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Review Article

Preliminary Survey of Water Hyacinth in Lake Tana, Ethiopia

Abstract

Investigation of water hyacinth was conducted from October 27, 2011 to November 3, 2011 by interdisciplinary expedition groups. A total of 24 sites were delineated using geographical positioning system (GPS) during investigation of water hyacinth incidence along the whole periphery of Lake Tana. Water hyacinth was started from Mitreha Abawarka kebele of Gondar zuria woreda specifically around at Netseba village with an estimated of 3 hectare area coverage. Highest infestation of the weed was observed at Megech River mouth with estimated area coverage of c. 80-100 hectare. Its infestation extends up to Dirma River mouth. Especial adaptation of water hyacinth on land based conditions at which soil moisture relatively high was observed around Tana woina kebele of Gondar zuria woreda adjacent lake shore side. The incidence and depth of water hyacinth infestation in Lake Tana is still at its infant stage, because except the North and to some extent North-east direction, the other parts of Lake Tana were devoid of the water hyacinth. Generally water hyacinth remains a major problem in Lake Tana where effective control programs are not in place as soon as possible.

Background and Justification

Water hyacinth has been identified under seven species and all water hyacinth species comprise the genus Eichhornia, of which Water hyacinth (*Eichhornia crassipes*) species is common and widely distributed all over the world. Water hyacinth are a free-floating perennial aquatic plant native to tropical and sub-tropical South America; with bright green, waxy leaves and attractive, violet flowers that have yellow strips on the banner petals. These plants tend to form mats on the water surface. Some times water hyacinth can be found growing in muddy soils near the edge of an aquatic system. The leaves are arranged in a rosette. The leaf stem usually is some what to completely swollen and filled with spongy tissue and thus acts as afloat. The blade of the leaf is oval to round and usually much smaller than the leaf stem. The common water hyacinth (*Eichhornia crassipes*) is vigorous growers known to double their population in two weeks. Water hyacinth grows rapidly. Growth of more than one tone of dry matter per day per hectare is not uncommon. One plant may be able to produce enough growth to cover 600 square meters in one year. Infestation break up in to "rafts" that drift wherever the winds and currents take them, rapidly infesting entire river systems [1].

Water hyacinth spread through fragmentation of established plants and may resprout from rhizomes or germinate from seeds [2]. Dispersal also occurs by water-borne seeds and by seeds that stick to the fit of birds. Migratory birds may be important in long distance dispersal [1]. The major means of dispersal, and the most difficult to control, is active transport by people who, ignorant of its impacts, seek to propagate it in other ponds and lakes. Humans also contribute to its spread in some areas by using the plant as a packing material and as cushions in boats [1].

Botanists and gardeners carry plants with them in their travels, and experts suspect that this is how the water hyacinth came to East Africa in the 1980s. Due to its attractive flowers; it was probably brought over as an ornamental for garden ponds [3]. The consensus is that Water Hyacinth entered Lake Victoria from Rwanda via the river Kagera [4]. The exact time and place of introduction has been debated, but the plant is native to South America, and therefore reached Lake Victoria due to human activity. It has spread prolifically, due to lack of natural enemies, an abundance of space, agreeable temperature conditions, and abundant nutrients [5]. It increased rapidly between 1992-1998, was greatly reduced by 2001, and has since resurged to a lesser degree. Management techniques include (hyacinth-eating) insect controls and manual beach cleanup efforts [6]. A water hyacinth infestation is seldom totally eradicated. Instead, it is a situation that must be continually managed [7,8].

The weed is a major concern in other countries as well. It has resulted in tremendous losses annually in fish and paddy rice production in India. In the Sudan it had invested over 3,000 kilometers of rivers by 1979, resulting in an estimated 10 percent loss in the normal flow of the Nile River and costing more than $ 3 million per year in control efforts (Parson, 1992). Water Hyacinth affects the Lake Victorian population in many negative ways. There are economic impacts when the weed blocks boat access. The effects on transportation and fishing are immediately felt. Where the weed is prolific, there is a general increase in several diseases, as the weed creates excellent breeding areas for mosquitoes and other insects. There are increased incidents of skin rash, cough, malaria, encephalitis, bilharzias, gastro intestinal disorders, and schistosomiasis [3,9,10]. Water hyacinth also interferes with water treatment, irrigation, and water supply [5]. It can smother aquatic life by deoxygenating the water, and it reduces nutrients for young fish in sheltered bays. It has blocked supply intakes for the hydroelectric plant, interrupting electrical power for entire cities. The weed also interrupts local subsistence fishing, blocking access to the beaches [7].

Lake Tana is situated on the basaltic Plateau of the north-western highlands of Ethiopia covering an area of about 3,150 km^2 with an

elevation of 1830 m and an average depth of 8 m The lake is bordered by low plains in the north (Dembea), east (Fogera) and south-west (Kunzila) that are often flooded in the rainy season. Lake Tana has multidisciplinary uses for example fishing, electric power generation, transportation, communal grazing land and drinking for humans other animals, and a site for different birds. Wetlands are located all around the lake which has high potential for biodiversity and the wellbeing of the lake. Lake Tana sub basin with diverse ecosystem (the Lake, the wetland and the rivers) support unique endemic fish species in the world. 20 of the 27 fish species of Lake Tana are endemics to the Lake Tana catchment. Of economically important fish species of the lake, there is one cichlid, *Oreochromis niloticus* (Nile tilapia), which is the most widespread species in Africa; The catfish family (Clariidae) is also presented by one species, *Clarias gariepinus* (African catfish) and The largest fish family in the lake is the cyprinids which are represented by four genera: *Varicorhinus*, *Garra*, *Labeobarbus* and *Barbus*. Despite this unique fish biodiversity and its high economic value, fish resources are under pressure from several threats. The major threat is illegal fishing, habitat destruction (wetland, rivers and the lake itself) due to human intervention; encroachment and pollution are the major ones. Now the above mentioned notorious weed called water hyacinth has been introduced in Lake Tana through unknown reasons and agents at a moment. The purpose of this preliminary survey was therefore; to investigate the incidence and estimate infested area coverage of Lake Tana.

Objectives

To investigate the incidence and estimate depth of infested area coverage of the lake

To build knowledge about its biology, propagation and threat to resource of Lake Tana

To show ways and means of controlling the weed as soon as possible prior to large area coverage

To create awareness for respective higher officials, different stakes and policy makers

Result and Discussions

A total of 24 sites were delineated using geographical positioning system (GPS) during investigation of water hyacinth incidence along the whole periphery of Lake Tana. As a result the weed was started from Mitreha Abawarka kebele of Gondar zuria woreda specifically around at Netseba village with an estimated of 3 hectare area coverage (Table 1). The most devastating area coverage by the weed was observed at Megech River mouth extended both east and north direction with estimated area coverage of 80-100 hectare and widely distribution of daughter plants observed that moved forward by the assistance of the wave. Especial adaptation of water hyacinth on land based conditions at which soil moisture relatively high was observed around Tana woina kebele of Gondar zuria woreda (Figure 1).

Unstructured interviews to the local fishers and inhabitants were made about its source, time of occurrence and propagation abilities. As a result almost all respondents replied its source as if it was from western part of the lake particularly from Kunzila direction, but it was confirmed by the investigators that the whole periphery of North-west, West, South-west, South, South-East and Eastern parts of the lake was totally devoid of water hyacinth (Figure 2). Therefore, the most possible explanations would be birds because the infested area is known by cross boundary bird species, fishing equipments, wastewater treatments, and ornamental purposes in general it might be again introduced by human activities. Regarding to its introduction time, about 50 percent of the respondents replied that the weed has been introduced in the area with in two years time and the other 50 percent respond, as it has only been observed since July, 2011. During the survey, water hyacinth was at its 60 percent blooming stage that is ready to set its copious seeds (Figure 3).

What threats does it cause in Lake Tana, surrounding wetlands and its tributary rivers?

- It can quickly dominate a water way or aquatic system because of rapid leaf production, fragmentation of daughter plants, and copious seed production and germination.
- It degrades habitat for waterfowl by reducing areas of open water used for resting, and when decomposing it makes water unfit for drinking.
- It displaces native aquatic plants used for food or shelter by other animals and wildlife species.
- Causes problems for humans by obstructing navigable water ways, impending drainage, fouling hydroelectric generators and water pumps, and blocking irrigation channels.
- The protected water with in mats of water hyacinth makes ideal breeding sites for mosquitoes and other vectors, which, in tropical countries, increases the danger of malaria, schistosomiasis, and other diseases.
- Water hyacinth increases water losses from the lake, wetlands and tributary rivers because of the plant's high transpiration rate, calculated to be almost eight times the evaporation rate of open water surfaces (Parsons, 1992).
- It changes water quality beneath the mats by lowering pH, dissolved oxygen, and light levels, and increasing CO_2 tension and turbidity [6]. This affects the health of fish and other animals (Table 2, 3).

Possible strategies for water hyacinth control in Lake Tana

How can we get rid of it?

The best method of controlling water hyacinth is to prevent it from being introduced in to a fresh water system. This can be done by educating the public about the problems that occur from disposal of unwanted water garden or aquarium plants in to fresh water systems or by not properly cleaning boats, trailers, other water sports equipment, bait buckets, or fishing equipment to remove all plant material before moving the equipment to another fresh water system or with in the lake boundaries itself.

Physical control: Manual /mechanical methods: For small ponds or lakes infested with water hyacinth, harvesting and removal of plant material from the water can be attempted. Care must be taken

Table 1: Sampling site coordinates while assessing the incidence and extent of water hyacinth on lake Tana using UTM calibration.

№	Sampling sites	Coordinates	Elevation	Remark
1	Gorguadit	0327097	1797	
		1287416		
2	Egashu	0328277	1793	
		1289674		
3	Gelda	0328352	1795	
		1297621		
4	Korata	0331140	1798	
		1300724		
5	Eyariko	0337509	1790	
		1314380		
6	Wagetera	0342209	1793	
		1318494		
7	Rib River mouth	0344760	1793	
		1326050		
8	Rib River old mouth	0344708	1793	
		1325937		
9	Rib River new mouth	0347685	1790	
		1331541		
10	Mitreha Abaworka Kebele (Netseba Gots)	0347970	1794	Water hyacinth started
		13415225		About 3 hectare weed coverage
11	Woyna kidanemihret (Tana woyna kebele)	0332409	1789	Local name “Afeshfasho”
		1359606		land based adaptation on moist soils observed
12	Megech River mouth	0326782	1792	Extensive coverage observed (80-100 ha)
		1357949		
13	Addisgie dingie	0324580	1796	
		1356679		
14	Dirma river mouth	0316186	1791	End of water hyacinth occurrence
		1356528		
15	Delgy	0287554	1789	
		1347263		
16	Delgy Asratie Gots	0290065	1785	
		1351565		
17	Galaye Gots (Achera kebele)	0285934	1791	
		1337425		
18	Eseydebry	0284190	1793	
		1329363		
19	Qunzila	0286166	1793	
		1314287		
20	Qunzila intake site	0233814	1789	
		1314610		
21	Abay River mouth	0295080	1792	
		1313156		
22	Abaydar Gebriel Kebele (Amluk gots)	0297157	1796	
		1305669		
23	Sekelets kebele	0307904	1794	
		1308572		
24	Enfranz River mouth	0316347	1791	
		1288636		

Figure 1: Water hyacinth inved both grazing and farm lands around Tana woina kebele of Gondar zuria woreda.

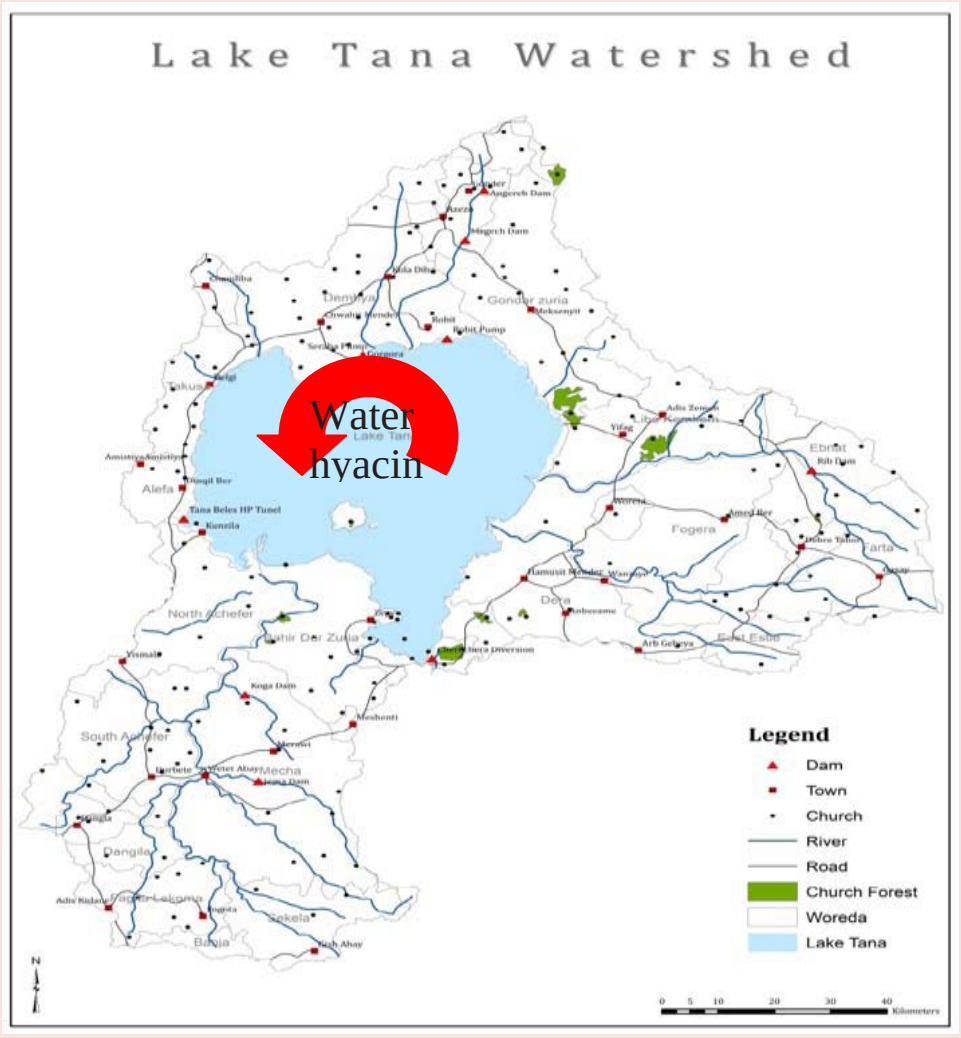

Figure 2: Water hyacinth infestation coverage in Lake Tana.

Figure 3: Water hyacinth blooming around Netseba village of Mitireha Abaworka kebele during the survey.

Table 2: Physical property of L. Tana (reference) and its tributary river Qumen which is infested by water hyacinth around Mitreha Abawerka Kebele, Gondar zuria woreda.

Site	Ph	DO mg/l	DO %	T °C	TDS gm/l	Salinity	Conductivity	Sp. conductivity	Remark
Qumen river mouth	6.93	6.29	74.9	23.94	0.11	0.08	169	166	
L. Tana	9.34	5.27	65.3	25.9	0.1	0.07	152	156	

Table 3: Chemical properties.

Site	Phosphate mg/l	Ammonia mg/l	Nitrite mg/l	Total hardness mg/l	Salphate mg/l	Turbidity	Alkalinity mg/l
Qumen River mouth	0.42	0	0.0099	102	7	26	85
L. Tana	0.4	0	0.0231	90	8	100	60

to remove all plant material, including small fragments. Removal of water hyacinth can be integrated with the preparation of organic fertilizer, so that it can add value for the community by preparing compost around each spots of removal sites.

Biological control: Three insects and a fungus have been extensively studied and subsequently released to control water hyacinth. This needs multidisciplinary study prior to introduce exotic species to Lake Tana ecosystem, that might cause for massive degradation of the resource.

Grazing**:** most animals, except rabbits, do not readily eat the plant, possibly because its leaves are 95 percent water and have a high tannin content.

Chemical control: Water hyacinth can be controlled using glyph sate as a foliar spray and copper complexes used only as a foliar spray. But herbicide use is more highly regulated in aquatic systems than in terrestrial systems. Chemical control, through the use of certain herbicides such as 2,4-D or glyphosate, seems to be an economically feasible option in some countries, but not in others with less economic development. In addition, in many countries public opinion is strongly against the use of chemicals in water, which is used for drinking purposes. So that can not be recommended at this moment. Even though Manual removal requires a large labor force, and Governments of the developing world do not always have the means to pay for this operation, this would seems the best means of controlling the water hyacinth in Lake Tana.

Conclusion and Recommendations

The incidence and depth of water hyacinth infestation in lake Tana is still at its infant stage as a result can be controlled and overcome its problem easily. But when not controlled as soon as possible, water hyacinth will cover the lake, surrounding wetlands, tributary rivers and rice farms entirely; this dramatically impacts water flow, blocks sunlight from reaching native aquatic plants, and starves the water of oxygen, often killing fish (or other life in the water). The plants also create a prime habitat for mosquitoes, the classic vectors of disease, and a species of snail known to host a parasitic flatworm which causes schistosomiasis (snail fever). Hydroelectric power, transportation and irrigation schemes will be definitely victims by the invasive weed. Generally water hyacinth remains a major problem where effective control programs are not in place. As chemical and mechanical removal is often too expensive and ineffective, researchers have turned to biological control agents to deal with water hyacinth, but this has also a limited success and time taking properties there has to be exhausted studies on ecosystem interactions prior to the introduction of weevils.

Among the short-term control measures there are physical (mechanical and manual) removal and chemical control. All have serious constraints for implementation in water bodies of developing countries of the tropical and sub-tropical regions. Mechanical removal requires the purchase of harvesters, many of them too costly for most of developing countries. Even though Manual removal requires a

large labor force, and Governments of the developing world do not always have the means to pay for this operation, this would seems the best means of controlling the weed in Lake Tana.

Water hyacinth reproduces primarily by way of runners or stolons, which eventually form daughter plants. But it also produces large quantities of seeds, and these are viable up to thirty years. Therefore, long-term eradication measures have to be designed.

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