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Ecosystem Service Shared Value Assessment (ESSVA) for Integrated Lake Basin Management (ILBM)

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The overall purpose of this paper is to present a methodology for guiding the planning and management processes of a basin system of lakes, rivers, and coastal embayments. Integration of the Ecosystem Service considerations into the planning and managing such basin systems is essential but not so simple. This paper describes a method called the Ecosystem Shared Value Assessment (ESSVA) for basin stakeholders to gain insights into the ES profile of the subject basin system. The insights gained through stakeholder interactions could be interfused into the Integrated Lake Basin Management (ILBM) process for gradual, incremental, and long-term pursuit of sustainable use and conservation of the overall basin Ecosystem Service. The paper introduces this combined process in five parts, first on the ES concept, second on ESSVA, third on the ideas of Ecosystem Service Perceptional Profile (ESPP) and Ecosystem service Factual Profile (ESFP), and fourth on the relationship between ESSVA and ILBM, and fifth on the ESSVA application examples. The combined use of ESSVA and ILBM is hoped to contribute significantly to the participatory process of basin management.

Keywords: ecosystem service, assessment, Integrated Lake Basin Management (ILBM), perceptional profile, participatory process

1. Introduction

Planning and managing a basin system of the lake, river, and coastal embayment for sustainable use of their land and water resources requires holistically addressing various socioeconomic, political, and environmental issues. Though unintended, the decisions made to fulfill the stakeholder needs within and outside the basin also bring about alterations to the basin ecosystems and their service profiles. The basin stakeholders today are facing the need to consider the long-term sustainability of the basin Ecosystem Service (ES) as a whole rather than the resource values in the narrow sense of the words. However, integrating the ES implications into planning and managing a basin system is quite challenging. There are two kinds of challenges, both of which pertain to conceptual and methodological issues. The first (1) relates to the very concept of ES, which consists of four subcategories of services, i.e., Provisioning (PS), Regulating (RS), Cultural (CS), and Supporting Services (SS), each requiring specific assessment and valuation approaches. There have even been controversies about the virtue or appropriateness of particular valuation approaches, such as monetarization. The second (2) relates to integrating the ES assessment results into the planning and management process. Although there are methodologies proposed for the purpose discussed in Section 2, they are generally quite data-intensive and expert-driven, requiring dedicated supporting institutions to carry out the studies for the subject basins. Further, most basin management cases in developed or developing countries have evolved their policies, institutions, and participatory processes have evolved and will evolve in the future through long, incremental, and gradual processes for addressing multiple and often conflicting objectives to accommodate for the continuously arising needs of the relevel stakeholders, and not easily adapted for by the assumed scenarios.

In addressing (1), this paper presents the concept of Ecosystem Shared Value Assessment (ESSVA), which involves the identification of the Ecosystem Service Perceptional Profile (ESPP), a questionnaire survey approach complemented with the factual data which form the basis for determining the Ecosystem Service Factual Profile (ESFP). In addressing (2), this paper discusses the usefulness of the Integrated Lake Basin Management (ILBM) approach, already reported elsewhere (Nakamura, 2011; Nakamura and Rast, 2014). Some useful literature on integrating the ES considerations into the basin planning process will be summarily presented in Section 2. Precisely how the ES considerations, as represented by ESSVA, may be embedded into the ILBM and the Integrated Lentic Lotic Basin Management (ILLBM) frameworks will be elaborated in Section 5. The paper also reviews the applied study undertaken for three Kenyan lakes in Section 6. The results of the three-lake study were presented together with the results of the analysis focused on Lake Nakuru, discussing how the ESFP information helps interpret the ESPP results.

2. Ecosystem Service Framework (ESF)

2-1. The Ecosystem Service Concept, An Overview

According to the definition of the Millennium Ecosystem Assessment (MEA) framework, ES consists of subcategories of Provisioning Service (PS: food and fiber, fuelwood, genetic resources, bio-chemicals, natural medicines, and pharmaceuticals, ornamental resources, animal products, freshwater, Regulating Service (RS: air quality maintenance, climate regulation, water regulation, erosion control, water purification, and waste treatment, regulation of human diseases, biological control, pollination, storm protection), Cultural Service (CS: cultural diversity, spiritual and religious values, knowledge systems (traditional and formal), educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, recreation, and ecotourism) and Supporting Service (SS: supporting services are those that are necessary for the production of all other ecosystem services such as primary production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat). The ES concept is also closely linked with the Ecosystems Approach that has been strongly advocated by the Convention on Biological Diversity, the global multilateral environment agreement which aims to conserve and protect biodiversity; ensure the sustainability of biodiversity, and promote the fair and equitable sharing of benefits arising from the use of genetic resources. [i]

In the development and implementation of a basin management plan for a subject basin system, the typical questions that arise on its ESF may include;

a) What is the current understanding of the basin stakeholders about the basin ES?
b) What policy interventions should be introduced to enhance sustainable use of the basin ES?
c) What lessons have been learned to pass on to future generations concerning the basin ES?

d) What is the status of ES regarding its four component services, and how well are PS and RS balanced today?

e) What is the prospect of achieving the desired future level of balance between PS and RS?

Answering these critical questions is quite challenging. For example, Scott et al. (2014) consider that, although the Ecosystem Approach (i.e., the ES concept) provides a valuable framework for managing ecosystems, the concept has not been fully utilized to inform decision-making on ecosystem management. The generic barriers to using the Ecosystems Approach in the policy and decision-making process are listed in Box 1 below.

Box 1. Generic Barriers to Using the Ecosystem Approach in Policy and Decision-Making Processes (source: Scot et al., 2014)

- Inconsistent approaches to ecosystem service modeling, assessment, and valuation.
- Lack of knowledge and appreciation of the Ecosystem Approach and/or the Ecosystem Services Framework and terminology amongst the built environment and business professions.
- Highly academic vocabulary and rhetoric that is not easily understood or implemented in practice by people at the grassroots level.
- Prevalence of complex ecosystem tools and ecosystem service models which are inaccessible to people on the ground.
- Cherry-picking of selected ecosystem services leads to non-systemic application and also perceived deficits in understanding ecosystem services that are difficult to assess (e.g. cultural services).
- Economic valuation of nature is controversial and fails to capture the intrinsic (non-use) value.
- Ecosystem services are data-heavy and resource-intensive, which leads to the use of other techniques.
- Institutional inertia is prevalent amongst decision-makers and consultants who are reluctant to adapt working practices to encompass new and time-consuming approaches.
- Resource limitations make new work practices difficult to employ.
- No system exists that can be used reliably to test cumulatively and comparatively the different streams and trade-offs within different Ecosystem Services. For example, testing cultural heritage against water quality and the effect of one on the other.
- Mistrust or misunderstanding of ecosystem science.

Nonetheless, Costanza et al. (2017) summarily state, based on the review of the literature published over two decades since its inception in 2005, "The interaction between built, social, human and natural capital affects human wellbeing. Built capital and human capital (the economy) are embedded in society, which is embedded in the rest of nature. Ecosystem services are the relative contribution of natural capital to human wellbeing; they do not flow directly." and then goes on to state, "It is therefore essential to adopt a broad, transdisciplinary perspective in order to address ecosystem services)."

2-2. Assessment and Valuation of Ecosystem Services

According to Berghöfer et al. (2015), "There is a considerable diversity of methods suitable for examining ecosystem services. Different methods generate different results because they represent different perspectives or choose different foci. Not all methods are suited to examine all ecosystem services, and not all are suitable for every assessment purpose. As a crude characterization, however, we can say that:

- **bio-physical methods** focus on ecological, hydrological, and atmospheric processes, among others;
- **economic methods** consider aspects of scarcity and/or efficiency, and many are used to calculate economic benefits, mostly in monetary terms;
- **social valuation and anthropological methods** examine stakeholder perspectives, particularly concerning the social and cultural meaning

- **integrated methods** seek to combine supply and demand data (e.g., by means of modeling)
- **(other) decision support instruments** process diverse data into scores, ratios, or qualitative conclusions (e.g., Cost-Benefit Analysis, Multi-Criteria Analysis)."

In a similar vein, Ervin et al. (2014) provide the following valuation spectrum in their article, "Principles to Guide Assessments of Ecosystem Service Values:

1) Quantification

Many costs and benefits can be quantified, for example, the number of lives saved through disaster planning and recovery. Biodiversity and ecological integrity are notoriously difficult to quantify, and though various metrics are available, improved metrics are needed. However, it may be inappropriate to put dollar values on human life or nature in certain situations.

2) Monetization

Some benefits are already monetized, typically because they are sold and bought in the market with observable prices, such as food, timber, and energy. Other services, such as flood mitigation or the social cost of greenhouse gas emissions, may not be traded, but their monetary values can be estimated.

3) Qualitative analysis

Other ecosystems' benefits, especially cultural ones, may hold significant value. However, these values are not readily quantifiable and may be more appropriately analyzed qualitatively with interview and survey data. [ii]

In a different vein, there has been great emphasis on ES mapping in the last decade.

2-3. Applied ES Assessment Methods to Planning and Management

There are great many applied ES assessment methods reported in recent literature. For example, Harrison, et al. (2017) provide an overview of the ecosystem service assessment methods categorized into "broad method groups, and "examples of methods within the broad groups" in the table form containing some 26 classifications. On the other hand, Costanza et al.(2017) state, "New formal valuation approaches acknowledge the variety of individual and group dimensions on the valuator side and incorporate the dynamics of natural capital and ecosystem services at multiple geographical and temporal scales. This type of policy or project assessment generally includes identifying and mapping, modeling the properties and values of landscapes and ecosystems, eliciting social preferences, deliberative processes, ranking, and quantifying the potential benefits of the proposed policy. This so-called total system approach implies estimating the value of systems and their services, including the causal mechanisms in service-producing ecological systems and the contributions by human action to make potential services actual and on the appropriate spatial and temporal scales. He also states, "'Ecosystem services' (ES) are the ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being: that is, the benefits that people derive from functioning ecosystems." He then goes on to state, "it is important to distinguish between ecosystem processes and functions, on the one hand, and ecosystem services on the other." and provides 17 such examples."

Provided below are two rather popular but versatile approaches to applied ES assessment methods, 1) the Inventory Method and 2) the Mapping Method, which will be referred to again in the discussion of Ecosystem Service Shared Value Assessment (ESSVA) in Section 3 and the remaining sections.

1) Inventory Method

According to Orenstein et al.(2012), the "Inventory Method" is a method aimed at inventorying a broad range of services and assessing spatial variation in the presence and amount of services across large scales (e.g., country or continental) along ecological gradients. This approach allows characterizing ecosystems, not by using classical habitat classification approaches, but by examining similarities between ecosystems in what they provide to people. .an assessment system of data sets and models to help users understand the provision of specific ecosystem services, and the distribution of these services geographically across the province. Results are provided in a report or can be viewed in an online mapping application. Ecosystem Service Assessment (2022) introduced their system called "Ecosystem Services Inventory (ESI)" and introduced it as "a credible, science-based estimation of the supply of ecosystem services in Alberta. It is based on an assessment system of data sets and models to help users understand the provision of specific ecosystem services, and the distribution of these services geographically across the province. Results are provided in a report or can be viewed in an online mapping application." In addition, there are many applied studies reported on the use of the Inventory Method for the assessment of ecosystem service situations in Japan, including one by Duraiappah et al. (2012) on what is called "Satoyama," about which the introductory remarks state that it is "a Japanese term describing mosaic landscapes of different ecosystems--secondary forests, farmlands, irrigation ponds, and grasslands--along with human settlements managed to produce bundles of ecosystem services for human wellbeing." It also states, "The concept of Satoyama, longstanding traditions associated with land management practices that allow sustainable use of natural resources, has been extended to cover marine and coastal ecosystems (Satomi). These landscapes and seascapes have been rapidly changing, and the ecosystem services they provide are threatened by various social, economic, political, and technological factors."

2) Mapping Method

In particular, mapping has been extensively promoted in relation to the EU Biodiversity Strategy to 2020 (European Union, 2022) called "Mapping and Assessment of Ecosystems and their Services – MAES," which is aimed to provide a coherent analytical framework as well as common typologies of ecosystems for mapping and a typology of ecosystem services for accounting have been developed to be applied by the EU and its Member States to ensure consistent approaches. All Member States are actively involved in mapping and assessing the state of ecosystems and their services in their national territory. It contributed to the sub-global assessments of ecosystems and ecosystem services under the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). The fourth technical report (European Union, 2016) is on mapping and assessing urban ecosystems and their services. The fifth technical report (European Union, 2018) provides an integrated analytical framework and set of indicators for mapping and assessing the condition of ecosystems in the EU.

Brouwer et al.(2013) state, "Most provisioning services are or will be, valued using market prices, and most regulating services are valued using methodologies based on (substitution) costs, where possible; however, monetary valuation of cultural ecosystem services, mainly using stated preference methods, is much more complicated. This is due to methodological challenges, lack of data, resources to conduct original valuation studies, and criticism of using monetary non-market valuation in some countries.

2-4. Assessment and Valuation of River Basin Ecosystem Services

Over the past decades, a large body of literature has been generated on applying ES to river basin management. For example, Brauman et al. (2014), in their paper entitled "Ecosystem Services and River Basin Management," present a review of its application status in the EU region. They state, "This framework is inherently anthropocentric, organizing ecological processes by their effects on human beneficiaries and explicitly connecting ecosystem processes to human welfare." It also says, "The ecosystem services approach facilitates management of a complex system by incorporating important aspects of risk-informed management." Then it concludes that "ecosystem services are a useful tool for river basin managers because they provide a coherent context to incorporate stakeholders and complex biophysical processes into a consistent, learning-based management scheme." On the other hand, McInnes and Everard (2017) developed a method called the Rapid Assessment of Wetland Ecosystem Services (RAWES). They illustrated through its practical application in over 60 wetland sites supporting the development of a Wetland Strategy for the Metro Colombo Region, Sri Lanka. The approach is based on the trained, local assessors using a variety of field indicators to assess the positive or negative contribution of over 30 wetland ecosystem services provided at local, regional, or global scales. Outputs are simplified, signaling to decision-makers the diversity of interlinked ecosystem service outcomes consequent from management policies and actions.

With the above in the background, introduced in the following section is called the Ecosystem Service shared Value Assessment (ESSVA))."

3. What is ESSVA?

3-1. ESSVA: A Method for Assessing the Sharing of Ecosystem Service Values

The term ESSVA stands for "Ecosystem Service Shared Value Assessment." It is a methodology for assessing the state of the ES shared by the basin stakeholders. Ideally, the ESSVA process is supported by determining what is called the "Ecosystem Service Perceptional Profile (ESPP)" together with what is called the "Ecosystem Service Factual Profile (ESFP)."

The process features the perceived magnitude of ES shared by the basin stakeholders. The ESSVA process is driven by obtaining the based on the questionnaire survey. The antonym of ESPP is to be determined using factual data. Because, in general, the factual data for determining the ESFP are not readily available, the available data for evaluating the ESFP, but not the ESFP itself, may supplement the ESPP results. (see Section 6. For details)

The ESSVA methodology was developed with the following aim in mind.

a) To provide an opportunity for the basin population to undertake a comprehensive assessment of their lake basin ecosystem and ES by helping them to shape a shared vision and common understanding of the issues and challenges facing the lake basin;
b) To support the participatory process of ILBM by providing the basin stakeholders an opportunity to recognize and overcome their perceptional gaps.
c) To guide the government to listen to the community's voice and allow the government policies and programs to be widely supported and easily implemented.
d) To form a basis for mutual collaboration within a basin and across basins by enabling stakeholders to discuss their problems based on the same general ES framework

Before going into the details of the ESSVA methodology, the relationship between the basin configuration and the ES components will be illustrated in Section 3.2, and the notion of balancing between PS and ES willdescribedated in Section 3.3

3-2. ESF in the River-Lake-Estuary Basin Systems

The people living in different basin parts invariably possess different perceptions of ESF. For example, a lake may be connected with inflowing rivers from upstream and an outflowing river downstream, which discharges to the delta and the embayment formation. Each stretch of the rivers and the lake and its basin part possess PS, RS, and SS, while the lake and its surrounding land have not only PS and RS but also CS. In pursuing PS, e.g., water withdrawal from the lake, the RS values the lake possessed, such as biodiversity, healthy food chain, and self-purification capacity, might be damaged. This schematic representation of a river-lake-coastal embayment system will be referred to again in Section 5.

3-2.1. Factual Profile (ESFP) and Perceptional Profile (ESPP) of Ecosystem Service

As mentioned earlier in Section 3-1, ESSVA consists of the "Ecosystem Service Factual Profile (ESFP)" and the "Ecosystem Service Perceptional Profile (ESPP)". ESPP assessment can be undertaken through a questionnaire survey. For example, the perceptional magnitude may be defined on a scoring scale of 1 to 5, where Score 1 may be perceived as least significant, Score 2 as slightly more meaningful, Score 3 as moderately significant, Score 4 as much significant, and Score 5 as most significant. Undertaking ESPP assessments can be quite demanding because of the time and manpower requirements. However, the whole process of survey design, the output processing using such tools as the spread-sheet application software and associate statistical analysis, and interpretation of the compiled results make ESPP quite useful both for the survey implementers and the survey participants. In particular, ESPP can be flexibly designed and implemented to allow maximum interactions between the surveyors and the surveyed basin communities, sharing the survey results' statistical analysis. Most important, however, is the feedback from the questionnaire respondents and other basin stakeholders involved in management. The results could always be subjected to debates about whether or not they truly reflect the reality faced by the basin community.

In the meantime, ESFP involves transforming "hard" factual data such as land and water uses, crop types, population distribution, and physical, biological, and chemical assessment through monitoring. Such data will have to be transformed to surrogate values representing the ecological service magnitude through 1) Quantification and or 2) Monetization since such data are generally not readily available for lake-river-coastal basin cases. Such data may be appropriately transformed to the form applicable to such methods as the Inventory Method and the Mapping Method.

In reality, however, the inauguration of the ESPP survey provides an excellent opportunity for the ESFP to be undertaken, in phases, i.e., initially to compile the readily available data collected for other purposes, than to enrich such efforts over time, eventually to arrive at a more comprehensive ESFP, along the lines of such studies as those illustrated under Section 2.

3-2.2 Integration of ESVA Output into the ILBM Platform Process

The ambiguities associated with ESPPs won't pose serious misgiving to the ESSVA approach in ILBM. The reasons are as follows. See, for example, in Figure 1 below, the cyclic process of the ILBM Platform Process. In managing lakes, rivers, estuaries, and their basins, the ILBM Platform Process proceeds gradually, incrementally, and for an extended period to improve the Six Pillars of Governance, i.e., (1) Institutions, (2) Policies, (3) Participation, (4) Technology, (5) Knowledge and Information, and (6) Funding and Finances.

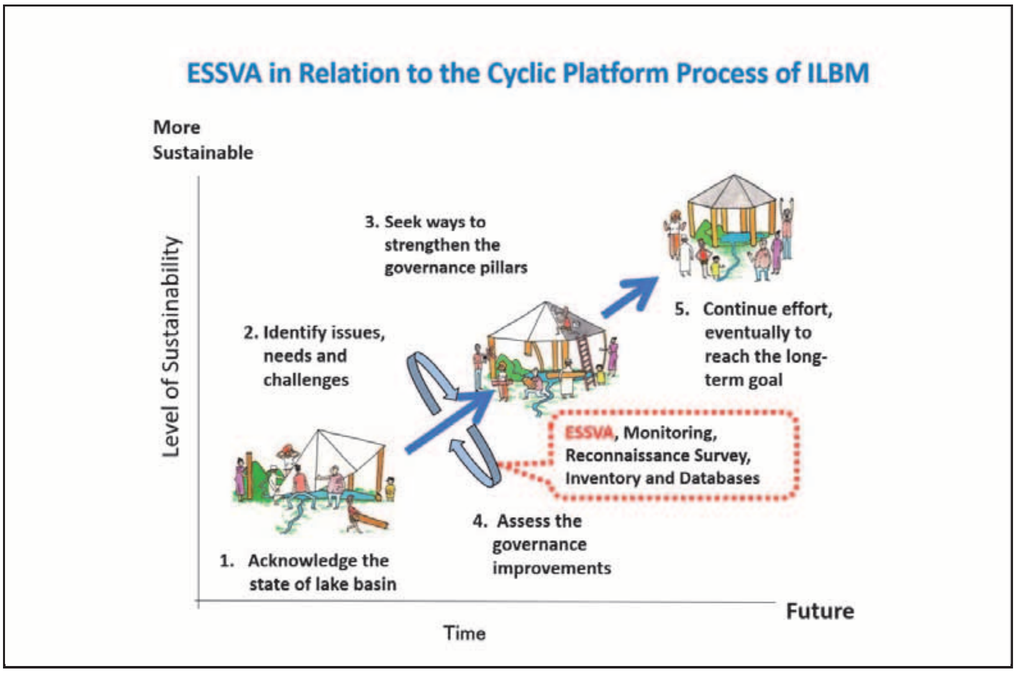


Figure 1. The Long-Term Goal of the ILBM Platform Process

Integrated Lake Basin Management (ILBM) is an approach to achieving sustainable management of lakes and reservoirs through the gradual, continuous, and holistic improvement of basin governance, including sustained efforts to integrate institutional responsibilities, policy directions, stakeholder participation, scientific and traditional knowledge, technological possibilities, and funding prospects and constraints. It has been conceptualized based on the premise that achievement in managing lakes, reservoirs, and their basins is facing a serious global challenge. ILBM also assumes that the problems facing individual lakes cannot be properly and adequately addressed unless the fundamental issue of sustainable resource development, use, and conservation facing the lakes are addressed globally and with strong, long-term political commitment. The ILBM Process is also designed for lake basin stakeholders to fill the gaps between what has already been achieved and what remains to be achieved as continuing governance improvements over time. The ESSVA approach enhances interactions among the basin stakeholders in the cyclic. This interaction among the basin stakeholder groups will allow the stakeholder groups to come to terms with the ambiguities associated with ESPP.

The ESSVA approach enhances interactions among the basin stakeholders in the cyclic ILBM Platform Process, characterized by the gradual, incremental, and long-term improvement process of the Six Pillars of Governance. This interaction among the basin stakeholder groups will allow the stakeholder groups to come to terms with the ambiguities associated with ESPP.

3-3. Balancing PS and RS

As shown in Figure 2, the ES values can hardly be subjected to simple financial transactions in the cases of actual basin management. This leads to the natural tendency for us to make the PS-based decisions, slighting the implications of RS, CS, and SS. To simplify the story, let's consider the relationship between PS and RS. Considering basin management, suppose the demand for PS had exceeded the amount initially available (inherently endowed by nature). The difference between the two PSs had to be technologically supplemented (water resources development by impounding structures such as dams and barrages), resulting in the reduction in RS (reduction in the natural flow of water for ecosystem use) from the original level, resulting in the PS-RS imbalance (lefthand side of Figure 2. that needs to be restored in the future (right-hand side of Figure 3. The question is how such a PS-RS balance may be pursued in the process of basin management involving such a river-lake-embayment system, as illustrated in Figure 1.

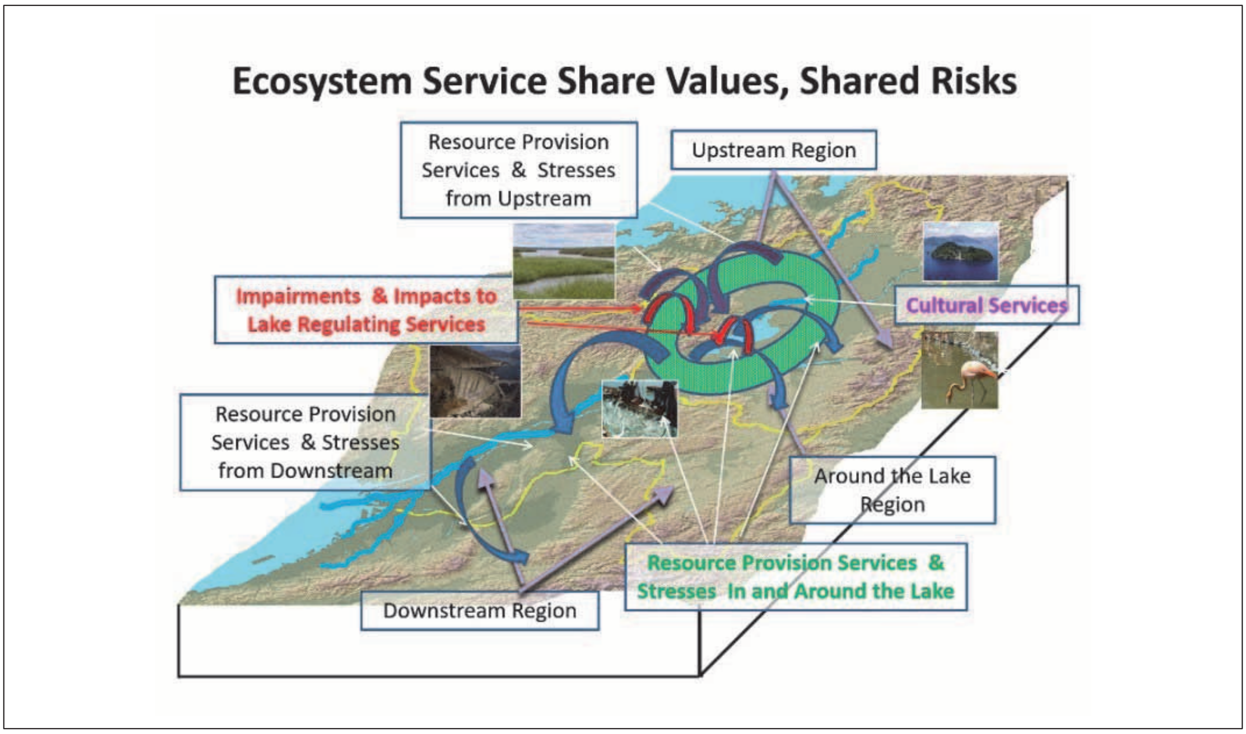


Figure 2. The ES Framework for a Lake-River-Coastal Basin System

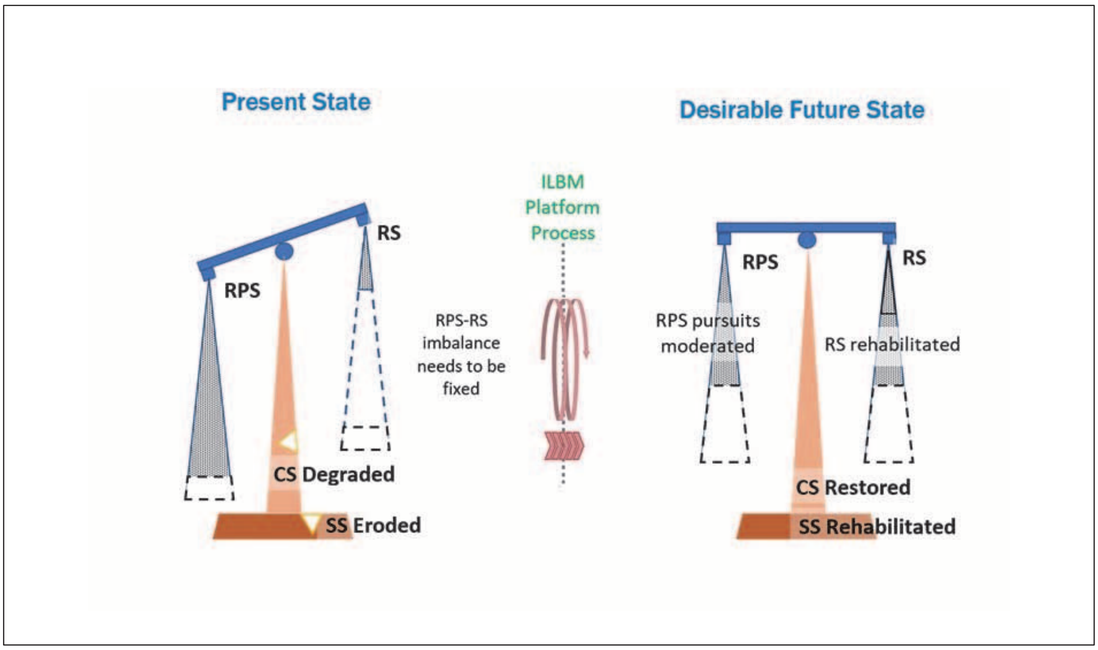


Figure 3. A Schematic Image of the Balance between PS and RS at Present and in Future

Over time, these dynamic relationships among PS, RS, and SS in the ES framework dictate how such a river-lake-embayment complex be managed. For example, a contentious situation may arise due to the imbalance in the distribution of the overall ES values to be shared among different people within the basin. It may happen, for example, among people residing in other parts of the basin and people belonging to different social sectors. The most notable case may be the sufferance of the diminished RS and CS strongly felt by the people living the most downstream of the basin due to the flow regime of the basin. Another severe issue is that the remnants of PS activities would cause pollution of all kinds. In other instances, there would always be an imbalance in the distribution of ES between the upstream and the downstream of a particular stretch of the river system.

3-4. Regaining the Ecosystem Balance via the ILBM Platform Process

Of course, there is no universally satisfactory solution to arrive at a formula to share the ES values, benefits, or risks. However, it would be possible to gradually develop a continuously evolving interaction process among various entities (stakeholder groups) to come to terms with the reality of mutual facilitation and collective improvement. This process is tentatively called the "platform process" as it relates to the process that involves as large several stakeholder groups as possible to be on the same platform gradually to be engaged in the collective and concerted actions. The conceptual image of the process to regain the Ecosystem Balance via the ILBM Platform Process is shown in **Figure 4**.

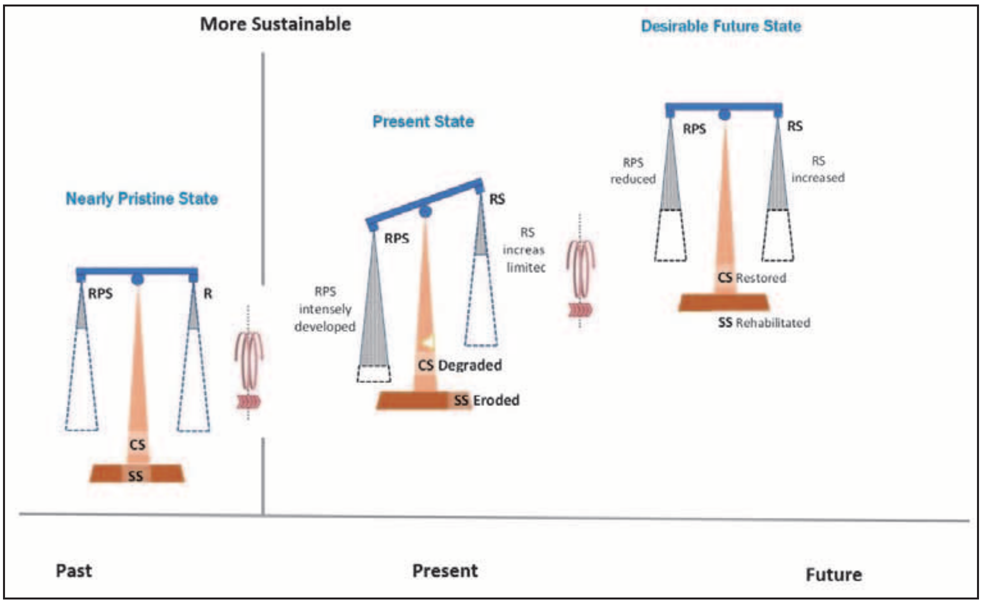


Figure 4. A Schematic Image of Regaining the Ecosystem Service Balance Over Time

4. Outline of the ESSVA Applied Study Framework

4-1. Outline of the Procedure

The proposed methodology for undertaking ILBM-ESSAVA applied studies for ESPP is illustrated below (**Figure 5**) and described in the following sections.

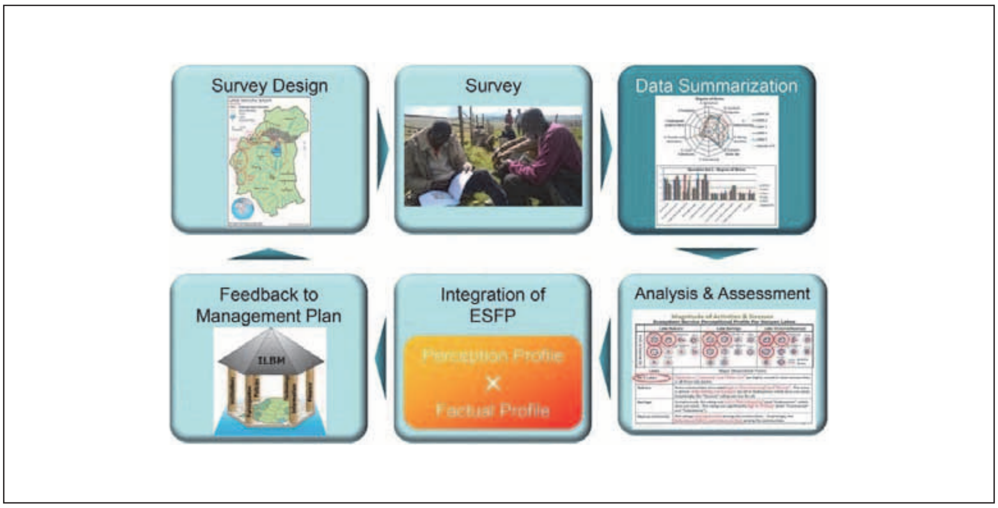


Figure 5. An ESSVA Applied Study Procedure

4-2. The Basin Configurations Consisting of Lentic and Lotic Subsystems

Successful management of lake basins requires a shared vision and understanding of the issues and challenges. It also requires the basin stakeholders to overcome differences by identifying and filling the perception gaps between different stakeholders and for the government to listen to the voices of the basin community. Such actions may lead to developing policies and programs that can be widely supported and easily implemented. Further, the basin stakeholders must mutually collaborate within the basins to address their commonly shared problems. The concept of ES concept would be very useful for the above process.

Two important observations may be made on the case of a lake interlined with the inflowing and outflowing rivers forming a lentic-lotic water complex compared to a lake singly existing as a lentic water system. **Figure 6** shows the case of a basin consisting of lentic-lotic-lentic-lotic linkages where the interactions of respective stakeholder communities may be complexly intertwined. (see also Nakamura and Rast, pp13-14 for visual illustrations)

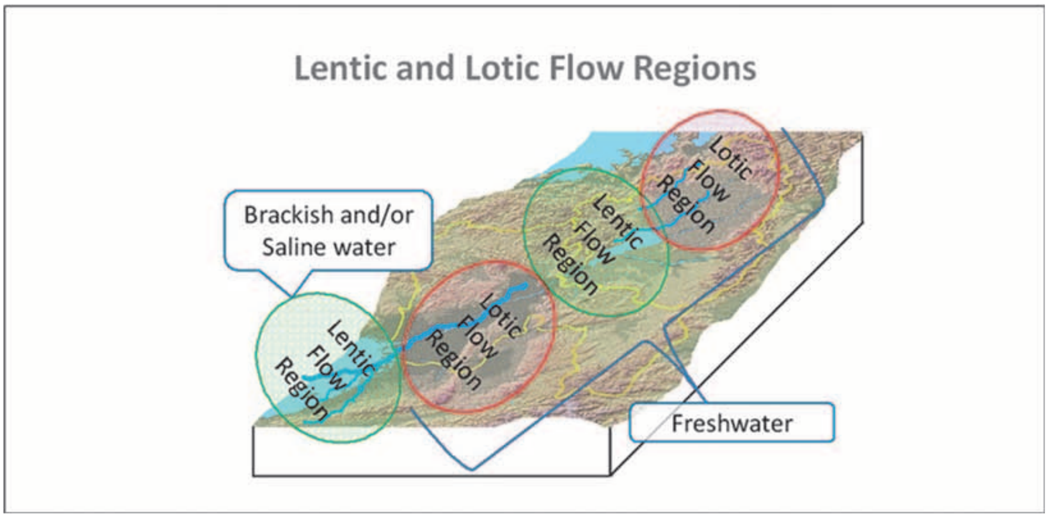


Figure 6. A River-Lake-Coastal Basin System with Lentic-Lotic Flow Regions

4-3. Integrated Lentic-Lotic Basin Management (ILLBM) and the Spheres of Influence

The ILBM concept, having been developed for application to lake basin management, is also proposed for application to the lentic (lakes, estuaries, and embayments) and lotic (inflowing and outflowing rivers) basin management and is termed the Integrated Lentic-Lotic Basin Management (ILLBM). As with ILBM, ILLBM also features the gradual, incremental, and long-term process of basin governance improvement. Integrating the ES considerations obtained through the ESSVA process is adaptable to ILLBM.

ESPPs are assessed using a survey form developed based on the Ecosystem Services Framework. The assessment methodology for ESPP recognizes overlapping spheres of influence/interaction of ecosystem services at different spatial scales, such as regional, inter-basin level, basin level, municipal, village and community level, and individual household/neighborhood level. Therefore, the ESPP is depicted as the sphere of influence/interaction of different scales for different ecosystem services. Typical ESFPs include governmental data on land use, water use, population dynamics (census data), and legal and regulatory aspects such as water quality and quantity data. ESFPs also include information from established assessment tools such as economic valuation, payment for ecosystem services, and environmental impact assessment. In most cases, the scientific data and information needed for ESFPs are lacking or inadequate. Therefore, it is often the case that ESFP is only partially developed or is developed with time as data and information become available.

The overall Ecosystem Service (ES) associated with a river-lake-estuary complex provides values (benefits) to be shared by the basin communities. Still, its value would diminish without proper management, and the ecosystem risk would increase. Using the past data and information, future values and risks may be scientifically identified and assessed. However, even with such data and information, sharing the values and risks across the entire basin would be difficult, not only because the predicted values and risks are often beyond the comprehension of the affected population but also because there are perceptional gaps among the different groups of the population belonging to other sectors, residing at various locations, etc. Different perceptional profiles for the same physical existence of a basin complex might prevent sharing the values and risks associated with that basin.

The methodology proposed here to overcome the above challenge, i.e., sharing of the values

and risks, involves identifying and developing what may be called the Ecosystem Service Profiles (ESPs). One may be able to conceptualize two broad categories of ESP for a river-lake-estuary basin, the first being the fact-based ESP (ESPF) and the second being the perception-based ESP (ESPP), as already discussed in **Section 4-2**. For the well-studied river-lake-estuary systems, some ESPF information is likely to be already available in databases in the government and research institutions about the basin ecosystem services. The typical ESPFs include governmental data on land use, water use, population dynamics (census data), and legal and regulatory aspects such as water quality and quantity data. They may also include the information and data developed and compiled in a research database, e.g., the GIS and remote sensing analysis results and their application to modeling various kinds.

4-4. The Questionnaire Form

The questionnaire contains a series of questions regarding the kind of resource values (PS) provided in the drainage basin and the stresses, impairments, and impacts of these values. The respondents are asked to assign an ordinal ranking score between 1 and 5 by referring to illustrative images (photos) of the perceived prevailing conditions. It should be designed to suit the local situations.

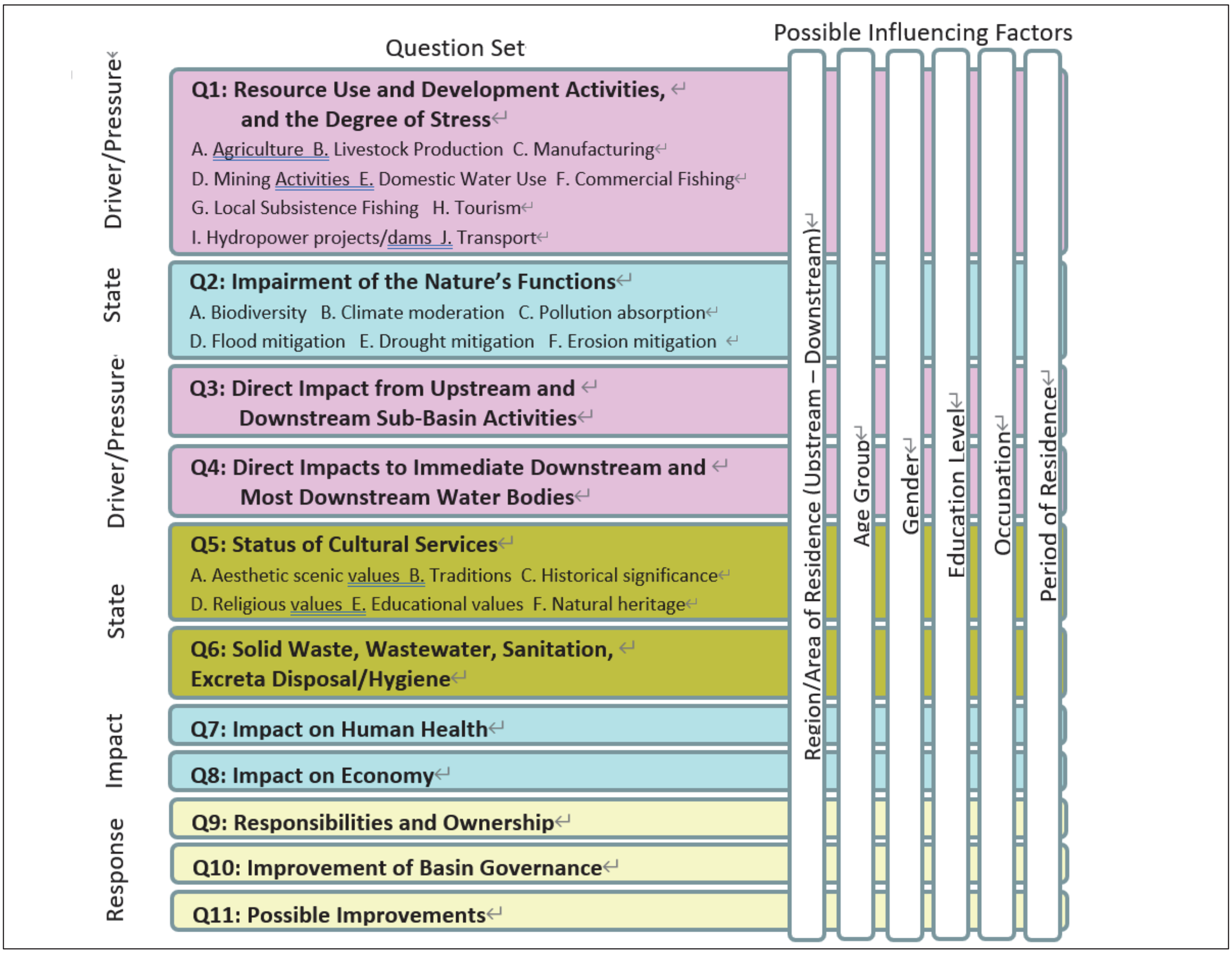


Figure 7. Structure and Contents of the ESSVA (ESPP) Questionnaire

4-5. Participatory Approach

4-5.1 Participatory Development of an ESSVA Questionnaire

As noted above, in most lake basins, it is generally difficult to obtain data and information on ESFPs. Therefore, in most cases, the initial focus of ESSVA, after a preliminary consultative process involving hearing and interactive discussion on the occasion of community gathering, will be on collecting data and information for ESPPs, later on incorporating ESFPs as data and information become available. This section describes the structure and content of questionnaires used to develop ESPPs.

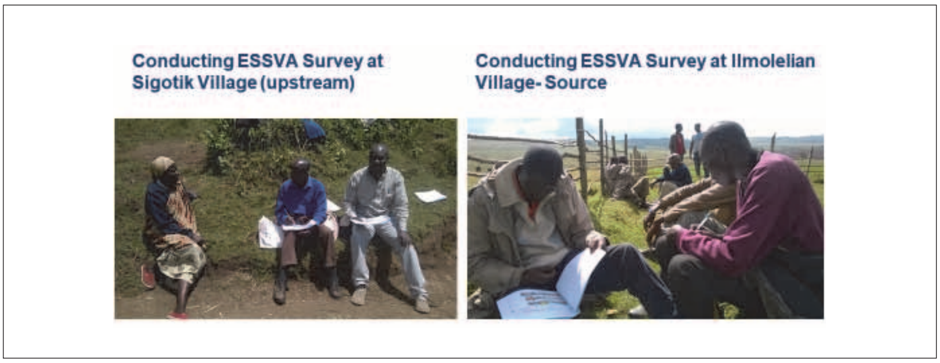


Figure 8. Participatory Engagement of the ESSVA Respondents

4-5.2 ESSVA Subjectivity Mediated by the Cyclic Process of ILBM

While the ESSVA methodology has been regarded as a valuable tool for enhancing stakeholder participation in ILBM, some concern has arisen about the inherent subjectivity in the magnitude of ESPP values and their statistical confidence levels. However, in applying to the ILBM process, the pilot project implementation teams have agreed that the above methodological shortcomings will not seriously hinder the adoption of ESSVA in the ILBM Platform Process because of its cyclic nature. The Platform Process features gradual, incremental, and long-term improvement in cycles of the Six Pillars of Governance, i.e., (1) Institutions to manage the lake and its basin for the benefit of all lake basin resource users; (2) Policies to govern people's use of lake resources, and their impacts on lakes; (3) Involvement of People to facilitate all aspects of lake basin management; (4) Technological Possibilities and Limitations that are often quite dictating regarding long-term decisions; (5) Knowledge and Information of traditional, as well as modern scientific nature, forming the basis for informed decisions; and (6) Sustainable Finance to support the implementation of all of the above activities. Thus, the subjectivity of ESPP with ambiguity in the assessment results will generally be compensated for by the ILBM Platform Process.

5. ESSVA Survey and Analysis of Outputs

5-1. Survey Implementation

The survey is implemented by administering the questionnaire to the target stakeholders in an interview or meeting setting (focus group discussion). Depending on the objectives, scope, and availability of resources and for ease and convenience to the prospective respondents, the questionnaire may be appropriately amended An example of the ESPP score rating is shown in Table 1.

Table 1. Meaning and Interpretation of the ESPP Survey Scores

Score	Meaning	Interpretation of the Status
1	None	Problem-free situation
2	A little	The situation is indicative of problems requiring a minor level of remedial measures.
3	Moderate	The situation is indicative of problems requiring a moderate level of remedial measures.
4	Much	The situation is indicative of problems requiring a significant level of remedial measures.
5	Very much	The situation is indicative of problems requiring an intensive level of remedial measures.

5-2. Survey Data Compilation

The questionnaire survey generates many data compiled in a spreadsheet to facilitate easy data handling. A spreadsheet template may be customized to suit the specific local needs. A schematic image of the data system is shown in **Figure 9**.

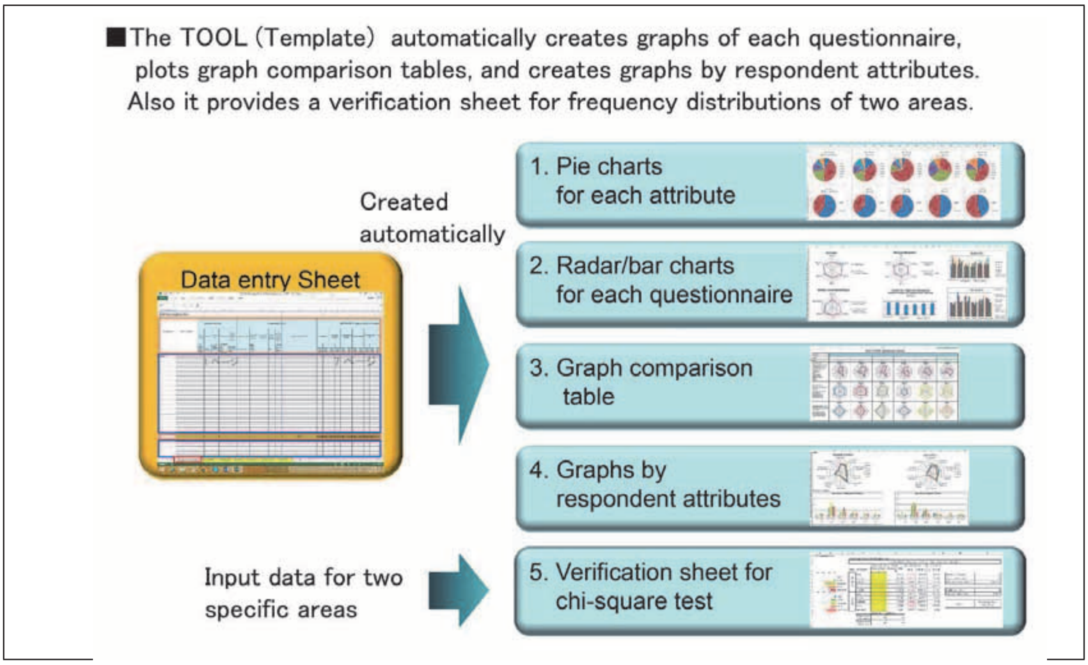


Figure 9. Illustration of a Spreadsheet-based Tool Set for Compiling and Summarizing the ESSVA (ESPP) Data

5-3. Data Analysis and Assessment

The questionnaire survey results should be analyzed to determine the differences in perception and possible reasons. For example, differences in perception may exist depending on the relative locations of the respondents in the basin (such as upstream or downstream, and rural or urban) or on the socio-economic status of the respondents (such as age, gender, education level, occupation, and residency period in the basin).

5-4. Display of ESPP Outputs

5-4.1 Graphical Displays

The ESPP assessment of a particular basin is carried out using a questionnaire survey form. The form features the visual images of ES components associated with the basin. The basin stakeholder groups respond by assigning scores to the individual images according to their perceived magnitude of importance resulting in the outputs in the form of radar charts, the details of which will be discussed in Section 6.

5-4.2 Statistical Analysis

Because the ESPP approach in the ESSVA involves questionnaire surveys of stakeholder groups involving multiple factors (e.g., multiple numbers of ES components, multiple numbers of stakeholder groups, multiple numbers of attributes associated with different stakeholder groups, etc.,) the statistical analysis to be employed has to be related to "hypothesis testing of means that tests whether or not the means of different samples or subgroups of the same population are equivalent." The most widely used method is ANOVA[iii] or the "Analysis of Variance" technique, which tests the difference between two or more means and generalizes the t-test beyond two means.

6. ESSVA Application for Some Kenyan Lake Basins

6-1. ESSVA (ESPP) Survey Map

Figure 10-a, 10-b, and 10-c show the ESSVA (ESPP) survey maps, each for Lake Baringo, Lake Nakuru, and Lake Victoria (Nyanza Bay), for which the ESSVA pilot project was undertaken from 2015 through 2019. Lake Baringo is a freshwater lake located in the northern part of the Kenyan Rift Valley lake system, at an elevation of about 1000 masl, some 220 km from Nairobi. It has a surface area of 130 km2, with a mean depth of some 5m. It serves water for humans and livestock and supports local fisheries and minor tourism featuring rich biodiversity and ethnic and cultural heritage. Lake Nakuru is a saline lake and part of the Kenyan Rift Valley lake system some 160 km northwest of Nairobi, at an altitude of 1759 masl. The lake has a surface area of 40–60 km2 and an average depth of 1 m. The lake and its surrounding shoreland constitute the Nakuru National Park, famous for the flamingo migrations, but it immediately borders Nakuru City with a population of 0.6 million. The Nyanza Bay (Gulf) is situated on the north-eastern corner of Lake Victoria. It has a surface area of 1400 km2, a mean depth of 7 m, and a maximum depth of 30 m. Its basin encompasses several municipalities, including Kisumu City, the capital of this region of Kenya, harboring a population of some 0.6 million. There are many artisanal fishing communities and fish landing sites for pelagic fishery fleets along the lake shore.

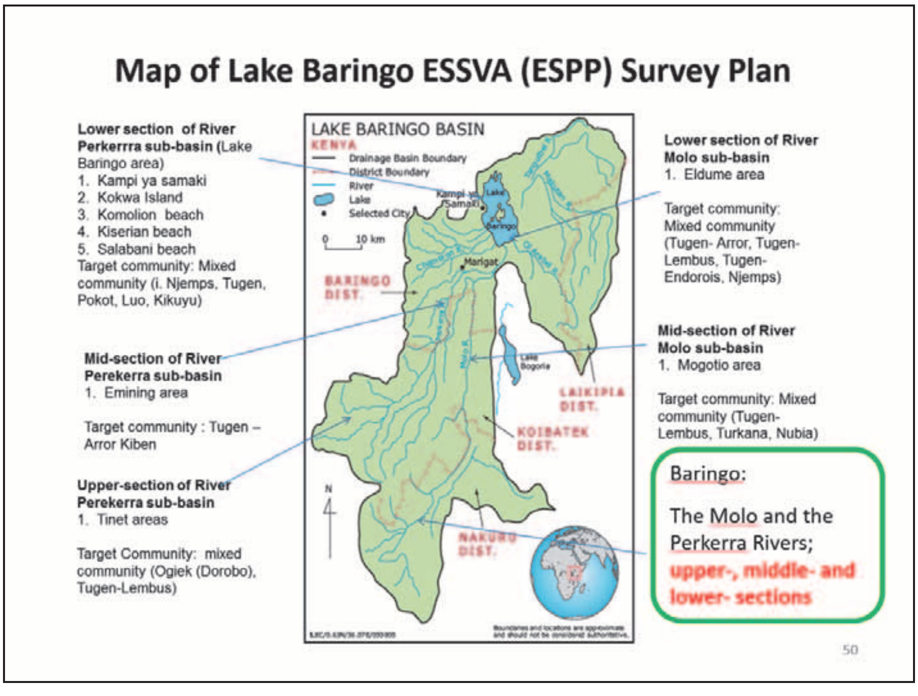


Figure 10-a. ESSVA (ESPP) Survey Map and the Basin Community Scenes of Lake Baringo

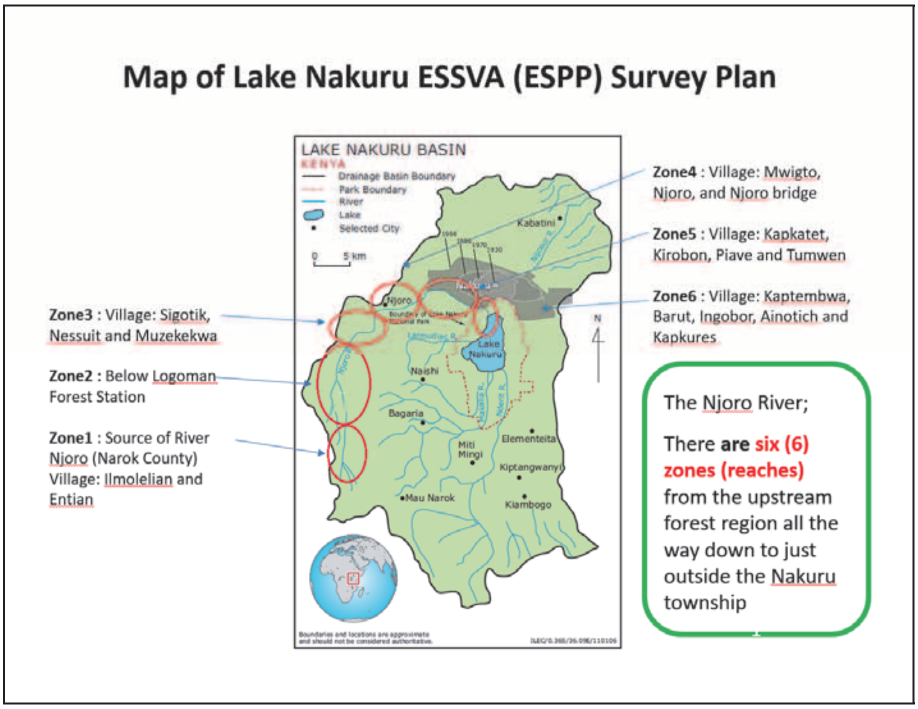


Figure 10-b. ESSVA (ESPP) Survey Map and the Basin Community Scenes of Lake Nakuru

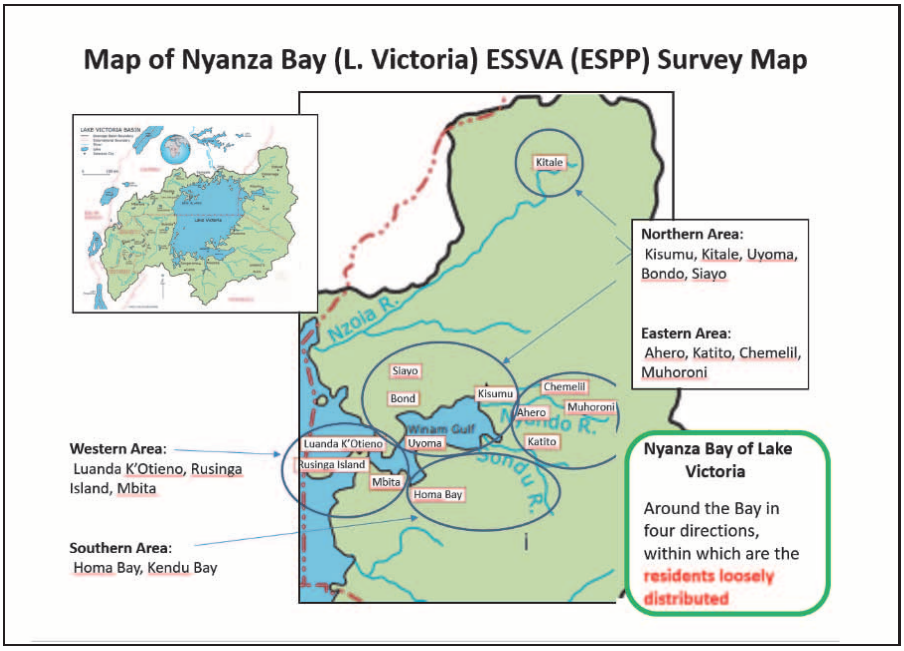


Figure 10-c. ESSVA (ESPP) Survey Map and the Basin Community Scenes of Lake Victoria [Nyanza Bay]

6-2. The Survey Form Structure

6-2.1 Typical Survey Form

Shown in Figure 11 is an outline of the structural design of the ESPP survey form corresponding to the schematic image shown in Figure 7. Please note that the survey facilitators and the community members provided the photo images in the form. Underneath the photo images are the score-rating boxes for indicating the magnitude of importance as perceived by the respondents.

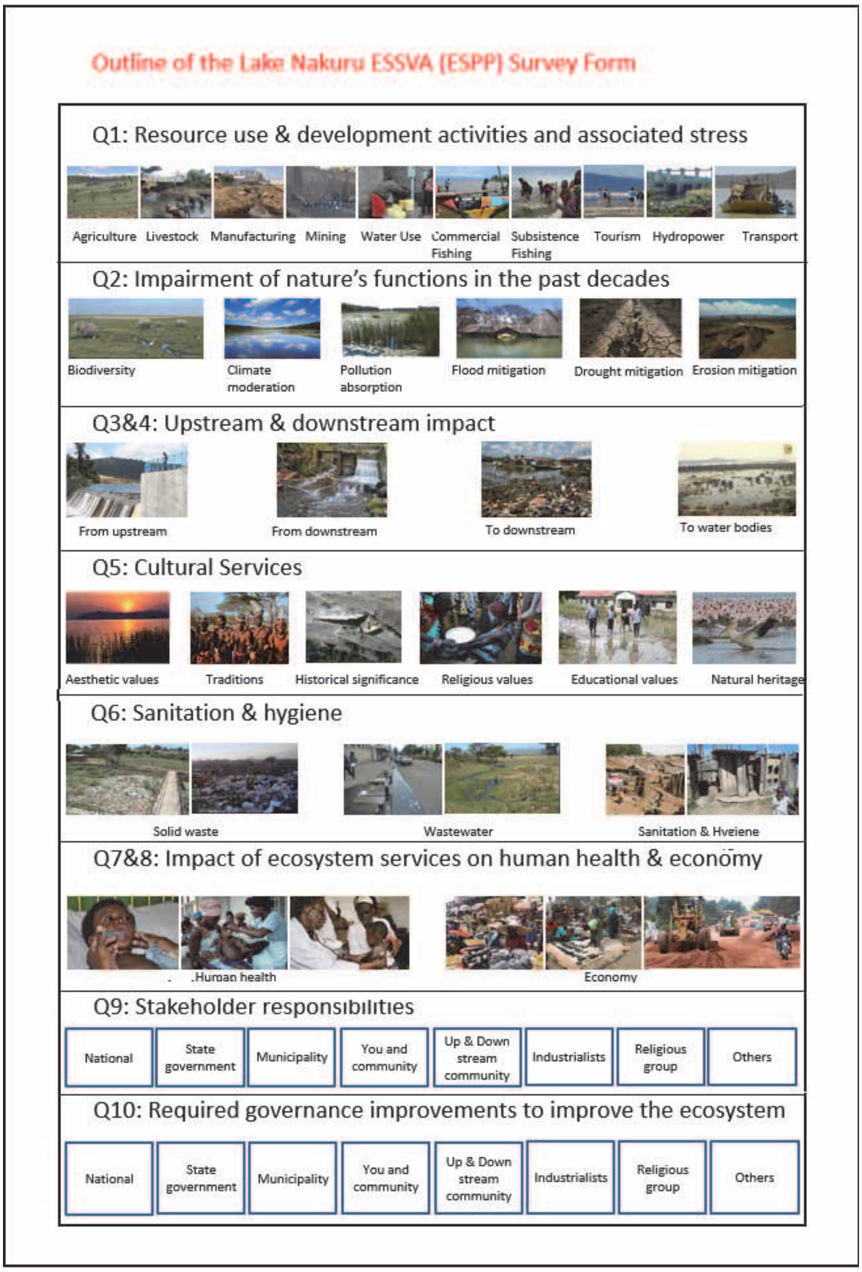


Figure 11. Structural Design of the Survey Form

6-2.2 The Overall Survey Output for the Three Kenyan Lake Basins

Figure 12 summarizes the radar-chart ESSVA survey outputs on Questions 1 through 10 for the three Kenyan lakes. The axes of the charts represent the communities in each of the three lake basins, i.e., seven community zones (1A, 1B, 2, 3, 4, 5, Nakuru Municipality, and the Nakuru National Park) in the case of Lake Nakuru, six communities (upstream and downstream communities in each of the three major river basins) in the case of Lake Baringo, and fourteen townships in the Nyanza Bay basin of Lake Victoria. Please note that the rating-score scale is associated with each diagram axes for the respective survey questions. The radar diagram shapes and sizes appear indistinguishably similar in some cases while vividly different in others. It is essential to have interactive discussions among the participating stakeholder groups by referring to the factual profiles (ESFPs), if available.

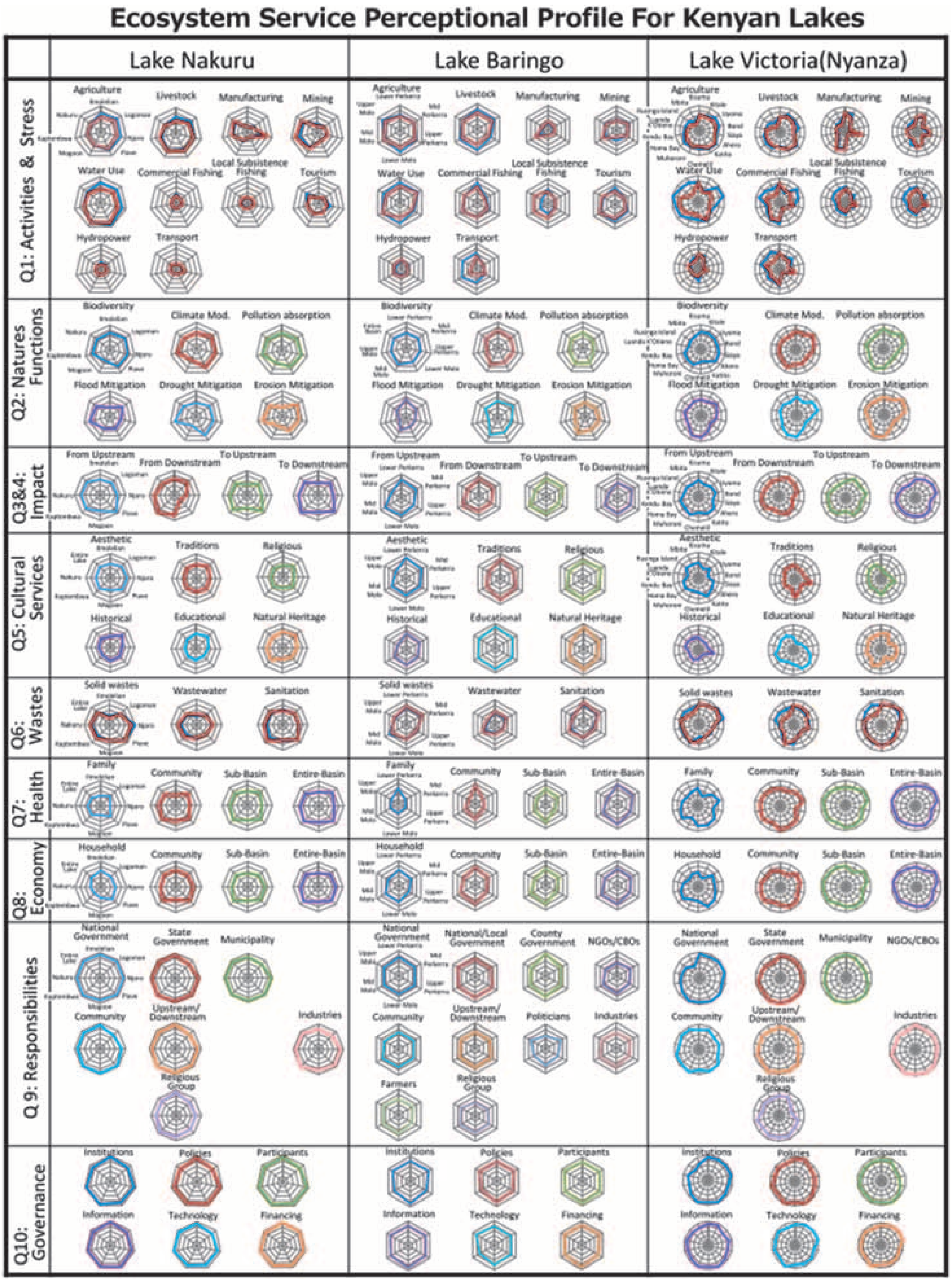


Figure 12. Comparison of the Survey Outputs of Question Sets 1-10 for All Three Lake Basins

6-2.3 The PS, RS, and CS Profiles

The balance between the kind and amount of activity pursuing PS and the type and the effort level to conserve RS, resulting from the ESPP assessment results, provides essential clues on whether or not the lake basin resource utilization is sustainable. The sustenance of the CS level depends significantly on the attained balance level of PS and RS. The ESPP and ESFP would facilitate the purposeful implementation of the ILBM Platform Process.

In the case of Lake Nakuru, both RS and CS are rated as moderately degraded, indicating that there are problems and, therefore, remedial measures are required. The collective knowledge of the basin communities was shared through the discussion sessions, often referring to the available ESFP data. Figure 13 shows a comparison among the PS, RS, and CS profiles for all-zone means, and Figure 14 shows a comparison among the Means of PS Component Services by Zones, both for Lake Nakuru.

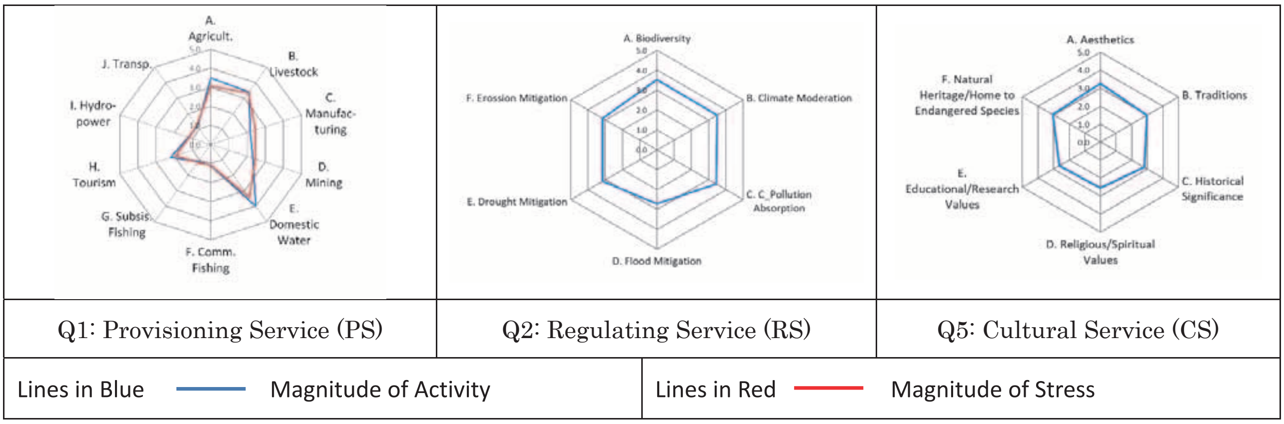


Figure 13. Comparison among the PS, RS, and CS Profiles for All-Zone Means

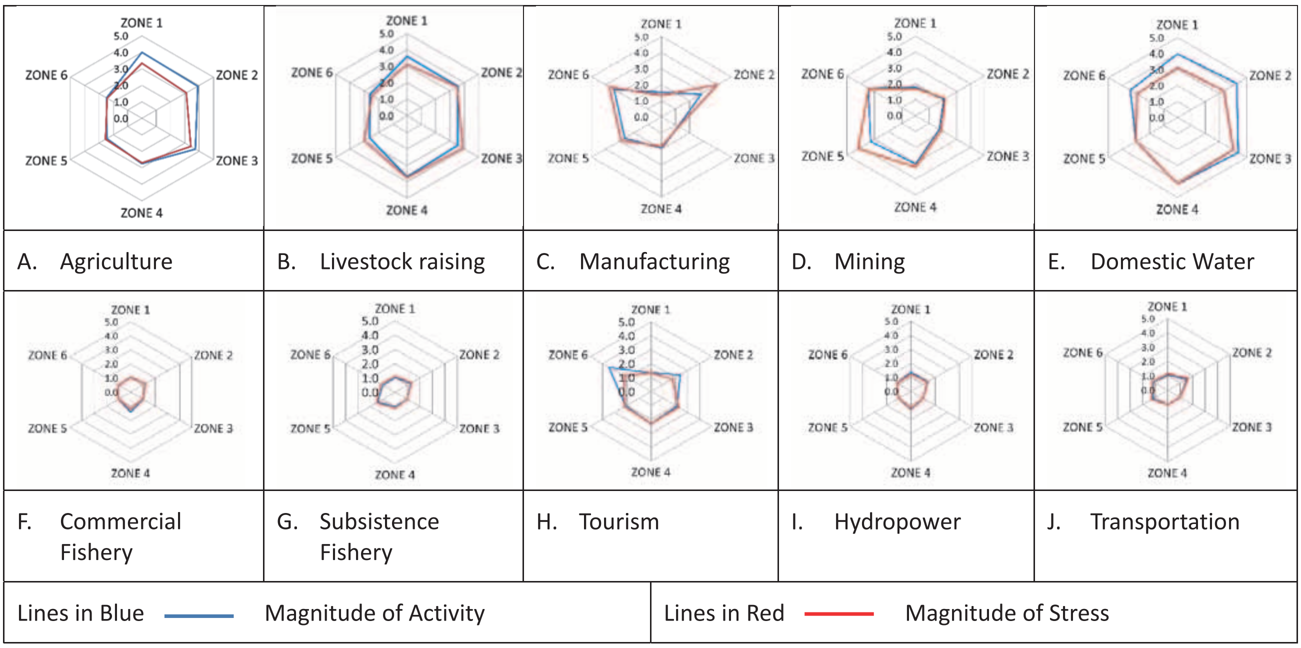


Figure 14. Comparison among the Means of PS Component Services by Zones

6-2.4 The Upstream-Downstream Relationships and their Interpretation

Q3 and **Q4** relate to complicated upstream-downstream relationships.

Q 3: Direct Impact Your Sub-Basin Water Receive from Your Upstream and Downstream Sub-Basin Activities

a) How much stress and negative impact do you think your sub-basin waters have been receiving from the activities of your immediate upstream communities?

b) How much from those immediately downstream of yours?

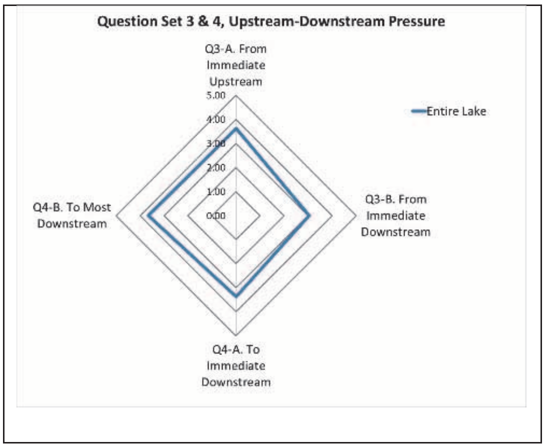
Q 4: Direct Impacts of your Sub-Basin Activities on your Immediate Downstream and the Most Downstream Water Bodies

a) How much stress and negative impact do you think your sub-basin activities affect your immediate downstream communities?

b) How much to the most downstream water bodies, such as lakes, river-mouth estuaries, and embayments?

Table 2. Q3 & 4: The Mean Scores of the Upstream-Downstream Impacts from the Q3-Q4 Responses

.	(A) Direct Impact **from** Upstream and Downstream		(B) Direct Impacts **on** Downstream	
	(A-1) From Your Immediate Upstream	(A-2) From Your Immediate Downstream	(B-1) To Your Immediate Downstream	(B-2) To Most Downstream Water Bodies
Entire Lake Basin	3.62	3.04	3.36	3.65



As shown in Table 2 and Figure 15, the impacts from the upstream to the downstream are consistently recognized as a big problem. The recognition that the impacts from the downstream are rather significant could be considered affected by the location of facilities such as a dam or a dumping site, as confirmed through ESFP data. If there is a discrepancy in recognition, it may indicate that information sharing is insufficient, affecting efforts for improvemen.

Figure 15. The Mean Score Spider Graph of the Upstream-Downstream Impacts based on the Q3-Q4 Responses

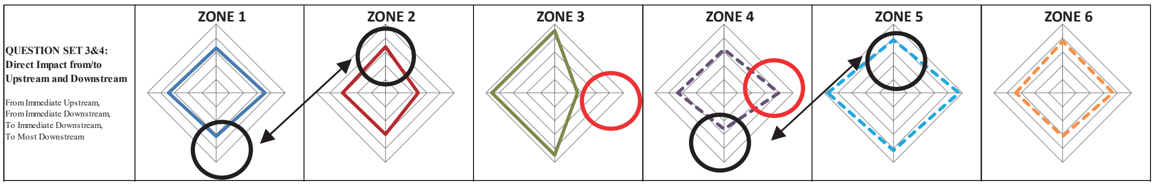


Figure 16. The Upstream-Downstream Impact Scores and their Neighbor-Zone Relationships

Further, as shown in Table 3, all regions except Zone 5 feel their sub-basins receive more pressure from their immediate upstream than they send to their immediate downstream. Zone 5, the exceptional area, thinks that its sub-basin receives less stress from immediate upstream (M=3.83). At the same time, it sends more pressure immediate downstream (M=4.17) and even more force to most downstream water bodies (M=4.75), which is the highest any region has acknowledged.

Table 3. The Upstream-Downstream Impact Scores for All Zones

	Direct Impact from Upstream and Downstream		Direct Impacts on Downstream	
	From Your Immediate Upstream	From Your Immediate Downstream	To Your Immediate Downstream	To Most Downstream Water Bodies
ZONE 1	3.29	3.54	3.12	3.41
ZONE 2	3.35	2.38	3.00	3.11
ZONE 3	4.55	1.65	4.48	4.55
ZONE 4	3.15	4.00	2.60	3.35
ZONE 5	3.83	4.75	4.17	4.75
ZONE 6	3.76	3.65	3.15	3.40

When the perception of the pressure is sent to the immediate downstream compared to the perception of the downstream community regarding pressure they receive from upstream (shown by arrows in column graph), the general trend is that upstream sub-basins feel they send less stress. In contrast, downstream communities feel they receive more pressure from upstream than the upstream communities. The exceptions are Zone 3 and Zone 5, which feel they send more force downstream than is owned by Zone 4 and Zone 6, respectively.

Regarding pressure to most downstream water bodies, two regions (Zone 2 and Zone 6) think they send less stress to the most downstream water bodies than they receive from their immediate upstream. Zone 3 thinks there is a balance. The remaining three regions (Zone 1, Zone 4, and Zone 5) think they send more pressure to the most downstream than they receive from their immediate upstream. However, the upstream-downstream differences were not significantly different at p=0.05.

Regarding pressure from immediate downstream, three regions (Zone 1, Zone 4, and Zone 5) feel they receive more pressure from downstream than from upstream. On the other hand, Zone 2, Zone 3, and Zone 6 think that they receive less stress from immediate downstream than the pressure from immediate upstream. The upstream-downstream differences were significant in Zone 2, Zone 3, and Zone 4 (p=0.05). It is essential to confirm the situation of installation of facilities (such as dump sites) in the areas as possible reasons for the observed differences.

6-3. The Three Lake Basin Comparisons

Figure 17 shows the degradation of ecosystem functions causing a reduction in ecosystem service values that result in the "Impact on Human Health" at the levels of family, community, sub-basin, and entire basin, of each of the three Kenyan lakes. In all three lake basins, the respondents gave successively greater score ratings from "Family" to "Entire Basin." It is unclear if they consider that "Family" is relatively less vulnerable than "Entire Basin" because they can take care of the family better than the entire basin.

Figure 18 shows an overall comparison of the ESPP scores. The figure gives the following rather striking observations about the three lakes. The Lake Baringo respondents seem to be feeling less threatened about the states of the state stem Services than Nakuru and Nyanza respondents. The Lake Baringo respondents seem more concerned about the degradation of their Cultural Service aspects than the Nakuru or the Nyanza respondents. And the Lake Nyanza and Nakuru respondents seem to be more frustrated about the status of their Health, Economy, Responsibility-sharing, and Governance Failures.

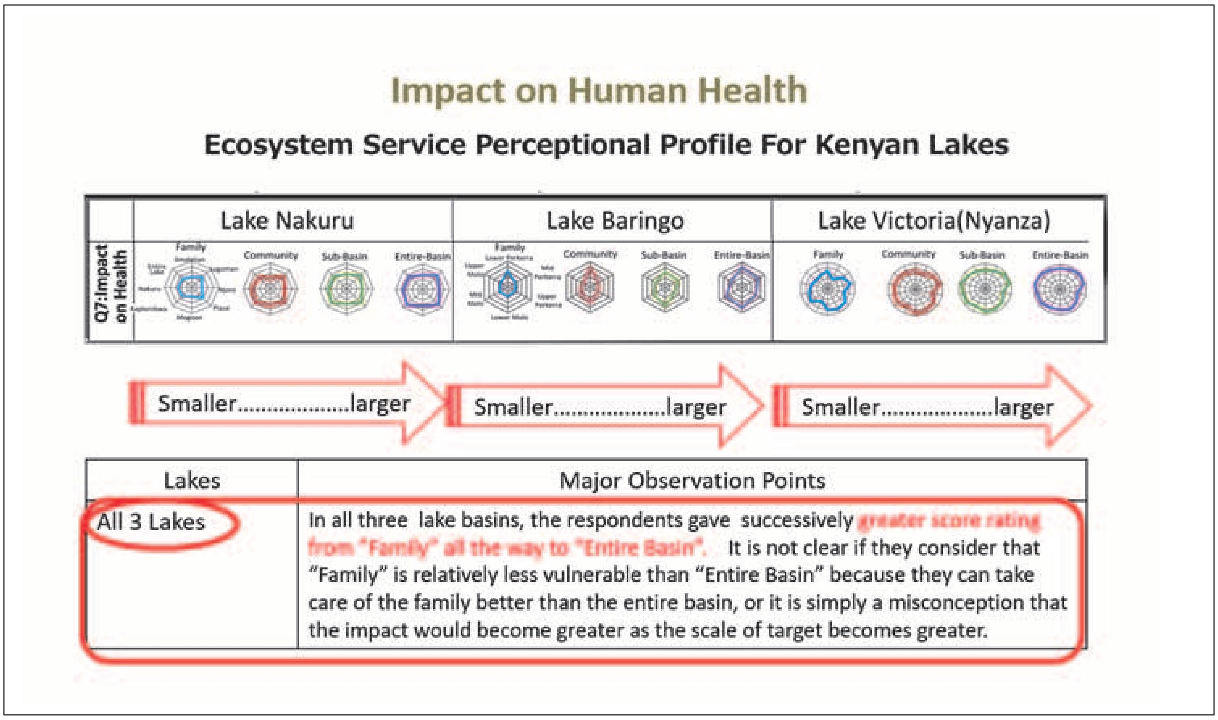


Figure 17. Similarly Increasing Trend of Q8 "Impact on Human Health" from "Family" to "Entire Basin" for All 3 Lakes

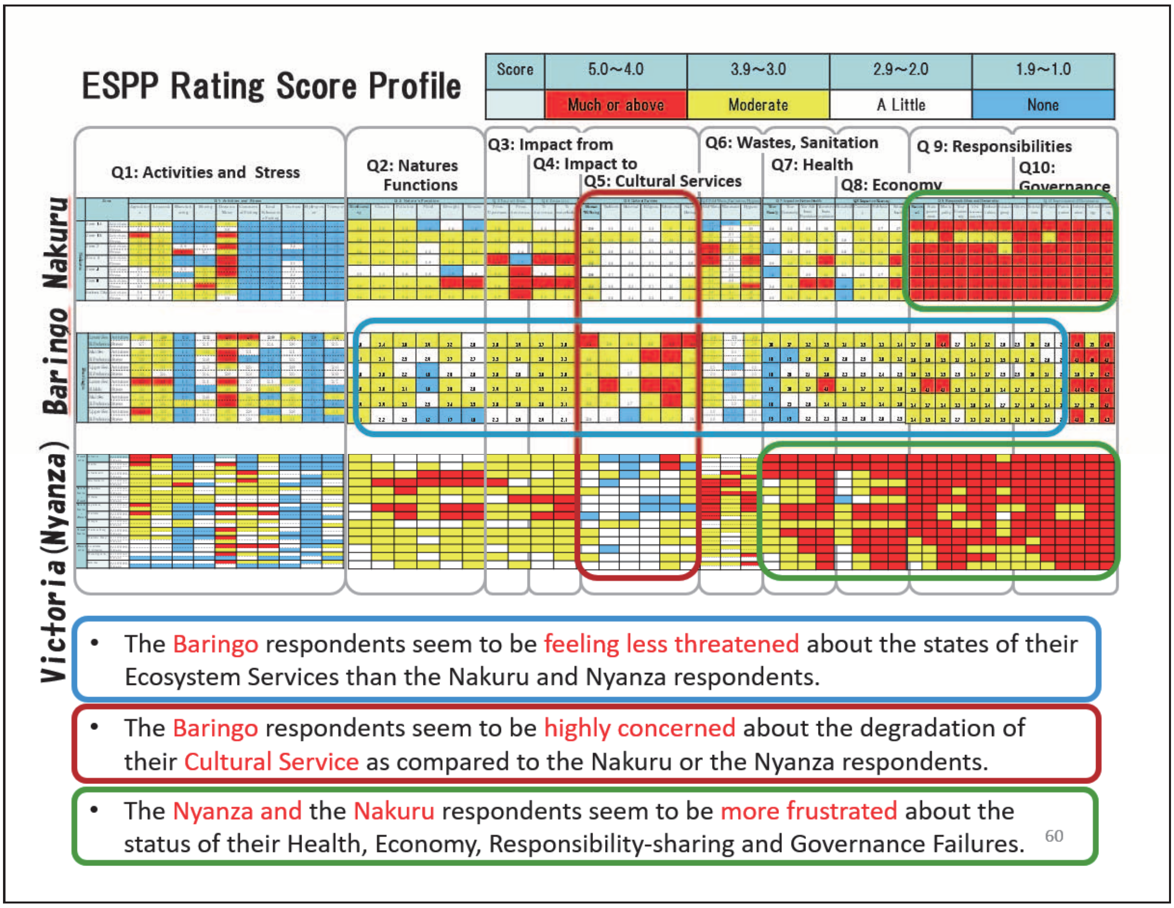


Figure 18. ESSVA (ESPP) Survey Output for All Question Items for All Three Lakes

7. Conclusion

The purpose of this paper was to outline a method called ESSVA that integrates the assessed Ecosystem Service values into the planning and management processes of river-lake-coastal basin systems through the Integrated Lake Basin Management (ILBM) process. The paper outlined the conceptual framework, methodological features, and the implementation protocol. Specifically, the article discussed the development and use of the ESSVA concept for ILBM, illustrated a general framework for ESSVA applied studies, and presented a case application of the methodology to Lake Nakuru, Kenya, with its survey questionnaire and implementation output summaries. There could be several ways to guide the planning and management processes in pursuit of balancing PS and ES of the overall basin Ecosystem Service to be accepted by the basin stakeholders. Since such balancing can be realized only through gradual, incremental, and long-term pursuit for participatory improvement of basin governance, the methodology illustrated in this paper of combining ESSVA and ILBM seems to be quite promising as it is further refined through a broader range of application studies.

The general observations on the ESSVA (ESPP) study on three Kenyan lakes includes the following points.

1) The ecosystem service perception profiles in 3 lakes are unique. It shows a need for efforts commensurate with the respective.
2) The similarities and differences of ESPP can be shared by the individuals and group entities.
3) The similarities would possibly lead to the development of the efficient implementation of standard plans and programs for pursuits toward sustainable ESs.
4) The differences among entities within a given lake basin would inspire those responsible for implementing the basin governance improvement process to be able to focus their attention on the issues and the reasons that lead to such differences.
5) It is necessary to evolve ESSVA to open the progress even somewhat by Ecosystem Service Fact Profile (ESFP) survey firmly.

The overall benefits of ILBM-ESSVA include the following points.

a) It provides an opportunity for the basin population to evaluate their lake basin on current and future status and values, helping them shape a shared vision and common understanding of the issues and challenges facing the lake basin.
b) It provides a way to fill perception gaps between different stakeholders with different views and interests and gaps between people living in various locations in the basin (Upstream, Downstream of the lake, and around the lake).
c) It provides a methodology for the government to listen to the community's voice, enabling them to develop policies and programs to be widely supported and easily implemented.
d) It helps develop a sense of "ownership" in the basin population, facilitating community participation in the lake basin management process.
e) It enables different basins to discuss their problems based on the same general framework that would help enhance the opportunity for mutual collaboration

References

- Berghöfer, A. A.Wittich, H. Wittmer, J. Rode, L. Emerton, M. Kosmus, and H. van Zyl. 2015. Analysis of 19 Ecosystem Service Assessments for Different Purposes - Insights from Practical Experience. ValuES Project Report.

Helmholtz Zentrum für Umweltforschung (UFZ) GmbH, Leipzig, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn. Germany. 27pp. Accessed at: http://aboutvalues.net/case_studies/

- Berbe´s-Bla´zquez, M. 2012. A Participatory Assessment of Ecosystem Services and Human Wellbeing in Rural Costa Rica Using Photo-Voice. Environmental Management. 2012. 49:862–875, DOI 10.1007/s00267-012-9822-9. Accessed at: at: https://www.researchgate.net/publication/221688863
- Brauman, K. A. S. van der Meulen, and J. B. Brauman. 2014. Ecosystem Services and River Basin. Risk-Informed Management of European River Basins, the Handbook of Environmental Chemistry 29, DOI 10.1007/978-3-642, Springer-Verlag Berlin Heidelberg. Accessed at: file:///C:/Users/ILEC/Downloads/Brauman_ESRiverBasin_Riskbase2014.pdf
- Brouwer R, Brander L, Kuik O, Papyrakis E, Bateman, I. 2013. A synthesis of approaches to assess and value ecosystem services in the EU in the context of TEEB. Final Report. 15 May 2013. VU University Amsterdam, Institute for Environmental Studies. Accessed at:
at: http: //ec.europa.eu/environment/nature/biodiversity/economics/pdf/ EU%20Valuation.pdf
- Convention on Biological Diversity. 2020. Statement by Elizabeth Maruma Mrema, Executive Secretary of the CBD, at the opening of the Virtual Expert Forum on SEEA Experimental Ecosystem Accounting 2020, 24-25 August 2020. Accessed at: https://www.cbd.int/doc/speech/2020/sp-2020-08-24-ecosystem-en.pdf
- Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., and Grasso, M. 2017. Twenty Years of Ecosystem Services: How Far Have We Come and How Far Do We Still Need to Go? Ecosystem Services, 28, 1-16. Accessed at: https://www.sciencedirect.com/science/article/abs/pii/S2212041617304060
- Duraiappah, A. K.; K. Nakamura; K. Takeuchi. 2012. Satoyama--satoumi Ecosystems and Human Well-being: Socio-ecological Production Landscapes of Japan, United Nations University Press.
- Ecosystem Service Assessment. 2022. Ecosystem Services Inventory. The Alberta Biodiversity Monitoring Institute, Accessed at: https://ecosystemservices.abmi.ca/ecosystem-services-inventory/
- Ervin, D., S. Vickerman, S. Ngawhika, F. Beaudoin, S. Hamlin, E. Dietrich, P. Manson, and J. Schoenen. Vickerman, E. D., S. S. Ngawhika, F. Beaudoin, S. Hamlin, E. Dietrich, P. Manson, and J. Schoenen. 2014. Principles to Guide Assessments of Ecosystem Service Values, first revised edition. Portland, Oregon: Cascadia Ecosystem Services Partnership, Institute for Sustainable Solutions, Portland State University.
- European Union. 2016. Mapping and Assessment of Ecosystems and their Services. Urban ecosystems. 4th Report Technical Report. Accessed at: https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/102.pdf
- European Union. 2018. Mapping and Assessment of Ecosystems and their Services: An EU Ecosystem Assessment. An analytical Framework for Mapping and Assessment of Ecosystem Condition in EU Discussion paper – Final January 2018. Accessed at: https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/5th%20MAES%20report.pdf
- European Union. 2022. Mapping and Assessment of Ecosystems and their Services – MAES. Accessed at: https://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/index_en.htm
- Harrison, P.; Dunford, R.; Barton, D.N.; Kelemen, E.; Martín-López, B.; Norton, L.; Termansen, M.; Saarikoski, H.; Hendriks, K.; Gómez-Baggethun, E.; Czúcz, B.; García-Llorente, M.; Howard, D.; Jacobs, S.; Karlsen, M.; Kopperoinen, L.; Madsen, A.; Rusch, G.; van Eupen, M.; Verweij, P.; Smith, R.; Tuomasjukka, D.; Zulian, G. 2018. Selecting methods for ecosystem service assessment: a decision tree approach. NERC Open Research Archive, Center for Ecology and Hydrology. UK. Accessed at: https://nora.nerc.ac.uk/id/eprint/518213/1/N518213PP.pdf
- ILEC and UNEP. 2016. Transboundary Lakes and Reservoirs: Status and Trends. United Nations

Environment Programme (UNEP), Nairobi. Accessed at:
http://geftwap.org/publications/TWAPVOLUME2TRANSBOUNDARYLAKESANDRESERVOIRS.pdf

- Kumar, R., D. Mohil, A. Pattnaik, and Sikka, R. 2018 Perceptions, Attitudes and Preferences for Wetland Ecosystem Services: a Case Study of Tampara, Odisha. Kumar, R., Mohil, D., Pattnaik, A. and Sikka, R. Wetlands International South Asia, New Delhi. Proceedings of the 17th World Lake Conference, Ibaraki, Japan. Pages 847-849. Accessed at https://www.pref.ibaraki.jp/seikatsukankyo/kantai/kosyou/documents/wlc17procidings-13.pdf
- Maes J., C. Liquete, A. Teller, M. Erhard, M. L. Paracchini, J. I. Barredo, B. Grizzetti, A Cardoso, F. Somma, J., E. Petersen, A. Meiner, E. R. Gelabert, N. Zal, P. Kristensenc, A. Bastrup-Birk, K. Biala, C. Piroddi, B. Egoha C. Lavalle, B. Egoh, P. Degeorges, C. Fiorina, F. Santos-Martíne, V. Naruševičius, J. VerbovengHenrique, M. Pereira, J. Bengtsson, K. Gocheva, C. Marta-Pedroso, T. Snäll, C. Estregui, J. San-Miguel-Ayanz, M. Pérez-Soba, A. Grêt-Regamey, A. I. Lillebøo, D. Abdul, M. Sophie, C. J. Moen, B. Czúcz, E. G. Drakou, G. Zulian, C. Lavalle. 2020. An indicator framework for assessing ecosystem services in support of the EU Biodiversity Strategy to 2020. Ecosystem Services, 17, February 2016, Pages 14-23. Accessed at: https://www.sciencedirect.com/science/article/pii/S2212041615300504
- Maes, J., Teller, A., Erhard, M., Condé, S., Vallecillo, S., Barredo, J.I., Paracchini, M.L., Abdul Malak, D., Trombetti, M., Vigiak, O., Zulian, G., Addamo, A.M., Grizzetti, B., Somma, F., Hagyo, A., Vogt, P., Polce, C., Jones, A., Marin, A.I., Ivits, E., Mauri, A., Rega, C., Czúcz, B., Ceccherini, G., Pisoni, E., Ceglar, A., De Palma, P., Cerrani, I., Meroni, M., Caudullo, G., Lugato, E., Vogt, J.V., Spinoni, J., Cammalleri, C., Bastrup-Birk, A., San Miguel, J., San Román, S., Kristensen, P., Christiansen, T., Zal, N., de Roo, A., Cardoso, A.C., Pistocchi, A., Del Barrio Alvarellos, I., Tsiamis, K., Gervasini, E., Deriu, I., La Notte, A., Abad Viñas, R., Vizzarri, M., Camia, A., Robert, N., Kakoulaki, G., Garcia Bendito, E., Panagos, P., Ballabio, C., Scarpa, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O., Santos-Martín, F. 2020. Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment, EUR 30161 EN, Publications Office of the European Union, Ispra, 2020, ISBN 978-92-76-17833- 0, doi:10.2760/757183, JRC120383. Accessed at: file:///C:/Users/ILEC/Desktop/eu_ecosystem_assessement_final.pdf
- Malinga, R., L. J. Gordon, R. Lindborg, and G. Jewitt. 2013. Using Participatory Scenario Planning to Identify Ecosystem Services in Changing Landscapes. Ecology and Society 18(4): 10. http://dx.doi.org/10.5751/ES-05494-180410
- McInnes, R.J., M. Everard. 2017. Rapid Assessment of Wetland Ecosystem Services (RAWES): An example from Colombo, Sri Lanka. Ecosystem Services. Ecosystem Services 25 (2017), 89–105. https://www.sciencedirect.com/science/article/abs/pii/S221204161630417X?via%3Dihub
- Nakamura M. 2011. Outline of the Lake Basin Governance Research Promotion Activities. Science for Environment and Sustainable Society. Vo. 8, No.1. Research Center for Sustainability and Environment, Shiga University, Otsu, Japan.
- Nakamura M. and S. Pokharel. 2011. Integrated Lake Basin Management (ILBM) for the Sustainable Conservation of Himalayan Lakes of Nepal. Science for Environment and Sustainable Society. Vo. 8, No.1, Research Center for Sustainability and Environment, Shiga University, Otsu, Japan.
- Nakamura, M. and W. Rast. 2014. Development of ILBM Platform Process: Evolving Guidelines Through Participatory Improvement, 2nd edition. Shiga University Center for Sustainability and Environment (RCSE-SU) and International Lake Environment Committee (ILEC). Accessed at: https://www.ilec.or.jp/wp-content/uploads/pub/DevOfILBMPP_en_2nd.pdf.
- Orenstein, D.E.; E. Groner; D.; E. Argaman; B. Boeken; Y. Preisler; M. Shachak; E. D. Ungar; and E. Zaady. 2012. An Ecosystem Services Inventory: Lessons from the Northern Negev Long-Term Social Ecological Research

(LTSER) Platform. Geography Research Forum 32:96-118. Accessed at:
https://www.researchgate.net/publication/235718872_An_Ecosystem_Services_Inventory_Lessons_from_the_Northern_Negev_Long-Term_Social_Ecological_Research_LTSER_Platform

- Prip, C. 2018. The Convention on Biological Diversity as A Legal Framework for Safeguarding Ecosystem Services. Ecosystem Services 29: 199-204.
  Accessed at https://nbsapforum.net/sites/default/files/cp%20Cbd%20ecosystem%20service.pdf
- Saito, O., C. Kamiyama, and S. Hashimoto. 2018. Non-Market Food Provision and Sharing in Japan's Socio-Ecological Production Landscapes. Sustainability 10, 213
- Scott, A., Carter, C., Hölzinger, O., Everard, M., Rafaelli, D., Hardman, M., Baker, J., Glass, J., Leach, K., Wakeford, R., Reed, M., Grace, M., Sunderland, T., Waters, R., Corstanje, R., Glass, R., Grayson, N., Harris, J., and Taft, A. 2014. UK National Ecosystem Assessment Follow-on. Work Package Report 10: Tools – Applications, Benefits and Linkages for Ecosystem Science (TABLES). UNEP-WCMC, LWEC, UK.
  Accessed at: http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=DYBPt9wHeYA%3D&tabid=82
- van der Meulen, S. and J. Brils. 2013. Participatory ecosystem services assessment; lessons learned with special focus on scale issues. Deltares. Accessed at:
  https://www.deltares.nl/app/uploads/2014/12/Participatory-ecosystem-services-assessment-lessons-learned-with-special-focus-on-scale-issues.pdf

NOTES

i The MEA concept has been brought into widespread use since its inauguration in 2005 by the United Nations initiative. Among other things, the UN Convention on Biological Diversity (CBD) in 2010 adopted the following Vision for its Strategic Plan: 'By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people'; and the following Mission: 'to take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication,' This makes the CBD a global framework for national-level action to protect not only biodiversity per se but also Ecosystem Service. (Prip, 2018).

In addition, a recent report by the CBD Executive Secretary (Convention on Biological Diversity. 2020) states, "As we are now five years into the Sustainable Development Goals, there is growing recognition that we cannot separate economic development, social development and the environment into siloed dimensions of development, but that protecting biodiversity and sustainably using natural resources is at the heart of achieving the Sustainable Development Goals." and then states, "There is also a growing recognition among leaders that the Sustainable Development Goals will fail without 'Urgent Action on Biodiversity for Sustainable Development'…". It also states, "Currently, Parties to the Convention, in collaboration with stakeholders, have embarked on developing a robust and ambitious post-2020 global biodiversity framework to build a resilient and sustainable future for all people. The global biodiversity framework will set a path to achieve an ambitious 2050 Vision for living in harmony with nature and will include a series of aspirational goals related to: (a) Improving the connectivity and integrity of natural ecosystems supporting healthy and resilient populations of all species while reducing the number of species that are threatened and maintaining genetic diversity; (b) Valuing, maintaining and enhancing nature's contributions to people through conservation and sustainable use, supporting the global development agenda for the benefit of all people; (c) Ensuring that the benefits, from the utilization of genetic resources are shared fairly and equitably; (d) Promoting means of implementation for achieving the global biodiversity framework. The post-2020 global biodiversity framework will also establish action-oriented targets which aim to provide a transformational pathway for realizing these goals, as well as means of implementation.

ii Typical "Qualitative Analysis" cases are discussed, for example, in Berlin-Bla' zquez (2012).

The key points of her view are as follows.

- Much of the work on ecosystem services to date has focused on the assessment and classification of environmental functions. The need for the inclusion of community perspectives in ecosystem assessments has been widely recognized in order to better understand the distribution of impacts and benefits resulting from natural resource use.
- Communities can offer a direct route to understanding the complex relationships between ecosystems and human well-being and how environmental management affects their livelihoods.
- Photovoice has been made popular as a tool for participatory needs assessment but it has had limited use in ecosystem assessments to date. The purpose of this paper is twofold: (1) to present the results of a community-level assessment of environmental services in a watershed-dominated pineapple monoculture in Costa Rica; and (2) to evaluate the strengths and the limitations of photovoice as a tool for mapping the relationship between ecosystems and people.

Malinga et al. (2013) on the other hand propose the use of scenario development, a tool for dealing with uncertainties and complexities of the future gives important insights into the selection of ecosystem services in changing landscapes. Using an agricultural landscape in South Africa they compared different sets of services selected for an assessment by four different groups: stakeholders making the scenarios, experts who have read the scenarios, experts who had not read the scenarios, and services derived from literature. They found significant differences among the services selected by different groups, especially between the literature services and the other groups. Cultural services were least common in literature and that list was also most dissimilar in terms of identity, ranking, and numbers of services compared to the other three groups.

iii Analysis of variance (ANOVA)

ANOVA is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among means. ANOVA was developed by the statistician Ronald Fisher. ANOVA is based on the law of total variance, where the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether two or more population means are equal, and therefore generalizes the t-test beyond two means. In other words, the ANOVA is used to test the difference between two or more means. (Ref. Analysis of variance, from Wikipedia, https://en.wikipedia.org/wiki/Analysis_of_variance)