nostoc sp.* HK01 is a non-toxic and desiccation-tolerant cyanobacterium. We succeeded in the semi-mass culture and the dry processing in the preservation of the *Nostoc sp.* The dry cells after a year storage kept ability for regrowth, when inoculated onto the lawn field. The theoretical calculation showed that the fertilizer runoff can be efficiently reduced by using the terrestrial microalgae.

Keywords: Ecobiotechnology, Fertilizers, Nonpoint source pollution, Runoff, Soil algae

## IMMOBILIZATION OF HEAVY METALS TOWARDS ALLEVIATION OF ECOSYSTEM HEALTH RISK: A GREEN HYDROTHERMAL TREATMENT APPROACHED

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The generation of huge amount of waste and containing more hazardous metals (HMs) such as chromium, cadmium nickel and lead especially coming from the tannery industries, has become serious problems on aquatic ecosystem and poses risk of bioaccumulation in the food chain. Surface water and soil pollution by these HMs as a result of improper disposal of sludge has become a great ecosystem health-hazard concern to the environmental researchers. There are two approaches that can be applied; removal of heavy metals and immobilization of heavy metals. Immobilization techniques for HMs that have been proposed utilizing subcritical water (SCW) is one of the new technologies, which is regarded as environmentally friendly and sustainable. The SCW technology can stabilize and reduce the volume of sludge as well as immobilize HMs to reduce direct toxicity and the risk. Present study focuses on subcritical water treatment by formation of tobermorite or similar crystalline minerals. In the study, XRD and SEM techniques are used to establish the optimal subcritical water conditions and Ca/Silica ratio to form tobermorite. Heavy metals trapped by the pore space of tobermorite, which can be formed depending upon temperature and Ca/Silica ratio under the subcritical water conditions. Based upon the preliminary SCW treatment experiments, which were conducted at moderate temperature of up to 280°C and under the saturated water vapor pressure with amended silica and calcium, and leaching tests, it was observed that heavy metal concentrations in the leachate from sludge decreased after the SCW treatment.

Key words: Hazardous metals; Immobilization; Tannery sludge; Subcritical water; Waste Management

## RESTORING INDONESIAN LAKE BUFFER ZONES USING NATIVE PLANT SPECIES

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Lake buffer zones are essential area to protect freshwater from pollutants originating from the catchment area. Empirical research projects on the restoration of lake buffer zones' function as pollutants trappers have been undertaken in some sub-tropical countries with mixed results. Most projects agreed that vegetated lake buffer zones significantly reduce pollutants depending on the width of buffer area and vegetation types. In tropical country including Indonesia, empirical research projects attempted to measure buffer zones effectiveness in reducing pollutants are still limited. Existing regulations only consider buffer sizes; meanwhile few research projects on plant species that are capable in trapping pollutants have been exposed. This paper aims to explore potential plants for restoring buffer zone functions. Nitrogen accumulator plants were chosen as Nitrogen is one of major pollutant sources on some Indonesian lakes. The exploration on Nitrogen accumulator plants was carried out to gather information on the species. All collected plants were then sorted into species distributed and native to Indonesia. Result from World Agroforestry Database explained that there are 125 Nitrogen accumulator plants, 46 of which are distributed in Indonesia and 23 of them are native. The native plants consist of timber sources from genus *Acacia*, *Albizia*, *Casuarina*, *Dalbergia*, *Dipterocarpus* and *Intsia*; food sources such as *Cajanus cajan* and *Gnetum gnemon*; medicine sources like *Cajanus cajan*, *Erythrina variegata*, *Flemingia macrophylla*, *Peltophorum pterocarpum* and fodder such as *Flemingia macrophylla* and *Sesbania grandiflora*.

Keywords: lake buffer zones, rehabilitation, native plant species, Indonesia

## **POSSIBILITY OF SEDIMENT MICROBIAL FUEL CELLS TECHNOLOGY FOR MONITORING WATER QUALITY**

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From the point of view of understanding and preventing water contamination, monitoring and measuring water quality in water area become more important globally. On the other hand, water quality measurement instruments need cost and efforts like boat, staff and measurement time. Furthermore, water quality measurement instruments tend to be expensive and unsuited for continuous measurement due to fear of losing it. We developed a simplified electrode potential measurement instrument that has similar measurement mechanism to oxidation-reduction potentiometer (ORP meter). This instrument was applied Sediment Microbial Fuel Cells technology and it was composed of carbon electrode, silver chloride electrode, voltage recorder and wire that are connecting to these materials. We expect that people in developing country can use this because it is easy to make and inexpensive. In this study, we aim to examine possibility of the developed water quality monitoring instrument for a new water quality measurement technology. We set developed water quality measurement instrument in water area where untreated sewage flow in, and measured water quality continuously over 6 months. Electrode potential measured the water quality change clearly during experiment period. For example, electrode potential was increased when rain water flow in due to the increasing amount of dissolved oxygen. In addition, electrode potential was decreased when the water quality degrading due to anaerobic decomposition of organic matter from untreated sewage. From the results, it was suggested that developed water quality monitoring instrument can use for a new water quality monitoring system.

Keywords: SMFC technology, Oxidation-reduction potential, Carbon electrode, Dysoxic environment

## **ECOHYDROLOGY MANAGEMENT OF LAKE AND WETLAND IN PUTRAJAYA URBAN ECOSYSTEM**

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Putrajaya has successfully implemented the creative ecohydrology concept of 'ecosystem exploitation' to achieve the targeted 'hydrological quantity and quality' of water in its urban drainage system by constructing a 600 ha of Lake and Wetland. The appropriately managed and conserved constructed wetland leads to the evidently functioning ecosystem services that benefit to the wellbeing of the communities. It has not only produced the high quality of water, help in flood mitigation but also creates amazingly numerous benefit such as functioning as breeding grounds, nurseries and homes to numerous flora and fauna. The diverse aquatic organism that has been amazingly improving since it was created 15 years ago, represents a good sign of a balance ecosystem. In addition, the lake has now supporting the healthy lifestyle and become a renowned venue to community, national and international high-profile events, though an attraction for domestic and international tourism as well. In 2015 and 2016 various management innovative applications have been applied in order to achieve healthy and balance ecosystem the expected conservation status. Among all an innovative method of algae removal through the non-destructive micro-bubble technology, a study of Economic Assessment of Ecosystem Services and the integration of Putrajaya Lake model and catchment management models becomes the long-term initiative towards conserving the Putrajaya Lake and Wetland resources. Another innovation management effort that are taking place is the formation of the International ASEAN Lake Network (IALN). The idea for IALN were than agreed as prospective way forward to encourage information and experience exchanges among members.

Keywords : eco-hydrology, ecosystem services, constructed wetland, healthy ecosystem, Putrajaya Lake

## **INTEGRATED MULTI TROPHIC AQUACULTURE FOR ENVIRONMENTALLY SAFE FISH PRODUCTION IN SMALL RESERVOIR**

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Integrated multi trophic Aquaculture (IMTA) is one technique in fish culture. These systems culture organism of varying trophic levels to maximize the system's energy and nutrient utilization efficiency. IMTA systems have been implemented in an effort to utilize the waters on small reservoirs. The objectives of this study was to assess the growth of catfish (*Clarias* sp.) and tilapia (*Oreochromis niloticus*), water quality and fish production on IMTA system. Application of IMTA systems by utilizing the two treatments in different small reservoir. The study was conducted in May-August 2016 at the Enrekang Botanical Gardens, Central Sulawesi. This study consisted of two experiment of different type of small reservoir. First small reservoir located on inside of botanical garden is a fish pond with area 20x25x1.5 m<sup>3</sup>. The second reservoir located on outside of botanical garden is a new pond consists of two units (30x30x1.5 m<sup>3</sup> and 20x40x1.5 m<sup>3</sup>). In the first reservoir, catfish cultured in the nets (1x5x1 m<sup>3</sup>), with stocking density of 200 fish/m<sup>2</sup>, an average total length 5.6 cm and average weight 1.34 g. The duckweeds planted in the two net of the same size as catfish net's are placed on both sides of the outside of the catfish net's. The tilapia cultured in outside the net, with stocking 2,000 tilapia. The size of tilapias were 6.93 cm average total length and average weight of 6.10 g. Surrounding catfish net's and duckweed net's installed plastic tarps to limit water from catfish culture mixed directly with the water outside the net. On the second reservoir catfish cultured in a net (4x4x1m<sup>3</sup>), with stocking densities 187.5 fish/m<sup>2</sup>. An average of total length of catfish 4.9 cm and average weighs 0.84 g. The tilapia cultured with stock 2,000 fish separately in another small reservoir with has water connection with catfish reservoir. The size of tilapias were 6.5 cm average total length and an average weight of 5.3 g. The catfish were fed pelleted by 5% per day, while the tilapia fed by duckweed, which is about 400 g wet weight per day. The results showed the growth of catfish reached 0.33 - 0.71 g day<sup>-1</sup> and the growth of tilapia reaches 0.30-0.51 g day<sup>-1</sup>. The duckweeds were planted growth well and It can be used as a fed source for tilapia. Water quality conditions in IMTA systems observed still support for the life of both of fish, catfish and tilapia.

Keywords: aquaculture, trophic level, fish production, feed efficiency

## **DEVELOPMENT OF WATER COLUMN SAMPLER FOR THE STUDIES OF MICRO-SCLAE VERTICAL STRUCTURE IN THE LAKE**

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In lakes, physical, chemical and biological phenomena interact with each other and affect ecological functions such as material cyclings. Proper knowledge on these functions is prerequisite in any action of management of lakes. However, because of the vertical stratification of the water column, distributions of environmental properties including biological constituents such as bacteria, phytoplankton and micro-zooplankton can be quite uneven, showing fine structures. Nevertheless, spatial and temporal resolution in the environmental measurements of lakes has historically been not enough to detect the fine structure. To improve this situation, we have developed a free-fall device to sample water from the water column without disturbing the vertical structure. While free-falling, using a suction mechanism it takes and preserves water keeping the vertical structure in the sampling tube. Sampled water is segmented into waterlets with injected air in the tube. At one sampling, about 500 mL of water can be taken. The spatial resolution is finer than 10 cm. The temporal resolution is determined by the frequency of deployment. To maintain thin-layered shape of the vertically fine structure of the water column, a special mechanism for gentle suction is devised. In fact, the suction flow generated with this apparatus produces smaller turbulence than conventional samplers. By recurrently introducing the samples of water in the tube, we can measure three-dimensional distributions of environmental properties. This three-dimensionally high-resolution measurement gives more proper understandings of the lake environment..

Keywords: sampling technologies, vertical distribution, water column

## IMPACT OF CRESOLS IN THE AMMONIUM RICH WASTEWATER ON ANAMMOX PROCESS

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Eutrophication is a serious problem in lakes all over the world. It causes water bloom, therefore eutrophication protect control are in urgent need. One of the causes of eutrophication is industrial wastewater because it contains high concentration ammonium. Nitrification-denitrification is effective in removal of ammonium from wastewater, while much attention has been paid to the anaerobic ammonium oxidation (anammox) process, which can treat ammonium more efficiency than nitrification-denitrification process. It is reported that anammox bacteria is highly sensitive to chemicals such as phenol, cresols. However, no study has been conducted on the influence of cresols on anammox activity. In this study, the effect of cresols on anammox activity was evaluated in laboratory scale experiment, adding synthetic wastewater containing cresols. No change in Nitrogen Conversion Rate (NCR) was observed until o-cresol concentration reached 20 mg/L, while at 30 mg/L, NCR was decreased. At that time, it was found that the concentration of ammonium and nitrite in treated water increased. It was reveal that NCR decreased at 150 mg/L and 100 mg/L for m- and p-cresol respectively, and it was found that only ammonium concentration increased in treated water. The results showed that denitrification bacteria consumed nitrite with m- and p-cresol as a carbon source. When synthetic wastewater containing 200 mg/L of m- or p-cresol was supplied. It was showed that NCR in both cases decreased, and ammonium and nitrite were detected in treated water. Therefore, cresols in wastewater affected the anammox process.

Key words: Anammox, denitrification, cresols, eutrophication

## Room E, Topic ILBM (Integrated Lake Basin Management)

### INTEGRATED LAKE BASIN MANAGEMENT OF GAIDAHAWA LAKE, RUPANDHI IN WESTERN NEPAL

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Gaidahawa lake is a freshwater perennial water body of 28.5 ha with > 4560 ha basin area in Bishunapura, Rudrapur and Suryapura Village Development Committees (VDCs) of Rupandehi district in Western Nepal. Its core area belongs to Bishunapura VDC where as basin area is shared in 3 VDCs (Bishunapura, Rudrapur and Suryapura) with a human population of 20,951 populations in 3,120 HHS. GL is very close to the Lumbini Cultural Heritage Site, the birth place of the Lord Buddha. Yet, lake area has been subjected to the succession and encroachment by hill migrants. Senior citizens claim that GL used to be >80 ha. Lake basin represents subtropical climate with 3 distinct noticeable seasons such as hot/dry, monsoon and cool/dry. There is no major drainage in core area, but Kanchan river in north east. Lake water is non-arsenic, slightly alkaline and coliform contaminated. All physical & chemical parameters are within reference of the National Drinking Water Quality Standard and comply with prevailing national guidelines for irrigation; aquaculture; livestock watering; and recreation. This lake is biodiversity rich with 134 species of plant (51 families & 112 genus) including 6 species in IUCN Red List; 17 sps of mammals species; 95 sps of birds (41 families & 71 genera); >26 species of herpetofauna; and 18 species of local and 7 species of exotic fishes (Annex 4 to 7). An endemic Indian-eyed Turtle i.e., *Baldhyangre Kachhuwa (Morenia petersi)* was reported the first time in 1995 from Sagrahawa tal within the basin of GL. Political leaders and communities have been reiterating since many years for a huge potential of GL to contribute to the biophysical surrounding of the Lumbini as well to promote this area for lake tourism. Therefore, NLCDC as the only government institution for lake in Nepal responded in 2015 to the interest of local communities to assess and prepare a broader intervention plan of GL in the framework of ILBM approach for tourism, biodiversity and livelihoods. Consequently, 'INTEGRATED LAKE BASIN MASTER PLAN OF GAIDAHAWA LAKE, BISHUNAPURA VDC, RUPANDEHI DISTRICT, NEPAL (2015-2025)' is now in hand. This plan evolved out after national, district and communities level consultations, assessment study and community planning processes. This plan has explored activities in 4 components such as 1) Lake Basin Governance, 2) Lake Basin Environment, 3) Lake Tourism & Livelihoods, and 4) Lake Basin Management Capacity. 1<sup>st</sup> component will deliver semi-governmental institution to execute plan to restore 2<sup>nd</sup> component 'Lake Basin Environment' for 3<sup>rd</sup> component 'Lake Tourism & Livelihoods'. For all these, 4<sup>th</sup> component 'Lake Basin Management Capacity' builds technical, managerial and financial strength of institution and communities to integrate basin environment to tourism, biodiversity and livelihoods.

Keywords: Basin, Governance, Biodiversity, Livelihoods.

### DEVELOPING LOCAL LEADERSHIP FOR FUTURE SUSTAINABLE USE AND MANAGEMENT OF LAKE ATITLÁN, GUATEMALA

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In developing countries deficiencies in governance represent one of the greatest obstacles to the management and sustainable use of lakes and their basins. This paper presents an analysis of the consequences of a lack of governance in the development of environmental policy and law for the Lake Atitlán basin. Different stakeholder views regarding the threats and state of the lake are analyzed, and the resulting policies, laws, and technological proposals for solutions are evaluated. Lake Atitlan is a tropical oligotrophic deep volcanic caldera lake. Lake stakeholders include an indigenous Maya resident majority in the basin and influential non-resident government officials, lakeshore recreational homeowners, and tourism associations. The main consequence from deficient planning and centralized development of environmental law and policy is lack of environmental justice, mainly from avoiding active and effective participation of the indigenous basin resident majority and their leadership. A revision of environmental law and policy for the basin is of utmost importance, but as a midterm and long term strategy, it is recommended to increase literacy and leadership skills in the local indigenous population for more effective participation in decision making processes and actions which will sustain the environmental quality in the lake Atitlán basin.

Keywords: lake, governance, policy, Maya, leadership

## **STAKEHOLDER PARTICIPATORY ROLE IN MALAYSIAN ILBM INITIATIVES – RESEARCH PERSPECTIVE**

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This paper explores the status and challenges in adopting the lake basin heartware concept in Malaysian integrated lake basin management initiatives. Realizing the importance of interacting with stakeholders to buy-in their supports, stakeholder consultative approach has been used to develop a national research agenda and a management tool for lake. This work is based on review of the development process of three national studies over the period of 2.5 years to strengthen the research pillars to support the national ILBM initiatives following to the implementation of the strategic plan for sustainable management of lakes in the country. The study confirmed the positive involvement of various stakeholders in developing together the research agenda and national water quality criteria for lakes. A case study on the challenges in strengthening the ILBM process of Chini Lake is also discussed.

Keywords: Heartware, Malaysia, Sustainable management

## **PROMOTING INTEGRATED LAKE BASIN MANAGEMENT IN LAKE NAKURU WATERSHED, KENYA**

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Lake Nakuru is one of several shallow, alkaline-saline lakes lying in closed hydrologic basins in the eastern African Rift Valley. The lake is located between longitude 36°05' E and Latitude 0°24' S. In the past five years, we have promoted an Integrated Lake Basin Management (ILBM) approach to address major Lake Basin Governance in the lake basin issues that include; land use/ land cover changes, Climate Change (water shortage, flooding, landslides), environmental degradation, loss of biodiversity, loss of tourism revenue, deforestation & degradation of forested areas, urbanization, poor crop yields and damaged infrastructure (e.g. roads, bridges), poverty and environmental pollution. The ILBM concept relates to the Millennium Ecosystem Service Framework as applied to the river-lake-estuary basins. The "ILBM Platform Process", a cyclic process of gradual, incremental, and long-term improvement of basin governance, makes use of the Ecosystem Service framework as a major conceptual basis. The improvement of basin governance should not only focus on artificially augmenting for greater human uses the intrinsically endowed provisional services components to the basin, e.g water, land and forest resources, fauna and flora of human-use value, but also focus on preventing the undue diminishment of regulating service capacities such as biodiversity conservation, sound food chain, moderation of the microclimate, mitigating functions of floods and droughts. Major accomplishments of the ILBM working group include promoting ILEC supported such as concepts such as ILBM-Heartware and ILBM- Ecosystem Service Shared Value Assessment (ESSVA) which have also evolved through activities held at the national, regional and global levels.

## **INTEGRATED LAKE BASIN MANAGEMENT - SAROWAR SAMWARDHINI OF LONAR CRATER LAKE, INDIA**

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Lonar crater is formed by a meteorite impact before some 50000 years ago. It is situated in the Buldhana district of Maharashtra state of India and located between latitude 19°58'N and 76°31'. Being as a saline crater; its aquatic ecosystem is unique. Anthropogenic activities caused a serious threat, hence for conservation point of view, this study carried out from more than a decade. Qualitative assessment of water shows that lake is under eutrophication. The domestic sewage from Lonar town is introduced into the lake. In the periphery of lake basin, improper agricultural practices were also a major nuisance ongoing from last many years. Cutting of trees, cattle feeding, tourist for site seeing and pilgrims, etc are some harmful activities carried out which need to stop immediately. *Sarowar Samwardhini* is working on the principles led down by the six pillars of ILBM concept. Scientists have demanded to declare this lake under Ramsar site, thereby giving the lake an international perspective towards its conservation strategies. Continuous scientific studies showed that this geological monument needs to be provided with special attention for its proper conservation planning.

Keywords: Crater Lake, Eutrophication, ILBM, Ramsar site, Sarowar Samwardhini.

## **LIMNOLOGY OF LAKE LANAOS, MINDANAO ISLAND, PHILIPPINES: INPUTS FOR AN INTEGRATED LAKE BASIN MANAGEMENT**

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Due consideration of a lake's limnology or its lentic properties in integrated lake basin management (ILBM) would result to good lake basin management for sustainable resource use. Thus, this paper reviews and summarizes limnological data obtained in Lake Lanao from studies done by Frey and by Lewis in the late 1960's and early 1970's, respectively, to the currently ongoing characterization of physical and chemical factors in Lake Lanao. These data will serve as inputs to an ILBM of Lake Lanao. Good basin management of Lake Lanao in order for it to be utilized sustainably would require an evolving and improving lake governance that is founded on and integrates the six pillars of ILBM: institutions, policies, participation, technologies, knowledge and information, and financing.

Keywords: limnology, Lake Lanao, integrated lake basin management

### **ILLBM PROGRAM OF THE COAHUAYANA BASIN, MEXICO**

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The Integrated Lentic-Lotic Basin Management (ILLBM) of the Coahuayana Basin (Mexico) was developed as a tool to guide the organization of human activities, in order to maintain and restore ecosystem services (Provisioning, Regulating, Supporting and Cultural types) within its 4,958 km<sup>2</sup> of territory. These services create conditions to maintain both healthy aquatic ecosystems (Lake Zapotlan and a set of rivers) and quality of life for 400 thousand watershed dwellers. The ILLBM-Coahuayana was built from a set of analysis of environmental, economic, social and spatial aspects; it was conceptualized as a model to facilitate intergovernmental and intersectoral linkages, having as center the basin functioning. It's the first instrument for basin management in Mexico developed completely under ILLBM principles, fostering basin governance as a core component of the process. It was held from 2015-2016, including fieldwork, data collection, stakeholder involvement through participative workshops and feedback with the Intermunicipal Council of the Coahuayana River-Lake Zapotlan Basin, a technical institution which provides counseling to 12 municipalities within the watershed. The final document includes a comprehensive description of physical-biological and social aspects (with special attention to lentic-lotic ecosystems), an analysis of problems, causes and effects; a report of focal groups, a map of stakeholders, a Conflict-collaboration Matrix, a diagnosis of environmental governance, a 27-layers GIS system, and an analysis of legal framework. Finally, using the afore mentioned products there was structured a Conservation and sustainable management strategy, which includes a whole section directed to Governance improvement, with a indicators monitoring system.

Keywords: ILLBM, Multistakeholder platform, lentic-lotic waterbodies.

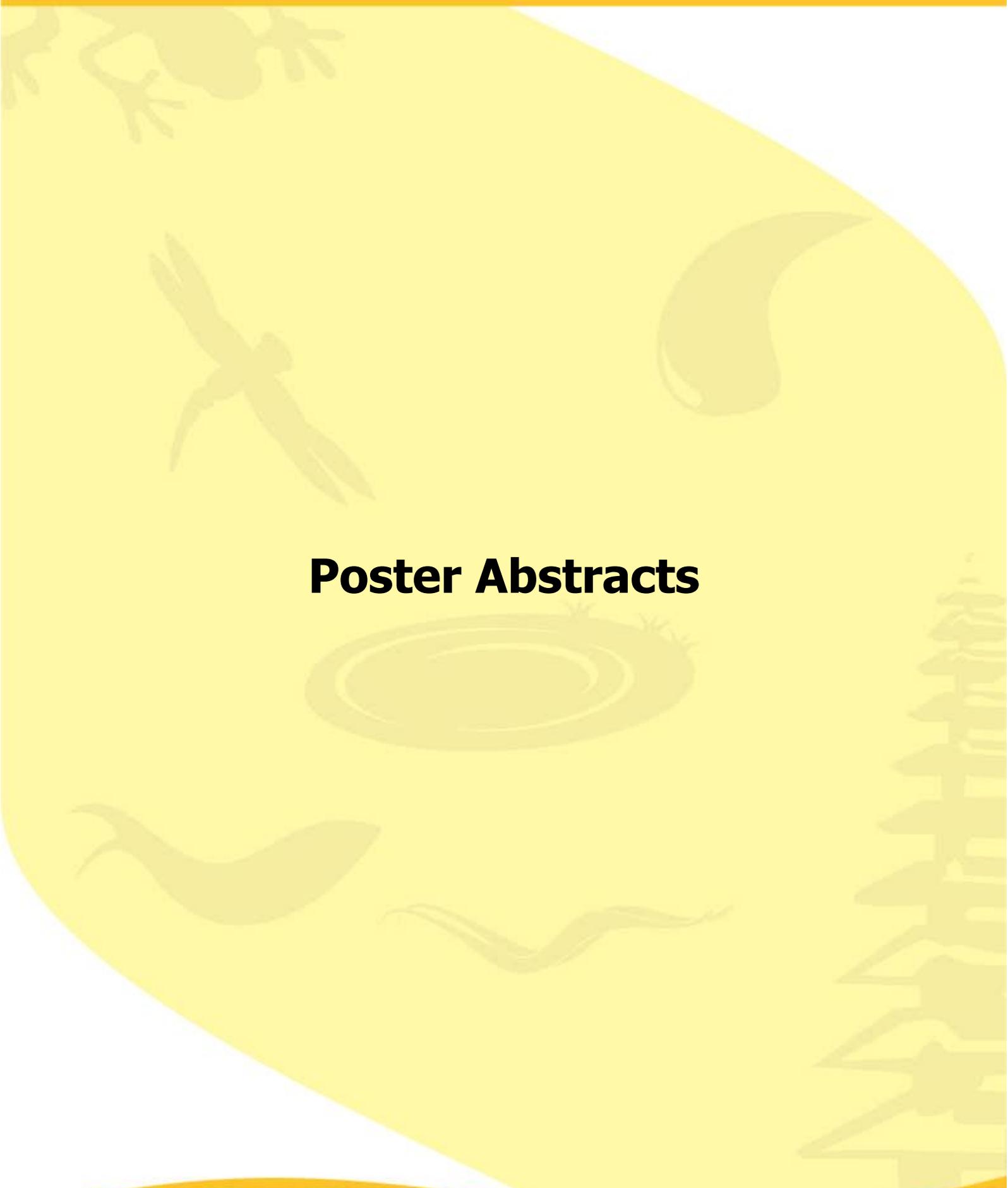
### **INTEGRATED MANAGEMENT APPROACH OF SELANGOR DAM AND EX-MINING POND TO MITIGATE EL-NINO EFFECT ON WATER RESOURCES IN SELANGOR, MALAYSIA.**

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Sungai Selangor Dam is among of seven dams in Selangor State together with ex-mining ponds located along Selangor River which are gazetted as Protected Zone under Section 48, Selangor Water Management Authority (SWMA) Enactment 1999. Management of the dam is inclusive of impounding water body and water catchment area to ensure the water resource security. Both dams and ex-mining ponds are functioning as water supply to the nearest Water Treatment Plant. Sungai Selangor Dam have been established in the basin to regulate the river flow and ensure sufficient amount of water is available to all even during dry seasons. LUAS will monitor the water quality as well as water level and report regularly to the State of Selangor. Water resource from the ex-mining ponds are utilized by pumping from the ponds to the Selangor River. The total capacity that can be abstracted from the ponds is 1,000 million litres per day (MLD). The utilization of the ponds have been proven to reduce the dependency on the release of water from Selangor River Dam thus can increase the storage life of the dam. Weekly monitoring of the water quality from the ponds is also implemented to ensure that the raw water quality meets the Malaysian National Raw Water Quality Standard. Another initiative undertaken by the Selangor Waters Management Authority (SWMA) is the cloud seeding operation over the catchment areas of the 7 dams in the state of Selangor inclusive of Selangor River Dam. The cloud seeding operation is conducted daily depending on the meteorological conditions to increase the possibility and intensity of rainfall thus increasing the storage of the dams.



# Poster Abstracts

# Poster Abstracts

## Topic 1 Climate Change and Water Crisis

### IMPACT OF CLIMATE CHANGE ON DISSOLVED ORGANIC CARBON AND DISSOLVED INORGANIC CARBON COMPOSITION IN AN OLIGOTROPHIC LAKE

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Climate changes and global warming has been an important issue in the world because their impact to the environment. Carbon dioxide is one of green house gasses, that also present in carbon cycles. In aquatic environment, Dissolved Organic Carbon (DOC), Dissolved Inorganic Carbon (DIC) and Particulate Organic Carbon (POC) are important component in carbon cycle. Each environment has a uniqueness to adapt and retain the climate change as well as Lake Matano, Southern Sulawesi. Lake Matano is an oligotrophic lake and many endemic biota live in this lake. The objective of study is to reveal the impact of climate change to water quality of Lake Matano, especially DOC and DIC parameters. DOC and DIC concentration were determined using TOC analyzer, Shimadzu TOC-L. According to TRMM data in Sulawesi region, the air temperature has been increasing about 1 °C during 1948 to 2016, it means air temperature increase about 0.15- 0.2 °C per decade. This phenomenon perhaps increases the water temperature in lake. The results showed that DOC concentration in Lake Matano was in the range 0.4308-3.8890 mg/L, and DIC was 19.33-28.58 mg/L. Some researchers reported that climate changes will decrease DOC concentration in aquatic environment because releasing carbon dioxide to the atmosphere. However, in Lake Matano DIC concentration is higher than DOC concentration. Lake Matano has alkaline pH, it is about 8.4- 8.9. Therefore solubility of carbondioxide is higher, and carbondioxide will present in bicarbonate dan carbonate form. It indicated that the releasing carbondioxide to the atmosphere is low.

Keywords: Dissolved organic carbon, dissolved inorganic carbon, oligotrophic, climate change.

## Topic 2 Lake Environment Under Stress and Their Restoration Challenges

### LEAD (Pb) DETECTION IN KNIFE FISH (*Chitala ornata* GRAY, 1831) FROM LAGUNA LAKE PHILIPPINES

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*Chitala ornata* or Knife fish was accidentally introduced in Laguna Lake last 2009 after the typhoon Ondoy hit the Philippines. Knife fish became an invasive species that threatened the biodiversity and aquaculture in the lake. As control for Knife fish proliferation, Bureau of Fisheries and Aquatic Resources Postharvest Division is now using knife fish as a raw material in making nuggests, burger patties, kikiam and siomai. However, there is a threat of heavy metal bioaccumulation upon eating these products made from Knife fish since the lake serves as catch basin of heavy metal from various tributaries. This study seeks to determine the lead concentration in various organs of Knife fish namely; liver, intestine and muscle. Fish and water samples were collected in 3 different stations in the lake within the jurisdiction of the Municipality of Binangonan, Cardona and Morong. Samples were collected during the dry season (September and October 2015) and wet season (November and December 2015). Highest mean concentration of lead was recorded in liver ( $0.20 \pm 0.05 \text{ mg/L}$ ), followed by intestine ( $0.18 \pm 0.06 \text{ mg/L}$ ) and muscle ( $0.17 \pm 0.06 \text{ mg/L}$ ). Highest mean concentration of lead in water samples was noted in Binangonan in all sampling months ( $1.454 \pm 0.487 \text{ ppm}$ ). Lead concentration in the organs of *Chitala ornata* significantly varied between dry season and wet season, wet season having higher lead concentration for the 3 organ. This is due to the prolonged dry season in the area as forecasted by Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). The lead concentrations recorded from the organs of *Chitala ornata* were considered as toxic to human since there is no known safe concentration of lead in the human system.

## THE ANALYSIS OF TYPICAL NON-POINT SOURCE POLLUTION LOADS IN LAKE ERHAI BASIN

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Inflow rivers is the main factor for xenobiotic pollutants into Lake Erhai. There are totally 117 rivers in Lake Erhai basin and the pollutants into the rivers are mainly from residents life, agricultural cultivation and livestock breeding. Having been highly contaminated, Luoshi River, one of the three most significant rivers flowing into the northern Lake Erhai, is the key point of pollution control and treatment in Lake Erhai. The thesis taking Luoshi River as the main research object has analyzed the status of water contamination along the river and studied the changing characteristics of pollution loads in different sections of Luoshi River basin. The result showed that the lower reaches of the Lake Xihu is the most polluted section in Luoshi River basin and the pollution loads accounts for 46.86% of the total. Besides, the river inlet section, Xiaojiangqiao section and lower reaches of the Dengchuan section are all highly polluted, whose pollution loads account for 23.37%, 12.66% and 10.86% respectively. The contribution rate of different pollution types to pollution loads in Luoshi River basin are as follows: livestock breeding 83.3%, agricultural cultivation 13.5%, residents life 3.1%. The contribution rate of main villages to pollution loads in Luoshi River basin, listed from high to low, are as follows: Zhaoyishaping Village, Zhongsuo Village, Xinzhou Village, Zhonghe Village, Tuanjie Village, Xingfu Village and Xihu Village.

Keywords: Lake Erhai Basin, Luoshi River, Equal Standard Pollution Loading Method, Pollution Contribution Rate

## WATER QUALITY AND CADMIUM CONTAMINATION IN MAE TAO STREAM, MAE SOT DISTRICT, TAK PROVINCE, THAILAND

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Cadmium is a non-essential element that found from natural soils concomitantly with zinc or zinc mining activities. Many researches revealed the contamination of cadmium from zinc mining activities in Mae Sot District, Tak Province, Thailand. The aims of this study were to evaluate physical-chemical parameters of Mae Tao Stream and level of cadmium concentration in water and sediment from Mae Tao Stream and from contaminated fish farm. Samples were collected from upstream of zinc mine (reference site) and the other sites were downstream of zinc mine and in fish farm, which receive water from Mae Tao Stream. Samples were collected in August, October and December 2015. Physical-chemical parameters including water temperature, pH, conductivity, DO, BOD5 and nutrients (Nitrate-nitrogen, Ammonia-nitrogen and Orthophosphate) were measured. The result showed that Mae Tao Stream was classified to Type III of the Surface Water Quality Standard of Thailand whereas; the water quality of fish farm was classified to Type IV. Cadmium concentration in water samples was ranged of 0.00-0.016 mg/L. The water quality of reference site and other contaminated sites was no significantly difference ( $p > 0.05$ ). Cadmium concentration in sediment was ranged of 1.12-93.00 mg/kg, where reference site and other contaminated sites was significantly difference ( $p < 0.05$ ). The expected usefulness of the study is to monitor the contamination of cadmium in Mae Sot area.

Keywords: cadmium contamination, water quality, Mae Tao stream, Mae Sot District

## CADMIUM CONTAMINATION IN ENVIRONMENT ALONG MAE TAO CREEK, MAE SOT DISTRICT, TAK (THAILAND)

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The study of cadmium contamination in water sediment and some edible riparian plants were conducted along Mae Tao creek, Mae Sot district, Tak province. This creek is subjected to cadmium contamination due to zinc mining activity in the area. Four sampling sites were selected for water quality monitoring and cadmium contamination determination; site 1 before mining area and site 2-4 after mining area. Three plant species were selected for this study including *Lasia spinosa* (L.) Thw. *Diplazium esculentum* (Retz) Sw. and *Colocasia esculenta* (L.) Schott var. *aquatilis*. Water, sediment and plant samples were collected in August and December 2015 which represent wet and dry seasons, respectively. The water quality from all sampling sites were not exceed value of the surface water standard of Thailand. The lowest cadmium concentration in water and sediment were found in site 1. Cadmium concentration in sediment of site 2-4 were higher than standard (at  $29.970 \pm 12.766$  mg/kg) with the highest value recorded in site 2, which located near mining site. However, plant samples from all study sites contained cadmium higher than the level that allowed for vegetable. The highest cadmium contamination was found in *L. spinosa*, followed by *D. esculentum* and *C. esculenta*, respectively. In *L. spinosa* accumulation in shoots was higher than in roots. Where as in *D. esculentum* and *C. esculenta* the accumulation were mostly in roots. Therefore consuming of these three plant species are not recommended.

Keywords: cadmium contamination, water, sediment, riparian plants, Mae Tao creek

## BIOMONITORING CADMIUM (Cd) USING *Oreochromis niloticus* AS BIOINDICATOR SPECIES IN BUYAN - TAMBLINGAN LAKE BALI

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Buyan and Tamblingan Lake in north Bali has become severely degraded over recent years by deforestation for agroindustry and over using of organic pesticide or fertilizer which contained heavy metals. This research aimed to study the bioaccumulation of cadmium (Cd) in Nile Tilapia (*Oreochromis niloticus*) as bioindicator species. Nile Tilapia weighted 200 g and 20 cm body-long was introduced and exposed in each lake during 30 days. Bioaccumulation of cadmium (Cd) was analyzed in muscle and liver using Atomic Absorbance Spectrophotometer (AAS) in 0, 15 and 30 days. The result showed that the cadmium (Cd) bioaccumulation range from 0  $\mu\text{mol g}^{-1}$  to  $2,79 \times 10^{-3} \mu\text{mol g}^{-1}$  in muscle and  $0,07 \times 10^{-3} \mu\text{mol g}^{-1}$  to  $2,89 \times 10^{-3} \mu\text{mol g}^{-1}$  in liver and the concentration in water colom are  $0,8 \times 10^{-3}$  both lake. The fluctuation of each station are influence by cadmium (Cd) mechanism in the process of metals excretion and the range of pollutant resources. This result proved that cadmium (Cd) trace from the anthropogenic activity and natural surface runoff from the riparian lakeside primary forest of Batukahu.

Keywords: Cadmium (Cd); *Oreochromis niloticus*; Buyan; Tamblingan; Batukahu.

## IMPACT OF AGRICULTURAL ACTIVITIES ON EUTROPHICATION LEVEL AND PHYTOPLANKTON DIVERSITY AT LAKE BUYAN, BALI

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This research aimed to find out diversity of phytoplankton and water quality of Lake Buyan, Bali. Research was conducted at Lake Buyan, Buleleng Regency, in February – June 2014. Organic compound were analyzed at UPT Balai Laboratorium Kesehatan Provinsi Bali. Analyses of phytoplankton community structure was done at UPT Laboratorium Sumberdaya Genetika dan Biologi Molekuler Universitas Udayana Denpasar. Purposive sampling method was employed to take samples from 4 stations around Lake Buyan that represent agricultural activities. Water sample from Lake Buyan was taken to find out diversity of phytoplankton. Physical and chemicals measurements includes TDS, TSS, pH, DO, BOD, COD, NO<sub>3</sub>, NH<sub>3</sub>, NH<sub>4</sub> and PO<sub>4</sub>. Thirty species of phytoplankton from 6 Phylum were found, i.e. *Bacillariophyta* 81,7%, *Chlorophyta* 13,3%, *Cyanophyta* 3,1%, *Chrysophyta* 1,7%, *Dinophyta* 0,1%, dan *Pyrrophytophyta* 0,1%. Varied phytoplankton species were found on each station. There are 18 species were found at station I, 10 species at station II, 15 species at station III and 20 species at station IV. Phytoplankton abundance ranging between 53 individual/liter - 90 individual/liter. The highest abundance was at station III: 90 individual/liter. Dominance species at all station was *Synedra ulna*. Highest phytoplankton diversity index was at station IV (1.5) (mildly polluted) and lowest at station III: 0.8 (heavily polluted). Highest similarity was at station IV: 0.5 (mid similarity index) and lowest at station III : 0.3 (low similarity index). Highest dominance was at station III: 0.7 (high partial dominance) and lowest at station IV: 0.5 (mid partial dominance).

Keywords: Bali Lake, plankton, pollution

## MONITORING AND EVALUATION OF THE WATER QUALITY OF TAAL LAKE, TALISAY, BATANGAS, PHILIPPINES

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This paper presents an update on the physico-chemical properties of the Taal Lake for local government officials and representatives of non-government organizations by monitoring and evaluating a total of nine (9) water quality parameters. The study further shows that the Taal Lake's surface temperature, pH, total dissolved solids, total suspended solids, color, and dissolved oxygen content conform to the standards set by the Department of Environment and Natural resources (DENR); while phosphate, chlorine, and 5-Day 20°C BOD are below the standard. Likewise, the T-test result shows no significant difference in the overall average of the two sites at the Taal Lake ( $P > 0.05$ ). Based on the data, the Lake is safe for primary contact recreation such as bathing, swimming and skin diving, and can be used for aqua culture purposes.

Keywords: Cool dry season, hot dry season, rainy season, Taal Lake, water quality

## FERTILITY WATERS BASED ON THE ABUNDANCE OF PHYTOPLANKTON IN BATUR LAKE, KINTAMANI, BALI

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Batur Lake is the largest lake in Bali, located in Kintamani, Bangli. Batur Lake is located at 1050 meters above sea level (asl) which is geographically located in a position of 115022'42,3 " -115025'33,0" East Latitude and 8013'24,0" -8017'13,3" South Latitude. The water surface area of Batur Lake is of 16.05 km<sup>2</sup> with a volume of 815.38 million meters<sup>3</sup> and an average depth of 50.8 meters. The catching area is covering 105.35 km<sup>2</sup>, and other activities around Batur Lake are agricultural (49.35%), cultivation of floating net cage, settlements (2.22%), tourism activities, and dock. Those activities may increase nutrient input into waters that affect the fertility of waters. The aims of this research was to determine the abundance of phytoplankton that can be used as an indicator of fertility of waters in Batur Lake. The results of plankton community was supported by the diversity of phytoplankton as many as 16 species of 4 phylum. The abundance value of phytoplankton ranged between 2686-2983 individuals/liter respectively which belongs to the mesotrophic waters (moderate waters fertility). The range of water quality parameters of temperature was 24,90C-25,60C ; pH 9.02-9.06 ; DO 4.4 mg/l-5.0 mg/l ; brightness 119.1 cm-138.4 cm ; nitrate 0.452 mg/l-0.598 mg/l ; and phosphate 0.332 mg/l-0.488 mg/l.

Keywords: Abundance, Phytoplankton, Water Fertility

## THE CHANGING ECOLOGY OF DAL LAKE, KASHMIR

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The present paper represents an attempt to compare the ecological changes that have taken place in Dal lake (a multi-basined lake of Kashmir located at 34°07'N, 74°52'E, 1584m above MSL) over a period from 1977-2012. The physico-chemical parameters have undergone a considerable increase over a period of three decades. One way ANOVA reflected a significant increase ( $p=0.05$ ) in the concentration of nutrients particularly, ammonical-nitrogen, nitrate-nitrogen and total phosphorus. The aquatic plant and benthic diversity has undergone a serious decline with the ever increasing trophic status of the lake. *Azolla cristata*, a free floating invasive plant, which prefers highly eutrophic and stagnant waters, has been dominating the lake for the past one decade. The benthic community is dominated by high pollution tolerant species including, *tubifex tubifex*, *Limnodrilus hoffmeisteri*, *Branchiura sowerbyi*. The comparison of the ecological data and an evaluation of the conservation/restoration plans for the lake reflects a failure in the basic ecological understanding required to conserve this fragile ecosystem.

Keywords: nutrients, aquatic plant, benthic, invasive, pollution

## DOMINANCE OF CYANOBACTERIA FROM TROPICAL MAN-MADE LAKES IN MALAYSIA

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Cyanobacteria blooms often occur in eutrophic ecosystem. They have potential to produce toxins and taste-odor compounds which may cause to public health concerns. The relationship between eutrophication and extension of cyanobacteria abundance in two different trophics man-made lakes in Malaysia was carried out. In this study, temporal population of cyanobacteria dominance was analyzed from deep stratifying man-made lake in Malaysia. Main objective of this study is to identify the physical and chemical conditions of environment in promoting and sustaining cyanobacteria dominance. Water samples for phytoplankton enumeration and nutrient analysis were collected monthly from November 2013 to October 2014 at Puchong Lake (2°57'13.9" N, 101°36'37.3" E) and Mines North Lake (3°02'03.7" N, 101°42'44.8" E) using 5 ml Niskin water sampler. Water parameter, such as temperature, pH, dissolved oxygen, conductivity, total dissolved solid and turbidity had been taken from numerous depths using in-situ multi-parameter Troll 9500 water quality instrument. Phytoplankton samples was preserved using Lugol's iodine for enumeration while nutrient samples was kept in ~ -2 °C ice chest until reach to laboratory for immediate analysis. Our results showed the lower phytoplankton diversity index value was recorded where cyanobacteria blooms are frequent. Cyanobacteria dominated by *Planktothrix agardii* and *Merismopedia glauca* revealed the highest quantity in Puchong Lake, comprise 84.31-99.85% where the highest nutrients loading recorded. In general, though there is clear evidence for direct stimulation of cyanobacterial bloom by nutrient over-enrichment, the relationships between nutrient excess and potential toxicity species of phytoplankton blooms remain poorly understood.

Keywords: Cyanobacteria bloom, *Planktothrix agardii*, eutrophication, nutrients, diversity index.

## CHANGES IN THE CHEMICAL ECOLOGY OF BLUE-GREEN ALGAE DURING PERIODS OF ACTIVE GROWTH

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It is well-known that tremendous growth of blue-green algae during summer is one of the causes for freshwater pollution all over the world. Although the importance of photosynthesis, nutrient, and water temperature on the growth mechanism of blue-green algae is well recognized, chemical ecology of blue-green algae has not been elucidated yet. To understand this, we elucidated the effect of chemical ecology of blue-green algae in various water depth on the growth mechanism by quantifying 110 chemicals relating requisite biological activity. In August, the best energetically season for the blue-green algae growing, we collected the stagnating water from a man-made lake including blue-green algae. The water samples from the surface layer and layer of 0.4 to 0.5 m depth were collected at daytime and nighttime. The samples blue-green algae were analyzed with an Agilent CE-TOFMS (capillary electrophoresis-time of flight mass spectrometry) system (Agilent Technologies) and the detected chemicals with a molecular weight of less than 1000 were grouped into relating compounds. Based on our results, the effect of living depth in freshwater was more important than that of sunlight exposure as to chemical ecology of blue-green algae. Indeed, higher concentration of nucleic acid-relating compounds and dipeptides were detected at the surface water layer, while higher concentration of free amino acids were found in mid-depth water layer. This correlation between the depth and composition of metabolites must be a significant fact to reveal unknown biological event of blue-green algae during periods of active growth.

Keywords: Blue-green algae, chemical ecology, water depth, metabolome, 110 chemicals required, photosynthesis

### **Topic 3 Lake and Lake Basin Management and Policies**

#### **CAGE CULTURE AND LAKE MANAGEMENT PRACTICES IN LAKE DANA0, SAN FRANCISCO, CENTRAL PHILIPPINES**

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Lake Danao is a first runner up of the cleanest and greenish lake throughout the Philippines. This becomes also the tourist destinations and its aquaculture activities have been controlled by the government so as to maintain its status as a tourist destination. Cage culture was undertaken by the Bureau of Fisheries and Aquatic Resources (BFAR), Department of Agriculture (DA) and the Cebu Technological University (CTU). Freshwater fishes like tilapia, carps, mudfish and catfish were stocked in the cages fed with both commercial feeds and local feeds. The BFAR engaged in grow out and breeding of tilapia and other freshwater fishes and distributed throughout Central Visayas as seedlings and breeders for grow out and propagation purposes. The Department of Agriculture reared tilapia until marketable sizes and are sold to tourists where it is placed in the cages for dispersal in Lake Danao Park and the tourists will catch them through hook and line and weighed and priced then they are cooked according to the choice of the tourists. The CTU undergo research activities of tilapia cultivation and processing using different types of feeds and processing techniques on the value added products of tilapia and other freshwater fishes. The BFAR stocked 150,000 tilapia fingerlings into the Lake every quarter to replenish the tilapia caught by fishermen in the lake. Fishing in the lake was regulated by imposing ordinances on regulated mesh size of the gill net and banning fine meshed net fishing. Proper waste disposal, banning the washing of clothes, tree planting, using paddle boats in fishing and no private aquaculture activities in the lake except the three government agencies were imposed in the lake to sustain the lake as a tourist destination and as part of the management of Lake Danao.

Keywords: Cage culture, Lake Danao, Central Philippines

#### **SUCCESSFUL PUBLIC- PRIVATE MODEL FOR ECOLOGICAL RESTORATION OF KHAM RIVER, AURANGABAD, MAHARASHTRA, INDIA**

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ILBM principles to successfully convert an aerobically dead river into a living lotic system. The flow of the river (about 190 MLD) mainly consists of domestic wastewaters. This was initiated in October 2015 and then the ecotechnological Green Bridge™ system was developed after getting four of the pillars – Policy, Institutions, Finance and Public Participation to support knowledge and technology pillars to revitalize the Kham River by in-situtreating the wastewaters flowing through the River. Confederation of Indian Industries along with the Aurangabad Cantonment Board took the responsibility of local co-ordination. Finances were provided by Varroc Engineering Pvt. Ltd. Knowledge and technology was volunteered for by Shrishti Eco-Research Institute (SERI), Pune, which is known for its pioneering work in ecotechnological pollution treatment spanning almost two decades. SERI was requested by the CII to guide the project. Green Water Revolution Pvt. Ltd. has worked on the engineering designs and on field execution of the project. Green Bridge is horizontal eco-filtration system having different physical and biological filters working inn combination removes suspended and dissolved impurities of water. This ecological restoration work has strengthened the faith that appropriate network and timely actions with thorough knowledge of ecology can result in successful revitalization of lentic and lotic systems.

Key words: River eco-restoration, Green Bridge™, network, biodiversity

## **THE POLITICS OF LAKE-SYSTEM CONSERVATION: THE CASE OF MISSION KAKATIYA IN TELANGANA, INDIA**

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In 2015 Telangana State Government launched Mission Kakatiya. The stated goal of Mission Kakatiya is to bring back the prosperity of the Kakatiya dynasty (12th to early 14th century) by restoring lakes across the region through technological interventions. The administration hopes to achieve this goal by beautifying the lakes, preventing encroachments and increasing the ground water. Mission Kakatiya is being internationally lauded for its design. In this paper I discuss Mission Kakatiya based on an analysis of ethnographic field data gathered on the traditional communities that have customary claims over lake-resources at select lakes over three years. Additionally, my analysis will be based on archival research, documentation of lake-centric Bathukamma festival, and a content analysis of statements made by the state government, administrative officials and other key resource persons on conservation of lakes. Under Mission Kakatiya, the aesthetic value of the water body will be enhanced and may even bring in revenues through tourism. These notwithstanding, I argue, Kakatiya Mission may not enhance needs of drinking water, nor augment livelihoods for communities. To sustainably 'restore' urban lakes, the 'ecosystem' of a lake, which includes communities exercising customary claims over the waterbody is to be considered. My paper will recommend ways in which Mission Kakatiya can be modified for this purpose.

Keywords: State, Beautification, Customary Claims, Conservation, Commons

## **MANAGEMENT OF WATER RESOURCES IN NORTH SUMATERA (CASE STUDY : LAKE TOBA AND ASAHAN RIVER )**

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Inland water ecosystems in North Sumatra has specific characteristics, especially with the presence of Lake Toba with Asahan river as the flow out of Lake Toba water. This lake is a water resource that has a very important value in terms of the function of ecological, hydrological and economic functions. The utilization of the water of Lake Toba is very diverse as a source of clean water for the surrounding communities, as a fishing and fish farming in floating net cages, activities of water transport, tourism, as a source of water for hydropower in the downstream area, on the one hand requires lake water quality well and fulfill certain requirements. Instead of Lake Toba is also used as a place to dispose of various types of waste generated from agricultural activities in the surrounding area of Lake Toba, domestic waste from residential and hospitality, waste nutrients from the rest of the fish feed that is not consumed by the fish cultivated, waste from tourism and water transportation , If the pollution continues without any attempts to minimize the pollution that occurs then the ecosystem of Lake Toba burden will be heavier and will ultimately harm all parties concerned. It is necessary for the conservation of a well planned so that the quality of the environment and preservation of the ecosystem of Lake Toba can be maintained.

Keywords: Lake Toba , the Asahan River , Biodiversity Management

## **ECOSYSTEM SERVICE AWARENESS – CONCEPTUAL FRAMEWORK TOWARD DISASTER RISK REDUCTION AND RESILIENCE**

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The study reported here aims to propose a conceptual framework to employ awareness-raising of the ecosystem and its services and functions toward disaster risk reduction as well as resilient society. The role of ecosystem in disaster risk reduction have been globally recognized as a means not only to attain ecosystem-based disaster risk reduction (Eco-DRR) but also to contribute to sustainable development. The framework proposed in this study seeks to encourage tangible actions at local level in line with Eco-DRR and international agreements such as the Hyogo Framework for Action, the Sendai Framework for Disaster Risk Reduction, and Goal 15 of the Sustainable Development Goals. This study used literature reviews on a few Eco-DRR cases mainly in Japan and developed matrices for workshops based on theories of education sociology and communication studies, then conducted a pilot workshop to high school students in Shiga, Japan. The results of the workshop made it clear that the students perceive certain functions of the regulating service, especially functions related to disaster risk mitigation, as high priority yet less close, as the scale of such functions are too large to visualize. Through peer discussion, the students became aware of the ecosystem as a product of an accumulation of natural history and life, including historical disasters and their influences. This paper concludes that integrating knowledge on local nature resources and disaster experiences can be key in promoting an ecosystem adaptation approach for disaster risk reduction so as to achieve resilience and sustainability.

Keywords: Ecosystem services, awareness-raising, disaster risk reduction (DRR), resilience

## **Identification of Lake Sentarum's Potential Ecosystem Services, Social and Institutional Profiles to Support Ecotourism Development ( A Review Paper)**

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A memorandum of understanding of ecotourism development in Kapuas Hulu District has been signed by several institutions. Among some covered ecosystems, Lake Sentarum as a very unique ecosystem is the prime destination included in the tourism plan. This paper is aimed to review and identify the lake's potential ecosystem services (i.e. biodiversity, water supply, and tourism) as well as social and institutional profiles of the surrounding areas which are the main elements of the tourism plan. Moreover, a useful information that can be easily read by the decision maker about the strengths, weaknesses, opportunities, and threats is also presented in the paper. The informations were obtained by reviewing all possibly accessed papers and then they were analyzed by using a strength, weakness, opportunity and threat (SWOT) analysis. The results of the analysis show that the biodiversity and unique ecohydrological process are the main strength of the area. At the same time the discrepancy of hydrological pattern in wet and dry system also becomes the main weakness as it increases the difficulties of water transportation establishment. The main identified opportunity is governmental and private institution supports. Whilst the identified main treats are both deforestation and land use changing. Eventually, it is concluded that eventhough Lake Sentarum is significantly potential for ecotourism development, structural and institutional improvement is imperative to be conducted to support the tourism plan.

Keywords: Lake Sentarum, Ecotourism, ecosystem services

## **CONFIGURATION OF LAKE TOBA MANAGEMENT BASED ON PRESIDENTIAL DECREE NO. 81/2014**

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Utilization of lake area continues on expanding and, especially in multipurpose lake, has led to the vexing problems multi-dimensionally either in ecological, economical, and sociological aspect. Lake Toba, known as the largest lake in Indonesia and located in seven districts in North Sumatra Province, has a variety of functions with an intensive utilization rate. Management of the multifunctional lake requires profound attention towards the existing interests. The Indonesian Government through the Government Regulation number 26/ 2008, on the National Spatial Planning, has set a list of areas projected as National Strategy Region (NSR), and among them is Lake Toba area. The decision on incorporating Lake Toba as NSA is based on lake's location which is shared within seven regencies, various sectors' exploitation, as well as the presence of utilization associated with the national interest. Lake Toba management is a comprehensive activity that relates to how to support the sustainability of the ecosystem and benefit values for the locals in the surrounding area. Presidential Decree No. 81/ 2014 has authorized the management of Lake Toba area, which aims to : i) manage the catchment area pertaining to the maintenance of the water resources sustainability, and minimize the erosion to prevent sedimentation; ii) maintain the water quality and protect against the land and water contamination; iii) sustain the biological resources and the stocks through the biodiversity and endemic biota protection, as well as maintain the stability of biological production that bestows myriad benefit for locals. To conclude, Presidential Decree number 81/2014 synergistically binds together scientific and local wisdom aspects.

Keywords: Lake Toba, National Strategy Region, Presidential Decree 81/2014

## **LAGUNA LAKE AS DRINKING WATER SOURCE: AN ASSESSMENT OF ITS WATER QUALITY**

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As part of the agreement, Maynilad, the largest private water concessionaire in the Philippines in terms of customer base, must provide an uninterrupted and enough potable water to the West Zone of Metro Manila. They took initiative by exploring various alternatives such as Laguna Lake which became their new water source through Putatan Water Treatment Plant (PWTP) since 2009. However, it possesses more water quality challenges than Angat Dam, one of the major water sources in the country. PWTP gathered data to look for trends of turbidity, manganese, algal count, ammonia, total dissolved solids (TDS) and taste-and-odor (T&O). The first three parameters showed patterns: high turbidity and manganese occurred during Northeast Monsoon seasons. Maximum of 212 nephelometric turbidity unit (NTU) was observed last January 2016. Likewise, increase in algal count is likely to occur whenever growth conditions are achieved. In contrast, ammonia, TDS and T&O challenges seemed to be unpredictable. Study showed ammonia and turbidity relationship vis-à-vis weather conditions. However, 2014 data deviated when ammonia values > 3ppm happened more than 10 times compared to previous data. 1180ppm of TDS was also analyzed last 2014, the highest value ever recorded by PWTP. TDS also increased four years ago but only up to 555ppm. Furthermore, T&O challenges were seen to take place during the summer of 2010, 2011, 2013 and 2015. Based on these findings, it is recommended to continue data gathering and conduct higher data analyses to provide more reliable information for future plans and expansion of the company.

Keywords: Laguna Lake, Maynilad, Philippines.

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Keywords: Laguna Lake, Maynilad, Philippines.

## **Topic 5 Water education, ecotourism, culture**

### **CHANGES OF THE FARMING LIFE AND THE LAKE ENVIRONMENT**

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Taihu Lake is the birthplace for the farming culture of the Southern Regions of the Yangtze River, and it is known as a land with abundant fish and rice. From the 1980s, the eutrophication of Taihu Lake has been a problem. In 2007, the large-scale algal blooms outbreak in Taihu Lake, resulting in the drinking-water crisis in the cities around the lake. Because of the changes of the production and the lifestyle of the rural area, the relationship between man and nature, between the rice-farming and the lake environment, which is formed in the long history, has been changed. The rapid development of urbanization has brought the changes in the production and life. Especially the farming practices of the lake surrounding plays a vital role on the lake environment. From the historical review of the rice-farming culture in the area around Taihu lake, from the point of view of sociology and archeology, the article analyses the relationship between the rice-farming and the environmental changes of the lake, explores the development of rice-farming in the lake surrounding area. Keywords: lake environment, rice-farming life

### **RELATIONSHIP PATTERN BETWEEN ACTOR AND NATURE BASED ON “TRI NING DANU” IN BEDUGUL TOURISM REGION, BALI**

Nyoman Sunarta, Adi Kampana, Sukma Arida, Saptono Nugroho

This study aims to find a profile in the form of relationship pattern between tourism stakeholders and lake-based tourism in Bedugul Tourism Region. The scope of this study are the identification of tourism stakeholders, the relationship pattern between the actor with the three lakes (Tri ning Danu) in Bedugul caldera (Beratan, Buyan and Tamblingan), as well as the implications that arise from the relationship patterns. The design of the study is field research by using parallel mixed methods, combining qualitative and quantitative approaches in all phases of the research process. Quantitative approach was utilized in collecting data (surveys) by the means of the data crawler instrument (questionnaire) and probability sampling (sampling of a given population). Simultaneously, a qualitative approach was conducted by using interviews (in-depth interviews) to the informants that have been selected previously by using purposive sampling until the data was gained. Quantitative research data was then integrated with the qualitative research findings to be concluded. The results show that Bedugul tourism stakeholder consists of local communities, government apparatus and elements associated with certain bureaucratic (NGOs, environmentalists), as well as tourism entrepreneurs. Each actor has a distinctive interpretation that determines the pattern of their relations with the lake, namely: the theological, ecological, and touristic. The local communities produce theological interpretation, namely governance relations with the lake in a spiritual frame by conducting ritual and productive work (agriculture, fisheries). The apparatus of government and certain bureaucratic elements have ecological interpretation, which sees nature as an asset with an ethical obligation to preserve the administrative and scientific practices. Tourism entrepreneurs produce touristic interpretation, approaching the nature pragmatically that produces economic (economic) practices. The implication of this interpretation spawned a variety of contestation among actors in the utilization of Tri Ning Danu, in the form of latent conflict.

Key words: Tafsir, actor, Bedugul Tourism Region, Tri ning Danu,

## **CULTURAL INSIGHT ON MANAGING COMMON POOL RESOURCES IN LAKE MANINJAU**

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Lake Maninjau was known not only for its green landscape. It also caters the livelihood of 9 Nagari in Agam District, West Sumatera. The 99.5 Km<sup>2</sup> lake served numbers of strategic functions namely tourism, fisheries, ecological, and more importantly for hydropower plant. Its multi-purpose function served benefit and trade-off while uncontrolled activities took place. Overexploited resources with low community participation in managing the lake contradictory to its local wisdom message; “alam takambang jadi guru”. The message conveys the idea of managing natural resources in balance, and it has gone through generation. Unfortunately, this wisdom message left the lake management behind and led to the “tragedy of common” in Lake Maninjau. This paper discussed the cultural insight and trade-off in Lake Maninjau as the impact of uncontrolled over-utilization. A qualitative insight as main data collected through the in-depth interview as well as a household interview as a quantitative data to enhance the analysis. The data collected was part of “The Optimization of Multi-purpose Lake to Develop Regional Economy” studies conducted in 2015 to 2016. Other data collection method such as focus group discussion with essential stakeholders was applied to complement the analysis. The study found that overexploit and insufficient management model of the Maninjau Lake has led to the polarization of interests, causing significant environmental damage. Therefore, paradigm shifting from that polarization to collaboration management is necessary for a more sustainable benefit.

Keywords: Lake Maninjau, Local wisdom, Cultural insight, Multi-purpose economy, Common pool resource

## **THE ROLE OF LOCAL COMMUNITIES IN RESERVOIR MANAGEMENT IN JAKARTA, INDONESIA**

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This study aims to determine the role of the people living around the dam in the management of reservoirs in the area of Jakarta, the capital of the Republic of Indonesia. The method used is the in-depth interviews to a number of key informants who live around the reservoir in seven reservoirs scattered in the Jakarta area. In addition, the method also conducted group discussions and direct observation of community activities around the reservoir associated with the use of reservoirs. The results of this study indicate that the reservoirs in the Jakarta area changes the function of irrigation in the colonial period became a household waste disposal at the present time. This function changes occur due to changes in land use in the capital city of Jakarta and changes in legislation governing authority in the management of the reservoir. At this time, when the capital city of Jakarta is often flooded, the government is trying to use the reservoir to support the flood control system in the capital city Jakarta. Physical infrastructure of reservoirs carried out without the participation of the local community, even the people living around the dam is seen as a problem in flood control. They were moved from their homes around the dam to the apartment relatively far from the reservoir through the low-cost housing program. Meanwhile, in several reservoirs located on the outskirts of the capital Jakarta, the local community is still showing a harmonious relationship with the reservoir to preserve the reservoir and obtain the benefit of clean water from the reservoir.

Keywords: Reservoir, local community, participation, land use change

## Potential Identification of Flora and Fauna Lake Buyan as Basis for Tourism Development Strategy Based on Aquatic Ecosystems

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Lake Buyan is located in Buleleng, Bali which has been used for a variety of human activities with quite intensive, such as fishing, aquaculture, tourism and recreation. Aquatic tourism is one of the great potential that has been developed in Lake Buyan such as boat trips, recreation and fishing. The development of tourism activities in Buyan Lake have done quite intensive and it's may decrease the potential and diversity of aquatic resources. As a natural resources system, Lake Buyan contain the potential biological and non biological resources are not recorded and inventory adequately in order to empower the development of multi-activity and conservation of public waters. Therefore, this "Potential Flora and Fauna Lake Buyan as a Basis for Ecosystem-Based Tourism Development Bodies" research is needed. The aimed of this research was to identify the flora and fauna as a basis for tourism development strategy in Lake Buyan. Research was conducted during six months from June to November 2016. Sampling was carried out at the aquatic plant parameters 9 observation point using 1 x 1 m transect, while the parameters of fish resources conducted in Buyan Lake by boat with fishing rod and fishing nets. There are eight species aquatic plants found that; *Scirpus mucronatus*, *Salvinia molesta*, *S. natans*, *Myriophyllum Brasiliense*, *Brachiaria mutica*, *Cyperus odoratus*, *Eichornia crassipes Solms*, *Ludwigia adscendens*, and *Ceratophyllum demersum L.* *Salvinia molesta* was found in every observation point, whereas *S. natans* found only in one observation point (point 8). It was found six species of fish, there were Nilem, Zebra, Tilapia, Shrimp, Mujair, and Carp. The most fish catches was Zebra fish (218 animals) and the lowest was carp (1 fish

Keywords: aquatic tourism development, Buyan Lake, potential of flora and fauna

## THE SUSTAINABLE CENTRE OF LAKE AS PATH WAY FOR COLLABORATING ALL STAKE HOLDERS AND GOVERNMENT

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Responsibility for lake management is divided among so many units in public and in units local government agencies that it is extremely difficult to organize an effective and comprehensive lake management program among the agencies and citizens. To rescue the lake, according to Arief Deputy Of Ministry of Environment and Forests for Environmental Degradation Control and Climate Change (TEMPO.co 4/3/2015), takes the commitment of various parties, including local governments and communities. Since 2009 has an agreement among nine ministers for sustainable management of the lake put priorities funds to save of lakes in Indonesia. At least 15 lakes have been assigned priority to be saved, such as Lake Toba, Minanjau, and Rawapening. "The aim of this review is to show several evident that the sustainable lake management can be work by apply the sustainable center of lake. Sustainable Lake Centre (SLC) can engage in more informed and effective lake planning efforts than have historically been conducted and enhance cooperation among community organization and local governments and local lake managers for improved lake management. So SLC will become Centre for data collection, Center for Lake Conservation Planning, Center for both promotion and physical activity of lake conservation, Center for Environmental Education of lake in society and last but not list Center for Information for people and institutions associated with the plan in each institution.

Keywords: Sustainable, lake, path way, collaborating

## **Topic 6 Database and Knowledgebase Systems, Informatics, and Monitoring Technologies**

### **SURFACE WATER QUALITY MONITORING OF WATER BODIES IN NANDED DISTRICT, MAHARASHTRA, (INDIA) USING GIS**

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The quality of water in reservoirs and tanks used for domestic and irrigation purposes is of vital concern for human health. Water quality of reservoirs and tanks is required to be monitored regularly for their allocation to different uses as well as corrective action for pollution abatement. The present study has attempted to develop water quality index corresponding with different conditions and characteristics of the concerned water bodies such as geographical, hydrological, discharge rate and pollution sources. 10 water bodies (tanks and reservoirs) of Nanded District of Maharashtra, India were studied with reference to their physico-chemical and biological parameters for one year using standard methods of water analysis. DBMS maps were generated using Geographical Information System to understand the status of water bodies based on the water quality data. The DBMS maps provide information regarding the status of seasonal water quality, quantity, surface area and location of the water bodies. This will prove to be a good and effective monitoring tool for the planners and administrators of the district to maintain water quality in the water bodies.

Keywords: Water Quality Index (WQI), Physico-chemical & biological parameters, GIS, Management tool.

### **TERRITORY DIAGNOSIS USING LANDSCAPE UNITS ON LAKE ZAPOTLAN AND RIVER COAHUAYANA BASINS, MEXICO**

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A diagnosis using landscape units was performed to assess the environmental situation of the Lake Zapotlan-Coahuayana river basin, allocated in Western Mexico. Transects were designed from top to bottom of the watershed, using the methodology of Evaluating landscapes through linear infrastructures. The analyzed territory covers 4958 square kilometers, including completely or partially 12 municipalities of Jalisco state, with heights ranging from 300 to 3,969 meters above sea level.

The results show that in the whole area there is an ongoing deforestation process, mainly caused by a systematic advancement of agriculture and animal husbandry. This causes excessive sediment inputs in the river and lake, aggravated by agrochemical pollution of water bodies and untreated wastewater. These processes impact the terrestrial and aquatic ecosystems as well as causing changes in the hydrological cycle, which are reflected in the reduction in the volumes of surface water bodies, increased vulnerability of the basin, and losses in agricultural profitability involving socio-economic damages in the rural sector and agricultural-industrial production.

The information obtained allowed to generate field data to establish lines of action and sub-programs of Conservation and Management, as part of the Integrated Management Program of Coahuayana-Zapotlan Basins, prepared for the Inter-municipal Board of the Coahuayana River.

Keywords: altitude profile, landscape analysis, GIS.

## **SIMULATOR DEVELOPMENT FOR 2D PHOSPHOROUS CONCENTRATION DISTRIBUTION IN LAKE MAHONI USING RESOURCE MODELING ASSOCIATES (RMA) PROGRAM**

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Lake Mahoni, part of the lake system in Universitas Indonesia, located in Depok, West Java has a phosphorous concentration of 2.34 mg/L based on previous research by Aziz, 2015. Government Regulation Number 82/2011 states that the water quality standards of phosphorous for first and second class bodies of waters shouldn't exceed 0.2 mg/L. A simulator is built to aid the university's management by providing cost-effective engineering solution. The objective of this research is to assess the use of RMA model in developing a simulator that can predict the 2D phosphorous concentration distribution in Lake Mahoni, using limited data available. Measurements of total phosphorous is used as input data, however organic phosphorous is simulated due to constraints of the model. The decay and settling rates of total phosphorous in Lake Mahoni is 0.28 m/day and 0.046 m/day based on Aziz' research. Three locations are considered to load phosphorous into Lake Mahoni: Lake Agathis, surrounding residential areas, and the Engineering Faculty's cafeteria. The process of developing the model includes: discretization of Lake Mahoni, data input, sensitivity analysis, and calibration of diffusion coefficients. The transversal and longitudinal diffusion coefficients chosen are 800 m<sup>2</sup>/s and 0.1 m<sup>2</sup>/s, based on the least SSE of 0.2557. The model is able to give expected responses of phosphorous concentration distribution against time and space, when various scenarios of phosphorous loading are simulated.

Keywords: Lake Mahoni, organic phosphorus, RMA, Universitas Indonesia, water quality modeling

## **A CASE STUDY ON THE SIMPLE FLOODS OBSERVATION AND MAPPING SYSTEM BY SMARTPHONES**

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In the Philippines, flood disasters are increasing. And the governments and many donors are trying to mitigate it by introducing monitoring stations. However, many systems cannot work well to protect the regional community. The local people did not react well for the warnings. Why does this happen? The warnings issued by the authorities said to be quite general. This is due to limited monitoring systems. In addition, people treated floods as a part of normal life. To tackle the difficulty, we started our researches with LLDA (Laguna Lake Development Authority) from 2013. Simple web cameras have been installed to four rivers just for visual surveillance.

This study analyzed the effectiveness of the simple floods monitoring and mapping system to improve the economic resilience of the local community and provided some policy recommendations to the local governments and donor organizations to increase the people's response to the floods.

The method of the effectiveness evaluation on the simple monitoring system is including number of images, maps and warnings from the authorities and other social issues including security of the town, traffic jam, and illegal waste disposal. And we examined technical sustainability of the system under the bad internet environments. We had a series of discussions with the target LGUs (Local Government Units), LLDA, private companies including Japanese factories and other stakeholders. And we have found that the system can never be effective without education and community's involvement. We found that the simple observation system can increase the people's involvement.

Keywords: Flood around Laguna Lake, Web camera monitoring, Early warning, Waste management, Problem Mapping by smartphone

## **GEOSPATIAL ANALYSIS OF ECOLOGICAL CHANGES IN WETLAND URBAN TANKS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT**

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Wetlands, the natural or artificial transition zones between land and water are those areas which permanently or seasonally get saturated with water and support the ecosystem. Urban Water tanks such as Waddepally, Bhadrakali and Dharmasagar tanks were the main source of drinking water and irrigation in the Warangal province of India for centuries. During the past two decades ground water level in several parts has been falling and these tanks get either shrunk or become defunct. This Study focuses on the evolution changes in above three urban water tanks. Geospatial technologies provide cost effective methods for change detection analysis in the eco-system of urban wetland environment over the decades. Land use and Land cover changes can be analyzed by 25 years Landsat data and change detection algorithms. Multivariate regression analysis and Cramer's V analysis is conducted for the periods of 1994-2004, 2004-2014 to analyzed the climatic, physical geographic and demographic factors to quantify the explanatory factors on the wetland degradation. Extensive field work and community interviews were conducted to understand the community dependence on wetland ecosystem for economic benefits. How the degradation in wetland ecosystem is affecting and it further endanger the water availability to three-cities were also studied. The rapid urbanization and encroachments are going on and blocking the inflow of water in the ecosystem of this ever shrinking urban wetland. This research assist planning and reviewing of land use allocation in the province Warangal to maintain ecological sustainability. It also evaluate a suite of ecosystem services provided by above Urban Water tanks in order to provide a deeper understanding of the economic benefits expected to result from efficient and effective conservation and management of the wetland resources.

Keywords: Geospatial Analysis, Wetland Conservation, Wetland Ecology, Urban Wetlands, change detection.

## **ONLINE MONITORING AND EARLY WARNING SYSTEM FOR MASS DEATH OF FISH IN MANINJAU LAKE**

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Lake management issues were very complex and involve many stakeholders because of many sectors depend on Maninjau Lake such as: fisheries, tourism, environment, agriculture, transportation and electrical energy. It gave impact to required the aquatic environment data that were accurate, fast and real time. Maninjau Lake is categorized as the **tecnovolcanic** lake which has a surface area of 9737 ha, a water catchment area of 13.260 ha, and a maximum depth of 170 m. Findings indicate that Maninjau Lake have morphometric characteristics with low stability of lake water and retention time of 25 years. Mass death of fish on floating net increased. Disaster for mass death of fish associated with upwelling of water from the bottom to the surface water. In fact, lake water oxygen layer content close to zero. This upwelling of water associated with a decrease in the surface temperature of the water and an increase in wind speed. Mass death of fish process are monitored by recording stratification of the water temperature, dissolved oxygen, and wind speed. The data used as a key parameter for early warning system. This paper aims to discuss the real-time environmental monitoring and early warning system for mass death of fish. The Results of monitoring station (site) measurements transmitted directly to server in Research Center for Limnology LIPI Cibinong. Real time conditions of Maninjau Lake can be seen by website. When the level of fish kill's criteria are met then a warning signal is sent to mobile phone.

Keywords: Maninjau Lake, water temperature, online monitoring, mass death of fish

## Topic 7 Biodiversity and conservation

### EARLY DETECTION OF ICHTHYOFAUNA ALIEN SPECIES AT GADJAH MUNGKUR RESERVOIR, WONOGIRI, CENTRAL JAVA, INDONESIA

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Alien species is one of threats to the ecosystem. Alien species of freshwater ichthyofauna could lead to the extinction of native species and ecosystem disturbance. Distribution through human activities allow alien species spread easily. Early detection of alien fish species provides information about the types and existence of alien fish species. This research was held at Gadjah Mungkur Reservoir, Wonogiri in July 2015 to August 2015. Collection of data held by direct sampling and observations of angler's catches in 7 locations. Results showed 5 of 19 species were alien fish species. *Cyprinus carpio*, *Clarias cf. gariepinus*, *Pterygoplichthys pardalis*, *Pangasianodon hypophthalmus* and *Oreochromis niloticus* were observed as alien species. *Pterygoplichthys pardalis* is a forbidden species to enter in the territory of Indonesia based on the Regulation of Minister of Maritime Affairs and Fisheries Number 41 Year 2014. The alien species have been detected in Gadjah Mungkur Reservoir and need urgent treatment to control the alien species.

Keywords: alien species, early detection, gadjah mungkur, fish, reservoir.

### MICROCRUSTACEAN ZOOPLANKTON FAUNA OF PHILIPPINE LAKES: UPDATED TAXONOMY AND DISTRIBUTION RECORDS

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In the Philippines, freshwater zooplankton research in major lakes started as early as late 19th century. The taxonomy and distribution of these groups remain underrated, yet, their knowledge is important to understand lake biological processes and to develop sound conservation policies for this type of ecosystem. High endemism and unique patterns of distribution in microcrustacean zooplankton were expected due to country's archipelagic nature, biogeographical origins, and location in the tropics. A total of 51 lakes were surveyed for microcrustacean zooplankton collection and results were consolidated with published literature to provide updates on the taxonomy and distribution of freshwater zooplankton in Philippines lakes to aid in efforts of documenting freshwater biodiversity in the country given its current prevailing conditions. Results from published zooplankton studies and recent samplings (1872 to 2016) listed a total of 98 species of freshwater microcrustacean zooplankton from 51 lakes in the Philippines, including 66 Cladoceran and 32 Copepod species, which belong to 2 cladoceran orders, 6 families and 29 genera; 2 copepod orders, 4 families and 12 genera. Among these, there were 4 species known to be endemic in the country. However, recent taxonomic inventories (2008-2016) of lakes in the country revealed disappearance of several cladoceran and copepod taxa, biological invasion of non-native calanoid, *Arctodiaptomus dorsalis* together with misidentification and synonymies in taxonomy of several species. Mainly, these problems can be attributed to the increase in aquaculture activity in Philippine lakes through introduction of non-native fishes and further expounded by the problems in eutrophication and climate change.

Keywords: Zooplankton, taxonomy, diversity, tropics, and inland waters.

## INDIGENOUS FISH FAUNA OF UPPER LAKE (BHOJ WETLAND, CENTRAL INDIA) WITH REFERENCE TO BIODIVERSITY CONSERVATION AND LIVELIHOOD.

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The Upper lake of Bhopal is a major part of Bhoj wetland, a Ramsar Site of central India. It is a thousand year old man made reservoir formed by damming Kolans river near Kamla Park. The lake has an area of 32 sq. km with catchment area of 360 sq.km spread in Bhopal and Sehore districts. Kolans is the main feed river to the lake. Upper lake supports rich fish diversity. 52 species fishes have been reported from the lake out of which 18 are of economic importance. About 500 fisherman families depend on the fishery resources of the lake for their livelihood. Fishing rights are given by the Bhopal Municipal Corporation to the cooperative society of fisherman on short term lease. Fish seed of culturable species of Indian major carps (i.e. *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) is released. The catch composition consists both cultured and self- recruiting indigenous fishes. About 80% of the catch is contributed by indigenous self- recruiting fishes indicating importance of the indigenous fish in livelihood. Since breeding of these species is dependent on monsoon rains, climatic conditions and flow in incoming streams, disruption in any of these may affect breeding processes thereby affecting the self-recruiting fish population. Lateral connectivity of the lake with its incoming streams is largely affected by late onset of monsoon, reduced number of rainy days, scanty monsoon and to a greater extent by degradation in water quality due to pollution. The concern in this case is the changing hydrology pattern of the lake which affects the breeding of self –recruiting indigenous varieties of fishes which will in long run affect the fish catch which contribute 80% to the total fish catch in the lake. This will directly hit the food and livelihood security of poor fisherman families. The present paper focuses on the indigenous self recruiting fish fauna of the lake and threats because of changing hydrology of the lake basin

Keywords: Biodiversity Conservation, Indigenous Fish Fauna, Livelihood, Ramsar site, Bhoj wetland, Fisherman.

## FECUNDITY OF THREE SPOT GOURAMI *Trichogaster trichopterus Pallas* IN LAKE LANA O, LANA O DEL SUR

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The study aimed to assess the fecundity of *T. trichopterus* and determine its relationship to body length, body weight, egg diameter, and gonadosomatic index (GSI). A total of fifty-five (55) samples (24 males and 31 females) of non-native three spot gourami (*T. trichopterus*) were collected from Lake Lanao, Lanao del Sur in February 2016. The collection represents the first documentation of this species in Wato, Lanao del Sur. The correlation coefficient analysis of each parameter of the said species was obtained through Pearson-Product moment correlation. Result showed that there was a very high positive and significant correlation between body length and body weight in male ( $r = 0.967$ ,  $P = 0.01$ ) and female ( $r = 0.952$ ,  $P = 0.01$ ) *T. trichopterus*. The fecundity showed a high positive and significant relationship with both body length ( $r = 0.857$ ,  $P = 0.01$ ) and body weight ( $r = 0.939$ ,  $P = 0.01$ ). Egg diameter showed low positive and no significant relationship with body length ( $r = 0.344$ ,  $P = 0.05$ ), body weight ( $r = 0.369$ ,  $P = 0.05$ ) and fecundity ( $r = 0.405$ ,  $P = 0.05$ ). The fecundity showed a moderate positive correlation with GSI ( $r = 0.599$ ,  $P = 0.01$ ). The findings of this study showed that *T. trichopterus* has a relatively high fecundity compared to other studies. Thus, the introduction of *T. trichopterus* in Lake Lanao could be one of the reasons of the declining distribution of its endemic cyprinids.

Keywords: *Trichogaster trichopterus*, fecundity, introduced fish.

## ISOLATION AND MOLECULAR IDENTIFICATION OF *Microcystis* spp. IN PUTRAJAYA LAKE, MALAYSIA

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The objectives of this study are to isolate and identify the *Microcystis* species in Putrajaya Lake Malaysia using both the conventional and molecular methods. Two *Microcystis* species, UPM A0038 and UPM A0039, isolated from the lake by a combination of techniques including microselection, serial dilution and plate streaking. The cells/colonies were cultured and maintained in BG-11 medium pH 8 in an environmental chamber (Sanyo, Japan) at 25 °C with light intensity of 120 μmoles photon m<sup>-2</sup> sec<sup>-1</sup>, and a photoperiod of 12h light:12h dark. The process was repeated until a pure culture of different species was obtained. After the purification, the identification of the species was carried out by using direct sequencing of purified polymerase chain reaction (PCR) products with the use of 16S rRNA gene sequence. Based on 16S rRNA sequence and polyphasic approach, the isolates were identified as *Microcystis aeruginosa* and *Microcystis viridis*. Both isolates varied substantially in term of morphological features such as cell size, colonial formation and cell arrangement. The colonies of *Microcystis aeruginosa* are in irregular forms but sometimes they can be spherical and usually overlapping. The colonies consist of a large number of densely packed cells embedded in a colourless mucilage and sometime can be seen with naked eyes. On the other hand, *Microcystis viridis* colonies are firm, smaller and composed of cubical subcolonies. Each subcolony is composed of four cells and regularly arranged.

Keywords: Cyanobacteria, *Microcystis aeruginosa*, *Microcystis viridis*, 16s rRNA

## GUT CONTENT ANALYSIS OF *Puntius Tumba* TAKEN FROM THE RIVERS OF LANA O DEL SUR

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Gut content analysis of *Puntius tumba*, one of the two remaining endemic cyprinids in Lake Lanao, was carried out to gather additional information that could be used for any planned scheme to develop appropriate culture techniques for the prevention of the extinction of this fish. The guts from 60 samples of *P. tumba* taken from the river along Ramain, Saguiaran, and Marantao were examined and analyzed. With the use of stereomicroscope, macroscopic gut contents were identified. Data on gut contents were subjected to frequency of occurrence and were analyzed by points (volumetric) method. Costello's method was used to determine whether the fish species is a generalists or specialists. Macrophytes are found to be the most frequent gut contents consumed by *P. tumba*. The least in frequency of occurrence are bivalve juveniles. The gut contents with the highest volume percentage are macrophytes and the least are fine sand grains, bivalve juveniles, and detritus. Other food items found include gastropod fragments, bivalve fragments, and gastropod juveniles. Costello's method indicated that *P. tumba* is a generalist fish species. In addition, only a slight correlation was determined between gut length and body length of *P. tumba*.

Keywords: *Puntius tumba*, gut content analysis, endemic to Lake Lanao, Costello's method, generalist

## THE ABUNDANCE OF HETEROTROPHIC BACTERIA IN SEVERAL OXBOW LAKES IN CENTRAL KALIMANTAN, INDONESIA

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Researches and scientific information on limnological conditions of Central Kalimantan Lakes which generally are oxbow lakes are still very limited. The lakes support high fishery resource potential or even serve function as fishery reserves (sanctuary). It is estimated that there are about 23 fishery reserve lakes in Kalimantan and 10 of the lakes are located in Central Kalimantan. In the aquatic ecosystems, heterotrophic bacteria play important roles in decomposition process and nutrient remineralization into simple inorganic components which will be further utilized by phytoplankton, periphyton and other aquatic floras. This study is aimed to determine the heterotrophic bacteria abundance in oxbow lakes. It is also expected to be the basic limnological data and scientific information for the lake management. The sampling was conducted in 2015 at Lake Sebangau, Lake Hurung, Lake Batu, Lake Tehang, Lake Purun and Lake Jalan Pangen. The abundance enumeration was conducted by using the total plate count (TPC) method with spread plate and dilution techniques. The used media was Tryptone glucose yeast (TGY) incubated in room temperature for 24-48 hours. The results showed that bacterial abundance in oxbow lakes in the rainy season was higher than it was in the dry season. In addition, it is also shown that bacterial abundance in Lake Sebangau was the highest among all observed lakes. The abundance value was  $231-340 \times 10^3$  upk.ml<sup>-1</sup> in the rainy season and  $216-321 \times 10^3$  upk.ml<sup>-1</sup> in the dry season. It can be explained since Sebangau River used for public transportation and a lot of human activity and there is a boat dock. Moreover, during rainy season Sebangau River forms a floodplain lake, thus the riparian vegetations are relatively wide exposed and soaked. The emerged and rotten vegetations then become organic matter autochthonous sources. The lowest bacterial abundance was observed from Lake Jalan Pangen ( $69 \times 10^3$  upk.ml<sup>-1</sup> in the rainy season and  $45 \times 10^3$  upk.ml<sup>-1</sup> in the dry season). The main reason of this condition is presumably caused by very low pH condition (pH 3.4). Therefore, suspected only certain species of acid-bacteria that can live in the lake. Meanwhile, the abundance level of heterotrophic bacteria in the lake Hurung, Lake Stone, Lake Tehang, and Lake Purun are relatively the same. The value of the abundance level was  $142-181 \times 10^3$  upk.ml<sup>-1</sup>,  $169-183 \times 10^3$  upk.ml<sup>-1</sup>,  $153-162 \times 10^3$  upk.ml<sup>-1</sup> and  $197-201 \times 10^3$  upk.ml<sup>-1</sup> respectively. The total nitrogen concentration of Lake Sebangau is considered quite high ( $0.55-0.82$  mg.l<sup>-1</sup>). While the measured ammonia, nitrite and nitrate concentration are the lowest compared to other lakes. These results indicated that there is organic matter decomposition activity by nitrifying bacteria. The concentration of dissolved oxygen ( $3.1$  to  $7.0$  mg.l<sup>-1</sup>) was observed to be sufficient to support the nitrification process.

Keywords: Oxbow lake, abundance, heterotrophic bacteria

## **PLANKTON DIVERSITY IN AN AQUACULTURE AND CAPTURE FISHERIES SITE IN LAGUNA DE BAY, PHILIPPINES**

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Laguna de Bay is the Philippines' largest inland water used for aquaculture and capture fisheries. The study was conducted to determine the impact of decades-long aquaculture activities on plankton in this lake. Bi-monthly samples of plankton were collected in an aquaculture site (AQS) and open fishery site (OFS) from March 2013 to February 2015. AQS has been an aquaculture site for thirty years with cages stocked with Nile tilapia, Bighead carp, and giant freshwater prawn. OFS was a former aquaculture site more than 30 years ago but has since been left open for capture fisheries. Differential counts were conducted for each plankton sample, with identification limited to genus level. Large fluctuations in plankton density as observed throughout the observation period. Despite this, paired t-test showed significantly higher phyto- and zooplankton densities in the AQS compared to the OFS (at  $P < 0.10$  level). Phytoplankton diversity indices such as species richness, Shannon-Wiener, and Simpson was also significantly higher in the AQS compared to the OFS. In the case of zooplankton, except for species richness where significantly higher values were observed in AQS, no significant differences were seen in the other diversity indices. This could be due to the regular provision of feeds for the fish caged in the AQS which lessened the demand for plankton as feed. OFS, on the other hand is home to both native and introduced species such as catfish, snakehead, theraponids, tilapia, milkfish, among others that rely solely in natural food available in the site, including plankton, for nutrition.

Keywords: plankton diversity, aquaculture, open fisheries, Laguna de Bay

## **AQUATIC MACROPHYTES IN SEVERAL PRIORITY LAKES FOR CONSERVATION 2010-2014**

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According to national conference of Indonesian Lakes II in Bali on 2009 concern about sustainable lake management, 15 lakes regarded as the Indonesia's priority lakes for conservation in 2010-2014. The presence of controlled aquatic macrophytes in an inland water ecosystem is recognized as one of the most important factors to support the ecosystem sustainability. Ecologically, the plants provide shelters and spawning sites for the fish, purification system, water current stabilizing system, and erosion and turbidity controller. This research aimed to study the diversity of aquatic macrophytes. The observation was conducted from 2012-2014, at several lakes in Indonesia: Lake Sentarum (West Kalimantan), Rawa Pening (Central Java), Tondano (North Sulawesi), Tempe (South Sulawesi) and Sentani (Papua). As the results, there were 34 identified species categorized within 18 families. The recorded families were Ceratophyllaceae, Plantaginaceae, Alismataceae, Onagraceae, Salviniaceae, Cyperaceae, Araceae, Pontederiaceae, Polygonaceae, Convolvulaceae, Lentibulariaceae, Poaceae, Hydrocharitaceae, Fabaceae, Menyanthaceae, Nymphaeaceae, Pandanaceae and Equisetaceae. Based on life form were found: 7 species submerged plants, 14 species emergent plants, 3 species free floating plants, and 10 species rooted with floating leaves plants. Among the listed species, 24 species were recognized as natives; meanwhile, 10 others were alien species (South America, America, Asia, India).

Keywords: lakes, conservation, diversity, aquatic macrophytes

## **OCCURRENCE OF WATER-BORNE BACTERIAL PATHOGENS IN LAKE MATANO, INDONESIA**

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Water-borne pathogens can be the threatening substances if adequate surveillance is not routinely carried out. Pathogens in water grow at speedy abundance if environmental factors permit. The study of water-borne pathogen in Lake Matano is underrated although the biogeochemistry of this lake is studied well. We tried to identify the existence of bacterial pathogens from water samples and expected the different spectra of pathogens on each sampling sites. In August 2016, seven sampling stations of Lake Matano were determined. Each of 100 ml water samples was filter plated simultaneously in Rimler and Shotts Base, and Xylose-Lysine Deoxycholate Agar. Incubation was set at 35<sup>o</sup> C for 24 hr. The single colony isolation was then completed to obtain the bacterial cells of interest followed by biochemical assay. We managed to isolate eight colonies that seemingly belong to enteric pathogens (likely from the genera *Salmonella* and *Escherichia*) and four colonies of likely Aeromonads. Occurrence of pathogens between sampling sites seems encouraging to which these are likely subject to environmental attributes. Future works may cover the molecular analysis of isolated bacterial cells to confirm the identification based on 16S rRNA and select pathogenic gene sequences.

Keywords: Lake Matano, water-borne pathogens

## **BIODIVERSITY ASSESSMENT OF LITTORAL MACROZOOBENTHOS IN LAGUNA DE BAY, PHILIPPINES**

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Zoobenthos are particularly susceptible to monitoring pollutants due to their restricted mobility. Their biodiversity typically reflects changes in the local environment, making them crucial bioindicators to detect trends in pollutant concentrations. Thus, this study gathered samples of zoobenthos species from 33 littoral sites of Laguna de Bay to determine the littoral zoobenthos richness and diversity of the species present in Laguna de Bay. The results have recorded 6 identified families (Ampullaridae, Corbiculidae, Pachychilidae, Planorbidae, Thiaridae, and Viviparidae) of macrozoobenthos and one unidentified species. Computation of Shannon–Wiener index ( $H'$ ) showed the highest diversity which was recorded from Pinagdilawan, Binangonan ( $H'=1.20$ ) while the lowest was in Pulong Ligaya, Bogombong, Jala-Jala ( $H'=0.04$ ). The output of this study also seeks to provide records on littoral zoobenthic community and preserved specimens for natural history collection and character line drawings of present species in Laguna de Bay.

Keywords: zoobenthos, biodiversity, richness, Shannon–Wiener index

## MAPPING TO DISTRIBUTION OF ENDEMIC AND INVASIVE FISH SPECIES IN SOME LAKES OF SULAWESI

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Diversity of freshwater fish in Indonesia the second highest after Brazil. Biodiversity include diversity of ecosystem, species and genetic. In inland waters found 1300 of fish, in lakes of Sulawesi there are 68 species (52 endemic). The high fish biodiversity in Sulawesi inland water could be decline and even extinct caused by over exploitation, water pollution, degradation habitats, species invasion, and flow modification. Distribution of fish in several lakes of Sulawesi include: Lake Matano having 14 endemic fish and eight exotic fish. Distribution of fish in several lakes of Sulawesi include: Lake Matano having 14 endemic fish and eight exotic fish. "Louhan" is the result of a cross *Amphilopus citrinellus* x *Cichlasoma trimaculatum* is invasive in this lake. In Lake Towuti there are 21 endemic fish and 3 exotic species, Lake Poso have 8 endemic and 1 native species *Anguilla marmorata*. Lake Tempe having 1 native species *Glossogobius aureus* and 15 exotic fish; in Lake Tondano (2 endemic fish and 13 exotic species); Lake Limboto have 15 species (10 exotic species, 1 native species, *Ophieleotris aporos*, and 4 species the peripheral type). In 1950-1993 year from abroad put 16 species and in 2014 are 19 species. The act of protection to endemic and native species and to control invasive species will be discussed on manuscript.

Keywords: Distribution, endemic, native, invasive, lakes, Sulawesi

## HABITATS CHARACTERISATION FOR IHAN (*Neolissochilus* sp.) CONSERVATION PLANNING AROUND LAKE TOBA, NORTH SUMATERA, INDONESIA

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Lake Toba is a home for some Indonesian native fishes including the endemic species. Ihan (*Neolissochilus* sp.) is a local name for a fish with high economic and sociocultural value inhabiting Lake Toba and rivers in North Sumatra. However, the population of ihan in the wild has declined because of several factors such as overfishing and habitat degradation. Conservation program for ihan is required to protect them from extinction. We have identified ihan (*N. cf. sumatranus*) from some rivers surrounding Lake Toba. The present study aimed to physically and chemically characterise some ihan habitats potentially developed as conservation areas. Four rivers were selected namely Silitio River in Binangara, Bonandolok River in Bonandolok, Tulas River in Siboro, and Boho River in Boho. Habitat mapping and measurement of the physical and chemical parameters were conducted at the locations. Mapping was done by Geographic Information System (GIS) and direct measurement in the field. Water quality was measured by Water Quality Checker and laboratory analysis. Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis were used to evaluate the strategy for developing the conservation area in a selected location. Based on the physical and chemical properties, the four rivers support the growth and development of ihan. Bonandolok River was chosen to be the most suitable site for conservation because two thirds of the sub-catchment areas are dominated by natural forests. The existing local wisdom in Bonandolok related to ihan capture will play a role in the conservation program and sustainable utilization of ihan.

Keywords: *Neolissochilus sumatranus*, Lake Toba, habitat characteristics, conservation area

## **EFFECTS OF WATER QUALITY AND QUANTITY ON MACROINVERTIBRATES IN TEMPORARY STREAM AT HARIPHUNCHAI EDUCATIONCENTRE, THAILAND**

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A temporary stream that delivers water to a reservoir in Hariphunchai Education Centre, Lamphun Province was studied on water quantities and quality to macroinvertebrates assemblages during November 2015-August 2016. Four study sites were selected and monitored. The study showed that average of water discharge flowing into the reservoir was about 0.04 m<sup>3</sup>/s. During November 2015, a water level in the stream began to decrease and stop flowing in late of month and became a small pool and the stream began to flowing again in late of June 2016. For an environmental factor pH range was 6.68-8.50, Dissolved Oxygen range was 0.9-8.8 mg/L. Water temperatures range was 23.0-38.0°C. Total Dissolve Solid range was 114.0-312.0 mg/L. Conductivity range was 213.7-571.0 µS/cm. Concentration of NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup> and PO<sub>4</sub> in water were under the Thailand standard of surface water quality. Macroinvertebrates were found 6 orders and 24 families. The first study site found highest abundant of Baetidae. The second study site found Thiaridae and Chironomidae as the dominance group. Third study site, the highest taxa were Chironomidae in October. But in the November in study site became dry out. Study site forth the highest abundant family were Gerridae. The effect of changing a discharge condition in 10 months caused the stream dry out especially in the downstream area. This impact caused disappearance of many macroinvertebrates taxa when the stream became a pool. Chironomidae and Thiaridae were only the well adapted group to this condition. Finally, all aquatic macroinvertebrates disappeared when the stream completely dry.

Keywords: temporary, stream, macroinvertebrates, reservoir, water discharge, Hariphunchai.

## **COMMUNITY STURCTURE ANALYSIS OF CHIRONOMID LARVAE ON LAKE MATANO'S LITORAL ZONE**

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Chironomid larvae is an important biotic component in lentic ecosystems. Distribution and wide tolerance of this animal are the main reasons that make this biota adapt to live in almost all types of water bodies. Lake Matano is categorized as one of the most ancient generally oligotrophic tectonic lakes in Indonesia. The biota larvae is generally associated with the research on biodiversity, pollution, as well as aquatic environment quality assessment. Unfortunately, the studies on chironomid larvae biodiversity in tropical oligotrophic lakes are still very limited. The purpose of this study was to assess the composition and distribution of Chironomid larvae in Lake Matano. The study was conducted based on 2013 and 2015 ecological survey database. Chironomid larvae was sampled by placing a kick-net at the rocky substrate and Ekman grab at sandy/ muddy substrate. The results showed that Chironominae larvae tends to dominate the sampling area (32-70%), followed by tribe Tanypodinae (13-54%), and Orthoclaadiinae (3-35%). It was also revealed that the abundance of Chironomid larvae is greater at the 1 m depth than the surface (0 m) depth. The abundance level for both depth was 362-762 idv/ m<sup>2</sup> and 89-474 idv /m<sup>2</sup> respectively. Whilst the abundance of the 2 , 5, and 10 m depth was 59-519 idv/ m<sup>2</sup>, 22-419 idv/m<sup>2</sup>, and 10 m (133-444 idv/m<sup>2</sup>). Overall, it can be concluded from the abundance data that the shallow littoral parts with high habitat complexity are more productive than the deeper parts.

Key words : abundance, composition, diversity, oligotroph, matano, Chironomid.

## **BENTHIC MACROINVERTEBRATES COMMUNITY STRUCTURE OF A SHALLOW OXBOW LAKE HANJALUTUNG, IN CENTRAL KALIMANTAN**

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Macroinvertebrates play an important role in the ecosystem of the lake, in the food chain system, nutrient cycles, and portray the state of water quality. This research aims was to explore the conditions of the benthic macroinvertebrates structure as a community in the oxbow Lake Hanjalutung and its relation to the physical and chemical water quality parameters. The Lake Hanjalutung is a shallow oxbow lake where located in Palangkaraya, Central Kalimantan, Indonesia. In addition we also conducted sampling at Rungan River as the main input for Hanjalutung. The research was conducted in September 2015. Total 14 taxa richness of benthic macroinvertebrates are determined during the research. The value of Shannon-Wiener diversity index ranged from 0 to 0.734, the evenness index value ranged 0 to 0.944, and the total abundance ranged between 18-960 individuals/ m<sup>2</sup>, which the amount varied in each location. In the present study, values of the macroinvertebrates index showed in a low range. More than 60% taxa of benthic macroinvertebrates strongly correlated to the pH, showed by the results of the Canonical Correspondence Analysis that the nine taxa were characterized by pH, DO, and TDS, they were *Clinotanypus*, *Tanytarsus*, *Cryptochironomus*, *Cullicoides*, *Polypedilum*, *Micronecta*, *Caenis*, *Ecnomus*, and *Aulodrilus*. While five other taxa *Goeldichironomus*, *Parachironomus*, *Kiefferelus*, *Nais*, and *Tubifid* immature were characterized by temperature parameters.

Keywords: oxbow, lake Hanjalutung, macroinvertebrates, Kalimantan

## **DIVERSITY OF PLANKTON IN WATER VELVET BLOOMED WATERS (CASE STUDY: SITU PERIKANAN, BOGOR, WEST JAVA, INDONESIA)**

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Situ Perikanan had water velvet bloomed in 2015. This condition could lead changes of water quality and organism diversity of waters. The aim of this research was to determine phytoplankton and zooplankton diversity in Situ Perikanan in water velvet bloom condition. Sampling was conducted for nutrient and plankton analysis, and in situ observation for several water quality parameters (temperature, pH, and DO). The results showed that water quality was in common condition for freshwater with relatively high N:P ratio (>30). Blooming water velvet caused a high P uptake that lead the high N:P ratio condition. Phytoplankton was dominated by diatom and Chlorophyceae, respectively. It was related to the high N:P ratio. The domination of diatom also indicated the association with water velvet that diatom might attached to. Zooplankton was dominated by Rotifers. As a whole, the bloom of water velvet influence nutrients condition that lead specific domination of plankton community structure.

Keywords: blooming, diversity, plankton, *Salvinia molesta*

## PHYTOPLANKTON COMMUNITY AT LITTORAL ZONE OF LAKE MATANO IN RELATIONSHIP TO WATER QUALITY

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Research on phytoplankton in Lake Matano has been carried out, but observations of phytoplankton in the littoral zone has not been done, even though the role of the littoral zone are important. This study aims to find out the composition and abundance of phytoplankton at littoral zone of Lake Matano in relationship to water quality. Observations were made in April and August 2015 at six locations in littoral zone of Lake Matano. Water samples were taken 10 - 20 liters at surface waters and Secchi depth, filtered using a plankton net no. 25, and preserved with Lugol 1%. Water quality parameters measured were temperature, pH, dissolved oxygen, conductivity, and turbidity. Phytoplankton abundance was calculated using the Sedgwick Rafter method. Phytoplankton community structure was analyzed by Diversity Index ( $H'$ ), Evenness Index ( $E$ ) and Simpson Dominance Index ( $D$ ). There are five phyla and 57 species of phytoplankton were found in Lake Matano, comprised of Chlorophyta (16 species), Dinophyta (2 species), Bacillariophyta (34 species), Chrysophyta (1 species), and Cyanophyta (6 species). The abundance of phytoplankton in April and August 2015 ranged between 198 –  $1.281 \times 10^4$  individual/Liter, where *Peridinium inconspicuum* and *Peridinium cinctum* were higher than other types. Diversity Index ranged from 0.719 to 2.632 indicates low to moderate community stability. Evenness Index ranged from 0.065 to 0.216, this value is close to zero means the uniformity among species in community is lower, there is usually a species that dominates. From Dominance Index (0.216 to 0.749), dominance species occur in some locations of observation at Lake Matano, especially in April 2015. CCA ordination shows that dissolved oxygen, pH and temperature influences the existences of *Ulothrix*, *Navicula radiosa* and *Nitzschia*, while conductivity impact on the *Spirulina* on the surface area in April 2015.

Keywords: phytoplankton, abundance, composition, water quality, matano

## A PRELIMINARY STUDY OF STOMACH CONTENT OF FLOWERHORN FISH IN LAKE MATANO, SOUTH SULAWESI

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Lake Matano is an ancient lake and known with its high aquatic biota endemism. Most of the native fish in Lake Matano is endemic species. However, at this time a non native fish species, flowerhorn fish, also presents. Currently, the flowerhorn population in Lake Matano is relatively abundant and stable. It is concluded by the previous analysis of the size and its reproduction aspect. There are no reports about stomach contents of flowerhorn in Lake Matano. Therefore, this paper aims to provide a preliminary information on the analysis of its stomach contents. The sampling activity was conducted in May 2016 at four sites. The fish were captured by using seven different mesh size gillnets set at the daylight. The length of the specimen was measured to the nearest 1 mm and weighted to the nearest 0.1 g. Subsequently, the specimen was dissected to identify the sex and maturity stage. The gut was removed and preserved in 5% formalin. Further analysis was conducted in Laboratory of Physiology, Research Center for Limnology, Indonesian Institute of Sciences under binocular microscope. Data were quantitatively analyzed by calculating frequency of occurrence. Among 42 specimens have been examined, there were 29 male, 11 female, and the rest could not be determined. The total length of sample ranged from 53 to 185 mm and weight 2.5 to 102.6 gram. Based on the analysis, it is found that there are four types of flowerhorn stomach contents, they are body's parts of fish, molluscs, crustaceans that could not be identified. The frequencies of occurrence of each type flowerhorn's stomach contents are 80%, 45%, 12.5%, 2.5% and 42.5% respectively. This result showed that flowerhorn in Lake Matano tends to be.

Keywords: Lake Matano, flowerhorn fish, stomach content

## **CONSIDERATIONS FOR THE TROPICAL EEL (*Anguilla* spp.) RESOURCES MANAGEMENT IN CIMANDIRI RIVER, SUKABUMI WEST JAVA**

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Cimandiri River is located in Sukabumi, West Java. The river has a length of 100 km with a catchment area of 201,431 hectares. The river flows into Palabuhan Ratu bay which is situated in the south of Java Island and is known as a location for eels catches mostly at larval stage (glass eel). The anguillid eel is a catadromous fish in which the adult (silver eel) migrates from freshwater to the sea for spawning and the larvae return to freshwater to grow until it is ready to spawn. Eel is an economically valuable fish commodity with important ecological value. Catch production of eels in Sukabumi contributes to the highest economic value compared to other freshwater fish commodities. However, it has been reported that eel catches production is declining. Habitat degradation, disruption of migration tracks, overexploitation, and environmental pollution are believed to be some factors causing the decline of eel catch production. The management of eel resource is a complex issue as it involves two ecosystems; the freshwater and marine ecosystems. Some considerations for eel resources management will be discussed in this paper. The approaches to ecosystem, bio-ecology, socio-economic and institutions, as well as appropriate regulations are the main factors that should be addressed as an attempt for sustainable eel resources management.

Keywords: eel, Cimandiri River, Ecosystem consideration, Habitat Conservation

## **Evaluation of genetic relationship among select six fish species using the partial fragment of mitochondrial Cytochrome C Oxidase Subunit-1 gene (CO1)**

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In modern conservation and sustainable management approaches of species, it is important to have knowledge about biodiversity, population structures and dynamics. In the present study, the genetic relationship among select fish species in Lubuk Lampam floodplain region is investigated, utilising partial fragment of mitochondrial Cytochrome C Oxidase Subunit-1 gene (CO1). This study aims (1) to reveal genetically relevant relationship of fish species in the Lubuk Lampam floodplain and (2) to find more pronounced substructures on the fine scale analysis. Tissue samples from 10 specimens of fish species were collected during several field trips in 2012 at sample sites across Lubuk Lampam floodplain Ogan Komering Ilir regency South Sumatra Province. The results show congeneric species that diverged from a common ancestor relatively recently and will be close to each other on the tree. Confamilial genera are further apart on the tree because their common ancestor was more remote, and member of different families are even more widely spaced. The molecular marker, a 570 bp region of the mitochondrial cytochrome c oxidase I gene (COI) has been successfully found to be species-specific, and was also more variable between species than within species.

Key words: Phylogeny, Lubuk Lampam and species assignment

## BIODIVERSITY OF NON-CULTIVATED FISHES IN CIRATA LAKE WEST JAVA<sup>1</sup>

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Cirata Lake is an artificial lake that will function as a hydroelectric power plant. Fish culture in floating net cages thrives as compensation for people whose territory is inundated. Along with decline production of floating net cages culture, people began to do fishing activities in outside floating net with target fish is non-cultivated fish. Therefore, in order to ensure the sustainability of fishing activities, it must be known diversity and potential biomass of non-cultivated fishes. The aim of this study is to assess biodiversity and potential biomass of non-cultivated fishes in Cirata lake. This study has been conducted in March until April 2013. In this study assessed diversity ( $H'$ ), equity ( $E$ ), and dominance ( $D$ ) indices, and participatory fish stock assessment (Parfish). The results showed non-cultivated fishes that many captured are golsom fish (*Amphilophus alfari*), tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*), pomfret (*Colossoma macropomum*), lalawak fish (*Barbonymus sp.*), hampal (*Hampala macrolepidota*), catfish (*Pangasius pangasius*), jambal fish (*Pangasius sutchi*), and baung fish (*Hemibagrus nemurus*). Tilapia is the highest biomass and percentage with 424 kg of biomass (68.1%) and golsom fish is the smallest with 2 kg of biomass (0.3%). Non-cultivated fishes in Cirata lake have indices value 1.30 for  $H'$ , 0.59 for  $E$ , and 0.42 for  $D$ . Based on  $H'$  value, diversity of non-cultivated fishes in Cirata lake is low. Based on Parfish, allegations total catches of non-cultivated fishes  $B_{\text{now}}$  is 1.1012 kg/day so that the potential biomass of non-cultivated fishes in Cirata lake is 5,550 tons of fish/year.

Keywords: Cirata lake, diversity, non-cultivated fishes, potential biomass

## Topic 8 Ecotechnology, ecohydrology

### DISSOLVED OXYGEN AND PHOSPHATE CONDITION OF POST-HYPOLIMNETIC AERATION IN LAKE LIDO, BOGOR, WEST JAVA

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Dissolved oxygen and phosphate are very important indicators for ecological process in aquatic ecosystem. Lake Lido has a low oxygen concentration with high phosphate condition in hypolimnion layer, as a consequence of floating cage activity. The research was carried out to study the impact of hypolimnetic aeration to the oxygen and phosphate condition in hypolimnion layer of Lake Lido. One set of hypolimnetic aeration equipment was operated in 10 hours to lift hypolimnetic water mass to the surface and directly agitated to atmospheric oxygen, and turning back down to the origin point. The distribution of oxygen and phosphate were measured horizontally, before, along, and after aeration. The result shows that the closer the position from aeration point, the higher of oxygen and the lower of phosphate will be. The oxygen was increased up to 90% and the orthophosphate was decreased 91.88% after 10 hours operational time. The oxygen and orthophosphate were still better than the original condition at 10 and 5 hours, respectively, after the equipment has been stopped. The 10 hours operational of hypolimnetic aeration decreased AHOD about 13.96%. The hypolimnetic aeration technique has a high potential ability to improve hypolimnetic condition of Lake Lido.

Keywords: AHOD, dissolved oxygen, hypolimnetic aeration, hypolimnion layer, phosphate

### STUDY ON AVAILABILITY OF OXYGEN PRODUCTIVE ELECTRODE (OPE) FOR IMPROVEMENT OF ANAEROBIC CONDITION IN LAKE

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Eutrophication is a serious problem in freshwater lake, triggering excessive growth of algae known as water bloom. Water bloom may cause some problems such as musty odor of drinking water and blocking filtration at water treatment facilities. As a consequence of eutrophication, depletion of dissolved oxygen (DO) occurs at the bottom layer of lake due to decomposition of organic matter by microorganisms and thus nutrients such as phosphate, ammonium or manganese ion can be released from sediment. Oxygen productive electrode (OPE) using solid polymer electrolyte (SPE) membrane can produce microbubble oxygen by water electrolysis even in freshwater, which is expected to improve anaerobic condition at the bottom layer of lake. However, the device is supposed to utilize only in pure water. In this study, a mesocosm experiment using Lake Kasumigaura water and sediment was conducted to clarify whether OPE could be available for practical use in lake, and experiments using the artificial lake water containing as the same concentration of cations ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Al}^{3+}$ ) as Lake Kasumigaura water were carried out to elucidate SPE membrane degradation mechanism. The results showed OPE aeration, which could keep high DO, prevent nutrients and metal ions release compared with control and normal air aeration. On the other hand, it was found multivalent cations ( $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Al}^{3+}$ ) were more adsorbed into the membrane than monovalent cations ( $\text{Na}^+$ ,  $\text{K}^+$ ), and caused ion exchange capacity loss of the membrane. The results showed OPE aeration could be effective for improvement of anaerobic condition at the bottom layer and mitigation strategies for SPE membrane degradation were necessary.

Keywords: OPE, microbubble oxygen, Eutrophication, SPE membrane

## **WATER FOOTPRINT ASSESSMENT OF STRAWBERRY CULTIVATION IN BOR KEAW SUB-DISTRICT, CHIANG MAI PROVINCE, THAILAND.**

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Water footprint is the indicator that can evaluate not only how much of freshwater consumption in production but also show the location which happened. The aim of this study was to evaluate the 3 types (green, blue and grey) of water footprint of strawberry cultivation in 80 farmers in 4 villages of Bor Keaw Sub-district, Samoeng District, Chiang Mai Province, Thailand. In this cultivated area with mountainous-forested watershed, water scarcity and pollution should be concerned about area of vulnerability. The water footprint was analyzed based on the guideline of Water Footprint Network. By using CROPWAT 8.0 models with local meteorological and primary data from interview strawberry producer during agricultural season in year 2014-2015, green and blue water footprints were calculated. Nitrogen fertilizer was considered as a source of grey water footprint. The water footprint of strawberry cultivation in this region was 228 m<sup>3</sup>/ton which the green, blue and grey water footprint was 84(36.84%), 29(12.72%) and 115 m<sup>3</sup>/ton (50.44%) respectively. The fraction of green water footprint revealed significant of rainfall for this cultivation area. The grey water footprint was three times higher than the world average. The grey water footprint showed the important role and high fertilizer use of nitrogen which will impact on surface and ground water resources. To provide sustainability clean agriculture in this region, application of this result to the water management organization and fertilizer used effectively that is expected to decrease the grey water footprint.

Keywords: water footprint, strawberry cultivation, Bor Keaw Sub-district

## **INTRODUCTION ON GENERAL PLAN OF ECOLOGICAL ENVIRONMENTAL PROTECTION OF CLEAN LAKES**

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At present, the overall situation of the ecological environment of lakes (including reservoirs) in China is unoptimistic. Since the "Ninth Five-Year Plan", China has carried out the large-scale work of treating severely polluted Lake Taihu, Lake Chaohu and Lake Dianchi; as a result, the deterioration of water quality has been initially controlled. In order to protect the ecological environment of lakes and avoid the old route of "pollution first and treatment later", the Ministry of Finance and Ministry of Environmental Protection, with the approval of the State Council, have been supporting the lakes having the area of over 50 square kilometers (km<sup>2</sup>) with drinking water sources or important ecological functions, and the current water quality or target water quality of being higher than Grade III (including Grade III) to carry out the ecological environmental protection work since 2011. So far, the central government had invested a total of RMB 15.8 billion (in 3 batches) to support the ecological environment protection work for 77 lakes, including Lake Fuxian, Lake Qiandao and Lake Erhai, which had mobilized the local and social investment of about RMB 40 billion. Since the treatment, the water quality of these lakes has been improved, and the ecological environment has been gradually restored.

Basic Principles of the Plan: 1. Giving priority to protection and putting prevention first; 2. Protecting in accordance with laws and conducting goal constraint; 3. Guiding by regions and comprehensively implementing the policies; 4. Clearing the responsibility, and conducting planning and coordination; 5. Broadening the channels and making the multiple investment. Protection Strategy of the Plan: (I) Regional Protection; (II) Protection Countermeasures: 1. Investigate and evaluate the ecological security situation of lakes; 2. Adjust the industrial structure and layout in lake basins; 3. Strengthen the pollution control in lake basins; 4. Carry out the ecological construction and recovery of lake basins; 5. Rationally use the land and water resources in lake basins; 6. Strengthen the construction of lakes' environment supervising ability.

Supporting Measures of the Plan: (I) Strengthen the responsibility of entities and make strict the performance assessment; (II) Perfect the policy measures, and establish the long-term mechanism; (III) Broaden the financing channels and innovate financing methods; (IV) Strengthen the ecological monitoring and intensify the scientific support; (V) Implement the information disclosure and encourage the public participation.

Keywords: Clean Lakes; Ecological Environmental Protection

## **PHYTOTECHNOLOGY APPLICATION TO CONTROL LAKE WATER QUALITY: A PRELIMINARY TRIAL IN A SMALL LAKE OF SITU CIBUNTU, CIBINONG, WEST JAVA, INDONESIA**

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A preliminary trial to use aquatic plants for controlling small lake – Situ Cibuntu in Cibinong, West Java, Indonesia - water quality has been carried out. A phytotechnology pond system consisted of 2 tarpauline pond series, each contained 1 reservoir pond, 4 phytoremediation ponds, and 1 buffer pond. The phytoremediation function was facilitated by some floating plants which were planted in the phytoremediation ponds. The experimental floating plants were minute duckweed (*Lemna perpusilla*), greater duckweed (*Spirodella polyrrhiza*), water lettuce (*Pistia stratiotes*) and water hyacinth (*Eichornia crassipes*). The phytoremediation capacity was evaluated according to some water quality parameters monitored at points of the reservoir pond, phytoremediation ponds, and buffer pond. They included pH, DO, conductivity and turbidity measured twice a week, as well as total suspended solid (TSS), total organic matter (TOM), total nitrogen (TN) and total phosphorous (TP) which sampled and analysed every week. The results shows that floating aquatic plants can be potentially used for lake water phytoremediation agents. Meanwhile, the observed variation among the plants phytoremediation capacity emphasizes the important of plant selection in developing the phytotechnology for lake water quality control. This selection has to consider the lake water trophic status and in particular has also optimized by appropriate phytotechnology pond design.

Key words: phytotechnology, aquatic plants, lakes, water quality

## **MONOFILAMENT GILLNET AS A CONTROL OF MIDAS CICHLID (*AMPHILOPHUS CITRINELLUS*) AT WADUK IR. H. DJUANDA, WEST JAVA**

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Midas cichlid (*Amphilophus citrinellus*) is a invasive alien species in the Ir. H. Djuanda Reservoir. The presence of these fish is one of the factors leading to the decline of fish species diversity. The purpose of this study was to gain control techniques midas cichlid populations in the Ir. H. Djuanda, West Java. The results showed for the control these population to do with catching fish using gillnet monofilament with mesh size of 3.8 cm (1.5 inch). The use of mesh sizes can catch fish on the size of the first length of maturity are 11.3-13.5 cm (average 12.4 cm) for male and 11.6-12.7 cm (average 12.0 cm) for female. Mesh size of 3.8 cm was also just catch fewer another important economic fish species. Gillnet monofilament installation can be done at the aquaculture location like zona 5 (Baras Barat). At the location of the aquaculture of a number of fish caught midas cichlid was high and most have mature gonad. Catching with mesh sizes and the exact location is expected to break the reproductive cycle of the fish.

Keywords: control, midas cichlid, gillnet monofilament selectivity, Ir. H. Djuanda Reservoir

## EFFECTIVENESS OF THE COAL ASH FOR IMPROVEMENT OF WATER ENVIRONMENT

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Is coal ash superior to the ash of plants and trees? The ingredients of coal ash are almost same as them of plants and trees. But, the composition ratio of ingredients is different. The ashes have been used for improvement of the living environment from ancient times. For example, it has been utilized as the source of mineral. There is a famous Japanese fairy tale that Grandfather Cherry Blossom made dead trees bloom by using the ashes. In modern society, ashes of plants rarely have been seen in daily life. Can coal ash substitute the ashes of plants as the essential material for human life? The purpose of this paper is to propose the utilization of coal ash as the valuable material for restoration of water environment. Deterioration of sediment quality is one of serious problems in water area. Recently, restoration technologies with granulated coal ash ("Hi-Beads") are widely applied for sediment remediation in Chugoku district, Japan. Hi-Beads is a valuable product made from coal ash and is proven to absorb phosphate and hydrogen sulfide. From our findings, biodiversity and ecosystem have been recovered in the water area with sprayed Hi Beads. Like the story of Grandfather Cherry Blossom, it was confirmed that coal ash can supply minerals same as ashes of plants and trees. It is a logical environmental purification method that an algal can grow proliferously, because of the supply of SiO<sub>2</sub> from Hi-Beads. In addition, an aquatic plant can recover with Fe supplied from FeO<sub>2</sub> in Hi-beads.

Keywords: Granulated coal ash, Coal ash, Covering material, Supply of mineral, Sediment remediation

## Topic 9 Manmade Lakes

### EFFECTS OF CHECK DAM ON MACROINVERTEBRATES IN HUAI TON KOK WATERSHED, CHIANG MAI PROVINCE, THAILAND

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Check dam is a construction that used for water and soil conservation but, river ecosystem was changing by check dam. The aim of this research was to study physico-chemical parameters and macroinvertebrate communities before and after check dam constructed. The study sites were located in 3 Check dam sites including above and below check dam and 1 non-check dam site (reference site) in Huai Ton Kok watershed, Chiang Mai Province, Thailand. Physico-Chemical parameters including DO, BOD<sub>5</sub>, pH, Conductivity, water velocity and nutrients were measured and the macroinvertebrates were collected between June 2015 and April 2016. It was found that check dam had none significant effect on physico-chemical factors, except velocity, BOD<sub>5</sub> and nutrients. The BOD<sub>5</sub> and nutrients of the below check dam sites were lower than above check dam sites. In addition, the BOD<sub>5</sub> and nutrients were increased after check dam constructed. According to the construction of check dam, the macroinvertebrate communities were changed. The insect order Trichoptera, Coleoptera and Ephemeroptera were dominant orders before check dam constructed. Then, after check dam constructed, the Coleopterans Hemipterans and Dipterans were dominant in above check dam sites which different from the below check dam sites where Trichoptera, Odonata and Ephemeroptera were dominant orders. In addition, according to the Surface Water Quality Standard of Thailand, both before and after check dam constructed water quality was classified to moderate level. In conclusion, water velocity and habitat type were changed according to the check dam construction, which effect to the changes of macroinvertebrates communities.

Keywords: check dam, macroinvertebrate, water quality, Huai Ton Kok

## **BIOLOGICAL, PHYSICAL AND CHEMICAL PROPERTIES OF PENJALIN RESERVOIR IMPLICATIONS FOR ASSESING LONG-TERM MONITORING**

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Majority of local society in Brebes, Central Java had been depended to Penjalin Reservoir for a long time. It utilized for agriculture irrigation, fisheries and plantation. It have a lot of nutrient flow because anthropogenic activities around it. This work was held since 2014. This work has 3 parameters, biology, physic and chemical properties of Penjalin Reservoir in 6 sampling spots. These properties relationship analyzed using correlation and ordination data processing to know well changes that had been happened in the past 3 years. For biology properties, survey has been done with plankton net and observed under light microscope. Plankton community structure then being correlated with Penjalin chemical (Nitrit, Phospat, DO, BOD etc) and physical factor (light penetration, pH, and temperature). Ordination analyses has been done to know these properties tendency. These result and trend for the past 3 years could be used to asses eutrophication event and make a policy also strategy to do a long term monitoring.

Keywords: reservoir, eutrophication

## **DETERMINATION OF UTILIZATION ZONING FOR ECOSYSTEM SUSTAINABILITY OF WADASLINTANG RESERVOIR**

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Wadaslintang is a multipurpose reservoirs as a consequence a lot of problems occurred, among which are siltation, eutrophication, pollution, productivity declines due to overfishing, reduced volume of lake water when drought and floods when it rains. Zoning is a form of engineering utilization of space through the establishment of functional limits in accordance with the resource potential, carrying capacity and ecological processes. In determining the reservoir utilization zones based on the principle of sustainability must be based on the criteria of an ecological approach (water quality), water pollution load capacity, status management, socio-cultural aspects surrounding dams and economical aspects. Water quality of Wadaslintang reservoir was heavily polluted. There were 10 parameters that exceeded the standard quality of class II on the TSS, BOD, COD, PO<sub>4</sub>, Cd, Pb, Cu, H<sub>2</sub>S, oils/fats and detergents. Furthermore, the load pollution entering the reservoir has exceeded its maximum capacity (up to 47.32%), Therefore, there were 5 (five) zoning could be determined to conserve the ecosystem of Wadaslintang Reservoir, that were : Fish Conservation Zone, Border Zone, Captive Fishery Zone, Fish Farming Zone, Recreation Zone and Hidropower Zone.

Keywords: Zoning, pollution load, carrying Capacity, Wadaslintang Reservoir

## NITROGEN LOAD INFLOW TO LARGE SCALE RESERVOIRS IN THE CITARUM RIVER BASIN, INDONESIA

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Human population growth has led to increases in energy and food production, use of fertilizers, and wastewater flows. Enhanced availability of nitrogen is a cause of eutrophication of rivers, lakes, and estuaries worldwide; however, quantitative evaluation of the impact of population growth on nitrogen load has been insufficient in developing countries because data are often unavailable. In this study, a nitrogen-load estimation model, which has three nitrogen pools, was developed and applied to the Citarum River Basin, West Java, Indonesia. Simulated river discharge and nitrogen load were in good agreement with observed data, and the proposed model successfully estimated nitrogen inputs into reservoirs. Next, we investigated the future variation of nitrogen load in this basin under population growth scenarios. Future population growth increased the nitrogen inflow to all reservoirs, but the magnitude of the increase varied between the different scenarios. For the water environment of the Citarum River, a spread-type population increase is desirable; however, population increase normally occurs mostly in urban areas because living in a city is more convenient for housing, finding employment, and accessing public services.

Keywords: Nitrogen balance, Population growth, Urban and rural areas, Reservoir, West Java

## Topic 10 Limnology and Limnological Science Fundamentals

### WATER QUALITY STATUS OF SINGARVA LAKE AT AHMEDABAD, GUJARAT, INDIA

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The present study was carried out to determine the Water quality of Singarva Lake at Ahmadabad –Gujarat, for period of two year during 2010. The minimum and maximum values of pH varied from 6.8 to 8.5 respectively .variation in TDS 305 to 1210 mg/l , Total hardness 100to 200 mg/l , Calcium Hardness varied from 50 to120mg/l were in good amounts in water and magnesium hardness is minimum and maximum 40 to 130 mg/l. Concentrations of Chloride is 141.91 to 629.85 mg/l . D.O concentration 0.6 to 3.6 mg/l, COD varies from 1.0 to 117 mg/l and BOD 8.1 to 37 mg/l respectively in Singarva Lake.

Keywords: Lake, Singarva Lake, water quality.

### ASSESSMENT OF WATER QUALITY MONITORING IN THE TOBA ASAHAN RIVER BASIN

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Toba Asahan River Basin is located in the North Sumatra Province, Indonesia. The main water resources in the basin is originated from Lake Toba which cover the area of 2,225.45 km<sup>2</sup> with three main sub basins, Asahan, Silau and Piasa. The main challenge in water resources management in the basin especially in water quality monitoring due to the pollution from tourism activities, domestic waste, fisheries activities and industrial pollutant. Therefore, is needed an assessment of the condition on the dispersion of pollutants in the basin to determine the sampling point for water quality monitoring. The methods in this study is using dispersion pattern of dissolved material in the lake and using approach of stratification system in the deep lake. The findings of the study are there are three groups of point sampling water quality in the Lake Toba, (1) the sampling point to obtain a reference quality data of lake Toba in the area which is not contaminated and potentially protected from pollution sources (one point); (2) the sampling poin to obtain data to describe lake water quality based on administrative area (twelve point) and (3) the sampling point to obtain data which describes the condition near the sources of pollution (pollution zone) (seven point). The determination of the location of sampling point should be implemented gradually and should be evaluated every year. For medium term objectives (5-10 years), an online monitoring should be developed and implemented in the basin based on the sampling point that have been evaluated periodically.

Keywords: river basin, water quality monitoring, dispersion of pollutants, sampling point, lake stratification system.

## **PHYTOPLANKTON BASED ASSESSMENT OF TROPHIC STATE OF TIKUB LAKE IN TIAONG, QUEZON, PHILIPPINES**

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Tikub Lake is circular Crater Lake with surface area of 48.34 hectares and maximum depth of 75 meters. The lake has been used primarily for ecotourism and aquaculture. However, the lake is experiencing stress due to the different anthropogenic along its bank such as cutting of trees along the bank, human settlement and excessive use of fish feeds for aquaculture. Despite this scenario, there is no published research regarding the quality of the lake's water. Thus, this study seeks to provide a baseline information regarding the trophic status assessment of Tikub using phytoplankton as indicator species. The phytoplankton community, abundance and some physico-chemical parameters were analyzed from September to December 2015. Four stations in littoral zone and two stations in limnetic zone were selected. Phytoplankton samples were collected in the littoral zone using horizontal hauling and vertical hauling for limnetic zone. A total of 13 species were recorded throughout the sampling period. For phytoplankton, Cyanophyta was the most abundant group with relative abundance of 53%, followed by Bacillariophyta (24%), Chlorophyta (22%) and Dinophyta (1%) In terms of mean density (per m<sup>3</sup>) (MD) and relative abundance (RA) for phytoplankton, the highest is *Microcystis* (MD= 11,619,939; RA= 53.88%), followed by *Melosira* (MD= 5,121,058; RA= 23.75%) and *Staurostrum* sp. 1 (MD= 12.11% RA= 18.277%). Abundance of these plankton species indicates that the lake is still experiencing mesotrophic to eutrophic condition. In terms of diversity, phytoplankton community in the lake showed low species richness, diversity and evenness.

## **PHYSICAL-CHEMICAL ENVIRONMENTAL FACTORS FRESHWATER CRABS CAUGHT IN THE RIVER MENGAJI, DISTRICT BANYUMAS**

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Freshwater crabs is one of the aquatic organisms that contribute in converting nutrients, improve mineralization and maintaining the ecological balance. This study aimed to determine the physical-chemical environment of freshwater crabs in The river Mengaji, District Banyumas. Physical-chemical factors examined include the type of substrate, the speed of the river flow, water temperature and the substrate, water pH and substrate, and DO. Physical-chemical factors data were analyzed by descriptive analytic. Identification of freshwater crabs crustacean conducted at the Laboratory of Crustacea Lembaga Ilmu Pengetahuan Indonesia (LIPI) Cibinong, Bogor. The results showed that the physical-chemical environmental factors which include the composition of the substrate, substrate temperature, substrate pH, DO and flow velocity effect on different types of crab are caught.

Keywords: freshwater crabs, physical chemistry waters factors, substrat

### **MESOCYCLOPS SARS, 1914 AND THERMOCYCLOPS KIEFER, 1927 (COPEPODA: CYCLOPIDAE) IN THE PHILIPPINE LAKES**

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In spite of the large number of the fresh water bodies in the numerous islands of the region, the freshwater cyclopoid copepods of the Philippines have not been given much attention. A study on the species composition and distribution of *Mesocyclops* and *Thermocyclops* are conducted to update the species list in the Philippines. A total of 53 lakes were examined and analyzed from the samples deposited in University of Santo Tomas – Zooplankton Reference Collection (UST-ZRC) (collected from 2006 to 2013) together with more recent collections (April 2014 to 2015). Also, all available published materials were reviewed for all Philippine records of freshwater Cyclopidae. Five species of *Mesocyclops* and three species of *Thermocyclops* were identified from the samples. An updated list of 11 species of the genus *Mesocyclops* and *Thermocyclops* recorded for the Philippines is here presented, including all sources of information. Our results include the first recorded occurrence of *Mesocyclops woutersi* in the Philippines which was so far unknown from insular South East Asia. The endemic *M. microlasius*, previously only reported from Luzon Is., was also found in Lake Danao (Pacijan Is.) which is now considered to be its southernmost distribution in the country. Geographic distribution of the species, the possible causes of the low number of species observed and its implications for further fauna studies are also discussed. Our data suggest a strong connection of the Philippine Cyclopidae in other neighboring Asian and Australasian fauna.

Keywords: distribution, freshwater, *Mesocyclops woutersi*, species composition, zooplankton

### **WATER QUALITY AND TROPHIC STATUS OF MAE KLONG RIVER, WESTERN THAILAND**

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The aim of this study was to determine water quality and trophic status of the Mae Klong River, Western Thailand. Three replicates of water samples were collected from 6 study sites along Mae Klong River between October 2015 and February 2016. Six physicochemical factors were chosen for trophic status analysis base on physicochemical index which modified and applied for water quality classification in Thailand. The results showed that water quality of Mae Klong River were classified as clean to moderate level. It could be classified as oligo-mesotrophic status. However, the study site which located nearly discharged point of pulp and paper mill effluent, represented moderate to polluted water quality (mesotrophic to eutrophic status) while, study site which located at the Ban Pong City showed moderate water quality (mesotrophic status). The overall water quality of Mae Klong River was decreased from upstream to downstream and classified to class 3 of the surface water quality standard of Thailand base on beneficial use.

Keywords: water quality, trophic status, Mae Klong River

## WATER QUALITY AND DIVERSITY OF AQUATIC INSECTS IN HIGHT LAND AGRICULTURAL AREA, CHIANG MAI THAILAND

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The highland agricultural products are widely popular in Thailand. One of the most important rose production area is located in Northern Thailand. In high production season, high volumes of chemicals have been used for enhancing their products which have also been contaminated in highland soil that eroded by rain and runoff to stream. The stream organisms have been affected by these chemical erosion. This study was aimed to investigate physico-chemical parameters and diversity of aquatic insects from upstream to downstream of Mae-Sa tributary streams in Buak Tuei village, Pong Yang Sub-district, Mae Rim District, Chiang Mai Province, Thailand. Water samples and aquatic insects were collected from 5 study sites of Mae-Sa tributary stream. The upstream sites located nearby agricultural area. The results showed pH, conductivity, velocity were significant difference ( $p < 0.01$ ) between sampling sites. Whereas, TDS, BOD<sub>5</sub> and ortho-phosphate represented significant different between sampling sites at  $p < 0.05$ . According to aquatic insect diversity, the highest abundant in upstream were represented by Chironomidae, Simuliidae, and Gerridae Family respectively. Whereas, the downstream sites were presented by Chironomidae, Simuliidae, Hydropsychidae and Baetidae. The downstream sites showed higher diversity as they presented 27 of insect families, while upstream sites presented only 17 families. As the results, upstream sites showed the higher concentration of BOD<sub>5</sub> and ortho-phosphate than downstream sites. Therefore, they might be affected to diversity of aquatic insects nearby agricultural area.

Keywords: water quality, highland agricultural, aquatic insects

## COMMUNITY STRUCTURE OF PHYTOPLANKTON AND THE TROPHIC STATUS OF TELAGA TUNJUNG RESERVOIR

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Telaga Tunjung reservoir is located in Timpag Village, Kerambitan Subdistrict, Tabanan Regency. The reservoir is used for industry, irrigation and tourism development. The aim of the research was to determine the community structure of phytoplankton and to obtain information on the current condition of the Telaga Tunjung trophic status, viewed from the abundance and diversity of phytoplankton. Phytoplankton plays a very important in a water body. The abundance of phytoplankton can be connected with fertility waters because phytoplankton can transform inorganic substances into organic matter through photosynthesis. This research was conducted from January to February 2016. Water sampling was conducted twice with a sampling interval of 2 weeks in 4 stations. There was a total of 50 species of phytoplankton found, consisting of 5 classes: Chlorophyceae (19 genera), Bacillariophyceae (13 genera), Cyanophyceae (7 genera), Dinophyceae (1 genera) and Euglenophyceae (2 genera). The most common species of phytoplankton found in the sampling station were *Peridinium* sp., *Chlorococcum* sp. and *Trachelomonas rugulosa*. Phytoplankton diversity was low, its value was 1.86. The average value of similarity index was 0.59. The average value of dominance index was 0.29. The average abundance of phytoplankton was 802.62 cell/l. Based on the abundance of phytoplankton and nitrate concentration, the trophic status of Telaga Tunjung reservoir is oligotrophic.

Keywords: community structure, phytoplankton, Telaga Tunjung reservoir, trophic status

## THE EFFECT OF NITRATE (NO<sub>3</sub>) ON THE GROWTH OF WATER HYACINTH BY WET BIOMASS IN BATUR LAKE

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Batur Lake is one of the natural lakes in the province of Bali where the activity of fishing, agriculture, tourism and housing available. This study aims to determine the effect of nitrate relation to the natural growth of the water hyacinth (*Eichornia crassipes*). Increased water hyacinth biomass in Songan station is the highest among the three other stations (Batur, Buahon, and Trunyan). At the end of the study (day 42), water hyacinth biomass of Songan station increase by 338.2 % from the initial weight, while at another station the increase weight ranges from 75 % -158 %. The highest daily growth rate in Trunyan station 3.68% / day, and the lowest in station Buahon which only reached 0.88% / day. At the station Songan where are many floating net which contribute to increase nitrate. There is a tendency of growth of water hyacinth faster at higher nitrate conditions. Nitrate conditions ranged from 0,35 to 0,62 mg /l which shows that the waters of Batur Lake classified into waters that have a high fertility rate (eutrophic).

Keywords: Water Hyacinth, Wet Biomass Growth, Nitrate, Batur Lake

## WATER QUALITY AND TROPIC STATUS IN LAKE MANINJAU WEST SUMATRA, INDONESIA

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Lake Maninjau in West Sumatra, Indonesia has very high utilization in inland area and aquatic area. In aquatic area cultured with floating net cages were one of primary activities had causing the significantly increase of the number of floating net cages, thus caused a decrease in water quality and mass mortality fish cultured in floating net cages. This study was aimed analyzed water quality and trophic status from 2012 to 2015. Water quality data measured every year in September around the area of floating net cages at four site ie Sungai Batang, Sungai Tampang, Bayur and Intake of Hydroelectric Power Plant in Muko-Muko village. Aquatic trophic state determination was based in Carlson Trophic State Index (TSI) measurement. This method used some represented parameters of physics, chemistry, and biology such as water transparency, total phosphorus, and chlorophyll-a. The results showed average water transparency in 2012, 2013, 2014 and 2015 each is 1.93±0.09 m; 1.67±0.39 m; 1.85±0.23 m; 1.40±0.18 m. Nitrite each is 0.14±0.03 mg/L; 0.16±0.05 mg/L; 0.17±0.04 mg/L; 0.15±0.04 mg/L. Total nitrogen each is 2.56±0.16 mg/L; 2.18±0.80 mg/L; 2.28±0.85 mg/L; 1.84±0.64 mg/L. Total phosphate is 0.26±0.01 mg/L; 0.62±0.09 mg/L; 0.49±0.14 mg/L; 0.46±0.15 mg/L. Aquatic area state of Lake Maninjau based on Carlson TSI from 2012 to 2015 was classified to high eutrophic category with the value of each 70.28; 79.09; 74.4 and 75.08.

Key words: Lake Maninjau, water quality, aquatic trophic state, Carlson Trophic State Index

## **ANALYSIS OF WATER QUALITY BASED ON TOTAL SUSPENDED SOLID, TURBIDITY, AND WATER CLARITY IN TELAGA TUNJUNG RESERVOIR**

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Telaga Tunjung reservoir has a function for irrigation for around 1.335 Ha irrigation land. Beside, also for supplying clean water to the household in 6 village in Selemadeg District, 2 village in Kerambitan District and 1 village in Tabanan District. The clean water also used in Soka tourism area and in Berembeng village. Telaga Tunjung reservoir also used for water resources conservation. This research aim to know total suspended solid at Telaga Tunjung reservoir as a reference for reservoir management. The method of this research were survey method and laboratory analyzing. The results of TSS in Telaga Tunjung reservoir were 2.667-91.278 mg/L. The lowest value of TSS was in January and the highest in February. The condition of TSS was in January (no rain). The difference between inlet and outlet was 19.051 mg/L or 61,22 %. In the downstream of reservoir, the TSS was getting lower. In February the differences between inlet and outlet was 53.315 mg/L or 140,43 %. The TSS at inlet, upstream and outlet in February increased significantly compared that in January and March. In February there was some location that exceed the second class water standard of central Government Regulation Number 82 in 2001 and Bali's Governor Regulation number 8 in 2007.

Keywords: Management, Reservoir Telaga Tunjung, TSS

## **THE ECOLOGY OF NILNAG LAKE, KASHMIR**

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The present paper describes the ecology of Nilang Lake, Kashmir. The physico-chemical parameters of the lake reflect the mesotrophic status of the lake. The aquatic plant community is dominated by Polygonum amphibium and Potamogeton lucens. The free floating community is represented by only one free floating macrophyte, Riccia fluitans. The plankton community is dominated by Bacillariophyceae. The benthic community is dominated by Chironomidae and Tubificidae. A number of tourism development related activities are taking place around the lake which are believed to have an impact on the ecology of this mesotrophic lake.

Keywords: mesotrophic, aquatic plant, plankton, benthic, tourism

## **PHYSICO-CHEMICAL CHARACTERISTIC IN DIFFERENT LAKES OF MALAYSIA**

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The objective of this study is to assess the physico-chemical characteristic of five selected lakes in Malaysia. The depth of the selected lakes range between 4 m and 100 meter. The selected lakes with increasing depth are Sembrong Reservoir, Bekok Reservoir, Dayang Bunting Lake, Sg Terip Reservoir and Kenyir Reservoir. Measurements were carried out at three sites in all lakes using a multi-parameter probe. The main parameters studied include temperature, dissolved oxygen, pH and chlorophyll-a. Additionally, water samples were also collected near surface for analysis of total phosphorus. Temperature-depth profile indicate that stratification of temperature was only apparent in deeper lake such as Kenyir. Stratification of dissolved oxygen was observed in most lakes despite their depth variation. Chemical stratification in the studied lakes was likely influenced by geological and chemical processes. Shallower lakes were observed to have higher nutrient concentration compared to deeper ones.

Keywords: reservoir, tropical lake, water quality

## **ANALYSIS OF LAKE TEMPE SEDIMENT CHARACTERISTIC BY STATISTICAL APPROACH**

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Sediment is a deposit for various of compounds, such as carbon and nitrogen compounds. These compounds are needed by aquatic plants and easily available for the growth of aquatic organisms. Factor analysis of multivariate statistic used to determine multivariable correlation at the same time. This study aims to look at the distribution of sediment characteristics as the aquatic life substrate in Lake Tempe. Sampling was conducted using Ekman Grab in March 2016 at six stations. The sediment samples were analyzed in the laboratory with parameters nitrogen, total organic carbon, total organic matter (TOM), and particle size with three fractions (sand, silt, and clay) based on technical analysis methods of sediment. The results showed that the type of substrate sediments in Lake Tempe dominated by clay substrate (70.83%). Based on principal component analysis (PCA), stations 1, 3, and 5 are characterized by sand substrate with high concentrations of total organic carbon and TOM, while the stations 2, 4, and River Bila characterized by silt and clay substrates with high concentration of nitrogen and a lower pH.

## **NUTRIEN CHARACTERISTICS AND TROPHIC STATUS OF LAKE SENTANI , PAPUA INDONESIA**

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Lake Sentani is the largest lake in Jayapura with the area extending about 96, 300 m<sup>2</sup> at 75 m above sea level height. The main activity in the Lake Sentani is the tourism sector. The development of community activities around Lake Sentani has caused changes the lake water limnological characteristics. The particular change is observed from Nitrogen (N ) and Phosphorous (P) loading causing the water becomes more fertile. This study was conducted to determine spatial and temporal chemical properties (mainly N and P) distribution. It is expected that the obtained information can be the basic for the lake sustainable management. The sampling was conducted in April and October 2014. The measured nutrient concentration at the surface, the sechi depth and the bottom were relatively similar. In general, TN concentration in April ranged from 0.612 to 1.310 mg / L with an average of 0.896 mg / L (the surface area), 0.720 to 1.293 mg / L with an average of 0.930 mg / L (Secchi Depth), and 0.496 to 1.070 mg / L with an average of 0.838 mg. Whilst, TP concentration for the same depths ranged from 0.19 to 0.23 with an average of 0.22 mg / L, 0.13 to 0.33 with an average of 0.24 mg / L, and 0.19 to 0.33 mg / L with an average of 0.24 mg / L respectively. The observed concentration of TN in October was slightly lower. The concentration of the surface area, Secchi Depth, and bottom depth was 0.51 to 1.32 mg / L with an average of 0.94 mg / L, 0.21 to 0.81 mg / L with an average concentration of 0.59 mg / L, and 0.10 to 1.16 mg / L with an average of 0.70 mg / L. The concentration of TP in the same month ranged from 0, 02 to 0.06 mg / L with an average of 0.04 mg / L, 0.03 to 0.38 mg / L with an average of 0.08 mg / L, 0.07 to 0.28 mg / L with an average of 0.12 mg / L for the three depth respectively. The TSI Carlson's calculation showed that Lake Sentani is lightly eutrophic. The TSI values ranged from 52.658 to 57.896 with an average of 54.304 in April. While in October the value of TSI ranged from 33.717 to 45.016 with an average of 40.508.

Keywords: Characteristics, nutrients (N and P), Trophic Status and Lake Sentani

### **PRELIMINARY LIMNOLOGY PROFILE OF CIBEUREUM URBAN LAKE IN BEKASI**

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Cibeureum lake is one of urban lake in Bekasi with map position -6.298653, 107.043200. This lake have a quite disturbance because anthropogenic activities such as fisheries, agriculture irrigation and tourism. Nutrient pollution flow to this lake will also be the most important thing to be noticed. This work will contribute to urban lake monitoring that could affect microclimate change in the future and better understanding to do a paleolimnology approach. Field work initiated by taking a sediment samples in 2 purposive area by a single core. Sediment sample processing (HCL and H<sub>2</sub>O<sub>2</sub> reagent) will be held in Jenderal Soedirman University laboratory to get a diatom assemblage profile. Any physical and chemical properties will be taken to support diatom community analyses. Diatom community data processing by PRIMER 7 and will be represented using PAST package.

Keywords: urban lake, paleolimnology, nutrient pollution

### **SITUBUNTU AND ECOLOGY PARK LAKE WATER QUALITY ASESSMENT IN BOGOR**

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Situbuntu and Ecology Park is an urban lake located in near area at Bogor. These lake was utilized as recreational park for a long time. Water quality assessment for both lake is needed to know a significant different and to know what a significant factor affected and changes those lake. We had done a phytoplankton spatial sampling in both lake in different period. The highest abundance of phytoplankton in Ecology Park Lake is 1637,5/m<sup>3</sup> in central area and 12.733/m<sup>3</sup> in central area situbuntu lake. Other parameter was taken such as DO, pH, Temperature and brightness with water quality checker. Correlation between those parameter has been done This work will give us basic informations and will be used to create a management strategies for these recreational lake

Keywords: situbuntu, ecology park

### **THERMAL STRATIFICATION AND STABILITY OF LAKE MANINJAU, WEST SUMATERA**

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Lake Maninjau is a deep and eutrophic lake, located in west Sumatera, Indonesia. Geographically, lake Maninjau experiences a hot and humid climate throughout the year. Atmosphere temperature variations was greatly influences the physical phenomena in lake, especially thermal stratification and lake stability. This paper describes the fluctuation of thermal stratification and stability in lake Maninjau at 2007, 2009, 2015 and 2016. There are four mathematical calculations related to lake stability as a function temperature: thermocline depth (t.d), bouyancy frequency (N<sub>2</sub>), center of bouyancy (c.b) and stratification index (SI). The water coulumn temperature is measured in DM7 station. The t.d is different in evey year. The deepest thermocline depth is 10.9 m in 2009 and the shallowest is 1.5 m in 2015. While the thermocline depth in 2007 and 2016 are 8.9 and 9.3 m respectively. Thermal stratification of water coulumn is varying in every year which is shown by the highest thermal stratification index is 14422.4 Jm<sup>-2</sup> in 2007 and the lowest is 3270.6 Jm<sup>-2</sup> in 2015. The same with SI and t.d, center of bouyancy and bouyancy frequency are varying in every year. The deepest of the center of bouyancy is in 2007 (c.b = 35.7 m) then decreased until 2016 (c.b = 15.3 m). The fluctuation of stability parameter in every year, indicates that lake Maninjau is quite susceptible to the physical characteristics changes of the atmosphere.

Keywords: Thermal stratification, lake stability, bouyancy frequency

## DISTRIBUTION AND DIVERSITY OF DIATOM ABUNDANCE IN SEDIMENTS OF SHALLOW LAKE IN CIBINONG BOTANICAL GARDEN

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Diatoms are classified as algae within the Division of Bacillariophyta. They are unicellularly eukaryotic organisms characterized by siliceous cell walls that can be long preserved in sediments. Therefore, diatom analysis in sediment records is potential indicator used for environmental reconstruction. The current knowledge on the distribution and diversity of diatoms in the sediment in many shallow lakes in Cibinong-Bogor is poorly known. This study aimed to identify the distribution and diversity of diatoms from the sediments of the shallow lake. We expect to obtain primary data base of a variety of diatoms. The sediment samples were taken from Lake Cilalay and Lake Cibuntu in Cibinong Botanical Garden. Sediments were digested using HCl and H<sub>2</sub>O<sub>2</sub>. The resulting diatom solution was dried and transferred onto glass coverslip, which subsequently mounted onto microscope slides using *Naphrax* (Refraction index 1.7). Diatom Identification was examined using light microscopy at 1,000x magnification. Diatom communities in Lake Cilalay were dominated by genus *Stauroneis*, *Eunotia*, and *Pinnularia* whereas Genus *Eunotia* was predominant in Lake Cibuntu. This exploratory survey provides the first inventory of diatom assemblage in Cibinong region for roughly inferring the environmental changes in shallow lake ecosystem.

Keywords: Diatoms, palaeolimnology, shallow lakes, Cibinong Botanical Garden

## THE GEOLOGICAL PROCESSES IN AND AROUND MANASBAL LAKE, KASHMIR

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The present paper attempts to represent the geology of Manasbal lake, Kashmir ( ) situated in the lap of Triassic limestones of approximately 245 million years. The middle Triassic limestones pass upped into more massive beds of upper Triassic limestone of several thousand meters and covers much wider than area lower and middle units and the escarpments formed out of this limestone series exhibits the best scenic geological formations around. These comprise pale grey limestone and dolomites with occasional quartzite layers. The dissolution processes in and around the lake have given rise to sink holes, caverns, caves on the periphery and floor of the lake. The presence of sink holes on the floor of the lake have made it the deepest lake in the region. The lake is fed through springs oozing out of these solution cavities and joints. The biggest advantage of these geological processes is that no major influx of sediments finds way into the lake. The recent subsidence of Nesbal area is an outcome of these geological processes associated with cavern formations. The physico-chemical parameters of the lake are chiefly governed by these geological processes.

Keywords: geology, limestones, quartzite, sediments, springs

## **BIOGEOCHEMISTRY OF TROPICAL KARST LAKES: STUDY CASE IN LAKE AYAMARU, WEST PAPUA, INDONESIA**

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When it comes to inland lake management, a lake's hydrological and biogeochemical characteristics should be understood before making any decisions. Especially the biogeochemistry of a lake is critical for effective long-term planning and resource management. Lake Ayamaru is a shallow lake located in a karstified limestone terrain in West Papua, Indonesia. Due to its relatively large size (ca. 22 km<sup>2</sup>) it might play an important role in the hydrogeology of the Ayamaru district. We have conducted a first limnogeologic pilot campaign in spring 2016 to measure the water parameters, take water samples and ca. 80 cm long sediment cores. The lake's water is clear and oxic; sunlight and oxygen penetrate to the surface of the sediment, which is methane saturated and mainly composed of conspicuously pinkish carbonate minerals. Due to the carbonate bedrock the lake is highly alkaline (up to 20 meq/L) despite its very low salinity. Pore water profiles show that hydrogen sulphide is eight times higher concentrated than sulphate (>150 µM and 20 µM, respectively). The lack of any sulphide minerals together with high methane concentrations indicates that remineralization of organic matter is driven mainly by sulphate reduction and methanogenesis. Other terminal electron acceptor processes do not seem to play any significant role. The lake's response to human activity and whether the unique biogeochemistry can influence the porosity of the lake's bedrock will be the subject of future studies. We hope that our biogeochemical study will provide valuable input for a holistic management of the lake.

Keywords: Shallow lake, Sulphur cycle, Methanogenesis, Karst lake.

## **THE STATE OF ORGANIC MATTER DURING DRY SEASON 2015 IN LAKE TONDANO, NORTH SULAWESI, INDONESIA**

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In this study, we present data on OM, TOC, total nitrogen (TN), and C/N from two different depths of Lake Tondano, North Sulawesi, Indonesia to identify the source of OM and understand the spatial distribution and interrelation among various parameters. Data were collected from 12 creeks within the lake vicinity. *In situ* measurement on chemical parameters was conducted by using Horiba and further analysis was done in the laboratory. PCA, Biplots Analysis and MDS as packages of Open Source Statistical Software R were used to figure out those parameters. TOC, TN% and C/N ratio of the Tondano lake waters indicate a mixed source of OM (terrestrial and *in situ* lake fish culture and other biota). Aquatic weeds, mainly *Echornia grassipes*, and plant detritus that grow along its margins as well as the use of fertilizers in paddy fields surrounding the Tondano lake also contributed to the current situation. To the same token excessive use of artificial food for floating fish cage culture was also assumed as a major cause contributing to the situation. The lake margins and lake-bed morphology control the distribution of sediment particulate matter and texture.

Keywords: Lake Tondano, dry season, Organic Matter, PCA, Biplots Analysis.

## ZOOPLANKTON SPATIAL DIVERSITY IN LAKE TONDANO, INDONESIA

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Study on freshwater ecology have been long focused toward subtropical habitats with few references to tropical regions. Despite the increasingly recognized as biodiversity hotspots, there is still lack of study of how spatial patterns drive ecological heterogeneity in tropical regions, particularly no such study has been conducted in Indonesia. Zooplankton, in particular, are among the most abundant aquatic organism and are key player of aquatic food webs and a solid understanding of their community structure can be of direct benefit to freshwater ecosystem management. We studied spatial patterns of zooplankton diversity in Lake Tondano, Celebes Island - Indonesia, with the aim to understand how local environmental and habitat heterogeneity driving the zooplankton diversity. We performed field samplings to collect zooplankton using a vertical two with a 156  $\mu\text{m}$  mesh net from 1 meter above sediment to surface, and to measure environmental parameters using portable multi probes water quality checker from three different water columns. The sampling designed included different habitats within the lake to look at diversity of the entire zooplankton communities (Rotifera, Cladocera, Copepoda) in Lake Tondano. We identified 22 species of cladocerans, 32 copepods and 59 rotifers. Our result indicates relatively low number of cladoceran which is found to be associated with high predatory pressure from planktivorous fish especially within the open pelagic zone. Lake Tondano is subjected to ecological disturbance due to several factors including invasive introduction and eutrophication. Our future work will look at temporal shift in zooplankton community composition in response to environmental disturbance in Lake Tondano.

Keywords: Zooplankton diversity, tropical lake, Lake Tondano.

## MICROZOOBENTHIC COMMUNITY STRUCTURE IN RELATION WITH CONCENTRATION OF TSS IN BANJARAN RIVER OF BANYUMAS, INDONESIA

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This study aimed to know concentration of Total Suspended Solid (TSS) in Banjaran River, structure community of microzoobenthic in Banjaran River as well as the relationship between TSS with abundance microzoobenthic Banjaran River. This study using survey method at 7 locations based on existsting environmental setting in Banjaran River. Sampling was performed 3 repetitions with interval of 2 weeks. Parameters are number of species and individual microzoobenthic as well as value of TSS. Analysis of data to determine concentration of TSS done in a descriptive way. Community structure of microzoobenthic utilize diversity index, evenness index, dominance index, and similarity index. To determine relationship between the abundance microzoobenthic with TSS concentration using regression analysis and correlation. Concentration of TSS in the Banjaran River 160.1 - 253.5 mg/l is still good to support life of microzoobenthic. Structure community of microzoobenthic in Banjaran River consists of 2 Phylum. They are Protozoa consists 10 species and Rotifera consists of 9 species. Abundance microzoobenthic in Banjaran River range 130 – 1039 ind/cm<sup>2</sup>. Diversity of microzoobenthic in Banjaran River is low. Dominance is low or no domination. The level of evenness microzoobenthic at each station on average is unequal, and the similarity between the station on average types are low and medium. The relationship between the concentration of TSS and microzoobenthic abundance in the Banjaran River showed a very low or negligible ( $r = 0.11$ ), This imply that microzoobenthic abundance determined by TSS at 1.21% and 98.79% is determined by other factors such as type of substrate.

Keywords: Microzoobenthic, Structure Community, TSS.

## **<sup>210</sup>Pb AND <sup>210</sup>Po TROPHIC TRANSFER WITHIN THE PHYTOPLANKTON – ZOOPLANKTON – NILE TILAPIA/COMMON CARP FOOD WEB : A CASE STUDY FROM THE CIRATA RESERVOIR, INDONESIA**

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Lead-210 (<sup>210</sup>Pb, half-life: 22.4 years) and Polonium-210 (<sup>210</sup>Po, half-life 138 days) are non-conservative natural radionuclides produced from the <sup>238</sup>U decay chain whose distribution and behavior in the fresh water for toxic reasons owing to <sup>210</sup>Po and <sup>210</sup>Pb accumulation on organisms and health concerns via the radiation dose received by humans through fish consumption. The transfer of <sup>210</sup>Pb and <sup>210</sup>Po in the food web of pelagic fishes (from phytoplankton and zooplankton to Nile tilapia, *Oreochromis niloticus* and common carp, *Cyprinus carpio*) will investigate in the Cirata Reservoir. The purpose of this research is to (i) investigate seasonal and spatial variability of <sup>210</sup>Pb and <sup>210</sup>Po activity in phytoplankton, (ii) determine <sup>210</sup>Po and <sup>210</sup>Pb bioaccumulation from phytoplankton to zooplankton trophic levels and (iii) define <sup>210</sup>Po bio-magnification from plankton to fishes. Data to be collected are <sup>210</sup>Pb and <sup>210</sup>Po activity concentration, C and N stable isotope ratios, measure from (i) different size classes of phytoplankton and zooplankton during dry and wet season in different environmental of the Cirata Reservoir, and (ii) in two fish species. A chlorophyll-a (*Chlo-a*) concentration will be obtain at each sampling site. Plankton will be collected using 200 µm, 60 µm and 6 µm mesh size plankton-net. Two small plankton size fractions will retain ([6 – 60 µm] and [60 – 200 µm]). Larger plankton organisms immediately sieved onboard through three different filter meshes: 1000 µm, 500 µm and 200 µm to obtain three large plankton fractions: [200 – 500 µm], [500 – 1000 µm], and [> 1000 µm]. Common carp and Nile tilapia will collected and dissected to extract muscle, liver and body remain (skin, head and skeleton). <sup>210</sup>Pb and <sup>210</sup>Po analyses will be performed on plankton, fish organ and water sample that filtered through 0.45 µm filter. Three replicate will be performed on each plankton fraction for each site and season for both δ<sup>13</sup>C and δ<sup>15</sup>N. Prior to stable isotope analyzes, the taxonomic composition of plankton fraction will estimate under a binocular microscope. The dominant groups of organisms will determine in each size fraction. A hierarchical clustering will be implemented to average <sup>210</sup>Pb and <sup>210</sup>Po mean activity concentration in plankton fraction using complete linkage and Euclidean distances to investigate radionuclide variation between sites and potential spatial structuring in zones in Cirata Reservoir with season. The differences in mean activity concentration of <sup>210</sup>Pb, <sup>210</sup>Po and <sup>210</sup>Po/<sup>210</sup>Pb ratios with size per season will be tested by a non-parametric Kruskal-Wallis Procedures. <sup>210</sup>Pb and <sup>210</sup>Po activity concentration, δ<sup>13</sup>C and δ<sup>15</sup>N values will be tested using two-way crossed ANOVAs to assess the effects of the zone and size parameters for plankton fraction for each sampling season. When the differences were significant, post-hoc comparisons of means will be performed with Turkey Tests. To test for bioaccumulation process across plankton fraction and within the two analyzes pelagic fish species, linear regressions will be run between the log<sub>10</sub> of <sup>210</sup>Po activity concentrations and δ<sup>15</sup>N values of plankton fractions and fishes.

Keywords: <sup>210</sup>Pb, <sup>210</sup>Po, phytoplankton, zooplankton, common carp, Nile tilapia, Cirata reservoir.

## **RELATIONSHIP BETWEEN SPECTRAL OPTICAL PROPERTIES AND OPTICALLY ACTIVE SUBSTANCES IN LAKE MANINJAU.**

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Light conditions in water are very important for primary production. Optical properties play a major role in the ecological structure and functioning of lakes. This study aims to look at the relationship between spectral optical properties (attenuation coefficient, transmittance) with optically active substances (secchi depth, suspended solid and volatile suspended solid concentration). The study have been conducted on eight stations during the month of May and August 2015 in Lake Maninjau. The attenuation coefficient of light is influenced by secchi depth. The shallowest of secchi depth in Koto Gadang (1.65 m) with attenuation coefficient is 0.6781. Transmittance of light decreases exponentially with increasing depth of the lake. For ach stations, suspended solid concentration ranges 0.83 – 3 mg/L and VSS value ranges 0.75 – 2.38 mg/L. The attenuation coefficient and depth correlated with VSS concentration. The concentration of suspended inorganic matter has a strong influence on the rate of attenuation of light into the lake.

Keywords: depth, attenuation coefficient, transmittance, suspended solid, volatile suspended solid.

## CHANGE OF PHYTOPLANKTON COMMUNITY OF ERHAI LAKE AND THE DRIVING FORCE DURING THE PAST CENTURY

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Erhai lake is one of the largest lakes (size 251 km<sup>2</sup>) in Yunnan-Guizhou plateau of China, which serve as the main water resource for drinking water and agriculture for the local region. Since 1996 severe algal bloom keep occurring in Erhai lake occasionally, posing threats to aquatic ecosystem and drinking water. To understand the phytoplankton community change during the past century, a paleolimnological investigation was conducted. 326 diatom species in total were observed in the sediment core with a span of about 150 years. *Cyclotella dubius* was dominant in the whole history, and *Aulacoseira granulata* and *Aulacoseira ambigua* became dominant since 1960s. The abundance of the mesotrophic indicator *A. granulata* showed a great increase from 1992 to 2004, positively correlated to TN increasing of the lake water quality. TP in sediment remained at low level until 1980s, and then gradually increase. An *in-situ* mesocosm experiment was also carried out to evaluate the improvement of nitrogen and phosphorus on the algal bloom formation. The results showed phosphorus was more important for the formation of *Microcystis* bloom in Erhai lake.

**Keywords:** Phytoplankton, community succession, paleolimnological record, Erhai lake

## ANALYSIS OF WATER QUALITY PROFILES AND THEIR UTILIZATION WITH SPECIAL REFERENCES TO SEVERAL LAKES IN INDONESIA

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Indonesian lake is one of the unique ecosystems which are functioning in both ecological and economic services. The objective of this study is to analyze the hydrological characteristics represented by several lakes in Indonesia. Surveys at Jatiluhur and Cirata reservoirs were conducted on July 2014 and March 2015, respectively. The results on the survey in Jatiluhur and Cirata reservoirs showed that the average depths are 32.9 m and 34.9 m, respectively. Jatiluhur reservoir covers 7,780 ha of area with maximum depth of 90 m. Meanwhile, Cirata reservoir covers approximately 6,200 ha of area with maximum depth of 106 m. Both of those reservoirs serve as important hydroelectricity power. Next, the percentage value of fish cages at Cirata reservoir was larger (2.02%) than that at Jatiluhur reservoir (0.51%). It indicated the potential impact from fish cages as pollutant at those reservoirs. In addition, based on water quality profiles (dissolve oxygen/DO, Chl-a and temperature), upwelling caused water quality degradation. In order to maintain the sustainability of the lake, basic ecological information is necessary for the next study.

**Keywords:** Jatiluhur reservoir, Cirata reservoir, Water quality, Fish cages

