TS9-1

琵琶湖・淀川流域圏における統合的流域管理の実現に向けたガバナンスのあり方

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抄録

本報告は琵琶湖・淀川流域を対象に,顕在化する課題解決に向けた関西広域連合の取り組みについてである.琵琶湖・淀川流域における課題の多くは,既存の政策的枠組みでは積極的に取り組みにくい“はざまの問題”であることを明らかにするとともに,その解決のためには流域各主体の自発的取組や連携・協働を促進するガバナンスが重要であることを示す.また,ガバナンス向上のためには政策決定に資する客観的根拠が重要であり,流域の状態を地先レベルで計量できかつ流域全体で俯瞰できる指標の活用が効果的であることを示す.そのうえで,関西広域連合が,流域の知識・知恵を集積し,調整役として裏方となり,流域各主体間が「現状の認識－課題の認知－連携・協働の枠組みと取組方針の設定－取組の実施」を繰り返しながらガバナンスを徐々に向上させ,結果として政策統合を進める方策を示す.本報告では,関西広域連合での統合的流域管理に関するこれまでの検討内容と取組を報告する.

1. 関西広域連合とは

関西広域連合は,地方自治法第 284 条に基づき 2010 年 12 月に設立された特別地方公共団体である.2017 年 3 月時点で,滋賀県,京都府,大阪府,兵庫県,奈良県,和歌山県,鳥取県,徳島県,京都市,大阪市,堺市,神戸市の 8 府県 4 政令市が参加している.関西広域連合は,広域行政の責任主体となることを設置目的に掲げ,防災,観光・文化・スポーツ振興,医療,産業,環境保全,資格試験・免許等,職員研修の 7 分野での広域事務を進めるとともに,国出先機関の権限移譲を求めるなど分権型社会の実現を目指している.関西広域連合は流域管理に関する直接的な権限・財源を持たないが,その一方で,連合委員会・連合議会の合意に基づき,構成団体間で共通政策の実施が可能である.

2. 背景

地球規模の気候変動や人口減少などに伴い,これまでの高度経済成長を支えた伝統的な政策的枠組みの中ではそれほど関心を示されなかった課題が顕在化するようになってきた.こういった新たに顕在化してくる課題の解決には,旧来の地域的・分野的・組織的“縦割り”を越えた対応が求められることも多く,それゆえ“縦割り”を克服する努力が各所で続けられている.流域関連政策の中でも水害リスク管理や環境リスク管理に関しては,“ガバナンス”の重要性が強調され,ガバナンスのあり方や向上方策について多くの研究が報告されている.

このような中で,関西広域連合は,2014 年 7 月に「琵琶湖・淀川流域対策に係る研究会(座長:中川博次京都大学名誉教授)」(以下「研究会」)を設置,同研究会の助言を得ながら,統合的流域管理を進めるための望ましい流域ガバナンスのあり方を検討し,2017 年度より段階的に実践しはじめている.

3. 統合的流域管理のための流域ガバナンス

(1) 琵琶湖・淀川流域に顕在化する課題とその特徴

流域 75 市町村を対象に実施したアンケート調査(2014 年 10 月)[1],各種白書などを基に流域圏の抱える課題を漏れなく可能な限り幅広く収集し,8 分類で約 50 課題を整理した.具体的な分類は、①流域治水・総合治水の推進,②利水システムの多重化,③ 地下水の保全,④水インフラの老朽化対策,⑤流域生態系サービスの総体的な維持・向上,⑥ 総合土砂管理の推進,⑦水の危機管理の強化,⑧流域文化の個性と繋がりの再生である。例えば,分類①の総合治水・流域治水を考える場合にも,河川部局・都市部局・農林部局・防災部局などの連携が必要であり,既存の枠組みではどの部局にとっても主要な課題として取り扱われ難い“はざまの問題”である.

(2)　統合的流域管理の必要性“はざまの問題”の解決

“はざまの問題”をこれまで以上に効率的に解決していくには，分断された地域・分野・組織に対して，流域単位で適時適切に縦串・横串を通して課題解決にあたる“統合的流域管理”を実現することを目指す．

(3)　統合的流域管理の目的

統合的流域管理の目的を，流域圏(集水域に氾濫域や給水域を加えた範囲)をひとつの単位として，①生態系サービスの総体的な維持・向上を図りながら，②水に起因するさまざまなリスクを軽減するとともに，③持続可能な水の利用を実現することによって，将来にわたって流域に暮らす人びとが享受する福利を最大化することとしている．

(4)　ガバナンスのあり方

統合的流域管理の実現のためには，現在では想定し得ない将来の課題に対し，行政区画や政策分野にとらわれることなく，適時適切に関係各主体(ステークホルダー)が集まり，その都度必要な合意形成・意思決定ができる“ガバナンス”を整える必要がある．

流域管理が適切に進められるよう，ビジョン(あるべき将来像)や課題の共有と関係主体間の連携・協働がより着実に進められる社会の構築を目指す．

4.　流域ガバナンスの社会実装

(1)　統合的流域管理の政策評価指標の提供

社会的インセンティブを与える政策手段として，政策決定に資する客観的(科学的)根拠を調達し，流域社会に提供することを通じて，関係各主体の自発的な行動や連携・協働を誘起していく．

＜客観的根拠となる指標の例＞

・治水・防災　水害リスク(発生確率別水理量など)

・水利用　　水循環　代替水源数，年水源涵養量等

・自然環境・生態系サービス

漂着ごみの発生源・フロー　等

(2)　主体的参加を誘起するコミュニケーション

流域ガバナンスを向上させていくうえで，流域の諸課題を他人事ではなく自分事として捉え，自発的・内発的に行動していただくことが欠かせない．それが統合的な流域管理の原動力となる．

(3)　流域ガバナンスの調整役

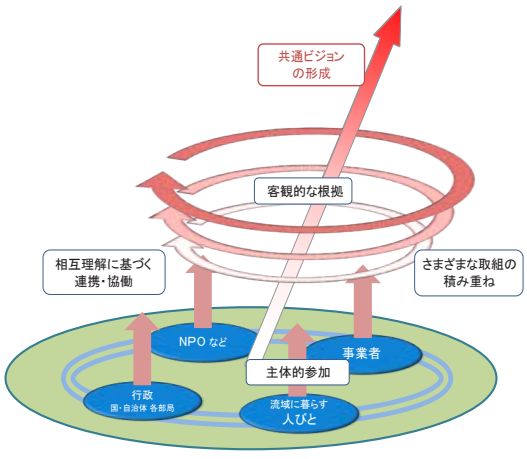
～関西広域連合が担うべき役割～

a)　調整役の役割

関西広域連合は，流域ガバナンスの向上のために，俯瞰的な視点(全体最適の視点)から“はざまの問題”を浮き彫りにし，流域社会に投げかけ，関係者間の相互理解を図り，それぞれの自主的な取組や連携・協働を促進する“調整役”としての役割を担うべきと考えている．この“調整役”の役割はA　流域に関する知識と知恵の収集・構成，B　現状分析と課題抽出，C　具体的な解決方策の検討，D　議論の機会づくり・場づくり，E　共有可能なビジョンの逐次とりまとめの5つである。

b)　調整役の留意事項－プロセスマネジメント

「D．議論の機会づくり・場づくり」は，関係各主体間で折り合いをつけながら一定の合意形成に至るまでのプロセスマネジメントであり，慎重な対応が必要と考えている．　この合意形成に至るまでのプロセスについては，取り組む課題の性質や，関係各主体の組み合わせ，時々の社会情勢，あるいは調整役自身の社会的立場



図−1　流域ガバナンスのイメージ，琵琶湖・淀川流域水環境会議 [1]を参考に加筆・修正

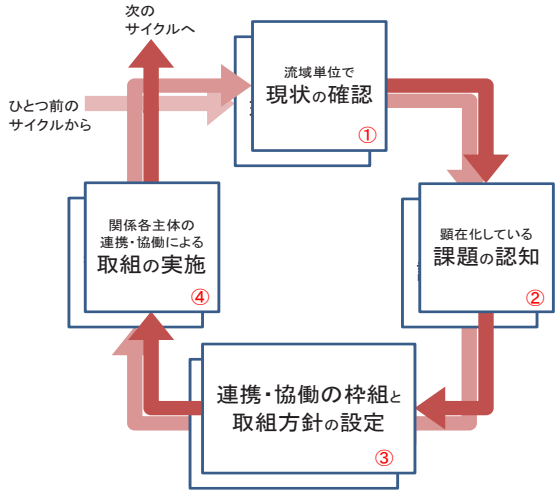


図-2　課題解決のフロー(1サイクル)

や信用能力なども十分に考慮し，柔軟に設計されるべきと考えている．

また，合意形成の過程において重ねられた議論が覆ることがないよう，客観的(科学的)根拠に基づく意思決定を丁寧に積み上げ，透明性を確保しなければならないと考えている．

c) 調整役の要件

流域ガバナンスの調整役は，政策決定に資する客観的(科学的)根拠を用意し，さまざまな工夫をしながら関係主体間の創造的コミュニケーションをお膳立てする舞台回し，裏方である．表-2 に，調整役に求められる要件を整理しておく．

表-2 調整役に求められる要件

信用	中立性・公平性が確保され，関係各主体からの信用があること．
課題設定能力（先見性）	全体最適の視点から適時適切な課題を抽出する能力があること．
課題解決能力（技術力）	技術的(科学的・制度的)に実現可能な解決策を見出す技術力があること．
課題解決能力（調整能力）	関係各主体の関心事に留意しつつ，連携・協働に導く調整能力を持つこと．

5. 適用状況と課題

流域ガバナンスの社会実装に向けて、関西広域連合は 2017 年度より以下 3 点に着手している．

・流域の状態(各種リスクやサービス等)に関する調査，および 8 つ課題に関連する国内外の取組事例の収集・整理を行い，定期的にレポートを作成

・流域管理に関連する既存のさまざまな議論の場に積極的に担当者が参加し，俯瞰的な視点と知識・知恵を駆使して，合意形成・課題解決に貢献すること

・流域の状態に関する客観的な根拠に基づき，既存の枠組みでは積極的に取り組まれて来なかった課題を取り上げ，議論の機会・場のお膳立てをし，事務局として具体的な解決方策を提案する

そこで，約 50 課題について，(i)広域性，(ii)分野横断性，(iii)実現性・実効性，(iv)既存取組の進捗状況といった観点から絞り込み，再編し，①水害に関する広域的なリスクファイナンス，②便益の帰着構造に基づく広域的な水源保全制度，③大阪湾海ごみ削減のための広域的な発生源抑制対策などを優先課題とした [2]．2017 年度は，①～③の実現化を図る準備として，流域各地点の水害リスクや水源涵養能力などの性能評価，大阪湾の海ごみの発生源を把握するための基礎調査に着手した．さらに調査結果をもとに，各課題解決の手段として，公的洪水保険・共済制度や，広域森林環境税・水源涵養税，ペットボトルのデポジット制度などについて制度化の可能性を探ろうとしている．

例えば仮に，水害リスクに応じた料率設定で保険制度が導入されれば，応分のリスク移転が進むだけではなく，副次的には水害リスクを考慮した土地利用・住まい方も誘導され，結果として都市計画や防災計画，河川計画にも反映されるかもしれない．これは，本稿で論じた流域ガバナンス，すなわち，流域全体を俯瞰しつつ課題抽出を行い，関係各主体の連携・協働による課題解決を図るプロセスに一歩踏み出すことに他ならない．

6. 結語

本報告は，琵琶湖・淀川流域を対象に，既存の社会的枠組みを前提としつつ，統合的な流域管理を実現するための望ましい流域ガバナンスのあり方を明らかにし，あわせて，関西広域連合が果たすべき役割を明らかにしたものである．

持続可能な流域社会の実現に向け流域政策の全体最適を図るには，既存制度や枠組の足らざるを補うアプローチが有効で，組織統合ではなく連携・協働を基調とした流域ガバナンスが必要である．さらに，流域全体を俯瞰する視点を持ち，客観的根拠を示しながら，関係主体間の合意形成・意思決定を促す“調整役”の存在がそのポイントとなる．

関西広域連合は，流域ガバナンスの中で，“調整役”の要件を現段階では十分に備えていないが，流域の状態に関する調査を定期的にレポートとして作成するとともに、流域の状態に関する客観的な根拠に基づき、既存の枠組みでは積極的に取り組まれて来なかった課題を取り上げ、議論の機会・場のお膳立てをし、具体的な解決方策を提案することを積み重ねることで、実務能力と信用を得る努力をすべきと考えている。

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TS9-2

Integrated Lake Basin Management (ILBM) as an integral part of Transforming the Malaysian Water Sector

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Keywords: Integrated Water Resources Management, Integrated Lake Basin Management, Water Resources Management, Water Services Management, the Malaysian Water Sector,

1. INTRODUCTION

The ASM Water Committee (AWC) was initiated and led, sometime in 2007, by the first Chair of the AWC, Tan Sri Shahrizaila Abdullah with the focus to assist the authorities in developing a National Integrated Water Resources Management Plan (National IWRM Plan or NIWRMP). In undertaking this task, the main IWRM paradigm were divided into some 24 sub-sets and sub-themes, of which ILBM was one of them. ASM benefited from the invaluable support from IAP and ILEC. Similar parallel studies on the other sub-themes identified, also progressed and study reports on some 10 key areas were completed and published by the end of 2015.

In early 2016, the time was opportune to carry out a synthesis of the outcomes and outputs from the detailed thematic studies to formulate a coherent National IWRM Plan and accompanying Strategies and Road Map for implementation. For the remaining 14 other sub-themes of the original 24 earlier identified, expert reviewers were commissioned on each, to complement the knowledge base in ensuring a more inclusive National IWRM Plan. Tan Sri Shahrizaila Abdullah led the Editorial Team to draft the synthesis report entitled *"Transforming the Water Sector: National IWRM Plan - Strategies and Road Map" [1].* It has since been published and formally launched by the Honourable Minister of Science, Technology and Innovation, Malaysia (MOSTI) in mid-December 2016. The report is in 2 volumes, Volume 1 being the Main Report and Volume 2, the set of Appendices. The report has since been presented to the Economic Planning Unit (EPU) of the Prime Minister's Department and other relevant ministries

2. LAKE MANAGEMENT IN MALAYSIA

Through its involvement in the Global Water Programme initiated by the Inter Academy Panel (IAP), ASM since 2004, has taken special interest in lake and reservoir management. IAP, with some 60 academics from around the world, identified the topics of Eutrophication of Lakes and Groundwater Management as 2 priority areas for its initial focus. ASM supported these two initiatives. For lake management ASM together with its partners, planned and initiated several studies and workshops to develop an information base line for an ILBM (Integrated Lake Basin Management). Some of these reports are detailed below.

2.1 A Desk Study on the Status of Eutrophication of Lakes in Malaysia [2]

NAHRIM (National Hydraulic Research Institute of Malaysia), with the support of ASM, commissioned UTM (Universiti Teknologi Malaysia) to carry out the above study in 2004.

This was a base line study with the objectives to

review existing information and status of the lakes, identify threats – both water quantity and quality, provide recommendations for remedial measures & environmental management strategies and for future planning, management, restoration and conservation

Among the findings of the 397-page report were

- There were at least 85 reports on lakes and reservoirs that have been documented
- In general, these studies can be classified into seven categories i.e.
  Aquatic flora, Fish & aquatic fauna, Dam & regulated rivers, Economic development, Management & tourism, Lake information system and Modelling & Water quality
- 62% of the 90 lakes surveyed were found to be eutrophic or nutrient rich, with the rest considered mesotrophic
- Major areas of research identified include
  Physical characteristics, Hydrology of lakes & reservoirs, Hydrologic & Chemical budget, Monitoring &assessment methods, Lakes & reservoir modelling and Environmental problems
- The national strategy for research and capacity building programs, requires funding mechanism and institutional & human resource

development

2.2 Lakes and Reservoir Management in Malaysia [3].

A Colloquium on Lakes and Reservoir Management was subsequently organised in August of 2007, and the proceedings were published, featuring articles related to ILBM such as by Prof Mahahisa Nakamura from Japan, Prof Maciej Zalewski from Poland, Prof Eduardo Mario Mendiondo from Brazil and nine other local papers. The output of this colloquium became another important document in preparing the next step of the required lake and reservoir management.

2.3 Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia [4]

A Technical Committee jointly hosted by ASM and NAHRIM, were set up to develop a strategic plan for Lake and Reservoir Management in Malaysia, through a multi-stakeholder consultation process with an initial conceptual framework report and several detailed thematic component plans. These reports were later synthesised to produce a three-volume publication on the "*Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia*" [4]. This publication recommended that lakes and reservoirs be sustained, restored and protected through the adoption of an ILBM approach, supported by the 8 strategies below:

- *To identify and empower a Lead Ministry/Agency*
- *To establish a National Lake Resource Centre*
- *To establish a Standing Committee on Lakes within the purview of the National Water Resources Council*
- *To establish Lake Management Committee at State Level*
- *The development of a Detailed Action Plan*
- *To support the Role of Local Communities in Lake Management*
- *To pass Appropriate Legislation to Strengthen Existing Legal Framework*
- *To enhance Networking and Strengthen International Strategic Alliances*

Since then, there have been other publications by ASM and partners before the preparation of the NIWRMP. These included the 3 series on lake briefs and several coffee table books.

3. PREPARATION OF THE NATIONAL INTEGRATED WATER RESOURCES MANAGEMENT PLAN (NIWRMP)

Ten component-plan water sub-sector studies were carried out prior to the development of the synthesis report on NIWRMP, entitled "*Transforming the Water Sector: National IWRM Plan - Strategies and Road Map" [1].* Each component plan was chaired by a Fellow of ASM in the specific Task Forces. Members of these Task Forces are drawn from experts in the public and private sectors as well as from the academia. The output from each Task Forces were prepared as rigorous as that for the Lake Management. Some Task Forces run in parallel, with some studies stretching to 2 to 3 years, and most running from 2007 to 2015. These Task Forces were on sub-sectors as shown below:

- *Integrated Lake Basin Management*
- *Integrated Aquifer Systems Management*
- *Water Demand Management*
- *Water Supply and Wastewater Management*
- *National Agenda for Integrated Water Research*
- *Climate Change and Water*
- *Integrated River Basin Management*
- *Agriculture Water Services for Water Business*
- *NKPA (National Key Priority Area) in the Water Sector*
- *ASM Mega Science Study: Water Sector*

Fourteen water sub-sector reports were invited from subject matter experts to complement the component plan studies and to ensure inclusiveness. These were

- *Integrated Flood Management*
- *Integrated Flood Management*
- *Water Quality Management*
- *Water and Land Use (National Physical Plan)*
- *Water and Health*
- *Water and Green Growth*
- *Water and Gender*
- *Virtual Water and Water Footprint*
- *Water Financing*
- *Water-Food-Energy Nexus*
- *Awareness, Advocacy and Capacity Building*
- *International Networking and Collaboration*
- *Integrated Urban Water Management*
- *NWRP Action Plan*

4. OUTPUT OF THE "TRANSFORMING THE WATER SECTOR: NATIONAL IWRM PLAN - STRATEGIES AND ROAD MAP" [1]

The report is published in 2 volumes, Volume 1 being the Main Report and Volume 2, the set of Appendices. Chapter 6 of volume 1, the centre-piece of the report, provides an overview of the Malaysian water scenario, highlighting the issues and challenges, followed by a synthesis of the strategies, organized into a coherent National

IWRM Plan. The Plan comes with a Road Map for implementation over a 15-year period until 2030, the end of the Sustainable Development Goals.

Twenty-five recommendations were provided, organised into 7 groups as shown below:

- 2 overarching recommendations

Adoption and implementation of NIWRMP together with the Component Plans nationwide by the key ministries and respective state administrations.

- 10 Enabling Environment recommendations,

addressing policies, legislation, regulations and finance among which is the need for an over-arching Integrated Natural Resources Policy; a contemporary National Water Resources Act to be expedited; and the need for funding arrangements and protocols especially pertaining to environment rehabilitation works.

- 5 Institutional Framework recommendations,

focusing on the review and strengthening of governance through institution of oversight and implementation of management structures at national, state, river basin and local hierarchical levels, and calls for greater intra-ministerial integration.

- 5 Management Instruments recommendations

Stresses on the establishment of a central IWRM database built around river basin platforms; the use of economic, financial and technical instruments for greater water use efficiency and accountability and to curb abuse; implementing a national agenda for integrated water research; mechanisms for promotion of green growth; and the pooling of resources to establish one-stop capacity building centres to improve skills and raise competency at all levels

- 1 recommendation on Investments in Water Infrastructure

A central recommendation for urgent Investments in Water Infrastructure to cater for the national water sector needs and to spur the transformation of the water sector. 15 major programmes with corresponding 95 Entry Point Projects were proposed.

- 1 recommendation on NIWRM Plan implementation Management Structure

Recommending the plan be managed nationally at the highest political level by the National Water Resources Council (MSAN), and at the state level by the State Water Resources Council (MSANg) with the support of a National Steering Committee (NSC) to oversee the implementation and assisted by a National Technical Committee (NTC) to resolve technical issues. Formation of a dedicated IWRM Implementation Unit (IWRM-IU) reporting to the NSC to ensure the timely and coordinated implementation of the Plan.

- 1 recommendation for champion/s

*The need for "**champion(s)**" to actively pursue "NIWRMP" initiative and the transformation processes.*

5. CONCLUSION

All the water sub-sectors, including that for Lake Management, are important and are integral parts of NIWRMP. The 25 recommendations are ***inclusive solutions.*** They should be implemented immediately and concurrently to overcome the challenges in the water sector, in ensuring sustainable water resources and to build resilience from the increasingly negative impacts of climate change, urbanisation and rapid development. NIWRMP implementation will contribute to Malaysia's target in achieving SDG no. 6 by 2030

New Task Forces will be set up for other water sub-sectors, such as identified in the 14 Complementary Reports, on a priority basis, for e.g. the Task Forces on Integrated Urban Water Management (IUWM), Water-Food-Energy Nexus (WEF Nexus) and on Awareness, Advocacy and Capacity Building (AACB)

The change in Malaysian government as of 9 May 2018 has resulted in the reorganizations of federal ministries. Primarily, many of the agencies under MoNRE and KeTTHA has been moved into a single ministerial entity, KATS (Kementerian Air, Tanah dan Sumber Asli or Ministry of Water, Land and Natural Resources). Other agencies such as energy, environment and climate change have been moved to the new MESTECC (Ministry of Environment, Science and Technology, Environment and Climate Change, the revamped MOSTI (Ministry of Science, Technology and Innovation)
As the detail strategies and action plans are based on responsibilities of specific ministries, the Editors of "*Transforming the Water Sector: National IWRM Plan - Strategies and Road Map" [1]* are currently relooking at this report to review and realign proposed strategies and action plans to current relevant ministries.

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O9-1

Governance gaps and prospects in the Sta. Rosa Watershed of Laguna Lake, Philippines

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Keywords: basin governance, collaboration, wise use and development of water resources

ABSTRACT

While bringing economic success, urbanization processes have resulted in stress and undesirable consequences such as pollution and depletion of water sources, sedimentation, flooding, biodiversity loss and degradation of lake and river systems that impact public health, food security, livelihoods and well-being. Using Sta. Rosa Watershed in Laguna Lake Philippines as a case study, this paper examines the evolution of local institutions that aim to mitigate these issues at the watershed scale. Challenges to watershed governance are examined using institutional and stakeholder analysis. Prospects for expanding and sustaining the capacity of the existing institutions are articulated to address multiple issues and mitigate concerns in this urbanizing landscape.

1. INTRODUCTION

The Santa Rosa Watershed is one of the 24 sub-watersheds draining to Laguna Lake, the biggest inland water in the Philippines. Due to its proximity to Metro Manila, this area experienced rapid industrialization and urbanization over the past 3 decades. The Sta. Rosa Watershed (hereinafter, SW) covers the whole city of Santa Rosa, 11 villages of Cabuyao City, 8 villages of Binan City and 24 villages of Silang Municipality. The fairly extensive and productive aquifers observed in this watershed[1] is said to be a critical factor for industrial companies to relocate in this area. About 97% of water permits granted by the National Water Resources Board (NWRB) in this area is for groundwater extraction pumped from shallow and deep wells[2] that supply domestic and industrial needs. Conservative estimates indicate water demand to exceed groundwater recharge by 2026[3]. Concerns due to vulnerability of groundwater resources to contamination have been raised[3], as warned by high nitrate concentration of groundwaters in some parts of the SW[4]. Furthermore, drastic changes in vegetated areas and impervious surface covers have been observed[5] and increased flooding risks due to increasing run off have been projected[3,4].

In order to address these threats in the SW, various types of institutions have been created. This paper examines the evolution of different institutions that can address issues at the watershed scale and sifts through lessons and ways in which to strengthen governance processes in the area.

2. METHODS

This is a descriptive study making use of document reviews, semi-structured interviews, focus group discussions and participant observation. Interviews were conducted with key informants from the national, local government agencies, river councils, NGOs, local communities and the private sector in the SW during the period September to December 2017. Various policy documents, project reports, organizational meeting minutes and online articles were reviewed and analyzed.

Diagnosis of governance gaps was undertaken, according to the OECD multi-level governance framework[6] that has been used to appraise water governance challenges in OECD countries (presented in Section 4.1). A participatory stakeholder workshop undertaken on December 2017 together with members of the Sta. Rosa Watershed Management Council informs the analysis in Section 4.2.

3. 3. EVOLUTION OF INSTITUTIONS IN THE STA. ROSA WATERSHED

Sta. Rosa Watershed has a history of rule-making dating as far back as 18th century [7] but this paper focuses on the 3 main phases towards institution building in Sta. Rosa watershed from the late 1990s to the present.

3.1 Formation of River Councils

In 1997, to improve environmental quality of river systems, Laguna Lake Development Authority (LLDA) organized the Save Silang Santa Rosa River Council (also known as S3R2) and Cabuyao River Rehabilitation Foundation. These multi-sectoral groups composed of the business sector, academic institutions and civic society have since then initiated environmental awareness campaigns, river clean ups, adopt-a-river projects and seminars on waste management. The S3R2 continues to be active and is

known for organizing *Silakbo*, a bike, walk and run event attended by about 2000 participants yearly, aimed at raising funds and awareness for river protection. The river council in Cabuyao City became inactive and was revived by the office of the Cabuyao CENRO and the LLDA as the Cabuyao River Protection Associates (CaRPA) in 2015. As a new organization, CARPA's members are quite eager and enthusiastic. While the S3R2 has evolved into a primarily business-sector membership, the CARPA has an expanded base composed of not just businesses but academic institutions, and local community organizations.

3.2 Profiling and characterization of the watershed

A number of scientific assessments have been conducted in the area starting in 2005, when the Local Environmental Action Planning under a World Bank project provided a baseline ecoprofile characterization of the watershed[1]. From 2008 onwards, the Sta. Rosa watershed became the focus of a number of projects by NGOs, research institutions and funding agencies. Hydrological assessments, water balance studies were undertaken by WWF Philippines in partnership with Coca Cola Philippines. The Research Institute for Humanity and Nature (RIHN) examined the impact of ecological hazards on the inter-relations of food production and public health. The Institute for Global Environmental Strategies conducted participatory land use planning incorporating climate change scenarios. RIHN through its new project, *e*-REC, has now conducted biodiversity and nutrient assessments, groundwater studies, and social research towards enhancing watershed governance.

3.3 Formation of the Sta. Rosa Watershed Management Council (SWMC)

The various projects implemented since mid-2000, involved a number of feedback sessions and workshops with different stakeholders in the area. These meetings brought into fore, the issues identified by stakeholders e.g. water pollution, water depletion and flooding—that shifted their attention from river systems to watershed boundaries. In 2014, after a series of intergovernmental workshops, the 4 local government units (LGU) decided to sign a Memorandum of Agreement for the implementation of an Integrated Watershed Management Program with the vision of unifying efforts to manage water resources at the scale of the Sta. Rosa watershed. In 2017, the Sta. Rosa Watershed Management Council (SWMC) was formalized with an initial composition of 4 LGUs of Santa Rosa, Binan, Cabuyao and Silang, Water Service providers and the 2 River Councils.

4. CHALLENGES IN WATERSHED GOVERNANCE

Institutionalization of a management body which can operationalize plans and programs for watershed conservation is a welcome development, however there remain various challenges for watershed governance and this section examines these gaps and the degree of stakeholder engagement in the SW.

4.1 Governance Gaps

The OECD multi-level governance framework [8] is adapted here in order to organize the analysis for diagnosing governance gaps in the SW. This includes looking at administrative, information, policy, capacity, funding, objective and accountability gaps for coordination (Table 1) in the Watershed.

Table 1. Governance gaps in the Sta. Rosa Watershed

Administrative. The formation of the SWMC which is an institutional body transcends 4 local administrative units and currently matches the hydrological boundary of the watershed.
Information. Wealth of scientific information exist whose results have been presented via various fora, meetings and discussions but asymmetry with regard to access to this information is observed. The data is also not being synthesized and no repository identified.
Policy. Environmental policies at the local government level (mainly on solid waste management and sewerage and septage) have been enacted. LGUs have varying policies especially on development, water management and land use which are relevant at the watershed scale and harmonization of policies has been identified as a priority
Capacity. Limited capacity for taking on administrative, technical, information dissemination and coordination responsibilities have been observed. Facilitative skills will be important in mobilizing the council and engaging more stakeholders into the process.
Funding. The Clean Water act sets the establishment of an Area Water Quality Management fund but no experience to date about how to access this or how to set it up for the SW. The LLDA has provided a meager USD3800 as start-up funds for the council. Financing mechanisms need to be set up in order to implement action plans.
Objective. Contradictory interests between stakeholders. Silang in the upstream wants to pursue development while downstream LGUs are afraid of the consequences. Water districts seem to be concerned about water sustainability but are primarily focused on protecting their interests. Common aspirations for all the key stakeholders have yet to be clearly identified and clear goals and objectives for the watershed council have yet to be articulated.
Accountability. Transparency processes have yet to be observed in this watershed due to limited representation and information flows in the SWMC even while the constituent base has not been clearly defined. For the SWMC action plans to have legitimacy, there is a need for a wide variety of stakeholders impacted by loss or degradation of the watershed functions to be engaged.

4.2 Participatory Stakeholder Analysis

The participatory stakeholder analysis identified the key impacting sectors, key impacted sectors, enablers and influencers pertaining to the issues of water pollution and depletion and flooding in the SW. These stakeholders were then prioritized and categorized according to their level of interest (priority ascribed to) and influence in (with power/actions that can affect)[8] watershed governance (Figure 1).

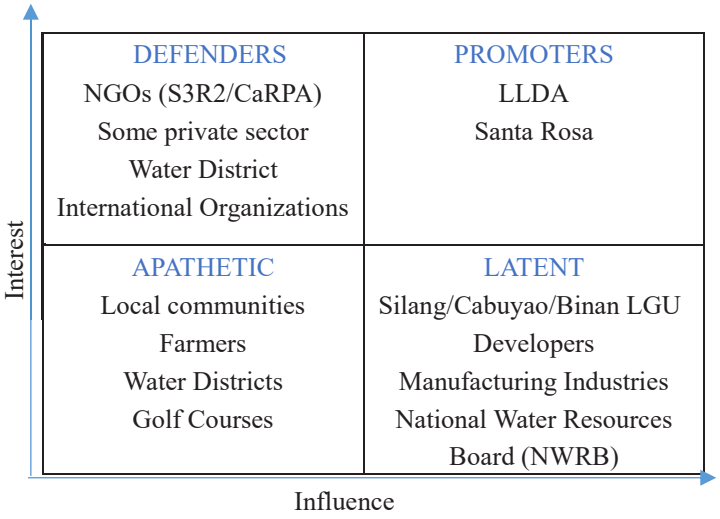

Figure 1. Characterizing Interest vs. Influence of key stakeholders in Sta. Rosa watershed

The framework for public participation is very much in place in the SW but this analysis revealed that actual participation in watershed governance has been limited. The LLDA and Santa Rosa LGU are the main promoters having high interest and high influence. Despite being key stakeholders considered to have a high impact on the watershed, 3 LGUs have low interest while developers and manufacturing industries have not been engaged for action. The NWRB who has the mandate for managing water resources was identified as crucial to be engaged. Influencers and enablers such as the river councils, some private sectors, Laguna water district were also identified whose strengths and capacities can be tapped and optimized for governance processes. The group currently labeled as "apathetic" has capacity to contribute considerably (e.g. water districts' businesses revolve around water). Local communities and farmers groups that are highly impacted need empowerment in order to participate in governance processes.

The need to engage multiple stakeholders as crucial to watershed governance[9] has been acknowledged which is the reason why a Watershed Forum is being developed for the SW. The forum is envisioned as a platform for stakeholder participation and information exchange, a hub where multiple actors can interface in order to participate in watershed governance as well as implement actual activities. A shared vision and plan for sustainability of the watershed will be facilitated and activities by different sectors that can be aligned to the watershed plan will be determined. It will be crucial that the key stakeholders previously identified, be a part of this governance process.

6. CONCLUSION

Governance in the Sta. Rosa Watershed has evolved from river conservation to collaboration at the watershed scale. This makes sense especially since issues on water pollution, depletion and flooding need to be addressed at the watershed scale. Governance gaps pertaining to information, capacity and funding are currently being compensated by external projects. However, the capacity needs to be built up locally to ensure continuity of initiatives. Accountability also needs to addressed by increasing involvement of various stakeholders, especially of local communities. Prospects are high for the development of a watershed forum which is hoped to engage the key stakeholders in the watershed governance and facilitate co-creation of a vision for sustainability of the SW that will help address the policy and objective gaps. The challenge is the realization of watershed plans that will lead to actual improved environmental and social well-being outcomes.

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O9-2

Paper title：Integrated Lake Basin Management in Malaysia – a decade of evolution

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Keywords: Governance, ILBM, lake management, sustainable

ABSTRACT

Integrated Lake Basin Management has been adopted in Malaysia for over a decade. This paper provides a review of the various national initiatives and studies concerning lake and reservoir management that have been undertaken in Malaysia. It detailed the evolution of ILBM implementation in the country over more than a decade since its inception in 2005 in particular the governance improvement as well as areas of lake research and management. The paper concludes with challenges that need to be addressed as the way forward to enhance ILBM implementation.

1. INTRODUCTION

Managing inland water resources such as lakes and reservoirs has been one of the agendas of Malaysia to ensure its waterbodies can be sustainably use for the future generation. The major issues of lake management in the country has been eutrophication, siltation, sedimentation, introduced species, and management challenges [1, 2, 3,4]. The integrated lake basin management (ILBM) approach has been adopted by Malaysia to address the issues. The National Water Resources Policy which was approved in 2012 also imbedded Integrated Lake Management as one of the management approaches for managing lakes and reservoirs in the country.

2. KEY PROGRESS

This work was based on reviews of various national initiatives that have been carried out throughout its inception in the year 2004 to 2018 (Table 1). The first 5-years (2005 – 2010) was dedicated to developing the strategic plan for sustainable lake basin management in the country. The second 5-year (2011 – 2015) phase involved fine-tuning and preparing a more detailed action plans and governance instruments. The third 5-year plan was focused on implementing the strategic plan.

3. GOVERNANCE IMPROVEMENT

The ILBM progress in Malaysia has been focusing on improving governance. The strategic and detailed action plan generally attempted to provide strategic direction in developing and managing lake resources based on the basin scale. The policy framework identified is "***Lakes and reservoirs will be sustained, restored and protected through the adoption of an Integrated Lake Basin Management (ILBM) approach***".

Seven strategies were identified in the strategic plan namely the lead agency to be driven by the Ministry of Natural Resources and Environment Malaysia (NRE). Two other departments namely the Drainage and Irrigation Department (DID) was identified as the implementing agency while the National Hydraulic Research Institute of Malaysia (NAHRIM) as the research agency entrusted for the lake resource research[1]. The creation of permanent lake committee known as the Catchment, Reservoir and Lakes Sustainable Management Permanent Committee chaired by NRE provided a platform to monitor progress in implementing the action plan. Similarly, the Lake Research Committee of Lakes, Reservoir and its catchment has successfully developed a blueprint for the lake research and development (R&D). A committee that foresee the implementation of the action plan such as at state levels, however, remains partially implemented and varied between States.

Development of scientific understanding on lakes and their issues are important in the lake management. A blueprint on lake R&D which was developed in 2014 identified research areas much needed to support lake management. Seven themes were identified namely (i) governance (ii) ecosystem services and socio-economic (iii) water quality (iv) ecohydrology and basin management, (v) biodiversity and natural products (vi) physical limnology and hydrodynamic and (vii) technology[4].

To strategically promoting monitoring of water quality of

lakes, National lake water quality standards was developed in 2015 and approved by the National Water Resources Council for implementation in August 2017. The standard promotes monitoring of parameters important for lakes and of concern to human health or ecosystem[5]. The standardized criteria are based on lakes uses with the aim to understanding the water quality conditions for lake management. Roadshows to various States in the country are in progress to brief and improve understanding on the application of the new standard at State's level.

To further aid management, a guideline for ILBM plan has been prepared by NAHRIM in 2017. The guideline provided step by step guide for lake managers in developing the ILBM Plan for their respective lakes[6].

Table 1 ILBM progress in Malaysia

Period	Initiatives
2005-2010	• Desk study on lake eutrophication in Malaysia • Colloquium on lakes and reservoir status and issues • Multi-stakeholders' workshops • Strategies for the Sustainable Development and Management of Lakes and Reservoirs in Malaysia • Lake Inventory Database • Lake Brief Series 1
2011-2015	• Endorsement of Strategic Plan • Lake Brief Series 2 & 3 • National Lake Research Blueprint • National Lake Water Quality Criteria & Standards (NLWQS) • Establishment of Lake Research Committee • Establishment of Lake Permanent Committee • Development of Detailed Action Plan for ILBM
2016-2018	• Integrated Lake Basin Management – component plan studies in National IWRM Plan (Strategies and road map) • Integrated Lake Basin Management Plan for Sembrong and Batang Ai lakes • Endorsement of NLWQS • Guideline for Developing ILBM Plan

4. CHALLENGES

Fragmented management has been the biggest challenge in Integrated Water Resources Management implementation including the ILBM in Malaysia[7]. The implementation of any plan formulated at national or Federal level depends on State's acceptance or adoption since management of land and water resources falls under their purview. Only few States has dedicated institution to manage water resources at basin levels including lakes (Table 2). With the exception of Selangor and Kedah, many of these agencies have limited capabilities to sustainably manage lake at basin scale. For Putrajaya Lake, transboundary challenges remain as the drainage basin transcends over two states namely FT of Putrajaya and Selangor[8].

Table 2 State and/or Lake Authorities in Malaysia

State	State or Lake Authority
Selangor	Selangor Water Management Authority (LUAS)
Negeri Sembilan	Water Regulatory Bodies of Negeri Sembilan
Melaka	Water Regulatory Bodies of Melaka
Johor	Water Regulatory Bodies of Johor
Pahang	Water Regulatory Bodies of Pahang
Kedah	Kedah Water Management Authority
Perlis	N/A. (Drainage & Irrigation Department)
Kelantan	N/A. (Jabatan Air Kelantan/ Drainage & Irrigation Department)
Terengganu	N/A. (Jabatan Air Terengganu/Drainage & Irrigation Department)
Penang	Badan Kawal Selia Air Pulau Pinang
Perak	N/A. (Lembaga Air Perak/ Drainage & Irrigation Department)
Sabah	Sabah Water Resources Council
Sarawak	N/A. (State Water Authority)
FT Putrajaya	Perbadanan Putrajaya
FT Kuala Lumpur	Kuala Lumpur Municipal Council (DBKL)
FT Labuan	Perbadanan Labuan

N/A – not available

To date, only a few management plans or basin management plan are in place or have been developed by

agencies to improve the governance framework in respective lakes (Table 3). Some of these plans are institutionalized with legal instruments such as the enactment for Control of Activities in the Putrajaya Lake (the By-Laws 2004) which aid the lake management by prohibiting or zoning certain activities and entrusting enforcement powers. Other management plans such as Chini, Jor and Batang Ai have yet been implemented.

Management plan is generally a tool to aid in decision making and developing strategies for the management. A success in integrated lake basin management depends on the capacity of the targeted central authority to enhance their management role as well to understand the specific lake basin issues. It also requires a long-term commitment from every stakeholder to achieve a common goal in managing lakes. To ensure success, awareness and capacity building of ILBM principles is required at all levels of stakeholders.

Table 3. Status of Lake Management Plan in Malaysia

Lake	Management Plan
Putrajaya	Putrajaya Lake Catchment Development and Management Plan (2000)
Bera	Tasek Bera Integrated Management Plan (2004)
Loagan Bunut	Loagan Bunut National Park Management Plan (2007)
Chini	Strategic Implementation Plan (2007), Lake Chini Management Plan (2014)
Jor & Mahang	Integrated lake management plan for Jor and Mahang reservoirs, Districts of Batang Padang, Perak Darul Ridzuan (2015)
Sembrong	Integrated Lake Basin Management Plan for Sembrong Lake (2016)
Batang Ai	Integrated Lake Basin Management Plan for Batang Ai Lake (2016)

5. CONCLUSION

ILBM implementation in Malaysia has undergone more than a decade of development. Progress are in place to strengthen governance framework and successful implementation of the ILBM strategies/action plans.

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O9-3

Conservation of Wetlands in Bhutan: Policy and Practice

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Key Words: Wetlands conservation in Bhutan; Ecosystem based conservation; Watershed management; Wetland Policy; and upstream-downstream linkages.

ABSTRACT

Benevolent leaders and associated strong environmental policy is the impetus of environmental conservation in Bhutan. Never – the – less, greater challenge exists today with faster paced modernization, as Bhutan advents into the 12th five-year planning cycle. Changing ecosystems and their services, is more visible and challenges in the water sector with the cascading phenomenon in the food-energy-climate nexus is escalating. In the past, an ecosystem-based approach to conservation was rarely visible as a common policy directive in the sustainable management of environmental resources in the country. The roadmap for wetlands conservation, followed by the Royal Government of Bhutan is envisaged to build information on wetlands, achieve the sustainable development goals, assess wetlands, build management plans for significant wetlands, and continuously monitor and evaluate the conditions of wetlands in the country. With this roadmap, the country envisions to add value to Bhutan's legacy to environmental conservation through an ecosystem based approach with an effective wetlands conservation program.

1. INTRODUCTION

The importance of wetland ecosystems in the watershed is crucial. The wetlands functions and benefits are well known and adopted globally as an important link in the overall health of the watershed. Wetlands such as lakes, streams, springs, rivers and marshes are common types of wetlands in Bhutan and also important water sources for both rural and urban settlements.

Benevolent leaders and associated strong environmental policy is the impetus of environmental conservation in Bhutan. Never – the – less, greater challenge exists today with faster paced modernization as Bhutan advents into the 12th five-year planning cycle.

Despite the fact that wetlands provide vital ecosystem services, loss of wetlands is observed in the country, especially in growing urban settlements. They are filled in, drained, or impounded by a variety of human influences including stream channelization, urban development, growing transportation sector or conversion to other land uses. Symptomatic issues of water sources drying are most urgent and the country is grappling with the cascading phenomenon in the food-energy-climate nexus.

This paper covers the road map to wetlands conservation in Bhutan. It looks into the enabling factors and unravels why there is loss in wetlands in the country, despite strong environmental policies. It then outlines the major steps taken to curb the problem and how Bhutan is moving forward with strategies for wetlands conservation in the country.

2. ENABLING FACTORS TO WETLANDS CONSERVATION

Bhutan is bestowed with numerous wetlands because of its complex underlying geology and its strategic location in the eastern fringes of the Himalayas. Natural conditions for fresh water storage and discharge are created. The summer monsoon, from the Bay of Bengal during June, July, August and mid September, provides precipitation in the form of rainfall. The annual average precipitation ranges between 2,500 and 5,550 mm per year at the southern foothills; 1000mm in the central inner mountains and 400mm in the northern regions with subtropical, temperate and alpine agro-ecological zones respectively[1].

From a period of strong traditional and cultural ethos to a much modern society where a unique development philosophy is revered, Bhutan has since then tried to maintain a balanced loop between conservation and development. Gross National Happiness, as a development philosophy has been adopted since the early 1970's in the country. Benevolent leaders and associated strong environmental policy through the constitutional requirement to maintain at least 60 percent forest coverage for all times to come and the responsibility of "every Bhutanese as a trustee of the natural resources and environment… " is the impetus of environmental

conservation in the country[2]. Bhutan has a total of 2,730,889 ha, amounting to 71% of its total geographical area as forest coverage [3].

3. STATE OF THE WETLANDS

There is no complete data on how much wetland the country has and how much has been lost. With no comprehensive record of the country's wetlands, there is no way of knowing - at what rate Bhutan's wetlands are being converted or lost.

However, there are persistent reports from many parts of the country; those wetlands, mostly springs and lakes are drying [4]. Wetlands in and around growing cities and town are the most significant wetland loss noticed in Bhutan. The rate of loss of - wetlands - is not as pronounced in other parts of Bhutan as it is in the capital city, *Thimphu*. This phenomenon is replicated in other urban centers in Bhutan. Many of the critical watershed management plans also report the drying of water sources in rural settlements. The Mid term review report of the 11th Five Year Plan also highlights drying up of water sources in the country and has created flagship programs in the water sector to curb this issue.

Until 2010, in the absence of a common strategy in wetlands management in the country, conservation activity was mostly through habitat enrichment (plantation) and water source protection (fencing). The Water and Wetlands Program was established in 2010 when the interdisciplinary Watershed Management Division was created in the Department of Forests and Park Services. Until then, an ecosystem-based approach to conservation was rarely visible as a common policy directive in the sustainable management of environmental resources in the country.

Most of the environmental conservation activities then, addressed forest coverage and not the protection of wetlands in the landscape. Wetlands conservation was not mainstreamed in the overall environmental policies and plans, resulting to loss in wetlands in the country.

4. STRATEGIES FOR WETLANDS CONSERVATION

In the absence of an ecosystem-based approach to environmental conservation, a Ministerial Notification was issued by the government in 2011; requiring all forestry clearances to consider the significance of wetlands and the need to retain it in its natural conditions. The only protection until then was the 30 m buffer from riverbanks and 100m buffer from lakes. However this was not adequate, because other type of wetlands in the country was oftentimes ignored, especially marshes. To address the lack of policies specific to wetland conservation, the Forest and Nature conservation regulations, incorporated a chapter on wetlands conservation. Simultaneously, the need for a guideline for wise use of wetlands was found crucial to implement the regulations in place. However, the tools necessary to implement the regulations require a comprehensive inventory of wetlands in Bhutan, encompassing the type and extent, which is currently not available.

Therefore, the entire 12th FYP focus for the wetlands program has been designed to carry out the National Wetlands Inventory of Bhutan. Numerous wetlands assessments carried out in the country will be used to develop the Framework for wetlands classification. The framework will then be used to adopt a standard methodology to comprehensively map the wetlands type and extent in the country. The information will be generated as a layer to the Atlas of Bhutan, to be used as a sieving mechanism in land allocation for development.

The implementation of the Forest and Nature Conservation Rules of 2017 is envisioned to be successful with the use of the comprehensive wetlands inventory map. The major conversion of wetland to other land use in the country will be regulated. This roadmap followed by the Royal Government of Bhutan is envisaged to build information on wetlands, achieve the sustainable development goals, assess wetlands, advocate for wetlands as important ecosystems deemed necessary for protection, build management plans and continuously monitor and evaluate the conditions of wetlands in the country.

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O9-4

Construction of partnerships to improve Integrated Management of Lake Chapala basin, Mexico

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Keywords: Integrated Lake Basin Management(ILBM), basin governance, basin management policies.

ABSTRACT

From 2002 to 2017 a series of 94 projects have been completed in the Lake Chapala basin (Mexico) by the Institute Corazon de la Tierra; they were directed to improve the conditions of terrestrial and aquatic ecosystems and the Environmental Services they provide. Creating partnerships has been a core part of this process, to properly deal with complex ecological, social and economic aspects, including conflicting activities and points of view regarding access and use of natural resources, most importantly, water and forests. This paper reviews the features of the strategies used to create effective partnerships, the challenges that were faced and how they were dealt with, in order to create a deeper involvement of stakeholders beyond their particular location and socio-political position, to involve them as a conglomerate into the integrated management of Lake Chapala basin, a strong collaborative effort that still has a challenging way ahead.

1. INTRODUCTION

The Lake Chapala basin includes the water body of same name, the largest one in Mexico and the third in size in Latin America. Most forest ecosystems at the basin present degradation processes derived of land use change, erosion, overgrazing and forest fires. This situation has resulted in water table lowering, reduced soil fertility and loss of biodiversity, which as a result has generated reduced agricultural production and increased levels of poverty, altogether with associated problems such as migration. According to data reported by the National Institute of Ecology-INE[1] and several researchers (Juarez et al., 2010)[2] the phreatic level has decreased dramatically during the last 50 years: in 1970 it was common to find underground water at depths of 5 meters (15 feet), while now sometimes it's necessary to drill more than 100 meters (300 feet) to find it. On the other hand surface runoff has increased, causing flooding and mudslides during the rainy season (May-September).

Lake Chapala basin, together with another 18 basins, composes the Lerma-Chapala basin (a macro-basin of 53,500 km²)[1]. This area is characterized by the diversity of ecosystems, related to changes in altitude and climate as well as the extent of topographic forms (mountains, plains, canyons and valleys), which in turn has generated a rich biodiversity and a set of environmental services[2], quite essential for a population of more than 15 million people dwelling in the basin and 6 million external users.

Alongside 15 years (2002-2017) a series of 94 projects have been completed in the Lake Chapala basin (Mexico) by the Institute Corazon de la Tierra, most of them following the Integrated Lake Basin management Platform[3] and its Six Pillars of Governance. Those projects were directed to improve the conditions of terrestrial and aquatic ecosystems and the Environmental Services they provide, strengthening the basin governance, mostly working with local communities and municipal authorities. Creating partnerships has been a core part of the process, to properly deal with complex ecological, social and economic aspects, including conflicting activities and points of view regarding access and use of natural resources, most importantly water and forests.

Even if some projects have been very specific in their territorial range, each one has been designed to work as part of an integrated basin vision, using a collaborative approach in order to create and strengthen a basin network in the medium and long terms. To help guiding

all projects on this collaborative way, four Methodological Criteria were defined (Juarez et al, 2007) [4] being these: 1) Dialogue of knowledge, 2) Questions engine, 3) Clarification of responsibilities and 4) Conflict as an opportunity.

Wanting to identify lessons about the way how partnerships were designed and the way they worked, a workshop was conducted in order to organize and analyze the projects' partnership information.

2. METHOD

First, a list of all 94 projects was prepared, altogether with a descriptive file for each one of them, describing their goals, location, period and particular outcomes. Also the participant partners (institutions and groups) that were involved in each project. Eight categories of partner roles were identified.

Then a workshop was organized to analyze the data. Participants were projects leaders, technicians and directives of the institute, besides partners' representatives. The Multistakeholder Platform (MPS) structure[5] was used to identify how partners interacted, the conflicts that emerged alongside the projects and the way how they were dealt with. Complementarily, a matrix of Conflict-Collaboration was created for each case. With those outputs, a group of "good partnership practices" were identified and later discussed, in order to propose ways to improve partnerships in a medium and long term.

RESULTS

As mentioned, eight categories of partner roles were found (shown in Table 1)

Table 1 Partners involvement

No.	Categories	Number of projects
1	Decision-making process	26
2	Design of the project	11
3	Financial support	82
4	Institutional support	32
5	Networking-Communication	16
6	Public divulgation	17
7	Research	6
8	In-kind	63

Four challenges were identified as the most common and difficult to solve along the projects, being these:

1. Communication breaks: refers to situations when information didn't flow properly or didn't reach its right audience.
2. Uncertain information: use of not reliable info to guide decision-making processes and project field activities.
3. Organizational problems: reduced capabilities to understand information, limited decision-making experience, abridged representativeness, leadership conflicts.
4. Lack of continuity: change of administrative representatives, funding discontinuity, people abandoning the process (due to conflicts, immigration and other causes).

The way how those challenges were solved showed an interesting variation. In summary, a set of alternatives were identified, including: Informative meetings, involvement of mediators, open public reunions, community research, printed announcements, radio invitations, promotion of local business, women empowerment, definition/improvement of rules, broadening of partnerships, involvement of universities and NGOs, legal procedures, field demonstrations, among others.

The matrices of Conflict-Collaboration showed that even when initial positions of partners were coincident, there were difficulties that arise as part of the development of the process, related with the four challenges identified.

Interestingly, several alternatives were used to address more than one challenge, depending of the context. For each of these a descriptive file was integrated..

3. DISCUSSION

A set of valuable features was identified as core

components to create successful partnerships.

- Creation of common goals.
- Definition of precise outcomes and times.
- Precise responsibilities and benefits for each partner.
- Use of effective communication tools.
- Transparency and accountability.
- Identification of current/potential conflicts between partners and/or with project beneficiaries.
- Frame the project within a vision of the basin.
- Use of dialogue mechanisms.
- Clear closure of the projects, informing all partners.
- Count with a record of meetings, discussions, and agreements.
- Integration of diverse-sectors working groups, to promote practical information exchange and to reduce risks of administrative changes.
- Raising awareness among beneficiaries of Environmental Services to foster support for next stages of projects.

There is agreement that such aspects are difficult to achieve by a single institution, requiring by themselves the use of partnerships.

The whole set of workshop outputs proved to be both rich and complex. Even if integrating the descriptive files was an important advance, it's necessary to organize them as a Tool Box, which could be used to improve current and future partnerships, reducing times, effort and costs.

There would be interesting to compare partnership processes of Lake Chapala basin with those of other Mexican lakes, as Patzcuaro and Cuitzeo. Besides there is interest of other institutions allocated at the Lerma-Chapala macro-basin to compare information and it's also a common interest with members of the Mexican Basin Management Network and watershed managers from Costa Rica, Guatemala, Colombia, Bolivia and Peru.

The strengthening of Participation is one of the six pillar of ILBM Governance, we hope to contribute to this participatory platform with this ongoing process.

4. CONCLUSION

Despite the step forward that this analysis represents, the integration of a Tool Box will require a good deal of time and resources. It's necessary to continue assessing and evaluating partnerships to maintain the upgrading of this aspect of projects, which represents a key component to deepen the reach and transcendence of the integrated management process of the Lake Chapala basin.

Creating successful partnerships it's not an easy task, given frequent conditions of shattered information, competition, distrust, overlapping of functions and others. For this reason is extremely important to foster experience exchanges, divulge ongoing and concluded projects, promote the replication of success cases and raising public awareness. Informing previous and current partners in order to create a more extensive network to achieve integrative programs and to better existing basin management policies and institutions is a long term goal.

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O9-5

Peace & Governance: Challenges for Sustainable Development of Lake Lanao, Southern Philippines

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Keywords: basin governance, ecosystem services and basin management policies, sustainable development, cultural heritage

ABSTRACT

One of the world's ancient lakes, Lake Lanao in the province of Lanao Sur, southern Phiippines, is home to the Meranaws, a Muslim group who inhabit the area since precolonial times. Lake Lanao is also a major economic resource of the country being the source of water of six hydropower plants, the *Agus Powerplant Complex*, which provide a big bulk of electricity to Mindanao, the country's southern most island and home to more than 30% of Filipinos. Lanao Sur is one of the poorest province and known to be hotbed of violent conflicts in the country, ranging from clan violence to historical Moro/Muslim armed secessionist rebellion and other forms of "shadow economy". Against this social backdrop, the study inquires on the state of sustainable development of Lake Lanao. From a survey of 500 respondents, key informant interviews and on-site observation, the study reveals that Lake Lanao matters has not trigger conflict among the locals. However, the professional groups and development actors in the area, private and government alike, deplore the absence of, or poor, governance of Lake Lanao which, they argue, abetted the socially and environmentally damaging monopolistic control and utilization of the Lake by a government-owned and controlled corporation. The study highlights the (a) challenges of competing resource use, between local - subsistence and cultural - versus national, highly economic ; and (b) effective governance in addressing peace and security in the locality as pillars of sustainable development.

1. INTRODUCTION

Lake Lanao is not just a cultural heritage of the Meranaws; it is likewise a major economic resource for both Lanao areas and Mindanao, in general. As a cultural heritage, the Lake is crucial to the daily life of the Meranaws in terms of food for consumption and livelihood, as well as for religious practices in Islam. However, since the 50s until present, the National Power Corporation (NPC) has the monopolistic role in the industrial utilization of the lake through its seven-power generating plants, the Agus Hydropower Project. NPC provides more than 50% of the electricity power base of Mindanao.

The construction of the NPC regulatory dam in 1978 already has some changes on the Lake as NPC now controls the outflow of the Lake. Prior to this, NPC only harnessed the natural flow of the Agus River to feed its turbines in the Agus 6 Hydorpower Dam which is more than 30 kilometers away from the lake. But it was only in 1991, where Agus 1 Hydropower Plant, constructed along the side of the Lake and with turbines at the bossom of Lake, will have been operational that a popular contestation against NPC's utilization of the Lake, particularly protesting against the operation of Agus 1 plant. This was the condition which paved the way for the creation of SALAM (Save Lake Lanao Movement, composed mostly of Meranaw professionals and traditional leaders, which embarked on an advocacy to bring justice, transparency and equity of Lake Lanao utilization. SALAM argues that Agus 1 operation will directly and radically affect Lake Lanao and its corresponding ecological and economic roles. To date, NPC still holds the monopolistic reign over the Lake.

This study explores and documents cases of conflict that have occurred in the region which are directly or indirectly related to Lake Lanao. Moreover, this study inquires on the challenges on governance in the context of sustainable peace, both as experienced and perceived by the various stakeholders in the area.

2. METHODS

A case study research design employing mixed method of qualitative and quantitative approaches. 500 community respondents were covered in the random survey and some 15 key informants for the in-depth unstructured interviews, and nonparticipant observation. Key informants are community personalities and officials of the municipality and NPC.

3. RESULTS & DISCUSSIONS

Experiences of Conflict

The Lanao region is popularly known to be a hotbed of violent conflicts between clans and family traditionally called *rido. Rido* has become the most important conflict issue facing the Philippines' Autonomous Region of Muslim Mindanao (ARMM) as this is the leading contributor of violent conflicts in the region *(Ferolin & Constantino 2014).* Table 1 below shows

cases of of violence in Mindanao with *rido* gaining a gigantic lead.

In several studies conducted about *ridos*, the following are identified as causes and triggers for the development of *ridos* in Lanao del Sur, as follows (in random order): land disputes, political rivalry, homicide, business rivalry, non-payment of debts, sex crimes (eg rape, physical contact, elopement), pride/ disgrace/shame/affront to *maratabat,* accidents and drug-related cases.

Table 1. Cases of Violence in Mindanao

Cases of Violence in Mindanao	%
Between families & clans "rido"	17
Between farmers and landowners	4
Between Muslims and Christians	0.3
Between the AFP and Abbu Sayyaf, a Muslim extremist group	2
Between the Armed Forces of the Philippines (AFP) and the New Peoples Army (NPA)	3
Due to crime	3
Due to Muslim rebels	2

Source: Social Weather Station 2005

Respondents ascertained that the utilization of Lake Lanao by the locals has never been a cause or a source of conflict, trouble or problem among the locals. They explain that the Lake is accessible to all of them; they all have access to the lake and has been using the lake their entire life, especially for their daily needs. On a similar vein, majority of the respondents have not heard of any news or information about occurrence of conflicts between Meranaws nor between anybody in their communities and nearby areas that concerns or relates to the Lake.

However, contrary to the experiences and perceptions of community-based respondents, key informants reported of a harrowing experience in 1990 in the National Power Plant, (NPC), the only industrial utilizer of Lake Lanao since 1950s. This involved the killing of some personalities connected with NPC by Meranaws who were formerly NPC employees. Key informants expressed dismay over the seemingly unfair practice of NPC in terms of employment, where Meranaws are rarely provided the chance even if they are qualified (Naga 2010).

Activities that Threaten the Lake

More than half of the survey respondents report they are well aware of on-going activities that can harm Lake Lanao. Most identified logging as a major threat to the Lake as it causes denudation of forests in the uplands of the area (see Table 2). Other activities identified are agriculture, quarrying and garbage dumping into the lake. These activities have been existing for a long time already and many respondents perceive them as "normal" practices. They recognize though that these practices must be controlled and regulated in order to safeguard the integrity of the Lake Lanao's ecosystem.

Table 2. Activities Threatening the Lake

Activities	Frequency
> Logging in the forests	50-66%
> Dynamite fishing	21%
> Other destructive fishing	20%
➢Agriculture	9%
➢Quarrying	8%
➢Garbage throwing, no toilets	5%

Existing Laws and Ordinances For Lake Lanao

A big majority of the survey respondents said they are not aware of any law or policy or ordinance, whether local, regional or national, that are existing for the protection of Lake Lanao. Key informants, however, report that there are issuances on the maintenance of the water quality of the lake, especially controlling pollution. However, there are no documents as proofs of these issuances. Key informants from the government and private sector explained that policies regarding lake protection usually stem from programs implemented by either by NGOs or government agencies in specific communities. Few key informants though asserted that there exists no local policies as the lake is entrusted to the NPC.

Members of the Save Lake Lanao Movement (SALAM) reiterate their long-standing woes and complains on the non-implementation of laws and national policies regarding Lake Lanao. This non-implementation has been to the detriment and deprivation of the Meranaws of the gargantuan bounties of the Lake. They identify the following national policies and enabling laws that are existing for the protection and development of Lake Lanao and the Meranaws:

> Environmental Compliance Certificate of NPC which mandates NPC to deliver services akin to a corporate social responsibility;
> Presidential Decree Declaring Lake Lanao Watershed for the protection and conservation of the lake
> National Integrated Protected Area System 1992- for the protection of Lake Lanao watershed
> Water Code of the Philippines - protection and conservation of Lake Lanao watershed

Secondary data also shows the existence of other nationally mandated laws and policies and for the protection of Lake Lanao and the Meranaws, as follows:

> 1992 Presidential Memo No. 30 - a decree stopping the issuance and operation of all forms of timber cutting in Lake Lanao watershed
> 1997 Republic Act 8435 - for the implementation of the Integrated Riverbasin Management and Development Master Plan for the Ranao (Agus) River Basin, for watershed conservation, river basin rehabilitation, flood control/mitigation, and water security for domestic, irrigation and industrial use, livelihood and economic opportunities in the area.
> 2001 - A Republic Act 9054 enforces total log ban in watershed areas.
> Republic Act 7160 - mandates NPC to provide monetary benefit to host local government. The share of host LGU to national wealth tax shall be applied to lower the cost of electricity and to finance local development and livelihood projects.

Existing Programs and Projects for Lake Lanao

*Integrated Natural Resources and Environmental Management Program (INREMP) for Lake Lanao - a*ims to address the dual goals of poverty reduction and watershed conservation reducing forest denudation, unsustainable farming practices, loss of environmental services and loss of agricultural productivity.

National Greening Program is a massive forest rehabilitation program of the government. NGP seeks to enhance the country's forest stock to absorb carbon dioxide, reduce poverty by providing alternative livelihood activities for marginalized upland and lowland households relating to seedling production and care and maintenance of newly-planted trees. In 2011, two communities in Lanao del Sur are beneficiaries.

The My Lake Lanao Project (MLLP) is a one-year partnership between Mindanao State University, especially the College of Arts and Social Sciences being the lead implementer, and the NGO , ABAG sa Kalambuan Inc. The project was funded by the US Embassy in Manila Cultural Affairs Division. MLLP project focussed on advocacy on Lake conservation and raising awareness of the young generation on the role of the Lake, as well as community-based livelihoods with environmental enhancements.

Issues and Concerns and Experiences of Governance of the Lake

a] The survey show that following urgent concerns about the Lake:

> Maintain the quality of water of the lake

> restore the beauty of the lake

> Build fish port for easy access for the fishers

> establish fish ponds for fish production

> Establish public toilets

b] *The National Power Corporation: The "Lord of the Lake"*

National Power Corporation (NAPOCOR or NPC) is a government owned and controlled corporation has started operation since early 1950s using the natural outflow of lake water through the Agus River. In 1978, it constructed a regulatory dam which affected the water of the lake, locals argue (Naga 2010). Five power plants are built along this river producing a total of more than 746MW. The company has been operating without any significant opposition from the communities until 1990's hostage taking-incident[1]. This incident opened up employment opportunities for Meranaws to replace the Christian employees who refused to report back to work. Moreover, this incident spurred in the office. to spurred In 1991, NPC claims it has complete jurisdiction and control over watersheds surrounding its powerplants and energy sources, referring to national laws issued.

c] Recommendations from Local Stakeholders on the following:

> Management of the Lake: A tripartite co-management among DENR, ARMM and the LGU-Lanao del Sur. With co-management, NPC will have stronger basis to participate in watershed management and to attend to the eastern side of the lake where the tributary rivers are.

> Awareness-raising among the youth on the role of Lake Lanao - maximization of the roles of schools. Also, to further study Sharia Law, especially on the context of "Khalifa" - stewardship of man to nature.

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O9-6

Mexican Watershed Network, a proposal to work on the integral management of lakes in México

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Keywords: network, Mexico, watershed, synergies,

ABSTRACT

Mexican Watershed Network (MWN) was formed in 2007 as a result of the 1st. Nacional Watershed Congress which was held in the city of Santiago de Querétaro in Mexico. In 2011 the Network began a systematic and voluntary work with a new Strengthening Strategy focusing on four axes: dissemination and communication of information, generation of synergies, linkage, coordination and collaboration, strengthening technical capacities and systematization of national information on integrated management of watersheds in Mexico. The Network is formed today by more than six hundred members, 30 % of them with a complete update of basic individual information in a database. The Governance structure of the MWN is shaped by a Directive Board, an Advisory Board, an operational group and specific technical groups. One of this groups, with Integrated Lake Basin Management (ILBM) approach, is being generated in order to develop a better understanding and diagnosis of Mexican lakes, and its watersheds, and then build the appropriated synergies and capabilities towards the 18th World Lake Conference to be held in Mexico in 2020. This technical group must base its work on an interdisciplinary and multi-institutional fundaments and will present its first results in different forums of the 5th National Watershed Congress and its corresponding 1th Latin-American Congress to be held in 2019 at Mexico.

1. INTRODUCTION

The main objective of this paper is to describe the strengths and opportunities to promote the Integrated Lake Basin Management (ILBM) through the Mexican Watershed Network (MWN) and outline the great potential and next efforts that Mexico will do nationwide and in Latin America, all of this in the context of the 18th World Lake Conference.

The organization of a networked task to develop in Mexico a strategy proposal for the ILBM is based on the work carried out in the Chapala Lake basin, in Jalisco, Mexico by the *Instituto de la Tierra A.C.* In addition to the adoption and strengthening of capabilities of the MWN to align efforts with the ILBM, exist also the possibilities of amplification and construction of synergies with strategic allies that the Network has built since 2011: WWF Mexico, the Gonzalo Rio Arronte Foundation, the Fund for Communication and Education, A.C., through the Virtual Water Information Center [1] and the "*Nuestra Agua*" application [2] and the governmental institutions in charge of environmental and water issues in Mexico, these are the Ministry of Environment and the National Water Commission.

The Governance structure of the MWN is formed by a Directive Board, an Advisory Board, an operational group and the specific technical groups (Fig. 1).

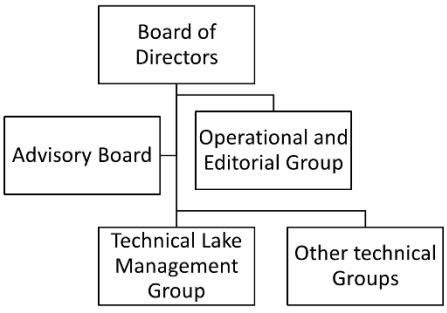

Fig. 1 Governance structure of the MWN.

Synergies from this structure could be triggered by the active participation of at least 60 organizations of the current projects of the Water Program of the Gonzalo Rio

Arronte Foundation, a Private Assistance Institution working since 2000 with the mission of influencing the revaluation of water, by supporting projects promoted by organizations, public or private, that, for purposes of social benefit, develop activities to promote a culture of water, care of bodies channels and watersheds, of control-correction or optimization of the use of water, of minimization of negative effects of excess water and in projects particularly directed to marginalized rural communities.

Also, synergies and technical capabilities can be amplified by the collaboration and coordination with the Socioecosystems and Sustainability Network [3] a Thematic Network financed by the Nacional Center for Science and Technology (CONACyT).

2. METHOD

The MWN has designed a networking procedure on its platform [4] and will invite to collaborative specialists registered in its database and researchers from the CONACyT thematic networks, specifically the Socioecosystems and Sustainability Network, to discuss the application of the ILBM approach in Mexican lakes.

The coordination and collaboration bases will be established in addition to the necessary agreements to make an articulated and transparent work.

A diagnosis, the state of the art of knowledge about lakes and the gaps between current work and that based on the ILBM approach will be requested as products of the technical group's discussion.

With the experts involved in this process, the spaces will be designed to present results and advances in 5th National Watershed Congress and its corresponding 1st Latin-American Congress to be held in 2019 as well as 18th World Lake Conference to be held in 2020, in Mexico.

3. RESULTS

The MWN is the perfect vehicle to implement the ILBM approach through a technical group of specialists with an interdisciplinary approach.

A group of specialists in lakes, formed for the first time in Mexico at the invitation of the MWN, with a database and a digital platform will exchange experiences and articulate future actions in favor of lake basins.

The results of the process will be available in the digital tools and the MWN page: networking, discussion forum and blog, and all will be obtained from the technical group.

In addition, the topics to be worked on in the development of the 2019 Congresses and the World Conference in 2020 in Mexico will be discussed in coordination and with the guidance of International Lake Environment Committee Foundation (ILEC).

4. DISCUSSION

The collaborative work supported with the technologies to develop a networked work will be essential to register Mexico within the countries that develop and commit to the ILBM approach**.**

A technical group, generated into the MWN, with an interdisciplinary and multi-institutional fundaments will be responsible for establishment of new era in the future of Mexican lakes.

The results and advances of this effort will be presented in the next important congresses in Mexico related to integrated watershed management, including the lakes.

5. CONCLUSION

The MWN will be the key player to introduce the ILBM approach throughout Mexico and a point of contact for future efforts of International Lake Environment Committee Foundation (ILEC)

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O9-7

Impacts of recent environmental changes on the livelihoods of fishing communities in the Tonle Sap Lake (TSL)

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Keywords: environmental changes, fisheries, livelihoods, socio-economic, Tonle Sap Lake

ABSTRACT

The Tonle Sap Lake (TSL) is among the most productive freshwater ecosystems, and one of the most fish-abundant lakes in the world. It is connected with the Mekong River by the Tonle Sap River. The TSL absorbs a huge volume of water, which helps to reduce flooding in the Mekong River floodplains during the peak flooding season, then releases water into the Mekong River during the dry season, which vital to maintain ecological flows and to prevent salt intrusion into the Mekong delta. Local communities who live in or around the TSL are well adapted to this hydrological phenomenon of the Mekong River and TSL. Local livelihoods are also deeply dependent on natural resources and services that the lake and its floodplains provide, including agriculture, trade and fishing, three most important livelihood sources. This study investigated impacts of and the recent environmental changes on the livelihoods of the fishing communities in and around the TSL. More specifically, the study intends: (i) to examine socio-economic and environmental changes occurred in and around the lake and its causes; (ii) to explore the impacts of these changes on the livelihoods of fishing communities; (iii) to identify the strategies that could enhance the resilience of the local communities and reduce their vulnerability.

1. INTRODUCTION

The Tonle Sap Lake (TSL) is the largest freshwater lake in Southeast Asia and is the seventh largest lake in the world, in terms of size in the wet season (ILEC, 2005). The lake size varies from approximately 160 km long and 35 km wide (250,000-300,000 ha) during the dry season (Somony, and Schmidt, 2004) to 250 km long and 100 km wide (1.0-1.3 million ha) during the peak wet season (Matsui et al., 2005). The Tonle Sap River connects the lake to the Mekong River and is known for its rich biodiversity and extraordinary hydrological phenomenon characterized by a huge seasonal variation in term of both water level and volume. The TSL absorbs a huge volume of water during wet season when the Tonle Sap River flows into reverse direction. This helps to reduce excessive flooding in the Mekong River floodplains and maintains beneficial inundation. In dry season, water is gradually released, when the Tonle Sap River flows into normal direction, and helps to maintain vital flow in the Mekong River prevent salt intrusion into the Mekong Delta. This process is referred as the "flood pulse", which causes the lake to swell 5-6 times larger, with water depth increasing from 1.5 m in the dry season to 9-10 m in the wet season (Kummu et al., 2006). The "flood pulse" transforms both the physical and the human landscape of the Lower Mekong and TSL. In the dry season, the water level of the TSL recedes and exposes the areas naturally fertilized by sedimentation of nutrients ready for regeneration of plants, farming and home to terrestrial species. As one of the most productive freshwater fisheries in the world, the Lake yields 230,000 tons fish annually; it has been estimated that approximately half of the country's population benefits, either directly or indirectly, from the lake's resources (Van, Zalinge, et al., 2000). Unfortunately, due to several negative changes have occurred due to human induced drivers which has led to the disruption of the TSL water environment. Cascade of hydropower dams developed along the Mekong River is one of the distinct interventions to TSL unique flood pulse system. The socio-economic context of the TSL is quite varied and the unsustainable pattern of resource exploitation, expansion of settlements, and discharge of wastes and pollutants into the lake has severely affected the lake environment. Deterioration of environmental condition of the TSL could have significant impacts on the livelihoods of communities directly relying on fishing, farming and other resources of the TSL. An insightful understanding of socio-economic and environmental changes occurred in and around the lake is critical for the

sustainable management of the lake and its basis as well as for enhancing the resilience of communities living in and around the lake.

2. METHODS

The study employed both qualitative and quantitative methods for data collection and analysis from both primary and secondary sources. The secondary data relies on published literature and statistical data (e.g. Cambodia Socio-Economic Survey 2014, 2015; Cambodia Inter-Census Population Survey 2013). Primary data were collected using following qualitative approaches in land-based, land-water based and water based (floating village) communities: (a) ethnographic-type fieldwork, in particular, participant observations in the selected study sites; and (b) semi-structured interviews with local residents; and (c) focus group discussion with local NGOs and communities, and village chiefs. Before conducting household interviews in each studied site, a Focus Group Discussion (FGD) was carried out targeting local residents, fishers, local NGOs and village chiefs, in order to get general understanding of the village and its livelihood situations. Totally, 3 FGDs have been conducted. In addition, altogether 253 interviewing samples have been carried out at households in 4 studied villages located in 4 major provinces around Tonle Sap Lake, namely Rohal Suong (land-based village) in Battambang Province, Muk Wat (water-land based village) in Siem Reap, Kampong Luong (water-based village) in Pursat, and Chhnok Trou (water-based village) in Kampong Chhnang Province (Fig. 1). The interviews were conducted using a semi-structured questionnaire. Main issues discussed in the interviews included household characteristics; geographical landscape of the community; linkages between TSL and their livelihoods; household income; farming and fisheries and their impacts on the livelihoods; access, availability and uses of water; changes in socio-economic conditions, living standards and surrounding environment during the past decade.

3. RESULTS

It is estimated that about 1.7 million were living in 1037 villages of TSL and surrounding floodplains (Sithirith 2011). They have learned to adapt to the hydrological changes and live in close relation with the environment. Fishing villages in the TSL are organized into three different groups situated in three different ecological zones, namely land-based village (948 villages), water-based village (53 villages), and water-land based village (36 villages) (Sithirith, 2011). In land-based villages, people are primarily engaged in farming with occasional fishing activities depending on water level. In water-based villages, often referred to as floating villages, local people are primarily relied upon fishing, which is an important activity for local livelihoods since they have little or mostly no access to land. Meanwhile, in water-land based villages, people often spend approximately six months of the year on land and six months in water. In the wet season,

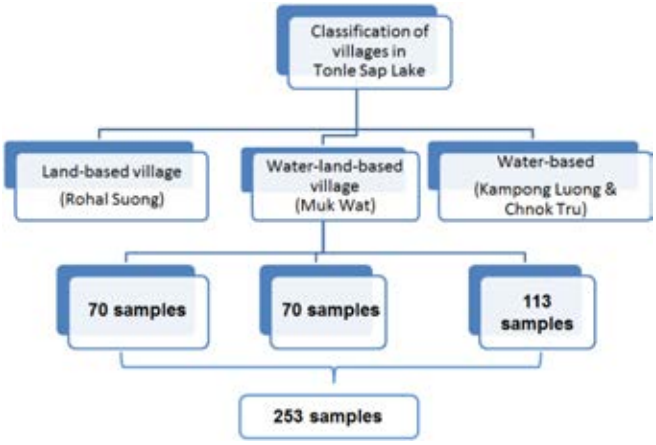

Figure 1. Sampling locations and sample size for household questionnaire surveys

the water floods the area around the village and surrounds the houses, which are built 6-8 meters above ground. Although fishing is a primary occupation for local livelihoods, villagers also supplement their incomes through small-scale farming. These villages are in the ecological zone mostly affected by seasonal water level changes. The livelihood setting of the TSL area is well adapted to its flood pulsing system and are deeply dependent on the resources and services that the lake and its floodplains provide such as agricultural products, fish and other aquatic animals, and plants. Local people also engage in several off-farm income generating activities, depending also on the seasons.

Declining fish catch and socio-economic impacts

Fisheries in all surveyed communities are crucial and forms their main or secondary income sources. (Kampong Luong and Chhnok Trou; Muk Wat). For example, in Chhnok Trou, 74% of households heavily rely on small-scale fishing as the main income source. The income is directly dependent of daily fish catch which is equivalent to 3-20 US$/day, and often the only revenue for household expenditure. Meanwhile, in land-based and water-land based villages, besides small-scale fishing as the secondary income source, rice cultivation is the main livelihood and income sources for majority of households living here. In this delicate situation, rapid fall in the fish catch (both quantity and quality) is one of the critical issues identified from the surveys. As a result the fishermen are unable to adequately support essential households' expenses. Fish catch has declined despite an intensification of fishing effort at the household level, which also means added time, financial and energy expenditures, and opportunity costs.

According to the local communities, the decline in fish catch can be attributable to several factors, including the use of illegal fishing methods, lack of control of fishing gear, unequal access to fishing grounds, an increase in the number of fishers, deterioration of fish habitat, hydrological changes in the flood pulse, and climate change. In particular, the construction of cascade of hydropower dams on the upstream countries as well as impact of climate change is believed to alter hydrological cycle affecting seasonal inundation of the lake, sedimentation and nutrient transport. Continuation with the disruption in the hydrological cycle and declining fish catch will increase people's vulnerability, especially, those with low assets base and relying on income from daily fish catch.

The impacts of environmental changes

The findings from the interviews showed that the most recent environmental changes is the deterioration of water quality in both the TSL and Tonle Sap River. The main causes of water quality decline are discharge of untreated wastewater and disposal of solid waste in the tributaries flowing towards the lake, runoff of agro-chemicals and poor water, sanitation and hygiene (WASH) and waste disposal within the floating villages. Houses in floating villages discharge effluents from toilets directly into the lake, which increased the risk of microbial contamination in the surrounding waters. Due to the nature of housing, people come under frequent direct contact with polluted water such as through washing raw food and fish, bath, hand wash and swimming. Due to primary and secondary contamination paths, at least some family members, especially children, had water borne illness and need to visit doctor frequently.

Climate change and low adaptive capacity of fishing communities

The local livelihoods and people's lives in and around Tonle Sap Lake are directly affected by the impacts caused by climate change, especially, through disruption on the hydrological cycle of the TSL. Number of extreme weather or unexpected events such as heavy storms causing high waves, severe floods (e.g. the flood events in 2000 and 2011) and droughts seem to occur more frequently and have huge economic impacts particularly to the poor households. This is highly critical for a large population dependent on the resources and services of the TSL basin floods and droughts mitigation (Grundy-Warr and Sithirith, 2016), agriculture and food security, terrestrial and freshwater ecosystems, and human health. Among 3 types of surveyed villages, the water-based communities (Kampong Luong and Muk Wat village) as such are physically less affected than those living in land. However, too high water level or waves caused by heavy storms cause many difficulties for their small-scale fishing activities. Meanwhile, too low water level will induce severe water pollution, therefore affecting to fish population, as a result the communities have to travel afar in search of better fishing ground adding fuel cost of the fishing boats, extra physical labour, and risk of accidents.

4. WAYS FORWARD TO IMPROVE THE RESILIENCE OF COMMUNITIES AROUND THE LAKE

Findings from the study indicated that in order to improve the resilience and to cope with unexpected environmental and climate change, diversification of income sources is one of the common options adopted by the households such as seasonal migration to cities, industrial estates for jobs, part-time or short-term workers or helpers in other villages or provinces, off-farm business (groceries). Improve and strengthen their housing structures, either using bamboo or woods, is another coping measure against rising tides and storms. The study found that micro-credits with low interest rate is also an important factor that help local communities to initiate supplementary livelihood sources and for buying new fishing gears.

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O9-8

Role of Local Authority in Integrated Lake Basin Management: Experiences from Malaysia

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ABSTRACT

ILBM (Integrated Lake Basin Management) is relatively a new concept in Malaysian context if it is compared to IWRM (Integrated Water Resources Management) and IRBM (Integrated River Basin Management), however, it can be fit in nicely and quickly because of relatively good understanding and buy-in from stakeholders at various levels in Malaysia. ILBM is quite a natural approach for Malaysia because there are so many lakes in the country such as natural lakes, ex-mining lakes, man-made lakes, and other multi-purpose lakes including for HORAS (hybrid off-river augmentation system) uses in Selangor State, etc. There are already active committees at the policy level on lakes as well as research and development levels too, including those chaired by several government agencies. Therefore, lakes may quickly and efficiently bring ordinary people closer to proper water management because of aesthetics and recreational attractions of lakes including for fishing, relaxation and retention purposes for water discharged or runoff from residential and business areas and estates. The key success factors for ILBM, based on literature review and informal interviews, is community buy-in along with embracement and enculturation of ILBM principals as well as aspirations for human and ecosystems health. In Malaysia, if there is a bold and sincere leadership of local authority, then the maximum of the implementation of ILBM can be won. Moreover, if there is support by academia and business professionals for expertise sharing and knowledge transfer, then the ILBM can be achieved entirely to promote the sustainable development in Malaysia.

1. INTRODUCTION

Integrated Lake Basin Management (ILBM) is a new approach in Malaysia in line with the integrated water resources management (IWRM) and integrated river basin management (IRBM), however, it can significantly contribute to the socio-economic development of the country since it is considered as the important reservoirs of fresh water [1]. For instance, Putrajaya lake is a successful example of operational UNESCO-IHP Ecohydrology Demonstration project out of seven such projects implementing globally since 2010 incorporating ecohydrology principals and relevant stakeholders [2]. Putrajaya lake which is a man-made lake of 600 hectare serves as a micro-climate moderator as well as serves as the sport and recreational purposes. However, the shortcomings in sustainable water resources management in Malaysia are reported mainly because of inadequate enforcement of policies and public participation along with the inadequate emphasis on non-structural measures [3;4].

11th Malaysia Plan (2016-2020) has also emphasized the water security in Malaysia for the green growth. Off River Storage (ORS) is an approach to tackle the pollution problem of the river for drinking water purposes. For instance, the Labohan Water Plant is following Off River Storage (ORS) which is storing water from the Langat River, Malaysia to supply drinking water at the household level after treatment [5]. Ex-mining ponds in Kampung Sungai Darah, Selangor has already been converted to special water storage for 600 million litres per day raw water supply for drinking purposes in Selangor. The particular water storage is termed hybrid off river augmentation system (HORAS) which is the combination of the off-river storage and horizontal collector well such as stormwater and underground water. The Selangor state government has already invested about RM300 million for the two HORAS projects to get 600 million litres and 700 million litres per day (MLD), respectively from Selangor River to meet up the growing demand of drinking water [6].

Although the water quality in the ex-mining pond is questionable concerning metal and radionuclide contaminants, however, Kusin et al. [7] reported the water quality regarding metal in the abandoned mining ponds including sediment at Selangor are within safe limit. Meanwhile, several best management practice projects have been carried out in line with the IWRM and IRBM

by the government of Malaysia over the last decade; however, Sukereman & Suratman [8] reported that the implementation of these projects remained in doubt and was unfamiliar by many parties. Therefore, the study proposed the leadership of local authority to implement the integrated lake basin management in Malaysia since they can involve the stakeholders effectively at all levels.

2. METHOD

The study is based on the review of the secondary literature as well as informal interviews with the public, private and civil sectors in 2017.

3. RESULTS AND DISCUSSIONS

National Hydraulic Research Institute of Malaysia (NAHRIM) is leading the lake management along with the monitoring of water quality in collaboration with Department of Environment (DOE), local authorities, universities, and as such [9]. NAHRIM has also already published the "National Lake Water Quality Criteria and Standards" for Malaysia, and the agency has arranged several stakeholder's participation from different ministries and departments through the workshop, seminars, etc. DOE [10] has also included the management of lake in the Environmental Management Plan and Environmental Monitoring of Malaysia. Although the present conventional approach to managing the water quality of Lake has not become successful to minimize the pollution of the lake through the Environmental Quality Act 1974 and the limitation to implementing Malaysia Waters Act 1920, however, the Local Government Act 1976 can be effective in reducing the pollution since the local authorities have got the mandate to punish the polluters economically through the act.

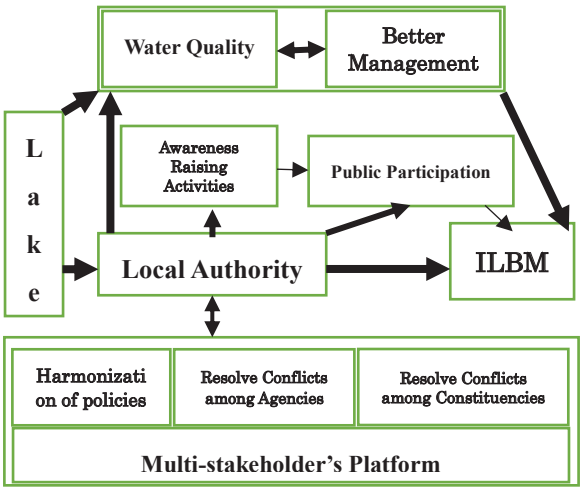

Fig. 1 Flowchart of better implementation of ILBM

Sharip et al. [11] also reported that all the important lakes in Malaysia (Table 1) are eutrophic and they could experience algae blooms or macrophyte problems due to enriched nutrients and can result in poor water quality. Therefore, to improve the water quality largely depends on the sustainable catchment practices along with the active collaboration among the public, private and civil sectors [1]. Hence the proactive leadership of local authority can lead to successful implementation of ILMB through involving the public in the decision-making process (Figure 1).

Although the beat management practice projects have potential in improving water quality status of the lakes in Malaysia (Table 1), however, the improvement of water quality highly depends on the active promotion of these projects incorporating various stakeholders to enhance the implementation of ILBM in line with the IWRM [8]. The challenges of lake basin governance are associated with the conflicts among many agencies and different constituencies not only in Malaysia but also in Canada and USA [12]. Similarly, the Great Lakes Basin, Canada is also getting chemical pollution for the rapid urbanization and which is a threat for the fresh water reservoir including the groundwater for drinking water supply purpose [13].

Table 1 Important lakes of fresh water reservoirs in Malaysia [1;11]

Lake	Area (km²)	River Basin	Water	Lake Type	Land Use
Talang	3.7	Pahang	Clear	Man-made	75% Forested
Kelinchi	1.9	Pahang	Clear	Man-made	75% Forested
Sg Terip	2.25	Linggi	Clear	Man-made	90% Forested
Bukit Merah	41	Kurau	Clear	Man-made	46% Forested
Chenderoh	25	Perak	Clear	Man-made	33% Agriculture
Raban	0.375	Perak	Clear	Man-made	33% Agriculture
Chini	2	Pahang	Coloured	Natural	50% Agriculture
Sembrong	8.5	Batu Pahat	Clear	Man-made	84% Agriculture
Kenyir	369	Terengganu	Clear	Man-made	99% Forested
Bera	6	Pahang	Coloured	Natural	50% Agriculture
Ulu Lepar	4.69	Pahang	Mixed	Natural	Mixed
Durian Tunggal	3.5	Melaka	Clear	Man-made	75% Agriculture
Ayer Keroh	0.5	Melaka	Clear	Man-made	Mixed
Aman	0.0224	Kelang	Clear	Man-made	Mixed
Layang	6.6	Johor	Clear	Man-made	50% Agriculture
Putrajaya	6	Langat	Clear	Man-made	Mixed

In Thailand, the local people perceived that the governance performance of lake basin management was below average mainly due to the institutional and agency fragmentation, inadequate coordination and integration of stakeholders as well as enforcement and compliance of policies [14]. However, the governance performance can be improved through integrating local people's perceptions in governance and management decision-making.

Similarly, the Lake Chini in the Pahang River Basin, Malaysia is not only a famous location of eco-tourism but also one of the largest freshwater reservoirs in the country [15]. However, the integrated and holistic management of the Lake Chini in line with the IWRM and IRBM largely depends on the inclusion of the local and indigenous people's livelihood in the lake ecosystem. Therefore, lakes

are not just for aesthetic beauty but also contribute significantly to the socio-economic development of the country. These lakes can also be used for freshwater storage to meet up the growing raw drinking water demand. Therefore, ILBM will be very pertinent for the Selangor and Kedah State of Malaysia since there is no reserve margin of fresh water during 2016 by the water treatment plants (WTPs), while other states in Malaysia have at least some reserve margin of fresh water [16].

4. CONCLUSION

The proactive leadership of local authority could be effective in implementing ILMB in Malaysia to promote the socio-economic transformation of the country in line with the IWRM. Hence, the leadership of local authority can be achieved via special training and education since the performance of all the local authorities in Malaysia is not equal. Besides, these inland lakes in Malaysia are also providing provisioning as well as regulating services. However, the success of ILMB largely depends on the meaningful participation of communities in collaboration with public and private agencies as well as harmonization of policies to enforce effectively. Therefore, under the proactive leadership of local authority, the implementation of ILMB can efficiently arrange the adequate stakeholders' participation through top-down and bottom-up approaches. However, the awareness raising activities, e.g. seminar, workshop, fair, etc. by the local authorities are required to encourage the people for willingness to participate and willingness to pay for lake basin management.

ACKNOWLEDGEMENT

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O9-9

River/Lake Chief, a new concept proposed by China to improve water environment

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Keywords: River Chief, top officials, sustainable development, water environment

ABSTRACT

With an aim to promote better coordination among government departments to protect the water bodies, the central government of China has decided to establish a nationwide river and lake chief system to cover all rivers and lakes by the end of 2018. It is expected to cover the provincial, city, county and township levels. Heads of provincial-level regions will be general chiefs responsible for all rivers and lakes in the region, other top officials at provincial, city, county and township levels will act as chiefs responsible for different parts of the water bodies. Responsibilities of the chiefs include water resource protection, pollution prevention and control, and ecological restoration. Their job performance will be assessed, and they will be held accountable if environmental damage occurs in the water bodies they oversee. Information including names and responsibilities of the chiefs will to be made public to ensure public supervision. China firstly appointed local government officials as chiefs in 2007 to address problem of blue-glue algae bloom in Lake Taihu, Jiangsu Province. Zhejiang Province began testing this new system in 2008 and expanded it across the whole province from 2013. In this presentation, we'd try to introduce this new concept and also its the achievement and challenges we've seen.

In China, along with fast development of economy, balancing economic development and ecological protection is becoming a major challenge. The central government of China has long realized the necessity and urgency to protect the environment. "Interplay between development and environmental protection is an intrinsic requirement of sustainable development, and the fundamental principle of modernization", "To protect the environment is to protect productivity, and to improve the environment is to develop productivity", as said by Chinese President Xi Jinping.

On 11 December, 2011, the general offices of the Communist Party of China Central Committee and the State Council, China's Cabinet, jointly issued a document to implement a river keeper system nationwide. According to the document, heads of provincial-level regions will be general chiefs responsible for all rivers and lakes in the region, other top officials at provincial, city, county and township levels will act as chiefs responsible for different parts of the water bodies. Responsibilities of the chiefs include water resource protection, pollution prevention and control, and ecological restoration. Their job performance will be assessed, and they will be held accountable if environmental damage occurs in the water bodies they oversee. Information including names and responsibilities of the chiefs is supposed to be made public to ensure public supervision.

The concept develops from a successful experience in Changxing County, Zhejiang Province in 2003. China firstly appointed local government officials as chiefs in 2007 to address problem of blue-glue algae bloom in Lake Taihu, Jiangsu Province. Zhejiang Province began testing this new system in 2008 and expanded it across the whole province

from 2013. The central government of China has decided to establish the nationwide river and lake chief system to cover all rivers and lakes by the end of 2018.

A similar scheme has been proposed in Australia in 2010. A chairman of Murray-Darling Basin Authority was appointed by the government, to restore the Murray-Darling river system. The chairman was asked to ensure the restoration plan balanced ecological outcomes with the socioeconomic impacts. However, such an ambitious scheme came to its end when the chairman resigned two months after the release of the draft plan, which prompted protests from the region's farm.

Although no systematic assessment has been done on the effectiveness of the river/lake chief system, some advantages of the new system can already be seen since after the release of the document and appointment of the chiefs. "The system helps to tackle tough challenges", as said by the director of the Department of Water Environment management at the Ministry of Environmental Protection. The efficiency of coordination among departments has been greatly improved. In the system, all the government departments related to waterbodies are members of a leading group and the top official acts as the chief. Such a hierarchy enables the system to coordinate their activities efficiently.

Due to the achievement the river/lake chief system has obtained, the newly proposed concept has been introduced to management on coast in Hangzhou, Zhejiang and street in Beijing, i.e. where the top officials are named coastal chief and street chief.

O9-11

琵琶湖流域の環境評価に影響を与える要因

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キーワード:・湖沼流域保全, 参加型評価, 滋賀県

抄録

琵琶湖は, 水資源としてだけでなく豊かな生態系を育み, 固有の文化や景観が形成されるなど多様な価値を持っている。滋賀県では2020年に琵琶湖の総合保全計画を再策定するため, 現行計画の評価を踏まえて次期計画の検討が始められている。本研究では, 公共政策において住民参加型評価が求められているという観点から, アンケート調査によって個人における琵琶湖流域の湖内, 河川, 農地, 森林の現状評価を把握し, 評価に影響を与える要因を検討した。その結果, 50歳以上の回答者は50歳未満の回答者に比べて全ての項目の満足度が顕著に低く, 田と森林について問題があると評価している, 滋賀県に10年以上住んでいる回答者は川と田に問題があると回答している, 湖に関わる頻度が多い人ほど田や森林に対して問題を認識し, かつ, 満足度が低い, 滋賀県住民は県外住民よりも森林の評価が低く満足度も低い傾向がある, などの傾向が明らかになった。

1. はじめに

琵琶湖は, 水資源としてだけでなく豊かな生態系を育み, 流域に住む人々によって固有の文化や景観が形成されるなど, 多様な価値を持っている[1]。しかし, 湖とその流域の環境は様々な要因が絡み合っており, また, 社会情勢の変化とともに新たな問題や課題も顕在化してきている[2]。このような背景を受け, 滋賀県では琵琶湖の多様な価値を次世代に引き継ぐための指針として2000年にマザーレイク21計画(以下, ML21計画)が策定された。同計画では, 2050 年頃の琵琶湖のあるべき姿と合わせて, 2010年度までを第1期, 2020年度までを第2期として, 琵琶湖を保全するための幅広い取り組みが進められている[1]。現行計画では,「暮らしと湖の関わりの再生」と「琵琶湖流域生態系の再生・保全」を掲げ[2], 進行管理として, ①計画の策定, ②事業・施策・活動の実施, ③琵琶湖総合保全の方向性の確認・評価, ④改善・対応策の検討, 協働への発展, のプロセスを組み込んだPDCAサイクルを実行することが想定されている[1]。

PDCAサイクルのCheckの段階では, 行政の評価だけではスムーズに改善が進まない可能性もあり[3], 外部の視点や考え方を取り入れる参加型評価が有効である[4]。参加型評価の導入によって, より多様な意見を得られる, 評価の透明性が上がる[5]など評価プロセスを通じて利害関係者自身に変化をもたらすことができる[6]。このような住民参加型評価の視点からML21計画では第2期策定の際, 琵琶湖やその保全に関する県民意識を把握するためのアンケート調査や琵琶湖流域の将来像を探るためのワークショップ等が実施された[7]。現在, 次期計画検討のために現行計画を見直す段階にあるが, 行政による一定の評価はされているものの, 流域住民(利害関係者)の評価は把握されていない。現段階では参加型評価を十分実行できていない状況である。

本研究では, 公共政策において住民参加型の評価が求められているという観点から, まずは琵琶湖流域住民の琵琶湖流域の現状評価とその理由を把握する。さらに, 住民と行政の評価結果の差異を明らかにするとともに, 現在の琵琶湖流域の課題や目指すべき姿について考察する。本研究の意義は, ML21計画の第3期計画へ反映させるべき内容の参考資料となることである。

2. 方法

上記の目的を達成するため, 2016年8月20日に開催された琵琶湖の環境活動に関する催事, 11月22日に開催された滋賀県内小学校教師を対象とする研修会, 11月30日に滋賀県立大学環境科学部の学生を対象とした授業において, それぞれ42名, 16名, 36名を対象にアンケート調査を実施した。調査方法は, まず, 図1に示すシートを用いて琵琶湖, 川, 田畑, 森林それぞれの現状について満足度および問題と感じる程度を評価し, シート上にプロットすることとした。また合わせて, 評価の際にイメージした場所と評価理由を尋ねた。次に, 現状評価に影響を与える要因を把握するため琵琶湖と

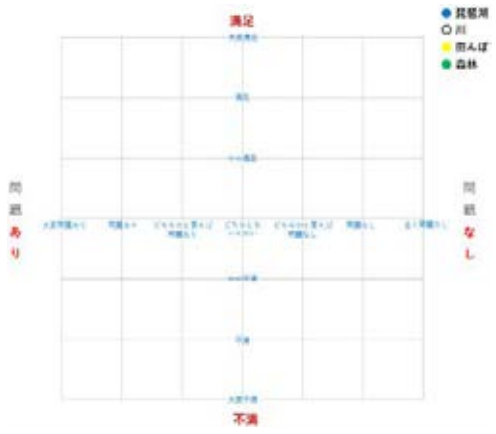

図 1 現状評価の記入シート

関わる頻度を，回答者の属性として性別，年齢，職業，居住地，滋賀県内居住年数を尋ねた。調査は対面で依頼し回収数は 94，回収率 100%であった。また，評価結果は大変満足を (0,1) ，大変不満を (0,-1)，問題なしを (1,0)，問題ありを (-1,0) として，原点からプロットされた位置までの距離によって数値化した。

3. 結果と考察

現状評価の結果を図 2 に示す。図より問題なしで満足（第 1 象限）および問題ありで不満（第 3 象限）は問題の程度と満足度が関連している結果であるが，問題があるが満足である（第 2 象限）との回答も多かった。この理由を確認したところ，問題があるが自分自身の生活に影響がない，保全活動の取り組みがされているため不満はないなどであった。これらの結果より，問題の程度と満足度は関連している回答が多数であるが，自分自身への影響の有無や自然環境そのもの以外に市民活

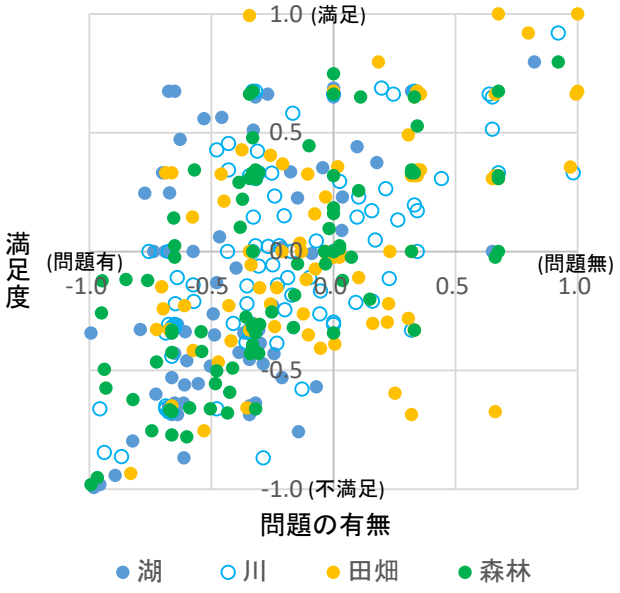

図 2 評価結果（N = 94）

表 1 現状評価の平均値

	湖	川	田	森林
満足度	-0.17	-0.03	0.05	-0.09
問題の程度	-0.41	-0.20	-0.01	-0.25

動や地域への愛着などが満足度に影響している可能性が考えられる。

次に，各項目の満足度と問題の程度の平均値を表 1 に示す。満足度については田のみ 0.05 で正，それ以外は負の符号となりどちらかというと不満に思っている人が多いことが分かる。特に湖については-0.17 とそれ以外の項目よりも顕著に低い。また，問題の程度については全て負の符号となり問題ありと評価している人が多いことが分かる。特に湖は-0.41 と最も評価が低く，川と森林もそれぞれ-0.20，-0.25 と低い評価であることが分かる。また，各項目における満足度と問題の程度の関係については，全ての項目で問題の程度よりも満足度が高く，また，湖の評価について，問題の程度と満足度が共に最も低い評価であること等から，問題の程度によって満足度に影響があることが考えられる。

最後に，属性や湖と関わる頻度による評価の違いについて検討するため，平均値の差の検定を行い 5%水準で有意に差があることを確認できた結果を表 2 に示す。表中では有意に低い値（評価が低い）のセルを灰色で示す。表より，50 歳以上の回答者は 50 歳未満の回答者に比べて全ての項目の満足度が顕著に低く，田と森林について問題があると評価している。また，滋賀県に 10 年以上住んでいる回答者は川と田に問題があると回答している傾向がある。湖に関わる頻度が多い人ほど田や森林に対して問題を認識し，かつ，満足度が低い傾向にある。滋賀県住民は県外住民よりも森林の評価が低く満足度も低い傾向がある。

以上の結果より，比較的滋賀県や琵琶湖に関わりが深い回答者ほど問題を認識している，もしくは満足度が低い結果となった。この理由として，まず，居住期間が長いもしくは年齢が高い回答者は，滋賀県や琵琶湖の過去の状態や変化を認識しており，過去と現在の自然環境を比較していることが考えられる。また，湖との関わる頻度が高いほど，問題を把握し保全活動を実施している，もしくは愛着があるためにさらに良い環境を求めていることなどが考えられる。

表 2 属性等による評価結果の違い

		湖	川		田		森林	
		満足度	問題の程度	満足度	問題の程度	満足度	問題の程度	満足度
年齢	50 歳以上	-0.32	—	-0.17	-0.25	-0.22	-0.40	-0.31
	50 歳未満	-0.08	—	0.04	0.12	0.20	-0.13	0.05
県内居住期間	10 年以上	—	-0.23	—	-0.10	—	—	—
	10 年未満	—	0.13	—	0.28	—	—	—
湖との関わり	多い	—	—	—	-0.31	-0.16	-0.49	-0.33
	少ない	—	—	—	0.08	0.11	-0.16	-0.01
居住地	滋賀県内	—	—	—	—	—	-0.32	-0.16
	滋賀県外	—	—	—	—	—	-0.02	0.12

p<.05

4. 結論

本研究では 97 名を対象として琵琶湖流域の湖内，河川，農地，森林の現状について評価を把握し，評価に影響を与える要因を検討した。その結果，次のことが明らかとなった。

・50 歳以上の回答者は 50 歳未満の回答者に比べて全ての項目の満足度が顕著に低く，田と森林について問題があると評価している。

・滋賀県に 10 年以上住んでいる回答者は川と田に問題があると回答している傾向がある。

・湖に関わる頻度が多い人ほど田や森林に対して問題を認識し，かつ，満足度が低い傾向にある。

・滋賀県住民は県外住民よりも森林の評価が低く満足度も低い傾向がある。

今後，個人の評価に至る心理構造などを明らかにするとともに，行政評価や政策への反映方法について明らかにする必要がある。

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O9-12

Perceptions, attitudes and preferences for wetland ecosystem services: a case study of Tampara, Odisha

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Keywords: wetlands wise use, ecosystem services, perceptions, lake basin management, ESSVA

ABSTRACT

Wise use of wetlands is predicated on the extent to which primary stakeholders, especially local communities participate in the management of these ecosystems. Limited empirical data on behavioural dimensions of ecosystem services and communities' response to management of these services impedes effective integration in management. We used Ecosystem Services Shared Value Assessment (ESSVA) tool to assess community perceptions, preferences and attitudes for ecosystem services of Tampara, a freshwater lake located along the eastern coast of Odisha State in India. Data from 278 structured questionnaire survey of basin communities and eight focal group discussions indicated that the demographic, socioeconomic and spatial heterogeneities within these communities had a significant influence on attitudes and preferences for 19 ecosystem services identified as being derived from the wetland. Relative significance for ecosystems services, mainly provisioning services varied when communities responded as a group as compared with when responding as an individual. Spatial location in the basin, gender, occupation and ownership of assets had a significant bearing on the preferences for ecosystem services. Communities directly dependent on the wetland perceived their role in restoration and management as being more prominent as compared with governments or other management agencies. A segmented and spatially nuanced understanding of ecosystem services, as enabled by the ESSVA tool, provides the basis for broadening stakeholder engagement in management for wise use of wetlands.

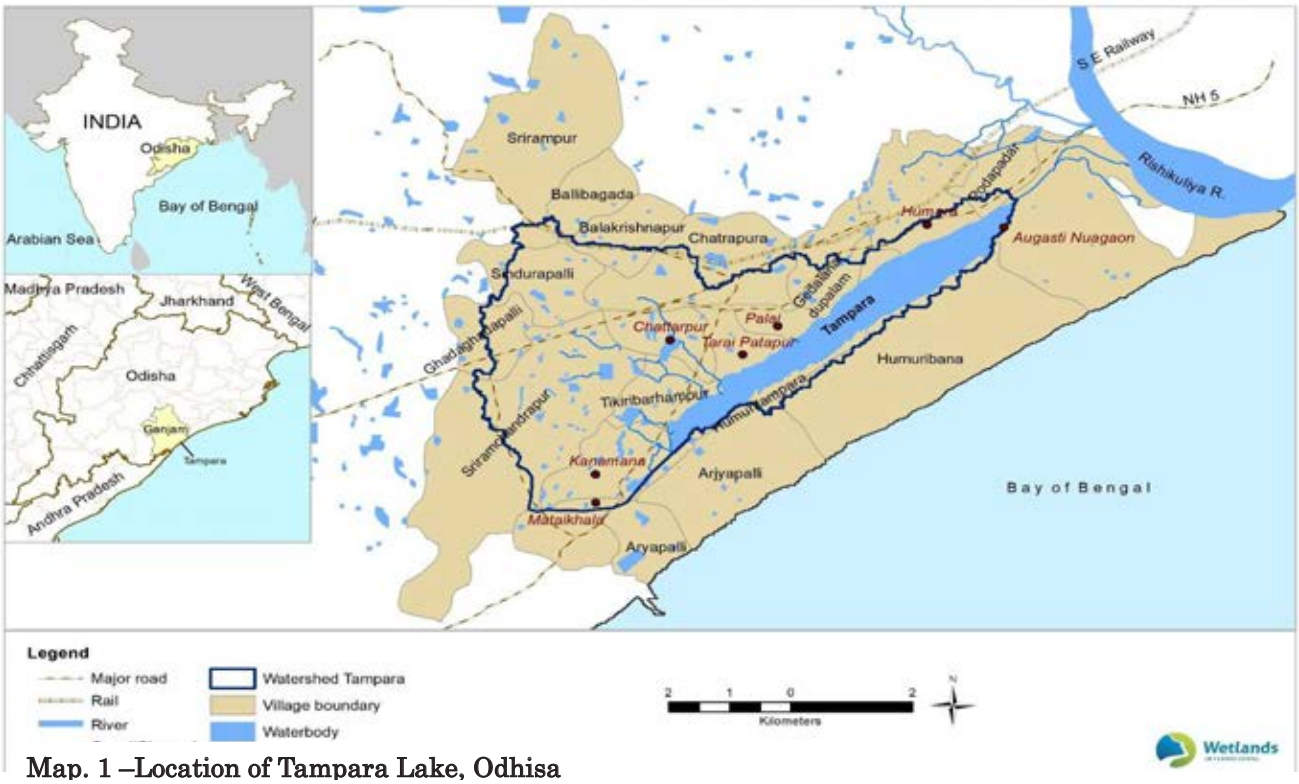
1. INTRODUCTION

The Ramsar Convention's wise use approach is premised on ensuring compatibility of human use of wetlands with the goal of maintenance of ecological character. The ecosystem services have been included in the definition of ecological character as a means of bridging wetland ecosystem functioning and their human use for well-being (Finlayson 2012). In a human-dominated world, it is increasingly appreciated that ecosystem services are not generated only by ecosystems, but by social-ecological systems of which human form an integral part. The perceptions, attitudes and preferences humans hold for ecosystem services are important institutions in themselves to engender changes in the ways stakeholders engage with management of ecosystems (Ostrom 2008; Jacobs 1997) by acting as a societal feedback mechanism, alerting the society on the consequences of consumption choices and behavior (Zavestoski 2004). However, there is a paucity of research on understanding the behavioural dimensions of ecosystem services (Asah et al. 2014), thus limiting their effective integration in management planning and decision making. The paper aims to present use of a participatory tool to uncover individual as well as societal attitudes and preferences for ecosystem services, through application in a wetland located in east coast region of Odisha State, India.

2. METHOD

We used Ecosystem Services Shared Values Assessment Tool (ESSVA) developed by International Lake Environment Committee (ILEC) to assess stakeholder perceptions, attitudes and preferences for wetland ecosystem services. The tool enables engagement with communities living around the wetland, and its upstream and downstream reaches, linking ecosystem services with various drivers of change and implications for well-being. Behavioural data is elicited through a structured questionnaire, options of which are represented mostly through photographs. A training workshop on the use of ESSVA tool was jointly conducted by ILEC and Wetlands International South Asia in December 2017.

Tampara, a freshwater lake on the east coast of Odisha State (Map 1) was selected as a demonstration site, wherein Wetlands International South Asia is formulating an integrated management plan for wetland wise use. The wetland, spanning 409 ha within a basin of 2,200 ha, is the primary source of water for over 25,000 households living in Chattarpur Municipality, and irrigation in and around. The lake is also an important source of fish, and aquatic aromatic Pandanus, sustaining livelihoods of over 700 households. Overall, 1% of the basin population living



Map. 1 –Location of Tampara Lake, Odhisa

within eight of the 15 basin villages was selected for ESSVA questionnaire survey. The households were selected based on stratified random sampling to ensure an appropriate representation of stakeholder occupations, geographical location and asset ownership. The questionnaire was developed through focal group discussions in three villages conducted during February 2018, and further modified through pilot testing in 30 households. The surveys were conducted during March – April 2018 by a group of trained surveyors.

3. RESULTS

The communities identified 19 ecosystem services (6 provisioning 6 regulating and 7 cultural services) as being derived from the wetland. When eliciting as a group, the respondents ascribed statistically significant higher values for 5 of the 6 provisioning services. Similarly, differences in mean scores for disaster risk reduction functions and select cultural services (religious values, aesthetic values, and education values) were statistically significant (Fig. 2).

Factor analysis (principal components with variance maximising rotation and Kaiser normalisation) of demographic, socioeconomic and environmental relationship data led to identification of eight variables which accounted for 68% variability within the data. The rankings ascribed to provisioning services mapped with the occupation categories (a fisher ranked fishing as the highest and a farmer to the provision of water for irrigation). However, communities which had a lesser direct dependence on the wetlands for livelihoods (such as business owners, wage labourers and private sector employees) ranked the regulating and cultural services as a highest preference. Respondents within the age group of 30-60 years scored almost all ecosystem services higher than those falling within a lower and more upper age group. Men scored provisioning services higher than the women (95% significance), whereas women scored cultural services higher than the men. Spatial location was observed to have a distinct influence on ecosystem service preferences. Awareness of ecosystem services amongst upstream communities was higher in the upstream reaches as compared with downstream reaches (99% significance). In general, the scores for provisioning and regulating services were higher for the communities located in the downstream (statistically significant with 99% and 90% significance), whereas the scores for cultural services were comparable. Scores ascribed to provisioning and regulating services by communities living within 500 meter from the lake shoreline (both 99% significant) than those living further away.

Regarding roles in the management of wetland, communities having a direct dependence on the wetland raked their role as an individual to be higher as compared to that of the municipality or the state and central government. Communities with lesser direct dependence on wetlands (those engaged in businesses and private service) felt that the state government had a major role to play in ensuring that wetland ecosystem services are sustained.

4. DISCUSSION

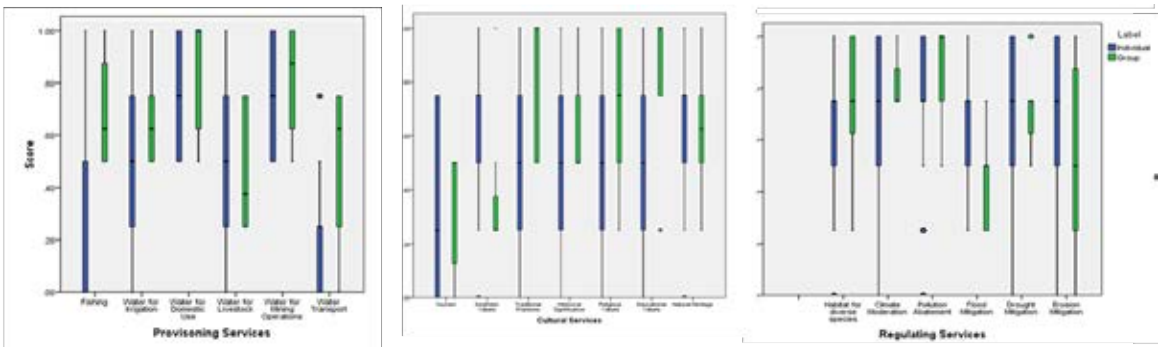


Fig. 2 - Ranking of preferences as a household and as a community group for 19 ecosystems of Tampara on a scale of 0 (=no preference) to 1 (=highest preference).

The valorised view of community as a contiguous spatial unit, similar social structure sharing similar norms has often been challenged (Agrawal and Gibson 1999; Lemos and Agrawal 2006). The case study of Tampara revalidates that the ways in which communities benefit from a set of wetland ecosystem services would tend to vary according to their interests (occupation), level of environmental awareness, location within a basin and related socioeconomic conditions. When ranking as a group, the importance of provisioning services was overestimated as compared with when ranking as an individual household, as group dynamics tend to vary with the social and physical environment in which discussions are held. A significant ramification of such difference is that perceptions and attitudes towards ecosystem services would change by the method of elicitation. Concordance of ecosystem services preferences with occupation maps with the Maslow's hierarchy of needs (primary preference to survival needs, followed by psychological and spiritual needs). The upstream communities, being urbaner and higher density of assets has accordingly placed the impacts of the decline in wetland ecosystem services as being higher than downstream communities (which have a higher concentration of farmers and fishers, with comparatively lower incomes than the upstream communities).

5. CONCLUSION

Technocratic and expert-driven assessments of ecosystem services are likely to render a simplistic view of ecosystem services, without indicating underlying social factors which have a bearing on the perceptions, preferences and attitudes towards ecosystem services. Gaining such a nuanced understanding is crucial to engage communities systematically in management for wise use of wetlands. Through the use of tools such as ESSVA, it is possible to dive deeper into factors which define the relationship communities have with wetland ecosystem services and use the assessment outcomes to develop a shared view of ecosystem services, trends therein, and possible restoration options. A critical application of the results is in developing targeted messages for various stakeholder categories while eliciting their participation in wetland management, and deciding on priority socioeconomic and demographic variables likely to influence participation.

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O9-13

Ecosystem Health Card for Laguna de Bay and its Tributaries

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Keywords: water quality, water pollution, ecosystem management, ecosystem health card, scorecard

ABSTRACT

An Ecosystem Health Card (EHC) provides simple and clear presentation of the current ecosystem health of a water body based on certain indicators. The first Ecosystem Health Card for Laguna de Bay was for 2013, where the lake scored a low passing mark of C- which is equivalent to 76%. In 2016, the EHC assessment was extended to the rivers that drain into the lake and it was named as LGU scorecard, with reference to the Local Government Units in a river basin. The same water quality parameters used in the 2013 assessment were used in the lake and river assessment. The score attained in 2016 was even lower at 72 % or a failing mark of D attributed to high phosphate concentrations and high chlorophyll a content. The East Bay garnered the highest score among the lake stations for having the least built-up areas. With the issuance of the new Effluent Standards where nutrients are already among the regulated parameters for industrial and commercial sources, the increasing nutrient loading into the lake can be effectively addressed.

1. INTRODUCTION

The Laguna de Bay, more commonly known as Laguna Lake, is the largest inland water body in the Philippines and the third largest in South East Asia. It has a surface area of 900 km^2 with an average depth of 2.4 meters (2014). Around 100 rivers and streams drain into the lake. The Pasig River through the Napindan Channel is the only outlet of the lake and drains into Manila Bay.

Laguna de Bay is a multiple use resource. The lake provides livelihood to the fisheries sector, supplies water for domestic use and irrigation purposes and supports hydropower production. The lake is also used for recreation, industrial cooling, navigation and as waste sink. Over the past decades, population expansion, urbanization, industrialization, deforestation and land conversion have led to the degradation of the lake water and the watershed.

In February 2016, the first Laguna de Bay Ecosystem Health Card (EHC) was launched by the LLDA. However, the data used was from to 2013 because of complete data set during this period. It was developed through the support of the Partnership in Environmental Management for the Seas of East Asia (PEMSEA) and patterned after the health cards of Chesapeake Bay and Chilika Lake in India. The health card was designed to easily convey information on the state of health of the lake environment to decision makers and stakeholders. The indicators used in the EHC were water quality and fisheries. Laguna de Bay scored a low passing mark, 76%, a C-, in water quality and 48 % or an F in fisheries. The lake's water quality consistently conformed with the Water Quality Criteria for Class C Waters for DO, BOD, NO_3, and total coliform but always scored poorly for chlorophyll *a* and phosphate. Laguna de Bay scored an F for fisheries due to low ratings on catch per unit effort, low ratio of native to introduced/invasive species, and dominance of invasive calanoids to cyclopoid species. Water quality and fisheries are negatively impacted by the increasing population and industrialization in the watershed.

The 2013 Ecosystem Health Card focused on the lake. Under the Wealth Accounting and Valuation of Ecosystem Services (WAVES) Project of the World Bank, the EHC assessment was extended to the river systems within the watershed using the results of the Ecosystem Accounts developed. The same water quality parameters in the EHC were used except for chlorophyll a. Instead of fishery indicators, other indicators such as waste management and ecosystem management were also included.

The scores in the EHC and Local Government Units (LGU) scorecard could serve as basis for the issuance of necessary policies and implementation of programs and projects, and encourage serious engagement of local executives for a more effective management of the lake, its watershed and resources.

2. METHODOLOGY

The EHC assessment on the water quality of the lake and river stations in 2016 was done using the LLDA

monitoring data. The different parameters were assigned scores and grades based on their compliance with the Water Quality Criteria for Class C Waters, which is fit for fisheries.

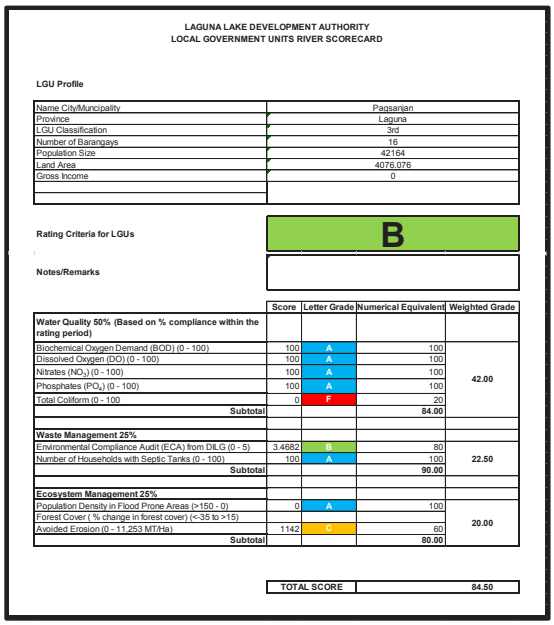
For the LGU Scorecard, the data on waste management such as the solid waste practices of Local Government Units (LGUs) and the number of households with septic tanks were taken from the Department of Interior and local Government (DILG). Assessment on ecosystem management specifically on population density on flood prone areas, percent change in forest cover and avoided erosion was based on the results of the WAVES Project.

3. RESULTS

Figure 1 shows the 2016 scores on water quality while Figure 2 shows an example of an LGU scorecard.

2016 Report Card Water Quality				
Region	Indicator	Score	Overall Score	Grade
West Bay	Nitrate	100.00	70.14	D
	Phosphate	25.00		
	Chl a	0.00		
	BOD	97.92		
	DO	97.92		
	Total Coliforms	100.00		
Central Bay	Nitrate	100.00	71.21	D
	Phosphate	27.27		
	Chl a	0.00		
	BOD	100.00		
	DO	100.00		
	Total Coliforms	100.00		
East Bay	Nitrate	100.00	75.76	C-
	Phosphate	54.55		
	Chl a	0.00		
	BOD	100.00		
	DO	100.00		
	Total Coliforms	100.00		
Southern Bay	Nitrate	100.00	71.21	D
	Phosphate	27.27		
	Chl a	0.00		
	BOD	100.00		
	DO	100.00		
	Total Coliforms	100.00		
Laguna de Bay	Nitrate	100.00	72.08	D
	Phosphate	33.52		
	Chl a	0.00		
	BOD	99.48		
	DO	99.48		
	Total Coliforms	100.00		

Figure 1. Water Quality Scores for the 2016 Ecosystem Health Card



LAGUNA LAKE DEVELOPMENT AUTHORITY
LOCAL GOVERNMENT UNITS RIVER SCORECARD

LGU Profile

Name City/Muncipality	Pagsanjan
Province	Laguna
LGU Classification	3rd
Number of Barangays	16
Population Size	42164
Land Area	4076.076
Gross Income	0

Rating Criteria for LGUs: B

Notes/Remarks:

	Score	Letter Grade	Numerical Equivalent	Weighted Grade
Water Quality 50% (Based on % compliance within the rating period)				
Biochemical Oxygen Demand (BOD) (0 - 100)	100	A	100	42.00
Dissolved Oxygen (DO) (0 - 100)	100	A	100	
Nitrates (NO_3) (0 - 100)	100	A	100	
Phosphates (PO_4) (0 - 100)	100	A	100	
Total Coliform (0 - 100	0	F	20	
Subtotal			84.00	
Waste Management 25%				
Environmental Compliance Audit (ECA) from DILG (0 - 5)	3.4682	B	80	22.50
Number of Households with Septic Tanks (0 - 100)	100	A	100	
Subtotal			90.00	
Ecosystem Management 25%				
Population Density in Flood Prone Areas (>150 - 0)	0	A	100	20.00
Forest Cover (% change in forest cover) (<-35 to >15)				
Avoided Erosion (0 - 11,253 MT/Ha)	1142	C	60	
Subtotal			80.00	
TOTAL SCORE			84.50	

Figure 2. LGU Scorecard

4. DISCUSSION

The water quality of rivers has deteriorated mostly at the western portion of the lake where there has been significant increase in the built-up areas which led to higher pollution loads to the lake.

The Laguna de Bay in 2016 scored a lower mark at 72 % or a D in water quality when compared to the 2013 rating of 76 % or C-. Results showed increasing trend in phosphate concentrations.

5. CONCLUSION

The low rating of Laguna de Bay and its tributaries in 2016 scorecard attributed to high phosphate and BOD levels and high coliform counts is indicative of pollution from domestic wastes that include laundry and untreated sewage. The findings call for the putting-up of centralized sewage treatment plants by the concerned LGUs and other agencies.

Areas with low ratings on avoided erosion and forest cover are identified as priority areas for the Greening Program.

In May 2016, the Department of Environment and natural Resources (DENR) issued Administrative Order No. 2016-08 which provides the new water quality guidelines and effluent standards. In the effluent standards, nutrients such as nitrate, phosphate and ammonia are already among the regulated parameters for specific industry sectors. With the new standards, it is expected that the nutrient loading in the lake will be effectively addressed.

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O9-14

Main Outcomes, results and lessons learnt from the international Workshop on Integrated Lake Basins Management with an emphasis on the importance of ESSVA in the ILBM framework in West Africa

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Keywords: basin management for sound water circulation, basin governance

ABSTRACT

From February 27 to March 2018 in Dakar, ILEC organized an International Workshop on Integrated Lake Basins Management (ILBM) with a focus on West African Lakes status and the current patterns for integrated lake basins management in Africa.

Discussions on lakes and wetland ecosystems were held and conducted in the framework of multiple crisis recorded in the sub-region, such as: climate change and extreme events, population growth, cities expansion, ecosystems degradation and poverty, pollution, etc. The objective of workshop was to develop guidelines in terms of research and collaboration with the African scientists and managers in order to develop knowledge and initiate research action especially in the area of the preservation and development of integrated lake basins management and ecosystems. One particular area of focus was the compliance with laws and regulations and the need to develop areas of cooperation between West African countries and experts in order to adopt common approach on research and methodologies in the area of lake basins, watersheds and wetland ecosystems integrated management.

Today's challenges are mostly focused on drinking water supply to large coastal cities populations, food self-sufficiency of lakeside villages and cities and the improvement of living conditions of populations living around lake basins. Thus the importance of integrated management of lake basins systems that takes into account the interface between the different pillars of ILBM process and the role of ecosystem approach in the context of improving the governance of lake basins, as largely discussed during the workshop.

As results, rainfall deficit observed in West African region for decades has strongly impacted the hydrological functioning of lake basins and water resources within West African countries. This situation has been exacerbated by the high pressure generated by economic activities of populations such as, agriculture, fishing with the use of illegal fishing gear, wastewater discharges and other forms of pollution that altered characteristics and biogeochemical processes of water resources. As overall consequences, poor water quality has negatively impacted agricultural activities, including fisheries resources in terms of abundance, size and spatial distribution. One can noticed as well that there are in some places development of aquatic plants, siltation/sedimentation phenomena and reduced fish production, saline intrusion into surface and groundwater as well as problems of drinking water supply to populations living around some lakes.

Today's challenges are mostly focused on drinking water supply to large coastal cities populations, food self-sufficiency of lakeside villages and cities and the improvement of living conditions of populations living around lake basins. Thus the importance of integrated management of lake basins systems that takes into account the interface between the different pillars of ILBM process as well as the role of ecosystem approach in the context of improving the governance of lake basins, as largely discussed during the workshop.

For the restoration and preservation of lake basins and ecosystems in West Africa, it will be necessary to improve existing overall management framework as well as to further strengthen and provide respect to legal and

institutional framework that govern lake basins and water ecosystems. Promoting training and capacity building on ILBM as well as generating scientific knowledge to underpin the integrated management of lakes and the interactions between lakes and surrounding watersheds are critical for the sustainable management and development of lake basins systems in Africa in general, West Africa in particular.

O9-15

Paper title : Ecosystem Services Valuation for urban lake and wetland - a case of Putrajaya

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Keywords: ecosystem services, urban, lake, wetland

ABSTRACT

The man-made lake and wetlands in Malaysia's Government Administrative City of Putrajaya has created a unique healthy ecosystem within the new city. This encourages many other cities to duplicate the same water body design. To ensure continuous financial support for its management, its economic values of this achievement need to be monitored and assessed. What benefit are we getting from such a healthy urban ecosystem? It is an important enquiry that needs to be carefully answered and understood by the city dwellers that benefit greatly from the existence of the ecosystem. This paper describes the valuation of the ecosystem services provided by Putrajaya Lake and wetland based on various economic assessment methods. Understanding of the value of this urban ecosystem, especially related to water body will enable the authorities or owner of the lakes to determine the source of financial assistance for a better management of the water body. This is crucial to ensure everybody will benefit appropriately with their contribution to the well-being of the areas.

1. INTRODUCTION

The construction of Putrajaya Lake and Wetland in the middle of a city has created various views. Some critics say it will not be easy to make sure the water is clean. While some others are more optimistic that Malaysian will rise to the occasion when common issues such as water quality at stake.

Innovative management approach is important to change the common people attitude towards a better status of our surface runoff water quality and common environment at large.

In this project, Perbadanan Putrajaya with the support of UNESCO-IHP, Jakarta has implemented the exercise of determining the 'economic value' of the 'Ecosystem Services' (ES) for Putrajaya Lake and Wetland.

The value of ES will allow the authority to start working on the source of funding the management of a large wetland and lake in the middle of an urban area.

This is almost impossible as of trying of getting large amount of fund to maintain a small ecosystem in a city.

It will only be possible if we can understand its value and will be able to share our understanding of the values with all other stakeholders.

Getting various related ministries (with actual interest) into action of sharing the management fund can be another main reasons of accessing the Ecosystem Services' Economic Value of the beautiful lake in the center of a city.

2. METHOD

There are many economic assessment methods used in this study. They are:

i. Direct Market Value (DMV);

ii. Benefit Transfer Method;

iii. Indirect Value of Economic Assessment

Direct Market Value (DMV)

Direct Market Value (DMV) method was applied to get the value of consumable water, fish and boat ridership. Direct Market Value (DMV) methodology is applied for the following assessment:

- The water value for supply (assuming the water available is made usable for domestic consumption);
- The Cruise Tasik Putrajaya ridership benefit; and

– The fish value (data taken over the five years of sampling exercise)

Benefit Transfer Method (DTM)

For other ecosystem services that are not conducted in this study, the Benefit Transfer Method (DTM) will be used. In this study, the Benefit Transfer Approach refers to the "estimating the value of an ecosystem service at a 'policy site' by assigning an existing valuation estimate for a similar ecosystem at a study site".

Indirect Value of Economic Assessment

The data collection is done for the basis of the three (3) components of the project implementation methods:

i. Contingential Value Method (CVM);

ii. Total Cost Method (TCM) and

iii. Hedonic Pricing Method (HPM) – Aesthetic value

3. RESULTS

As listed in Table 3.1, the total value of Putrajaya Lake and Wetland (as 31 of October 2015) is RM 5.89 Billion or equivalent to USD 1.38 Billion (conversion rate at that time).

According to Perbadanan Putrajaya Report [2], the estimated amount cost for the construction of the lake and wetland in 2000 is about RM 1.2 Billion. This shows that the Putrajaya Lake and Wetlands actual value (in terms of its ecosystem system value) is getting higher than it was previously developed or constructed.

This findings also provide some understanding of getting the proper ecosystem into a city may finally provide a better world and significantly assured that the lifestyle and well-being of the communities will be upgraded.

Table 3.1: the list of value of Putrajaya Lakes and Wetlands according to the various ecosystem values.

ITEM	VALUE IN RM
DIRECT MARKET VALUE	
Selling the lake water for drinking - Water Rent /Provisional/ Direct Value	19,162,500.00
Use of the Cruise Tasik Putrajaya boating service / Cultural/ Direct Value	24,176,000.00
Fish harvest / Provisional/Cultural/ Direct Market Price	4,866,600.00
Sub Total DIRECT MARKET VALUE	**48,205,100.00**
BENEFIT TRANSFER METHOD	
Water quality improvement / Regulating/ Waste Treatment	2,363,334.00
Local climate influence / Regulating/ Climate regulation	6,167,416.00
Nuisance prevention / Regulating/ disturbance modernation	37,737,511.00
Reduce flow energy/ Regulating/ Regulation of water flow	70,849,460.00
Slowing down the flow/ Regulating/ Erosion prevention	32,947,653.00
Retention time control /Regulating/ Nutrient Cycling	21,649,148.00
Pest or disease control / Regulating/ Biological Control	11,980,965.00
Breeding ground/Habitat/ Nursery Service	16,265,297.00
Genetic materials and resources/ Habitat/ Genetic Diversity	14,761,357.00
Education and research /Cultural/ Inspiration	8,846,704.00
Sub Total BENEFIT TRANSFER METHOD	**223,568,845.00**
INDIRECT VALUE – SURVEY	
WTP - *Conservation efforts ILBM/ Regulating/Cultural/ CVM- Contingent Valuation Method*	1,027,356,375.00
Events - *Recreational in lake / Provisional/Cultural / TCM – Travel Cost Method*	2,254,018,125.00
Aesthetics - *Lake front house price / Provisional/ Hedonic Pricing Model*	2,331,176,630.00
Sub Total INDIRECT VALUE – SURVEY	**5,612,551,130.00**
TOTAL ESTIMATION – 31 October 2015 (USD)	**5,884,325,075.00 (1,381,296,965.96)**

4. DISCUSSION

The method of assessment has produced reasonable value of the Putrajaya Lake and Wetland. The applications of Direct Value Method as well as the Indirect Value Method has given the opportunities for Perbadanan Putrajaya of getting good results in terms of the value of their lake and wetland.

Benefits of economic assessment

The findings of lake and wetland economic values from the research will enable the custodian of the water body to benefit especially for enhance the management of the water body. The following matters are important and will be useful:

– Sustainable source of management allocation;

– Multiple source of operation fund;

– Capacity building and training;

– Payment for ecosystem services

However, there are also opportunities for further assessment to be made such as:

i. The value of recreational benefit;

ii. Value of pollination and rare species of birds;

iii. Hedonic Pricing for all other housing, commercial and even for the government services.

iv. Applying the Ecosystem Services Shared Value Assessment (ESSVA) – non-monitory

5. CONCLUSION

Value of ecosystem services need to be assessed to provide the real values of our environment and ecosystem which will finally be handful for further discussion and negotiation with the administrative and political leaders.

From the discussion above, it is encouraged that another economic assessment with the approach of getting the total economic value should be done for Putrajaya Lake and Wetland, including the non-monitory assessment (ESSVA).

It will be useful for the owner of each lake and wetlands in Malaysia to start assessing the ecosystem services economic values of their water bodies. The process of making the assessment will also be an important matter to the custodians of such water body because it chartered the proper parameters and methods of making appropriate monitoring of data and information collection system.

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O9-16

Paper title：'Enhanced hydrological connectivity' facilitated improvement of LULC status in the catchment area of Lake Chilika: a case study from Partner's for Resilience (PfR) project in India.

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Keywords: Integrated Lake Basin Management, Ecosystem Management, Disaster Risk reduction.

ABSTRACT

Worldwide wetlands are suffering from various issues due to development initiatives. Also Natural disasters change the pattern of ecological services provided by the wetlands to the adjacent communities. Chilika is one of the important Ramsar site and largest wetland system of India. The changes in land use and land cover patterns have affected the creeks and natural canals of the lake. The occurrence of frequent floods and cyclones has also blocked the natural passage of water in to it and exacerbated the natural functioning of the wetland. 'Enhanced hydrological connectivity' has taken as a planned ecosystem based measures in building resilience of the communities. It has also taken as a key approach to rejuvenate the water bodies, revival of the creeks and mitigate water logging issues. Moreover this helped in the promotion of sustainable irrigation to 350 acres of crop land, increased flood water absorption capacity as a buffer zone of Lake Chilika and renovation of 3 ponds. The women of the community could gain economic profits from the pond aquaculture. This ultimately promoted the improvement of the LULC (Land Use and Land Cover) status of the area. The scientific LULC study conducted by Integrated Coastal Zone Management Project and Chilika Development Authority (CDA) in 2013 confirms the gain of ecosystem services due to such intervention. The recent LULC status shows 112.7 hectares of creek and 5158.6 hectares of aquaculture promotion in the area.

1. INTRODUCTION

Introduction-

Chilika Lake is the largest wetland system in India and an important Ramsar site. It is lake of 1135 sqaure km in size. The lake can be segregated in 3 sectors as per the water quality and salinity.

The upper catchment of sector of the lake towards the north-west zone is that of fresh water. This catchment area covers 3987 sq. km. Hydrologically the catchment area is influenced by two sub systems; one is Mahanadi river system (Bhargabi, Daya, Makara, Luna rivers) and another western catchment (Kusumi, Tarimi, Mangalajodi, Kantabaia, Badanai, Kansari and Kalajhar rivers). There has been frequent change in the land use and land cover pattern across the catchment area of the lake with time. Due to human interference and frequent occurrence of disasters like floods in these areas has changed the Land use and Land cover (LULC) status of the area. The local communities have been facing low ecosystem service and benefits for this from their adjacent wetland.

Land use and land cover (LULC) change is a major issue of global environment change. Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land. Land cover is that which covers the surface of the earth and land use describes how the land cover is modified. The Land cover reflects the biophysical state of the earth's surface and immediate subsurface, thus embracing the soil material, vegetation and water. Land use refers to man's activities on land which are directly related to the land. Land use and land cover are dynamic. The change happens due to human activities and natural processes. The LULC in the catchment of Chilika has shown several variability and changes with time.

The Intervention

NETCOAST was an implementation partner in PfR project in the Lake Chilika, which is also categorised as a Lentic water system. The goal of the project was to build the resilience of the local communities who were been facing the issues related to recurring occurrence of flood and water logging. These areas at Kanas of Puri district lies on the head of the lake, where fresh water pours into the lake system through its tributaries. Over the period of time, mouths of these rivers got chocked, due to several reasons. During the flood season this caused transversal stretching along the villages. There were several canal/ creek systems which were working as natural buffer zones to carry these excess flood waters. Due to lack of proper maintenance and slits carried by flood in regular years choked these natural passages of water. Gradually some of these canals were blocked by some vested people and transferred to aquaculture ponds. This eventually increased the risk in the area with water logging.

The model intervention planned to mitigate the issue through clearing of inlet and outlet of the creeks. These creeks were more vulnerable since they are worst vulnerable than other linked water systems to the river. Participatory consultative assessment was carried out along with the communities living around the lake. There were some of the vested individuals who have blocked the original path of these creeks and developed it into their aquaculture ponds illegally. In the beginning they were opposing, but later agreed internalizing the long term benefits even for their own crop fields. It was then finally concluded that de-siltation work will be carried.

Fig.1: Renovation of canal & de-siltation work

The work finally ended with renovation of old creek / canal system with 1.5 km length at river Daya. This virtually helped in the entry of fresh water to the crop fields. During the rainy period all the rain water drains to this system and thus water logging in the crop field minimized (record of water logging and reduction due to intervention please mention). The water from the creek was later used for irrigation purpose, in around 200 acres of land. No need for extraction ground water for the crops during the dry periods, since river water from Daya could easily flow to this with the use of a 5 HP motor. The canal itself serves as a mini-water reservoir for these fields. This success was again replicated in another such drain which was suffering a similar chocking. Both these creeks are now actively managed by the village committees. 3 ponds could be rejuvenated at the tail end of these creeks. This also helped in ground water recharging in the area. Most importantly, the old Creeks could started providing services as the buffer zones in the flood and water logging periods. The use of water from the canal thus increased the productive of the land and thus crop production in the area. 350 acres of the crop land get benefits from this, round the year.

Fig. 2: Irrigation helped in getting 2 crops from 350 acres of the land in the adjacent field.

Further, it helped in recharging water into 3 adjacent ponds, which were not functional for years. This helped in diversification of livelihood of 120 women from 4 SHGs, thus enhanced income from pond pisciculture.

Fig. 3: Rejuvenation ponds helped in promotion of pisciculture activities in the ponds by the women group.

The scientific data evidencing the recent change –

There was an assessment study on the LULC pattern of Chilika lake catchment conducted by Integrated Costal Zone Management Project (ICZMP) and Chilika Development Authority (CDA) in the year 2013. It used the Land use and land cover (LULC) assessment data and empirical observations which has revealed remarkable change in land use -land cover classification in Chilika Catchment. In this paper an attempt has made to study the changes in land use and land cover in this Catchment over 37 years period (1975 -2012). The study has been done through Remote sensing approach using SOI top sheet and Land Sat imageries of 1975 and 2009, 2012. GIS software is used to prepare the thematic maps.

The study has brought to light on the land use and land cover exhibited considerable influence on the various hydrologic phenomenon. In that study land use/land cover maps of Chilika catchment for the years 1975, 1999 and 2012 was prepared by Image processing and visual interpretation technique. The following table shows the differences, which confirms the achievements.

Table 1: LULC study summery; demonstrating the periodic differences (from 1975 to 1999 and 2012).

LULC indicators	1975		1999		2012	
	Area (ha.)	Area in %	Area (ha.)	Area in %	Area (ha.)	Area in %
Agriculture Land	87952.6	18.18	168608.4	34.84	125730.1	26.05
Chilika Lake	103410.7	21.38	91048.3	18.81	88734.6	18.38
Dense Forest	67904.6	14.04	43666.6	9.02	61377.7	12.72
Open Forest	13632.8	2.82	14674.7	3.03	24252.3	5.02
Plantation	2410.6	0.50	4830.5	1.00	3471.01	0.72
Water Body	1263.2	0.26	7484.6	1.55	2273.8	0.47
Aquaculture	0	0	1760.6	0.36	5158.6	1.07
Creek	0	0	0	0	112.7	0.02

In the year 1999 the 'double crop' area converted to 'agricultural land' and some new land use / land cover category created like 'aquaculture area' and some settlements are covered with vegetation, it means vegetation and agriculture area is increased but 'dense forest' decreased because of population growth here urban population increased in comparison with the year 1975.The Chilika lake also reduced its area because of sedimentation from its catchment area. The agriculture land converted partially to aquaculture ponds in 2012, which was found to be suitable and profitable income model by the community. There is evolution of creek systems in those areas in the year 2012.

Conclusion-

The restoration measures in the northern region have contributed in the revival of the catchment area of the lake and further provided livelihoods to the communities around the intervention areas. The catchment area could gain the original ecosystem service as the buffer zone to the issue of flood and water logging. The crop production of the area increased. This simultaneously illustrates the increase of the fertility of the adjacent crop fields. The women of the community also gained in terms of recharging the old and dysfunctional pond systems. Estimation showed the investment of Rs. 90000.00 from the project, resulted in the income generation of Rs. 200000.00 annually for the local communities for the subsequent years. The LULC study confirms the land use and land cover changes that have occurred in Chilika catchment in the last 37 years and considers as well as relates different components responsible for the change. Further restoration measures need to undertaken for conserving the lake. Community based initiatives need to firmed up to mainstream wetland protection.

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O9-17

Paper title: Participatory Basin Management and Biodiversity Conservation in Ansupa Lake, India

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Keywords: Integrated Lake Basin Management, Basin Governance, Eco-system Services

ABSTRACT

Ansupa is the largest freshwater lake in Odisha, with a catchment area of 5231 hectares. During the last 2 decades the Lake was under threat due to huge amount of sand, soil and debris flowed from the catchments and the river Mahanadi. The average depth of the Lake is 4 metre. Chilika Development Authority initiated participatory lake basin management and sustainable livelihood along with activities for weed management in the lake.

About 30,000 populations in 28 villages around the lake were depending on the Lake for their livelihoods, 70% on agriculture and 25% on fishing. 1836.99 hectares of agricultural crop (paddy and vegetables) depends upon its water. The capacity of the farmers have been enhanced through training programmes to increase the yield in agriculture with organic inputs and the yield increased significantly. Various plantation programmes in 132 hectares were carried out including soil conservation measures like continuous contour bond, staggered and half moon trenches. 8 nos. of new rain water harvesting structures (4.2 hectors) saved the needs of crops in stress period. Special skill building training was provided to fishers. Women SHGs helped in de-weeding the lake.

As a result the biodiversity improved in the lake ecosystem, development of favorable micro climatic conditions for wildlife viz. rabbit, small Indian civet cat, deer, python, hyena, elephants and tiger. Community based institutions like Watershed committees (7), women SHGs (30) and Primary Fisherman Cooperative Society (1) were promoted in the Lake Basin management which contributed significantly in the eco-system and economic growth.

1. Introduction

Ansupa is a freshwater lake by inflow of flood-water from the river Mahanadi and geographically located between 20.459142° latitude North and 85.603709° longitude East. It is a horseshoe-shaped lake situated in Banki Block of Cuttack district, Odisha India. The area of the lake is spread over 152 ha. (380 acres). It is a wetland of national importance with 152 ha. water spread area. 27 species of resident and 32 species of migratory birds, 9 species of submerged aquatic plants, 12 species of floating plants and 26 species of emergent aquatic plants, 33 species of fish, 3 species of prawns & 10 species of reptiles are seen in this lake. It covers 7 nos. of micro-watersheds in 28 villages in the catchment area having about 30,000 populations. The stakeholders were depending on the Lake eco-system for their livelihoods, 70% on agriculture and 25% on fishing. 1837 ha. of agricultural crop production depends upon its water.

The Issue

The lake faces soil erosion from Saranda hill (west) and Gunjar hill (north-east) and about one lakh metric ton of silt enters the lake every year. The lake was silted up and encroached by farmers for conversion to agricultural fields by the local stakeholders. The tourism stopped and the lake was almost dying. Excess use of chemical fertilizers and pesticides in the catchment increased weed infestation and eutrofication in the lake. Un-sustainable agricultural practices coupled with soil erosion and forest fires have degraded the lake eco-system. Despite several initiatives to clean up the lake, weed infestation could not be controlled. The "*Mayurinala*" is choked due to weed infestation and raising of its bed have diminished both water flow and flush out process. This resulted in the lake to behave like a closed pond and disturbed the water holding capacity. Revival of the lake was undertaken by the State Government on 2003

under the control of District Administration. Subsequently the renovation work was transferred to Chilika Development Authority (CDA), an independent Authority of Odisha Government as the nodal agency in 2010 which continued rejuvenation activities.

The Intervention & the Results:

Holistic approach for the restoration of Ansupa Lake has been carried out by the participation of the watershed committees, Primary Fisherman Cooperative Society and women Self Help Groups. Following conservation measures were taken and results have been achieved :-

* Reclamation of water spread area from encroachment: - 12 ha. of encroach area is made free and pillars are posted permanently for demarcation of the boundary.

* Re-delineations of mouth channel and its renovation:- The channel is fixed and capable of both entering and discharging flood water from river Mahanadi. Again the floating weeds like water hyacinth could be discharged through the mouth automatically which control the weed growth in the lake.

* Formation of watershed committee by the local stakeholders and involvement to the lake reclamation:- 7 micro watershed committees are formed. Total micro-plan and its implementation is executed in the Public Private Partnership mode under the guidelines of 2012 of Watershed Mission, Government of India. This increased the yield for their sustainable livelihood.

* Soil conservation measures taken in the catchment: - Different types of soil conservation measure like staggered trenches, half moon trenches, continuous bonding are executed in 129 ha. Staggered trenches over an area of 104 ha. in the catchment area increased the crop quality of cashew plantation both by Government and private. This helped in recharge of ground water table and saved the agricultural field from water logging. 8 nos. of rain water harvesting structures (4.2 ha.) saved the agricultural crop during the stress period. Fish farming training including necessary inputs have been provided to the stakeholders to increase their skill on pisciculture in these water bodies.

* Enrichment of forest through plantation and rehabilitation:- Plantation programme have been undertaken in the catchments covering 25 hectors cashew nut plantation, 20 Bald-hill plantation, 5 ha. eco-garden on the lake embankment, 2 ha. plantation in Saranda-hill for restoration of historical places. The suitable plant species such as 10 nos. of forest, 4 nos. of horticulture, 6 nos. of avenue, 11 nos. of medicinal and 23 nos. of ornamental plants and the local stakeholders also raised 80 ha. cashew nut plantation as cash crop in their own fields. All the planted area has been covered with different type of soil conservation measures which created around 100 workdays per day for 200 days per annum for continuously 3 years.

* Creation and development of eco-garden around the embankment and hillocks:- The soil erosion around the embankment is arrested through creation of eco-garden over 2 ha. Besides the erosion from the Saranda hill is arrested through creation of eco-garden in the hillock over 3 ha. Both the eco-garden is maintained in the Public Private Partnership mode with the women SHGs with the revenue collected from the tourists.

Fig.1: De-weeding by women SHG members

* De-weeding of lake manually and biologically:- Women SHG members were engaged in de-weeding to create an area of 22500 sq. meter water spread area for boating and generated 151 workdays. Organic manure around 125 tons produced in 3 years with the same weeds which is subsequently used by the farmers in agriculture resulting in decrease of chemical flow into the lake. Fingerlings of different carps for fish production through PFCS was

provided to enhance their livelihood and supplemented fingerlings of grass-carp variety as a pilot basis. In the first year, 2000 nos. of fingerlings of grass carp variety was released and subsequently the number has been increased up to 5000 per annum. In the 1st year the yield of fish of grass-carp variety was 3650 Kg. and also the production enhanced up to 6900kg. per annum subsequently.

* Dredging of lake mechanically:- The Authority has excavated the lake which resulted in increased depth up to 6 meters at places. The excavated earth is mounted in the embankment creating a smooth configuration resulting creating of tall tree plantation.

* Monitoring of lake: Lake-water quality, hydrology and migratory birds are monitored by the experts of CDA and ornithologist of BNHS, Bombay, India. This programme is being carried out by NIO, Goa, India and CDA jointly. 47 species of Hydrophytes, 27 species of residential birds, 32 species of migratory birds are seen in the lake.

Fig.2:Migratory Birds during winter in the lake

* Creation of animal friendly micro climate:-Many more species of birds, jackal, hyena, rabbit, small Indian civet cat, deer, python, elephants etc. have appeared in the catchment area since last 5 years. Tiger is also temporarily visiting the area is the indicator of creation of favorable micro climate in catchment of Ansupa lake.

Fig.3: Eco-tourism managed by women SHG

* Eco-tourism promotion: The Government provided the SHGs four boats and to run boating activity under ecotourism development programme in the lake in Public Private Partnership (PPP) mode. In the first year, 15,000 INR revenue was generated by the SHGs and this has been increased to 50,000 - 60,000 INR in the subsequent years.

Fig.4: Local women have access over lake resources

Conclusion:

As a result the biodiversity improved in the lake ecosystem, including development of favorable micro climatic conditions for wildlife. The LULC status of the lake has been increased remarkably. Community based institutions like Watershed committees (7), women SHGs (30) and Primary Fisherman Cooperative Society (1) were promoted to build participation in the Lake Basin management. It has got a new lease of life through holistic intervention initiated by CDA through the local stakeholders. The results are sustainable which provide protection to the life and livelihood of the local community and eco-system services from the wetland. This intervention and its impact is one of the most successful case study on Basin Governance and Integrated Lake Basin Management.

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O9-18

Paper title：Vulnerability and Ecosystem Services Assessment of Muda Lake Basin under the impact of Changing Climate

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Keywords: climate change, ecosystem services, lake management, tropical lake, vulnerability

ABSTRACT

Climate change influenced hydrological pattern in reservoir subsequently altered their ecosystem services. Muda Lake Basins support valuable ecosystem services and irrigate the largest paddy fields for the country. This study assessed the vulnerability of Muda Lake Basin to climate change using the Probability Distribution Model rainfall-runoff model and InfoWorks two-dimensional Integrated Catchment Model. The hydroclimate simulation was based on the downscaled global circulation model data to Peninsular Malaysia. Future hydroclimate model showed that the lake catchment will received slightly lower and higher rainfall amount at the mid of 21st century. A much severe rainfall pattern over a long period was projected at the end of 21st century. Simulation results provided pattern of lake hydrologic and hydrodynamic in association to future climatic changes. Long drought at the end of century will be affecting the lake services to supply water for irrigation and domestic. Economic valuation of the impact of climate change on the main ecosystem services during drought and flood events will enable identification of strategies to reduce the associated potential losses to infrastructure and communities.

1. INTRODUCTION

Many studies showed that climate change will be impacting water resources by altering rainfall pattern and water balance. Any changes in hydrological cycle may have ramifications to lakes and reservoirs hydrodynamic subsequently impacting water quality and ecosystem services. Climate warming were reported to intensify the eutrophication symptoms including by reducing lake levels, increasing internal nutrient loadings and supporting cyanobacteria blooms [1]. Climate change impacts will also be impacting forest and freshwater wetland ecosystems including shrinking the wetland area coverage and threatening endangered terrestrial and aquatic flora and fauna species[2,3]. Assessment on the vulnerability of Prairie wetlands to climate change showed that, under a drier climate, most wetland areas would be drained while the habitat for breeding waterfowl would be shifted from the most productive areas to the less productive but wetter areas[4].

Muda Lake Basin is one of the most endangered lake basin in Malaysia as it is located in the water stress area in the country. The lake which was constructed in 1965 and completed in 1969 was designed for irrigation of Muda Irrigation Scheme, Kedah. The lake has large catchment encompassing 984 km^2 of the Ulu Muda Forest Reserve. The lake surface area is about 15.5 km^2 with lentic ratio of 63.5[5]. The maximum depth of the lake is 25.9 m while the lake volume is 160 million cubic meters. The lake supply water to the Pedu Lake located in the north through a 6.8 km Salong tunnel. Both reservoirs were managed by the Muda Agriculture Development Authority (MADA). The Muda Lake Basin forms part of the Muda River Basin which is the largest river basin (4249 km^2) in Kedah and one of the transboundary rivers in the country.

Hydroclimate projection study has been undertaken by the National Hydraulic Research Institute of Malaysia (NAHRIM) since 2005. The study involved downscaling of the Global Climate Model (GCM) to the peninsular

region and simulated based on coupled atmosphere-ocean global climate models ECHAM5, CCSM3 and MRI[4]. The extension study on the impact of climate change in the Peninsular Malaysia that has been carried out in 2014 provided 15 projection scenarios data based on 6 by 6 km grid simulation of A1B, A2, A1F1 and B1[6]. Hydroclimate projection studies by NAHRIM indicate that Muda River Basin will experience a significant increase in rainfall amount[4]. The increase in mean monthly flows in this watershed associated to the expected climate change during 2040–2100 was reported to be statistically significant from April to May and from July to October [5]. This study aims to evaluate and simulate the impact of these climate changes using the downscaled hydroclimate data on Muda Lake Basin in particular to assess the vulnerability of the lake to changes in future hydrological pattern. Muda Lake Basin, which is situated at the most upstream of the Muda River Basin is a major water catchment for Kedah and Penang State.

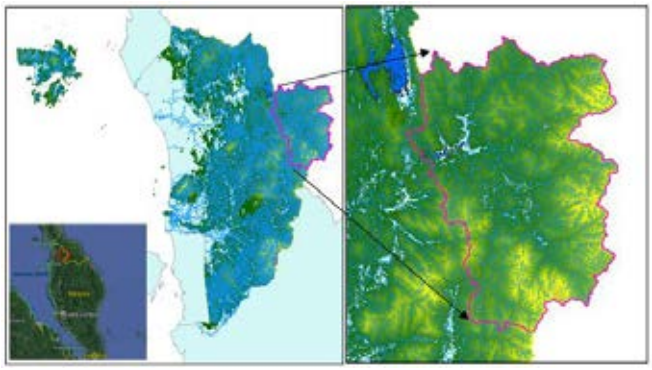

Fig. 1 Muda Lake Basin within the Kedah State, Malaysia

2. METHOD

Hydrological and hydrodynamic modelling using Probability Distribution Model (PDM) rainfall-runoff model[7] and Infowork 2-Dimensional Integrated Catchment Model is used to analyze the impact of climate change on Muda Lake Basin. The PDM was based on long duration continuous rainfall runoff and calibrated using rainfall and water level data for the period 2012-2017. Rainfall data was obtained from MADA and DID. In general, the main rivers that flow into Muda reservoir are Muda, Teliang, Che Song and Nipis Kulit. The catchment can be divided into 5 main sub-basins. The main sub-basins are the Ulu Muda and Teliang river basins that contain more than 85% of the rainfall amount that flows into the catchment areas. The hydroclimate scenarios were based on baseline data and future land use with hydrological pattern varied between scenarios. Climate impact assessment is carried out based on 3 slices period: early 21st century (2010-2040), middle 21st century (2040-2070), and end 21st century (2070-2100). Future hydroclimate projection from 35 grids were used in hydrological model (Figure 2).

Fig. 2 Catchment model and grid of hydroclimate model

3. RESULTS

The mean annual rainfall in Muda Lake basin is 3150.4 mm. This value is much higher than the mean annual rainfall between the period of 1970 to 2015 that is 2419.6 mm. Driest month is February while wettest month is September. Future hydroclimate projection data showed varied rainfall pattern between scenarios with increasing annual rainfall by end of century. Mean 30-year basin average by end of 21st century is still below 3000 mm. Preliminary simulation results showed Muda reservoir is sensitive to hydrological changes in particular drought. Existing water storage in Muda lake varied about 30 Mm^3.

Future climate projection during 2040-2070 show mild decrease and increase in rainfall amounts: dry trend (2040-2064) and wet trend (2064-2070). Such changes may be affecting slightly the water level and lake volume. In contrast, future climate projection during 2070-2100 will lead to sharp decrease and increase in rainfall amounts: long period droughts will be experience during 2070 to 2083 while long wet periods will be experience during 2083 to 2100. Due to the large catchment basin, hydrologic and hydrodynamic model of Muda Lake are being calibrated to ensure that the baseline model will adequately provide sound simulation to predict the impact of future hydroclimate projection. The expected results from this

research is an integrated catchment model that are able to predict the impact of future climate to lake water balance and its ecosystem services.

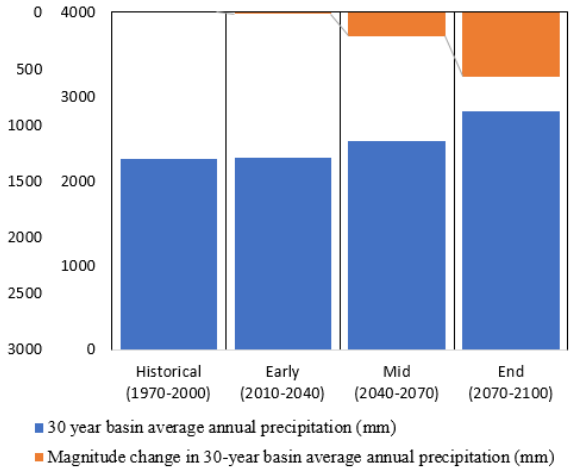

Fig. 3 30-year mean basin average annual precipitation and their magnitude of change

4. DISCUSSION

Changes in hydrology affects the water level and hydrodynamic pattern in the reservoir and its ecosystem services namely resource provision of water supply for irrigation and domestic. Due to its large drainage basin, Muda reservoir function as main collector of rainwater to channel to Pedu reservoir prior releasing to the Muda Irrigation Scheme which is also the largest paddy field in Malaysia and located about 80 km to the east. The paddy irrigation field encompass an area of 100, 685 ha, adopt double cropping of rice per year and involve a total of 68,000 farmers are dependent on the water supply from Muda and Pedu reservoirs. Water that flows downstream of Muda lake are extracted for water supply for both Kedah and Penang States. Climate change projection indicate significant increase in rainfall amounts during 2040-2100 in the inter-monsoon periods in the Muda Lake Basin consistent with prior findings in the larger river basin[6,8]. Significant changes in rainfall amount during these periods provide excess water for irrigation that can be stored during drought.

Long drought by end of 21st century will affect water storage needed for irrigation. To ensure minimum environmental flow is required for river to sustain water extraction, water transfer to Pedu Lake for irrigation will be reduced during long droughts and affect the double cropping cultivation. Increasing future rainfall indicate excess water and flood to downstream areas. The targeted findings of this work are to identify strategies to reduce the vulnerability of Muda Lake Basin to climate change including measures and policy to enhance infrastructure development and stakeholder management and cooperation at the catchment scale to sustain the overall lake ecosystem services. This will covers estimating the associated values related to the provisioning and regulating services and potential losses of crops, foods and water supply associated to floods and drought.

5. CONCLUSION

This study documents the vulnerability and ecosystem services assessment of Muda Lake Basin to climate change using the downscaled regional hydroclimate data. The study will enable identification of additional measures to reduce the climate change impacts.

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O9-19

Paper title : Government disaster response to flood and utilization of remote sensing to river observation ; An investigation in the Asia Pacific region

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Keywords: climate change, disaster prevention, mitigation

ABSTRACT

Among the natural disasters in the world, The largest number of afflicted countries among the natural disasters is " Hydro-meteorological disasters" such as floods, storm surges and landslide in the world. Important elements in river and lake disaster prevention are the diversity of gathering information of to the observation network by various sensors such as rain gauge, water gauge, weather radar and AMEDAS, in recent years it has been widely used for observation of information by remote sensing using satellite, UAV, drone and access It is recognized as an effective means for observation of difficult remote areas and afflicted areas. Consequently, based on the existing survey in Japan and Myanmar, Vietnam, we will describe the application and the problem to the disaster prevention field in each country river observation system and remote sensing

1. INTRODUCTION

There are many countries affected by disasters caused by natural disasters in the world, but most of losses due to natural disasters are hydro-meteorological disasters. Of the 22,200 events recorded between 1980 and 2011, 17, 400 (78.4%) caused the storms, floods, landslides, droughts etc. [1] and the number of affected countries is large. The observation system in Vietnam and Myanmar, which is a country susceptible to human and economic impacts due to climate change in the Asia-Pacific region, is weak compared with Japan, which is a disaster-prone country and advanced disaster prevention country. Under the circumstances under consideration, in order to investigate disaster prevention and mitigation in rivers and lakes, existing river management facilities and disaster prevention systems in each country and the possibility of utilization of observation data in UAV, drone and satellite remote sensing 1) Japan, (2) Myanmar, and (3) Vietnam.

2. METHOD

Investigate on the actual situation of river management facilities and disaster prevention systems in each country on-site survey and interview to relevant government agencies. We will also examine availability of observation data in UAV, drone and satellite remote sensing. Specific methods are as follows. (1) Information gathering by existing documentation,(2) On-site survey government related disaster prevention, listening to staff in charge,(3)Consideration of utilization of observed data in satellite remote sensing

3. RESULTS

Disaster prevention consist of three categories, such as “Information Gathering”, “Data Analysis” and “Information Delivery”.(1)At first, various information is gathered by using many kinds of sensors.(2)The gathered information is analyzed, and shared with disaster related ministry and other states and prompt and proper countermeasures are decided.(3)The decisions are sent to residents and other states through various devices.

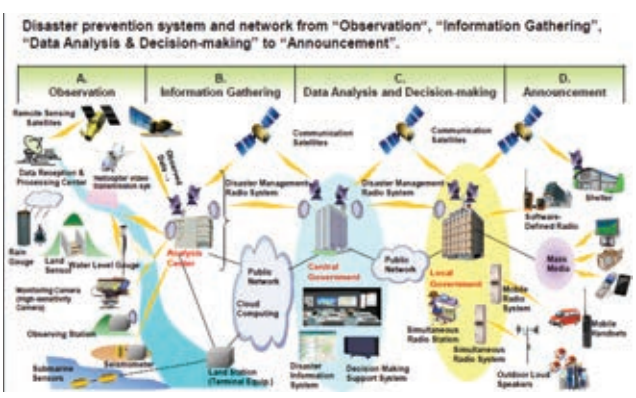

Fig. 1. Overview of Disaster Prevention in Japan

(1) Japan

Japan is globally known for a lot of natural disasters as well as advanced knowledge and technology of disaster prevention. Based on such a knowledge and technology, disaster prevention equipment such as various sensors, redundant network for disaster prevention, various monitoring and simulation systems are developed.

(2) Myanmar

The Republic of the Union of Myanmar has long history of suffering wide-scale disaster such as Cyclones, Floods, and Earthquakes. Especially in 2008, Cyclone Nargis caused devastated damages on Myanmar. More than one hundred and thirty thousand (130, 000) people are dead or missing, and two point four million (2.4 Million) people are affected. Also, cyclone “Komen” in 2015 wide-ranging and serious flood damage occurred across the country, 1.6 million people and 450,000 houses were affected. [2] With regard to Myanmar, excluding urban areas such as Naypyidaw, Yangon, traffic and communication infrastructure is still underdeveloped, international donor agencies and NGOs support to gather various information related disaster.

Based on the above, in order to investigate the existing disaster prevention system of Myanmar, visited DMH (Transportation Meteorological Hydrology Bureau) , RRD (relief of social welfare and relief and reconstruction Ministry) at Naypyidaw and Yangon in 2015.We conduct survey on Observation Facility and Emergency Operation Center as below.

1) Observation facility

Regarding the meteorological weather station, implemented 120 stations throughout the country.

Observation is operated manually, and observation data is taken five times / day every 3 hours from 6 am, and it is sent to DMH head office by telephone / FAX. Apart from that, a water level gauge and a telemetry system are introduced to each river and dam by country support including JICA. Also, at the time of 2015, observation facilities of the weather radar are under construction in Japan's ODA, further improvement of weather observation accuracy is expected.

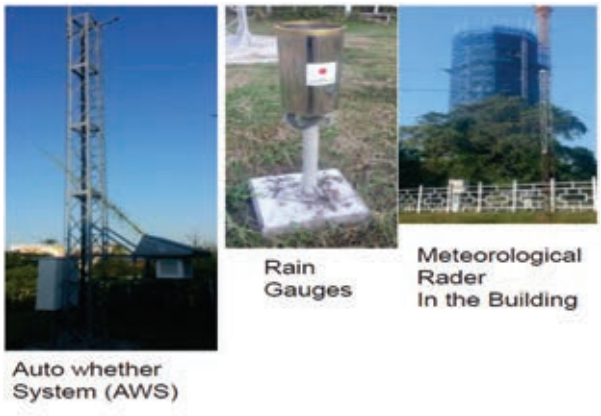

Fig. 2. meteorological weather station；DMH at Yangon

2) EOC；Emergency Operation Center

RRD governs EOC. Essentially, disaster information is gathered and decision making done by Heads of Administrative at EOC. In Myanmar, disaster response is handled by National Natural Disaster Management Committee (NNDMC) which chaired by vice-president accordance with the NNDML. The RRD is mainly responsible for (1) acceptance for international organizations and NGO support personnel in the times of disaster, (2) acceptance of emergency relief goods, (3) release situation report on disasters, etc.

Moreover, data collection in RRD is relay on telephone and fax. It contains a lot of potential errors and consumes much more human resources. Therefore it is very difficult for RRD to provide accurate information on time.

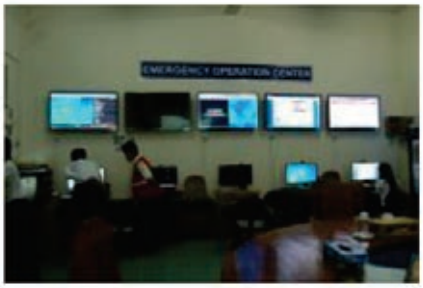

Fig. 3.EOC；RRD at Naypyidaw

(3) Vietnam

In this survey, we investigated Rainfall and water level observation facility in HCMC and SCFC (flood control center) building and existing system. All observation facilities we surveyed, managed by NHMS (National hydrological Meteorological Agency) South District Meteorological Center which is under MoMRE (Ministry of Natural Resources and Environment). The meteorological and hydrological observation office we investigated as below.

- Moc Hoa Weather and water level observation station (Manual)
- Kenh N79 Weather and water level observation station (Automatic)
- Long An meteorological hydrological observation station
- DongNai Province Bien Hoa Level Observatory (Manual)
- Dong Nai Province Meteorological Hydrology Bureau
- Tan Son Hoa weather station (manual)

1)Observation facility (meteorological hydrological information)

1) hydro-meteorological observation (Manual)

NHMS is conducting observations of hydrological weather related to disasters. The system of observation within the range heard is visually read from the recording paper twice a day. Loggers taking rainfall record are almost made in China. The tide level gauge that takes record of the water/tide level is a float type, made in the USA. According to the JICA survey report [3], there was a statement that tide level observations will be made 24 times a day in areas affected by the tide level. As for the ground weather, observation at least 4 times / day, 8 times / day.

Fig. 4.Rainfall observation station

2） Hydrological and meteorological observation (automatic)

Automatic hydro-meteorological observation station was equipped with a water level gauge and a rainfall gauge, and observation information was collected via satellite communication. Observed data is confirmed at the branch office, and data collected in nearly real time (delay of about 10 to 15 minutes) was displayed(Made by CAE Italy). Unfortunately, noises are found in the tide level data, and it is considered that there is a problem in the implementation system of maintenance.

3) Water level observation network

SCFC is conducting to observe only 7 water level gauges installed along the Nhieu Loc Thi Nghe (New Rottingge) waterway in HCMC. The observation device is installed on a pillar standing on the sidewalk along the water channel. The observation data is automatically collected in the data aggregation server via the GSM / GPRS communication module. Since it was a reply that the system handling observation data was not arranged in the server room installed in the office building of SCFC, management of observation equipment was left to external institutions such as Urban Drainage Company (UDC).SCFC is monitoring only at the observation result.

Fig.6.Water level observation station

4. DISCUSSION

Disaster prevention systems for hydro-meteorological disasters require gathering information, decision making quickly and accurately. In Japan, budget for disaster prevention infrastructure as well as maintenance are sufficient, but it is not sufficient for Vietnam and Myanmar.

They have been given top priority for the development of social infrastructure which contributes to the economy. Many observation equipment in their countries has been provided by Japan and other countries' donation and maintenance is not sufficient.

Meanwhile, an observation system based on vulnerable communication infrastructure, such as utilizing GSM / GPRS / SSB as infrastructure for sending disaster information, has implemented.

Regarding large-scale flood disasters such as Cyclone ·

Komen in Myanmar, remote sensing from artificial satellite or UAV is effective in times of disaster. It's possible to (1) instantly observe a wide range, (2) grasp the situation without going directly to the site, and (3) near infrared rays and microwaves which can't be confirmed by human eyes Observation. However, remote sensing by artificial satellites is expensive for developing countries.

Based on the above, it's convinced that remote sensing by utilizing drone is effective to grasp disaster information in real time. (There was also a question from the Director of RRD of Myanmar after the disaster cyclone "Komen" in 2015.

Consequently, based on considering the size of the economies of each country and the disaster prevention literacy, we should consider to implement a disaster prevention system.

5. Conclusion

Based on the results of on-site survey, we discussed the disaster prevention system for "Hydro-meteorological disasters" in Japan, Myanmar and Vietnam.

Although disaster infrastructure in Myanmar and Vietnam are vulnerable, we convinced that it will be improved their infractracture supported by JICA or multilateral assistance both hard and soft, and budget for disaster prevention infrastructure due to economic growth of our country will be improved.

Although the disaster prevention infrastructure in Myanmar and Vietnam is weak, although disaster prevention system in flood damage in Japan, Myanmar and Vietnam was discussed based on the on-site survey results, both JICA and multilateral assistance. Moreover, it will be improved by the increase of budget for disaster prevention infrastructure due to economic growth in their country.

Meanwhile, concerning Pacific islands, which are also areas where natural disasters such as cyclones, floods, earthquakes and tsunamis frequently occur, and which are susceptible to serious impacts of climate change, their "Narrowness", "Isolation", "Remotability" and "Maritime", there are many disaster prevention issues before disasters. Based on the discussion Japan, Myanmar and Vietnam, we try to investigate the hydro-meteorological observation and disaster prevention system in the Pacific islands.

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O9-20

Management of a Tropical Freshwater Lake under a Changing Climate and Environment

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Centre for Earth Research and Environment Management
Keywords: Sasthamkotta Lake, water quality, climate change, socio-economic

ABSTRACT

Lakes are under threat from the impact of environmental degradation and changing climate in India, a country with fast rising population and with several social, economic and political hurdles in manangement. The Sasthamkotta Lake , a designated wetland is the only freshwater lake in the tropical state Kerala. This spring-fed lake is the source of drinking water for 0.5 million people and residence of nearly 27 freshwater fish species. Input of chemicals, fertilizers and pesticides from farms carried through rivers, and the detergents and untreated domestic effluents from urban areas contaminate the lake's water. Rising needs in water and the extremes in local climate as part of global anomalies worsen the situation. Increasig rainfall intensity causes large-sclae erosion in the upper hills and the sediment load carried by rivers threatens the existence of the lake. Degradation of the lake leads to socio-economic issues such as pricing of water, migration, and conflicts. Rules and regulations for the protection of lake become farce bcause of various social and political reasons. This paper analyses the water quality of the lake, various factors leading to the degradation of the lake and the socio-economic issues associated with the degradation of the lake.

1. INTRODUCTION

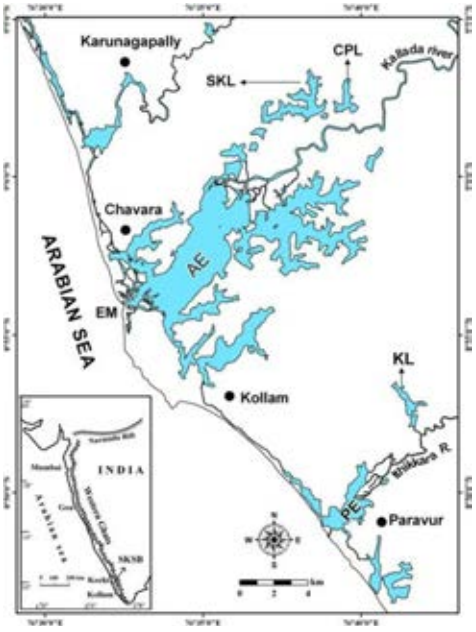

Fig. 1Location map

Sasthamcotta Lake, a designated Ramsar site is the largest natural fresh water lake in Kerala located in Kollam District between 9º 0′-9º 5′ N latitude and 76º 35′-76º 46′ E longitude, with an average depth of 6.5m. Except for an earthen embankment of 1.5 km length which separates the lake from the paddy fields on its southern side, bordering the alluvial plains of the Kallada River, all other sides of the lake are surrounded by hills which are steep and form narrow valleys. In the south and southwestern parts of the lake there are a number of smaller water bodies and waterlogged areas. This lake has an area of 3.75 km2 and volume of 22.4 km 3 (Vishnu Mohan et al., 2016). The lake receives water mainly from rainfall of (nearly 2500 mm/year) and surface runoff (3.54 million m3/ year) (Nair, 2015). In addition, it receives water from underwater springs. The wetland supports 27 species of freshwater fishes and two genera of prawns. It is the drinking water source for about 0.8 Million people. Inland navigation, tourism and fishing are the major source of income for the lake depending communities. Erosion associated with climate change and pollution from domestic, agricultural and industrial sectors deteriorates the water quality of the lake. Sand mining in the nearby Kallada, overexploitation of water, unscientific engineering constructions etc also badly affect the water quality (Sujayakumari & Lisy 2017). Floodplain area is becoming fallow lands because of indiscriminate sand mining, reducing the groundwater replenishment of the lake. Encroachment has reduced the depth and surface area of the lake considerably. Large tracts of land around the lake have been cleared off trees for paddy, plantain and tapioca cultivation. The lake is losing its water level at an alarming rate of 1 cm per day. Water level in the lake fell from around 16m in 2010 to 11.5m in 2018. Area of the lake fell from about 4.60 sq km in 1970 to 2.5 sq km in 2018.

2. METHOD

Quality of water in the lake was analysed during summer and monsoon seasons during 2016 & 2017. Data and reports from various government agencies and NGOs have been collected for the study. Meteorological data procured from the India Meteorological Department was analysed to find changes in rainfall characteristics over the area.

3. RESULTS

Analysis of the rainfall data shows that total rainfall during the study period was not much different from the

climatological normal, but intensity and seasonality of rainfall over the area is increasing. Surface water temperature of the lake is increasing. The total dissolved solids (TDS) shows a monthly range of 88.4mg/L to 55 mg/L, much below safety limits. The TDS values are high during monsoons due to the input of organic matter and wastes from rivers and canals. Surface water temperature of the lake ranged from 26.5C to 32.3C. Turbidity values varied from 14 NTU to 19 NTU, the dissolved oxygen values varied from 5.46 to 8.53 mg/L and the BOD varied from 0.68 to 5.3 mg/L. COD from 3.2 to 110.7 mg/Ltotal hardness from 7 to 25 mg/L (within desirable limits). High value of total coliforms (19 to 23700 count / 100mL indicates that water quality is unsafe to humans. COD, BOD, pH, and turbidity and coliform of the water samples were exceeding the desirable limit, though there is large seasonal variations. Microbial contamination was detected in all samples, which is a serious threat to human health. Water quality analysis shows that water is acidic, especially during the non-rainy months (December to May) when the pH values were always below 5.5.

4. DISCUSSION

As the rainfall is becoming more seasonal and intense, erosion and sediment input into the lake are increasing. Long gap in rainfall reduces groundwater recharge and adds to the deterioration of water quality. Rate of evaporation increases with the rise in water temperature, adding to decreasing summer water level. Main reasons for the degradation of water quality are: encroachment/reclamation for agriculture (mainly paddy, plantain, and tapioca), unauthorised sand and clay mining in the surrounding hillocks which serves as catchments, acacia plantation that consumes large water quantity, soil erosion on the banks and accumulation of eroded materials at the bottom of lake, dumping of agricultural and domestic wastes, dumping of wastes by restaurants and butchers, dumping of hospital wastes, dumping of municipality sewage via gutters, debris input from construction, coconut husk retting and, bathing (humans and animals) and washing clothes.

Fig. 2 Change in lake area 2011 & 2017

State government has started an action plan for the sustainable utilization and conservation and to address the threats faced by the lake. The forest department has planted trees to prevent soil erosion at some places along the embankments. Efforts had been made to control cultivation along the banks of the lake. It was proposed to rejuvenate the lake fishery by ranching with the seeds of indigenous fishes. Local NGOs are working actively to restore the lake. But, the progress is very slow.

Degradation of water quality leads to several socio-economic and health issues such as: local water crisis and hiking price of reliable water, migration and conflicts over allocation of water, spread of water-borne diseases and increasing poverty of lake depending communities.

Major challenges to the lake are changing climate, (especially the trends in rainfall and temperature), the national river linking programme to interconnect major rivers that may reduce flow into the lake, rising population, agricultural expansion, urbanization and industrialisation. Fall in water level allows nutrient-rich water from the nearby marshes to flow into lake. This will trigger algal bloom in the lake, causing eutrophication that may trigger anaerobic conditions, threatening the lake ecosystem. A good portion of the 3.73-sq km lake has turned lush grassland which is now being utilised for grazing livestock. When the grass gets decayed during monsoons, it will produce methane and result in eutrophication. Increasing use of surface water will lead to increased use of groundwater that may result in salinity intrusion, as the lake is not so far from the Arabian Sea. Another major challenge is the tourism development. Oil spills from houseboats is becoming a threat to the aquatic life. Fishing boats with outboard engines release large quantity of hydrocarbon in to the lake.

Recommendations for the protection of lake and to mitigate the impacts include public awareness to protect and improve the aesthetic environment near the lake, ensuring safe drinking water though domestic water purifiers, rainwater harvesting, enhancing groundwater recharge in the surroundings through traditional and environment friendly techniques, strict banning on the discharge of human wastes sewage and other pollutants directly into the lake, control of agriculture on the immediate vicinity of the lake, relocation of polluting industries, periodic evaluation of water quality and prohibition of bathing and direct washing of cloths in the lake.

5. CONCLUSION

Water quality as well as the water quantity of the lake is decreasing fast, as a result of encroachment, input of chemicals from domestic, agricultural and industrial sectors and the changes in temperature and rainfall patters associated with global climate change. This has seriously affected the availability of reliable water and livelihood of lake depending poor communities. Deterioration of water quality leads to serious health issues. The lake is receiving increasing pressure with requirements in land and water for the fast rising population. All these factors lead to several socio-economic issues. Current policies and strategies for the

conservation of wetlands are inadequate the implementation mechanism often fails due to various administrative, political and financial reasons. The state should develop an appropriate policy that includes social, economic and environmental factors and climate change adaption and a strong guideline for the implementation of the policy. Increased public awareness can be made with cooperation of NGOs. Financial crisis can be overcome with private sector participation with a strong control by the government.

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O9-21

気象条件の変動に対する近隣湖沼の水質応答特性に関する研究

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キーワード:近隣湖沼,気候変動,水質応答,ILBM,水質管理

抄録

霞ケ浦,手賀沼,印旛沼は利根川流域における同様の気象特性のエリア内の近隣湖沼である.気象条件の変動に対する近隣湖沼の水質応答特性には,気象変動特性による同期性と湖沼特性に応じた個別性がみられ,近隣湖沼における気象特性,湖沼特性に応じた水質応答特性の分析は,近隣湖沼の統合的な利水管理,環境管理に有効と考える.日平均水質の応答特性として,手賀沼は降水後の COD 低下,霞ケ浦は強風時の COD 上昇が顕著である.近隣湖沼の月平均の水質変動には同期性と個別性が見られる.近隣湖沼の年平均水質の応答特性として,手賀沼は年降水量,霞ケ浦,印旛沼は年降水量,年日照時間による年平均 COD の変動量が大きい.

1. はじめに

図 1 に示す霞ケ浦, 手賀沼, 印旛沼（以下 3 湖沼と言う.）はいずれも利根川水系に属する近隣湖沼である.ここで近隣湖沼とは,集水域の気象特性（降水,日照,風速,気温の年間変動特性）が同様の湖沼で,概ね半径 30km の円内に集水域が位置する湖沼を言う.表 1 の 3 湖沼の諸元のとおり,3 湖沼の容積,年平均回転数等,湖沼特性は大きく異なる.ここで 3 湖沼の流出係数は,手賀沼の日雨量と日平均自流量（利根川下流河川事務所データ）の相関式から求めた手賀沼流出係数を他の 2 湖沼にも準用した.3 湖沼における気象条件の変動は近隣であることから同期性がみられ,気象条件に対する湖沼水質の応答には湖沼特性の差異が反映される.本論は近隣湖沼における気象条件の変動に対する水質応答特性を分析し,近隣湖沼の統合的な利水,環境管理に資する.

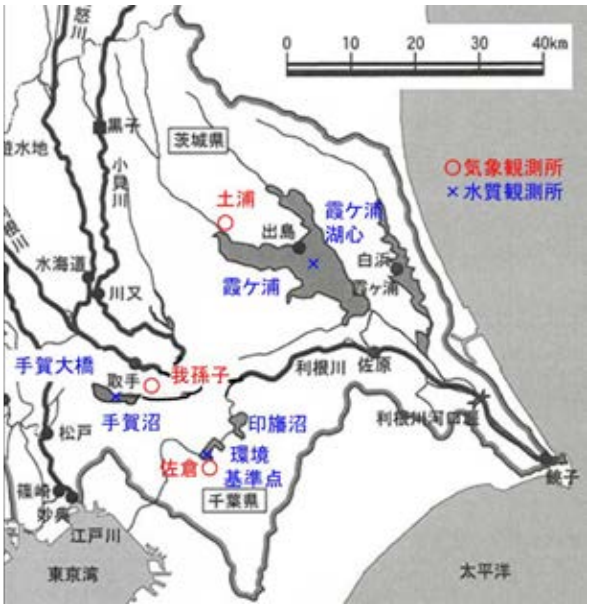

図１　３湖沼の位置図

表１　3 湖沼の諸元

		手賀沼	印旛沼	霞ケ浦
COD75%値(mg/L)	環境基準	5	3	3
	27年度現況	9.3	14	8.6
湖沼面積(100ha)		6.5	11.6	218.6
平均水深(m)		0.86	1.7	4
湖沼容積(百万m^3)		5.6	19.7	850
流域面積(100ha)		150.5	505.4	2156.7
年平均雨量mm（1984～2017年平均）		1407	1404	1210
年平均回転数		27.8	26.4	2.3

・手賀沼流出係数＝(1.407＊0.7335＊流域面積＋1.8941＊365日)/流域面積/1.407＝0.734

・年平均回転数
＝年平均雨量＊流域面積＊流出係数／湖沼容積

2. 近隣湖沼における日平均水質応答特性

湖沼の日オーダの水質変動要因として,強風による底泥巻き上げに伴う COD 上昇,降水時の汚濁負荷流出に伴う COD 上昇,降水後の湖水の流出交換に伴う COD 低下,気温低下による光合成の抑制に伴う COD 低下,日射による光合成に伴う COD 上昇が考えられる.図 2 は 2011 年 4 月の霞ケ浦近傍の土浦における日気象値（日平均気温,日日照時間,日平均風速,日降水量）と,水質指標として霞ケ浦湖心の日平均 COD 値を示す.日平均 COD の変動と気象値の対応から,日平均 COD の変動要因を推定し,気象要因別に丸印で示した.日照時間,ＤＯともに高い場合は日照による光合成に伴う COD 上昇と推定され,気温、水温ともに低い場合は気温（水温）低下による光合成減少に伴う COD 低下と推測さ

れる.複数の気象イベントが同時発生の場合は,複数の丸印を同日に示し,件数,COD 変化量は按分した..表 2 の定義により手賀沼と霞ケ浦の日平均 COD の変動要因と推測される気象イベント件数をカウントし,気象イベントによる COD 変化量の合計値を算定し,図 3 に示す.手賀沼は降水後の COD 低下,霞ケ浦は強風時の COD 上昇が顕著である.

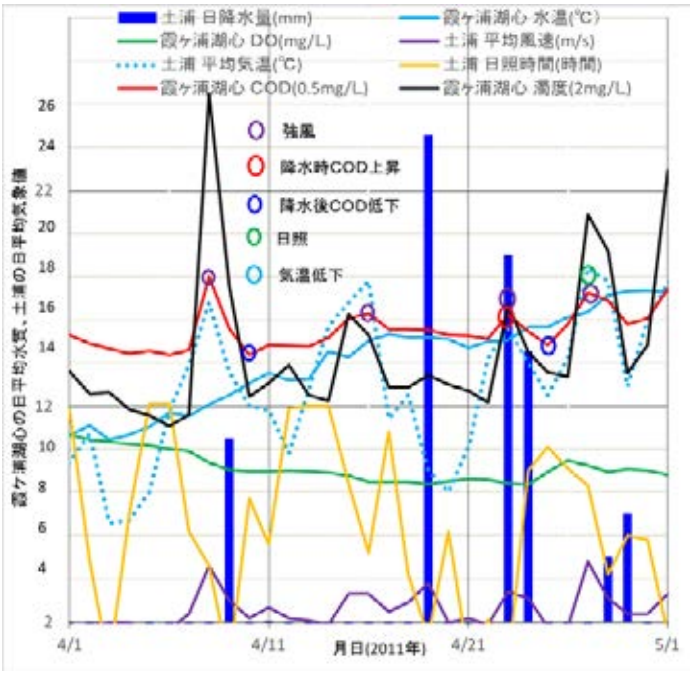

図 2　３湖沼の年平均ＣＯＤの経年変化

表 2. 気象イベントによる日平均ＣＯＤの変動量の定義

気象イベント	気象イベント前	気象イベント後（カッコ外の数値は手賀沼、カッコ内の数値は霞ケ浦）
強風	気象イベント直前のCOD値	日平均2m/s以上の風速後１日（２日）以内のCODピーク値
日照		３日連続8時間以上の日照後１日以内のCODピーク値、またはDOのピークから0日（２日）以内のCODのピーク値
降水時		日10mm以上の降水後１日（２日）以内のCODピーク値
気温		１０日で2℃以上の水温または気温低下後２日以内のCOD最低値
降水後		日10mm以上の降水後２日以内のCOD最低値

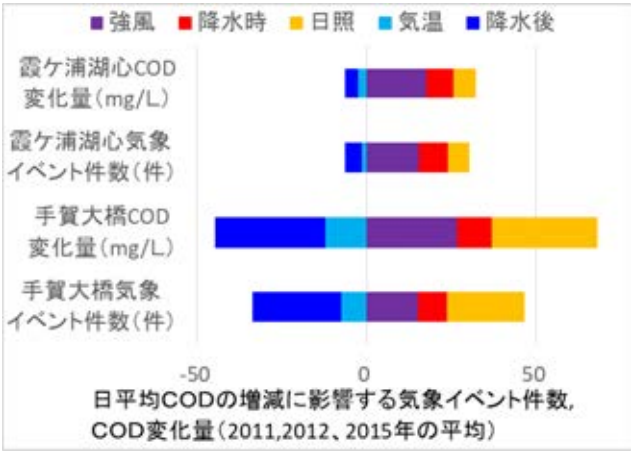

図 3　手賀沼、霞ケ浦の気象イベント件数、COD 変化量

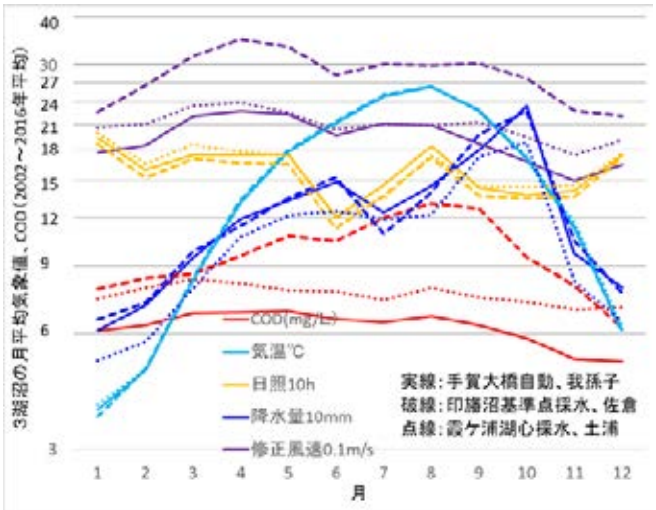

図 4　３湖沼の月平均気象値, COD

3. 近隣湖沼における月平均水質応答特性

図 4 は 3 湖沼の月平均気象値,COD 値を示し,表 3 は 3 湖沼の月別の COD の高低と図 4 における気象値と水質値の対応から推定される COD の変動要因を示している．3 湖沼とも秋雨以降の 10～12 月は COD が低い.印旛沼は夏季の 7～9 月の COD が高いが,霞ケ浦,手賀沼は 3～4 月頃の COD が高い．COD の高低は,年間上位 3 位までを＋,下位 3 位までをーで表示した.1～2 月は概ね弱風で COD は低く,3 月は少雨,強風,日照が強まり COD 上昇,5 月は強風で COD 上昇,6 月は梅雨,弱風で COD 低下,7～9 月は強風,日照,少雨により COD 上昇,10 月は梅雨により COD 低下,11～12 月は弱風等で COD 低下し、3 湖沼で月平均水質には,同期性と個別性がみられる.

4. 近隣湖沼における年平均水質応答特性

3 湖沼の年平均 COD,年平均気象値間の単回帰分析を行い,表 4 に示す.なお,2009 年以前の我孫子,土浦の風速は観測環境悪化による経年的な線形低下トレンドを修正した.図 5 に 3 湖沼の年気象値の変動（2＊標準偏差σ）による年平均 COD の変動幅（各気象要因は独立ではないため,合計で COD の 2σとなるように比例配分）を示す.手賀沼は年降

水量による COD の年変動量が大きく,降水流出により汚濁負荷が効率的に排出されていると考えられる.印旛沼、霞ケ浦は年日照時間,年降水量による COD の年変動量が大きい.

表 3　３湖沼の月別の COD の高低と COD 変動要因(2002～2016 年平均)

湖沼	区分	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
霞ケ浦	CODの高低		＋	＋	＋						－	－	－
	COD変動要因		少雨	日照、強風	日照、強風						多雨、日照少、弱風	弱風	弱風
手賀沼	CODの高低			＋	＋	＋					－	－	－
	COD変動要因			強風	日射、強風	日射、強風					少雨、弱風、日照少	弱風、日照少	弱風
印旛沼	CODの高低	－						＋	＋	＋		－	－
	COD変動要因	弱風						高温	高温、日照	高温		弱風、日照少	弱風

表 4　３湖沼の年平均 COD、気象値間の単相関、COD 変動幅

		年日照時間hr	年平均気温℃	年降水量mm	年平均風速m/s	年平均CODmg/L
導水前手賀沼	係数	0.0066	0.213	−0.0088	−1.173	
	決定係数	0.09	0.00	0.60	0.00	
導水後手賀沼	係数	−0.0005	0.206	−0.0036	−2.48	
	決定係数	0.00	0.00	0.19	0.03	
印旛沼	係数	0.004	0.513	−0.0034	−1.29	
	決定係数	0.32	0.04	0.30	0.02	
霞ケ浦	係数	−0.0011	−0.067	−0.0014	1.18	
	決定係数	0.13	0.00	0.15	0.01	
平均値	前手賀沼	1634	14.58	1418	1.98	19.44
	後手賀沼	1909	14.81	1462	1.92	9.03
	印旛沼	1771	14.70	1434	2.49	9.72
	霞ケ浦	1818	14.70	1241	2.07	7.72
標準偏差σ	前手賀沼	132	0.51	260	0.05	2.95
	後手賀沼	207	0.39	174	0.1	1.44
	印旛沼	189	0.5	222	0.15	1.36
	霞ケ浦	219	0.5	200	0.07	0.71
2σのCOD変動幅	前手賀沼	1.54	0.20	4.06	0.11	5.90
	後手賀沼	0.29	0.22	1.70	0.68	2.88
	印旛沼	1.05	0.35	1.05	0.27	2.72
	霞ケ浦	0.54	0.08	0.63	0.19	1.42
・1988～2016年データで解析						
・手賀沼は導水前1988～1999年、導水後2000～2016年						
・各気象値によるCOD変動幅＝係数＊各気象値の標準偏差						
＊実際のCOD変動幅／(各気象要因による計算COD変動幅)						

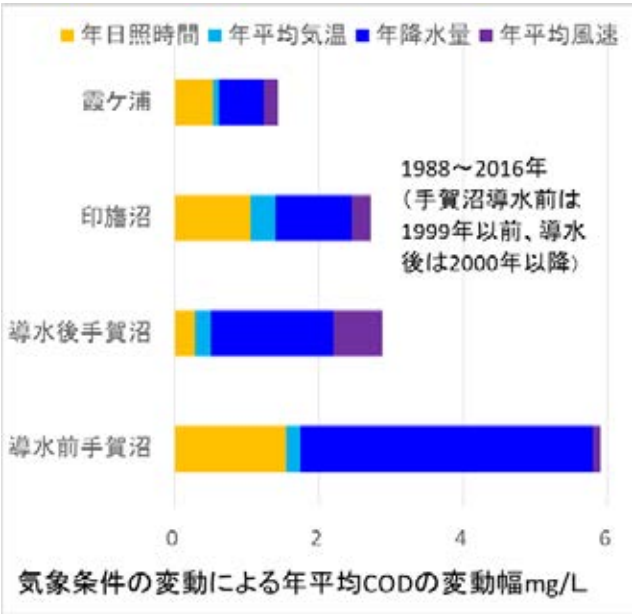

図 5　３湖沼の気象イベントによる COD 変動幅

5. おわりに

気象条件の変動に対する近隣湖沼の水質応答特性に関する結論は以下のとおりであり,近隣湖沼の比較により適格な湖沼水質変動特性の分析が可能となり,近隣湖沼の統合的な利水管理,環境管理に有効と考える.

1．日平均水質の応答特性として,手賀沼は降水後の COD 低下,霞ケ浦は強風時の COD 上昇が顕著である.

2．月平均水質の応答特性として,近隣３湖沼の月平均水質には同期性と個別性がみられる.

3．年平均水質の応答特性として,手賀沼は年降水量,霞ケ浦,印旛沼は年日射時間と年降水量による年平均 COD の変化量が大きい.

O9-22

Water availability and demand under climate change and population growth in Lake Guiers, Senegal

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Keywords: climate change, water resources, population growth, Lake Guiers, Senegal

ABSTRACT

During the last three decades, increasing population, changing patterns of water demand, and concentration of population and economic activities in urban areas has pressurize Senegal's freshwater resources. To overcome this deficit, Senegal turned to the exploitation of Lake Guiers. It is the sole water reservoir in the country and its water is use for irrigating crops and sugar refinery, as well as a drinking water resource for urban centres. To address the challenges that climate change and population growth poses in Lake Guiers water resources, it is necessary to consider its potential impacts on different dimensions of water resources. In this study, future water availability and demand has been modelled under scenarios of climate change and population growth until 2030, based on the representative concentration pathways (RCPs) 4.5 and 8.5 by applying the Water Evaluation And Planning System model (WEAP). The results show that the pressure on Lake Guiers's water resources will increase, leading to greater competition between agriculture and municipal demand site. Decreasing inflow due to climate change will aggravate this situation. WEAP results offer basis to Lake Guiers water resources manager for an efficient long-term planning and management.

1. INTRODUCTION

In Senegal, the supply of drinking water to satisfy population needs is one of the biggest issue. To overcome deficit on water supply, Senegalese authority turned to the exploitation of the Lake Guiers. It is a shallow reservoir located on the right bank of Senegal River, between latitudes 16°23'N and 15°55'N, and longitudes 16°12'W and 16°04'W. The Lake Guiers is mainly fed by Senegal River through Taouey canal (Figure 1). Its water is used for irrigating crops (90,000 ha) and as a drinking water resource for urban centres (165,000 m3/days for a population of 5 Million inhbts).

In the last decades, the Lake Guiers basin was subject to several changes. These changes concern socio-economic factors like growth of population and increased agro-industrial farming as well as hydrological changes in the Senegal River basin and the impacts of climate change.

Despite all these emerging issues, there is limited knowledge of the Lake's resources and how it might respond to global changes. Statistics on water use and supply are sparse and incomplete. There has been little assessment of the impacts of climate change and population growth in Lake Guiers which has much relevance for the formulation of climate adaptation policies. Many studies carried out in the Lake Guiers [1]-[2] provided only qualitative information. The lack of observations and studies limits our understanding of the dynamic relationship between the resources of the Lake and climate change and demographic change. In the future, increasing water abstraction will cause problems for downstream riparian communities and ecosystems [3], not only at the local, but also the national scale. The high spatial and temporal variability of water resource availability and its uneven spatial distribution and the further stress on this resource due to population growth, means that Lake Guiers water supply is at risk [4]

Therefore, this study aims to assess water availability and demand in Lake Guiers under scenarios of climate change and population growth until 2030, based on two IPCC scenario: the representative concentration pathways (RCPs) 4.5 and 8.5. To achieve research objective, we apply the Water Evaluation And Planning System model (WEAP).

2. METHOD

2.1 Data Set: We used hydrological data (discharge), climate data (Pmm T°C Etpot), and water demand and population growth rate. For scenarios analysis we use 2 IPCC scenarios: RCP 4.5 and RCP 8.5. Data are from CORDEX (Coordinated Regional Climate Downscaling Experiment) with 50km x 50km gridded and a length period of 2002-2030; 2051-2100

2.2 Water Evaluation and Planning System (WEAP): The main program that was used is WEAP, a management

program that is focused on the optimal distribution of water supply. WEAP is developed to combine water management and watershed hydrology [5]. The structure of demand and supply sites is created. Lake Guiers was characterized by the storage capacity, the initial storage and the netto Evaporation (ET_{net}).

The demand sites each got their annual water use rate by an activity level that means the population, the number of livestock or for agro industrial activities, the expand of cultivated land in hectares.

3.3 Scenario analysis**:** Three main scenarios have been developed on the basis of the current account year 2005 and the reference period from 2006-2030. The following Table 1 shows the structure of the scenarios created in WEAP.

The first scenario assumed the climate change in two of the RCP scenarios. The second scenario in WEAP is a growth scenario including the Lake Guiers region as well as the capital Dakar. The third scenario was created to test in which time the water in the reservoir will be exploited without a refill. It is based on the climate change scenarios and the growth scenario.

Table 1 Structure of the scenario created in WEAP

Current Account (2005)			
Simulation period (2006-2030)			
1	**Climate change scenario RCP8.5 or RCP4.5**		
Change in ET_{net} following change in RCP8.5 or RCP4.5			
2	**Growth scenarios on the basis of climate change scenario RCP8.5 or RCP4.5**		
Et_{net}	Population growth Implementation of introduced projects		
3	**Water supply from reservoir, Lake Guiers**		
ETnet	Population growth	Implementation of projects	Stopped inflow from Taouey canal

3. RESULTS

3.1 Water supply

The modeled stream flow in Taouey Canal into Lake Guiers show a distinct variation throughout the year representing the influence of Senegal River. Furthermore Figure 2 illustrates the distinct increase in inflow from 2006 - 2030 in both scenario RCP 4.5 and RCP 8.5 compare to current account year. The increasing differences between the two combined scenarios are very slight.

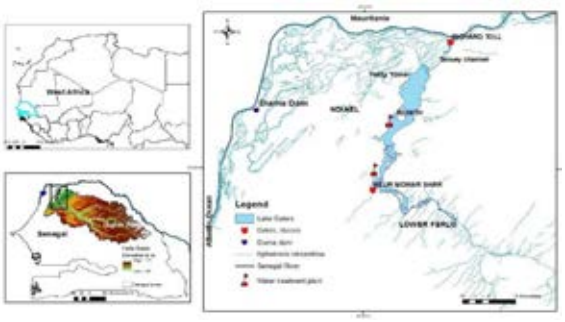

Fig. 1 Study area: Lake Guiers

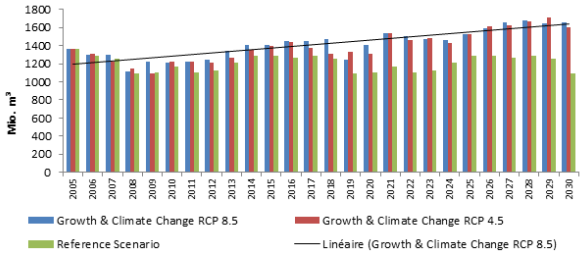

Fig. 2 Annual stream flow in Taouey Canal under RCP 8.5 and RCP 4.5 scenarios

3.2 Reservoir

It was tested, in case of a limitation of inflow (4,177,274.8 m^3/day) from the Senegal River, how long the water stored in the reservoir (655,616,099.3 m^3) will be sufficient when all projects are implemented. The water supplied by the reservoir (Figure 3) will not suffice for more than twenty months in RCP 4.5 scenario and nineteen months in RCP 8.5.

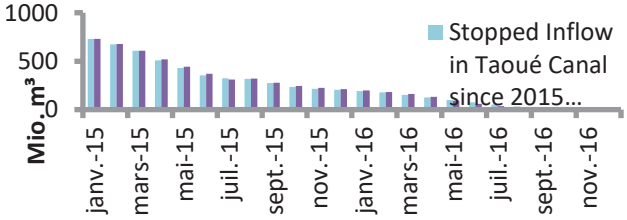

Fig. 3 Storage Volume in Lake Guiers with stopped inflow beginning in January 2015, combined scenarios of growth and climate change RCP 4.5 and RCP 8.5.

3.3 Water availability and demand

The total water demand (Figure 4) of the different demand site types is increasing throughout the study period and in all of the applied scenarios. Hereby, RCP8.5 shows the highest growth rates.

Results show that CSS (Sugar cane refinery), the biggest agro-industrial units, water demand is the highest. In 2005, it was estimate to 175 million m^3 and by 2030 the demand

will increase up to 25% in total. Furthermore, Senhuile, the second big agro-industrial units and private irrigation (others agro-industrial units) will face an increasing water demand by 2030. It was estimated that their demand will increase up to 20%.

For domestic demand the water demand in Dakar was estimate to 70,810,000 m^3 in 2005. This demand will increase up to 116,800,000 m^3 /year by 2030.

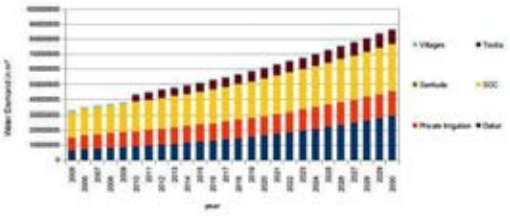

Fig. 4 Total water demand per user type in m^3

Unmet demand (Figure 5) is found in all scenarios, however, its amounts vary. Some demand sites will suffer unmet demand due to their dependency of Taouey canal which in turn depend on the inflow from Senegal River

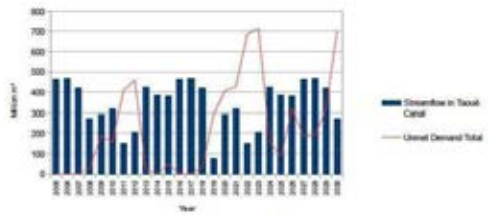

Fig. 5 Annual streamflow in Touey canal and Total Unmet demand

4. DISCUSSION

Like most of modelling tools, WEAP requires a large number of input data. Therefore, it faces uncertainties and constraints. One of the limits of the model is that it has not a quality assurance module [6]. Therefore, the challenge for a user applying WEAP model is to identify errors and to judge of the model results accuracy.

Data input uncertainties and constraints apply to both water supply and water demand data. The CORDEX data (spatial resolution 0.25°; rasta data) has been used for simulating evapotranspiration. The modelled demand might be underestimated as we don't take account to ground water data, livestock watering, industrial water demand, due to the lack of data availability.

Water availability and water supply situation could be ensured and achieved by using different management methods. Taouey canal should be adjusted in order to mitigate or anticipate unmet demand. In addition to increasing the reservoir capacities, other efficiency measurements should be applied: Adopt a basin approach, taking into account the adjacent ecosystems. Another efficiency measure is to establish water laws and allocations. This option imply water pricing and other market-based incentives to motivate further improvements in water use efficiency in agriculture dominated by private agro-industrial unit. Water evaporation mitigation is also another efficiency measure that could be used. Reducing the amount of water lost to evaporation would improve water security for Lake Guiers and lead to increased irrigation production. Substantial research and commercial testing on practical methods to reduce evaporation in a reservoir were completed recently [7] [8]. These methods use new technologies. Some of these new technologies are cost efficient solution to reduce evaporation each year and to maintain the highest quality drinking water.

5. CONCLUSION

The results show that the available amount of water in the reservoir is potentially high enough to satisfy users demand. However, the scenario analysis with WEAP reveal potential conflicts about water shortage. These shortages occur in both climate scenarios RCP 4.5 and RCP 8.5 with the decreasing of Taouey canal inflows. To ensure water security supply this research recommend to integrate the results in a DPSIR as an analyzing tools to help water resources managers to mitigate or anticipate future impacts.

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O9-23

Lake Basin Environment of the Lake Cluster Pokhara Valley (Ramsar Site), Nepal

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Keywords: Ecosystem, Lake-Basin, Biodiversity, Encroachment and Pollution

ABSTRACT

Lake Cluster of Pokhara Valley comprises nine lakes in Pokhara Valley in the Province-4, and 10th Ramsar Site (Site No.: 2,257) of Nepal covering the basin area of 262 km^2 with 9 km^2 of surface water across the Chitwan Annapurna Landscape. Each lake supports significant biodiversity, provides important ecosystem services and sustains local livelihoods and make Pokhara the globally known tourism destination in Nepal.

All lakes are sub-surface drainage basin type, and noteworthy with 362 species of plants comprising 286 terrestrial, 61 aquatic species and 32 species of orchid including 10 endemic one so it considered as the O*rchid Garden*. *Dischidia bengalensis* and *Phreatia elegans* are new plant species recorded where >146 plant species are valuable as NTFPs including key 82 agrobiodiversity species. Among wildlife 128 species are vertebrates (Mammal: 32 sps; Birds: 40 terrestrial and 52 water dependent sps; Reptile: 24 sps; Amphibian: 11 sps; Fish: 27 sps including 6 alien sps). The cluster hosts a wide variety of globally threatened migratory birds like the critically endangered Baer's pochard and Indian vulture, and mammals like the vulnerable clouded leopard, and the endangered Indian pangolin.

Anthropogenic activities associated to climate change has noted impacts to distress the structure, function and stability of lake ecosystems such as encroachment, siltation, pollution, and invasion by exotic species, so lakes are conditioned to degrade. Implementation of integrated lake cluster basin plan yet developed by government that stakeholders foresee instrumental document in improving lake condition in those lakes.

1. INTRODUCTION

The Lake Cluster of Pokhara Valley (LCPV) is located in the mid-hill region of Nepal in Pokhara-Lekhnath Metropolis (PLM), Province number-4 (Figure 1). It is designated as the 10th Ramsar Site in February 6, 2016. The cluster consists of nine small lakes i.e., Phewa, Kamalpokhari, Gunde, Khaste, Neureni, Dipang, Maidi, Begnas, and Rupa; which bequeathed Pokhara valley a title of the *'Garden of Lakes'*, at the panoramic setting of Chitwan Annapurna Landscape (Table 1).

Table 1 Location and areas of nine lakes under lake cluster of Pokhara valley (Source:

SN	Name	Latitude	Longitude	Altitude (m)	Area (km^2)	Water (Km^2)	% Water body
1	Phewa	28.1943-28.2902	83.8004-83.9898	763-2482	119.39	4.33	3.6
2	Begnas	28.1621-28.2167	84.0814-84.1332	647-1447	18.6	3.13	16.8
3	Rupa	28.139-28.2061	84.1004-84.1699	580-1420	26.02	1.11	4.3
4	Khaste	28.1908-28.2115	84.0449-84.0603	739-1186	2.69	0.13	4.8
5	Dipang	28.1777-28.2025	84.0645-84.0821	687-1269	2.39	0.14	6.2
6	Maidi	28.1753-28.1952	84.0785-84.0895	672-1123	1.6	0.007	0.4
7	Gunde	28.1889-28.2001	84.0392-84.0476	741-948	0.61	0.08	13.1
8	Neurani	28.1889-28.195	84.0465-84.0533	742-866	0.18	0.027	15.0
9	Kamalpokhari	28.2169-28.2377	84.0102-84.0217	822-1440	1.35	0.013	1.0
				Total	**172.8**	**9.0**	**5.2**

All lakes are subsurface drainage basin types that covers a total area of 262 km^2 of basin and about 9 km^2 of core water bodies. Phewa is the largest lake in cluster and 3rd largest lake of Nepal. Other lakes are shallow and smaller. Lakes are scattered across the valley at varying altitudes, Rupa at the lowest (582 masl) and basin peak of Phewa at the highest (2,483 masl).

The lakes and waterways are important sources of drinking water and water for biodiversity, navigation, fishery, irrigation, and hydropower. The cluster also have recreational, religious, spiritual and inspirational values. Overall economy of Pokhara is to some extent dependent on lakes resources. Pokhara fetches a significant amount of foreign currency which align to the lake tourism. Despite these values, the lakes are degrading from encroachment and reclamation, siltation, pollution and invasion of alien invasive species the prominent proximate threats. Siltation is widespread. Phewa alone had 269,752 m^3 sediment load from road networks and induced landslides [6 9,10,15]. The substantial evidences *E. colii* [19] and eutrophication are common [22]. The spread of invasive is increasing with colonizing plants water hyacinth, *Lantana* and *Parthenium spp* etc, and fauna the African Catfish and Tilapia [2]. Climate change impacts have been perceived at all levels

After designation as the Ramsar, local concerns are well versed for a need of effective measures in restoring lakes' environ. PLM has Phewa project more to the engineering works. Rupa is under community managed cooperative.

This paper is based on the assessment by CODEFUND while preparing Integrated Management Plan of LCPV (2016), and examines the basin biodiversity, lake basin governance and climate change impacts in the cluster.

2. METHODS

The consistent review of literatures like relevant policies; rules; regulations; assessment of biodiversity and climate; reports from national/international entities; and other relevant literatures were done followed by the series of focus group discussions, and direct and indirect

interview with communities of particular group interest in different locations in reference of Wetlands Inventory, Assessment & Monitoring Tool/Government of Nepal [3]

3. RESULT AND DISCUSSION

3.1 Change in launduse of the cluster in past 20 years

There is a significant spatial changes in landuse from 1996 to 2016[16]. The cultivated land has reduced from 88 km^2 to >71.2 km^2, forests land increased from 66.9 km^2 to 73.5 km^2, shrubland from 2.2 km^2 to 6 km^2, and grassland from 1.3 km^2 to 2.2 km^2 in the basin. Water bodies in Phewa, Begnas, Maidi, Kamalpokhari, and Gunde have decreased with the trend greatest in Phewa and Begnas by 4% and 17% respectively. Water cover in Rupa, Dipang, Khaste, and Neureni have increased with such extent almost doubled in Dipang (0.06 to 0.15 km^2).

3.2 The cluster as the biodiversity the basket

Ecoregions and vegetation. Of Nepal's 12 ecoregion, LCPV demonstrates the dynamics of Eastern Himalaya Temperate Broadleaf Forests, Himalayan Subtropical Pine Forests, and Himalayan Subtropical Broadleaved Forests (MoFSC 2014) [18]. It is the domain of four key forest types in a range of sub-tropical and lower temperate forests dominated by *Shorea robusta* (Sal), *Schima* spp. *Castanopsis* spp., *Daphniphyllum himalense* and *Alnus nepalensis* [12,21]. The aquatic vegetation is featured by macrophyte, hydrophyte and helophyte [6,7,8].

Floral diversity. A total of 362 species of plants are enumerated, with 286 terrestrial species (83 families), and 61 aquatic sps (22 families) including 32 sps of orchids with 10 endemic sps. Over 146 species are fund valued as NTFPs and 82 species important as agrobiodiversity. There is a record of new species of plants i.e., *Dischidia bengalensis* from the Phewa basin.

Faunal diversity. The cluster hosts 128 species of vertebrates comprised of 32 spp. mammals (17 families), Felidae and Muridae the most mammal rich families. Over 140 birds' spp. (including 52 wetlands dependent) from 37 families are found here with diversity most from Corvidae, Accipitridae, Passeridae, and Silviidae. Similarly, 24 reptile species (10 Families), 27 species of fishes, and 11 amphibian species in 3 families are reported [42] including 21 native and 6 alien fish species.

Endemism. There are a number of endemic species like Spiny babbler and Wren babbler. The Panchase area is famed for natural garden of endemic orchid like Fairy orchid, Terete Vanda, and Foxtail orchid [12].

Biodiversity significance. The cluster hosts numbers of nationally and globally significant flora and fauna such as 2 species of mammals Clouded leopard, and Indian Pangolin, and 3 species of nationally protected plants like Devil pepper, Red cotton tree, and Indian Dammer.

One endangered and two vulnerable mammals, four critically endangered and two endangered birds, and two vulnerable plant species occur in cluster. It also hosts some species under CITES-I (5 species of mammals and 2 species of reptiles, and CITES-II (14 birds' spp., 3 mammals' spp., 2 spp. of reptile and 1 of amphibian, and 33 spp. of plants).

Some birds of higher conservation value are spiny babbler, Wren babbler *Panoepyga immaculata*, Indian Vulture, and the globally threatened Comb duck and nationally threatened Ferruginous Duck. Rupa and Begans report for near threatened Eurasian otter. Smooth coated otter occurs along Seti River in Vijayapur Khola [1]. Some indigenous fishes are the Mahseer, Golden Mahseer, Katle, and Rewa in Phewa, Begnas and Rupa.

Rupa, Begnas, Dipang and Khaste are habitat of the wild rice, and wild gene pool of cultivated brownbeard rice is noticed in lakes. Other significant agrobiodiversity of the cluster includes Chinese Tinospora and monogeneric species of Hornwort, Devil pod and Common cattail.

3.4 Climate changes impacts now visible in the cluster

There has been visible changes in climate pattern in the cluster [4,5]. Kaski district, where the cluster is located, ranked low in the drought vulnerability index [17] and modest vulnerability index but high for landslides [22]. In addition, anthropogenic activities have increased the risk of climate vulnerability and disaster. The moderate vulnerability does not mean healthy socio-ecological system, it may add complexities to the *Himalayan Dilemmav* [14,24]. The community perceived about the risk of climate vulnerability, and identified 6 indicators with their corresponding scenario, sensitivities and impacts. The climate change has been contributing enormousness stresses to the lakes, and exerted pressure to the communities for extra effort, energy and investment in measures adapting over the stresses.

3.5 Evolving lake basin governance

The lake falls within the Ministry of Forests and Environment at the federal level. This ministry coordinates through the National Wetlands Coordination Committee but execute through the Department of Forests, and Department of National Parks and Wildlife Conservation in case if lakes are the Ramsar sites within protected areas. National Lake Conservation Development Committee as government agency has annual fund for some lakes. At the State, the cluster has direct link with PLM but also with the Ministry of Tourism, Industry, Forests and Environment. Over 2 dozen policies crosscut lake issues with the most relevant ones, the National Wetlands Policy (2012) and the National Ramsar Strategic Plan (2018-2024). No specific wetlands/lake Act prevail. Within these frames, lake is divided as open access resource to many other agencies like fishery, irrigation, drinking water supply, energy etc.

At grass-root, each lake has community organization, mostly the cooperative, and figure 2 indicates about their governing capacities. Though, lake basin governance is still evolving [11,20], communities' insitution in the cluster are weak in a view of institutional capacity, enforcement of formal/informal policies, stakeholders' participation, generation/dissemination of information and financial capabilities. Community responded very positive in the preparation of integrated plan of LCPV, which they think

will be instrumental to improve lake basin governance for the sustainability of the cluster.

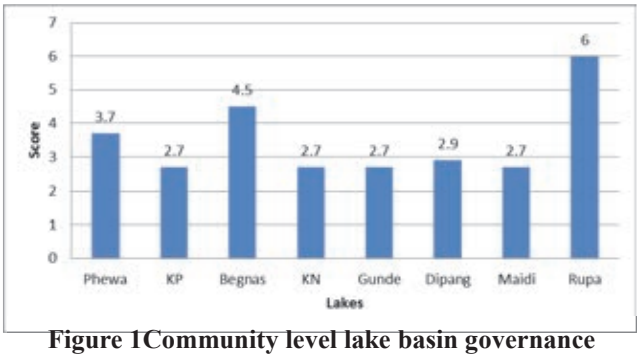

Figure 1Community level lake basin governance

4. CONCLUSION

Lake Cluster of Pokhara Valley is the 10th and only Ramsar site in the mid-hill region of Nepal, and adds value on making Pokhara the top lake-tourism vantage, *'City of Lake Garden'* also frequently referred *'Nepal's Tourism Capital'*. Each lake differs in habitat mosaics, water body and species diversity. The cluster is important biodiversity hotspots for globally and nationally protected, endemic, indigenous and monogeneric many species and so on which formed the basis of the cluster to enlisted in the Ramsar site.

In the past 20 years, the cluster has been experiencing impacts of climate change together with the significant spatial change in landuse. The core water bodies in Phewa, Begnas, Maidi, Kamalpokhari, and Gunde have decreased but increased in other lakes, Dipang almost doubled in area. The significant change in landuse in the past might have implications in characteristics of lake ecosystem and biodiversity which needs further enquiry.

All lakes are degrading due to anthropogenic activities leading to the encroachment, siltation, pollution and invasion of alien species in parallel with impacts of climate change. And, people are making new efforts adaptive to cope against climate vulnerability.

Institutional arrangement and policy unclarity among the government structures at all tiers and weak lake governance at communities level persist intact, which needs consolidation toward improving lake basin governance. In this context, the strength of Integrated Lake Management Plan of LCPV is understood the basis in managing the cluster (Ramsar site) in a sustained way.

5. ACKNOWLEDGEMENT

Authors are thankful to the Hariyoban Program/WWF Nepal/USAID for the opportunity given to CODEFUND for the preparation of plan of the cluster, and to all experts and communities for their outstanding contributions.

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Stakeholder's account of the social and environmental challenges in the Lake Victoria Basin

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Keywords: Lake Victoria, stakeholder engagement, problem analysis

ABSTRACT

It is important that policymakers are aware of stakeholder's account of societal challenges to develop policy that is relevant and supported. This paper reports on a problem analysis that was conducted stakeholders in the Lake Victoria Basin. A thorough stakeholder analysis was followed by semi-structured interviews with businesses, NGO's, governmental organizations and communities. The analysis resulted in 12 key challenges that were raised by the stakeholders covering social, environmental, health, economic and institutional issues. This paper concludes that a strong partnership between policy makers and stakeholders is crucial in order to mitigate of these challenges.

1. INTRODUCTION

In order to manage a Lake basin well, it is important to know what local stakeholders perceive as pressing challenges in the region so that policymakers can align their policy or adapt information provision accordingly. The world's second largest lake, Lake Victoria, would particularly benefit from mapping stakeholder's perceptions due to the diverse types of stakeholders spanning a large geographical area across three riparian countries. Indeed, local scientists have called for stakeholder involvement to address the issues as Lake Victoria [1], [2]. In order for stakeholders to be engaged properly, the first step is an assessment of their views.

A lot of research has been dedicated to understand the social and environmental challenges at Lake Victoria. These include: sanitation and health [3] hazards and disasters around the lake such as floods, droughts [4], water hyacinth [1], poverty [5], governance issues [4], overexploitation of immature fish [1], food security [1], corruption [1], water pollution and eutrophication [2]. climate change [6] and the prevalence of HIV/AIDS [7].

However, little research has reported on Lake Victoria's stakeholder's perceptions on the challenges in the area. An exception is a study that explored Ugandan fisher's perspective on the most important problems in the fishery [8]. This study reported that the biggest issue was perceived to be the use of illegal fishing method (arguably a cause of an issue rather than an issue itself), followed by corruption and gear theft. Nevertheless, no research has mapped out perspectives of different types of stakeholders at Lake Victoria. Therefore, this paper reports on a problem analysis that has been conducted with stakeholders in the Lake Victoria Basin. and will lay out their perceptions of the most pressing social and environmental issues in the Lake Victoria Basin.

2. METHOD

The stakeholder's of Lake Victoria were first identified through a comprehensive stakeholder analysis [9]. The stakeholder analysis process consisted of three steps: 1) identification of stakeholders, 2) categorization of stakeholders and 3) understanding (relations between) stakeholders. A 'snow sampling' technique was used as a first step in which individuals are identified through current contacts, who then identify further contacts until enough stakeholders were selected or no further stakeholders were identified. Next, the stakeholders were categorizes in terms of priority and role (e.g. businesses, NGO's, communities, government) to facilitate the selection of a diverse set of stakeholders, ensuring that different views were included.

The stakeholders that were interviewed for the problem analysis are reported in table 1. A total of 26 groups of stakeholders were interviewed, of which 14 located in Uganda, 3 located in Kenya and 9 located in Tanzania. These include 7 governmental organisations, 10 NGO's, 3 business organisations, 3 research institutions and 3 communities. Together these organisations cover a diverse set of stakeholders representing different interests and nationalities.

Table 1: overview of patriating stakeholders

	Counties Cooperation • Fisheries Training Institute • Ministry of Agriculture, Animal Industry & Fisheries • Lake Victoria Fisheries Organization	Commission	Environmental Management Programme • National Environment Management Council
NGO's	• Katosi • WWF • Association of Fishers and Lake Users of Uganda • Ugandan Fisheries & Fish Conservation Association • Young woman's Christian Association	• Osienala	• Environmental Management and Economic Development Organisation • Fishers Union Organisation • Kagera Development And Credit Revolving Fund • Naturland
Business	• East African Industrial Fishing & fish processors Association • East African Tourism Platform • Ugandan Fish Processors & Export Association		
Research institutions	• National Fisheries Resources Research Institute	• Kenya Marine and Fisheries Research Institute	• Tanzania Fisheries Research Institute
Communities	• Fishers, traders and boat owners in Mpunge		• Mubikamano Women's group (fisherwomen, boat owner and traders) • Beach Management Unit Kigoto

Structured interviews were conducted to learn about the perceived challenges in the region from each stakeholder. Stakeholders were interviewed about the key benefits, challenges, drivers of the challenges and mitigation of the challenges. Follow-up questions were asked to get the stakeholders to discuss the process of the issue and how different factors affect the issue. Participatory tools were used to aid the discussions and to visualise complex processes.

A coding scheme was developed to analyse the discussion from the interviews. This coding scheme facilitated the identification of recurrent issues discussed by the stakeholders. The analysis resulted in a matrix of issues discussed across stakeholders, and what particular aspects of the issue were discussed by each stakeholder.

3. RESULTS

The problem analysis resulted in a list of 12 issues that the stakeholders discussed. These challenges are not necessarily independent and may overlap or influence each other. These challenges will be discussed in the following sections in order of the frequency with which this challenge was raised (starting with the most frequently raised challenge), but it is acknowledged that this does not necessarily reflect the relative importance of the challenges.

1. Reduced fish catch

With 20 groups of stakeholders, the most frequently discussed challenge was a declining fish catch and stock as one of the most pressing issues in the Lake Victoria Basin. This mainly referred to the Nile perch. Stakeholders reported that too much immature Nile perch is currently being caught which causes a decline of the stock. They also expressed that a lack of monitoring results into noncompliance to fishing regulations meaning the use of destructive fishing gear. The stakeholders discussed how a high demand of Nile perch on the one hand, and a lack of alternative livelihoods on the other hand means that the fishery continues to draw people. Other causes of the decline of fish catch were also ascribed to climate change, poor water quality and corruption.

2. Water pollution

The second challenge that was often discussed was the water pollution in Lake Victoria which was mentioned 17 times. Many stakeholders reported that industry discharge waste water in the Lake and that the government is not sufficiently monitoring this. Mining practices around Lake Victoria were also discussed to contribute greatly to the water pollution, as well as an increase use of fertilizers for agriculture. Furthermore, stakeholders also discussed how a growing population, deforestation, poor sanitation practices, use of poison by fishers and unsustainable waste disposal by local communities continue to exacerbate the issue of water pollution

3. Soil erosion

Soil erosion and deforestation were discussed by 9 stakeholder groups. Most of these discussions focused on local communities cutting trees to use for fuel, to build houses and to clear land for cultivation. Stakeholders explained that a consequence of the soil erosion is the removal of a buffer zone that functioned to filter water mounting to Lake Victoria, meaning that deforestation contributes to the issue of water pollution.

4. Governing Lake Victoria

Various governance issues were raised by 8 stakeholder groups during the interviews. Stakeholders reported to not feel sufficiently involved in the mitigation of issues at Lake Victoria, wanting to see more partnership with the government. It was also discussed how regulations among the three riparian countries were harmonized on paper but how in practice this is not (yet) the case. The stakeholders also discussed how corruption prevented an effective approach to tackle the challenges in the region. A lack of an effective intuitional framework and unclear water borders further complicate successful governance in the region according to the stakeholders.

5. Water hyacinth

The water hyacinth that grows on Lake Victoria was mentioned by 8 stakeholder groups as a significant challenge in the region. Some stakeholders discussed how the growth of this plant is a result of poor sanitation practices, industrial waste and use of pesticides in the basin. Fishers often discussed how the growth of water hyacinth can prevent access to the lake. Nevertheless, many stakeholders also discussed that many mitigation strategies have been successful and that this challenge is not as big as it used to be.

6. Alternative livelihood

Six stakeholder groups reported that there were few alternative livelihood options for people living in the Lake Victoria Basin (besides fishing). The stakeholders discussed how people experience a large barrier to move away from fishing and into other professions due to a lack of capital, skills or knowledge or because of a strong fishers identity.

7. High prevalence of HIV/AIDS

Another challenge that was raised was the high prevalence rates of HIV/AIDS infection in the region, this was mentioned by 6 stakeholder groups. It was reported that HIV/AIDS prevalence is particularly high around Lake

Victoria, much higher than national average of the riparian countries. The stakeholders discussed how poverty and a lack of employment forces women into the sex industry. It was also discussed that the nature of the pay-out (daily wages) causes many fishers to spend their wages on alcohol and prostitution, which increases the chance of HIV/AIDS contraction. Stakeholders also mentioned that many men in the region are polygamous, which further increases the spread of HIV/AIDS.

8. Poverty

The issue of poverty in the region was discussed by 5 stakeholders. Most of these ascribed a lack of a savings culture among the fishing community to the continued poverty in the basin. The government was also said to not address this issue sufficiently and a lack of education opportunities were further proposed to exacerbate this issue.

9. Spread of diseases

Four stakeholder groups discussed how poor sanitation practices in the region result in a high prevalence of diseases such as malaria, cholera, diarrhea and typhoid. Particular attention was paid to a lack of access to clean drinking water in these discussions, reporting that many riparian communities drink untreated water from the lake.

10. Landownership

The issue of landownership, meaning that many citizens do not legally own the land they live on, was discussed by 4 stakeholders. The stakeholders discussed how the government owns a large share of the riparian land and is starting to sell this land to foreign investors, which means that the occupants are evicted or uncertain about their future.

11. Gender inequality

A lack of gender equality was discussed by one stakeholder who reported that women do not have equal opportunities and right in the Lake Victoria basin. Specifically, increase in scale and regulations has driven many women out of the fishing industry who tended to dry the fish for a living.

12. Food security

One stakeholder discussed that food security is increasingly becoming a challenge. This is because climate change is affecting the weather which in turn affects the harvest.

4. DISCUSSION AND CONCLUSION

This paper aimed to map out the most important challenges in the Lake Victoria Basin as reported by local stakeholders. The results show that stakeholders believe that the region suffers from many serious issues, which are affecting millions of lives in the region. The issues comprise a diverse set, including social, environmental, health, economic and institutional issues. It is therefore clear that addressing these issues is a challenging task and that not one solution can mitigate such a varied set of challenges.

However, it is clear that these stakeholders are aware, knowledgeable and engaged in these issues. Many stakeholders reported that they feel insufficiently consulted by policy makers even though they demonstrate to be keen to be part of the solutions to address these challenges. A key recommendation that therefore follows from this research is that a stronger partnership between stakeholders and policy makers should be build. This partnership will be mutually beneficial as this gives stakeholders the opportunity to voice their concerns and needs, and policy makers can develop policy that is relevant and supported by society.

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Limnological Studies of Lonar Lake, Buldhana District, Maharashtra, India

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KEYWORDS – Lonar crater, Limnlogical characteristics, Eutrophication

ABSTRACT

The Lonar Crater Lake situated in Buldhana District, Maharashtra is a natural crater lake formed by hyper velocity meteoritic impact in basaltic rock before some 50,000 years ago. It has an area of 256.15 hectares and declared as a wildlife sanctuary in 2002. The Lonar crater is said to be the world's oldest and the third largest meteoritic crater. It is surrounded on all sides by a rim ejecta blanket formed from the blocks of basalt, and a steep escarpment to an even height of about 150 m deep. The present study was undertaken to focus the need of its conservation because of its unique ecosystem all over the world. Unique aquatic ecosystem was developed in the Lonar Lake due to the high pH of lake water. Hence there is urgent need to conserve this world heritage by applying the seven principles, advocated by WLV (World Lake Vision) by which we can successfully achieve the goal to maintain ecological balance thus resulting into conservation of Lonar Lake.

1. INTRODUCTION

Limnology is the study of the geological, physical, chemical and biological aspect of all natural fresh water ecology. Whether an animal lives in water or on land its protoplasm holds about 70 to 90% of water. Lonar Lake (19° 59'N, 76° 31'E) is located at Buldhana, Maharashtra, India (see map below). The lake was discovered by a British officer J. E. Alexander in 1823. The lake is estimated to be about fifty-two thousand years old (Fredrikson *et al.*, 1973). Lonar crater is said to be the world's oldest and third largest meteorite crater. It is surrounded on all sides by a rim called as ejecta blanket formed from the blocks of basalt, and a steep escarpment (circulatory index <0.9) to an even height of about 150 m deep, having 6 km diameter from outer side and 3.5 km from inner side, whereas the depth of the brine is 5.5 m.

Fig.1 Map of Lonar Lake

2. MATERIAL AND METHODS

Water samples were collected seasonally at a depth of 2 feet from the surface of the water body from four sampling stations between 7 to 11 a.m. Water samples were collected in airtight and opaque plastic containers of five litre capacity, which were thoroughly cleaned, washed and rinsed before every collection. Separate containers were used for each station. Samples were labelled properly according to their location and date of sampling. Samples were stored and protected from heat and exposure to sunlight during transportation and stored in the refrigerator until analysis.

3. RESULTS AND DISCUSSION

The present study area - Lonar Lake is one of the best example of man's disregard towards nature. The rapidly growing population and increasing urbanisation, industrialisation and agricultural activities have resulted in over exploitation of the water body leading to degradation of its water quality.

Temperature

The temperature of Lonar lake water ranged from 21.6° C to 29° C and overall view showed fluctuations in accordance with atmospheric temperature.

pH (*Potentia hydrogenii*)

pH is the measure of intensity of acidity or alkalinity and refers to the concentration of hydrogen ions in water. The Lonar Lake was found to be alkaline. pH was found to be descending order viz., summer > winter > rainy season which may be due to dilution of alkaline substances by rain waters.

Electrical Conductivity
Lonar lake water showed high electrical conductivity which ranged from 14258 µmhos/cm to 20400 µmhos/cm at different sampling stations. The values of electrical conductivity observed by other researchers range between 11600 µmhos/cm to 15100 µmhos/cm reported by Siddiqui (2008).

Total Solids (TS)
In summer, higher values of TS were recorded due to the increase in evaporation resulting into high salinity and higher amounts of solids in the lake water. The water in the crater was observed to be very salty, may be carbonates, sulphates and magnesium, which together contribute to the dissolved solids in the water (APHA, 1992).

Total Dissolved Solids (TDS)
Ions such as potassium, sodium, chlorides, carbonate, sulphate and magnesium all contribute to the dissolved solids in the water (APHA, 1992). The total dissolved solid of lake water ranged from 11025 mg/litre to 15230 mg/litre at different sampling stations.

Total Suspended Solids (TSS)
The mean values of TSS ranged from 712.33 mg/litre to 787.33 mg/litre in monsoon, 580.66 mg/litre to 679 mg/litre in winter and 660.66 mg/litre to 732.66 mg/litre in summer.

Total Alkalinity
Alkalinity of water is caused by the presence of bicarbonates, carbonates, hydroxides and phosphates. The present study shows that maximum values of alkalinity ranged from 2404.9 to 2886.5 mg/litre which are far much greater as compared to the maximum permissible limits of ISO and BIS (200 mg/litre) as well as WHO (120 mg/litre).

Dissolved Oxygen (DO)
DO is required to maintain the health of aquatic ecosystems. Oxygen is produced during photosynthesis, but is also used by plants, animals and microorganisms that thrive in water. The DO of lake water ranged from 1.01 to 1.05 mg/litre at different sampling stations.

Biochemical Oxygen Demand (BOD)
BOD is the amount of oxygen required for microbial metabolism of organic compounds in water. In the present study, the BOD of the lake water ranged from 228 to 384 mg/litre at different sampling stations.

Chemical Oxygen Demand (COD)
COD is a measure of the total amount of oxygen required to oxidise all the organic matter in a sample into CO_2 and H_2O. In the present study, chemical oxygen demand of lake water ranged from 730 mg/litre to 1155 mg/litre at different sampling stations. Earlier investigators have observed COD of Lonar lake to be in the range of 263 mg/litre to 285 mg/litre and 0.01 mg/litre to 0.04 mg/litre (Babar, 2010).

Ammonia and Nitrate
Ammonia is dissolved in water to produce ammonium hydroxide and further dissociated to ammonium and hydroxyl ions. In the present study, ammonia content of the lake water ranged from 225 mg/litre to 386 mg/litre at different sampling stations. Nitrogen is an essential plant nutrient found in fertilisers, human and animal wastes, yard waste and the air. In the present study, the nitrate content of lake water ranged from 7.68 to 12.5 mg/litre at different sampling stations.

Phosphate and Sulphate
Phosphorous is an essential plant nutrient and most often controls aquatic plants (algae and macrophytes) growth in the freshwaters. In the present study, the phosphate content of lake water ranged from 2.18 mg/litre to 6.84 mg/litre at different sampling stations. The main source of sulphate in water is various sedimentary rocks which include gypsum and anhydride. In the present study, sulphate of lake water ranged from 45.5 to 76.4 mg/litre at different sampling stations.

Chloride
In the present study, chloride ranged from 2471.7 to 3153.42 mg/litre which is much greater than the maximum permissible limit of 250 mg/L as per WHO (1992) and ISO (2004), and 1000 mg/L as per BIS (1991).

Hardness
In the present study, hardness of lake water ranged from 110 mg/litre to 149.2 mg/litre at different sampling stations. Earlier investigators observed hardness of Lonar lake water in the range of 120 mg/litre to 140 mg/litre.

4. CONCLUSION

The parameters like pH, TSS, alkalinity, chlorides, sulphates, potassium, DO and BOD were found to exceed the maximum permissible limits as given by WHO (1991), BIS (1992) and ISO (2004) for human consumption and other domestic purpose. Nitrates and phosphates are essential for the growth of primary producers of the aquatic ecosystem. But excess of these nutrients has led to eutrophication, thereby causing an algal bloom which is disrupting the natural ecosystem of the lake.

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Property Regime Change and Lake Degradation: an Institutional Analysis of Lake Rawapening, Indonesia

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Keywords: property right regime, lake governance, Rawapening, Indonesia

ABSTRACT

Debate over the effects of different property regimes on natural resource systems has long been controversial. A large body of literature has investigated the links between different property rights regimes and environmental outcomes and shown that common, state, and private property rights regimes are each capable of yielding sustainable environmental outcomes. However, the existing evidence is highly mixed. This study examines how the alteration of property regimes at local level leads to the degradation of the lake by using the perspectives of institutional economics, in particular property-rights approaches. Lake Rawapening is a multifunctional semi-natural lake which is currently in environmentally degraded condition. Nearly 70% of its surface is covered by water hyacinth and its depth is in the process of shallowing. As consequences, the lake is not able to provide ecosystem services at optimum level. This research using a case study approach and used data collected from in-depth interviews with informants as well as reports and documents related to the lake. The study shows that the current property rights regime in the lake and its catchment area associated with social change is driving local resource users toward greater degradation of the lake. The opportunity exists to build on existing village level institutions to develop a collaborative management system to help protect the lake ecosystem.

1. INTRODUCTION

The linkage between property regimes and environmental outcomes has been controversial since seminal paper of Garett Hardin [1]. Property rights affect access to and distribution of natural resources, which in turn affects the level of poverty and long-run quantity and quality of resources. However, most of the studies of property rights effect on natural resources degradation focus on open access. A large body of literature has shown that common, state, and private property rights regimes are each capable of yielding sustainable environmental outcomes. However, the existing evidence is highly mixed. The failure to distinguish between common property and open access has been identified as a main reason of natural resources nationalization that can speed exploitation of the resources due to lack of local control over the resources[2, 3]. This study examines how the alteration of property regimes at local level leads to the degradation of the lake by using the perspectives of institutional economics, in particular property-rights approaches.

2. METHOD

This research applied a case study method. As the case is the alteration of property regime applied in Lake Rawapening, starting from Dutch colonial era in 1830s to current era of 2010s. Data were collected from in-depth interviews arranged in 2017. The interviewees included government officials, village elders, villagers and local non-governmental organizations concerned to the sustainability of the lake. In addition, for the purpose of this research we also collected reports and documents pertaining to the lake. Data and information were then analysis using qualitative approach.

3. RESULTS AND DISCUSSION

Lake Rawapening was converted from a marsh to a lake in 1912-16 and enlarged in 1939 by dams on the Tuntang River. When full, at 463 m above sea level, the lake covers 2500 ha but, in the dry season, may be as small as 620 ha at 460 m. The lake provides water for irrigating about 24,000 ha of rice fields and for generation of 20 MW of hydroelectric power. Rawapening has 9 inlets which are Galeh,Torong, Panjang, Legi, Parat, Sraten, Rengas, Kedung Ringin dan Ringis and 1 outlet: Tuntang River [4].

The construction of dams on Tuntang River was mainly motived by Dutch colonial interests in providing water irrigation for the cash crops of Cultivation System and electricity of Dutch people living in Salatiga. This is a

point of the beginning of property regime change of Lake Rawapening, from common property regime to state-property regime. At that time, 28 hamlets of 4 sub-districts was submerged and its inhabitants were moved to nearby villages. The Dutch also introduced water hyacinth brought from Bogor botanical garden as ornamental aquatic plant on the lake. Since then, the plants proliferated quickly and spread over almost the surface of the lake.

Following the operation of the dams, the Dutch colonial administrator imposed strict rules that deteriorated village-level social conventions that had previously acted to control lake ecosystem. It became increasingly difficult to take necessary, and customary, collective actions to address lake degradation.

Once the Dutch colonial transferred the governance to newly independent state, Republic of Indonesia, the prevailing property regime of the lake did not change much. The government has shown little interest in revitalizing local-level system of authority. This means that the lake has become the "property" of the national government.

The change of regime of the lake property into state-property regime was not followed by the managerial capability of government in managing the lake and its catchment area. A number of plans and programs have been initiated by government to reverse the trend of degradation. However, most of them were failed due to lack coordination and capability of government officers. This practically makes the lake, and especially its shoreline area, to be open access. Communities began to occupy the shoreline area and construct buildings and houses. Agricultural cultivation is also increasingly intensive by using modern inputs, such as nitrogen fertilizers, which further accelerate the degradation process of the lake. The most visible consequences are the decline in fish populations and the quality of lake water. Currently most fishermen can no longer rely their living from the lake, but instead get income from harvesting water hyacinth.

Nevertheless, both government and local communities still see opportunities to improve situation. One of the solution arise during the discussion is collaborative management between government and local community in managing the lake. From the government perspective, co-management systems are attractive because it open avenues for local participation in lake governance and more equitable benefit sharing while maintain some level of state control.

4. CONCLUSION

This paper highlighted the change of property regime of the Lake Rawapening from common property regime to state-property regime. The study shows that the current property rights regime is driving local resource users toward greater degradation of the lake. The opportunity exists to build on existing village - level institutions to develop a collaborative management system to help protect the lake ecosystem.

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