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Original Article

Prevalence and Intensity of Water Hyacinth Infestation in the Water Bodies of Rift Valley, Ethiopia

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ABSTRACT

This assessment was accomplished with the objective of mapping and identifying the infestation of water hyacinth in order to lay ground for any type of management practices or intervention planned. Accordingly, survey on the prevalence and intensity of water hyacinth infestation was made in some water bodies having connection with the Awash River including Abasamuel Dam, Koka Dam, Lake Ellen, Wonji Sugar Estate and Awash River near Koka Town. As a result, summarized data on prevalence of water hyacinth in the assessed water bodies indicated that the value that ranged from 17 -100% was observed. Moreover, the highest water hyacinth prevalence was recorded in Ellen (100%), Melka Hida (100%), Dodo wedera (98%) and Tere (96%), while the lowest (<20%) was recorded at Wonji-Shoa. Furthermore, the highest water hyacinth count [308 plants per quadrat (m^2)] was recorded at Koka Dam, whereas the lowest [12.00 plants per quadrat (m^2)] was found in Wonji-Shoa. Generally, the distribution map also confirmed that there was high degree of variability among water bodies in their infestation with water hyacinth that ranged from free to high. The result clearly revealed that the infestation of weed was increasing from time to time causing enormous negative effect by making the water inaccessible for utilization and by affecting the livelihood of the community directly and indirectly. Hence, integrated effort of community, governmental and non-governmental organization in reducing the disastrous effect of the weed on the society was mandatory.

Key words: Water hyacinth, assessment, prevalence, infestation.

INTRODUCTION

Water hyacinth, *Eichhornia crassipes* (Mart) Solms-Laubach, is a perennial, herbaceous, aquatic plant and is native to the tropical South America but, through introduction by man, has spread in the whole tropical zone. Over the last hundred years or so, gifts of water hyacinth have been taken from its native Amazonian to all parts of the world as an exotic contribution to ornamental and botanical gardens. But things went out of control; the water

hyacinth was like a tiger let out of its cage. It has found its way into almost every river and fresh water lake throughout the tropics and the subtropics, and become known as a noxious weed. It can be found in every continent, except Europe and even there it has a 'toe-hold' (Lindsey and Hirt, 1998). Julien *et al*. (1999) indicated that the weed was first introduced to the USA (Louisiana) in 1884 and spread further to Florida in 1890. It inevitably spread as a weed in China, Egypt, India, Indonesia, Japan, Madagascar, Myanmar, Philippines, Singapore, South Africa and Sri Lanka. Within South-East Asia, there has been extensive spread throughout Cambodia and Laos; Indonesia, Malaysia, the Philippines, Thailand and Vietnam; also through southern provinces of China and Japan. Important explanations for the continental spread of the weed include its capacity to quickly multiply when away from its natural enemies in South America (Rezene, 2005a).

Water hyacinth occurs almost throughout wet lands of Africa and poses serious socio economic and environmental problems on millions of people in riparian communities and is, therefore, added constraints on development (Howard and Matindi, 2003). It was first seen in the wild in the River Nile in Egypt in the 1890s. In the early 1900s it was introduced down in the Natal Province in South Africa, and in the 1930s in several lakes in Zimbabwe. In 1942 it was introduced to the Congo River, and took 14 years to colonize its full length before crossing to the Nile Basin via a swampy area in south west Sudan. In the 1950s it colonized the Pangani River in Tanzania. During the 1960s and 1970s, water hyacinth became well established in the White Nile and the Blue Nile, the Congo, the lower Zambezi, Lakes in Ethiopia, South Africa and Zimbabwe. In the 1980s and 90s it colonized coastal fresh water lagoons in Benin, Cote d'Ivoire, Ghana and Nigeria. The spread of water hyacinth in this period was very rapid. It was not reported in Uganda until 1987; however, it was probably there for some ten years before that. In Congo, it continues to be spread in fish ponds, because people believe that it encourage the growth of algae and plankton, which give better yield of fish. Also, can be bought in local markets, such as in Dakar, Senegal, where it is a source of income for women.

In Ethiopia, water hyacinth was officially reported in 1956 in Koka Lake and the Awash River (Stroud, 1994). Senayit *et al*., (2004) also indicated that the earliest observation of water hyacinth in Dugda Bora District was to be between 1949 and 1958. At that time, although the infestation was small, the appropriate authorities were notified, however, no subsequent action was taken. By 1962 the plant had succeeded in infesting the whole stretch of the White Nile from Juba to Jebel Aulia Dam; the whole length of the Sobat River from its mouth eastwards up to Baro and Gillo Rivers in Ethiopia and Southwards up to Pibo River to Akobo (Rezene, 2005a). The Baro River is the main transportation route between south the Sudan and the River port of Gambella. Difficulties experienced by steamers and boats have been frequently reported since the advent of water hyacinth (Rezene, 2005a).

Connectivity among diverse water bodies during the peak rainy season has further facilitated the spread of water hyacinth. In addition, the inability of communities and government authorities to respond to its infestations before it became crises in the water bodies resulted in severe infestation (Taye, 2006).The point of introduction and the primary source of infestation for Awash River is assumed to be Abasamuel Dam that is organically enriched by Akaki River, which receives many types of urban wastes from the city of Addis Ababa (Senayit *et al*., 2004).

Except Lake Ellen (eight killometers North of Alemtena town), most of the Rift Valley Lakes, such as Lake Ziway, Langano, Abiyata, Shala and Awassa are proved to be free from Water hyacinth, but the potential risk for their infestation is still there (Senayit *et al*., 2004; Rezene, 2005b).

The Ethiopian Electric Power Corporation (EEPC) has reported this plant as a problem disrupting their operation at the three hydropower stations located along the Awash River, where it emerges from Lake Koka (Stroud, 1994). The water intake points become blocked, which must be periodically closed down to clean out the weed.

In Wonji-Shoa, it is believed that water hyacinth was first introduced from Koka Hydroelectric Power Dam as a result of the 1996 flood of Awash River in the Factory area (Tariku, 2001; Firehun and Solomon, 2002; Abera *et al*., 2004). While in Metahara, when and how the weed is introduced to the estate is not yet known.

For researchers or decision makers to set priorities and measure outcomes of the Invasive weed research and control, they need a comprehensive and objective data on distribution and spread. Hence, systematic records of weed infestations can help support understanding of; what weed is found, where and when; changes in the area and density over time; and the effect of land management practices and weed management programs. Therefore, this assessment was accomplished with the objective of mapping and identifying the infestation of water hyacinth in order to lay ground for any type of management practices or intervention planned.

MATERIALS AND METHODS

Description of the Study Area

Field surveys were conducted in some water bodies having connection with the Awash River including Abasamuel Dam, Koka Dam, Lake Ellen, Wonji Sugar Estate and Awash River near Koka Town.

Abasamuel Dam is located near Akaki at 8°52’ N longitude, 38°04’ E latitude and at an altitude of 1900 masl. According to information given by the local people this Dam has been used by a significant number of local people for irrigation, fishing and as drinking water for cattle. Farmers in the area reported that foreign inhabitants residing nearby the Dam introduced water hyacinth to the Dam 30-40 years ago.

Lake Ellen is located at 08°23’ N longitude, 38°59’ E latitude and at an altitude of 1700 masl, 8 km west of Alem Tena town in Dugda Bora District. Koka Dam is located at 08°26’ N longitude and 39°10’ E latitude at an altitude of 1589 masl, is one of a few man-made reservoirs formed on the Awash River Southeast of Addis Ababa in the Rift Valley.

Wonji-Shoa Sugar Estate is located in the central part of the main East African Rift Valley at $8^{o}30`$ to $8^{o}35`$ longitude and $39^{o}20`$ latitude, at an altitude of 1540 masl. It is situated at about 107 km southeast of Addis Ababa. Major crops grown in these areas include teff, wheat, sugarcane, maize from cereals and cabbage, tomato and onion from vegetables.

Field Assessment on water hyacinth infestation

Survey was carried out in some of the Awash River catchments including Abasamuel Dam, Koka Dam, Lake Ellen, Wonji-Shoa Sugar Estate and Awash River near Koka town. The method adopted for surveying was going over the whole field of water bodies using local boats until all the area of the water bodies covered by the weed is noted. Then each infestation level of the weed was given an abundance score scale of 1 to 6 following the procedures of Phillips (1992) with slight modification: free = no infestation; 1 = a few individuals; 2 = only occasional patches or individuals; 3 = large patches or many individuals; 4 = widespread throughout the water body; 5 = a dense and serious infestation; and 6 = completely masked the water body. The abundance score value was again categorized from high to low infestation level following the procedure of Phillips (1992) (Table 1).

Table 1: Modified rating scale used for estimation of water hyacinth infestation level on water bodies (Phillips, 1992)

Level of infestation	Abundance score value
Free	No infestation
Low infestation	1 to 2
Medium infestation	3 to 4
High infestation	5 to 6

Moreover, plant population count was made by throwing a one meter square quadrat in zig-zag fashion by walking along the border for water bodies having limited infestation towards the border side. For those water bodies whose infestations were at the center, plant population count was made by throwing a quadrat ten times in x-fashion systematically over an assumed square encompassing at least most of infested water bodies using local boats. Numbers of samples were varied depending on prevalence and infestation level to accommodate at least one tenth of the infested area for the sample to be representative (Coyne *et al*., 2007). Hence the number of sample to be taken from each water bodies was determined following the procedures of Madsen (1993):

$$N = s^2 / (0.1 \times x)^2$$

Where: s is the standard deviation and x is mean from previous survey.

Moreover, to estimate water hyacinth coverage area distance from outside to the center was measured using a meter tape. Finally, prevalence and number of population per quadrat of the weed in the water bodies were analysed using SPSS (1996) computer software. Moreover, water hyacinth distribution map was developed for the Rift Valley water bodies using GIS computer software.

RESULTS AND DISCUSSION

Prevalence and Intensity of Water Hyacinth Infestation

Field assessment on the prevalence and intensity of water hyacinth infestation indicated that the weed was prevalent in all the surveyed water bodies with different magnitude of infestation. About 75% of the surveyed water bodies had more than 50% infestation level. Moreover, variations in the prevalence and level of infestation of water hyacinth were observed among and within the surveyed water bodies (Table 2). Fifty percent of the water bodies had more than 87% infestation (Table 2). The highest water hyacinth prevalence was recorded in Ellen (100%), Melka Hida (100%), Dodo wedera (98%) and Tere(96%), while the lowest (<20%) was recorded at Wonji-Shoa. In addition, the highest water hyacinth count [308 plants per quadrat (m^2)] was recorded at Koka Dam, whereas the lowest [12.00 plants per quadrat (m^2)] was found in Wonji-Shoa. This result agreed with a previous diagnostic survey result, whereby under severe infestation the number of water hyacinth reached up to 348 plants per quadrat (Dula *et al.,* 2008). This shows the importance of water hyacinth in the surveyed water bodies.

On the other hand, the interviewed people around Koka and Abasamuel Dam reported that there was severe infestation of the water bodies with water hyacinth prior to the survey period. Similarly, Senayit *et al.,* (2004) reported that the water bodies showed different level of water hyacinth infestation depending on the climatic factors. In most of the surveyed water bodies, it was found that high mats of water hyacinth infestation was prevalent in the border and shaded areas. This could be due to the high wind current blown over the water bodies and decrease in the water depth. In line with this, reports indicated that population dynamics of water hyacinth can be affected by the water level fluctuation and wave action (Gopal, 1987; Wilson *et al*., 2001). However, water hyacinths can still build-up on sheltered edges and at blockages.

Among the water bodies surveyed Lake Ellen, Melka Hida, Golodee, Dodo Wedera and Tere were having a dense and serious infestation with mean infestation of 4-5 abundance scale, while Koka Dam, Awash River, Sire Robi and Bate-gurmame have medium infestation (Table 2). The lowest infestation was recorded at Lake Abasamuel, Wonji Shoa and Afer Gidib.

Similarly, previous survey result showed that the infestation of water hyacinth on critical water bodies of Wonji-Showa Sugar Estate was reduced by over 73% within a period of 2 years, and only localized water hyacinth infestations were obtained with a magnitude ranging from free to low level in most parts of water bodies as a result of integrated management

Table 2: Prevalence, extent of infestation and infestation level of water hyacinth in the surveyed 12 water bodies of the Rift Valley

Water bodies	Numbers of spots of waterbodies observed	Approximate distance of distance from the border (m)	[a]Water hyacinth Prevalence (%)	Abundance scale	Infestation level	Mean water hyacinth count	[b]Number of water bodies with in water hyacinth density count	
							count interval	
							<250/m^2	251-350/m^2
Abasamuel	44	5.65	45	No infn to 5	Fto H	64.27	14	1
Afer Gidib	10	5.72	40	No infn to 4	F to M	261.00	2	2
Awash River	18	25.07	89	No infn to 5	F to H	185.63	7	9
Bate Gurmame	12	8.03	58	No infn to 4	Fto M	278.00	4	3
Dodo Wedera	44	77.50	98	5 to 6	H	243.81	24	19
Ellen	33	157.06	100	5 to 6	H	276.12	13	20
Ellen Golode	15	55.92	87	5 to 6	H	257.54	6	7
Koka Dam	10	9.67	60	3 to 6	M to H	308.00	1	5
Melka Hida	15	27.54	100	5 to 6	H	250.8	9	6
Sire Robii	32	12.40	88	3 to 6	M to H	283.00	11	17
Tere	24	40.78	96	5 to 6	H	211.04	9	14
Wonji-Shoa	17	2.00	18	No infn to 1	F-L	12.00	3	0
Mean	22.83	35. 61	73.21			219.27	8.58	8.58

NB- F- Free, M- Medium, H- High, L- low and No in fn- No infestation

[a] The percent of water bodies where water hyacinth prevailed, [b] Water hyacinth population count per quadrat with in the range

strategies performed by the Estate (Dula *et al*., 2008).

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High degree of variability was also observed among water bodies in their infestation with water hyacinth (Figure 1). At Lake Ellen, there were high water hyacinth infestations in most of the water bodies while a few spots showed low to medium infestation magnitude (Figure 1). This lake is located near farm lands and even part of the lake is farm land, which is cultivated as the water level decrease. So this created a high influx of nutrients into the lake which favored high reproduction rate of the weed. As a result water hyacinth forms mat covering part or all of the Lake making utilization of the water body very difficult. At this water body water hyacinth grew in association with other aquatic weed like *Typha*, *Cyperus*, *Panicum spp*. and other broad leaf weeds. The low infestation level depicted on the map didn't mean no water hyacinth weed in the area rather it was in association with other weed.

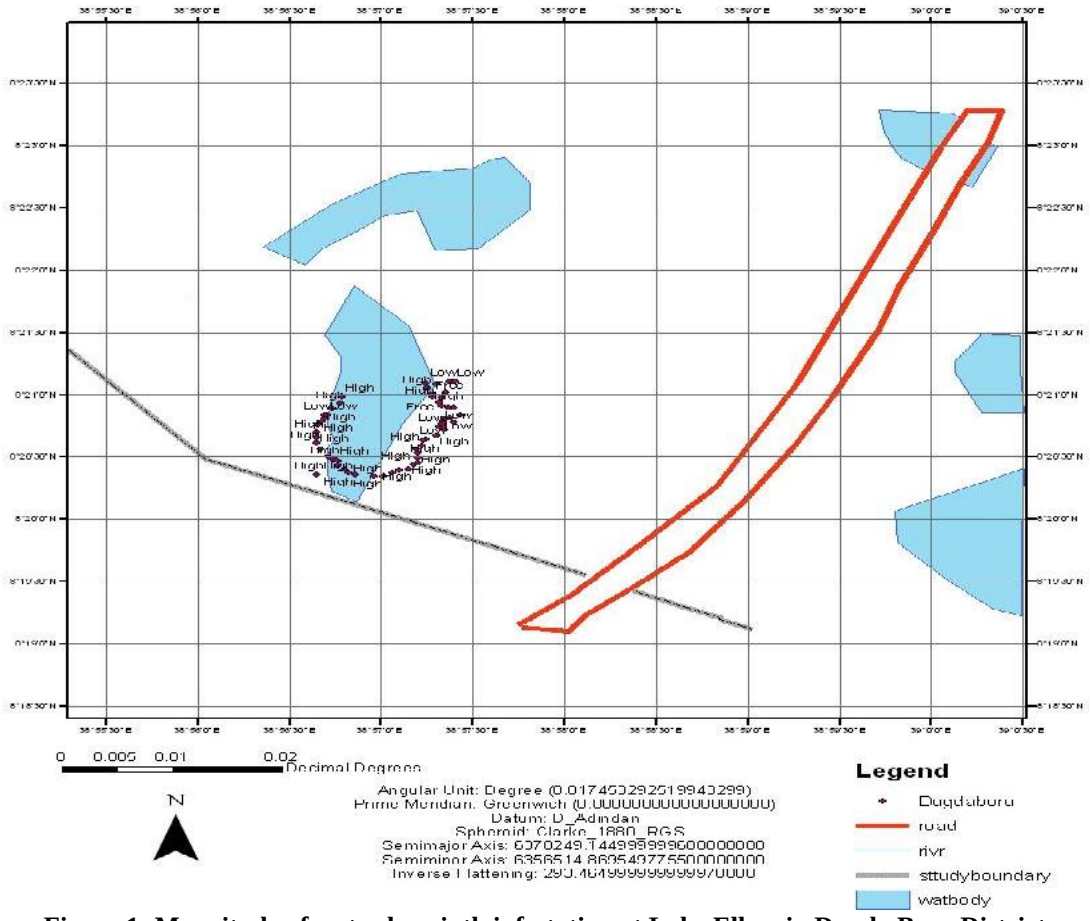

Figure 1: Magnitude of water hyacinth infestation at Lake Ellen, in Dugda Bora District

At Lake Koka and Awash River near Koka town, the infestation level ranged from no to high level of infestation (Figure 2). More than 50% of the water bodies showed high level of infestation. Severe water hyacinth infestation was observed at Koka Dam, near Sire Robe peasant association (PA) and at the upper Koka near Tere PA in Koka Lake and on Awash River on the border in part of the river on the side of Bora District. The result also indicated that the weed was concentrated on the border parts of the water bodies (muddy and high sediments accumulated part) where the disturbance by wind is relatively small. However, their mats were stretched towards the center (Figure 3). Part of the water bodies around the center remained clear with few floating plants which were detached as a result of the wind blown over the Lake.

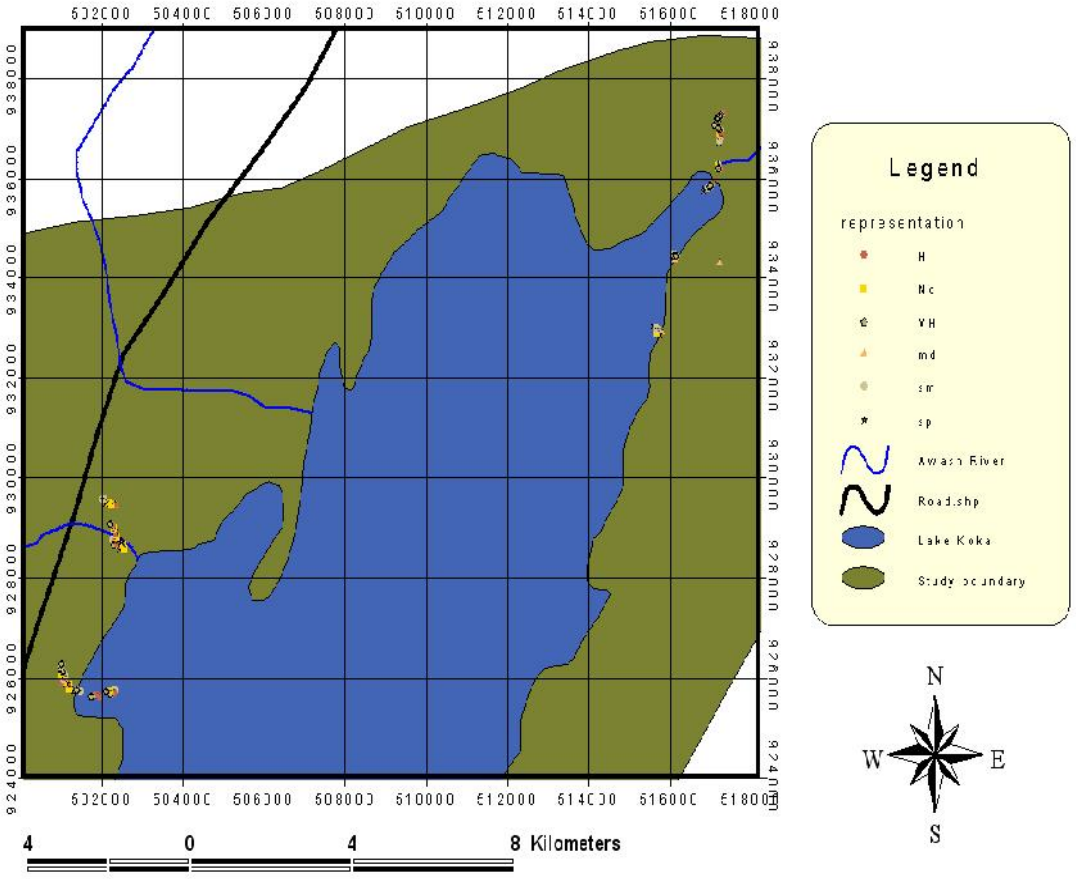

Figure 2: Magnitude of water hyacinth infestation at Lake Koka and in some parts of Awash River

Magnitude of infestation of Lake Abasamuel was relatively low in relation to the other water bodies (Figure 6) at that specific time. However, farmers in the area reported that the weed infests the whole water body in August and September. In October, the mats of water hyacinth break and move towards the border by the high wind pressure. It was observed in October that high dried biomass accumulation on the border of the Lake which proved the information given by the local farmers. This Lake is known with its high level organic residues that come from the nearby Addis Ababa which include factories and home waste disposal that arrives during the rainy season as a result of flood. So this makes the water body very favorable for water hyacinth growth. On the other hand, Abasamuel Lake is reported to be source of water hyacinth infestation to other water bodies in the Rift Valley (Rezene, 2005a)

CONCLUSIONS AND RECOMMENDATION

Summarized data on prevalence of water hyacinth in the assessed water bodies indicated that the value that ranged from 17 -100% was observed. Moreover, the highest water hyacinth prevalence was recorded in Ellen (100%), Melka Hida (100%), Dodo wedera (98%) and Tere(96%), while the lowest (<20%) was recorded at Wonji-Shoa. Furthermore, the highest water hyacinth count [308 plants per quadrat (m^2)] was recorded at Koka Dam, whereas the

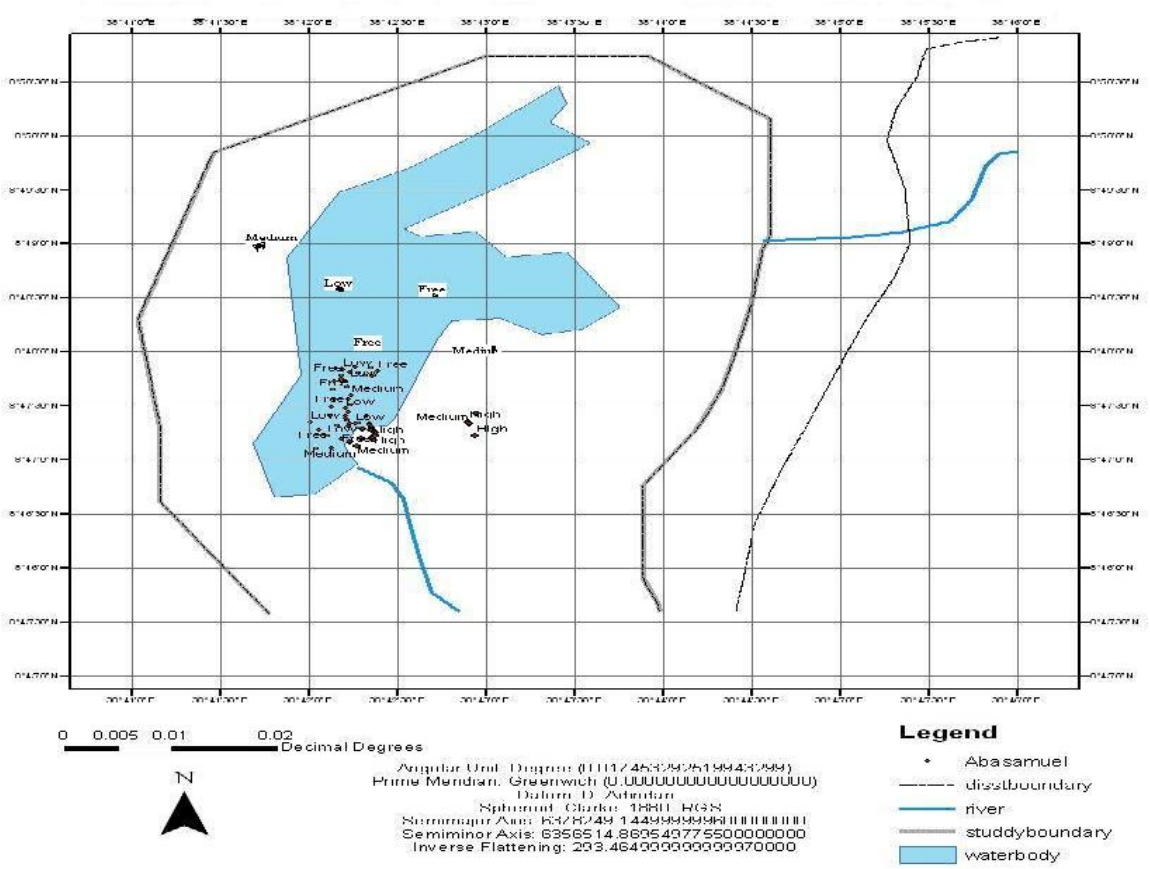

Figure 3: Magnitude of water hyacinth infestation at Lake Abasamuel

lowest [12.00 plants per quadrat (m^2)] was found in Wonji-Shoa. Generally, the distribution map also confirmed that there was high degree of variability among water bodies in their infestation with water hyacinth that ranged from free to high. The result clearly revealed that the infestation of weed was increasing from time to time causing enormous negative effect by making the water inaccessible for utilization and by affecting the livelihood of the community directly and indirectly. Hence, integrated effort of community, governmental and non-governmental organization in reducing the disastrous effect of the weed on the society was mandatory.

REFERENCE

Abera, T., G. Tariku, and Y. Firehun. 2004. Water hyacinth in sugarcane plantation of Wonji-Shoa. *A paper presented on Community Meeting on Invasive Alien Species Management in Ethiopia*, Melkassa, *EARO*, pp: 7-11.

Coyne, D.L., B. Claudius-cole, and J.M. Nicol. 2007. Practical Plant Nematology: A field and Laboratory Guide. SPIPM, IITA, CIMMYT, CTA Research to nourish Africa, Wagningen, The Netherlands, pp: 25-28.

Dula, A., Taye, T. and Y. Firehun. 2008. Efficacy of Integrated Water Hyacinth (*Eichhornia crassipes* [Mart] Solms-Laubach.) Management Strategies at Wonji-Shoa Sugar Factory. An M.SC. Thesis Presented to the School of Graduate Studies at Ambo University College. pp. 79.

Firehun, Y. and B. Solomon. 2002. Water hyacinth (*Eichhornia crassipes* Mart. Solms-Laubach) in Wonji-Shoa and Metahara Sugarcane Plantations: An Overview. Ethiopian Sugar Industry Support Center Research and Training Service, Wonji. pp: 7-11 In: *Second National Water Hyacinth Workshop of Ethiopia*. June 2006. Addis Ababa. Ethiopia.

Gopal, B. 1987. Water hyacinth. *Elesevier Science Publishers*, Amsterdam, 471 p.

Howard, G.W. and S.W. Matindi. 2003. *Alien Invasive Species in Africa's Wetlands. Some threats and solutions*. IUCN Eastern African Regional Program, Nairobi, Kenya, February 2003

in Ethiopia. *Arem* 6: Addis Ababa, Ethiopia pp: 24-30

Julien, M.H., M.W. Griffiths, and A.D. Wright. 1999. Biological control of water hyacinth. The weevils *Neochetina bruchi* and *N. eichhorniae*: biologies, host ranges, rearing, releasing and monitoring techniques for biological control of *Eichhornia crassipes*. ACIAR Monogrraph. No: 60. 87 p.

Lindsey, M., and H.M. Hirt. 1998. Use of water hyacinth: A practical handbook of uses for the water hyacinth from around the world.

Madsen, J.D. 1993. Biomass techniques for monitoring and assessing control of aquatic vegetation. 7, pp: 141–154. In: Madsen, J.D. and Bloomfield, A.J., ed., Aquatic vegetation quantification for lake management.

Phillips, MC. 1992. A survey of the arable weeds of Botswana. *Tropical Pest Management.* 38:1: 13 – 21.

Rezene, F. 2005a. A water hyacinth (*Eichhornia crassipes*): *A Review of its weed status in Ethiopia*. pp. 105 –111. *In*: Rezene Fessehaie (eds.), Arem, 6. Addis Ababa, Ethiopia.

Rezene, F. 2005b. Water hyacinth (*Eichhornia crassipes*): *A review of its weed status*

Senayit, R., T. Agajie, T. Taye, W. Adefires, and E. Getu. 2004. Invasive Alien Plant Control and Prevention in Ethiopia. Pilot Surveys and Control Baseline Conditions. Report submitted to EARO, Ethiopia and CABI under the PDF B phase of the UNEP GEF Project - Removing Barriers to Invasive Plant Management in Africa. EARO, Addis Ababa, Ethiopia.

SPSS. 1996. Statistical Packages for the Social Sciences. Cary, North Carolina.

Stroud, A. 1994. Water hyacinth (*Eichhornia crassipes* [Mart.] Solms) in Ethiopia. pp.7-16. *In*: Rezene Fessehaie (ed.). *Proceedings of the 9th Annual Conference of the Ethiopian Weed Science Committee*. 9-10 April 1991, Addis Ababa, Ethiopia. EWSC, Addis Ababa.

Tariku, G. 2001. Recurrent problems of the plantation department of Wonjishoa Sugar Estate.Wonji-Shoa Sugar Factroy, Wonji. In: Second National Water Hyacinth Workshop of Ethiopia. 12-14 June, 2006, a paper presented by Firehun et al , 2006.

Taye, T. 2006. The Biology and Ecology of water hyacinth. pp. 13-18. In: *Second National Water Hyacinth Workshop in Ethiopia*. Addis Ababa, Ethiopia.

Wilson, J.R., M. Rees, N. Holst, M.B. Thomas, and G. Hill. 2001. Water hyacinth population dynamics. 102, 152 p. In: Julien, M.H., Hill, M.P., Center, T.D. and Ding Jianqing, ed. 2001. Biological and Integrated Control of Water Hyacinth, Eichhornia crassipes. Proceedings of the Second Meeting of the Global Working Group for the Biological and Integrated Control of Water Hyacinth, Beijing, China, 9–12 October 2000.