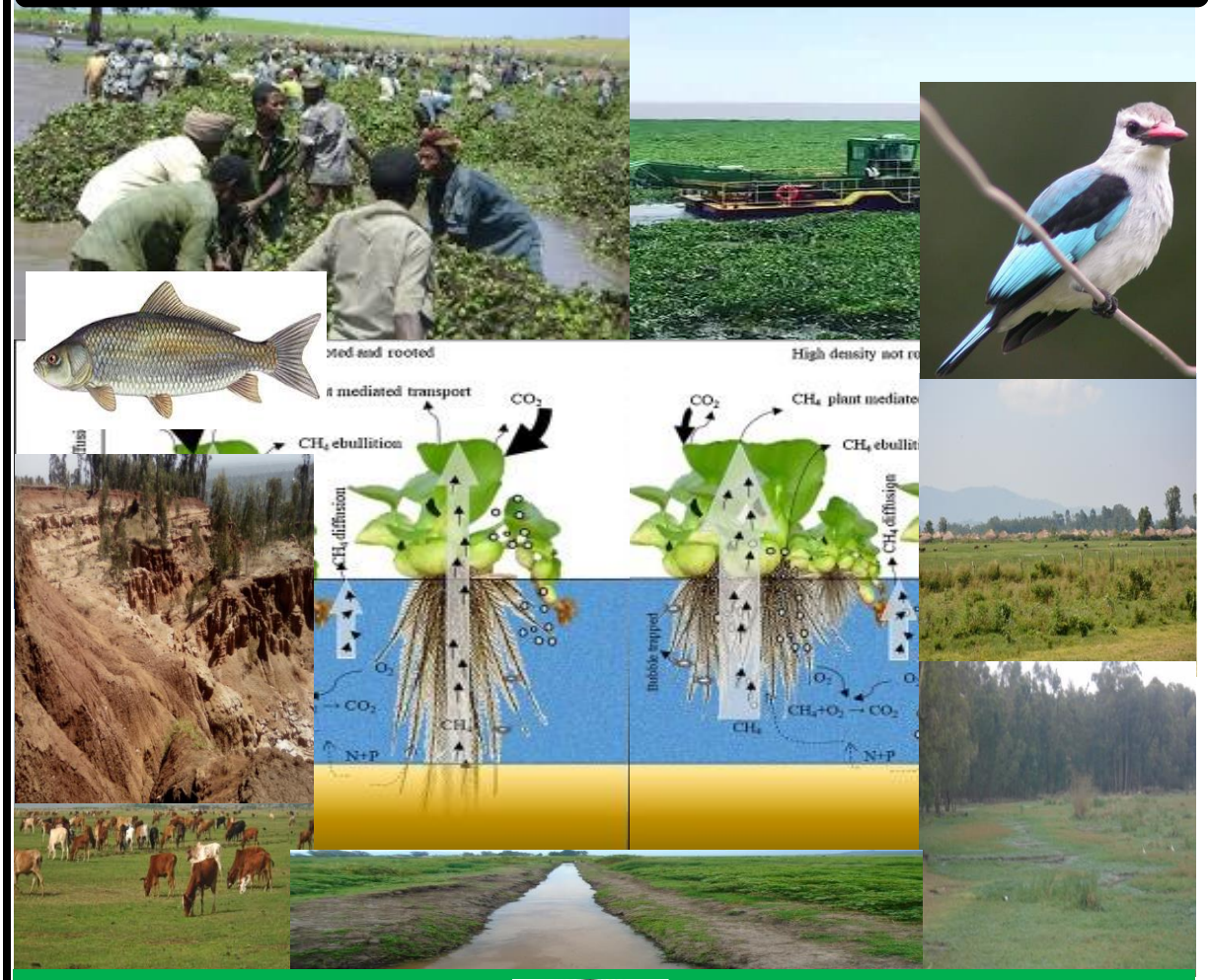
CENTER FOR ETHIOPIAN RIFT VALLEY STUDIES (CERVaS)

CERVaS Publications I Number 2, 2021

"Joining Hands to Reverse the Alarming Situations"

PROCEEDINGS OF THE WORKSHOP ON WATER HYACINTH AND EMERGING ISSUES



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1 OVERALL SUMMARY OF THE WORKSHOP

1.1 BACKGROUND

The Ethiopian Rift Valley Lakes (ERVL) include cluster of lakes stretched from Lake Turkana in the South to Afar crypto-depression lakes, including the lava lake "ERTALE". The lakes are stocked with highly diversified planktons (floaters), nekton (swimmers) and benthic (lake bottom dwellers) micro and macro organisms. The lakeshores are feeding and breeding sites for reptiles such as the Nile crocodile, mammals like hippopotamus and the tree dwelling colobines, and flocks of attractive residential and migratory birds. Coupled with high cultural diversity and origin of human kind the ERVL are unique tourist attractive sites.

Because of close proximity, the ERVL are serving as icons of the flourishing cities/towns linked to them. Unfortunately, there is "wrong marriage "between the lakes and the cities/towns, where the later posing growing threat on the biodiversity and ecological integrity of the lakes. As the lakes are sandwiched between the rural and urban population, they are continuously squeezed from both sides and face threat from overzealous human activities. They receive high silt load from degraded watershed, agrochemical (pesticides, heavy metal and nutrients) from the nearby farmlands (mainly horticulture and floriculture), toxicants/ pollutants from industrial effluent. The lakes are considered as damping sites /septic tanks for the urban waste, which are loaded with both pollutants and microbial pathogens.

Beside the aforementioned problems, the ERVL are currently exposed to the notorious water hyacinth. In addition to Lake Koka, where this invasive species has remained restricted at the bank of Awash River for more than 50 years, it has recently invaded Lake Ziway and Lake Abaya. A very large portion of these lakes is invaded by water hyacinth within the last 3 to 4 years. Taking the advantage of little or lack of public or governmental effort to control it, the notorious species has marched to invade Lake Chamo from Lake Abaya via Kulfo River and crossing the degraded wetland located between the two lakes.

Cognizant to the socio – economic and ecological problems associated with the introduction and expansion of water hyacinth in the standing and running water bodies of the ERVR, Hawassa University took the initiative to form consortium of Sister Universities (SU) to combat this invasive species. As public universities, these SU would play leading role and join hands to reverse the alarming situation. It is with this in mind that CERVaS of the Hawassa University organized a consultative workshop to bring eight SU for discussion on water hyacinth and emerging issues.

CERVaS, as initiator of the consortium for water hyacinth, will be at the front line to coordinate the collaboration and document all relevant activities performed together with SU. It is, therefore, imperative to compile all papers presented during the workshop and publish it as a proceeding. This is in line with CERVaS's initial plan to produce at least one publication per year as CERVaS publication where the first volume was produced in 2019. The Center was unable to produce its second publication in 2020, mainly due to COVID – 19 lock down. Thus, this proceeding will be the second publication of the Center. The Center will have more publications in its effort to build database for scientific research undertaken related to key issues of the ERVR.

The proceeding compiles background of the workshop and the ERVL as well as keynote speeches and papers presented by researchers from HU and SU. Moreover, it includes key issues of the workshop shared in parallel sessions of group discussions, general discussion and concluding remarks.

1.2. OBJECTIVES OF THE PROCEEDINGS

The objective of the proceeding is to document papers presented and activities accomplished during the consultation workshop on water hyacinth. Documentation of papers and the activities will not only serve as reference, but also will stimulate concerned and interested individuals, groups or stakeholders to learn, enrich and take immediate actions regarding water hyacinth.

1.3. EXPECTED OUTPUTS

The following were the expected outputs of the workshop:

1. Assessing the extent and magnitude of invasion of the major ERVL by water hyacinth,
2. Understanding the efforts made by various stakeholders in managing the spread of water hyacinth,

3. Proposing intervention strategies of managing invaded aquatics as well as its further expansion to other un-invaded aquatic systems, and
4. Transforming the existing platform into a strong and functional consortium.

2 KEYNOTE ADRESSES

2.1 Opening Speech, Tafesse Mathewos (PhD), Vice President for Research and Technology Transfer

Dear Guests and participants of this consultative workshop

Good Morning!

Let me start with thanking you all for being here with us today. Let me express that we are very pleased to welcome you to our 1st Annual Consultative Workshop which focuses on water hyacinth. Water hyacinth has been introduced to Ethiopia in the 1950 around Aba Samuel Reservoir. Then it reached Lake Koka through run off via Awash River. It was so restricted around the bank of Awash River and irrigation farmlands in the vicinity of Lake Koka for the past several decades. However, due to overzealous human activities, it spread to other areas, particularly to boat landing shorelines, water pumping stations, and tributary rivers. Recently, it has invaded Lake Ziway and Lake Abaya. At present, there is a growing threat that other Rift Valley Lakes, such as Lake Hawassa will also be vulnerable to invasions by water hyacinth. There is a general consensus that immediate interventions or control measures in integrated manner should be in place before irreversible damage occurs on water bodies of the RVLR. We are still late for action, while the invasion or expansion of water hyacinth is going at tremendously high scale.

Cognizant of the above problem, Hawassa University, as a pioneer public university located at the Center of Ethiopian Rift Valley Region, should stand at the forefront to address the growing threat of Water hyacinth. Equally important is that sister universities located in the Ethiopian Rift Valley Regions should join hands and form consortium to protect and control both the running and standing water bodies from water hyacinth. Hawassa University, taking into consideration the seriousness of the problem and the need to develop collaboration among different stakeholders for integrated water hyacinth control, will give all possible support to the outcome of this consultative workshop.

From this consultative workshop, we expect the following three outcomes:

1. Drafting a suitable working paper for water hyacinth control and management in the Rift Valley Lakes of Ethiopia,
2. An updated status report of water hyacinth control activities done by each of the sister universities, and
3. Identifying stakeholders and preparing framework of collaboration to control water hyacinth in the Rift Valley Lakes with a networking among sister universities, BDA and Rift Valley Lakes Basin Office.

At last, I wish you fruitful and productive consultation towards integrated actions. Thank you very much for being here and I officially declare the workshop is open.

I thank you!

2.2 Welcoming Remarks, Getachew Sime (PhD), Director of Center for Ethiopian Rift Valley Studies (CERVaS)

Dear Dr. Tafesse Mathewos, VP for Research and Technology Transfer

Dear guests from SU

Dear guests from BDA and RVLBO

Dear all invited guests from Hawassa University

On behalf of CERVaS, I would like to express my great pleasure and honour to welcome you all to Hawassa University. It is also my pleasure to thank you all for coming to participate in the workshop.

First and foremost, allow me to provide some background on the Consultative Workshop entitled "Water hyacinth (*Eihhornia crassipes*) invasion and consequences on the Ethiopian Rift Valley Lakes and communities and its mitigation strategies".

This consultative workshop is aimed at sharing knowledge and experience among eight sister universities situated in the Ethiopian Rift-Valley Region. The region contains various standing and running water bodies that are supporting the livelihoods of large number of communities. Nevertheless, most of these water bodies and their resources are adversely affected by human activities. Overfishing, degradation of riparian and shoreline vegetation, pollution from non - point and point sources, siltation from bare lands and excessive extraction of water are among the deleterious human actions. Consequently, deterioration of water quality, decline in fish catch and invasion of alien species have been alarmingly increasing from time to time. In particular, the invasion of major rivers, lakes and wetlands by water hyacinth has become a major national and regional concern. They are areas where the adverse effect of water hyacinth on the ecological integrity and livelihoods of communities are vivid.

Water hyacinth is an aquatic exotic weed species that is currently invading the Ethiopian Rift Valley Lakes such as Lake Koka, Ziway and Abaya. The remaining lakes are also highly vulnerable to invasion by water hyacinth. Water hyacinth has the ability to evapo - transpire huge amount of water from aquatic systems and impede boat movement, and irrigation. The weed also greatly reduces fishing activities by obstructing access to fishing grounds, clogging and damaging

fishing net and increasing costs of fishing and fish. It affects the livelihoods of communities who directly or indirectly depend on the water and its resources. The weed also outcompetes other aquatic species and by doing so causes a huge aquatic biodiversity loss.

In connection with these prevailing problems, CERVaS has organized a one-day consultative workshop that has brought together delegates from eight SU located in the Ethiopian Rift Valley Region. They are Arsi University, Wolkitie University, Worabe University, Wachemo University, Wolaita University, Arba Minch University, Dilla University, and Bule Hora University. The workshop has also engaged guests from the BDA and RVLBO to share their experiences. Of course, there were guests from our University.

Dear participants,

The overall objective of the Workshop is to discuss the negative influences of water hyacinth on the agro-ecological, environmental and socioeconomic conditions in the ERVL and its surrounding and further strengthening the existing collaboration network among the SU and other key stakeholders for combating further invasion and negative consequences of invasive aquatic weeds.

Specifically the workshop is hoped to:

1. *Discuss the extent and magnitude of invasion of water hyacinth in the major ERVL ,*
2. *Assess the efforts made by various stakeholders to managing the spread of the weed,*
3. *Propose effective intervention strategies of managing invaded aquatics (lakes and rivers) as well as its further expansion to other un-invaded aquatic systems (going for water hyacinth free aquatic systems in ERVR), and*
4. *Strengthen the existing platform and transform it into a functional consortium of universities in the ERVR, BDA and RVLBDO.*

The expected outputs of the workshop are:

1. Assessing the extent and magnitude of invasion of the major ERVL by water hyacinth,
2. Understanding the efforts made by various stakeholders in managing the spread of water hyacinth,

3. Proposing intervention strategies of managing invaded aquatics as well as its further expansion to other un-invaded aquatic systems, and
4. Transforming the existing platform into a strong and functional consortium.

Before I conclude, I would like to take this opportunity to thank Hawassa University and the organizers (CERVaS and VP RTT) for their arrangements for holding the Consultative Workshop and for allowing me to deliver these few brief remarks at the official opening of this Workshop. I wish you all a fruitful deliberation not only in identifying information needed for the betterment of the Ethiopian Rift Valley basin lakes, wetlands and the residing communities but also to elaborate on the thematic program activities that all key stakeholders propose for sustainable management of our Region.

I warmly welcome you all gain!

Thank you very much!

3 KEY PAPERS (KP)

KP 01: CENTER FOR ETHIOPIAN RIFT VALLEY STUDIES (CERVaS): FROM INCEPTION TO PRESENT

Girma Tilahun (PhD), founding member of CERVaS, Hawassa University

BACKGROUND

The foundation of CERVaS goes back to 2013. Prof. Zinabu G/Mariam of the Biology department initiated the idea. The idea was then evaluated and approved at the Department, College of Natural and Computational Sciences and the University levels. International inception workshop was organized by the Office of the Vice President for Research and Technology Transfer in 2015. The Center was established with the financial support of the Phase IV Norad project. However, the implementation of the project was started in 2016/17, much later than it was anticipated. This had delayed the establishment of CERVaS leadership and materialization of office facilities. A core research team (CRT) led the Center until the approval of its organizational structure and assignment of a director in 2019. Members of the CRT were drawn from different departments/colleges/institute (College of Agriculture, College of Medicine and Health Sciences, College of Natural and Computational Sciences, College of Social Sciences and Humanities, College of Forestry and Natural Resources, College of Law and Governance and Institute of Technology) belonging to diversified field of specialization.

These dedicated members of CRT that deserve to be founders of CERVaS include:

1. Prof. Zinabu G/Mariam
2. Prof. Tesfaye Abebe
3. Dr. Girma Tilahun
4. Dr. Nigatu Wondrad
5. Dr. Mulugeta Dadi
6. Dr. Mengistu Dinato
7. Dr. Mihret Dananto
8. Dr. Dagne shibru
9. Dr. Hirut Bekele
10. Dr. Alemante Amera
11. Dr. Menfes Tadesse
12. Dr. Adane Sewhuneghn

Despite all challenges, CERVaS has accomplished different activities and has achieved important outputs. The CRT members have enabled CERVaS to have strong foundation and to develop and implement several technical and financial proposals and working documents, including the organizational structure of the Center and rehabilitation of the extremely gullied and degraded landscape at Boricha.

Furthermore, the assignment of a director and cluster coordinators for biophysical and socio - economic wings has enabled the Center to boost its performance towards achieving more outputs. These outputs, attained from CERVaS inception until the end of NORAD Phase IV project lifetime, i.e., end of 2020, are presented as follows:

1. **ESTABLISHING THE CENTER**

   This includes:

- Forming CRT, which had performed most of the key initial activities of CERVaS until the formal assignment of Director,
- Designing organizational structure for the Center, which was approved by SEC (Fig.1),

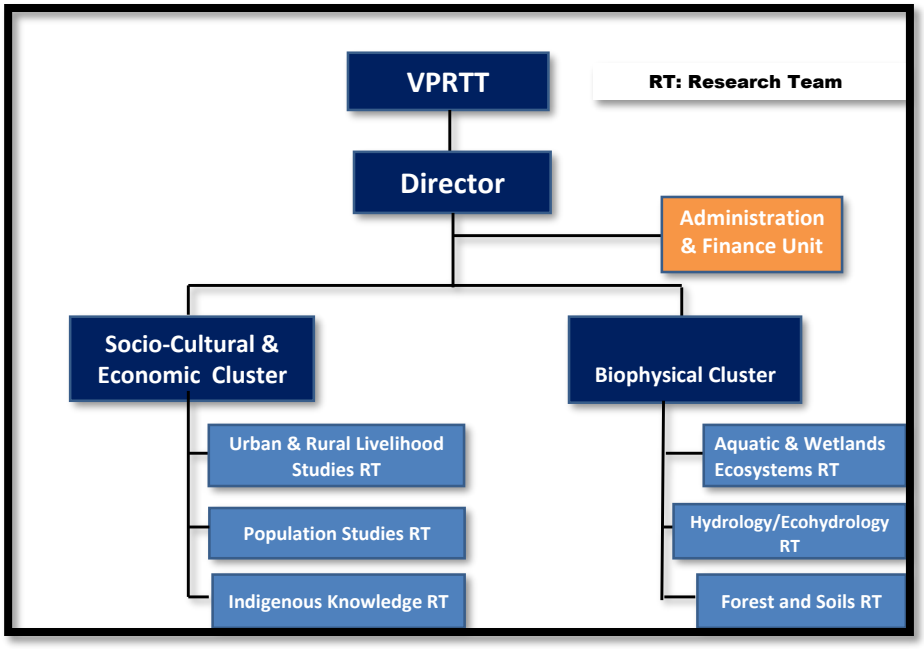
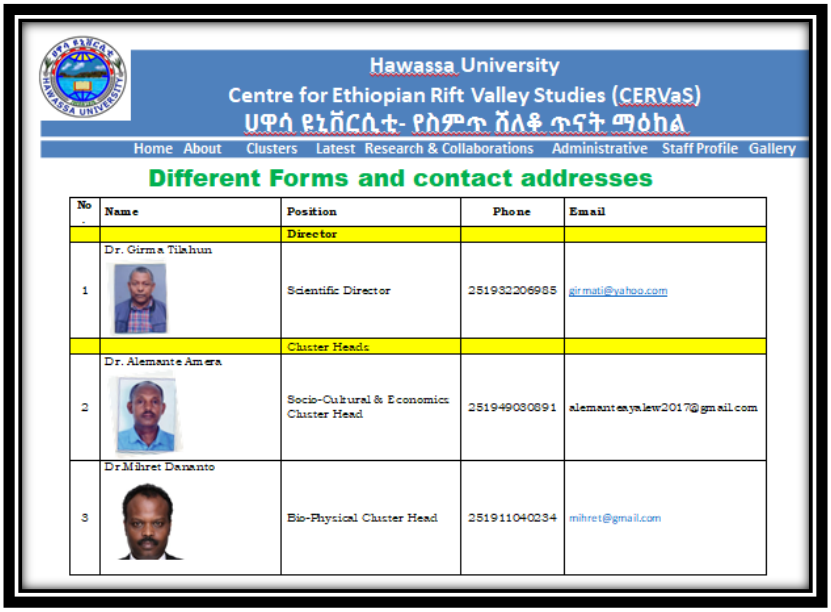


Fig. 1 CERVaS Organizational Structure

- Manning CERVaS as per the organizational structure (director, cluster coordinators, typist and office girl assigned)
- Instituting CERVaS with offices and office facilities ("All in one office")
- Popularizing CERVaS (HU Website & Brochure) (Table 1 & Fig. 2).

Table 1: CERVaS on HU website



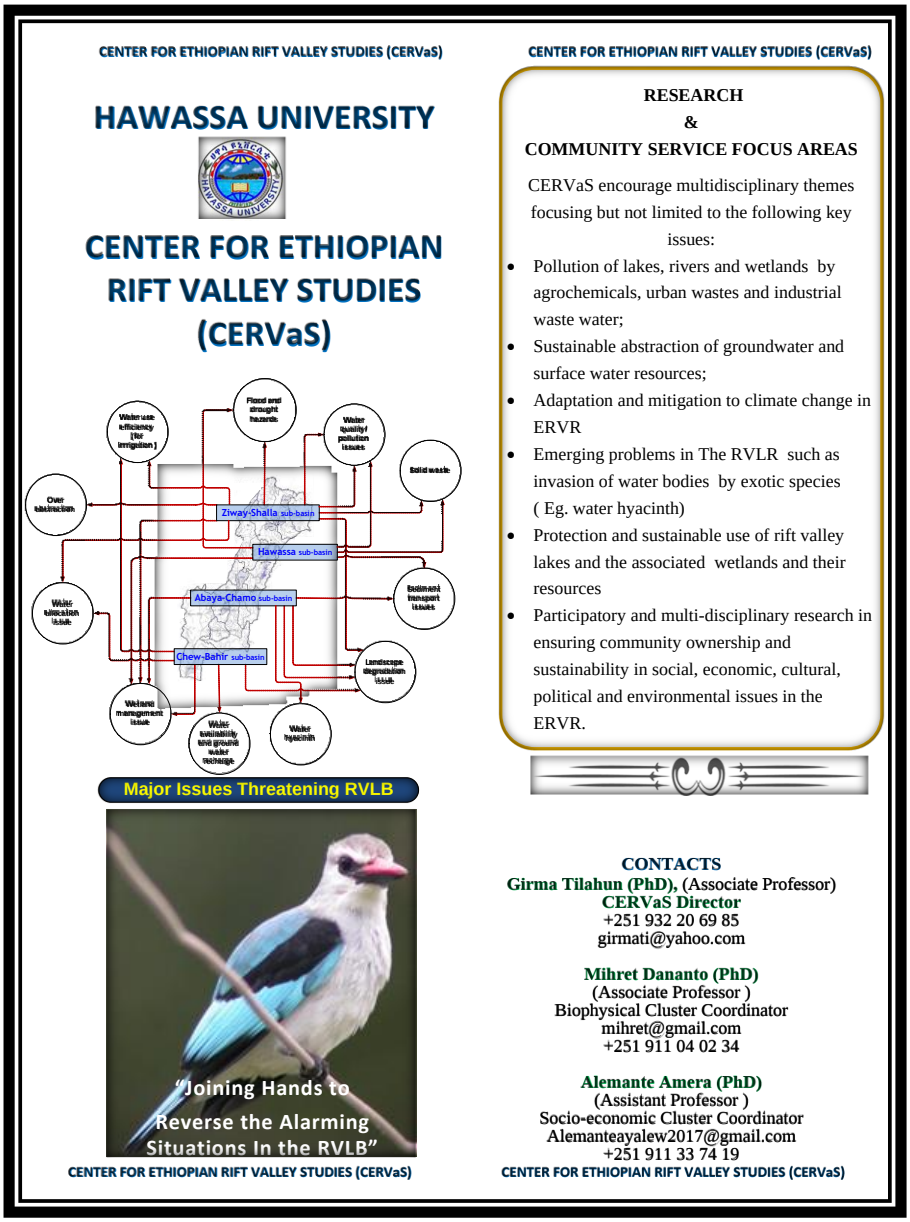


Fig. 2 Popularizing CERVaS through Brochure

2. INITIAL WORK: PILOT STUDY AND PILOT PROJECT ON LAKE HAWASSA WATERSHED

The CRT performed a series of key activities. The team has

- Conducted baseline survey (biophysical and socioeconomic) on Hawassa western sub - watershed and on the Chelelleka wetland (priority areas and technologies needed to control siltation and pollution were identified)

- Organized consensus building workshop to stop or reverse the alarming situation on Chelelleka wetland (the CRT organized the workshop that enabled high officials to participate and produce a working document to establish structure for ALLIANCE to protect the watershed)

- Produced the first CERVaS publication based on baseline survey (Fig. 3)

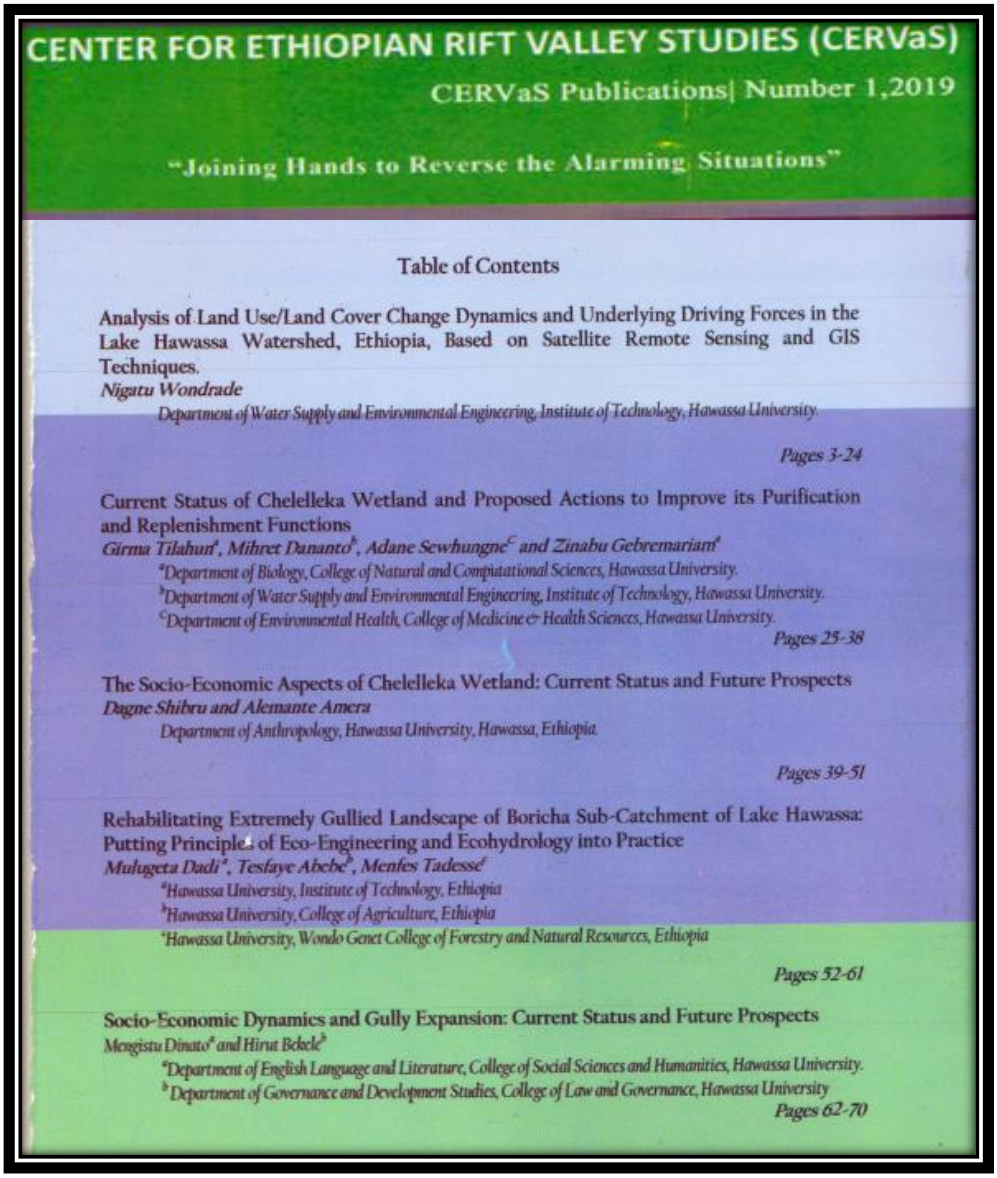


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Fig. 3 Contents of the first CERVaS proceeding

- Developed financial and technical proposal on

- ✓ Preparing synthesis/ comprehensive review on research done on Lake Hawassa with validation workshop: Five thematic/specialized areas (limnology & water qualities, hydrology & geology, wetland & watershed management, socio – cultural and economic aspects)
- ✓ Constructed wetland for the treatment of industrial wastewater (BGI brewery, Moha Soft drink, Hawassa textile factory) (Fig 4).

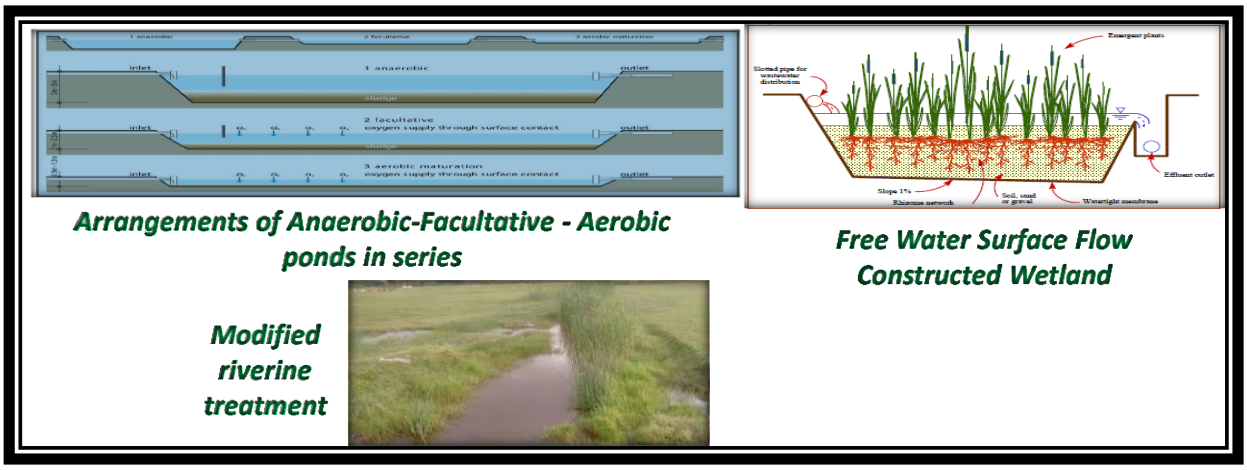

Fig. 4. Constructed wetland for industrial effluent treatment before it enters interconnected rivers directed to Lake Hawass via River Tikur Wuha

- ✓ Rehabilitating extremely gullied and degraded landscape at Boricha (Fig. 5)

Fig 5. Exemplary site at Boricha demonstrating principles of eco – engineering/phyto-engineering and eco-hydrology into practice

3. **LINKAGE & COLLABORATION WORK WITH SISTER UNIVERSITIES AND OTHER INSTITUTIONS –** CERVaS has developed:

- MoU between sister universities(SU) and RVLBO,
- A working document(MoA) as per MOU to work with RVLBO & SU
- Lake Hawassa sub – basin strategic plan (198 pages)
- A thematic plan for 2020 – 2035 on water quality and pollution control, wetlands and lake management in Ethiopian Rift Valley (116 pages)
- A water resource use allocation and management thematic plan for 2020 – 2035 for the Ethiopian Rift Valley Basins (95 Pages)

Remark: The documents were commented through virtual conference, enriched with national validation workshop, critically reviewed by known professors from HU, AAU & Haramaya University

- In collaboration with SIWI (Stockholm international Water Institute) CERVaS has organized two days training workshop on project preparation entitled “Implementing the source to sea project cycle using participatory approach & theory of change” (Fig. 6)

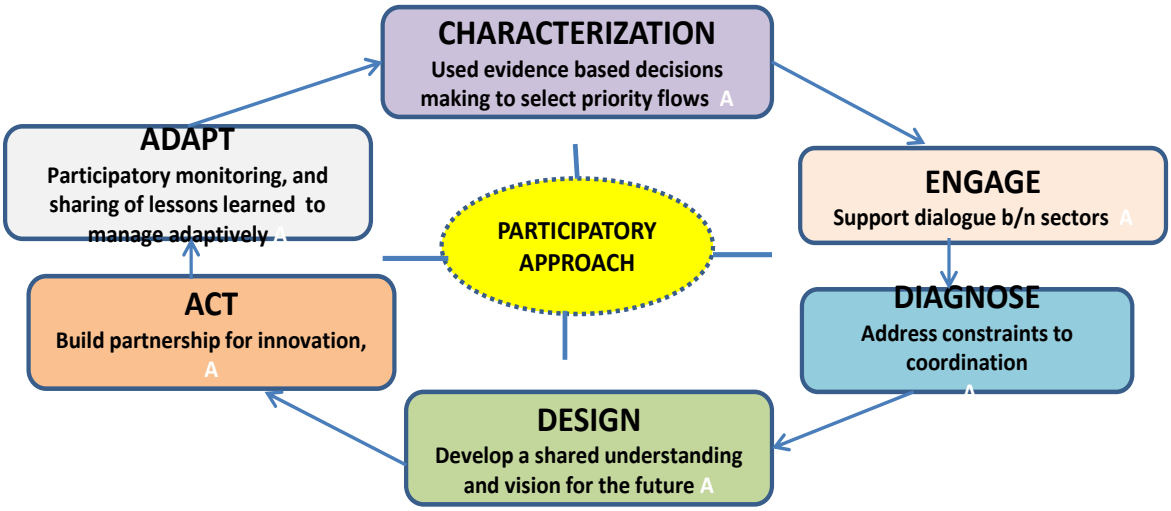

Fig 6: Participatory approach in project cycle

The workshop has enabled 20 key participants drawn from 6 SU located in the Rift Valley Region to share experience and develop a skill on preparation of project and Basin Plan (Fig. 7).

Fig 7: Training on participatory project and theory of change

- CERVaS served as evaluator in the technical team of the MOWIE "Water resources potential and demand study in the Ziway Shalla Sub – Basin – ZSSB", commissioned by BDA, RVBDO & IDH; Consultants: GIRDC. Three round peer review/feedback on inception report, draft and final report was completed and submitted to BDA.

- CERVaS carried out joint surveillance on water hyacinth on Lake Hawassa with AFLaH & EPA team in 2019

- CERVaS made joint effort to organize national workshop on water hyacinth with Ethiopian Fisheries and Aquatic Science Association (EFASA), AAU, ERVBDO, MOWIE, CEFCCO – until it was interrupted by COVID – 19 lock down.

4. DEVELOPING PROPOSAL FOR INTERNATIONAL GRANTS

CERVaS, in its effort to collaborate with international institutions and win grants, has developed the following proposals:

- First stage H2020 international proposal:

- Project title: Climate services for adaptive planning in African cities (CAPACities) - partner in the collaborative consortium led by Wageningen University - 4 cities from Africa: Hawassa, Dakar, Entebbe and Lusaka

- NORHED II Grant application:

- Project title: Capacity Building in Environmental Health Research and Education in East Africa (Partners: HU, AAU, Makerere University, Juba University, Bergen University & Norwegian University of Life Sciences)

- Project title: Hydrology, energy and climate change in African Rift Region (Partners: HU, Adama Science & Technology University, Juba University & Norwegian University of Life Sciences)

5. DEVELOPING PROPOSAL FOR LOCAL FUNDING

CERVaS in its effort to scale up the good experience gained from Boricha rehabilitation and restoration of landscape, the following two proposals are prepared:

- ✓ Lalima Sub-Watershed Rehabilitation & Landscape Restoration (LSWRLR) in Shalla; Siraro and Hawassa Zuria Woreda (Fig. 8)

- ✓ ehabilitating degraded landscape (RDL) in Shalla & Hawassa Zuria Woreda

Fig. 8. Degraded landscape of the Lalima sub watershed

6. THEMATIC RESEARCH AND GRADUATE STUDENTS SUPPORT

CERVaS has been established to promote research and support graduate programs. In this regard, the center prepared proposals on key issues related to the Rift Valley Region and created opportunities for graduate students to get fund for their thesis or dissertation. The centerCenter is currently working on "Thematic research entitled **"Biophysical and socio–economic settings of Lake Ziway watershed under the present development endeavors in the watershed".** This thematic research has three sub components, in which MSc and PhD students are made to do their research for graduation under sub – components I & II

- Sub – component I titled "LULC and climate variability on water resources of Lake Ziway watershed , Central Rift Valley Lakes Basin'', which has supported three MSc theses of IOT (water resource engineering and management department) with the following research titles:
    - Impact of Climate Change on Groundwater Available Recharge of Lake Ziway Watershed,
    - Impact of Land Use/Land Cover Change and Climate Variability on Meki Sub-Watershed of Lake Ziway Watershed, and
    - The Combined Effects of Land Use/Land Cover Change and Climatic Variability on the Hydrological Responses of Ketar Sub-Watershed of Lake Ziway Watershed.

Sub – component II, which is titled ‘’Agro-chemical Pollution & the Associated Risks with Shoreline Irrigation around Lake Ziway, Ethiopia’’ covered the expenses of one PhD thesis research from the Department of Biology with a dissertation titled “Assessment of Heavy Metals and Pesticide Residues and Associated Ecological and Human Health Risks from Soil, Fruits and Vegetables Grown on Irrigated Farmlands in the Vicinity of Lake Ziway”

As final remark, CERVaS is currently under the VPRTT and will remain so until it becomes an institution by its own. The Center is dedicated to advance excellence in research in the ERVR. It will work hard to coordinate thematic / multidisciplinary research. CERVaS will serve as a vital organ of the HU in disseminating knowledge about ERVR.

When CERVaS is established as an institute, it will be the only National Resource Center for the Rift Valley Region located at Hawassa University. It will probably be the only one of its kind in Africa. Therefore, it is foreseeable that the Center/ Institute will be engaged in working not only with Sister Universities located in the ERVR but also with international universities in East African countries of the Rift Valley and hence will grow to be a Center for East African Rift Valley Studies (CEARVaS).

KP 02: VULNERABILITY OF LAKE HAWASSA TO AQUATIC WEED INVASION WITH SPECIAL REFERENCE TO WATER HYACINTH

Zinabu Gebremariam, Professor Emeritus, Hawassa University

Abstract

Freshwater ecosystems are limited and sensitive resources that need proper care and management as they are vulnerable to impacts of environmental changes. Therefore, management and assessment of vulnerability of lakes to environmental changes are serious concerns of environmentalists, policy makers, and the public at large. Lake Hawassa, in spite of its importance for maintaining the life of different aquatic organisms, the ecosystem services it provides, etc., has been vulnerable to a number of environmental pressures. But little is known about how much the lake is vulnerable to impacts of emerging environmental threats like invasion of aquatic weeds. The objective of this talk was to portray some concerns about the vulnerability of Lake Hawassa to aquatic weed invasion with particular reference to water hyacinth. In the presentation, the most important causes of aquatic weed invasions that may also apply to Lake Hawassa, and the possible prevention/mitigation measures have been discussed. By putting together a number of facts that have been raised in the presentation, it has been concluded that there are enough reasons to believe that Lake Hawassa is prone to aquatic plant invasion including the dreadful weed – water hyacinth. The presentation wraps up by stressing on measures that need to be taken immediately to protect the lake from invasions of all types of aquatic weeds.

1. Introduction

Lakes are one of humanity's most important resources, especially in the tropics where they are often highly productive biological systems. They provide water for consumption, fishing, irrigation, recreation, biodiversity and a number of other ecosystem services (Zinabu, 2002). Since lakes are limited and sensitive resources, they need proper care and management as they are vulnerable to impacts of environmental changes. Environmental changes may bring about irreversible changes and lead to the loss of biodiversity and ecosystem services (Zinabu, 2013a).

Therefore, the management and assessment of the vulnerability of lakes are issues of serious concern to environmentalists, policy makers, and the public at large.

Lake Hawassa, like most of the Ethiopian Rift Valley Lakes, contains edible fish and is used for a number of domestic and industrial purposes. However, human factors in combination with the natural conditions of climate have made the lake vulnerable to a number of environmental factors (Zinabu, 2002, 2013b). But there is a lot of uncertainty about the extent to which Lake Hawassa is vulnerable to impacts of emerging environmental threats like invasion of aquatic weeds.

The objective of this talk is to give an account of the vulnerability of Lake Hawassa to aquatic weed invasion with particular reference to water hyacinth. In the first part of the talk, a general view of Lake Hawassa and the meanings of aquatic weeds as well as vulnerability are brought into context. Then an attempt was made to answer the questions why we should be concerned about vulnerability, what is required to avoid vulnerability, and what causes aquatic weed invasions. The presentation winds up with some concluding remarks and recommendations.

3. Lake Hawassa

Lake Hawassa can be portrayed as a lake with many guardians but the most unprotected; one of the most studied lakes but the least recognized; a lake with many friends but in the hands of its adversaries; a dying lake in a vibrant and growing city; and a water body in an incompatible bond with the city for the admiration of which the lake has been a reason.

From ecological point of view, Lake Hawassa can be described as a very fragile ecosystem, in a vulnerable watershed, with sensitive components located at a risky site. Hawassa city poses serious threats to the health of the lake and its watershed. Therefore, very careful management of Lake Hawassa ecosystem is required for the healthy co-existence of the city and the lake (Girma Tilahun, *et al*., 2014; RiPPLE, 2016; Zinabu, 2002).

In Lake Hawassa, the most common features of degradation are increased nutrient and sediment loading that eventually induce changes in the aquatic biota – particularly aquatic plants. Recent studies on Lake Hawassa (RiPPLE, 2016) have shown that deterioration of the water quality, from the discharge of domestic and industrial wastes, and extended macrophyte growth are among the nine environmental problems Lake Hawassa watershed is facing. This scenario begs the question

of the vulnerability of Lake Hawassa to aquatic weed infestation/invasion at large, and water hyacinth in particular. The ensuing presentation attempts to address this matter.

4. Vulnerability

It is appropriate to start by defining the term "Vulnerability". From the scientific point of view, the meaning of the term means inability of a system to withstand the effects of a hostile environment, or the extent to which changes could harm the ecosystem/community (https://en.wikipedia.org/wiki/Vulnerability). In our context, it can be defined as the reduced capacity of a water body to cope with, resist and recover from the impact of natural or man-made risk (Tamayo and Olden, 2014). The opposite of this state is the capacity or the ability to cope with a threat or to resist the impact of a hazard.

The reasons why one should be concerned with vulnerability are to counteract the continuous threats of vulnerability itself and to make scientific predictions that enable to give early warnings. Such warnings create vigilance to reduce the impacts of hazard and hence prevent ecosystem degradation and/or mitigate existing problems.

5. What are Aquatic Weeds?

The definitions of aquatic weeds in the literature are very broad. Therefore, I decided to make a concoction of a definition and came up with one that I believe fits my presentation: "unwanted vegetation that grows in abundance in aquatic systems and brings about some kind of undesirable effects on the water bodies in which it grows. "

There are a number of invasive aquatic weeds in the world and probably three are the most recognized in Africa: water hyacinth, water lettuce, and water fern - of which water hyacinth (Eichhornia crassipes [Mart.] Solm) is the most notorious. These three aquatic weeds are known to have been widely distributed in Africa including Ethiopia since the 1950s – 60s (Mitchell, *et al*., 1990).

Of the three aquatic weeds mentioned above, I am going to make some reference to only water hyacinth. Other presenters in this session are going to deal with it in depth; thus I will not talk

much about this weed except saying that it has become the most dreaded weed in Ethiopia at the moment. That is why I have been asked to speak on whether or not Lake Hawassa is vulnerable to the invasion of aquatic weeds at large and water hyacinth in particular.

6. Causes of Aquatic Weed Invasion

There are a number of causes to aquatic weed invasions. The most important ones and those that may apply to Lake Hawassa include human accessibility to the water body, high human population densities close to the water body, recreational use of the water body, presence and type of boat access, proximity to highways and urban land use, physicochemical conditions like the total surface area of the water body, productivity, plant nutrients - mostly phosphate and nitrate, etc. Other causes like trophic state of the lake, the percent of the lake considered a littoral habitat and the complexity of the shoreline are also among the most important ones to aquatic weed invasion (Tamayo and Olden, 2014).

7. Is Lake Hawassa Vulnerable to Aquatic Weed Invasion?

From our studies so far, we know that Lake Hawassa is vulnerable to degradation processes like eutrophication - due to nutrient loads from point and nonpoint sources (Zinabu, 2002, 2003, Grima Tilahun, *et al*., 2014; RiPPLE, 2016). The lake has been exposed to pollutants, mostly toxic substances like heavy metals, and pesticides (Zinabu and Pearce, 2003; Masresha *et al.* 2021; Samuel *et al.,* 2021 and references cited therein). The high concentrations of plant nutrients, like phosphate and nitrate in the lake, have encouraged the growth of aquatic plants, normally known as macrophytes, around the shore of the lake (Zinabu and Taylor, 1989). From the increasing aquatic plant growth (macrophyte invasions), it is possible to assume that the lake is on the verge of being invaded by at least one aquatic invasive plant - water hyacinth. Putting these and the following facts together, there are enough reasons to believe that Lake Hawassa is prone to aquatic plant invasion particularly water hyacinth.

Lake Hawassa is located very close to one of the fastest-growing cities with big highways crossing the city and where there is intensive urban land use for construction. The human population around the lake is high and it is accessible by the public for recreation (RiPPLE, 2016). There are a lot of boats being used for fishing and recreation. Some individuals bring their own inflatable boats for

recreation on the lake (personal observation). Moreover, industrial and domestic wastes find their ways into the lake in one way or another and the lake is being degraded (Grima Tilahun, *et al.*, 2014).

Lake Hawassa is a relatively small lake with an average depth of only about 11 to 13 meters which creates the possibility of suspending the rich nutrients from the bottom during mixing of the lake water. This makes it very productive with the high levels of nutrients contributing to the eutrophication of the lake ((Zinabu and Taylor, 1989). Moreover, as a result of sedimentation and associated nutrient load, the littoral zone of the lake is broadening and different species of macrophytes are growing (RiPPLE, 2016). It is, therefore, evident that all the factors presented in sections 6 and 7 are observable in Lake Hawassa, and hence there isa high possibility that the lake may be invaded/infested by aquatic weeds including the dreadful weed –water hyacinth.

Lake Hawassa is not hydrologically connected to any infested water body and it is not close to an infested lake - the nearest infested lake being Lake Ziway/Batu. It may appear that there is no risk of contamination from other water bodies. But, there are a lot of possibilities that water hyacinth from Lakes Ziway and Koka can end up in Lake Hawassa. Fruits and vegetables from Koka are sold in Hawassa (personal observation), and from anecdotal information, gill nets that are used at both Lakes Koka and Ziway are sometimes brought down to Lake Hawassa for fishing. It is very likely that tourists that use their own boats would visit at least Lakes Koka, Ziway, and Hawassa– not to mention Lakes Chamo and/or Abaya, lakes down to the south that are also heavily infested with water hyacinth. There is, obviously, some level of contact with the nearest infested lakes that could lead to possible contamination. It is, therefore, beyond question that Lake Hawassa is vulnerable to the infestation/invasion of any aquatic weed, particularly water hyacinth.

8. Prevention / mitigation of the problems

Like all environmental problems, any problem for that matter, prevention is one of the fundamental elements of the management strategies for aquatic invasive species. Understandably, there is no single method of preventing/mitigating vulnerability in water bodies. I only like to mention here those that can be applied to Lake Hawassa and its watershed. The issue that should come at the forefront in the prevention is identifying the lake ecosystems that are most vulnerable to future invasion. Then, identifying possible sources of nutrients and other contaminants (pollutants), mechanisms of reducing the nutrient load and contaminants from the sources, and taking the maximum precautions to avoid invasions by aquatic weeds should follow. Of course, climate change is among the problems, but there is no easy solution except increasing resilience by reducing the problems discussed so far (Mitchell *et al.,* 1990; Tamayo and Olden, 2014).

A detailed treatment of each prevention/mitigation method would have deserved some attention here, but I am leaving it out lest it goes beyond the scope of the talk. However, it will not be out of place to mention a few that should be applied to Lake Hawassa. Regular monitoring of the lake and its surroundings by collecting a database on physicochemical attributes of the lake and meteorological data should be mandatory. Setting up strategies and prevention/**m**itigation mechanisms like municipal plans for waste treatment, local wetland protection bylaws, and buffer zone protection policies, etc. are among the prevention/mitigation schemes that can be applied to Lake Hawassa and its watershed within the shortest possible time. The slogan for protecting natural resources that is chanted many times, and that applies here as well is: **Manage! Protect! Maintain! Restore!**

9. Conclusions and Recommendations

From the facts presented so far, there are enough reasons to believe that Lake Hawassa is prone to aquatic plant invasion particularly water hyacinth. It is, therefore, beyond question that Lake Hawassa is vulnerable to the infestation/invasion of any aquatic weed. I, therefore, conclude that Lake Hawassa is not only vulnerable to aquatic weed invasion, but pollution and aquatic growths of weeds have already become its noticeable environmental problems. Therefore, it is high-time to start the prevention/mitigation measures presented in section 8 above, with few additional

measures that have been advocated by us for nearly three decades: recognition of the problem, strengthening limnological research, consideration of environmental problems with developmental planning, and participatory approach to water management (Tudurancea *et al.*, 1999; Zinabu and Elias, 1989, Zinabu, 2002).

References

Girma Tilahun Yimer, Ermias Deribe, Solomon Sorsa, Zinabu Gebremariam (2014). Identifying Cost-Effective Mitigation Measures to Bring Down Concentrations of Pollutants that Enter Lake Hawassa: A Study Report. - Submitted to SOS-Sahel ETHIOPIA, 103 pp.

Masresha AE, Skipperud L, Rosseland BO, Zinabu GM, Meland S, Teien HC, Salbu B. (2021). Bioaccumulation of Trace Elements in Liver and Kidney of Fish Species from three Freshwater Lakes in the Ethiopian Rift Valley. **Environmental Monitoring and Assessment**, **Volume 193, Article number: 329**, https://doi.org/10.1007/s10661-021-09083-1.

Mitchell, D.S., Pieterse, A.H., & Murphy, K.J. (1990). Aquatic weed problems and management in Africa. Pp.341-354 In A.H. Pieterse & K.J. Murphy, eds. Aquatic Weed, the Ecology and Management of Nuisance. **Aquatic Vegetation**. Oxford, UK, Oxford University Press.

Samuel, B; Sorsa, S; DanieL, F; Riise, G; Zinabu, GM (2020). Heavy Metals in Fish Muscle from an Ethiopian Rift-Valley Lake (Hawassa) and a Neighboring Stream (Boicha): Assessment of Human Health Risks. **J. Appl. Sci. Environ. Manage. Vol. 24 (8) 1409-1418.** https://dx.doi.org/10.4314/jasem.v24i8.16.

Tudurancea, C., Zinabu, G.M. & Elias D. (1999). Limnology in Ethiopia. In: Wetzel, R.G and Gopal, B (editors). **Limnology in Developing Countries, Vol. 2, 63 – 118,** International Association for Limnology (SIL).

Tamayo, M. and J Olden, J.D. (2014). Forecasting the Vulnerability of Lakes to Aquatic Plant Invasions. **Invasive Plant Science and Management, 7:32–45**

RiPPLE (2016). Waste Management in Hawassa City and Preserving the Lake Ecosystem. Challenges and Interventions, Synthesis Report. By Zinabu Gebremariam, Mihret Dananto, in collaboration with Elias Dadebo. Hawassa, Ethiopia,185 pp.

Vulnerability, from Wikipedia, the free encyclopedia - (https://en.wikipedia.org/wiki/Vulnerability).

Zinabu, G.-M (2002). The Ethiopian Rift Valley Lakes: Major Threats and Strategies for Conservation, In: Tudorancea, C. and Taylor, W. D. (eds.) - **Ethiopian rift valley lakes**. Backhuys publishers, Leiden.

Zinabu G.-M (2003). Human Interactions and Water Quality in the Horn of Africa. In: T.L. Crisman, L.J. Chapman, C.A. Chapman, and L.S. Kaufman (editors). **Aquatic Conservation and Management in Africa.** University Press of Florida, Gainesville.

Zinabu Gebre-Mariam and Elias Dadebo (1989). Water resources and Fisheries management in the Ethiopian rift-valley lake. SINET: **An Ethiopian Journal of Science, 12 (2): 95-109.**

Zinabu Gebre-Mariam and Taylor, W.D. (1989). Seasonality and spatial variation in abundance biomass and activity of heterotrophic bacterioplankton in relation to some biotic and abiotic variables in an Ethiopian rift-valley lake (Awassa). **Freshwater Biology, 22: 355-368.**

Zinabu, G. -M and Pearce, N (2003). Concentrations of Heavy Metals and Related Trace Elements in some Ethiopia Rift-valley Lakes and their Inflows. **Hydrobiologia, 429: 171 – 178.**

KP 03: DESIGN, CONSTRUCTION AND TESTING OF ELECTROMAGNETIC RADIATION GENERATORS TO REGULATE THE GROWTH OF WATER HYACINTH (*Eichhornia crassipes*)

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1. Introduction

Electromagnetic generators have been developed in two configurations: linear generators (to harvest energy from vibrations) and rotating generators. They are based on Faraday's law of electromagnetic induction concerning the relative motion between a conductor and a magnet. By focusing on the first configuration (Fig. 1), the generator is composed of a conductive wire coil and a magnet. When the environmental vibration induces the relative motion between these parts, a potential difference (or electromotive force) is induced between the ends of the coil.

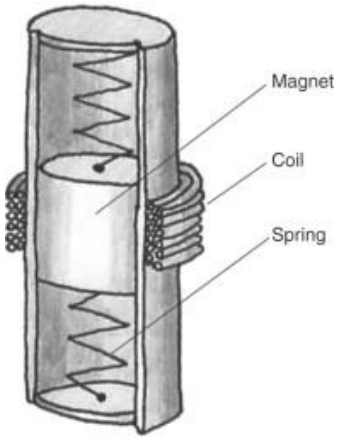

Fig. 1. An electromagnetic generator envisaged to generate UV radiation

Different design solutions have been proposed in the literature with fixed coil and oscillating magnet or vice-versa. The most important parameters to be considered in the dimensioning are the size and the material of the magnet which is responsible for the magnetic field intensity, and the

coil parameters (number of turns, length, coil area, wire diameter), which are responsible for the electric output. For generators in the centimetre scale, a small wire diameter (ranging from 0.1 to 0.5 mm) is usually needed to provide the necessary number of coils. On the other hand, the wire diameter is proportional to the coil resistance and directly influences the output current. Magnets with the best performance are rare earth permanent magnets, especially the neodymium iron boron (NdFeB) type, which produce the strongest available magnetic field.

2. Water Hyacinth Invasion and Its Status

Water hyacinth was officially reported in Ethiopia about 60 years ago in Koka Lake and the Awash River. However, the area infested at that time was small. The weed had spread into Blue Nile, Baro-Akobo and Rift Valley Basin Systems in the 1980s and 1990s.

In Ethiopia, water hyacinth has been affecting Lake Tana since 2011. The weed has invaded the lake substantially posing a challenge to its ecosystem services. The major factors which contribute to the growth of the weed are phosphorus, nitrogen, temperature, pH, salinity, and lake depth. Understanding and investigating the hotspot areas is vital to predict the areas for proper planning of interventions. The main objective of this study was to predict the hotspot areas of the water hyacinth over the surface of the lake using the geographical information system (GIS)-based multi-criteria evaluation (MCE) technique (Minychl et al., 2019).

The main parameters used in the multi-criteria analysis were total phosphorus (>0.08 mg L-1), total nitrogen (>1.1 mg L-1), temperature (<26.2 _C), pH (<8.6), salinity (<0.011%), and depth (<6 m) (Minychl et al., 2019).

Water hyacinth is a tropical plant that grows best in warm waters rich in macronutrients. The plant is, however, one of the most widely distributed aquatic weeds, having been translocated almost all over the tropical and sub-tropical world mainly by collectors of ornamental plants. There are basically three ways in which the weed may be dispersed from one location to another (Minakawa, Sonye, Dida, Futami, & Kaneko, 2008): (1) water-borne dispersal which demands connection between water bodies; (2) birds and animals that feed in sites of water-hyacinth infestation and transport seeds over considerable distances by their feet. Diving eater-birds could swallow the weed's seeds as they sift mud for food, and then pass them through the gut e.g the invasion of Lake

Victoria; (3) people who use it as an ornamental garden pond plant due to its exceedingly attractive purple flower. This is how it was introduced into the Congo River, Egypt and Uganda.

Water hyacinth is found across the tropical and subtropical regions. Originally from the Amazon Basin in tropical South America, its entry into Africa, Asia, India, Australia, Central America, North America (California and southern states) and New Zealand was largely facilitated by human activities (Dagno, Lahlali, Diourte, & Haissam, 2012).

3. Problems Related to Water Hyacinth Invasions

Water hyacinth has become a major pest in waterways around the world. It is considered the worst aquatic weed in the world. Its rampant growth can destroy native habitats, and high rates of transpiration through the weed's leaves during summer can cause up to four times the loss of water from normal water surface evaporation. The weed has inflicted enormous negative effects not only on the environment but also on the health status and well-being of many people whose livelihood depends on the infested waters, in particular, and the economy, in general (Dagno, Lahlali, Friel, Bajji, & Jijakli, 2007).

The most observed problems of aquatic weeds are:

a) Hindering water transport

Canals and freshwater rivers can become impassable as they clog up with densely intertwined carpets of the weed. It is also becoming a serious hazard to lake transport on Lake Victoria as large floating islands of water hyacinth form, while many of the inland waterways of south-east Asia have been all but abandoned (Never Mujere., 2016).

b) Clogging intakes of irrigation, hydropower and water supply systems

Many large hydropower schemes are suffering from the effects of water hyacinth. The Owen Falls hydropower scheme on Lake Victoria is a victim of the weed's rapid reproduction rates and the increasing amount of time and money to be invested in clearing the weed to prevent it entering the turbine and causing damage and power interruptions (Minakawa, Sonye, Dida, Futami, & Kaneko, 2008). Costs of cleaning intake screens at the Owen Falls hydroelectric power plant were calculated to be $1 million US dollars (USD) per year (Mailu, 2001).

c) Blocking canals and rivers, and causing flooding

Water hyacinth can grow so densely that a human being can walk on it. When it takes hold of rivers and canals, it can become so dense that it forms a herbivorous barrage and can cause damaging and dangerous flooding (Never Mujere., 2016).

d) Reducing biodiversity

Water hyacinth is a serious threat to biodiversity, hence a major driver of biodiversity loss worldwide (Vila et al., 2011). Water hyacinth is challenging the ecological stability of fresh water bodies by out-competing all other species growing in the vicinity, thus, posing a threat to aquatic biodiversity (Patel, 2012).

e) Depleting oxygen and reducing water quality

Large water hyacinth mats prevent the transfer of oxygen from the air to the water surface, or decrease oxygen production by other plants and algae (Villamagna & Murphy, 2010). When the plant dies and sinks to the bottom, the decomposing biomass depletes oxygen content in the water body (EEA, 2012). Dissolved oxygen levels can reach dangerously low concentrations for fish that are sensitive to such changes. Furthermore, low dissolved oxygen conditions catalyse the release of phosphorus from the sediment, which in turn accelerates eutrophication and can lead to a subsequent increase in water hyacinth or algal blooms (Bicudo et al., 2007).

f) Serving as breeding ground for pests and vectors

Floating mats of water hyacinth support organisms that are detrimental to human health. The ability of its mass of fibrous, free-floating roots and semi-submerged leaves and stems to decrease water currents increases breeding habitat for the malaria causing anopheles mosquito as evidenced in Lake Victoria (Minakawa, Sonye, Dida, Futami, & Kaneko, 2008). Snails serving as vector for the parasite of Schistosomiasis or bilharzia reside in the tangled weed mat (Borokini & Babalola, 2012). Water hyacinth has also been implicated in harboring the causative agent for cholera.

For example, from 1994 to 2008, Nyanza Province in Kenya, which borders Lake Victoria, accounted for a larger proportion of cholera cases than expected given its population size (38.7% of cholera cases versus 15.3% of national population). Yearly water hyacinth coverage on the Kenyan section of the lake was positively associated with the number of cholera cases reported in

the Province (Feikin, Tabu, & Gichuki, 2010). At the local level, increased incidences of crocodile attacks have been attributed to the heavy infestation of the weed, which provides cover to the reptiles and poisonous snakes (Patel, 2012; Ndimele, 2012).

g) Physical obstruction

Water hyacinth often blocks waterways hampering agriculture, fisheries, recreation and hydropower. It clogs waterways due to its rapid reproduction and propagation rate. The dense mats disrupt socioeconomic and subsistence activities. Moreover, it blocks waterways and clogs water pipes. Some of the activities that are disrupted include ship and boat navigation, access to water for recreation, fisheries, and tourism (Ndimele & Jimoh, 2011; Patel, 2012).

h) Increased evapotranspiration rate

Various studies have been carried out to ascertain the relationship between aquatic plants and the rate of evapotranspiration compared with evaporation from an open-surface water body. Hyacinth loses water rapidly through its broad leaves, which is about 3.5 times that from a free water surface (Gopal, 1987). This disrupts water flow, interferes with recreational activities and has great implications where water is already scarce. It is estimated that the flow of water in the Nile has been reduced by up to one tenth due to increased losses by evapotranspiration via water hyacinth in Lake Victoria (Ndimele & Jimoh, 2011). Lowering of the water table through massive evapotranspiration threatens aquatic life.

i) Effect on fishing

Water hyacinth affects fish reproduction, feeding and productivity. Access to fishing sites becomes difficult when weed infestation is present. Loss of fishing equipment often results when nets or lines become tangled in the root systems of the weed and the result of these problems is more often than not a reduction in catch and subsequent loss of livelihood. In areas where fishermen make a meagre living from their trade, this can present serious socio-economic problems. It was noted that areas in Lake Victoria where there is high water hyacinth infestation, water is still and warm and fish disappear. In such areas people complained that crocodiles and snakes have become more prevalent (World Agroforestry Center, 2006).

j) Effect on human health

Water hyacinth offers a micro-habitat for varieties of disease vectors such snails. Diseases associated with the presence of aquatic weeds in tropical developing countries are among those that cause major public health problems: malaria, schistosomiasis and lymphatic filariasis. Some species of mosquito larvae thrive on the environment created by the presence of aquatic weeds, while the link between schistosomiasis (bilharzia) and aquatic weed's presence is well known. It has been shown that the brughian type offilariasis (which is responsible for a minor share of lymphatic filariasis in South Asia) is entirely linked to the presence of aquatic weeds. The weed provides a natural habitat for organisms that spread diseases such as bilharzias and malaria. It also harbors snakes and has an itching effect on human skin. Water hyacinth has been recognized as the most damaging aquatic weed to human health.

4. Electromagnetic generators

The interest to high-power ultra-wide-band (UWB) electromagnetic radiation sources using a direct transformation of electrical pulse energy into the electromagnetic wave has essentially increased in the past few years due to not only their simplicity and high efficiency but also due to the broadening of possibilities of such application regions as radars, radiation influence on mediums and objects. TEM-antennae of different geometries are used most widely in high-power UWB radiation sources. However, the dependence of the radiator phase center position on frequency for this antenna type as well as for such well-known ultra-wideband antennae as Iogoperiodic and spiral ones limit their application for radars. In an approach that has been based theoretical for the construction of UWB radiator with a constant phase center in the operating frequency range intended to operate in multi-element antenna arrays has been suggested. The antenna presents a combination of electrical and magnetic dipoles allowing to expand the feeder-antenna matching band into the low-frequency region and simultaneously to increase the linearly polarized radiation directivity. Preliminary investigations from different literatures have shown that radiator energetic efficiency when excited by a bipolar voltage pulse is two or more times higher than when excited by a unipolar pulse due to the difference in frequency spectra of exciting pulses. Low voltage level of the pulse reflected from the antenna in case it is excited by a bipolar pulse increases the reliability of an ultrawideband radiation source.

References

Brooker, C.J. P.D. Smith " lkHz, 25kV output, sub- 150ps risetirne gas spark gap and antenna," Proc. 10th IEEE Intern. Pulsed Power Conf. V. 1. pp. 755-760, 1995.

Yalandin, M.L V.G. Shpak, S.A. Shunailov, M.R. Uhnaskulov, "Compact retitive generator of high-power broadband electromagnetic pulses,''proc. SPIE. V. 2557. pp. 289-297, 1995.

Gubanov, V.P. S.D. Korovin, I.V. Pegel, V.V. Rostov, A.S. Stepchenko, V.P. Tarakanov,''Generation of high-power ultrawideband nanosecond electromagnetic pulses in the system with coaxial TEM-hom,''Izv.

VUZOV. Fizika. N12. pp.1 10-118, 1996.

Yu. L.Astanin, A.A. Kostylev, "Bases of ultrawideband radiolocation measurement,"- Moscow. Radio isvyaz, 1989.

Yu. Andreev, V. Belichenko, Yu. Buyanov, V. Koshelev, V. Plisko, K. Sukhushin, "Synthesis of ultrawideband radiators of nonharmonic signals," Proc. VIth Intern. Conf. Math. Methods in Electr. Theory. pp. 425-428, 1996.

Yu.V. Vvedenski, "Tiratron generator of nanosecond pulses with universal output ," Izv. VUZOV. Radiotekhnika. N2. pp.249-251, 1959.

Bastrikov, A.N. B.M. Kovalchuk, V.V. Kremnev, E.V. Kumpyak,"A divider for measurement of megavolt pulses with nanosecond front, " Pribori i tekhnika ekspetienta. N4. pp. 79-82, 1995.

4 SUMMARY OF ACTIVITIES OF SISTER UNIVERSITIES (ASU) ON THEIR RESPECTIVE WATERSHEDS

ASU 01: GELANA WATERSHED MANAGEMENT ACTIVITIES AND EFFORTS MADE BY BULE HORA UNIVERSITY TOWARDS THE ISSUES OF WATER HYACINTH

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The Gelana River watershed covers more than 1157 km^2 in Lake Abaya sub-basin, which has five main tributary catchments considered the major tributaries and catchments along the riverbank of Gelana. It is located in the SNNPRS and Oromia Regional States. The Gelana River can be considered an upstream of the Gelana River system (Table 1 & Figs. 3 & 4).

Table 1: Gelana River basin, main tributaries and area coverage

Sub_Basins	Watersheds	**Main Tributaries**	Area_km2	Area_Ha
Abaya_Lake	**Gelana**	Bewaye River	83	8317
		Genidebisa River	53	5293
		Jelo River	442	44193
		Sero River	60	6028
		Upper Gelana River	519	51882
		Total	**1157**	**115713**

Currently, water hyacinth is spreading in the watershed and even is becoming evident during dry season. Flooding is observed taking away the weed from the River during wet season (Fig 2).

Fig. 2: Overview of Gelana River near Tore

There are increasing agricultural activities around the River. These activities are contributing pollutants to the River (Fig. 3).

Fig. 3. Agricultural activities near Gelana River

The major challenges of Gelana River Watershed include:

- Agricultural activities in the watershed,
- The spread of water hyacinth in the riverbank which may further intensify and severely affect the Gelana River and Abaya Lake
- Poor community awareness on water hyacinth and its impacts on the environment and livelihoods of the community
- Poor watershed as well as soil and water hyacinth management practices.

Remedial actions taken

- Bule Hora University has developed boats for clearing water hyacinth from Abaya Lake (Fig. 4).
- Gelana Woreda Administration has started plantation of trees on the watershed of Gelana River with main objective of managing soils

Fig. 4. A boat prepared to remove water hyacinth from Abaya Lake

ASU 02: A CALL TO ACTION: COLLABORATIVE ACTION PLAN TO SAVE NECH SAR NATIONAL PARK, LAKE CHAMO, LAKE ABAYA AND THEIR WATERSHEDS

Arba Minch University, KU Leuven AMU-IUC, EWCA, Nech Sar National Park, GIZ-BFP-IWP, KFW, Gamo Zone Administration and all relevant Zone and Woreda Offices

Arba Minch University,

1. Background

Nechsar National Park (NSNP) is one of the oldest protected areas in Ethiopia which was established by Emperor in 1974 for conservation of rich flora and fauna resources and its unique combination of aquatic and terrestrial landscapes (HRF and EWCA et al., 2021). The park is located in the beautiful natural setting together with two iconic Ethiopian Rift Valley Lakes, Abaya and Chamo, covering an area of 514 km^2, of which 78 km^2 is with lake area. Lake Chamo catchment is located between 5°.5 and 6.2° latitudes North and 37°.3 and 37°.7 longitudes (Figure 1). The entire catchment excluding the lake area covers a total area of 1,885 Km^2 (Teffera and Tafese, 2019).

Spring forest, riparian forest, woodland, bushland, grassland, streams, springs, hot springs, rivers, and lakes are the integral parts of the park which are fundamentally interconnected and provide important ecosystem services, such as fisheries, water supply, groundwater recharge, wildlife habitat, recreation, microclimate stabilization, water retention, carbon storage, preservation of cultural values and habitats for pollinators. However, human population growth coupled with poverty are putting a very high pressure on the park's natural resources and is speeding up the loss of biodiversity and degradation of natural habitat. The rapid destruction of the natural resources is also severely affecting the terrestrial and aquatic ecological integrity, and undermining the delivery of vital ecosystem services to the region.

Despite the prominent role of the park in maintaining biological diversity and economic sustainability, very little is being done to protect this iconic park and its lakes. Currently, the entire

Nech Sar Park and its catchment have no official integrated sustainable park management and land management practice. Unless urgent measures are taken to control the destruction in the park, it is expected that the unique socio-ecological value of park and its lakes will become history as we have witnessed the complete loss of Crocodile Market in Chamo Lake and Wallo Wetland in Abaya Lake outflow. A holistic and integrated sustainable park management practice should be implemented rather than fragmented and sectoral attempts to manage the resource.

To tackle this problem, by the initiation of AMU, GIZ, Arba Minch City Administration established a Technical Committee and Advisory Committee where the key stakeholders can participate in decision making and provide the chance to get a common understanding. A multi-stakeholder platform workshop was conducted and Collaboration & Action Agreement of Parties (CAAP) was signed among 48 institutions representing government, non-governmental, academic, and private sectors that have direct and indirect mandate in the conservation of the national park and creation of sustainable alternative livelihoods to those who subsist on the park biodiversity.

2. Action Plans for Short-term emergency works

Arba Minch University is actively engaged in actions that can help in the management of watershed in the short and long term.

2.1. Restoring the natural watercourse of Kulfo River

Kulfo River changed its natural course and started to flow through the Nech Sar National Park Forty Spring Forest. Extreme levels of sediment export led to physical disruption of the river course causing serious impact on park biodiversity. During rainy season the road of Nech Sar Park is completely blocked by sediments that since January 2020 the park road became the river bed. This resulted in enormous impact on tourism. Moreover, a large portion of the Nech Sar Park low land forest has now been covered by sediment deposition, and there is no more indigenous tree regeneration. If no measures are taken to control sedimentation, it is expected that the lowland forests of Nech Sar Park along Kulfo River will completely disappear and the unique socio-ecological value of the Forty Spring Forest in Nech Sar Park will become a history. There is urgent need for short-term emergency work to restore the natural watercourse of Kulfo River and to rehabilitate the Forty Spring Forest that has been destroyed by flooding from Kulfo River. In long-term, we need to implement sustainable river management practices that could prevent further sedimentation and environmental deterioration.

2.2. Screening water hyacinth in Abaya outflow (Wallo Wetland)

Lake Tana and Lake Abaya have been invaded by water hyacinth in 2010, but the consequences on Abaya Lake were less dramatic due to year-round strong wave that pushes the water hyacinth out of the lake and accumulates in Wallo Wetland which is located at the outflow of the Lake. Lake Abaya overflows into River Kulfo without any filtrations, ultimately flows into Lake Chamo together with the water hyacinth. Thus, since 2020, water hyacinth has been becoming a serious problem in Lake Chamo. The magnitude of the wave in Lake Chamo to control water hyacinth is not like that of Lake Abaya. If no measures are taken to screen water hyacinth in the outflow of Lake Abaya, it is expected that Lake Chamo will face the fate of Lake Tana. Hence, there is an urgent need to put artificial screen that can hinder water hyacinth from flowing into Lake Chamo. The screened water hyacinth behind the artificial screening will be turned out to useful economic resource which could contribute to sustainable income for the community.

2.3. Restoring the natural habitat of crocodiles

In the past several decades, the downstream inflow areas of Kulfo, Sile and Elgo (Sego) Rivers used to be very conducive habitats for crocodile nesting and basking. However, due to large scale anthropogenic modifications of land use (conversion of forest into steep slope rain-fed agriculture) with very poor soil and water conservation practices and very high population pressure, the area was exposed to severe sediment export risk which largely modified the river regimes and significantly altered the structure and composition of crocodile nesting and basking habitat. The highest exporter of sediment is the Kulfo catchment, which contributes about 39% of the total sediment export from the entire Chamo catchment (Teffera and Tefese, 2019). One of the best- and well-known crocodile nesting and basking habitat locally called *Azo Gebeya* 'Crocodile Market' – a name given because of the large congregation (more than 100 larger crocodiles) has now been completely destroyed due to excessive sediment deposition by Kulfo River. The crocodiles were discouraged by extensive sediment and vegetation matting that have been built up over several years on Crocodile Market beaches, and were forced to abandon the site and migrated to Ganjule Island which is covered predominantly by red ash soil. Currently, Ganjule Island has become tourist attraction site, however, the area of basking and nesting is quite limited. Thus, it needs maintenance and modification through the construction of artificial basking and nesting site.

If no measures are taken to restore and modify the basking and nesting sites in Ganjule Island, it is expected that Lake Chamo crocodiles will face serious challenge of survival and the number of tourists visiting Lake Chamo will fall drastically. There is a pressing need for a short term emergency work to restore the nesting and basking beaches for the crocodiles.

2.4. Mapping the buffer zone of Lake Chamo

Due to lack of buffer zone and political commitment, between 2017 and 2021, about 3,262 hectares of farmlands been completely destroyed from the catchment. Hence, there is an urgent need for short term emergency work to map the buffer zone of Lake Chamo. We are historically in an ideal time to delineate since the lake has reached its fully capacity and is draining into a Segan River. A fixed distance of 200m buffer zone from the current Lake Chamo boundary should be marked on ground. The implementation of the buffer zone needs further political commitment since almost the entire western part of Lake Chamo has been occupied by farmlands.

2.5. Generating Lake Chamo basin erosion hotspot priority map

The highest soil loss recorded in the Chamo watershed comes from Kulfo catchment which contributes about 39% of the total sediment export from the entire Chamo watershed (Teffera and Tafesse, 2016). Kulfo catchment is suffering from severe erosion since the top soil and sub soil of the catchment is highly susceptible to water erosion. The arable land expansion gradually moved from gentle slope lands into steeper slope agriculture with very poor conservation practices. In 2019 and 2020, several life-threatening landslides caused deaths, injuries, property damages that adversely affected varieties of natural resources in Gacho Baba Woreda of Kulfo catchment. Due to resource and time limitations, implementing sustainable land management practice in the entire Kulfo catchment is not feasible. Therefore, prioritization of restoration areas based on the severity classes of soil loss is vital. The geo-referenced prioritized kebeles within the micro catchment should be used as master plan during the implementation of sustainable land management.

ASU 03: WOLKITE UNIVERSITY PROJECTS IN ZIWAY WATERSHED TOWARDS THE ISSUES OF WATER HYACINTH

Sisay Shewamare , Wolkite University

1. Introduction

Lake Ziway is located about 160 Kms south of the capital city, Addis Ababa, between 7°51'N to 8°7'N Latitude and 38°43'E to 38°57'E Longitude. It has an open water area of 434 km^2 with an average depth of 4 m and an elevation of 1636 m.a.s.l.

Lake Ziway catchment falls in between 7°15 'N to 8°30 'N Latitude and 38 °E to 39°30 'E Longitude covering a total area of about 6991 km2 (Fig. 1). It starts from the highlands of Eastern Gurage Zone from which the Meki River originates, passes through the central parts of East Shoa Zone where Lake Ziway is located, and ends up in the Western Highlands of Arsi Zone from which the Katar River originates.

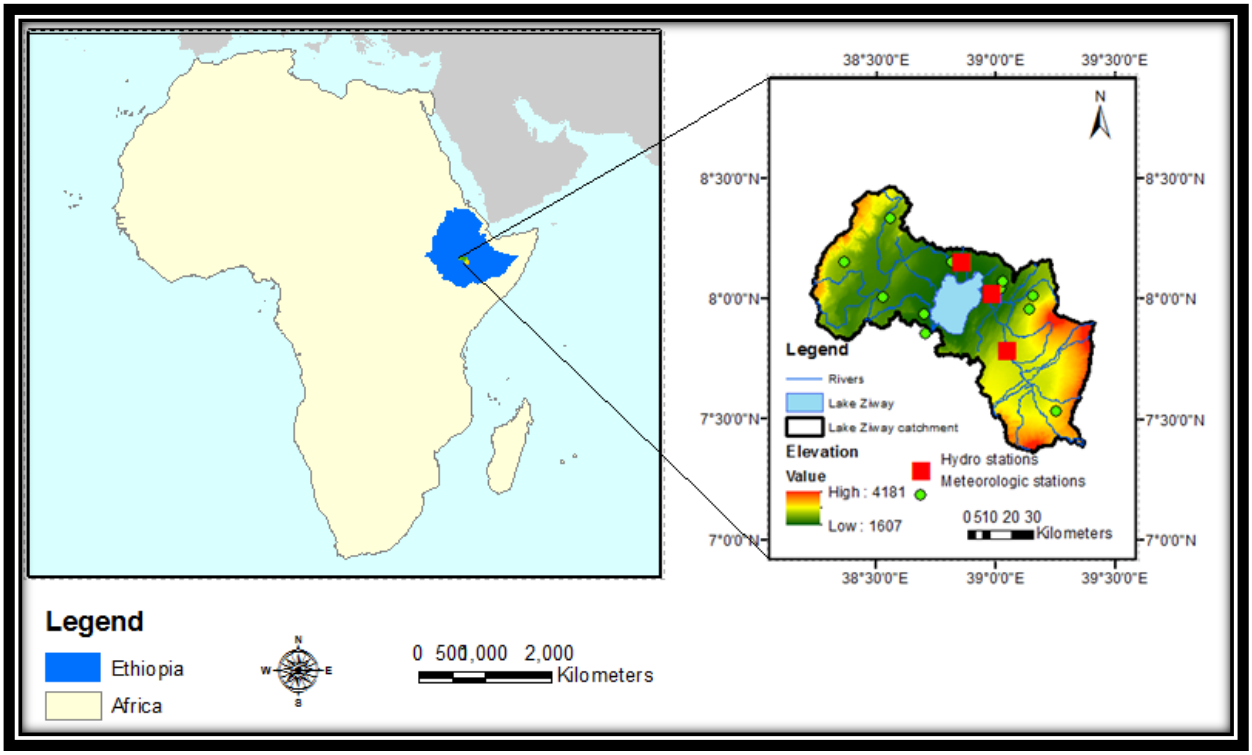


Fig. 1. Location map of the study area showing elevation, hydro-met stations, lake and streams.

2. Major Problems Identified

Field observation was conducted to investigate major issues in the watershed and to come up with issues requiring immediate attention by different actors in the basin. They include:

I. Water hyacinth infestation

Fig. 2. Water hyacinth infestation near the pump house at Ziway watershed

II. Water quality deterioration

Fig. 3. Pollution at Lake Ziway

III. Desertification and pollution

Fig. 4. Desertification and pollution at Lake Ziway

3. Interventions

I. Execution of different projects are in progress in the following study areas (Fig. 5): They include soil and water management, environment and health, agriculture and fishery, societal perception and attitude, economic issues, corporate responsibility, policy issues and energy.

Fig. 5. Avocado seedling for scion source at Yegech

ASU 04: KETAR - ZIWAY INTEGRATED WATERSHED MANAGEMENT PROJECT BY ARSI UNIVERSITY TOWARDS THE ISSUES OF WATER HYACINTH

Misbahu Aman, Abebe Terefe, Dereje Tsegaye, Kasim Dedefo, Kedir Amare, Getachew Alemu, Sisay Kebede, and Sisay Taddese

Arsi University

1. Introduction

The project intervention areas include six sub watersheds under a mega project of Ketar Ziway. These are: Herera, Chefa-Gumguma, Kaka, Ashebeka, Shalla-Chebeti, and Gonde sub watersheds. Intervention was already carried out at Herera, Chefa-Gumguma, Kaka, and Ashebeka sub watersheds.

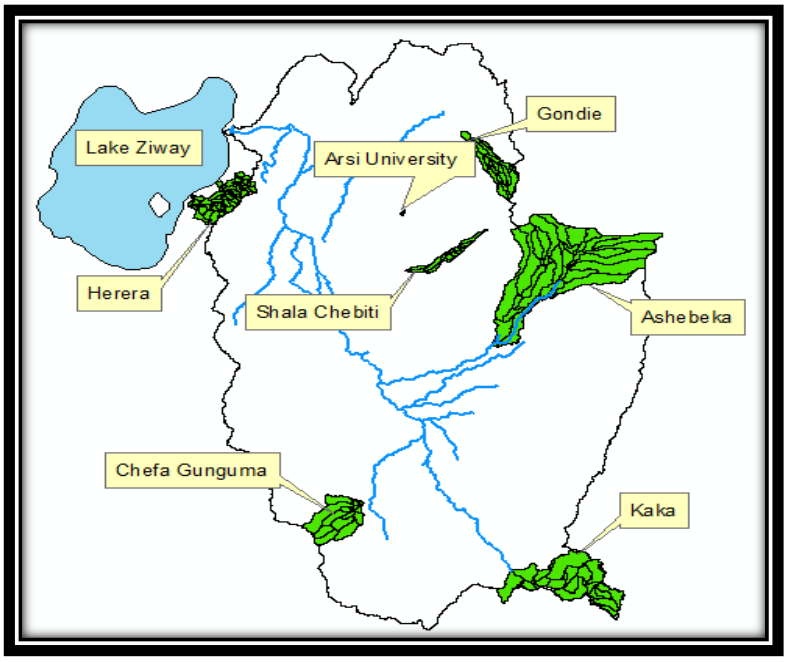


Fig. 1. Intervention areas

2. Major Problems Identified

Major problems identified in the watershed were land degradation, soil Erosion, deforestation, overgrazing, feed shortage, inappropriate agricultural practices and cropping practices, poverty, population pressure, unemployment, lack of extension service and technology adoption, lack of credit facilities, over exploitation of water resource, pollution in and around Lake Ziway, siltation and sedimentation, lack of buffer zone demarcation, invasion of water hyacinth, fishery and aquatic life deterioration,.

2. Interventions

Some of the interventions conducted were the following:

1. In the presence of higher officials of the university and zonal cooperative promotion office head and expert, a meeting was conducted with poultry and fattening cooperatives to solve the critical problems facing them
2. Continuous technical advices were given to members of fattening, poultry and irrigation water users on how to enhance their routine activities. Two poultry cooperatives have been registered after continuous follow up and support. Two poultry coops have been given audit service, and legal procedures were taken on sales committee who embezzled the societies' fund at Bashira Chaffa and Herara.
3. Five Irrigation water users' groups have been screened and were made ready to start their work in the coming year.
4. Frequent feedback was given for stakeholders' sectors (woreda Agriculture and Natural Resource, Zonal and woreda cooperative promotion, livestock and fishery development office).
5. Community was mobilized and planted more than 6,000 seedlings raised at Hallo Nursery site and added from woreda agriculture and natural resource office on hill area enclosure and Tesfa primary and secondary school.

Fig.2. Consultative meeting with woreda stakeholders

3. Challenges Encountered So Far

A number of challenges were observed in the course of the projects implementation. However, the following are worth mentioning:

1. Poor road infrastructure from Ogolcho (Abura) to the research site,
2. Overlap of mandate on the nursery site management at Hallo Kebele,
3. Lack of commitment of members and management committee of poultry coops in addressing problems of local communities,
4. Attitudinal challenge of the members towards their coops,
5. Lack of reporting system from the cooperatives and /or responsible organs about their progress,
6. Lacks of clarity of screening criteria used by woreda and kebeles to select members /beneficiaries of coops (fattening and poultry cooperatives),
7. Lack of proper coordination of stakeholders,
8. Lack of logistics especially during some critical tasks, and

9. Lack of external fund to address more areas and weak coordination of stakeholders (perception as if it is only Arsi University project).

4. Halo Nursery Site Establishment

The nursery site at Halo kebele was dismantled largely due to dissatisfaction of workers with the amount of payment rate.

5. Nursery Site Management

This nursery site was used for growing different seedlings for Katar Ziway sub watershed of Herera with the objective of area rehabilitation, reduction of soil loss, lessening of siltation to lake Ziway, minimization of land degradation and improvement of the livelihood of the local community. This site is located in the Arsi University research site and is with good tree shade for nursery (Fig. 3).

Fig. 3. The whole setup of the halo nursery site

ASU 05: BATENA RIVER WATERSHED MANAGEMENT ACTIVITIES AND EFFORTS MADE BY WACHEMO UNIVERSITY TOWARDS THE ISSUES OF WATER HYACINTH

Kibemo Detamo (PhD)

Wachemo University

1. Introduction

The study area is located around the Zonal capital, Hossana Town, south west of Addis Ababa, the capital of Ethiopia, having an area of 298 (Km^2) and 25 rural Kebeles (Fig 1). The mean annual rainfall of the area is 1397.625 mm with a mean annual temperature ranging between 15 °C to 19 °C.

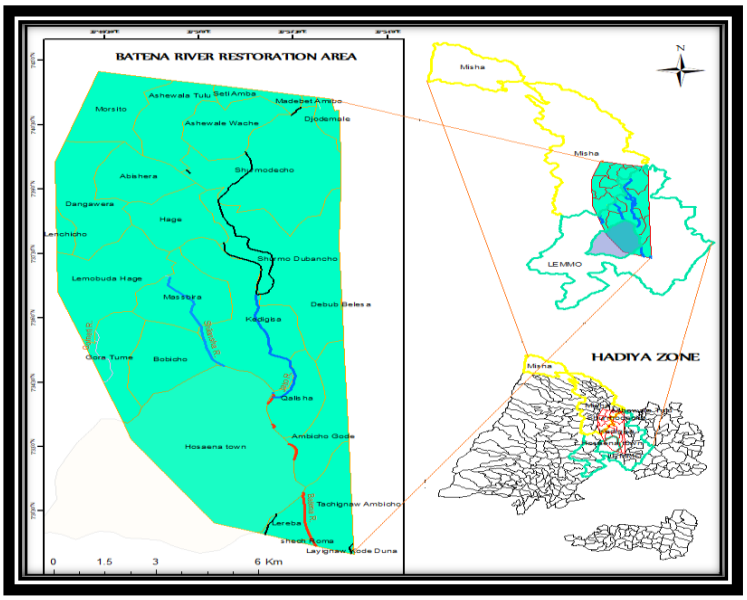
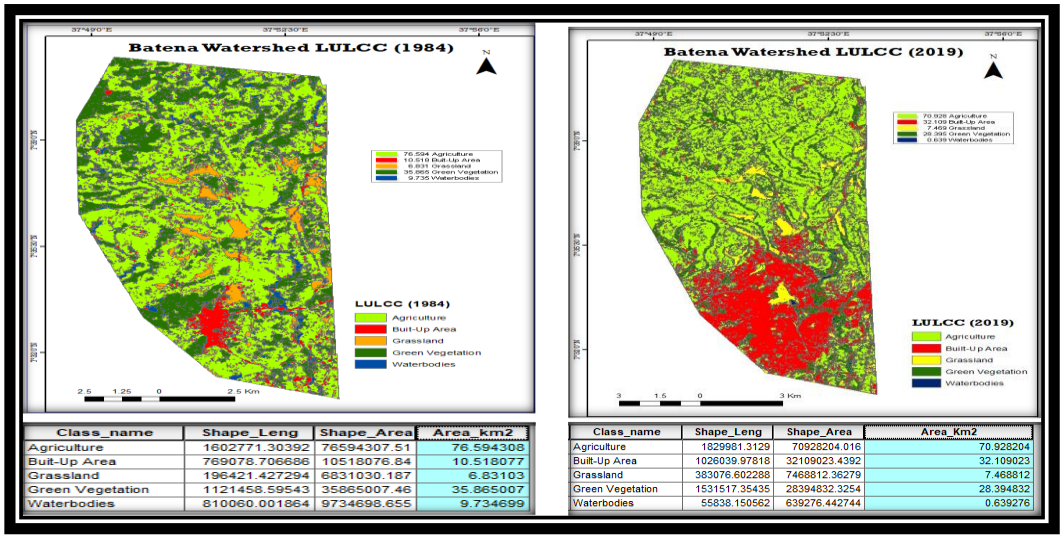


Fig.1. Map of Batena Watershed

2. Land Use Land Cover Change of Batena Watershed

In the past 35 years, the catchment has undergone a significant change in land use land cover (Fig. 2). Thus, there is a need for an urgent intervention to curb the problem of resource deterioration.



Class_name	Shape_Leng	Shape_Area	Area_km2
Agriculture	1602771.30392	76594307.51	76.594308
Buit-Up Area	769078.706686	10518076.84	10.518077
Grassland	196421.427294	6831030.187	6.83103
Green Vegetation	1121458.59543	35865007.46	35.865007
Waterbodies	810060.001864	9734698.655	9.734699

Class_name	Shape_Leng	Shape_Area	Area_Km2
Agriculture	1829981.3129	70928204.016	70.928204
Built-Up Area	1026039.97818	32109023.4392	32.109023
Grassland	383076.602288	7468812.36279	7.468812
Green Vegetation	1531517.35435	28394832.3254	28.394832
Waterbodies	55838.150562	639276.442744	0.639276

Fig. 2: Land use land cover change in Batena Watershed

The current project is envisaged to work in the catchment to reverse the aforementioned issue together with issues like population pressure, water demand, watershed degradation (siltation/erosion), lack of regulatory body, environmental pollution (liquid/solid waste disposal), low investment on water storage and infrastructure, groundwater depletion, inadequate resources assessment, inadequate enabling environment, and poor monitoring and evaluation process.

3. Interventions in the Watershed

Different soil and water conservation activities are undergoing in the basin

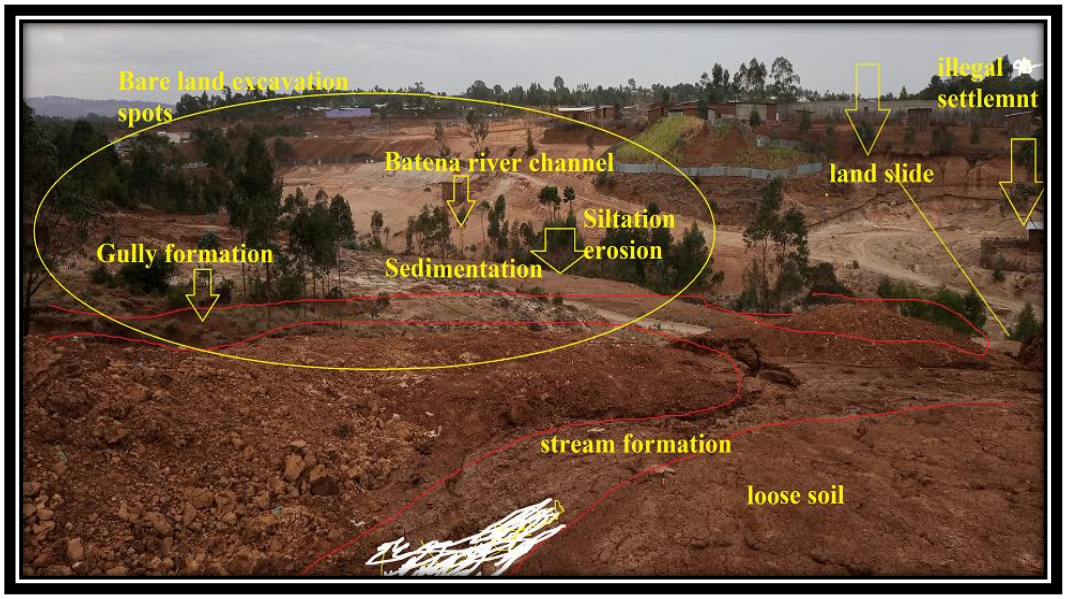


Fig. 3. Batena riverbank near Wachemo University

There is a huge potential for stream bank collapse and associated sediment load to downstream sites of Batena Reiver (Figs. 4 & 5).

Fig. 4. Gully rehabilitation of the basin

Fig. 5. Gully rehabilitation of the basin

Other major issues that require immediate attention include siltation (construction and query sites), solid waste dumping (organic & inorganic), vehicles/motor washing, run-off from adjoining farm lands (Figs. 4 & 5).

5 PARALLEL GROUP DISCUSSIONS

At the workshop, three parallel discussions were held focusing on different themes. Below are presented the summary of the results of the parallel group discussions.

GROUP ONE: Water hyacinth in the Ethiopian Rift Valley Region

The first group was assigned to explore the condition of water hyacinth in the ERVR. Members of this group discussed and came up with interesting insights. The presentation is structured into four sub-themes as follows:

1.1 Overall status of water hyacinth

Discussants reached a consensus that water hyacinth in the ERVR is found to be very high. To substantiate their arguments, participants mentioned recent studies carried out in some of the lakes in the ERVR. Findings attested that water hyacinth has highly invaded Lake Ziway and Lake Abaya with a total area of 1100 -1200 ha and 3500 - 3700 ha, respectively (Studies of 2020). Concerning Chamo Lake, the spread of water hyacinth is insignificant. Thus, it requires immediate attention. It was indicated that the socio-economic activities in the upper catchments and high floods into Abaya Lake during rainy season would set the water hyacinth risk very high.

The group participants also identified that the rate of invasion should be studied and figured out yearly. However, from the satellite images, identifying the specific reflectance of invasion and that of other green plants remains found to be the main problem to figure out the rate of invasion.

1.2 Extent and magnitude of the problem

The group participants explored the extent of invasion of water hyacinth in the water bodies of Ziway, Abaya, and Chamo Lakes to be high. Because of high level of invasion status, water hyacinth has become a big challenge for the communities whose livelihoods depend on resources in and around these lakes. The major problems water hyacinth causes are interference in transportation (navigation) activities, affecting the water quality, impacts on tourism (reduces the

number of tourists), rise in lake water levels, reduction in the amount of water for irrigation activities, intensification of competition on water use, reduction in fish production, interference with fishing activities and affecting ecosystem productivity/biodiversity.

1.3 Potential risk on other water bodies

The group participants came to assess the potential risks of invasion of water hyacinth to adjacent water bodies. Several plausible justifications were forwarded as to why water hyacinth would be a threat for the nearby lakes. They are conversions of wetlands into human settlements and agricultural land, deforestation, high population growth, improper watershed management, lack of awareness about the wetland, tourist boat exchange by tourists, high amount of pollutants from point and non-point sources, close human contact to the lake, improper solid waste disposal and fish net exchanges.

1.4 What should be done to avoid the invasions?

As a way out form this problem, participants suggested measures to be taken to reverse the existing situation. These are boat disinfections after visitors use it, enforcing buffer zoning regulation to reduce human contact, application of site specific mitigation measures, restricting fish net exchange, shifting from sectorial to multi-sectorial approach, focusing on a new approach of thinking - economic importance, carry out waste water treatment from points to sources and eliciting strong commitment from decision makers in implementing environmental policies, introducing effective and integrated watershed management activities and providing alternative livelihood strategies.

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GROUP TWO: Collaboration among sister universities in ERVR

The second group was assigned to look at the possible collaborations among the sister universities on emerging issues and water hyacinth problems in the region. Members of the group pointed out possible scenarios of cooperation.

2.1 Identify areas of collaboration

Universities, which are found in and adjacent to the ERVR, have to cooperate to mitigate the expansion of water hyacinth. One of the areas of collaboration identified by the group discussants was research. To the sister universities, RVLB is found to be an important area for research partnership in the region. Though RVLB has challenges & opportunities specially basin planning and implementation, the following would be potential collaboration areas with sister universities. Possible thematic areas to be subjected for such undertakings include pollution control, effects and use of water hyacinth, watershed management, natural recourse utilization such as fish production, land use policy, agriculture sectors and other stakeholders, adoption and development of technologies, sustainable consultative workshop, sustainable aquaculture production, utilization of laboratories found in different stakeholders, creating linkage between industries/universities.

2.2 How to form consortium for collaboration

Concerning establishing consortium on the overall activities in the ERVR, the participants referred to the previous experience of working together with sister universities. Therefore, strengthening the existing activities was considered a major task to be taken. In addition, there are four clusters, which are currently running basin planning & implementation in RVLB. These are: watershed management aspects, water quality, pollution control, lake & wetland management aspect; and emerging issues aspect including water hyacinth; and Water use, allocation & management. It was mentioned that there are several ground works underway to form consortium to tackle problems in the region. The presence of a steering committee in the UIL, organographies structure including the existing directive, using financial & human resources found in different stakeholders and producing scientific information, and disseminating them were believed to accelerate the process.

2.3 Collaboration in the fight against water hyacinth

Participants specifically discussed how to form collaboration to fight against the invasion of water hyacinth in the Rift Valley lakes. As mentioned in the aforementioned sub-heading, establishing collaborative activities could serve the effort to halt the spread of such invasive weed species. What is required from each institution is to strengthen the existing activities organized by UIL & RVLB. By organizing the different stakeholders in terms of research, awareness creation, sharing information and creating linkage between stakeholders it is possible to prevent the spread of water hyacinth and other invasive weed species in the Rift Valley lakes.

2.4. Communication & networking for collaboration

Focusing on the strengthening of the existing activities, it is possible to organize common data Center (owned by CERVaS) as database. Moreover, scientific information & dissemination media would be relevant. Developing common website owned by CERVaS & UIL in the universities and establishing Centers of excellence were suggested as mechanisms to exchange publication, proceedings & scientific journals. In this regard, it was mentioned that RVLB has currently become member of World Lake Database like UIL is in Rift Valley basin water & energy forum. Assigning steering committee from Research, Technology Transfer and Community Service V/ Presidents at RVLB universities will facilitate communication & networking for collaboration.

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GROUP THREE: Stakeholders on water hyacinth

3.1 Categorizing stakeholders

Using a manual referred to as "Implementing the Source-to-Sea Approach: A guide for Practitioners", participants were given to identify categories of stakeholders as: **Primary stakeholders, targeted stakeholders, enabling stakeholders, supporting stakeholders, and external stakeholders.** Accordingly, potential list of stakeholders in relation to water hyacinth was identified as follow:

3.1.1 Primary stakeholders

Definition: individuals or groups that are affected by the altered condition and will directly benefit from its prevention. These are: surrounding communities, fisherman, tourism service providers and crocodile ranchers.

3.1.2. Targeted stakeholders

Definition: individuals or groups that contribute to the altered condition and whose behaviours and practices must be directly targeted to prevent it. These are: local farmers (watershed farmers; fuel wood-deforestation), urban dwellers (waste materials disposal) and agro-industries (flower-farms).

3.1.3. Enabling stakeholders

Definition: institutions providing or should provide enabling conditions for behavioural changes and benefits to occur and be sustained over time. These are: local governmental offices, Zonal Administrations, etc.); institutions (Universities, Research Institutions, etc.), municipalities, etc.; RVBDO (BDA) and Federal Ministries and Regional Bureaus.

3.1..4 Supporting stakeholders

Definition: development partners or financiers whose strategies are aligned with prevention of water hyacinth. These are: local and international NGOs (GIZ, Hailemariam & Roman

Foundation, Resorts & Lodges, and PLCs.); influential local leaders and celebrities; and local Mass Media

3.1.5 External stakeholders

Definition: Individuals or groups outside the system boundary who share interest in the altered condition. Under this category are UNDP, IMF, World Bank, FAO, UNESCO, World Vision and USAID.

3. Stakeholders engagement

Participants sketched a tentative plan to engage identified stakeholders in the fight against water hyacinth.

8 GENERAL DISCUSSION & CONCLUDING REMARK

Following group presentations, a general discussion was conducted.

Key points /issues from general discussion:

- V/President for Research, Technology Transfer and Community Service of Arba Minch University, expressed discontents with the UIL linkages with his institution. Intentionally or unintentionally, the university has been left out from the project currently underway. He emphasized that the involvement of concerned universities should not depend on individual relations, rather it should be based on institutional collaboration. He indicated that the previous experiences were not good. The past problems have to be rectified. He added, "We should rebuild meaningful institutional collaboration with sister universities and figure out thematic areas.
- The chairperson of the UIL (from Wolkitie University) mentioned that it is good to work together and to avoid fragmented works. Collaboration and networking are more important to share experiences on water hyacinth and properly manage resources. In such matters, BDA could better take the coordination responsibilities. CERVaS is also responsible in linking the universities with other areas of research.
- The Director of the RVLBDO made remarks that institutional linkage should be formal. The linkage can be university to university or university to industry or industry to industry. The university to industry linkage is only its infancy. RVLBDO will organize a forum and develop guidelines regarding collaboration. He stressed that though individuals are important, specific attention should be given to institutional collaborations.
- A representative from RVLBDO, discussed the UIL forum's experiences. UIL conducts two meetings per year. He suggested that the UIL should be improved. CERVaS should also be improved. Answering the grievances forwarded by Arba Minch University, he gave explained discussions held between officials representing the VPRTT in different occasions. However, the university (AMU) rejected the research offer coming from RVLBDO with the explanation that the allotted money is small amount to do the research.

- The representative from BDA expressed their office's experience on outsourcing of the Omo - Gibe Basin Master plan and the Genale - Dawa Plans. It has become confusing as to whether to collaborate with individual experts or with the institutions after the bid to enter agreements for financial and project administration. He emphasized that institutional collaborations must be established for the smooth work relationship.

Concluding Remarks

As it was anticipated, the consultative workshop on water hyacinth has successfully achieved the following outputs:

1. The participants of sister universities and partner institutions have shared their best experiences and effort made to control the spread of water hyacinth in the Ethiopian Rift Valley Lakes Region,
2. The participants were able to establish a framework of collaboration/consortium/ to hamper the impact of water hyacinth and other invasive weed species in the Ethiopian Rift Valley Lakes Region. The consortium should not be limited to invasive species and should also widen the collaboration to take integrated action for other existing and emerging environmental issues,
3. The participants suggested having CERVaS contact or focal persons at each sister university for communications and joints activities, and
4. The participants strongly suggested that a platform of collaboration, partnership and networking, should be institution-to-institutions, not individual-to-individual. Hence, CERVaS should play key role in coordinating the consortium of sister universities to its level best.