

**A REVIEW OF THE EFFICACY OF THE LEGAL FRAMEWORK FOR WATER HYACINTH
MANAGEMENT IN KENYA'S WINAM GULF**

SUSAN ADOYO YARA

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CENTRE FOR ADVANCED STUDIES IN ENVIRONMENTAL
LAW AND POLICY (CASELAP)**

2019

DECLARATION

This Thesis is my original work and has not been presented for an award of a Degree in any other university.

Signature Date

SUSAN ADOYO YARA.

Z51/6853/2017.

This Thesis has been submitted for examination with our approval as university supervisors:

Signature Date.....

DR. IWONA RUMMEL BULSKA

SENIOR LECTURER

UNIVERSITY OF NAIROBI

Signature Date.....

DR. COLLINS ODOTE

SENIOR LECTURER

UNIVERSITY OF NAIROBI.

DEDICATION

This thesis is dedicated to my parents Mr. Francis and Mrs. Rachel Yara for their prayers, love and reassurance.

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ABSTRACT

Lake Victoria is a major source of livelihood to the communities living on the riparian land around the Lake with the communities heavily depending on it for water, fishing, transport and tourism. Over the years, the Lake has experienced high levels of pollution resulting to its degradation. Resultantly, an aquatic invasive weed known as the water hyacinth found a place to thrive and regenerate. The weed has been present in the Lake for decades now, wreaking havoc in its wake. Some of the negative effects include, reducing water levels, frustrating navigation, destroying fish gears, harboring snakes, providing a breeding ground for mosquitoes, causing the water to have a foul smell, lowering the oxygen levels in the water, preventing accessibility of the fishermen to fish and in some cases, death of children who drown while swimming around the weed. Despite all these negative effects, Kenya has been unable to effectively control/manage the weed. Among the four known methods of managing the weed, Kenya has tried biological control, mechanical control and manual harvesting, making chemical control the only method which has not been tested in the country. The legal framework on aquatic invasive weeds such as the water hyacinth is fragmented and incomprehensive with the main legislation touching on noxious weeds, The Suppression of Noxious Weeds Act (2012) being highly inadequate, scanty and irrelevant to Aquatic Invasive Species (AIS). The legislation fails to outline the standard procedures on the deliberate introduction of aquatic invasive species into natural habitats. Moreover, the Act gives provisions on land-based weeds only leaving aquatic invasive species ungoverned. The Act has failed to address how to manage, control and eradicate aquatic noxious weeds leaving authorities to experiment with management tools without any legal reference. The study sought to investigate the challenges facing effective implementation of the existing management techniques used to control hyacinth, the improvements that can be made to the legal framework on hyacinth and to find out the most suitable management tool that will curb the weed. The Winam Gulf, specifically Homabay County was the study area. Mixed method research design was used whereby information was obtained from fieldwork and review of past works of literature and legal instruments. The sample size derived was 137 which was divided among the main respondents; fishermen and fish traders. Key informants were interviewed and two focus group discussions conducted. From the study, it appeared that 100% of the respondents had no idea of any legal framework regarding the water hyacinth. Data that was collected showed that most respondents decided on mechanical control and manual collection as the most suitable method of controlling water hyacinth. The respondents believe that using machines would produce fast results which is what is needed since the hyacinth is greatly affected by the winds. On leaning towards manual collection, the respondents are of the idea that it would provide employment to the jobless youth under the initiative, '*Kazi Kwa Vijana*.' The Kenya National Bureau of Statistics (KNBS) County Statistical Abstract 2015 of Homabay County places 47.9% of the population to be living below poverty line. Some of the recommendations derived from the study include formulating legislation on AIS such as water hyacinth so that its control be in tandem with the law; need to clarify the specific ministry responsible for the management of AIS thereby knowing the exact department or agency to be held accountable; creating programs to deal with aquatic noxious weeds and allocating sufficient budget for such programs, encouraging coordination with other agencies to achieve interagency cooperation which will ensure that maximum effort is being put to realize positive results from joint initiatives, sanctioning individuals and industries discharging effluents into the Lake and its tributaries and upscaling enforcement actions. The overarching recommendation is for the optimum management option which is supported by the Integrated Weed Management theory, in this case, integrating mechanical and manual control to be supported by the law. From the comparative experience, it is clear that the countries discussed have been successful in controlling water hyacinth due to the inclusion of what they regard to be their optimum management option in their legislations and guidelines. Legal backing of the optimum management option legitimizes its application and provides the guiding principles to be followed.

ABBREVIATIONS

1. ACIAR Australian Centre for International Agricultural Research
2. ASAL Arid and Semi-Arid Land
3. BMU Beach Management Unit
4. EAC East African Community
5. ECOWB Ecologists Without Borders
6. ECOVIC East African Communities Organization for Management of
Lake Victoria
7. EMCA Environment Management and Coordination Act
8. FAO Food and Agriculture Organization
9. GDP Gross Domestic Product
10. GISD Global Invasive Species Database
11. IWM Integrated Weed Management
12. IUCN International Union for Conservation of Nature and Natural Resources
13. KARI Kenya Agricultural Research Institute
14. KMA Kenya Maritime Authority
15. KNBS Kenya National Bureau of Statistics
16. LVBC Lake Victoria Basin Commission
17. LVEMP Lake Victoria Environmental Program
18. LVFRP Lake Victoria Fisheries Research Project
19. LVRLAC Lake Victoria Local Region Local Authorities Co-operation
20. LVWATSAN Lake Victoria Water and Sanitation Initiative
21. NBI Nile Basin Initiative
22. NELSAP Nile Equatorial Lakes Subsidiary Action Plan
23. NEMA National Environment Management Authority
24. SEDAWOG Socio-Economic Data Working Group
25. WARMA Water Resources Management Authority
26. WRUA Water Resources Users Association

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LIST OF LAWS, POLICIES AND REGULATIONS

Kenyan Legal Instruments

1. Constitution of Kenya 2010
2. Environment Management and Coordination Act, No. 8 of 1999 as Amended in 2015
3. Suppression of Noxious Weeds Act, CAP 325
4. Fisheries Management and Development Act, No. 35 of 2016
5. Water Act, No. 43 of 2016
6. Agriculture, Fisheries & Food Authority Act, No. 13 of 2013
7. Lake Basin Development Authority Act, CAP 442
8. Pest Control Products Act, CAP 346 of 2012

Kenyan Policies

9. Kenya Fisheries Policy 2005

Kenyan Regulations

10. Water Quality Regulations 2006
11. Environmental Management & Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) Regulations 2009

EAC Regional Legal Instruments

12. Protocol on Sustainable Development of Lake Victoria 2003
13. Vision and Strategy Framework for Management and Development of Lake Victoria Basin 2003
14. The Convention for the establishment of the Lake Victoria Fisheries Organization 1996

Foreign Legal Instruments

New Zealand

15. New Zealand's Resource Management Act 1991

16. Biosecurity Act of New Zealand 1993
17. Hazardous Substances and New Organisms Act (HSNO) of New Zealand 1996

South Africa

18. Conservation of Agricultural Resources Act 43 of South Africa 1983
19. National Water Act of South Africa No. 36 of 1998

USA

20. Federal Noxious Weed Control and Eradication Act (FNWA) of USA 2004
21. Florida Statutes of 2011 Chapter 369
22. Colorado Noxious Weeds Act of 2003
23. Minnesota Noxious Weed Law 2018
24. Montana Code Annotated (MCA) 2017

CHAPTER ONE

INTRODUCTION

1.1 Background

Lake Victoria is a natural resource which is used by the communities living along the Lake for fishing, water supply, transport and tourism. More-so the Lake is shared between the three neighbouring countries i.e. Kenya which accommodates 6%, Uganda which takes a share of 43% and Tanzania which takes the larger share of 51%.¹ Furthermore, 18% of Lake Victoria's water catchment drains its voluminous waters into River Kagera as well as occupying part of Rwanda and Burundi in its upper watershed.² The Lake covers an area of sixty eight thousand square kilometers making it the second largest Lake in the world, supporting a population of approximately 30 million people.³ Lake Victoria is the backbone of socio-economic development in the riparian states. The fisheries provide employment with the fish industry contributing to the Kenya's GDP (Gross Domestic Product).⁴ The fish industry also contributes to the nation's revenue through the levying of taxes as well as license fees. Lake Victoria's fish production in 2013 made up 90% of inland capture fisheries from the total production from fishery and aquaculture which amounted to 186,700 tonnes.⁵

¹ Odada Eric, Wandiga Shem, Olago Daniel and Others, *Mitigation of Environmental Problems in Lake Victoria, East Africa; Causal Chain and Policy Options Analyses*. (2018) [online] ResearchGate. Available at: <https://www.researchgate.net/publication/8618949> accessed 11/1/2019.

² East African Community, Lake Victoria Basin Commission: Terms of Reference for Consultancy Services for A Project to Prepare Investment Plans for 15 Secondary Urban Centres Under The Lake Victoria Basin Water and Sanitation Initiative in Kenya, Tanzania, Uganda, Burundi and Rwanda. August 2008 at page 2

³ Odongkara, Konstantin., Abila Richard, and Onyango Paul. "Distribution of economic benefits from the fisheries of Lake Victoria." *Proceedings of the Lake Victoria stakeholders conference: meeting the challenges to sustainability of the fisheries resources*. 2005. Published by ResearchGate March 2014 accessed at <https://www.researchgate.net/publication/261133649>

⁴ Ibid "Kenya's fisheries and aquaculture sector contributes approximately 0.54 percent to the country's GDP (2013)"

⁵ FAO 2016-2019. Fishery and Aquaculture Country Profiles. Kenya (2016). Country Profile Fact Sheets. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 2016. [Cited 29 August 2019]. <http://www.fao.org/fishery/>

In 2014, the fisheries sector raked in Kshs. 40.4 billion making 0.8% of the country's GDP in that year.⁶

In Kenya; Siaya, Busia, Kisumu, Homa Bay and Migori Counties share Lake Victoria with Homabay and Kisumu Counties forming the Winam Gulf.

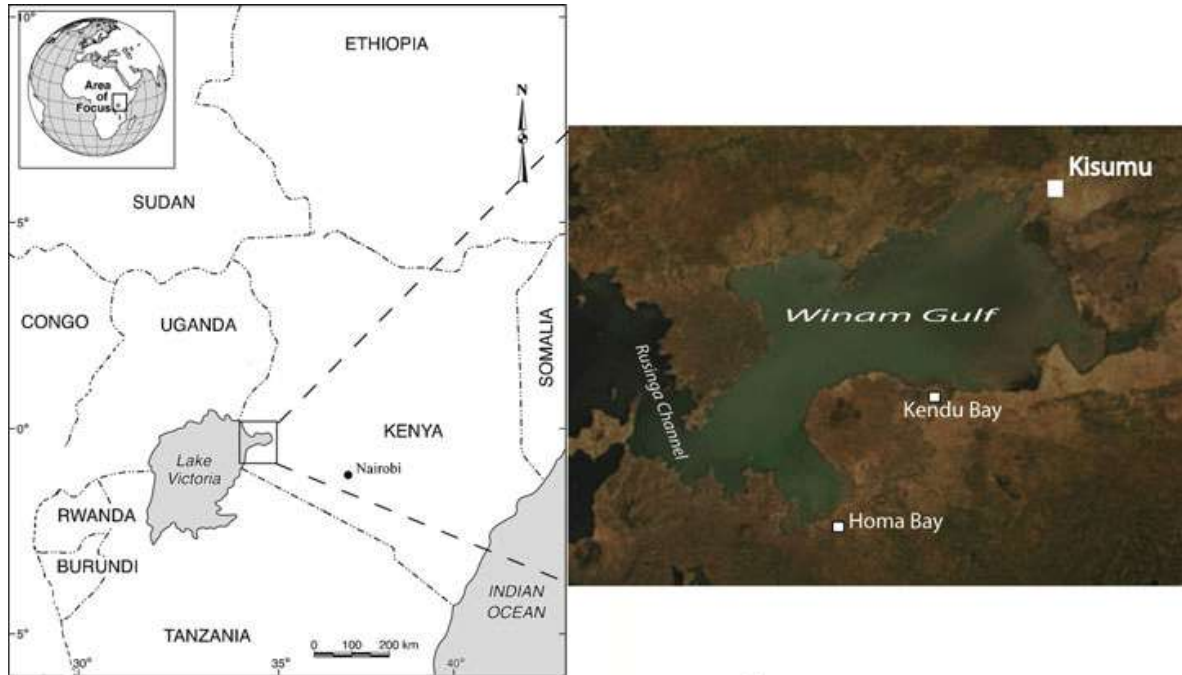


Figure 1: A map showing East African states that share Lake Victoria and the location of the Kenyan Winam Gulf (Source; Kiage, Lawrence M., and Obuoyo Joyce. "The potential link between El Nino and water hyacinth blooms in Winam Gulf of Lake Victoria, East Africa: evidence from satellite imagery." *Water resources management* 25, no. 14 (2011): 3931.)

The Lake's water quality and appearance has been deteriorating consistently over a considerable number of years as a result of increased quantities of heavy metals and antropogenic activities in the Lake.⁷ The most visible negative effect of the pollution is the presence of water hyacinth and the Winam Gulf is the most affected by the invasion of this

⁶ KNBS: www.knbs.or.ke. See also FAO 2016-2019. Fishery and Aquaculture Country Profiles. Kenya (2016). Country Profile Fact Sheets. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 2016. [Cited 29 August 2019]. <http://www.fao.org/fishery/>

⁷ Ogoyi, Dorington., Chacha Mwita, et al. 'Determination of heavy metal content in water, sediment and microalgae from Lake Victoria, East Africa.' *The Open Environmental Engineering Journal* 4, no. 1 (2011).

aquatic weed since it is the most polluted part of the Lake.⁸ The eutrophication of the Lake has been caused by direct discharge of untreated municipal sewage,⁹ use of fertilisers on farms which gets drained to the Lake by runoff water as it flows, collecting any waste along the way and drains the waste into the Lake.¹⁰ The rate of sedimentation of the Lake has been increasing over the past 150 years.¹¹ Since population has been on the increase, humans have been clearing land to create space leading to an increase in sedimentation in water bodies. The clearing of land around the Lake leads to attrition and vegetation depletion that act as sieves,¹² the sediments which are rich in nutrients, have encouraged eutrophication resultantly feeding hyacinth carpets. Eutrophication has been encouraged by unsustainable land use practices and lack of enforcement and monitoring regulations.¹³

Water hyacinth has thrived favourably due to plenty of nutritious contents in the Lake's water contents, abundance of space within the waters, conducive temperatures, lack of introduction to biological organisms aimed at consuming the weed as well as increasing levels of heavy metal contaminants in the Lake.¹⁴ Water hyacinth has resulted to adverse negative effects in terms of human health, water transport, water supply, agriculture as well as degradation of

⁸Otieno Ndede 'Water Hyacinth Menace in Lake Victoria, Kenya' (Japan International Cooperation Agency 3 October, 2016) <<https://www.slideshare.net/ElizaphanNdede/water-hyacinth-menace-in-Lake-victoria-kenya-66662407>> accessed 22/9/2018

⁹Wandiga Shem and Onyari John 1987. The concentration of heavy metals: Mn, Fe, Cu, Zn, Cd and Pb in sediments and fish from the Winam Gulf of Lake Victoria and fish bought in Mombasa town markets. Kenya J. Sci. 8, 5-18.

¹⁰Ibid p. 7

¹¹Markus Walsh, et al. Improved Land Management in the Lake Victoria Basin. Annual Technical Report July 2001 to June 2002. World Agroforestry Centre (ICRAF), Natural Resource Problems, Priorities and Policies Programme, Working Paper Series, Working Paper 2002-2. World Agroforestry Centre and National Agricultural and Livestock Extension Programme of the Kenya Ministry of Agriculture and Rural Development, Nairobi, Kenya.

¹²Lowe-McConnell, Rosemary. "The changing ecosystem of Lake Victoria, East Africa." *Freshwater Forum*. Vol. 4. No. 2. 2010.

¹³Scheren, P. A. G. M., H. A. Zanting, and A. M. C. Lemmens. "Estimation of water pollution sources in Lake Victoria, East Africa: application and elaboration of the rapid assessment methodology." *Journal of environmental management* 58.4 (2000): 235-248.

¹⁴Opande, George Ogueno, John Charles Onyango, and Samuel Otieno Wagai. "Lake Victoria: The water hyacinth (*Eichhornia crassipes* [MART.] SOLMS), its socio-economic effects, control measures and resurgence in the Winam gulf." *Limnologia* 34.1-2 (2004): 105-109.

biodiversity.¹⁵ More-so the hyacinth affects the normal breeding cycles of fish species namely the “Tilapia” where the weed blocks the light thus reducing the oxygen levels as well as allowing accumulation of toxic contaminant compounds such ammonia and hydrogen sulphide.¹⁶ Water hyacinth’s presence on the Lake has affected the water supply, human health, water transport, agriculture and the degradation of biodiversity.¹⁷ Since 1997, researchers have spent hundreds of millions of shillings seeking the best way to eradicate the hyacinth.¹⁸ Hyacinth mats have made navigation in the Lake difficult, records by The Kenya Maritime Authority (KMA) show that approximately forty thousand vessels had been in operation along the Kenyan shores of Lake Victoria way before water hyacinth invaded its waters.¹⁹ Management tools for hyacinth include; manual collection (collection by the people) of the hyacinth mats, biological intervention (use of insects among other natural predators to eat the weeds), chemical intervention (use of herbicides) and mechanical intervention (use of machines to remove the weeds). These tools, however, have their own challenges with manual collection being only viable in places where the hyacinth is not widespread,²⁰ biological intervention backfiring when the predators turn to destroy people’s crops on the land,²¹ chemical intervention posing a risk in contributing to irreversible

¹⁵ Otieno Ndede ‘Water Hyacinth Menace in Lake Victoria, Kenya’ (Japan International Cooperation Agency 3 October, 2016) <<https://www.slideshare.net/ElizaphanNdede/water-hyacinth-menace-in-Lake-victoria-kenya-66662407>> accessed 22/9/2018

¹⁶ Opande, George Ogueno, John Charles Onyango, and Samuel Otieno Wagai. "Lake Victoria: The water hyacinth (*Eichhornia crassipes* [MART.] SOLMS), its socio-economic effects, control measures and resurgence in the Winam gulf." *Limnologica* 34.1-2 (2004): 105-109.

¹⁷ Otieno Ndede ‘Water Hyacinth Menace in Lake Victoria, Kenya’ (Japan International Cooperation Agency 3 October, 2016) <<https://www.slideshare.net/ElizaphanNdede/water-hyacinth-menace-in-Lake-victoria-kenya-66662407>> accessed 22 February 2018

¹⁸ Odiwuor Mourine & Oywa John ‘War on Water Hyacinth Proves Costly for State’ Published by Standard Digital on 21st Feb 2017 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/article/2001230139/war-on-water-hyacinth-proves-costly-for-state> accessed on 2nd May 2019.

¹⁹ *ibid*

²⁰ Water Hyacinth Control and Possible Uses. Retrieved at http://library.uniteddversity.coop/Water_and_Sanitation/water_hyacinth_control.pdf on 1/10/2019

²¹ Odiwuor Mourine & Oywa John ‘War on Water Hyacinth Proves Costly for State’ Published by Standard Digital on 21st Feb 2017 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/article/2001230139/war-on-water-hyacinth-proves-costly-for-state> accessed on 2nd May 2019.

ecological changes and mechanical intervention proving too costly for Kenya.²² The hyacinth regenerates rapidly and this only frustrates the efforts of eradicating it.

In using chemical control, any small accident will lead to irreversible ecological damage. The advantage that chemical control has over mechanical control is that herbicide application is less costly though it has to be done more than once to prevent reinfestation. However, the application of herbicides has to be done sparingly and carefully so that water used for domestic consumption is not affected.²³ Jiménez cites that mechanical control (use of a shredder or chopper) is unsuitable since “fragmentation may accelerate the spread of plants..” resultantly, worsening the situation. For a country like Kenya, this mechanical control would be very costly as Jiménez puts the cost to be around US\$60 000 000-200 000 000. She goes ahead to discredit the efficiency of mechanical control by citing that the harvesting can only cover a small area per day of 1-2 acres and that the fragmentation during harvesting has the possibility of increasing the weed infestation. She further adds that the activity might cause the release of hydrocarbon pollutants which would prove to be costly and perpetual.

The use of biological control has been around from the 1960s. It involves use of natural predators of the weed. Jiménez is of the opinion that biological control is the most suitable intervention but subject to the following conditions; “surveying possible insect disease before and after release;ascertaining its reproductive capacity;continuing insect release;releasing new insects-ecotypes;understanding factors affecting insect population growth that regulate

²² ibid

²³Maricela M., Jimenez. “*Progress on water hyacinth (Eichhornia crassipes) management*”2003 Retrieved at ‘Weed Management for Developing Countries’ Addendum 1 Food and Agriculture Organization of the United Nations, Rome 2003 <http://www.fao.org/docrep/006/Y5031E/y5031e0c.htm> on 16/1/2019

and maintain populations at realistic sizes.”²⁴ An additional control measure that is noteworthy is phenology of the water hyacinth. In studying the life cycle of the weed, experts will know the best time to eliminate the weed.

1.2 Problem Statement

The presence of aquatic invasive weeds such as the water hyacinth poses a great danger to the availability of clean and fresh water. Lake Victoria has been attacked by this noxious weed with the Winam Gulf being the most affected region in Kenya.²⁵ Kenya has battled with effectively managing the weed for years. The Kenyan government contracted an American firm known as Aquarius Systems Co. Ltd in the early 90s to mechanically remove water hyacinth from Lake Victoria, paying it Kshs. 100 million. After failing to get rid of the weed, the company secretly left the country.²⁶ In 1997, Kenya Agricultural Research Institute (KARI), used biocontrol to try to stop the increase of hyacinth. KARI imported weevils which were released to the Lake and reported that the measure resulted to reduction by 50% of the weed cover. A year after the project was discontinued, the weed resurged and this time, covering a larger area than it had.²⁷ In 2016, water hyacinth harvester worth 81 million was purchased from Italy in a joint effort between LVEMP and the national government. The machine has been lying idle and a report tabled before the Senate showed that the machine was faulty.²⁸ On 16th January 2019, a dredger²⁹ measuring 70 metres was leased from ‘The

²⁴Ibid at Chapt. 2

²⁵‘Kenya Water Hyacinth’ <http://ecowb.org/kenya-water-hyacinth/> accessed on 5/3/2019 – “The environmental, social and economic impacts caused by the spread of water hyacinth have been extremely deleterious, particularly in Winam Gulf...”

²⁶Odiwuor Mourine & Oywa John ‘War on Water Hyacinth Proves Costly for State’ Published by Standard Digital on 21st Feb 2017 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/article/2001230139/war-on-water-hyacinth-proves-costly-for-state> accessed on 2nd May 2018.

²⁷ ibid

²⁸ Omollo Kevin, ‘Senate to probe controversial Sh81 million water hyacinth harvester.’ Published by Standard Digital on 21st Jan 2019 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/article/2001310153/senate-to-probe-controversial-sh81-million-water-hyacinth-harvester> accessed on 1/10/2019

²⁹ This marks a major milestone, the Lake was last dredged in 1990. According to the plan the port will be dug six metres deep. An 80-metre wide and 63km long canal will also be dug from Kisumu to Mbita. The waterway

Mango Tree Group’ which is a Chinese firm based in Uganda in conjunction with Lake Region Economic Bloc to eliminate water hyacinth, desilt the Kisumu Port and create a waterway for water vessels.³⁰ The multi-million dredger has been lying idle at the landing site of Kisumu’s Port since its commissioning by the AU High Representative for Infrastructure Development and ODM leader, Hon. Odinga and this delay is attributed to failure by the government to sign off a substantive agreement.³¹ Apart from the dredger³², the same firm was also contracted to ship in additional water hyacinth harvesters.³³ The Lake has been affected by water hyacinth and sedimentation which has blocked the Lake’s harbour and prevented navigation and docking.³⁴ On the day of the commissioning, Hon. Odinga said “The works to be done include clearing the marauding hyacinth and removal of accumulated silt, sand and rock which have built up due to prolonged inactivity thereby blocking access to the harbour.”³⁵ The dredging of the Kisumu Port project is intended to open up the Winam Gulf which is the most hyacinth infested area in Kenya’s Lake Victoria, extending to Homa Bay.³⁶ Out of all these initiatives, only the biocontrol of weevils by KARI held out long

will provide a key route for ships to transport cargo and people to far-flung islands and ports in Uganda and Tanzania.- Dredging port seen turning Kisumu into EA transport hub’ Published by Port News on 25/01/2019 <https://www.hellenicshippingnews.com/dredging-port-seen-turning-kisumu-into-ea-transport-hub/> accessed on 1/10/2019

³⁰ Otieno Kepher, ‘Port Dredger Unveiled by Raila Still Lying Idle’ Published by Standard Digital on 21st August 2019 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/business/article/2001338898/port-dredger-unveiled-by-raila-still-lying-idle> accessed on 1/10/2019

³¹ ibid

³² Dredging is an excavation activity usually carried out underwater to remove sand, silt, mud, rocks, weeds and rubbish among others to create routes for big vessels. - Dredging port seen turning Kisumu into EA transport hub’ Published by Port News on 25/01/2019 <https://www.hellenicshippingnews.com/dredging-port-seen-turning-kisumu-into-ea-transport-hub/> accessed on 1/10/2019

³³ Otieno Kepher, ‘Port Dredger Unveiled by Raila Still Lying Idle’ Published by Standard Digital on 21st August 2019 00:00:00 GMT +0300 <https://www.standardmedia.co.ke/business/article/2001338898/port-dredger-unveiled-by-raila-still-lying-idle> accessed on 1/10/2019

³⁴ Dredging port seen turning Kisumu into EA transport hub’ Published by Port News on 25/01/2019 <https://www.hellenicshippingnews.com/dredging-port-seen-turning-kisumu-into-ea-transport-hub/> accessed on 1/10/2019

³⁵ ibid

³⁶ Raballa Victor, ‘Lake Victoria shipping to grow as dredging of Kisumu port starts’ Published by Business Daily on 17/1/2019 at 20:48 <https://www.businessdailyafrica.com/news/counties/Lake-Victoria-shipping-to-grow/4003142-4939914-b242c9z/index.html> accessed on 1/10/2019

enough to produce noteworthy results and even this failed to be a long-term management option.

Despite the existence of varied management options (mechanical, chemical, manual and biological interventions) to deal with water hyacinth and efforts to apply them, the country is still facing the challenge of invasion of the Lake by the weed thus grappling with finding the most suitable and effective management tool, supported by a sound legal framework.

1.3 Research Questions

The study sought to answer the following questions;

- i. What are the effects of water hyacinth on the environment and fishing activities in the Winam Gulf?
- ii. What challenges face implementation of the existing management interventions to combat water hyacinth in Kenya?
- iii. How can the legal and institutional framework on water hyacinth in Kenya be improved to adequately address the management of water hyacinth in Winam Gulf of Kenya?
- iv. What lessons can Kenya learn from comparative experience of other countries?

1.4 Research Objectives

The study established the following objectives;

- i. To discuss the effects of water hyacinth on the environment and fishing activities in the Winam Gulf.
- ii. To explore the challenges facing implementation of the existing management techniques in combating water hyacinth.

- iii. To investigate possible improvements on the legal and institutional framework on water hyacinth in Kenya's Winam Gulf.
- iv. To study the lessons Kenya can learn from comparative experience from other countries.

1.5 Theoretical Framework

This study is theorized on Clarence Swanton's Integrated Weed Management (IWM) which is defined as the use of various weed control interventions including but not limited to biological, mechanical, chemical and physical control tools in a coordinated manner.³⁷ To manage invasive weeds, one has to use a combination of several tools as this will reduce the chances of the weed from adapting to the control tool if only one option was used.³⁸ Using only one tool will not be ideal to effectively control the weed and IWM involves different components that if used systematically, the result would be an advancement of weed management technology.³⁹ IWM relies on consolidating/integrating components, rather than separating them.⁴⁰ IWM should be acceptable ecologically, socially and economically.⁴¹ IWM is "predicated on ecological principles and integrates multidisciplinary methodologies in developing ecosystem management strategies that are practical, economical and protective of

³⁷Swanton J. Clarence and Weise F. Stephan, *Integrated Weed Management: The Rationale and Approach*. Weed Technology, Vol. 5, No. 3 (Jul. - Sep., 1991), pp. 657-663. Published by Weed Science Society of America and Allen Press. Retrieved at <http://www.jstor.org/stable/3987055> on 13/2/2019. See also "CREATING AN INTEGRATED WEED MANAGEMENT PLAN; A Handbook for Owners and Managers of Lands with Natural Values" Caring for the Land Series Volume IV March 2000 which describes IWM as "... a process by which one selects and applies a combination of management techniques (biological, chemical, mechanical, and cultural) that, together, will control a particular weed species or infestation efficiently and effectively, with minimal adverse impacts to non-target organisms."

³⁸*Integrated Weed Management*. Published by Montana Weed Control Association, retrieved at <https://www.mtweed.org/weeds/integrated-weed-management/> on 13/2/2019

³⁹Swanton J. Clarence and Weise F. Stephan, *Integrated Weed Management: The Rationale and Approach*. Weed Technology, Vol. 5, No. 3 (Jul. - Sep., 1991), pp. 657-663. Published by Weed Science Society of America and Allen Press. Retrieved at <http://www.jstor.org/stable/3987055> on 13/2/2019

⁴⁰Swanton J. Clarence, Mahoney J. Kris, Kevin Chandler, and Robert H. Gulden, *Integrated Weed Management: Knowledge-Based Weed Management Systems* published by Weed Science 2008 56:168–172. Retrieved at https://www.researchgate.net/profile/Clarence_Swanton/publication/232271636_Integrated_Weed_Management_Knowledge-Based_Weed_Management_Systems/links/09e41507f0b186a075000000.pdf on 13/2/2019

⁴¹Swanton J. Clarence & Murphy D. Scott. *Weed Science Beyond the Weeds: The role of intergrated weed management (IWM) in agroecosystem health* (1996). *Weed Sci.* 44:437-445

public and environmental health.⁴² IWM leads to ridding the water bodies off weeds which greatly affect the quality of water. This is in line with promoting sustainable development which is done through the effective and sustainable management of water resources.⁴³ To give a holistic approach towards conservation of water in Lake Victoria, IWM needs to be applied together with Integrated Water Resources Management (IWRM) and Integrated Waste Management to ensure comprehensive management of the Lake.

Global Water Partnership describes IWRM as ‘a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.’⁴⁴ Thomas and Durham describe it as ‘a sustainable approach to water management that recognizes its multidimensional character—time, space, multidiscipline and stakeholders—and the necessity to address, embrace and relate these dimensions holistically so that sustainable solutions can be brought about.’⁴⁵ IWRM aims to encourage integration and coordination to achieve a holistic water management to improve the sustainability of water resource.⁴⁶ Challenges facing IWRM include pollution, overconsumption of water, and the threats posed by floods and droughts which makes the journey towards achieving sustainable development difficult.⁴⁷ IWRM is based on the

⁴²Piper, G. L. 1991. Principles of integrated noxious weed management. In Proceedings of interagency weed management symposium, December 3-4, 1991. Corvallis, OR.

⁴³ Dungumaro, Esther W., and Ndalahwa F. Madulu. "Public participation in integrated water resources management: the case of Tanzania." *Physics and Chemistry of the Earth, Parts A/B/C* 28.20-27 (2003): 1009-1014.

⁴⁴ GWP, "Integrated water resources management", TAC Background Paper 4, Global Water Partnership Secretariat, Hantverkargatan 5, SE-112 21 Stockholm 2000

⁴⁵ Thomas, J., and B. Durham. Integrated water resource management: looking at the whole picture. *Desalination* 156(1-3):21-28. (2003)

⁴⁶ Braga, B. P. F. Integrated urban water resources management: a challenge into the 21st century. *International Journal of Water Resources Development* 17(4):581-599. (2001)

⁴⁷ Mitchell, Bruce. "Integrated water resource management, institutional arrangements, and land-use planning." *Environment and planning A* 37.8 (2005): 1335-1352.

following principles; ecological sustainability,⁴⁸ social equity⁴⁹ and economic efficiency⁵⁰ and these principles lead to the creation of sustainable water security.⁵¹

To get maximum positive results, there has to be application of Integrated Waste Management alongside IWM and IWRM so that the Lake does not undergo any further eutrophication. UNEP defines Integrated Waste Management as ‘a framework of reference for designing and implementing new waste management systems and for analyzing and optimizing existing systems.’⁵² This ensures that wastes from all media (liquid, solid and gas) are managed.⁵³

Since water hyacinth proliferation is encouraged by eutrophication which is caused by pollution. Undertaking activities on the premise of IWM, IWRM and Integrated Waste Management will yield positive results as there will be a multi-dimensional approach towards achieving sustainable development and ensuring that the Lake basin is sustainably managed. In creating an IWM-oriented plan, one needs to come up with basic steps and in this study, these steps will be; describing the area of study, stating the specific zones affected by the weed, create management objectives and goals, outline imports for weed control, choose management interventions based on the information gathered, develop and recommend an

⁴⁸ requires that aquatic ecosystems are acknowledged as users and that adequate allocation is made to sustain their natural functioning. Achieving this criterion also requires that land uses and developments that negatively impact these systems are avoided or limited.

⁴⁹ means ensuring equal access for all users (particularly marginalised and poorer user groups) to an adequate quantity and quality of water necessary to sustain human well being. The right of all users to the benefits gained from the use of water also needs to be considered when making water allocations.

⁵⁰ means bringing the greatest benefit to the greatest number of users possible with the available financial and water resources. This requires that the most economically efficient option is selected.

⁵¹ Integrated Water Resources Management: Basic Concepts. Retrieved from <https://www.iwapublishing.com/news/integrated-water-resources-management-basic-concepts> accessed on 3/10/2019

⁵² United Nations Environmental Programme 1996

⁵³ United Nations Economic Commission for Europe 1991. See also Seadon, J. K. "Integrated waste management—Looking beyond the solid waste horizon." *Waste management* 26.12 (2006): 1327-1336.

IWM-oriented plan and a monitoring plan to observe the results of the IWM plan.⁵⁴ Every researcher has to tailor-make an IWM-oriented plan for there to be high chances of success.⁵⁵ This study will therefore be based on IWM theory and the different water hyacinth management techniques will be analyzed extensively to see which techniques, if combined can effectively manage the spread of the weed. Since Kenya's legislature has immensely failed in the management of water hyacinth, IWM should back up the law so that environmental objectives are operationalized. It is clear that implementing this theory will assist in effectively implementing the laws regarding water hyacinth as it necessitates involvement of lead agencies, legislation, the public and stakeholders with the objective of achieving interagency co-operation and emphasizing importance on both human and environmental values.

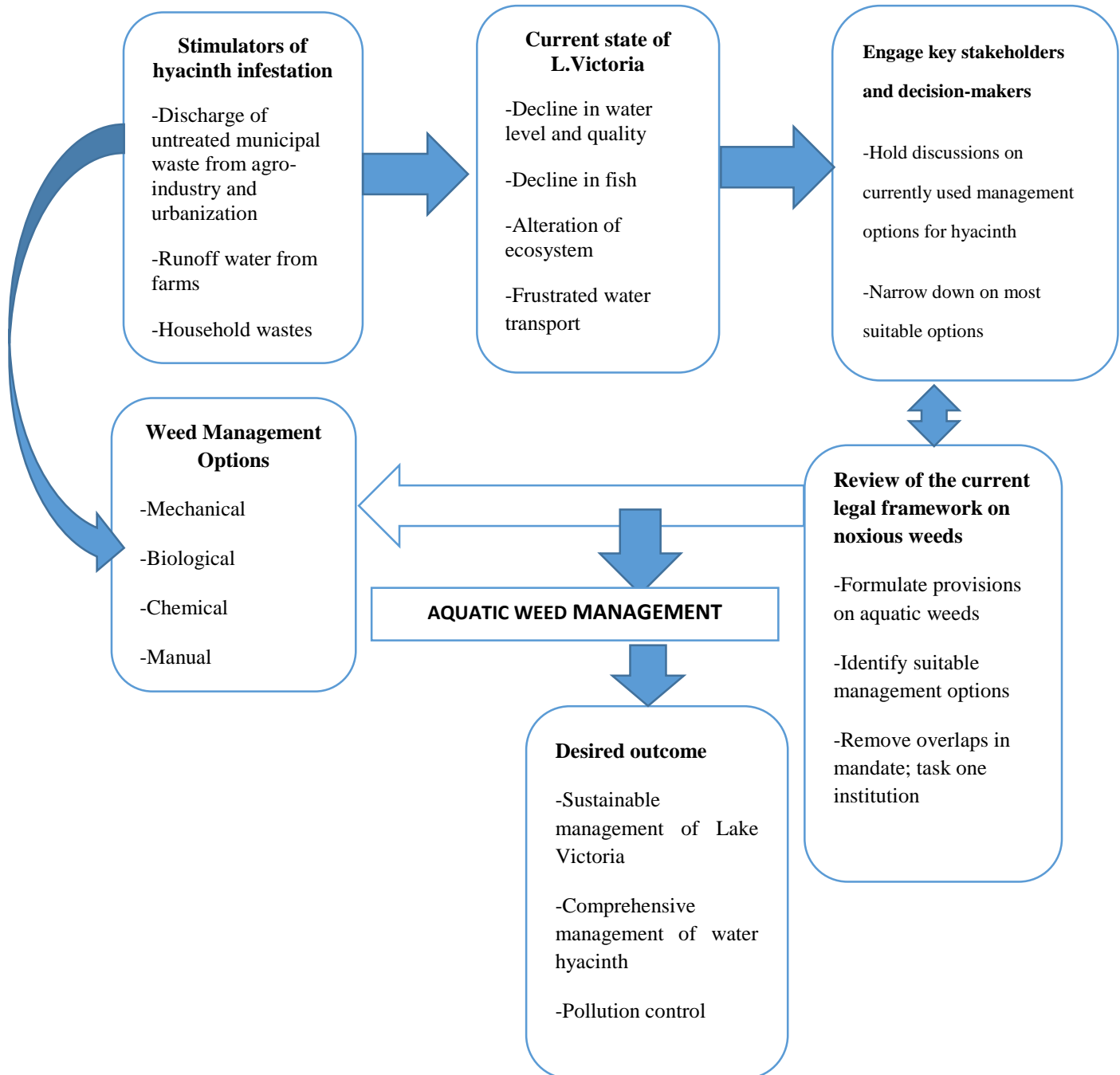
⁵⁴“CREATING AN INTEGRATED WEED MANAGEMENT PLAN; A Handbook for Owners and Managers of Lands with Natural Values” Caring for the Land Series Volume IV March 2000 Retrieved at <https://training.fws.gov/resources/course-resources/pesticides/IPM/IWMhandbooktext.pdf> on 14/2/2019

⁵⁵Ibid at page 58

1.6 Conceptual Framework

The conceptual model in this study shows the current state that the Lake is in due to the hyacinth infestation. It also shows the role that key stakeholders and the community have in formulating laws regarding the aquatic weed and the importance of creating a clear legal framework and mandating an institution to deal with aquatic weeds.

Figure 2: Conceptual Framework of the study (Source: Author's own)



1.7 Rationale/Justification of the Study

This study was conducted to assess the role of legal and institutional frameworks in aquatic weed management. Nationally, water hyacinth has not been given much attention despite its ecological effects. The various sectoral legislations and institutions have been unable to fight the invasive nature of the weed with the main legislation on noxious weeds in Kenya, the Suppression of Noxious Weeds Act 2012 mentioning hyacinth in the list of noxious weeds but giving provisions on land-based weeds.

1.8 Limitations of the Study

The study area, Winam Gulf is quite expansive, covering both Kisumu and Homabay Counties is also a limitation. The research had to ensure that there is time management to be able to cover Homabay County being the main focus of this study, which is a large area. Another limitation was financial restraints since this study was self-sponsored.

1.9 Thesis Outline

This thesis contains six chapters. Chapter one gives an introduction to the study which encompasses background of the study, statement of the problem, purpose of the study, research questions and objectives, theoretical and conceptual frameworks. Chapter two presents literature review. Research methodology is provided in chapter three. Here, the research design is outlined to contain the area of study, target population and research method that is used. Chapter four has the legal framework governing water hyacinth in Kenya, Uganda and Tanzania. It also provides a comparative lessons from Uganda, Tanzania, New Zealand and USA. Chapter five has findings from the field on the implementation of management options curbing water hyacinth in the Winam Gulf with chapter six containing conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This Chapter reviews relevant literature for the study. The literature reviewed are organized around themes of invasiveness of water hyacinth, its effects on fishing, its management options for dealing with the invasion of the weed to the Lake and the role of law in controlling the weed.

2.2 Origin of The Water Hyacinth and Its Invasive Nature

The weed was initially introduced in Africa through Egypt in the 1880s,⁵⁶ however, other authors state that the water hyacinth is said to have first been reported in Lake Naivasha in 1988.⁵⁷ The weed is described as the dominant weed species in Lake Naivasha because of its rapid spread over the surface of the Lake.⁵⁸ The same can be said for Lake Victoria.

As discussed earlier, the water hyacinth is an invasive weed which has changed the ecosystem of Lake Victoria. Gurevitch and Padilla⁵⁹ correlate invasive species with the extinction of native plants. They allude that invasive species cause the alteration of habitats, reduction in the number of native plants or their extinction altogether and the decline of species.

⁵⁶Warnimont, F.J. *La probleme la jacinthe de 'au Eichhornia crassipes Solms. problem in the Congo. The water hyacinth problem in the Congo catchment area.* (Democratic Republic of Congo, Leopoldville 1965) 23

⁵⁷Momanyi M., John, Mathooko Jude, Onywere Simon; 'Effect of Water Hyacinth Infestation on the Physicochemical Characteristics of Lake Naivasha' Published by International Journal of Humanities and Social Science Vol. 2 No. 7 April 2012.

⁵⁸ ibid

⁵⁹ Gurevitch Jessica and Padilla K. Dianna 'Are Invasive Species a Major Cause of Extinctions?' (TRENDS in Ecology and Evolution Vol. 19 No. 9 September 2004)

Eichhornia crassipes has been included in the International Union for Conservation of Natural Resources (IUCN) Red List⁶⁰ and Global Invasive Species Database (GISD 2010).⁶¹

2.3 Effect of Water Hyacinth on the Environment and Lake Victoria

The abundance of hyacinth on Lake Victoria has drastically changed the environment and the Lake. The presence of the weed has led to low water quality and a foul smell from the Lake.⁶² It has also caused evapotranspiration, water flow retardation, change in the physicochemical character of both hydrosol and water.⁶³ With the hyacinth, came an increased case of diseases such as bilharzia and mosquito as the weed mats provide breeding grounds for snails carrying bilharzia and mosquitoes that cause malaria.⁶⁴ The weed's mats also reduce the levels of oxygen in the water affecting the biodiversity in the Lake. When the weed dies and decays, it creates an anaerobic environment and production of harmful gases.⁶⁵ The weed seals off fishing grounds affecting the socio-economic status of the riparian communities.⁶⁶ Waterways are blocked by the mats leading to hindrance of navigation and stagnation of water vessels.⁶⁷ The presence of the weed impedes the generation of hydro-

⁶⁰IUCN (2003) *IUCN Red List of Threatened Species*, International Union for Conservation of Nature and Natural Resources – The World Conservation Union, Species Survival Commission accessed at <http://www.redlist.org> on 2/5/2018

⁶¹Global Invasive Species Database (2018). Downloaded from <http://www.iucngisd.org/gisd/search.php> on 02-05-2018.

⁶² Mailu, A. M. "Preliminary assessment of the social, economic and environmental impacts of water hyacinth in Lake Victoria Basin and status of control." *ACIAR proceedings*. ACIAR; 1998, 2000.

⁶³ Shanab, Sanaa MM, et al. "Allelopathic effects of water hyacinth [*Eichhornia crassipes*]." *PloS one* 5.10 (2010): e13200.

⁶⁴ Mailu, A. M. "Preliminary assessment of the social, economic and environmental impacts of water hyacinth in Lake Victoria Basin and status of control." *ACIAR proceedings*. ACIAR; 1998, 2000.

⁶⁵ Ibid page 136. See also Shanab, Sanaa MM, et al. "Allelopathic effects of water hyacinth [*Eichhornia crassipes*]." *PloS one* 5.10 (2010): e13200

⁶⁶ Balirwa, John S., et al. "Biodiversity and fishery sustainability in the Lake Victoria basin: an unexpected marriage?" *BioScience* 53.8 (2003): 703-715.

⁶⁷ Kateregga, Ezeza, and Sterner Thomas. "Lake Victoria fish stocks and the effects of water hyacinth." *The Journal of Environment & Development* 18.1 (2009): 62-78.

electricity and obstructs water intake for water supply.⁶⁸ It also affects the recreational use of the Lake like swimming, boat riding and sightseeing.⁶⁹

2.4 Relationship between Pollution and Emergence of Water Hyacinth

Extreme progression of floating macrophytes such as the water hyacinth is a well-known detrimental result of eutrophication.⁷⁰ The weed infestation has been encouraged by pollution caused by the rapidly growing population of the community living along the Lake and the establishment of industries which result to discharge of untreated domestic and industrial waste and nutrient-rich sediments into the Lake.⁷¹ The proliferation of water hyacinth is an indication of wider watershed management and pollution tribulations in the Winam Gulf.⁷² Section 72 of *EMCA* criminalizes discharge of poison, toxic, noxious or obstructing matter, radioactive waste or other pollutants into the aquatic environment in contravention of water pollution control standards established in the Act; this offence carries a prison term not more than two years or a fine of not more than one million or both. Additionally, upon conviction, the person found guilty is obligated to pay the cost of the removal of any pollutant, cater for the costs of restoration of the damaged environment, and to pay reparations to third parties, cost of restoration, restitution or compensation as may be determined by a court of law on application by such third parties. Section 49 of the *Fisheries Management and Development*

⁶⁸ Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* 42.JUL. (2004): 73-84.

⁶⁹ Téllez, Trinidad Ruiz, et al. "The water hyacinth, *Eichhornia crassipes*: an invasive plant in the Guadiana River Basin (Spain)." *Aquatic Invasions* 3.1 (2008): 42-53.

⁷⁰ Bicudo, Denise De C., et al. "Undesirable side- effects of water hyacinth control in a shallow tropical reservoir." *Freshwater biology* 52.6 (2007): 1120-1133. See also Mahujchariyawong, Jukkrit, and Saburo Ikeda. "Modelling of environmental phytoremediation in eutrophic river—the case of water hyacinth harvest in Thachin River, Thailand." *Ecological modelling* 142.1-2 (2001): 121-134.

⁷¹ Kateregga, Eseza, and Thomas Sterner. "Indicators for an invasive species: Water hyacinths in Lake Victoria." *Ecological Indicators* 7.2 (2007): 362-370.

⁷² Gichuki John et al. Water Hyacinth *Eichhornia crassipes* (Mart.) Solms-Laubach Dynamics and Succession in the Nyanza Gulf of Lake Victoria (East Africa): Implications for Water Quality and Biodiversity Conservation. *ScientificWorldJournal*. 2012; 2012: 106429.

Act 2016 also prohibits pollution of Kenyan fishery waters and imposes sanctions on the person who breaks this law.⁷³ The state should implement Integrated Water Resource Management together with Integrated Waste Management to abate pollution of water bodies and also conduct environmental education programmes within the Lake basin. A noteworthy approach for water hyacinth control would be the cutback of nutrients in the Lake and its feeder rivers. This can be attained by the treatment of waters discharged from sewage works and factories, and this is done by the installation of treatment plants; minimising the use of pesticides and fertilizers; practising best waste management practices and ensuring that court-sanctioned restoration orders are carried out. The main contributors of pollution on water resources are; use of pesticides and fertilizers and release of industrial and domestic wastes.

a) Use of Pesticides and Fertilizers

Lake Victoria (Kenya) gulf waters are highly eutrophic, with a number of rivers traversing fertile agricultural land and transporting significant amounts of eroded materials feeding into it.⁷⁴ The amplified presence of nutrients leading to eutrophication in the Lake water enables the sustenance of water hyacinth in the Winam Gulf.⁷⁵ The use of fertilizers and pesticides have been significantly used in large-scale farms within the Kenyan Lake Victoria basin to improve agricultural production.⁷⁶ Once it rains, run-off water laden with pesticides and

⁷³The Fisheries Service is established under the Fisheries Management and Development Act 2016 and mandated to conserve, manage and develop Kenya's fisheries resources in accordance with the Act – Section 7

⁷⁴ Mwamburi, Job. "Lake Sedimentary Environments and Roles of Accumulating Organic Matter in Biogeochemical Cycling Processes and Contaminants Loading Are Invasions of Water Hyacinth in Lake Victoria from 1989 a Concern?." *Persistent Organic Pollutants*. IntechOpen, 2018.

⁷⁵ Lung'ayia H, Sitoki L, Kenyanya M. The nutrient enrichment of Lake Victoria (Kenyan waters). *Hydrobiologia*. 2001;458:75-82. DOI: 10.1023/A:1013128027773. See also Lung'ayia HBO, M'Harzi A, Tackx M, Gichuki J, Symoens JJ. Phytoplankton community structure and environment in the Kenyan waters of Lake Victoria. *Freshwater Biology*. 2000;43:529-543. DOI: 10.1046/j.1365-2427.2000.t01-1-00525.x and Sitoki L, Kurmayer R, Rott E. Spatial variation of phytoplankton composition, biovolume, and resulting microcystin concentrations in the Nyanza gulf (Lake Victoria, Kenya). *Hydrobiologia*. 2012;691:109-122. DOI: 10.1007/s10750-012-1062-8

⁷⁶ Abong'o, Deborah Atieno et al. "Organochlorine pesticide residue levels in soil from the Nyando River Catchment, Kenya." *Africa Journal of Physical Sciences ISSN: 2313-3317* 2.1 (2015). See also Shepherd. K., M. Walsh, F. Mugo, C. Ong, T. Svan Hansen, B. Swallow, A. Awiti, M. Hai, et al. (2000): Improved Land Management in Lake Victoria Basin: Linking Land and Lake, Research and Extension, Catchment and Lake

fertilizers find their way into tributaries which flow into the Lake basin.⁷⁷ Huge amounts of residues of pesticides and their breakdown products were found in weeds, fish, soil and water in Kenyan Lake Victoria basin.⁷⁸

b) Discharge of Industrial Waste

Due to the increased pollution in the environment, The National Environmental Management Authority (NEMA) made the decision to shut down 25 factories which the Authority accused of discharging untreated industrial effluents into the Nairobi River. These factories are accused of failing to comply with regulations on waste discharge which includes putting up water treatment facilities in line with the *Water Quality Regulations*.⁷⁹ For closed factories to be re-opened, they have to comply with environmental laws and install effluent treatment plants.⁸⁰ Tributaries of Lake Victoria have been suffering from industrial waste discharge with establishment of factories along the courses of these tributaries. Sugar companies have been discharging their effluents into rivers feeding into the Lake. Chemelil and Muhoroni Sugar Factories discharge their molasses into River Nyando while Mumias Sugar Factory and the Webuye Pan Africa Paper Mill discharges its effluents to River Nzoia.⁸¹ Another

Basin, First Report of Progress and Results July 1999 to March 2000. Working paper 2000-2. Nairobi: International Centre for Research in Agroforestry.

⁷⁷ Abong'o, Deborah Atieno et al. "Organochlorine pesticide residue levels in soil from the Nyando River Catchment, Kenya." *Africa Journal of Physical Sciences ISSN: 2313-3317* 2.1 (2015).

⁷⁸ Madadi, V.O. Chemodynamics studies and assessment of pesticides residue levels in Lake Victoria catchment area for Rivers Sio and Nzoia. MSc. Thesis (2005) Department of Chemistry, University of Nairobi. See also Getenga, Z.M., Kengara, F.O. & Wandiga, S.O. Determination of organochlorine pesticides in soil and water from River Nyando Drainage system within Lake Victoria Basin, Kenya. *Bull. Environ. Contam. Toxicol*(2004) 72(2): 335-342.

⁷⁹ Mutanu Bernadine, 'NEMA shuts down 25 factory in Nairobi River Cleanup' Published by Daily Nation online on 15 May 2019 accessed at <https://www.nation.co.ke/news/Nema-to-close-down-25-factory-in-Nairobi-River-cleanup/1056-5116302-b2o0shz/index.html> on 11/9/2019

⁸⁰ Koech Gilbert, 'Nema shuts 36 factories for discharging effluent' Published on: 10 June 2019 - 05:00 accessed at <https://www.the-star.co.ke/news/2019-06-10-nema-shuts-36-factories-for-discharging-effluent/> on 11/9/2019

⁸¹ Mulei S., Kithiia 'Water Quality Degradation Trends in Kenya over the Last Decade, Water Quality Monitoring and Assessment', Dr. Voudouris (Ed.), ISBN: 978-953-51-0486-5, InTech, (2012). Available from: <http://www.intechopen.com/books/water-quality-monitoring-and-assessment/water-quality-degradation-trends-in-kenya-over-the-last-decade>

river which is affected is River Kibos which has been polluted by raw effluents being discharged by Kibos Sugar Factory.⁸² The three Rivers, Nyando, Kibos and River Nzoia drain into Lake Victoria leading to industrial pollution of the Lake.

c) Discharge of Domestic Waste

The growing population in Kenya has led to anthropogenic generation of waste, and some of these wastes are disposed off improperly into the environment. Domestic waste consists of biodegradable⁸³ and non-biodegradable⁸⁴ waste. Waste collection is taken care of by the county government which is expected to organize the collection and transportation of domestic waste. The waste is then disposed off in open dumpsites such as the Dandora Dumpsite. Majority of workforce managing the disposal spots have little or no training on how to run these facilities.⁸⁵ The challenges experienced in waste management along the Lake has led to improper disposal of domestic waste which find its way into the Lake. High poverty levels in Nyanza has made it difficult for households to afford paying for waste management services leading to dumping of waste in undesignated areas such as highways, rivers and streams feeding into Lake Victoria.⁸⁶ The 2014 *National Solid Waste Management Strategy* suggests that to achieve management of waste, the following have to be implemented; “adoption of emerging technologies in waste management, increased public awareness on waste management and related opportunities, increase involvement of the private sector, source for external financial resources from development partners and

⁸² Raballa Victor, ‘Sugar miller on the spot for polluting Lake Victoria waters’ Published on 24 February 2019 accessed at <https://www.nation.co.ke/business/996-4996792-1437dlz/index.html> on 12/9/2019

⁸³ which comprises of food and kitchen waste, green waste paper

⁸⁴ such as plastics, glass bottles, cans, metals and wrapping materials.

⁸⁵ The National Solid Waste Management Strategy. A publication of the National Environment Management Authority, Kenya (NEMA) 2014

⁸⁶ Ibid p. 20-26

investors, explore investment opportunities in recycling, energy recovery, composting, incineration.⁸⁷

2.5 Effects of Water Hyacinth on Fish And Fishing Activities

A LVFRP (Lake Victoria Fisheries Research Project) study in 1999 conducted in all 3 of the riparian states sharing Lake Victoria, showed that 33% of the respondents blamed the decline in fish stock to the contravention of the fishing regulations in place, 32% attributed the decline to excessive fishing while 11% attributed the decline to invasive species.⁸⁸ The interlink in fish decline to water hyacinth invasion is that the weed mats cover breeding, nursery and feeding grounds of fish stocks.⁸⁹ The water hyacinth affects fishing activities along the Lake and this is evidenced by the writings of Kateregga and Sterner⁹⁰ which link the 'catchability' of fish to the presence of water hyacinth. In a previous study done from 1983-2000, it showed a positive effect to the weed invasion in that water hyacinth frustrated fishing activities resultantly leading to the prevention of overfishing and this ultimately, temporarily stalled the decline of fish stocks. They describe water hyacinth as an 'obstacle' to fishing. Their study showed that fish catchability went down by a factor of 2-45% at a time when the water hyacinth infestation was at its peak. Although water hyacinth is problematic, it is worth noting that it prevents overfishing and thus prevents major fish stock decline. Kateregga and Sterner attributed the decline in Nile Perch catches in Uganda by 20% in 2005 to water hyacinth with more decline in 2007. They used data from Uganda Statistical Abstract 2006 to support their stand that hyacinths cause delays in overfishing.⁹¹

⁸⁷ Ibid p. 31

⁸⁸ Fisheries Co-Management Options at Kiumba Beach: A participatory Pilot Study. LVFRP/TECH/00/08, *The Lake Victoria Fisheries Research Project Technical Document No. 6, Jinja, Uganda.* (SEDAWOG 2000)

⁸⁹ Twongo Timothy 'Evolution of the Water hyacinth Problem in Uganda.' Presidential Economic Council Report prepared for the Task Force on Water Hyacinth Control, May 1998.

⁹⁰ Kateregga Eseza, and Sterner Thomas. "Lake Victoria fish stocks and the effects of water hyacinth." *The Journal of Environment & Development* 18, no. 1 (2009): 62-78

⁹¹ Ibid p. 65

2.6 Options for Controlling/Managing Water Hyacinth

Water hyacinth can be controlled through the following management methods; chemical control, biological control, mechanical control and manual collection. These methods have their strengths and weaknesses.⁹² Most authors lump ‘manual collection’ and ‘mechanical control’ to be one approach, ‘physical control’. However, it would be better that these two be separated as the former is a ‘hands-on’ approach based on human intervention while the latter is through use of machines being operated by people who have specialised in using such machinery. The management of water hyacinth is vital since it causes an ecological imbalance. Using two or more of the methods listed above would work well if these methods promote sustainable development.

a) *Biological Control*

Also known as ‘biocontrol’, biological control is the use of host specific natural predators such as insects to get rid of water hyacinth in water bodies. Countries such as Benin, South Africa, USA, Uganda, Tanzania, Papua New Guinea and Kenya, have used weevils as biocontrol measure. *N. bruchi* and *N. eichornea* have proved to be very useful in the control of water hyacinth. Eutrophication of water bodies has encouraged the progression of water hyacinth since the weed thrives in high concentrations of Nitrogen and Phosphorous which can be reduced by the weevils.⁹³ Water hyacinth growth in nutrient-rich area can increase eight times in biomass with higher and leafy foliage than water hyacinth found in nutrient-poor areas.⁹⁴ *N. bruchi* and *N. eichorniae* reduce the weed’s growth as they feed on its leaves

⁹²Momanyi M., John ‘Lessons for Effective Management of Water Hyacinth (*Eichornia Crassipes* (Mart.) Solms) in Kenya. Published by International Journal of Humanities and Social Science Vol. 4 No. 9 July 2014

⁹³ Gopal, B. (1987) *Water Hyacinth*. Aquatic Plant Studies I. Elsevier, Amsterdam, the Netherlands.

⁹⁴ Lugo, A.E., Utsch, G.R., Brinson, M.M. & Kane, E. Metabolism and biomass of water-hyacinth (*Eichornia crassipes*) dominated ponds and canals in the vicinity of Gainesville, Florida. *Geo-Eco-Trop*, 2, 415±441. 1978

and roots thereby reducing its biomass.⁹⁵ *N. bruchi*,⁹⁶ however, is the most ideal weevil to use where there are high nutrient concentrations since *N. eichornea* does not exert the same reduction levels.⁹⁷ Although weevils are preferred to herbicides, some authors like Center, propose that an integrated approach using both insects and herbicides should be used.⁹⁸ Biocontrol as an alternative to mechanical and chemical approaches, prevents the use of lethal substances into the environment, does not require intensive labour or equipments and has the ability to be self-sustaining.⁹⁹ Most of the financial costs in biocontrol is directed towards research and development.¹⁰⁰

b) Chemical Control

Chemical control involves the use of herbicides such as Glyphosate (Roundup), Diquat and 2, 4-D amine to control the weed. It has proved to be efficient in countries like Mexico where dissolved oxygen increased and Nigeria where it led to a rise in fish stock fourteen days after application.¹⁰¹ Chemical control is less costly and requires less labour compared to mechanical control.¹⁰² However, using chemical control would be expensive if it required constant applications.¹⁰³ Use of chemical control can lead to oxygen depletion when the

⁹⁵ Heard, Tim A., and Shaun L. Winterton. "Interactions between nutrient status and weevil herbivory in the biological control of water hyacinth." *Journal of Applied Ecology* 37.1 (2000): 117-127.

⁹⁶ *N. bruchi* reflects quicker development, higher survival and higher fecundity, particularly in early adult life. The net reproductive rate is a measure of their capacity to multiply within the generation. Thus on plants grown at high water nutrient concentrations, *N. bruchi* has the capacity to increase 93 times in a generation. On plants grown at medium nutrient concentrations, however, *N. bruchi* can increase only 55 times in a generation. - Heard, Tim A., and Shaun L. Winterton. "Interactions between nutrient status and weevil herbivory in the biological control of water hyacinth." *Journal of Applied Ecology* 37.1 (2000): 117-127.

⁹⁷ *Ibid* p. 126

⁹⁸ Center, Ted D., et al. "Biological control of water hyacinth under conditions of maintenance management: can herbicides and insects be integrated?." *Environmental Management* 23.2 (1999): 241-256.

⁹⁹ Seagrave C., Aquatic Weed Control. Published by Fishing News Books, Surrey (1988)

¹⁰⁰ Villamagna, A. M., and B. R. Murphy. "Ecological and socio- economic impacts of invasive water hyacinth (*Eichhornia crassipes*): a review." *Freshwater biology* 55.2 (2010): 282-298.

¹⁰¹ *Ibid* p. 94

¹⁰² Guitierrez-Lopez 'E. Effect of glyphosate on different densities of water hyacinth. *Journal of Aquatic Plant Management*', 31, 255-257. (1993)

¹⁰³ Villamagna, A. M., and B. R. Murphy. "Ecological and socio- economic impacts of invasive water hyacinth (*Eichhornia crassipes*): a review." *Freshwater biology* 55.2 (2010): 282-298.

weeds start to decompose after treatment and this will ultimately lead to death of fish.¹⁰⁴ It's advisable to treat the weed infested area in sections and let every section decompose for approximately 2-3 weeks before proceeding to treat another section. The oxygen depletion will be cured by aeration of the sections taking place.¹⁰⁵ This control measure is subject to water-use restrictions because it is likely pose irreversible harm to the environment.

c) Mechanical Control

Water hyacinth can be controlled using machines. This control method has no water-use restrictions and does not need superior technical expertise.¹⁰⁶ Since mechanical control involves in-situ cutting, the plants are left to die and decompose in their habitat, leading to decreased dissolved oxygen and alteration of trophic structure due to released nutrients and carbon.¹⁰⁷ Though mechanical control is fast and considered the best short-term solution, it is costly as the machines are expensive.¹⁰⁸ Moreover, using a shredder machine will only lead to dispersal of the weed, making it spread to uninfested areas.

d) Manual Control

Water hyacinth can be manually collected by using rakes. This method is mostly used by riparian communities as a self imposed initiative. This control method is however, suitable to small areas since it is labour intensive and it is plagued with serious health hazards, for example, Lake Victoria is has crocodiles, hippos and snakes. The Lake also acts as a breeding

¹⁰⁴ 'How to Control Water Hyacinth' accessed at <https://aquaplant.tamu.edu/management-options/water-hyacinth/> on 26/9/2019

¹⁰⁵ *ibid*

¹⁰⁶ Villamagna, A. M., and B. R. Murphy. "Ecological and socio- economic impacts of invasive water hyacinth (*Eichhornia crassipes*): a review." *Freshwater biology* 55.2 (2010): 282-298.

¹⁰⁷ Greenfield B.K., Siemering G.S., Andrews J.C., Rajan M., Andrews S.P. & Spencer D.F. "Mechanical shredding of water hyacinth (*Eichhornia crassipes*): effects on water quality in the Sacramento-San Joaquin River Delta, California. *Estuaries and Coasts*," 30, 627– 640. (2007)

¹⁰⁸ Villamagna, A. M., and B. R. Murphy. "Ecological and socio- economic impacts of invasive water hyacinth (*Eichhornia crassipes*): a review." *Freshwater biology* 55.2 (2010): 282-298.

ground to mosquitoes and schistosomes (blood flukes) which cause malaria and bilharzia respectively. The collectors would have to wear protective gears while harvesting the weed so as to work efficiently. Another challenge facing manual control is the transportation of the weed from the Lake after its removal; 90% of water hyacinth is comprised of water making it weighty to transport.¹⁰⁹

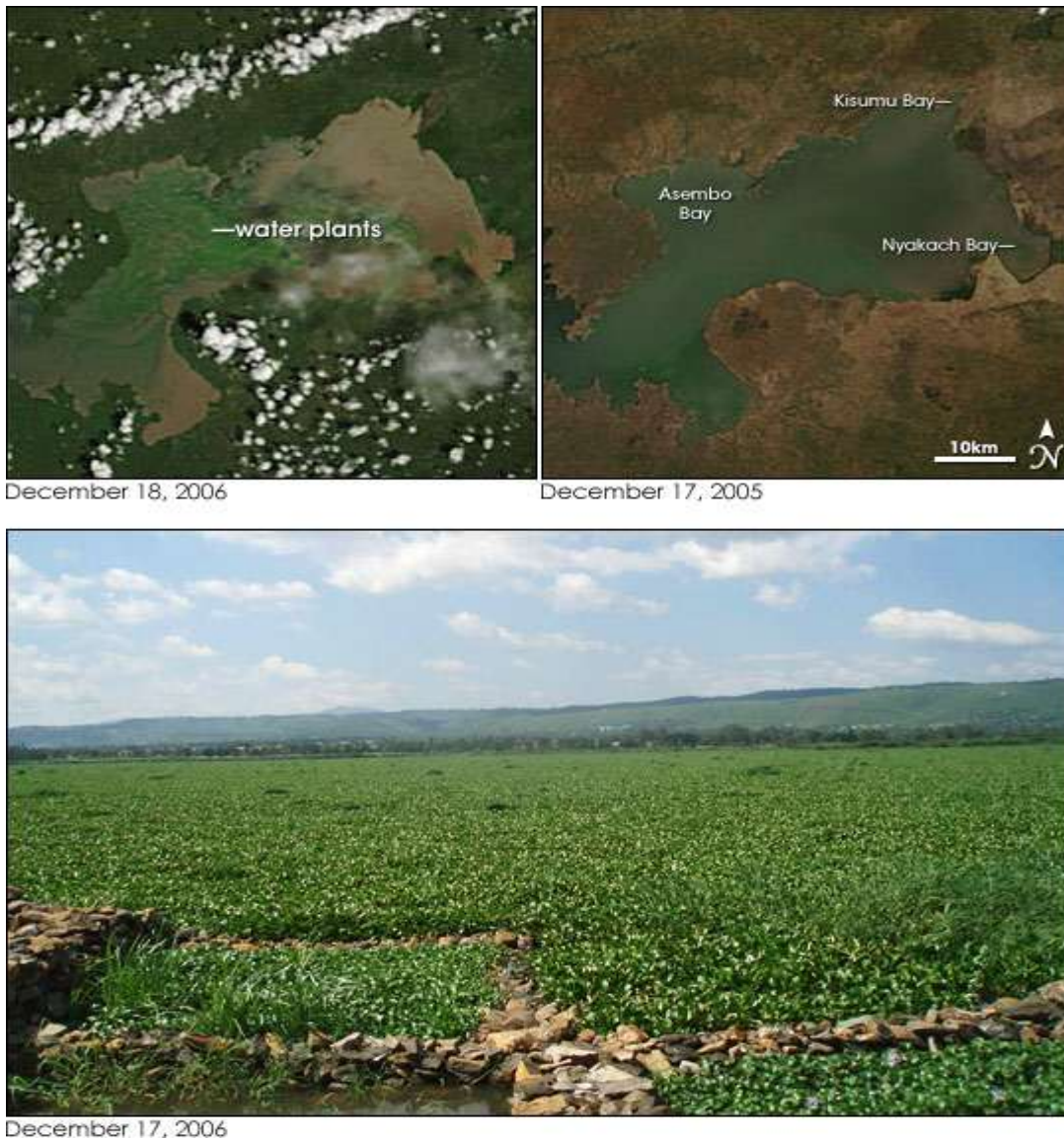


Figure 3. Demonstration of swift progression of hyacinth in the Winam Gulf, between 2005 and 2006.¹¹⁰

¹⁰⁹ Gopal B. Water Hyacinth. *Elsevier Sci. Publ., B. V. Amsterdam.* 471. (1987)

¹¹⁰ Source: NASA's Earth Observatory website: Water Hyacinth Re-invades Lake Victoria: <http://earthobservatory.nasa.gov/IOTD/view.php?id=7426>

2.7 Gaps in Literature

Literature on aquatic weed control in Kenya is minimal with most of the authors concentrating on scientific research of the weed. The absence of proper legal provisions on how to deal with aquatic weeds has led to lack of clarity as to which agency should deal with the issue and ways in which the weed can be dealt with. The several fragmented sectoral legislations that have been discussed above concerning the conservation of the Lake from external factors need to be consolidated into a law that will offer coordination, support, guidance and legitimacy to the management of the hyacinth. There is inadequate information on the management water hyacinth available to law makers and the community. The authors who have contributed on water hyacinth have failed to comprehensively discuss the control tools of water hyacinth and their effectiveness and potential impacts to the environment. In as much as the Lake Victoria Basin Commission has made steps towards providing legislation on conserving the Lake, it would be more ideal if the countries sharing this transboundary resource would come together and make joint efforts in eradicating the weed.

CHAPTER THREE

LEGAL FRAMEWORK ON NOXIOUS WEEDS AND WATER POLLUTION

3.1 Introduction

Lake Victoria had been free of noxious weeds until the year 1989 when water hyacinth attacked its waters¹ and from then, studies have been conducted to unravel the causes of the weed's proliferation. Between 1994 and 1995, Kenya, Uganda and Tanzania experienced the worst hyacinth attacks with the weed covering 80% of Uganda's shoreline (4000ha), 6000 ha in Kenya's shoreline and In Tanzania, the coverage was about 2000 ha.²

3.2 Kenya's Legal Framework

International Framework

The *Constitution of Kenya* in Article 2 (6) states that "Any Treaty or convention ratified by Kenya shall form part of the law of Kenya under this Constitution." This provision gives legal status to the international treaties and conventions that Kenya is a signatory to. Section 124 of *EMCA* provides that "Where Kenya is a party to an international treaty, convention or agreement, whether bilateral or multilateral, concerning the management of the environment, the Authority shall, subject to the direction and control of the Council, in consultation with relevant lead agencies:- initiate legislative proposals for consideration by the Attorney-General, for purposes of giving effect to such treaty, convention or agreement in Kenya or for enabling Kenya to perform her obligations or exercise her rights under such treaty, convention or agreement; and identify other appropriate measures necessary for the national implementation of such treaty, convention or agreement."

¹ Mailu, A. M. "Preliminary assessment of the social, economic and environmental impacts of water hyacinth in Lake Victoria Basin and status of control." *ACIAR proceedings*. ACIAR; 1998, 2000.

² *ibid*

Kenya is a signatory to the *Stockholm Convention (SC) on Persistent Organic Pollutant (POPs)*³ signed in 2002 in Sweden which banned the use of chlorinated pesticides (whose effects have been discussed in Chapter 2) so as to ensure preservation human life and the environment which is the main objective of the Convention.⁴ Despite the ban, some of the POPs listed to be dangerous under the Convention have been in use in Kenya, an example is the Dichlorodiphenyl-1, 1, 1-trichloroethane (DDT) which is mainly administered through aerial spraying to control tsetse flies and for malaria vector control in the health sector.⁵ The use of DDT was officially banned for agricultural use in Kenya in 1986 but stockists could be secretly supplying farmers with the pesticide.⁶

On invasive species, there are three legal frameworks (Kenya is a signatory to all three) that are applicable and these are⁷: the quarantine laws under the IPPC (International Plant Protection Convention) whose main aim is to stop introduction of plant pests. Countries are expected to establish what is known as “phytosanitary” systems which act as plant quarantine schemes. These phytosanitary systems limit the introduction and spread of invasive species;⁸ the related SPS Agreement promulgated as part of the WTO (World Trade Organization) which has an international legal framework on developing national phytosanitary standards and also the international mechanisms to enforce those standards⁹ and the CBD (Convention on Biological Diversity) which described as “...the only globally applicable, legally binding instrument to address generally alien species introduction, control and eradication across all biological taxa

³ Kenya ratified this Convention on 24/09/2004

⁴ Abong'o, Deborah Atieno et al. "Organochlorine pesticide residue levels in soil from the Nyando River Catchment, Kenya." *Africa Journal of Physical Sciences ISSN: 2313-3317* 2.1 (2015).

⁵ *ibid*

⁶ Saoko Paul, Kenya POPs Situation Report: DDT, Pesticides and Polychlorinated Biphenyls. *Fostering Active and Effective Civil Society Participation in Preparations for Implementation of the Stockholm Convention*. The International POPs Elimination Project (IPEP) 2005

⁷ Miller L. M., Fabian R.N., *Harmful Invasive Species: Legal Responses*. Published by Environmental Law Institute 2004

⁸ *Ibid* pp 5-8

⁹ *ibid*

and ecosystems.” Article 8 (h) of the CBD states that “Each Contracting Party shall, as far as possible and as appropriate...prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.” According to Miller and Fabian, this article has a weak foundation despite it being expected to create comprehensive, articulate and solid laws and policies on invasive species in Contracting Parties. They further state that the language used in Article 8 (h) seems “too narrow for comprehensive invasive policies to the extent it limits concerns to natural systems.”¹⁰

Since the international laws have a binding nature to states that are members, they obligate member states to comply with the rules set in place so as to fulfil their international duties. Some of these Conventions like the United Nations Framework Convention on Climate Change (UNFCCC) require states to draft National Plans and the CBD requires states to draft Biodiversity Strategic Plans, and to report the steps they have taken on implementing the Conventions. These Conventions also require states to establish domestic enforcement agencies/authorities to oversee the implementation of their provisions; an example is the CITES¹¹ Implementation Department established by the Kenya Wildlife Service (KWS) and the IPPC official contact point in Kenya being the Kenya Plant Health Inspectorate Service. Some of these Conventions offer funds to states for research, development and to enable the member states to fulfil their obligations; an example is the the Montreal Protocol on Substances that Deplete the Ozone Layer which created the *Multilateral Fund for the Implementation of the Montreal Protocol*.¹²

¹⁰ ibid

¹¹ the Convention on International Trade in Endangered Species of Wild Fauna and Flora,

¹² Freestone David. ‘International Environmental Conventions’ <http://www.iloencyclopaedia.org/part-vii-86401/environmental-policy/89-54-environmental-policy/international-environmental-conventions> accessed on 9/10/2019

Regional Framework

a) The Convention for the establishment of the Lake Victoria Fisheries Organization

It was entered into force on 24th May 1996 and LVFO became a specialized institution after the EAC Treaty came into force on 30th November 1999. This Convention rose from the efforts of the Partner States and (Food and Agriculture Organization) FAO. The Convention was signed in 1999 with FAO becoming its depository.¹³ It was amended in 1998¹⁴ and 2016¹⁵ and its main objective is to *“To foster cooperation among Contracting Parties, harmonize national measures for the sustainable utilization of the living resources of Lake Victoria and to develop and adopt conservation and management measures.”*¹⁶ One of the functions of the LVFO is to *“consider and advise on the effects of the direct or indirect introduction of any non- indigenous aquatic animals or plants into the waters of Lake Victoria or its tributaries and to adopt measures regarding the introduction, monitoring, control or elimination of any such animals or plants.”*¹⁷ In implementing its objective and functions, the Organization is expected to cooperate with other intergovernmental agencies and bodies which are related to fisheries.¹⁸ This Convention is vital since it has mandated the LVFO to advise on the implications of the introduction of invasive aquatic plants in Lake Victoria and tasked it to undertake measures to monitor, control and eliminate the species.

¹³ LVFO is also registered under Article 102 of the United Nations Charter and is recognized as a Regional Fisheries Management Organization (RFMO).

¹⁴ The amendments included inter alia, establishing a Policy Steering Committee, and allowing the EAC Secretariat and the designated representatives of key regional projects on the Lake in the three Contracting States to participate in the meetings of the Executive Committee in an observer capacity.

¹⁵ The Council of Ministers of the LVFO adopted amendments to the Convention with a view to, inter alia, opening membership to all Partner States of the East African Community, and extending the competence of the LVFO to the fisheries and aquaculture resources of the East African

¹⁶ Convention for the Establishment of the Lake Victoria Fisheries Organization. Source www.fao.org

¹⁷ Article II Para 3

¹⁸ Article XIX

b) EAC Treaty

In looking at the regional legal framework relating to water hyacinth, the East African Community (EAC) has taken part in the huge role of promoting sustainable approach to the development and management of the basin resources as well as improving the socio economic development of the East African countries. Article 5 para. 3 (c) of *The Treaty for the Establishment of the East Africa Community*¹⁹ states that the “community shall ensure the promotion of sustainable utilisation of the natural resources of the Partner States and the taking of measures that would effectively protect the natural environment of the Partner States.” The Treaty establishes a Council which is in-charge of formulating of the Community²⁰ and whose functions include: making decisions concerning policies; initiating and submitting Bills to the Assembly; making regulations, issuing directives, taking decisions, making recommendations and giving opinions in line with the Treaty’s provisions among others.²¹ The EAC Treaty provides for co-operation between the member states in the management, development and conservation of the environment and natural resources.²² The Community’s activities are expected to be geared to: *“preserve, protect and enhance the quality of the environment; contribute towards the sustainability of the environment; ensure sustainable utilisation of natural resources like Lakes, wetlands, forests and other aquatic and terrestrial ecosystems; and to jointly develop and adopt water resources conservation and management policies that ensure sustenance and preservation of ecosystems.”*²³ In implementing the activities outlined above, the Community has to “develop a common environmental management policy that would sustain the eco-systems of the Partner States, prevent, arrest and reverse the effects of environmental degradation; develop special environmental management strategies to manage

¹⁹ 2012

²⁰ Article 14

²¹ *ibid*

²² Article 111

²³ Article 111 para. 2

fragile ecosystems, terrestrial and marine resources, noxious emissions and toxic and hazardous chemicals; take measures to control trans-boundary air, land and water pollution arising from developmental activities; take necessary disaster preparedness, management, protection and mitigation measures especially for the control of natural and man-made disasters.”²⁴ The Treaty also established the Lake Victoria Development Programme in 2001 to manage Lake Victoria Basin.²⁵ The programme was created to coordinate the numerous interventions on the Lake and its basin; and to advance the Lake basin into a financially viable growth zone.²⁶

EAC through LVBC developed the *Water Hyacinth Surveillance and Control Strategy*, it has a three-dimensional approach to combat the weed: removal by hand (manual collection), by machine (mechanical control) and biologically (biocontrol) using beetles that attack the weed.²⁷

c) Protocol on Sustainable Development of Lake Victoria

In 2004, Kenya Tanzania and Uganda ratified the *Protocol on Sustainable Development of Lake Victoria* which gives provisions regarding conservation and sustainable utilization of basin resources. Most importantly, this protocol mandates each partner state to jointly and individually take all measures to conserve, protect, manage and to rehabilitate Lake Victoria basin and its ecosystem by coming up with initiatives for preserving and conserving the wetlands of the basin as well as conserving the fisheries resources..²⁸ EAC formed the *Lake Victoria Basin Commission* (LVBC) under Article 33 of the Protocol, as a specialized institution and whose headquarters is in Kisumu, Kenya. The work of the Commission is to

²⁴ Article 112 para. 1

²⁵ Enhancing water resources management through inclusive green economy: The case of Lake Victoria Basin. Published by the United Nations Economic Commission for Africa 2016 https://www.uneca.org/sites/default/files/uploaded-documents/Natural_Resource_Management/EGM-IGEPST-SAC-2015/enhancing_water_resources_management_through_inclusive_green_economy-Lake_victoria_basin_final.pdf accessed on 2/10/2019

²⁶ Ibid page 7

²⁷ Apollo Silas & Chepkoech Anita, ‘There is a way but no will to get rid of the weed’ Published by Daily Nation on 23rd April 2017 <https://www.nation.co.ke/lifestyle/dn2/957860-3900992-bbbgy9z/index.html> accessed on 2/10/2019

²⁸ Article 6.1

organize the sustainable development and administration of the Lake basin in the five EAC partner states through joint cooperation.²⁹ The Protocol states that the Partner States should “take all appropriate measures, individually or jointly and where appropriate with participation of all stakeholders to protect, conserve and where necessary rehabilitate the Basin and its ecosystems in particular.”³⁰ Over the years, LVBC has implemented projects such as Lake Victoria Environmental Management Project (LVEMP) I and II, Lake Victoria Water Supply and Sanitation (LWATSAN) I and II and Lake Victoria Integrated Water Resources Management (LVIWRM) which is currently an undergoing project. LVEMP is an extensive program run by the Kenya, Uganda and Tanzania to maintain and rehabilitate the ecosystem of the Lake so that the riparian communities living along the Lake benefit from the resources being provided by the Lake.³¹ LVEMP initiated efforts to control water hyacinth in the Lake in 1995 using Integrated Weed Management (IWM).³² The project proved to be a success as the weed presence reduced in the years 1998-2000.³³ Under the LVEMP project, each riparian country undertakes activities to control water hyacinth within its borders.

National Framework

a) Constitution of Kenya

The Constitution of Kenya affirms the right of every person to a clean and healthy environment in its Article 42; making this provision a right goes to show that environmental protection is

²⁹ East African Community Lake Victoria Basin website

³⁰ Article 6 Para 1

³¹The overall objectives of the LVEMP are to maximize the sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water and sustain a disease free environment, to conserve biodiversity and genetic resources for the benefit of the riparian communities and global community, and to harmonize national management programs in order to achieve, to the maximum extent possible, the maintenance of a healthy Lake Victoria ecosystem and the reversal of increasing environmental degradation.- Prof. F.L. Mwanuzi, Dr J.O.Z. Abuodha, Dr. F.J. Muyodi and Prof. R.E. Hecky (eds.) *‘Lake Victoria Environment Management Project (LVEMP) water Quality and Ecosystem Status’ Lake Victoria Regional Water Quality Synthesis Report p. ii-v*

³² Mallya, G., P. Mjema, and J. Ndunguru. "Water hyacinth control through integrated weed management strategies in Tanzania." *Proc. ACIAR. Biological and Integrated Control of Water hyacinth* 102 (2001): 120-122.

³³ Twongo, Timothy., et al. "Status of water hyacinth infestation and control in River Kagera." *Lake Victoria Environmental Management Project, Water Hyacinth Control Components Uganda, Tanzania ~nd Kenya Water hyacinth Research Sub-component, Uganda* (2002).

accorded a high status in Kenya. Section 43 (d) provides for a right to clean and safe water in the right quantities. The Fourth Schedule of the Kenyan Constitution obligates the government to ensure that the environment and natural resources are protected; *“the national government is mandated to protect the environment and natural resources and this includes fisheries resources.”* With the state being a custodian of the fisheries resources, it is obligated to ensure that Lake Victoria waters are protected and conserved for the people of Kenya. The citizens of Kenya are also obligated to cooperate with the state in the management and conservation of natural resources.³⁴ Article 72 states that the provisions of Part 2 of the Constitution which is on ‘Environment and Natural Resources’ shall be given full effect through enactment of legislation by Parliament. This should encourage Parliament to enact legislation on Aquatic Invasive Species (AIS), specifically water hyacinth, since it affects the water quality and quantity in Lake Victoria which is heavily dependent on by the community living around it.

b) Environment Management and Coordination Act (EMCA)

Section 3 of EMCA mirrors Article 42 of the Constitution in according the right to a clean and health environment to persons. Section 4 of the Act establishes the National Environment Council which is responsible for policy formulation and directions; outlining national objectives and goals and establishing policies for the conservation of the environment; encouraging co-operation among government departments, local authorities, private sector, Non-Governmental Organisations and any such other organisations.³⁵ The Act also establishes NEMA as the implementing authority to *“exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment.”*³⁶ Section 42 provides for the preservation and conservation of waterbodies and any wetlands in Kenya. The section further

³⁴ Article 69

³⁵ Section 5

³⁶ Section 9

prohibits the “introduction of plant any part of a plant specimen, whether alien or indigenous, dead or alive, in any river, Lake or wetland and deposit of any substance in a Lake, river or wetland or in, on, or under its bed, if that substance would or is likely to have adverse environmental effects on the river, Lake or wetland.”³⁷ EIA and EA which are carried out by NEMA, are provided for in the Act to ensure that projects that pose a danger to the environment are identified and stopped.³⁸ Under NEMA, the Standards and Enforcement Review Committee³⁹ is established to deal with water quality standards and whose functions include but are not limited to: “recommend guidelines to the Director-General for the preservation of water resources and fisheries; identify and recommend to the Authority areas of research on the effects of water pollution on the environment, human beings flora and fauna; advise the Authority to carry out investigations of actual or suspected water pollution including the collection of data and advise the Authority to take steps or authorise any works to be carried out which appear to be necessary to prevent or abate water pollution from natural causes or from abandoned works or undertakings.”⁴⁰ The Act prohibits the discharge of effluents into the aquatic environment by persons,⁴¹ owners or operators of irrigation project schemes, sewage systems, industrial production workshops⁴² and the owner or operator of a trade or industrial undertaking.⁴³ It is a requirement that for industry and trade owners or proponents to acquire licences from NEMA, they should fix a suitable plant for the treatment of pollutants before they are released into the environment.⁴⁴ NEMA has the power to “*issue and serve on any person in respect of any matter relating to the management of the environment an environmental restoration order to restore the environment as near as it may be to the state in*

³⁷ Section 42 (d) & (e)

³⁸ Part VI & VII

³⁹ Section 70

⁴⁰ Section 71

⁴¹ Section 72

⁴² Section 73

⁴³ Section 74

⁴⁴ Section 74 (2)

which it was before the taking of the action; prevent the person on whom it is served from taking any action which would or is reasonably likely to cause harm to the environment; award compensation to be paid by the person on whom it is served to other persons whose environment or livelihood has been harmed by the action; levy a charge on the person on whom it is served which in the opinion of the Authority represents a reasonable estimate of the costs of any action taken by an authorised person or organisation to restore the environment to the state in which it was before the taking of the action."⁴⁵ EMCA seems to be leaning more towards pollution control which is very crucial to the management of water hyacinth. However, it would be better if AIS are featured in the country's main environmental legislation. Currently, there is no department focusing on AIS at NEMA, water hyacinth management has solely been left to LVEMP.

c) Water Act

The Water Act establishes the Water Resources Authority⁴⁶ whose functions include: "formulating and enforcing standards, procedures and Regulations for the management and use of water resources and flood mitigation; regulating the management and use of water resources; providing information and advice to the Cabinet Secretary for formulation of policy on national water resource management, water storage and flood control strategies; coordinating with other regional, national and international bodies for the better regulation of the management and use of water resources."⁴⁷ Section 24 of the Act establishes a Basin Water Resources Committee responsible for the management of the water resources within a respective basin area. More-so with the quality of water in Lake Victoria deteriorating because of the presence of the water hyacinth, the Lake's water is no longer safe for human

⁴⁵ Section 108

⁴⁶ WRA shall serve as an agent of the national government and regulate the management and use of water resources.

⁴⁷ Section 11-12

consumption. Interestingly, Section 16 provides one of the objectives to be “*prevent siltation of rivers and Lakes and control pollution or and other activities likely to degrade the environment.*” Again Section 17 of the same goes ahead to state general principles relevant to these regulations and of them is that “*special measures including prevention of soil erosion, siltation and water pollution are essential for the protection of river banks, Lake shores and the seashore.*” In recognition to the right to clean and safe water in adequate quantities⁴⁸ the Act states that after every five years, the Cabinet Secretary is supposed to formulate a Water Services Strategy taking into consideration public participation.⁴⁹ The main object of the Water Strategy is to deliver the Government’s proposals and initiatives for the advanced fulfilment of the right to water to all citizens of Kenya.⁵⁰ There are several other statutory authorities created by the Water Act whose functions are incidental to conserving the ecological character of Kenya’s waterbodies including; The Water Resources Users Association (WRUA)⁵¹, Basin Water Resources Committee,⁵² Water Resources Authority (WRA)⁵³ and Water Services Regulatory Board (WASREB).⁵⁴ The Act criminalizes the blockade or pollution of a water source or a watercourse in Section 143. Although the Act is quite detailed, it has failed to capture the existence of AIS and their management options. Out of all the institutions

⁴⁸ Article 43 (d) of CoK & Section 63 of Water Act

⁴⁹ Section 64

⁵⁰ Section 64 (2)

⁵¹A WRUA (established under the Water Act) is an “association of water users, riparian land owners, or other stakeholders who have formally and voluntarily associated for the purposes of cooperatively sharing, managing and conserving a common water resource” (definition in WRM Rules 2007) - https://cmsdata.iucn.org/downloads/formation_of_water_resource_user_associations_kenya.pdf accessed on 5/3/2019

⁵²BWRC’s (established under the Water Act) function is to “manage catchments, facilitate establishment of Water Resource User Associations and to play an advisory role to the WRA.” - <https://www.2030wrg.org/wp-content/uploads/2016/12/Understanding-the-Kenyan-Water-Act-2016.pdf> accessed on 5/3/2019

⁵³The functions of WRA (established under the Water Act) are inter alia; “to protect, conserve, control and regulate use of water resources through the establishment of a national water resource strategy, formulation and enforcement of standards, procedures and regulation for the management and use of water resources and policy development.”- <https://www.2030wrg.org/wp-content/uploads/2016/12/Understanding-the-Kenyan-Water-Act-2016.pdf> accessed on 5/3/2019

⁵⁴ Principal object is to protect the interests and rights of consumers in the provision of water services.- Section 70

established under this Act, none is mandated to deal with AIS and none has been featured in any of the previous efforts made to control water hyacinth.

d) The Pest Control Products Act

*The Pest Control Products Act*⁵⁵ regulates the importation or exportation and use of pesticides. The Act creates three classes of products for pest control. Pesticides listed under the Stockholm Convention are part of the ‘Restricted Class’⁵⁶ of pesticides which should not be used. The other two classes are the ‘Commercial Class’⁵⁷ and ‘Domestic Class.’^{58, 59} Fertilizer standards in Kenya are strict with Kenya Bureau of Standards (KEBS) scrutinizing fertilizer imports for presence of metals. Companies have to submit certificate of conformity and analysis given by Bureau Veritas⁶⁰ which have to complete.⁶¹ However, there have been cases of KEBS officials conspiring with importers to allow substandard fertilizers in the country and an example is when the Directorate of Criminal Investigations (DCI) ordered the arrests of several Kenyan Officials from KEBS and from a Moroccan fertilizer company known as OCP on 22nd June 2018, for the circulation of fake KEBS stamps and the importation of substandard fertilizers into the country.⁶² Permitting the importation of substandard fertilizer leads to criminal

⁵⁵ CAP 346 of 2012

⁵⁶ a class of products which present significant environmental risks and these are products which are intended for use in aquatic and forestry situations

⁵⁷ class with environmental effects which are limited to a specific region.

⁵⁸ this is a class of products for which

(i) No special precautions are required in use

(ii) No equipment are required for inhalation hazard

(iii) No irreversible effects from repeated exposure.

(iv) Disposal of Containers can be safely done by placing it in the garbage bin; and

(v) The package sizes are limited to amounts that can be safely used and stored by consumers.

⁵⁹ Kenya Legal Resources accessed at <http://www.kenyalawresourcecenter.org/2011/07/regulation-of-pest-control-products.html> on 8/9/2019

⁶⁰ an international certification agency which provides certifications and HSE expertise (Health, Safety and Environmental).

⁶¹ Bailey A. Anders, ‘The Curious Case of Substandard Fertilizers in Kenya.’ International Policy Digest 30 June 2018 accessed at <https://intpolicydigest.org/2018/06/30/the-curious-case-of-substandard-fertilizers-in-kenya/> on 11/9/2019

⁶² *ibid*

culpability⁶³ which can lead to a custodial sentence upon conviction. The use of pesticides and fertilizers should be controlled so as to reduce their concentrations in the rivers feeding into Lake Victoria. *EMCA* provides that before any person manufactures, imports or processes a new pesticide, they should apply to NEMA for registration of the product or activity.⁶⁴ The Standards and Enforcement Review Committee (under NEMA) is obligated to monitor and control pesticides and in doing so, identify pesticides which are toxic to the environment and ensure that they are banned.⁶⁵

e) Lake Basin Development Authority Act

The *Lake Basin Development Authority Act*⁶⁶ 2012 was enacted to oversee the establishment of an Authority (Lake Basin Development Authority hereinafter known as LBDA) whose main function is to initiate and co-ordinate the undertaking of projects seeking to develop the Lake Victoria catchment area.⁶⁷ This Act commenced in 1979 and since then it has undergone 6 revisions; 1980, 1984, 1985, 1990, 1991 and the recent one being 2012. The LBDA was launched in 1979, but it has not been so vocal in dealing with water hyacinth when it should be at the forefront on coming up with initiatives to control the weed.

f) Fisheries Management and Development Act 2016 (Formerly the Fisheries Act 2012)

The Act⁶⁸ established the Fisheries Service⁶⁹ and mandated it to conserve, manage and develop Kenya's fisheries resources in accordance with the Act. The Act has not touched on water

⁶³ Muriuki Benjamin, 'KEBS boss to face charges including attempted murder.' Published on: June 23, 2018 11:41 (EAT) accessed at <https://citizentv.co.ke/news/kebs-boss-to-face-charges-including-attempted-murder-204919/> on 11/9/2019

⁶⁴ Section 95

⁶⁵ Section 94

⁶⁶ CAP 442

⁶⁷ Lake Basin Development Authority Website <https://www.govserv.org/KE/Kisumu/898164133654522/Lake-Basin-Development-Authority> accessed on 2/10/2019

⁶⁸ Act No. 35 of 2016

⁶⁹ Section 7

hyacinth or its management and the Fisheries Regulations 2012 is also silent on the same. The Act also establishes the Kenya Fisheries Council whose function is to appraise and counsel the government on: policies related to the co-ordination of fisheries management in relation to the aquatic environment and human dimensions; the apportionment and access to fisheries resources; arrangements and agreements between governments in relation to development and management of fisheries; education and capacity building in supervision of fisheries among others.⁷⁰ Section 34 empowers counties to come up with fisheries management plans and measures for fisheries resources within their jurisdiction.⁷¹ Section 37 of the Act establishes Beach Management Units (BMUs) whose standards for management are set out in the regulations made by the Cabinet Secretary.⁷² This Act is mainly focused on the commercial part of fisheries with only a small part concentrating on the sustainable management of fisheries. Although it is a comprehensive and long legislation, a huge opportunity was missed when the main concern was directed to commercialization rather than conservation of fisheries. *The Kenya Fisheries Policy 2005* provides that there exist institutions to cater for the effective management of fisheries in the state with the government being the one in-charge of establishing these institutions.⁷³

g) Suppression of Noxious Weeds Act

Kenya's specific legislation on noxious weeds is the *Suppression of Noxious Weeds Act* of 2012 whose first date of commencement fell on 1st August 1945. The Act has since been revised three times; in 1948, 1967 and most recently in 2012. Despite all these revisions, the drafters never took into consideration that the Act only provided for land-based weeds. The Act is brief, uncomprehensive, poorly drafted and incoherent; it has all the makings of what a legislation

⁷⁰ Section 6

⁷¹ Section 34

⁷² Section 37

⁷³ Kariuki Muigua, et al. *Natural Resources and Environmental Justice in Kenya* 2015 at page 302

should not be. The Act does not establish any Authority, Committee, Council or Board unlike other Acts. This then equates to lack of an institutional framework in what is known to be the sole legislation on noxious weeds in Kenya. The burden of implementing the Act rests on the ‘Director of Agriculture’ who has the duty to appoint an ‘Inspector’ whose function is to enter land to ascertain the presence or absence of a noxious weed;⁷⁴ to order persons to clear areas covered by noxious weeds⁷⁵ and to eradicate noxious weeds where the land owner/occupier has failed to do so.⁷⁶

Water hyacinth has invaded the Kenyan waters since 1988 in Lake Naivasha⁷⁷ and 1991 in Lake Victoria⁷⁸ and even the 2012 revision missed the great opportunity to include its governance in the Act. After thirty-one years since the first intrusion of water hyacinth in Kenyan water bodies, it would be expected that some legislation on it would have already been drafted and put into force. The lack of legislation on Aquatic Invasive Species (AIS) which would be used to govern water hyacinth, has shown how the effects of these species have been downplayed. Since the Suppression of Noxious Weeds Act has failed to effectively include provisions on AIS, we have been compelled to rely on other legislations such as the *Fisheries Management and Development Act 2016* formerly the *Fisheries Act 2012*, the *Water Act 2016*, the *Agriculture, Fisheries & Food Authority Act 2013* and policies such as the *Kenya Fisheries Policy 2005*, and regulations such as *Water Quality Regulations 2006*, *Environmental*

⁷⁴ Section 5

⁷⁵ Section 6

⁷⁶ Section 7

⁷⁷ Momanyi M., John, Onywere Simon, Mathooko Jude ; ‘Effect of Water Hyacinth Infestation on the Physicochemical Characteristics of Lake Naivasha’ Published by International Journal of Humanities and Social Science Vol. 2 No. 7 April 2012.

⁷⁸ Gichuki, John, et al. "Water Hyacinth *Eichhornia crassipes* (Mart.) Solms-Laubach dynamics and succession in the Nyanza Gulf of Lake Victoria (East Africa): implications for water quality and biodiversity conservation." *The Scientific World Journal* 2012 (2012). See also Mailu, A. M., G. R. S. Ochiel, W. Gitonga and S. W. Njoka. 1998. Water Hyacinth: An Environmental Disaster in the Winam Gulf of Lake Victoria and its Control, p. 101-105. In: M. Hill, M. Julien and T. Center (eds.). First IOBC Global Working Group Meeting for the Biological Control and Integrated Control of Water Hyacinth.

Management & Coordination (Wetlands, River Banks, Lake Shores and Sea Shore Management) *Regulations 2009*. These legislations lack specificity in that they have no provisions on noxious weeds or AIS, the institutions established under them have not been mandated to deal with AIS thus they're inoperable when it comes to managing water hyacinth and most importantly, none has mentioned AIS or water hyacinth.

3.3 Weaknesses of Kenya's Legal Framework

There are several ministries in Kenya whose functions are incidental to ensuring that Kenya's waterbodies are conserved including; Ministry of Water and Sanitation, Ministry of Environment and Forestry, Ministry of Transport and Infrastructure Development (due to the water navigation) and Ministry of Agriculture, Livestock, Fisheries and Irrigation. Despite the creation of all these ministries, there is none that has been specifically coordinated and mandated to deal with aquatic invasive species. It is unclear which institution bears the responsibility of eradicating water-based invasive weeds and which management options should be used in this quest resulting to an overlap of the mandate in these institutions. Management options should be predicated on practices and values and that are at par with "current sciences, prevention, detection and rapid response, control methods... and restoration to meet noxious weed management objectives."⁷⁹ Governance at the national and county level is important for creating, controlling and implementing programs related to noxious weeds and apportioning resources to combat the weed. The law does not mention any management option or how water hyacinth should be controlled. There is lack of a comprehensive legal framework that outlines the management options that should be used, how they should be used to prevent

⁷⁹Montana Noxious Weed Management Plan 2017 accessed at <file:///C:/Users/user/Desktop/MT%20Noxious%20Weed%20Management%20Plan-%20Update%202017.pdf> on 25/2/2019

the weed from regenerating and to control it from causing more harm to the Lake and its environs.

Currently, there is lack of clarity in the legal framework on which management option is most efficient and best suited to dealing with water hyacinth and how the law can support it and give a robust guidance on how the option should be implemented. The main legislation concerning the water hyacinth in Kenya is the “*Suppression of Noxious Weeds Act*”⁸⁰ which was first enacted in 1945 and has been revised over the years with the latest revision being in 2012. This Act despite listing the water hyacinth as a noxious weed, does not provide for any control measures of the weed; only providing for the eradication of land-based weeds. The Act has failed to address how to manage, control and eradicate aquatic noxious weeds and which institutional arrangement is optimum, leaving authorities to experiment with management tools without any legal reference.

3.4 Comparative Analysis of Legal and Management Reactions to Invasive Species

3.4.1 Introduction

Despite the threat that is caused by invasive species, it has been an uphill task to form a coherent and comprehensive legal framework or actualize changes to national laws for many countries, with New Zealand being an exception.⁸¹ New Zealand has made the most commendable efforts to implement a policy regarding non-indigenous species that is comprehensive comparing to other countries which suffer from the surge in invasive species.⁸²

⁸⁰CAP 325 of 2012

⁸¹ Preexisting laws in most countries have focused on governance of wildlife, water, forests among other natural resources with the exception of leaning towards indigenous species – Miller L. M., Fabian R.N., *Harmful Invasive Species: Legal Responses*. Published by Environmental Law Institute 2004

⁸² Miller L. M., Fabian R.N., *Harmful Invasive Species: Legal Responses*. Published by Environmental Law Institute 2004

Miller and Fabian⁸³ did a comparative analysis of legal responses on harmful invasive species in six countries – United States of America, New Zealand, South Africa, Germany, Poland and Argentina and have summarized several common issues on policy and law regarding harmful invasive species as follows: different degrees of appreciation at the level of policy and law of invasive species by countries; lack of conclusive evaluation of the status of non-indigenous species while putting a focus on policy and legal exertion at specific non-indigenous species (“most countries appear to be reactive rather than proactive with regard to harmful non-indigenous species, even at the level of basic knowledge”); most of the investigated countries still place reliance on fragmented legal frameworks⁸⁴; most countries have failed to make dramatic changes to their laws and policies despite the issue of invasive species being an environmental problem. Kenya can learn from the comparative experience discussed below from the following countries;

a) Uganda

Since Uganda takes a share of 43% of Lake Victoria⁸⁵, it is important to observe how it deals with water hyacinth. Water hyacinth was first sighted in the Ugandan side of Lake Victoria in 1989⁸⁶ and since then, the weed’s rapid proliferation has been caused by a nutrient-rich environment and shelter from off-shore winds.⁸⁷ The negative effects caused by the weed in

⁸³ *ibid*

⁸⁴ New Zealand is partially exempted from this point as it has enacted two frameworks on invasive species, namely ‘the ‘Biosecurity Act 1993’ and the ‘Hazardous Substances and New Organisms act 1996’

⁸⁵ Odada Eric, Wandiga Shem, Olago Daniel et al, *Mitigation of Environmental Problems in Lake Victoria, East Africa; Causal Chain and Policy Options Analyses*. (2018) [online] ResearchGate. Available at: <https://www.researchgate.net/publication/8618949> accessed 11/9/2019.

⁸⁶ Gichuki, John, et al. "Water Hyacinth *Eichhornia crassipes* (Mart.) Solms-Laubach dynamics and succession in the Nyanza Gulf of Lake Victoria (East Africa): implications for water quality and biodiversity conservation." *The Scientific World Journal* 2012 (2012). See also Mailu, A. M., G. R. S. Ochiel, W. Gitonga and S. W. Njoka. 1998. Water Hyacinth: An Environmental Disaster in the Winam Gulf of Lake Victoria and its Control, p. 101-105. In: M. Hill, M. Julien and T. Center (eds.). First IOBC Global Working Group Meeting for the Biological Control and Integrated Control of Water Hyacinth.

⁸⁷ Balirwa John-Stephen, Wanda Fred-Masifiwa & Muyodi Fredrick-Jones. ‘Impacts of Water Hyacinth and Water Quality Change on Beneficial Uses of Lake Victoria. 13th World Lake Conference, Wuhan, China, 1-5 November 2009.

Ugandan waters mirror those experienced in the Kenyan waters and which have been discussed in the previous chapters being; blocking of navigation and fishing, sealing of nursery and breeding grounds of fish and affecting socio-economic activities of the community living along the Lake. Between 1996 and 1998, Uganda experienced the worst infestation with the weed covering more than 3,000ha in 1996 and this increased to 4,732 ha in 1998.⁸⁸ Uganda has made efforts to curb water hyacinth and it achieved the highest success rate in 1999 where 80% of the weed was cleared when Integrated Weed Management (IWM) approach consisting of large-scale biological control⁸⁹ was used together with mechanical and manual control.⁹⁰ Murchison Bay is the most affected by water hyacinth due to strong winds which spread the weed to cover a large surface area.⁹¹ The main environmental legislation in Uganda is the National Environment Act Cap 153 of 1995 and this Act established the National Environment Authority (NEMA) in the same year. NEMA is tasked with monitoring, coordinating, regulating and supervising environmental management in Uganda.⁹² The Authority has the duty of setting water quality standards in Ugandan waters,⁹³ standards for discharge of effluent into water⁹⁴ and issue guidelines for the management of the environment of Lakes and rivers.⁹⁵ The

⁸⁸ Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* 42.JUL. (2004): 73-84.

⁸⁹ In late 1995, *Neochetina bruchi* and *N. eichhorniae* water hyacinth weevils were released into the Ugandan portion of Lake Victoria but it was not until February 1997 that observation on weevil feeding activity on plants in Murchison Bay was done. Thereafter, the weevils multiplied rapidly attaining an average number of 13.8 weevils per plant in 1998 and 24.7 weevils per plant in 1999 on Lake Victoria in Uganda (pers. comm., Uganda National Agriculture Research Organization, 2000). Also during 1998 to 1999, mechanical removal work was occurring at Port Bell. By 1999, there was only 15 and 1 ha of water hyacinth detected in March and July, respectively. By late 2001, weevil numbers had declined to an average of 8.8 weevils per plant (pers. comm., Uganda National Agriculture Research Organization, 2001).- Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* 42.JUL. (2004): 73-84.

⁹⁰ Balirwa John-Stephen, Wanda Fred-Masifiwa & Muyodi Fredrick-Jones. 'Impacts of Water Hyacinth and Water Quality Change on Beneficial Uses of Lake Victoria. 13th World Lake Conference, Wuhan, China, 1-5 November 2009.

⁹¹ Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* 42.JUL. (2004): 73-84.

⁹² Uganda National Environment Management Authority (NEMA) accessed at <https://www.nema.go.ug/> on 15/9/2019

⁹³ Section 25 of National Environment Act (NEA) 1995

⁹⁴ Section 26 of NEA

⁹⁵ Section 34 (4) NEA

Authority, in consultation with NEMA is obligated to take the necessary measures to preserve river banks and the Lake shores in Uganda from anthropogenic activities that will cause adverse effects to rivers and Lakes.⁹⁶ Uganda has been successful since it adopted an integrated approach towards managing water hyacinth; the weed management has been done through biocontrol together with mechanical control and manual collection. This integrated approach has ensured that the weed cover has been significantly reduced. Kenya however has never used an integrated approach and this seems to be the underlying reason why Uganda has been more successful in controlling the weed than Kenya. Kenya needs to adopt an IWM approach in curbing water hyacinth as a lesson from Uganda.

b) Tanzania

Tanzania has the largest portion of Lake Victoria, 51%⁹⁷ but despite of this, it has not experienced the same level of hyacinth infestations as the two other countries.⁹⁸ The weed was first discovered in River Sigi in 1955 and River Pangani in 1959⁹⁹ prompting the state to gazette it as a noxious weed in 1955.¹⁰⁰ The hyacinth proliferation in the Tanzanian shores of Lake Victoria rose from 700ha in 1995 to 2,000ha in 1998.¹⁰¹ In 1995, LVEMP initiated an Integrated Weed Management Management (IWM) strategy with a prominence on biological control to curb the hyacinth infestation.¹⁰² As part of the IWM, Tanzania used biological

⁹⁶ Section 35 NEA

⁹⁷ Odada Eric, Wandiga Shem, Olago Daniel et al, *Mitigation of Environmental Problems in Lake Victoria, East Africa; Causal Chain and Policy Options Analyses*. (2018) [online] ResearchGate. Available at: <https://www.researchgate.net/publication/8618949> accessed 11/9/2019.

⁹⁸ Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* 42.JUL. (2004): 73-84.

⁹⁹ Mallya G., Ndunguru J., & Mjema P., 'Water Hyacinth Control through Integrated Weed Management Strategies in Tanzania' 2001 Retrieved at <http://www.bio-nica.info/Biblioteca/Mallya2001Eischhornia.pdf> on 14/9/2019

¹⁰⁰ Ibid p.120

¹⁰¹ LVEMP (Lake Victoria Environment Management Project) 1999. Review of progress on implementation of water hyacinth control (July 1997–June 1999). Paper presented at a regional workshop on LVEMP implementation, Mwanza, 1–5 November 1999, 1–15

¹⁰² Mallya G., Ndunguru J., & Mjema P., 'Water Hyacinth Control through Integrated Weed Management Strategies in Tanzania' 2001 Retrieved at <http://www.bio-nica.info/Biblioteca/Mallya2001Eischhornia.pdf> on 14/9/2019

control and physical control in implementing the LVEMP project. Additionally, quarantine regulations¹⁰³ and nutrient-control measures were put in place to ensure that the Lake water is free from pollution.¹⁰⁴ Tanzania imported *Neochetina* weevils from Benin and released them into Lake Victoria in 1997 for the first time leading to eleven weevil-rearing units being established around the Lake. In physical control, both the state and the community are involved in removing the weed. The government has provided protective gear and hand tools that cost US \$20,000 to improve manual removal of the weed.¹⁰⁵ The main environmental legislation in Tanzania is the Environmental Management Act (EMA) No. 20 of 2004 whose enforcing authority is the National Environment Management Council (NEMC) which is mandated with enforcing and implementing the provisions of the Act. Section 106 of EMA prohibits pollution to the environment with section 109 specifically prohibiting water pollution. The Act provides for an integrated pollution, prevention and control approach whose implementation guidelines are prescribed by NEMC.¹⁰⁶ To specifically govern water hyacinth, the National Plant Protection Act No. 13 of 1997 gave life to the 'Water Hyacinth Regulations' in 1999 to control the spread of water hyacinth. The Regulations provide for hyacinth control methods to be biological control, chemical control and mechanical control which is the only unrestricted method out of the two.¹⁰⁷ To encourage involvement by the community, the legislation places a duty on people living near a water body affected by water hyacinth to collect and destroy the weed.¹⁰⁸ Just like Uganda, Tanzania adopted the IWM approach by using biocontrol and physical control and this proved to be a success in controlling water hyacinth. The legislation by Tanzania is quite comprehensive and detailed providing for the management tools and how

¹⁰³ Tanzania prepared the 'Water Hyacinth Control Regulations' in September 1999 developed from the National Plant Protection Act (No. 13 of 1997).

¹⁰⁴ Mallya G., Ndunguru J., & Mjema P., 'Water Hyacinth Control through Integrated Weed Management Strategies in Tanzania' 2001 Retrieved at <http://www.bio-nica.info/Biblioteca/Mallya2001Eischhornia.pdf> on 14/9/2019

¹⁰⁵ Ibid p.120

¹⁰⁶ Section 108 EMA

¹⁰⁷ Regulation 10

¹⁰⁸ Regulation 4

they should be used. It also encourages public participation and community initiatives. This is a commendable effort and Kenya can learn from Tanzania with regard to revising the legal framework to include provisions on water hyacinth management and public participation.

c) New Zealand

New Zealand identified the reduction of indigenous biodiversity as the main ecological concern facing it.¹⁰⁹ This decline is attributed to the presence of pests and weeds that have posed a threat to New Zealand's agricultural base.¹¹⁰ Due to this, the country introduced an integrated and comprehensive method to reduce the introduction of invasive species and to control the ones that are present already.¹¹¹ New Zealand has been implementing two Acts in the last two decades namely; the *Biosecurity Act* of 1993 and the *Hazardous Substances and New Organisms Act* (HSNO) of 1996. The Biosecurity Act's main objective is to stop the introduction of invasive species and to manage the invasive species that are already present. While the Act is very comprehensive, it is empowering rather than requiring since there is no provision imposing obligations to any agency to take charge regarding the presence of any invasive species.¹¹² The HSNO Act on the other hand, aims at controlling the deliberate introduction of new organisms (organisms that were absent in New Zealand before 29th July 1998 or a GMO that is unapproved for release) into the country.¹¹³ Management of biosecurity in New Zealand is overseen by a two-tiered government structure consisting of the central government and regional councils.¹¹⁴ This is equivalent to Kenya having a national government and a county government. Just like New Zealand where a huge degree of autonomy is

¹⁰⁹ New Zealand Department of Conservation and the Ministry for the Environment, New Zealand's Biodiversity Strategy (2000) [hereinafter New Zealand's Biodiversity Strategy 2000]

¹¹⁰ Miller L. M., Fabian R.N., Harmful Invasive Species: Legal Responses. Published by Environmental Law Institute 2004 at Pg 24

¹¹¹ *ibid*

¹¹² Miller L. M., Fabian R.N., Harmful Invasive Species: Legal Responses. Published by Environmental Law Institute 2004 at pg 28

¹¹³ *ibid*

¹¹⁴ *ibid*

decentralized to regional councils, a big section of responsibility is devolved to the county government while the funding is done by the national government. The 16 regional councils in New Zealand are in-charge of eradicating and managing the invasive species.

The primary responsibilities of preventing the unintended introduction of invasive species lies with the Ministry of Agriculture and Forestry (MAF) which receives approximately 95% of biosecurity funding from the government. Other agencies that share biosecurity responsibilities include the Ministry of Fisheries¹¹⁵, the Ministry of Health¹¹⁶ and the Department of Conservation.¹¹⁷ The HSNO Act has established the *Environmental Risk Management Authority* which has an organizing role and observes the efficacy of the HSNO Act in lessening the negative effects of new organisms on the environment. It also improves public education, takes part in continuing enquiry and collecting information and keeping records. New Zealand's government has placed priority in dealing with invasive species and apportioned a generous budget towards preventing the spread of invasive species. AIS management in Kenya would be easy if the government would also apportion a sizeable amount from the treasury every financial year. With adequate resources and well-researched management options, the weed cover in the Winam Gulf would be significantly reduced.

d) USA

The country's main legislation on invasive weeds is the *Federal Noxious Weed Control and Eradication Act* (FNWA) of 2004 and the Noxious Weed Regulations. The main objective of the FNWA is "To require the Secretary of Agriculture to establish a program to provide assistance to eligible weed management entities to control or eradicate noxious weeds on public

¹¹⁵ Provides advice on marine biosecurity

¹¹⁶ Provides policy advice and specific disease response in relation to biosecurity risks to people's health posed by pests and diseases

¹¹⁷ Provides policy advice on biosecurity risks to indigenous flora and fauna and biodiversity

and private land.” Section 453 of the Act tasks the Secretary to establish a program that will provide both technical and financial support to control noxious weeds. The Secretary is also mandated to issue grants to entities that can control or eradicate noxious weeds. Each state in the USA has legislation on noxious weeds, this study found Colorado, Montana and California states to have the most comprehensive legislations.

Colorado has an ambitious and detailed legislation on noxious weeds, the Colorado Noxious Weeds Act of 2003 which stresses on integrated management of weeds comprising of biological¹¹⁸, chemical¹¹⁹, cultural¹²⁰ and mechanical¹²¹ management of noxious weeds. Montana has a whole chapter on Aquatic Invasive Species (AIS) in its *Montana Code Annotated* (MCA) 2017. The main objective of this legislation is “to establish a mechanism for Montana to take concerted action to detect, control, and manage invasive species, including preventing further introduction, importation, and infestation, by educating the public about the threat of these species, coordinating public and private efforts and expertise to combat these species, and authorizing the use of check stations to prevent the movement of invasive species from infested areas to uninfested areas to protect the state's economy, environment, recreational opportunities, and human health for the benefit of all Montanans.”¹²² The MCA states that the departments tasked with implementing it will collaborate and coordinate their responsibilities while undertaking their work.¹²³ The departments are also allowed to either individually or collectively enter into cooperative agreements with each other or with any other person who

¹¹⁸ use of an organism to disrupt the growth of noxious weeds.

¹¹⁹ use of herbicides or plant growth regulators to disrupt the growth of noxious weeds.

¹²⁰ methodologies or management practices that favor the growth of desirable plants over noxious weeds, including maintaining an optimum fertility and plant moisture status in an area, planting at optimum density and spatial arrangement in an area, and planting species most suited to an area.

¹²¹ methodologies or management practices that physically disrupt plant growth, including tilling, mowing, burning, flooding, mulching, hand-pulling, hoeing, and grazing.

¹²² Part 10, 80-7-1002 MCA 2010

¹²³ 80-7-1005

has the skill and administrative ability to carry out the obligations of the agreement.¹²⁴ The departments are also expected to collaborate, develop and implement a strategic program on invasive species to realize the object of the MCA.¹²⁵

In 2008, the state of California came up with the *California Aquatic Invasive Species Plan* (CAISMP), a comprehensive document with one hundred and seventy-three pages whose main goal is to “identify the steps that need to be taken to minimize the harmful ecological, economic and human health impacts of AIS in California.”¹²⁶ The Plan bears 163 management action plans organized under 8 objectives namely; “Coordination & Collaboration, Prevention, Early Detection & Monitoring, Rapid Response & Eradication, Long-term Control & Management, Education & Outreach, Research, Laws & Regulation.” The plan offers the state’s premier complete, harmonized attempt to curb new invasions, lessen effects from established Aquatic Invasive Species (AIS) and launch programs for action statewide. Additionally, it also recommends a procedure for the evaluation and improvement of the annual plans to ensure that AIS are being controlled effectively now and in the future.¹²⁷

To control water hyacinth, *Florida* state created a program known as “maintenance” water hyacinth control¹²⁸ which is mandated by legislature. This Maintenance Control is defined by statute to be “*A method for the control of non-indigenous aquatic plants in which control technologies are utilized in a coordinated manner on a continuous basis in order to maintain the plant population at the lowest feasible level as determined by the Florida Department of*

¹²⁴ *ibid*

¹²⁵ 80-7-1006

¹²⁶ California Aquatic Invasive Species Plan. Prepared and published by State of California Resources Agency Department of Fish and Game January 2008 at pg 13

¹²⁷ *ibid*

¹²⁸ Schmitz D., Charles et al. The ecological impact and management history of three invasive alien aquatic plant species in Florida. Pages 173–194 in B. N. McKnight (ed.), *Biological pollution. The control and impact of invasive exotic species*. Indiana Academy of Science, Indianapolis, Indiana, 1993, 261 pp.

Environmental Protection.”¹²⁹ Florida State has limited the implementation of this policy to waterbodies which are under the management of the state and which have public access. This isolates the private waterbodies which lack public access. Florida released 3 insects as part of bio-control; *N. eichhorniae* (in 1972), *N. bruchi* (in 1974) and *S. albigutalis* (in 1977). In Louisiana, the acreage of water hyacinth reduced due to biocontrol and the reinfestation was frustrated by the onset of winter.¹³⁰ Florida State prefers using the biocontrol method in the management of water hyacinth. The State also uses an integrated approach of herbicides and insects. In California, surveys in recent years show that by the onset of summer, water hyacinth infestation can cover about 4,000 acres of the Sacramento-San Joaquin Delta¹³¹. Presently, aquatic herbicides are the primary tools which are available to manage water hyacinth. Two weevils and a moth were introduced as biocontrol methods, unfortunately these methods have been unsuccessful. Programs to control the weed in the Sacramento-San Joaquin Delta, its tributaries and the Suisun Marsh have been the obligation of the state’s Department of Boating and Waterways (DBW). Within the program’s 22-year history, DBW’s costs for hyacinth control have resulted to about \$25 million dollars, with annual spending currently around \$2.5 million dollars.¹³² In the USA, the states have managed to draft their own legislations and create their own programs to deal with water hyacinth with Colorado having the most comprehensive act and California having the most comprehensive management plan. The states discussed above have conducted researches on the most suitable management options and made provisions for them in their legislations, plans and programs. This legitimizes the use of these management options and ensures that they are applied according to the guidelines and laws in

¹²⁹Florida Statutes of 2011 Chapter 369 Section 22(2)(d)

¹³⁰Dray Allen et al ‘Biological Control of Water Hyacinth Under Conditions of Maintenance Management: Can Herbicides and Insects Be Integrated.’ Retrieved at <https://www.researchgate.net/publication/13435963> on 1/11/2018

¹³¹ The Sacramento–San Joaquin River Delta, or California Delta, is an expansive inland river delta and estuary in Northern California.

¹³² California Aquatic Invasive Species Plan. Prepared and published by State of California Resources Agency Department of Fish and Game January 2008 at pg 12.

place. Kenya can emulate these states and create a legislation on AIS that will include the management options derived from informed decision-making.

From the legal frameworks above, it is pertinent for Kenya to emulate these countries and bridge the gaps on AIS legal framework. The creation of an AIS-specific legal framework is important as this will provide a backdrop to which the weed management plans and programs are guided, implemented and supervised. The countries discussed have shown great levels of success in controlling water hyacinth and this shows that the management of water hyacinth is feasible with the guidance of a robust legal framework and a well-researched management option.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This chapter entails a discussion of the area of study, research design, target population and procedures that were used for sampling.

4.2 Research Design

Mixed research design was used whereby information was obtained from fieldwork (primary data) and review of past works of literature and legal instruments (secondary data). There was literature review of books, journals, articles, both international and national legislations on water hyacinth, conducting of interviews of respondents which included fishermen, fish traders and key informants and focus group discussions.

4.3 Study Site

Lake Victoria is the biggest Lake in Africa covering a surface of 68,000 km²¹³³ making it the main source of inland fishery production.¹³⁴ However, the Lake has suffered from severe eutrophication since the rivers streaming into the Lake are greatly polluted by discharge of untreated industrial wastes, soil erosion, agricultural run-off sediments and disposal of domestic wastes by people living around the Lake.¹³⁵ Lake Victoria has two gulfs namely the Napoleon Gulf which is in Uganda and the Winam Gulf which is in Kenya.¹³⁶

¹³³ Verschuren, Dirk, et al. "History and timing of human impact on Lake Victoria, East Africa." *Proceedings of the Royal Society of London. Series B: Biological Sciences* 269.1488 (2002): 289-294.

¹³⁴ Balirwa, John S., et al. "Biodiversity and fishery sustainability in the Lake Victoria basin: an unexpected marriage?." *BioScience* 53.8 (2003): 703-715.

¹³⁵ Fusilli, Lorenzo, et al. "Assessment of the abnormal growth of floating macrophytes in Winam Gulf (Kenya) by using MODIS imagery time series." *International Journal of Applied Earth Observation and Geoinformation* 20 (2013): 33-41.

¹³⁶ Campbell, Linda M., Hecky E. Robert, and Wandera BSB Sylvester. "Stable isotope analyses of food web structure and fish diet in Napoleon and Winam Gulfs, Lake Victoria, East Africa." *Journal of Great Lakes Research* 29 (2003): 243-257.

The study was conducted in Homabay Town whose bay is part of the Winam Gulf. The Winam Gulf¹³⁷ is a semi-enclosed embayment located in the northern side of Lake Victoria and connected to the Lake by the Rusinga Channel which is 3 metres wide. The Gulf covers a surface of 1400km² and a mean depth of 10-m.¹³⁸ Kisumu's port is located on the northeastern side of the shore and it extends 64 kilometres to the channel from Kisumu¹³⁹ while ¹⁴⁰Homabay is located along the southern shore of the Gulf. The Gulf has experienced the highest water hyacinth infestation¹⁴¹ with the hyacinth covering 17,231 hectares of the Lake in 1998¹⁴² and the weed covering the entire Kisumu Bay in 2006.¹⁴³ Since then, weed has continuously attacked the Winam Gulf due to pollutants, sediments and nutrients.¹⁴⁴

There are several bays at the Gulf namely; Asembo Bay, Mirunda Bay, Naya Bay, Nyakach Bay, Osodo Bay, Mirunda Bay, Kendu Bay and Olambwe Bay.¹⁴⁵ Rusinga, Maboko and Ndere Islands are also within the Gulf.¹⁴⁶

¹³⁷ Formerly known as Kavirondo Gulf or Nyanza Gulf

¹³⁸ Okely Patricia, Imberger Jörg, and Antenucci P. Jason. "Processes affecting horizontal mixing and dispersion in Winam Gulf, Lake Victoria." *Limnology and Oceanography* 55, no. 5 (2010): 1865-1880.

¹³⁹ <https://www.touristlink.com/kenya/winam-gulf/overview.html> accessed on 5/3/2019

¹⁴⁰ <http://ecowb.org/kenya-water-hyacinth/> accessed on 5/3/2019

¹⁴¹ Fusilli, Lorenzo, et al. "Assessment of the abnormal growth of floating macrophytes in Winam Gulf (Kenya) by using MODIS imagery time series." *International Journal of Applied Earth Observation and Geoinformation* 20 (2013): 33-41.

¹⁴² The weed's presence in the Winam Gulf significantly reduced in the years 2004 and 2005 but in February 2007, NASA observed an exponential growth of the weed in the Gulf. NASA attributed this proliferation to the unusual heavy rains in Kenya which occurred between 2006 and 2007 which flooded the rivers flowing into the Gulf. The rains increased the level of water in the Lake and swept nutrient-rich and agricultural run-off sediment into the Lake.- Fusilli, Lorenzo, et al. "Assessment of the abnormal growth of floating macrophytes in Winam Gulf (Kenya) by using MODIS imagery time series." *International Journal of Applied Earth Observation and Geoinformation* 20 (2013): 33-41.

¹⁴³ <https://earthobservatory.nasa.gov/images/7426/water-hyacinth-re-invades-Lake-victoria> accessed on 6/9/2019

¹⁴⁴ Okely Patricia, Imberger Jörg, and Antenucci P. Jason. "Processes affecting horizontal mixing and dispersion in Winam Gulf, Lake Victoria." *Limnology and Oceanography* 55, no. 5 (2010): 1865-1880.

¹⁴⁵ <https://www.touristlink.com/kenya/winam-gulf/overview.html> accessed 5/3/2019

¹⁴⁶ Ibid



Figure 4: A map showing the position of Homabay County on the Winam Gulf in Lake Victoria(Source:<https://www.weather-forecast.com/locationmaps/Homa-Bay.10.gif>)

4.4 Target Population

The target population of this study comprised of fish sellers and fish buyers, fishermen, Beach Management Units, Civil Society Organisations (CSOs), officers from the national and county governments.

4.5 Sample Size and Sampling Techniques

4.5.1 Sample Size

The study area, Homabay Town, has a population of approximately 55, 532 which was used to derive the sample size.¹⁴⁷

To get the sample size, the formula below has been used¹⁴⁸

¹⁴⁷ Kenya Census 2009

¹⁴⁸ <https://www.surveysystem.com/sample-size-formula.htm>

$$\text{“Sample Size = } \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where: Z = Z value (1.65 for 90% confidence level)

p = percentage picking a choice, expressed as decimal (.5 used for sample size needed)

c = confidence interval, expressed as decimal¹⁴⁹ (0.09)

$$137 = \frac{1.65^2 \times (0.5) \times (1-0.5)}{0.09^2}$$

With a margin of error of 7% and confidence level of 90% which made the z score 1.65, the sample size derived was 137. Therefore, the sample size of the study was 137 respondents.

The sample size was divided among fishermen (68) and fish traders (69) who were the main respondents in the study.

4.5.2 Sampling Procedure

Purposive sampling was used to identify the people and groups to be interviewed, then snowball sampling method that enabled the people and groups identified to identify further respondents to interview.

4.6 Data Collection Tools and Methods

The tools that were used to collect information in this study included documents and records, observation and recordings, surveys through questionnaires with both closed-ended and open-ended questions, interviews, focus groups, usage data, checklists and case studies. The sample size of the study was 137 and this number was divided among fishermen and fish traders. Key informant interviews were used to extract information from people with specialized knowledge

¹⁴⁹ ibid

from the Ministry of Environment, NEMA, LVEMP, Homabay County Beach Management Unit Secretariat, Homabay County Ministry of Water, Environment and Natural Resources, Office of the Governor, County Commissioner of Homabay and Homabay County Water and Sanitation Co. Ltd (HOMAWASCO). There were 2 focus group discussions and group interviews held with Beach Management Units. There were questionnaires which were administered by the researcher and one research assistant to the fishermen, fish traders and county officials on the activities that are encouraging the spread of hyacinth, the challenges being faced due to the weed invasion, the management tools that have been in use and their success rates, involvement of key stakeholders and lead agencies and legal awareness on invasive weeds.

4.7 Data Analyses and Presentation

The study was based on qualitative data analysis method. Qualitative data analysis was done through coding and organizing of data into themes and concepts. Patterns were then identified and there was formulation of theories and generalizations. The information was condensed into a report.

4.8 Ethical Considerations

A researcher has to apply ethical standards in the conduct of the study, data collection, data analyses, distribution and utilization of the results.¹⁵⁰ Examples of ethical issues that may crop up during research include; plagiarism, misuse of privileges while ethical issues concerning research subjects include confidentiality, anonymity, physical and psychological harm, voluntary and informed consent, use of vulnerable and/or special populations, financial issues

¹⁵⁰Ibid at page 293

and sponsored research, dissemination of findings and academic freedom.¹⁵¹ A research permit was obtained from National Commission for Science, Technology and Innovation (NACOSTI) through the University, the County Commissioner of Homabay and County Director of Education also gave their permission. All the respondents gave their informed consent in the conduct of this study. The confidentiality of the respondents was protected as they were not required to write their names in the questionnaires.

¹⁵¹Mugenda M. Olive & Mugenda G. Abel *Research Methods: Quantitative & Qualitative Approaches* published by ACTS Press at page 190-194

CHAPTER FIVE

RESULTS AND DISCUSSION OF FINDINGS ON MANAGEMENT OF WATER

HYACINTH IN THE WINAM GULF

5.1 Introduction

Homa Bay County's geographical coordinates are 0° 31' 0" South, 34° 27' 0" East and it covers an estimated area of 4,267.1 km² including the water surface which encompasses an area of 1,227 km².¹⁵² Predominant inhabitants include the Luo tribe and the Basuba which make up 95% of the population and a small population of Kisii. The four major townships in the county are; Homa Bay, Mbita Point, Oyugis and Kendu Bay. Fishing, commercial and subsistence farming, trade, transport and light industry are the main economic activities with fisheries, livestock and agriculture accounting for the largest share of household income in the region.¹⁵³ Tourism also plays a key role with the county having attractions such as Ruma National Park, extended shorelines of Lake Victoria, Rusinga and Mfangano Islands, the Volcanic Lake at Simbi Nyaima as well as Hills overlooking Lake Victoria.¹⁵⁴ Homabay County is a semi-arid place with daily temperatures that range between 26°C during the coldest months which are April and November and 34°C during the hottest months; January to March. The county receives an annual rainfall of between 250mm and 1200mm; the average annual rainfall is approximately 1,100mm. The county experiences 2 rainy seasons; March-April-May which experience long rains and September to November which experience short rains.¹⁵⁵

¹⁵² Kenya National Bureau of Statistics (KNBS) 2015 Homabay County Statistical Abstract

¹⁵³ *ibid*

¹⁵⁴ *ibid*

¹⁵⁵ <http://www.kenya-information-guide.com/homa-bay-county.html> accessed 31/7/2019



Figure 5: A map showing Homabay County and its position in the Kenyan map (Source: <https://kenyapoa.files.wordpress.com/2015/03/homa-bay-county-map.png?w=474&h=205> retrieved on 1/8/2019)

5.1.1 Respondents' Response Rate

The response rate was 100% since the number of respondents was achieved.

Table 5.1: Response Return Rate

Expected	Percentage		Sample	Percentage
Sample Size			Return	
Total Response	137	100	137	100
Total	137	100	137	100

5.2 Gender of the Respondents

The pie chart below shows that 44% (60) of the respondents were female when 56% (77) of the respondents were male.

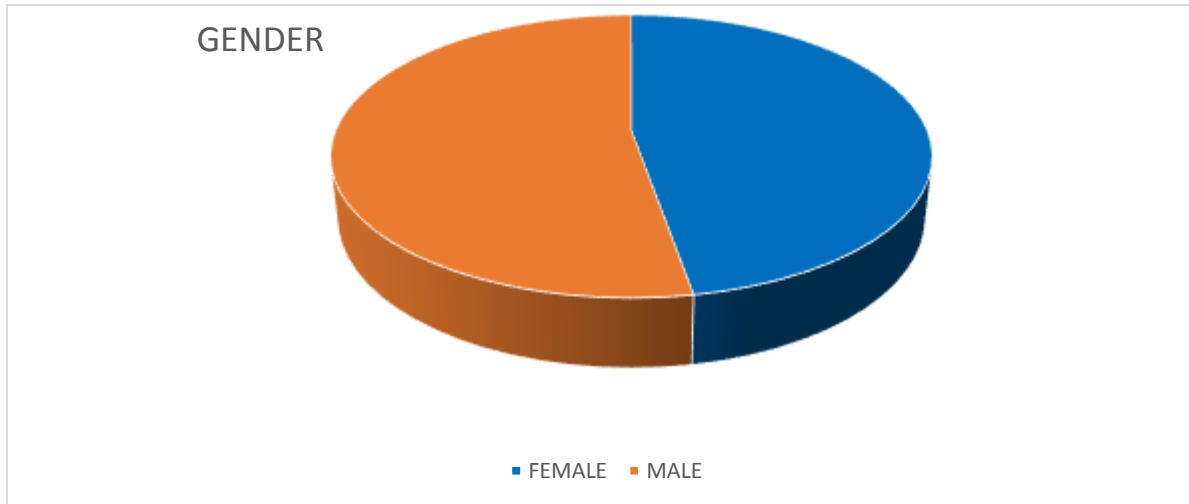


Figure 6: A pie-chart showing the gender of the respondents.

5.3 Respondents' Age

Most of the Respondents fell between the ages of 15-39 bearing the highest percentage of 60% with those between ages 40-59 making up 37% and old respondents who were above 60 made up 3%. Young adults were the ones who were most into the fishing and fish trading business. The old respondents percentage is lower since with old age, comes less vigour.

Table 5:2 Respondents' Ages

Age	Frequency	Percentage
Young Adults (15-39)	82	60
Middle Aged Adults (40-59)	51	37
Old Adults (60 and above)	4	3
Total	137	100

5.4 Marital Status

Most of the respondents were married forming 91% (126) with single respondents forming 6% (8) and widowed respondents coming at 2% (3).

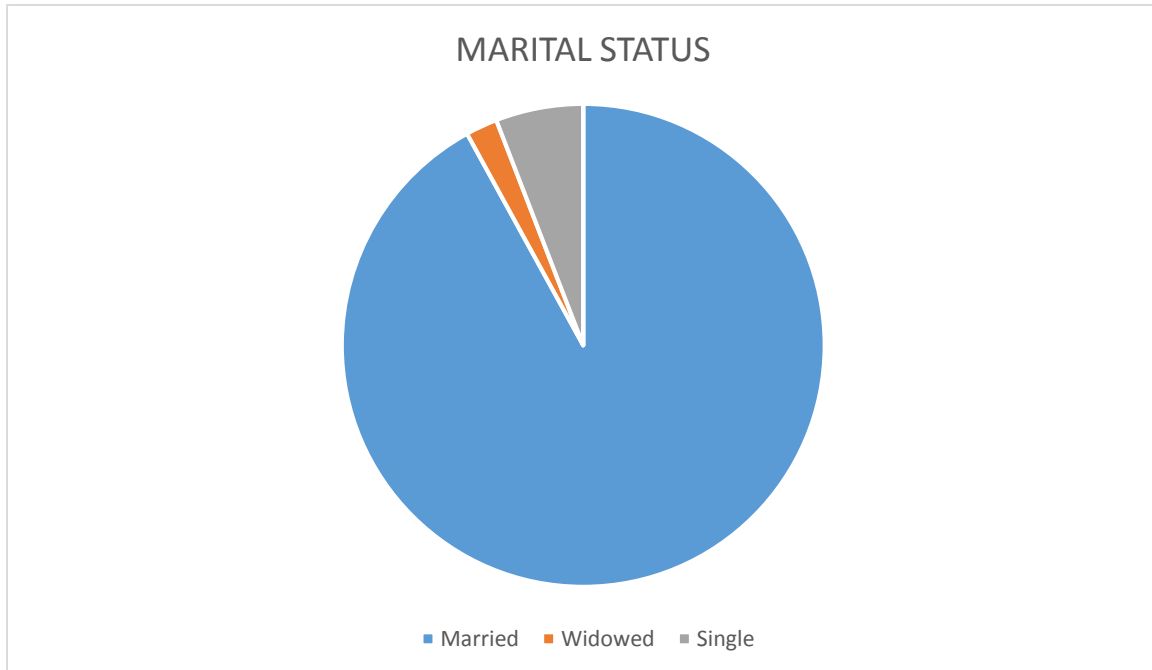


Figure 7: A pie-chart showing the marital status of the respondents.

5.5 Respondents' Level of Education

Respondents whose level of education had reached primary school was the highest at 63% (86), followed by those who had gone to secondary school at 31% (42) and lastly those who had received college/university education at 6% (9).

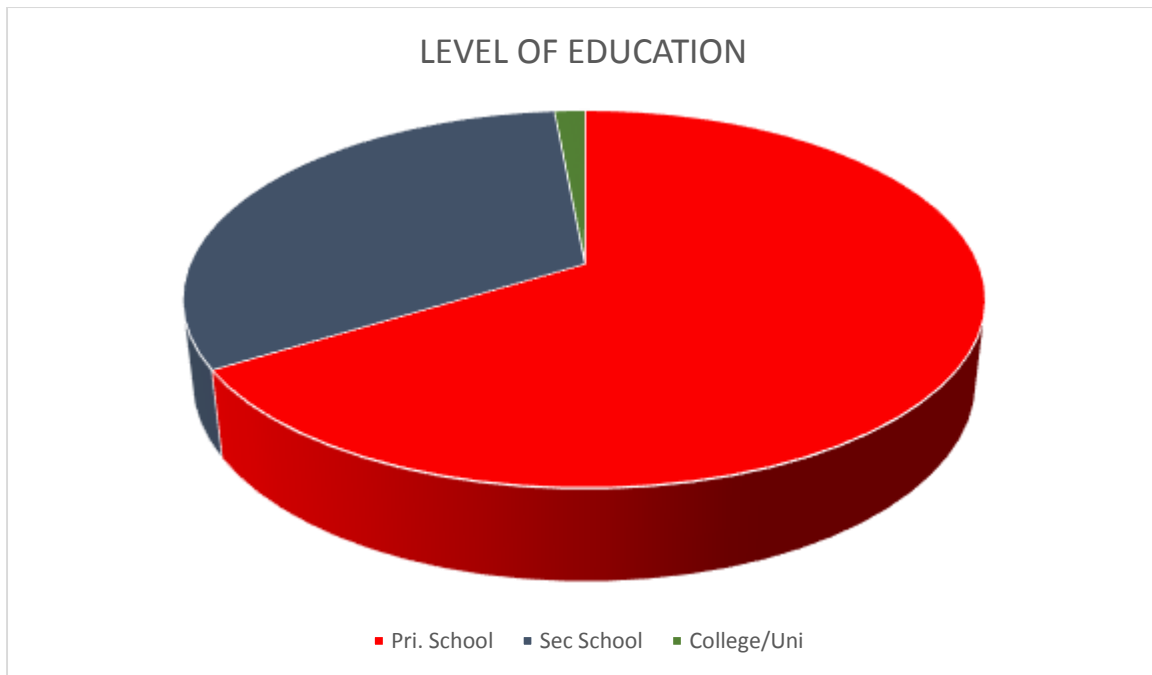


Figure 8: A pie-chart showing the respondents' level of education.

5.6 First Sightings of Water Hyacinth in Lake Victoria

Studies show that the first sighting of water hyacinth in East Africa was in May 1988 in Uganda (Lake Kyoga)¹⁵⁶ and also Kenya (Lake Naivasha) in 1988.¹⁵⁷ The weed appeared in Lake Victoria in 1989 in the Ugandan and Tanzanian waters and 1991 in Kenyan waters.¹⁵⁸ The Winam Gulf came out to be the most affected region in Kenya in 1998 with the weed covering 17,231 hectares.¹⁵⁹

¹⁵⁶ Gichuki, John, et al. "Water Hyacinth *Eichhornia crassipes* (Mart.) Solms-Laubach dynamics and succession in the Nyanza Gulf of Lake Victoria (East Africa): implications for water quality and biodiversity conservation." *The Scientific World Journal* 2012 (2012).

¹⁵⁷ Momanyi John, Mathooko Jude, Onywere Simon ; 'Effect of Water Hyacinth Infestation on the Physicochemical Characteristics of Lake Naivasha' Published by International Journal of Humanities and Social Science Vol. 2 No. 7 April 2012.

¹⁵⁸ Mailu, A. M., G. R. S. Ochiel, W. Gitonga and S. W. Njoka. 1998. Water Hyacinth: An Environmental Disaster in the Winam Gulf of Lake Victoria and its Control, p. 101-105.

¹⁵⁹ <https://earthobservatory.nasa.gov/images/7426/water-hyacinth-re-invades-Lake-victoria> accessed on 6/9/2109

The respondents were asked to state the year they first noticed water hyacinth in the Lake. 72% of the Respondents stated the years between 1991 and 1998, 18% stated the years 1999 and 2007 while 10% stated years ranging from 2008 to 2013. Below is a table showing the same.

Table 5:3 Sighting of Water Hyacinth

First sighting of hyacinth	Frequency	Percentage
1991-1998	96	72
1999-2007	26	18
2008-2013	15	10
Total	137	100

5.7 Duration of Presence of Water Hyacinth in the Lake

Water hyacinth has the ability to double its population within 12 days making it a highly invasive weed.¹⁶⁰ The hyacinth infestation in Lake Victoria is attributed to strong winds, eutrophication¹⁶¹ and the weed's ability to reproduce both sexually and asexually. In finding out the months which the Lake is infested, the study showed that most of the Respondents being 69% chose the months of August to September as the months which are most affected by the hyacinth. They attributed this to the winds which move the hyacinth from Kisumu to Homabay. 13% of the respondents chose October while 12% chose November and December. In stating the number of months which the hyacinth covers the Lake, 89% of the respondents stated that once the hyacinth covers the Lake, it can even stay for 8 months, 8% stated that the duration

¹⁶⁰ PN AM, Madhu G. 'Removal of heavy metals from waste water using water hyacinth. International Journal on Transportation and Urban Development'. (2011) Apr 1;1(1):48.

¹⁶¹ Albright, Thomas P., T. G. Moorhouse, and T. J. McNabb. "The rise and fall of water hyacinth in Lake Victoria and the Kagera River Basin, 1989-2001." *Journal of Aquatic Plant Management* (2004): 73-84.

lasts upto 6 months with the remaining 3% stating 4 months. This shows that the weed stays for several months in the Lake which is quite a long time as shown in the table below.

Table 5:4 Duration of Water Hyacinth in L. Victoria

Months hyacinth stays in Lake	Frequency	Percentage
8 months	123	89
6 months	10	8
4 months	4	3
Total	137	100

5.7.1 Effects of the Hyacinth on Fish Stocks and Fishing Activities

The respondents intimated that the presence of water hyacinth frustrated their fishing activities. The weed destroys their fishing gear; makes their boats get stuck and in some instances, they may be trapped for several days; prevents accesibility to fish, provides a breeding ground for mosquitoes which bite the fishermen at night when they go out fishing; causes a bad smell to emanate from the Lake and provides hiding ground for snakes and crocodiles. When asked if water hyacinth affects fish quantities, 98% of the respondents said ‘yes’ while 2% stated ‘no.’

Table 5.5: If Water Hyacinth Affects Fish Stocks

Water hyacinth affects fish quantities	Percentage
Yes	98
No	2
Total	100

Majority of the respondents stated that when the hyacinth is present, they are unable to catch fish since the fish find hiding grounds beneath the hyacinth mats and these mats frustrate boat movement in the Lake. This asserts the study made by Katarrega and Sterner that water hyacinth reduces the catchability of fish¹⁶² and the 2001 report by Mailu¹⁶³ which reflects the same. When the fishermen cannot fish, this means that fish stocks increase according to the above mentioned authors. However, other authors like Twongo have written that hyacinth mats have caused the decline of fish due to the weed's ability to mats seal off breeding, nursery and feeding grounds of fish species.¹⁶⁴ A study conducted by Momanyi et al affirms this position by attributing the low levels of dissolved oxygen to hyacinth mats resulting to accumulation of poisonous gases like hydrogen sulphide in the water. Additionally, the study showed that there was high concentration of free carbon dioxide in areas with water hyacinth.¹⁶⁵

¹⁶² Their study from 1983-2000 show that water hyacinth frustrated fishing activities and this resultantly led to the prevention of overfishing and this ultimately, temporarily stalled the decline of fish stocks - Katarrega, Eseza, and Sterner Thomas "Lake Victoria fish stocks and the effects of water hyacinth." *The Journal of Environment & Development* 18, no. 1 (2009): 62-78

¹⁶³ cites declines of 14 percent, 37 percent, and 59 percent in the catches of *Oreochromis* (a large genus of tilapia), *Clarias* (a genus of catfish), and *Mormyrus* (a genus of bottom-feeding breams), respectively, in the Kenyan section of Lake Victoria.- Mailu, A. M. *Preliminary Assessment of the Social, Economic, and Environmental Impacts of Water Hyacinth in the Lake Victoria Basin and the Status of Control*. In 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. Australian Centre for International Agricultural Research (ACIAR) Proceedings, no. 102: 130–139.

¹⁶⁴ Twongo Timothy 'Evolution of the Water hyacinth Problem in Uganda.' Presidential Economic Council Report prepared for the Task Force on Water Hyacinth Control, May 1998.

¹⁶⁵ Momanyi John, Mathooko Jude, Onywere Simon ; 'Effect of Water Hyacinth Infestation on the Physicochemical Characteristics of Lake Naivasha' Published by International Journal of Humanities and Social Science Vol. 2 No. 7 April 2012.

5.7.2 Relationship between Price of Fish and Presence of Hyacinth

The respondents had to indicate when the price of fish changes the most; if there is low level of water, if there is presence of water hyacinth, if there is absence of hyacinth and when there is partial presence of hyacinth. 92% of the respondents stated that the fish price changes drastically when there is full presence of water hyacinth. This is because the fishermen fail to catch enough fish due to the hyacinth mats providing hiding grounds for the fish and the inability of the fishermen boats to move easily in the Lake. This then creates a shortage in fish making the demand supersede the supply which in turn causes an increase in the fish price. 7% of the respondents believed that partial presence of hyacinth causes a change in fish price while 5% of the respondents stated that low level of water is what affects fish price.

Since hyacinth mats cover the Lake's surface and reducing catches by fishermen, this leads to a delay in the access of markets due to loss of output thereby causing an increase in the price of fish.¹⁶⁶ This is because of the effort and time spent by the fishermen in clearing waterways of the hyacinth, forcing translocation and damage to the fishing nets.¹⁶⁷ The study by Kateregga and Sterner shows that fish catchability in Lake Victoria went down by a factor of 2% to 45% for the duration the Lake experienced a high hyacinth infestation.¹⁶⁸ This in turn causes a higher demand than supply and resultantly a hike in fish prices.

¹⁶⁶ Kateregga, Ezeza, and Thomas Sterner. "Lake Victoria fish stocks and the effects of water hyacinth." *The Journal of Environment & Development* 18.1 (2009): 62-78.

¹⁶⁷ Ibid p. 62

¹⁶⁸ Ibid p. 76

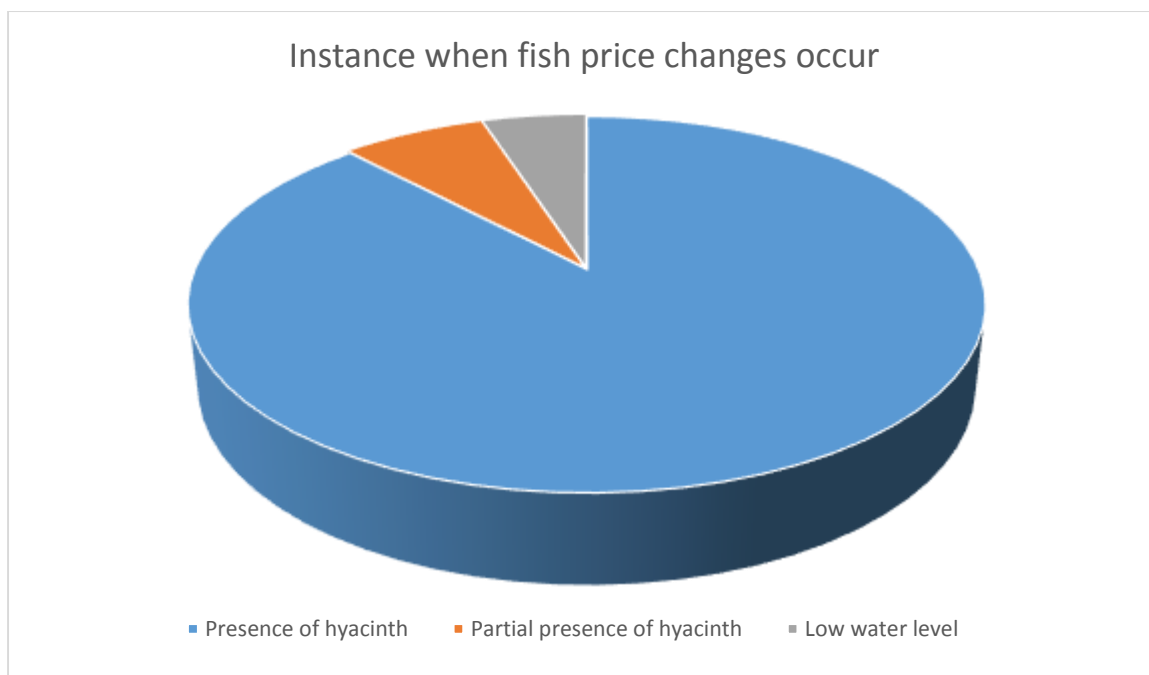


Figure 9: Circumstances affecting price changes in fish trade.

5.7.3 Uses of Water Hyacinth After Its Removal

Water hyacinth has both negative and positive effects and in this section, the positive effects are discussed. When asked about the uses of the weed after it has been removed from the Lake, most respondents, 53% stated that the water hyacinth can be used as manure while the rest, 47% did not have any idea as to how the hyacinth can be utilized. This shows that the Homabay community has not been sensitized on the uses of water hyacinth. Even the 53% just had a slight idea of how the hyacinth can be used as manure but had never tried to use it. If the hyacinth is well-harvested and dried, it can be used to produce wood fuel, biogas production for generating electricity, making ornaments and furniture. A study by Andika et al¹⁶⁹ shows that water hyacinth can be used to produce liquid organic fertilizer¹⁷⁰ which can replace the use

¹⁶⁹ Andika Darius, Ogada Jane, Hayombe Patrick, 'Producing Liquid Organic Fertilizer from Water Hyacinth: A Case Study of Lake Victoria Kenya.' International Journal of Science and Research (IJSR) Paper ID: NOV161013, Volume 5 Issue 2, February 2016

¹⁷⁰ The study confirms that liquid water hyacinth is a better fertilizer since it improved the crop yield better than the chemical fertilizers. It was found that at 5% level of significance, one liter water hyacinth sample significantly increased the plant height, number of leaves per plant and the leaf area, of crotalaria ochroleuca vegetable...

of chemical fertilisers.¹⁷¹ Njogu et al state that water hyacinth can generate electricity through biogas production if the water hyacinth is in great quantities. Instead of leaving the water hyacinth to decompose, they suggest that it can be used to produce biogas which is clean energy hence promoting recycling and sustainable development. They further state that water hyacinth is a ‘good feedstock’ which can be recycled to produce renewable energy.¹⁷² In Bangladesh, India, Thailand, Indonesia and Philippines, water hyacinth is used to make paper. In South East Asia, it is used as animal fodder while in Sri Lanka, it is used as fertiliser.¹⁷³ With water hyacinth having so much potential after its harvest, it is important to educate the community on how it can benefit from the weed. Ecologists Without Borders (ECOWB) made a proposal that community involvement would be key and they suggested paying the fishermen to use their boats in manually harvesting the water hyacinth from Homa Bay county.¹⁷⁴ Figure 12 shows the steps that ECOWB suggested would be most ideal to manage the weed. The ecologists further propose that the harvested water hyacinth would offer an alternative fuel production and this would reduce the use of fossil fuels by the communities and the resultant sludge can be used as a fertiliser thereby reducing the use of chemical fertilisers.

¹⁷¹ Andika Darius, Ogada Jane, Hayombe Patrick, ‘Producing Liquid Organic Fertilizer from Water Hyacinth: A Case Study of Lake Victoria Kenya.’ International Journal of Science and Research (IJSR) Paper ID: NOV161013, Volume 5 Issue 2, February 2016

¹⁷² Njogu Paul and others, ‘Biogas Production Using Water Hyacinth (*Eichornia crassipes*) For Electricity Generation in Kenya Energy and Power Engineering, 2015, 7, 209-216 Published Online May 2015 in SciRes. <http://www.scirp.org/journal/epe> <http://dx.doi.org/10.4236/epe.2015.75021> accessed on 2/5/2019

¹⁷³ Water Hyacinth Control and Possible Uses published by Intermediate Technology Development Group 2005 accessed at http://library.uniteddiversity.coop/Water_and_Sanitation/water_hyacinth_control.pdf on 2/5/2019

¹⁷⁴ Ecologists Without Borders (ECOWB) ‘Kenya Water Hyacinth’ 2018 Retrieved at <http://ecowb.org/kenya-water-hyacinth/> on 15/1/2019.

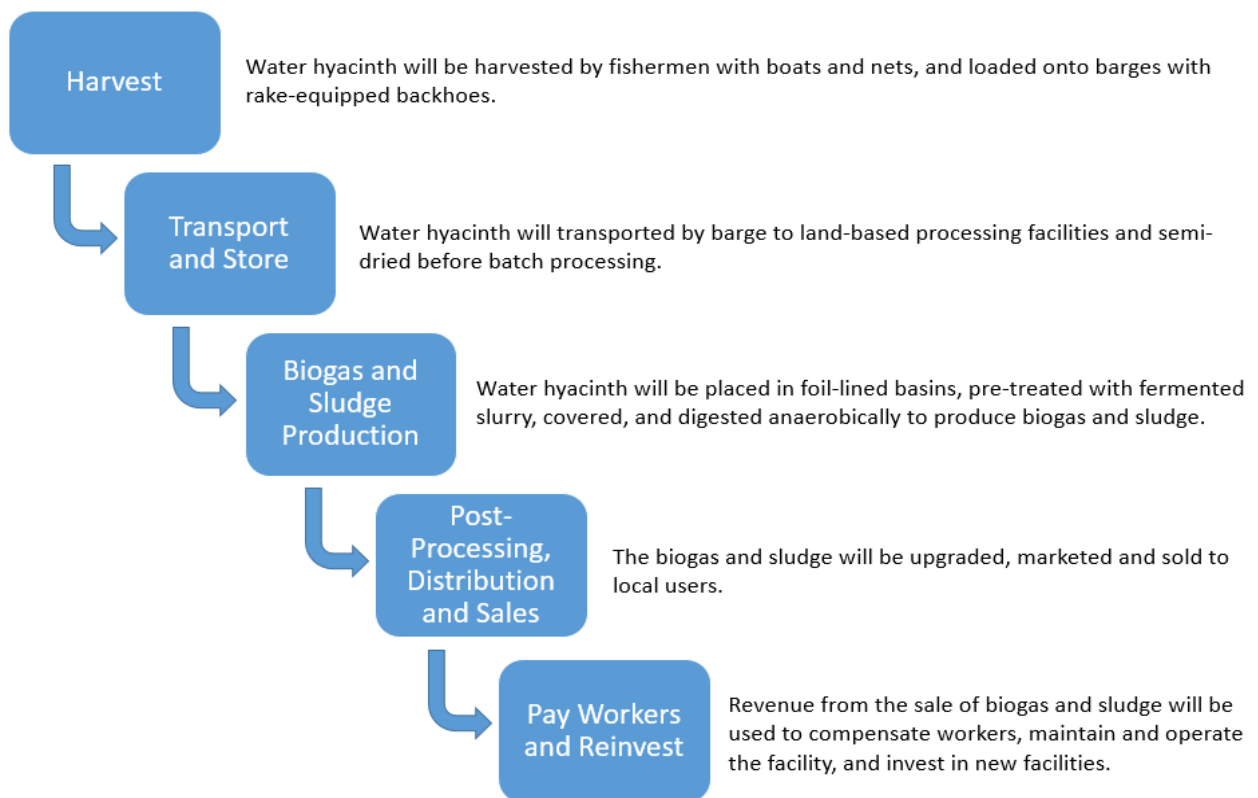


Figure 10: Strategic stages in Ecologists Without Borders (ECOWB’s) proposed project. (Source: Njogu *et al.* 2015)¹⁷⁵.

¹⁷⁵Njogu Paul, Kinyua Robert *et al.* Biogas Production Using Water Hyacinth (*Eicchornia crassipes*) for Electricity Generation in Kenya. *Energy and Power Engineering*, 2015, 7, 209-216.

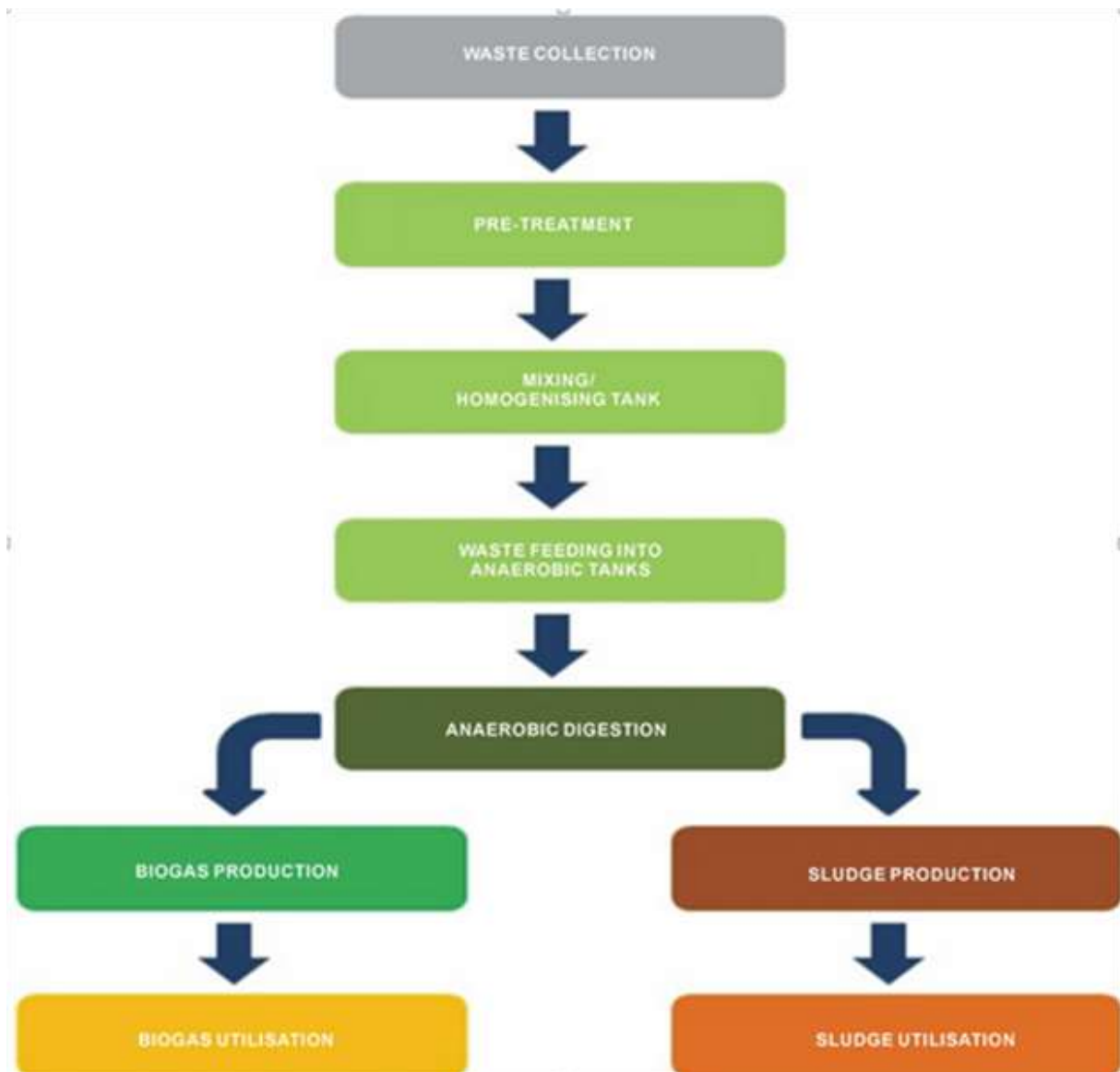


Figure 11: How the water hyacinth will be processed to produce biogas and sludge. (Source: Njogu *et al.* 2015)¹⁷⁶.

The project aims at offering clean energy that can be used by the community which will slowly eradicate the strained use of fossil fuel that contributes to global warming through the pollutant emissions. The project also seeks to restore the quality of water, fish population and increase fishing activities on the Lake which will in turn help in establishing a sustainable fisheries plan

¹⁷⁶Njogu Paul, Kinyua Robert et al. Biogas Production Using Water Hyacinth (*Eicchornia crassipes*) for Electricity Generation in Kenya. *Energy and Power Engineering*, 2015, 7, 209-216.

thereby promoting ‘community-based resource management plans.’¹⁷⁷Njogu et al also sees water hyacinth as a renewable source of biogas fuel, sludge and fodder for livestock.¹⁷⁸ With the water hyacinth providing a clean source of energy in terms of biogas production, the local communities will be able to benefit from the clean energy.

5.8 Presence of Water Hyacinth in the Lake

5.8.1 Respondents’ Views on Management Efforts on Water Hyacinth

All of the respondents stated that they have not seen any efforts either by the National Government or Homabay County Government in controlling the hyacinth. The Water and Environment County Executive Committee Member (CECM) admitted that there have been no projects regarding the management of water hyacinth in place. When asked to rank environmental problems (choices included; reduction in fish, low levels of water, low water quality and lastly, presence of hyacinth) facing Lake Victoria in order of their severity, the presence of water hyacinth came in first at 64% followed by low water quality at 19%, then reduction in fish at 13% then lastly, low levels of water at 4%. The respondents felt that the presence of water hyacinth had dealt a big blow to the sanitation of the Lake and to their source of livelihood. It is in this backdrop that they lament on the lack of action by the national and county governments in controlling the weed.

¹⁷⁷Ecologists Without Borders (ECOWB) ‘Kenya Water Hyacinth’ Retrieved at <http://ecowb.org/kenya-water-hyacinth/> on 15/1/2019.

¹⁷⁸Njogu Paul, Kinyua Robert et al. Biogas Production Using Water Hyacinth (*Eicchornia crassipes*) for Electricity Generation in Kenya. *Energy and Power Engineering*, 2015, 7, 209-216.

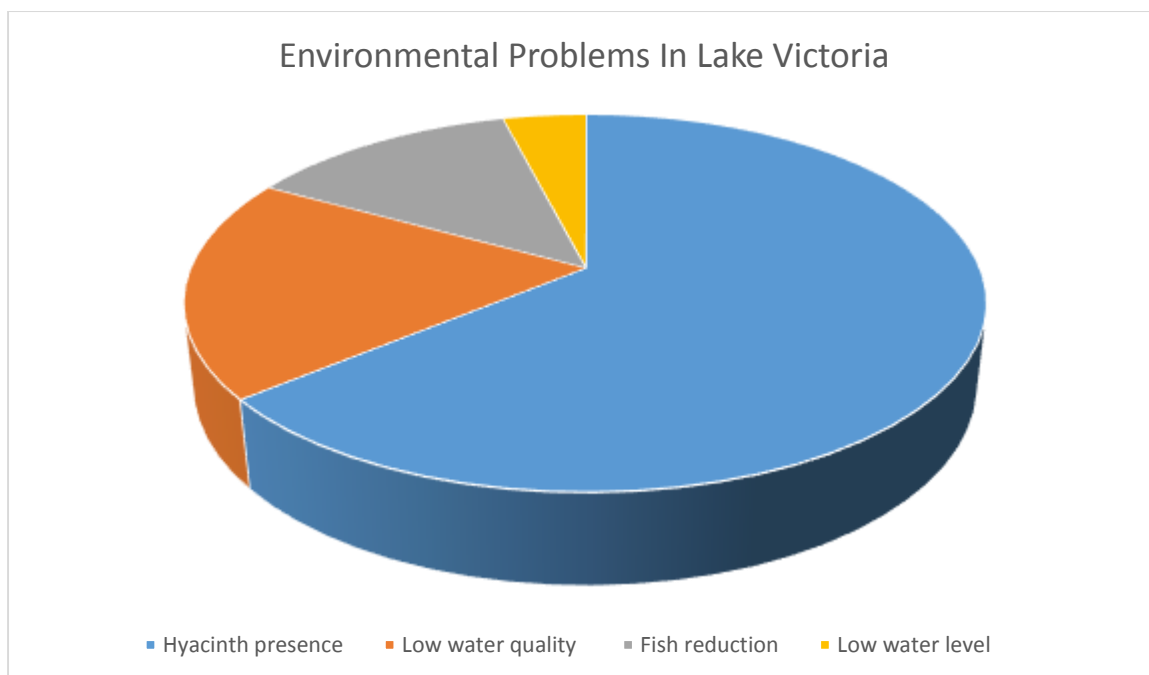


Figure 12: A pie-chart showing the environmental problems facing Lake Victoria.

To reduce environmental problems in Lake Victoria, the first regional (Uganda, Tanzania and Kenya) co-ordinated effort to promote the sanitation of the Lake and curb water hyacinth, was funded by the World Bank through Global Environmental Facility (GEF) and the International Development Association in 1997. The project, LVEMP, was started to harmonize approaches in Lake Victoria to benefit the three countries and provide a forum for co-operation between these countries.¹⁷⁹ Kenya’s government has failed to act hastily enough to control the weed and this is due to weaknesses associated to access to information on matters pertaining to water hyacinth, implementation of management tools and inadequate research on areas such as the efficacy of available management tools.¹⁸⁰ World Bank initiated the second phase of LVEMP

¹⁷⁹ Momanyi M., John ‘Lessons for Effective Management of Water Hyacinth (Eichornia Crassipes (Mart.) Solsm) in Kenya. Published by International Journal of Humanities and Social Science Vol. 4 No. 9 July 2014

¹⁸⁰ Ibid p. 121

and this time all EAC states including Burundi and Rwanda were included. LVEMP II encourages community participation and this has led to positive results.¹⁸¹

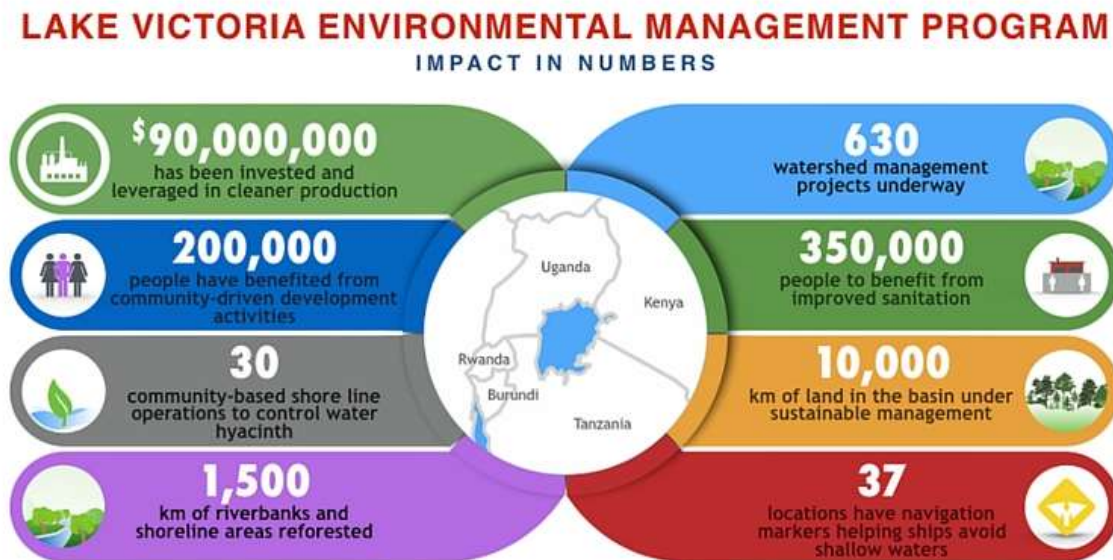


Figure 13: World Bank’s LVEMP success (Source: Reviving Lake Victoria by Restoring Livelihoods. Feature Story by World Bank published on 29 February 2016.)

LVEMP’s activities include “monitoring and control of water hyacinth, harmonizing management policies for fisheries and water resources, improving navigation safety on the Lake, rehabilitation, sanitation and wastewater treatment facilities, and working with private companies to reduce industrial pollution.”¹⁸²

Lake Victoria being an important source of water, food, transport and income to riparian communities, the presence of water hyacinth has dealt a big blow to the Lake’s dependants. Apart from the weed causing a reduction in fish catches; frustration of navigation, irrigation

¹⁸¹ Reviving Lake Victoria by Restoring Livelihoods. Feature Story by World Bank published on 29 February 2016. Accessed at <https://www.worldbank.org/en/news/feature/2016/02/29/reviving-lake-victoria-by-restoring-livelihoods> on 27/9/2019

¹⁸² Ibid p.1

and electricity generation; increased evapotranspiration by water loss and providing a breeding ground to malaria-causing mosquitoes and bilharzia-carrying snails,¹⁸³ residents of Sikrii, Homabay have also attested that the weed has caused the death and/or disappearance of several children who drown under the hyacinth mats. To curb the weed, the community in Homabay has on numerous occasions tried to start initiatives to deal with the hyacinth and this is through manual collection. However, when the hyacinth mats are so widespread, the community fails to make significant progress. The respondents have faced a myriad of challenges in manually collecting the hyacinth. The weed regenerates at a very high rate, at one point, it can cover up to 4,000 hectares of the Lake posing a challenge to the community and fishermen who do not have the capacity to deal with the weed. It is important to note that not all fishermen saw water hyacinth as a menace. One of those who held this opinion was quoted saying,

“The season when the hyacinth is on the Lake, there are many small fish called ‘nyapos’ which we use as bait to capture ‘mbuta’. This ‘nyapos’ is only seen when there is water ‘ford’ (hyacinth) on the Lake.”

The respondents seemed to have knowledge of the other management tools used in controlling water hyacinth namely; biological control, mechanical control and chemical control. Out of these tools, 64% of the respondents supported using both mechanical and manual control. They stated that mechanical control was fast and produced results as long as the machine was not a shredder. They stressed that using a shredding machine would make things worse as it would disperse the seeds of the weed thereby increasing the presence of the weed. They also said that once the weed was cut by the machine, it should be manually collected by the community. If

¹⁸³ Mailu, A. M. "Preliminary assessment of the social, economic and environmental impacts of water hyacinth in Lake Victoria Basin and status of control." Australian Centre for International Agricultural Research *proceedings* (ACIAR); 1998, 2000.

left on the surface of the water, it will sink to the bottom of the Lake, giving the Lake a dark image and a pungent smell.

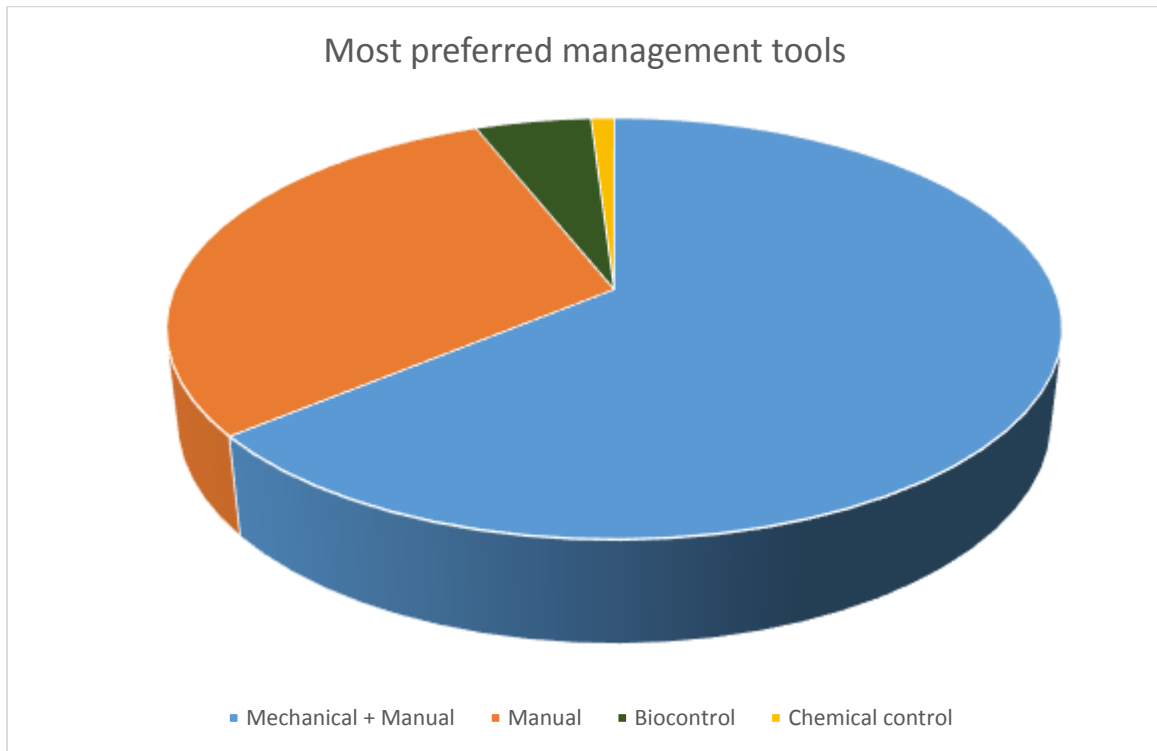


Figure 14: Most preferred management tools of water hyacinth.

In using manual collection, the respondents said that there should be a mechanism in place where the people collecting the hyacinth will be paid in terms of the kilograms of hyacinth they have harvested. One of the Beach Management Units who participated in the Focus Group Discussions added that if the county government would give them protective gears, they would manually collect the hyacinth and the government would in turn pay them for the work done. The protective gears, they said, were to prevent the hyacinth from getting into contact with their skin since they stated that the contact lead to an irritating and burning sensation which reduces when they apply oil on their skin. 30% of the respondents preferred using manual collection on its own. By choosing manual collection to be used, the respondents said that it would create employment opportunities to the jobless people and it would also act as an

alternative source of income to the fishermen who are unable to fish when the hyacinth covers the Lake. 5% of the respondents chose biological control to be best; they stated that the government's use of weevils slightly controlled the hyacinth in 1997. Kenya Agricultural Research Institute's (KARI) project of importing 4.2 million adult neochetina weevils from South Africa, Uganda and Australia and unleashing them to Lake Victoria to feed on hyacinth proved successful but soon thereafter, the weevils started to attack people's farms and ruin crops forcing KARI to discontinue the project which KARI had claimed to have reduced the weed infestation by around 50%.¹⁸⁴ 1% of the respondents chose chemical control but were quick to add that it should be used only if its application does not affect the fish or the water.

South Africa has taken biological control measures to eradicate water hyacinth. In doing so, the country has used six natural enemy species among them being one pathogen and five arthropods between the years 1974-1996. However, the success of these biological tools have said to be variable in South Africa and this can be attributed to the ever changing conditions of the climate, eutrophication of the water body and the interference on the integrated control operations. This has prompted South Africa to take additional courses of action which Hill and Olckers state to be "(i) mass-rearing and re-release of agents that failed to establish at specific sites; (ii) evaluation of the impact of the combinations of agents already established; (iii) development of management strategies in which biocontrol can be appropriately integrated with existing control operations; and (iv) search for additional agents that are effective under more temperate conditions."¹⁸⁵In *Uganda* and *Papua Guinea*, two insects were used- *Neochetina eichhornia* and *Neochetina bruchi*. These insects managed to control the water

¹⁸⁴<https://www.standardmedia.co.ke/article/2001230139/war-on-water-hyacinth-proves-costly-for-state> accessed on 3/8/2019

¹⁸⁵Hill P., Martin & Olckers Terrence 'Biological Control Initiatives against Water Hyacinth in South Africa: Constraining Factors, Success and New Courses of Action' 2001. Retrieved at <https://www.researchgate.net/publication/237299279> on 1/11/2018.

hyacinth infestation in a span of four years in Lake Victoria. The success experienced in Papua New Guinea and more recently in Uganda overpass that in South Africa. Hill and Cilliers attribute the strain in water hyacinth management in South Africa to include “cold winters, which vastly increase the time taken to control the weed; (ii) highly eutrophic waters in which the weed thrives; (iii) periodic removal of the weed and natural enemy populations through flooding and drought; and (iv) interference from other control methods, notably herbicide applications.”¹⁸⁶ While South Africa has struggled with eradicating water hyacinth, in 1990, the country used 200 adult *N. eichhorniae* to reduce the hyacinth mats that had covered 80% of the New Year’s Dam. By 1994, the weevils had reduced the hyacinth by 70% leaving only 10% of the dam surface covered by hyacinth mats. The 10% which had remained was because the hyacinth plants that were left were 10-20cm tall and therefore could not sink in the shallow water.¹⁸⁷

5.8.2 The Place of the Law in Controlling Water Hyacinth

The respondents opined that the law would be very crucial in controlling hyacinth in that it would put legal framework in place, set up an authority, appoint officials and implement projects that would provide viable solutions to the scourge. 100% of the respondents do not know of any current legal framework in place. One of the respondents was quoted stating,

“The law will deal with corrupt leaders who would like to embezzle money allocated for the removal of the weed.”

¹⁸⁶Hill P., Martin and Cilliers C. Johan. A review of the arthropod natural enemies, and factors that influence their efficacy, in the biological control of water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae), in South Africa. *African Entomology, Memoir*, 1999, 1, 103–112.

¹⁸⁷Martin P. Hill & Olckers Terrence ‘Biological Control Initiatives against Water Hyacinth in South Africa: Constraining Factors, Success and New Courses of Action’ 2001. Published by Research Gate.

The study showed skepticism by the respondents with regard to the government's promise in putting in place mechanisms to control the weed.

The respondents expressed hope that if a law on the control of water hyacinth can be put in place, then the government would show more responsibility in dealing with the issue. This would mean that there would be revenue allocation towards projects concerning the management of water hyacinth. For control interventions to succeed, there has to be an availability of suitable laws, policies and regulations to direct management.¹⁸⁸ Laws ensure that standards are set to manage natural resources (fisheries), establish and confer powers to authorities and institutions to implement provisions of legislations, provide mechanisms to acquire funds to run projects and human capacity to carry out sustainable fisheries programs.¹⁸⁹

Law plays a major role in the juridical expression of environmental programmes and policies. This role has three dimensions:¹⁹⁰ the law provides for institutional mechanisms for natural resource allocation, rules regulating the appropriation and development of these resources and the sanctions meted on violations; it sets standards and sanctions with respect to, (a) disposal of industrial by-products and here, the law ensures that during the development process, the by-products are subjected to appropriate and adequate waste treatment processes before being discharged into the environment, (b) trade and utilization of new technology during production and the role of the law here is to guarantee that the introduction of new technology in production does not impinge upon the quality of the environment.

The law can introduce anticipatory mechanisms to regulate and evaluate the effect of development programmes on the environment. Here, the law establishes mandated institutions to inspect proposed projects and the impact they would have in the environment.

¹⁸⁸ Ogutu- Ohwayo, Richard, and John S. Balirwa. "Management challenges of freshwater fisheries in Africa." *Lakes & Reservoirs: Research & Management* 11.4 (2006): 215-226.

¹⁸⁹ Ibid p. 15

¹⁹⁰ Ogolla, Bondi D. "08_Role of Environmental Law in Development." (2016).

The presence of water hyacinth is encouraged by pollution at the Lake hence making it necessary to curb pollution. The law is vital in preventing pollution since it assigns responsibility to the national and county governments and relevant lead agencies in conserving water bodies and promoting sanitation.¹⁹¹ It also establishes mandated regulatory bodies and institutions whose functions are outlined and sets up funds and provides for budgetary allocations that will enable the institutions to carry out their functions.¹⁹² The water in Lake Victoria should be free from any kind of pollution and be safe for human use. In controlling pollution at the Lake, the water hyacinth will not have a conducive environment to regenerate. The law also paves way for environmental litigation which is classified into; “a) private lawsuits to seek damages or equitable relief against the polluting sources; 2) the resolution of criminal and civil charges against law breakers of statutes on pollution; and 3) citizen suits against the actions of public servants in protecting or managing public resources.”¹⁹³

5.9 Summary of Findings

The study sought to answer the research questions set out in Chapter 1 by examining the legal framework of aquatic invasive species in Kenya, specifically the water hyacinth and also its management tools. The study was based in Homabay County which is part of the Winam Gulf, which is greatly affected by water hyacinth. The respondents were mainly fishermen and fish traders with the rest being key informants.

Finding 1

The first question sought to find out the consequences of water hyacinth on the environment and fishing activities in Lake Victoria. Studies have shown that water hyacinth reduces the

¹⁹¹<https://www.2030wrg.org/wp-content/uploads/2016/12/Understanding-the-Kenyan-Water-Act-2016.pdf> accessed on 13/3/2019

¹⁹²Ibid p.1

¹⁹³Water Pollution: Role of the Courts, 1972 Wash. 291 (1972). Available at: http://openscholarship.wustl.edu/law_lawreview/vol1972/iss2/6 accessed on 13/3/2019

water quality and quantity; frustrates navigation; destroys fish gears; harbors snakes; provides a breeding ground for malaria-causing mosquitoes; causes the water to have a foul smell; lowers the oxygen levels in the water; prevents accessibility of the fishermen to fish and in some cases, death of children who drown while swimming around the weed. The weed also causes the decline of fish due to the weed's ability to mats seal off breeding, nursery and feeding grounds of fish species. It is important to also note the positive effects of water hyacinth: it can be used to produce fuel, biogas and liquid organic fertilizer. The weed can also be used to make paper, furniture and ornaments and to generate electricity.

Finding 2

The first part of the second question of the study was to find out the challenges facing implementation of the existing management techniques in combating water hyacinth. The existing management tools include; mechanical control, biological control (biocontrol), chemical control and manual collection. Majority of the respondents, 64%, chose a combination of mechanical and manual to be effective while 30% chose manual collection, 1% chose chemical control with 5% choosing biological control. The challenges facing mechanical control is that since the weed hinders navigation, the machine being used to eradicate the weed also has a possibility of being stuck in the weed. If the machine is a shredder, then it will cause the hyacinth seeds to disperse far and wide thereby encouraging its regeneration. As for manual collection, the respondents stated that the weed grows at a fast rate and thus it gets quite difficult for it to be harvested manually. Moreover, the weed provides hiding grounds for crocodiles and snakes which pose danger to the people. Biological control, which was used in LVEMP II proved to have its challenges when the weevils used attacked people's farms afterwards. Additionally, after the weevils fed on the hyacinth, the remaining hyacinth mats sunk to the depths of the water making the water dark and smelly. Chemical control is highly risky as the chemicals used can alter the quality of the water, kill fish and other organisms living in the

Lake. The agencies responsible have been using them on a trial and error basis without following a well-thought out plan. Once the agencies get funds, they rush to experiment with a management tool before investigating its merits and demerits. The implementation of these management tools need a thorough research, an informed legal framework, a properly constituted Authority/Board that has experts and qualified persons, adequate budgetary allocation and accountability by the persons responsible.

The second part of the second question was to find out the most appropriate management tool(s) to stop the spread of water hyacinth. From the study, it is clear that mechanical control and manual collection were the most preferred management tools. This would mean coming up with an Intergrated Weed Management (IWM) Plan and examine how these two tools can be incorporated into hyacinth control. This should involve both legal and environmental experts to come up with a comprehensive, functional, unified and informed IWM plan. This process should include the public, key stakeholders and relevant agencies.

Finding 3

The third question was to find out improvements on the legal and institutional framework for water hyacinth. The study showed that 100% of the respondents had no knowledge of any laws governing water hyacinth. Since the Suppression of Noxious Weeds Act has information relating to land-based weeds only, it should be repealed to include water-based weeds. The amendments to the law should feature the creation of an Authority/Board to deal with aquatic noxious weeds, functions of the Authority/Board, budgetary allocation, specify which management tools should be used and how they should be used, put in place penalties and sanctions on whoever hinders the implementation of the law. Alternatively, a whole new legislation mainly focusing on aquatic noxious weeds can be drafted. The riparian counties which are facing challenges from the weed should also make their own specialized county laws.

Currently, Homabay, Migori and Siaya counties are in talks to come up with a single, unified law governing the control of water hyacinth. These counties are on the verge of drafting ‘Hyacinth Coordination and Management Action Plan’ which is expected to be completed by the end of the year 2019.

Finding 4

The fourth question was to find out the lessons that Kenya can learn from comparative experience from other countries. Out of the four countries (Uganda, Tanzania, New Zealand and USA) analysed, the use of Integrated Weed Management (IWM) was evident and this approach proved to be successful. All the countries except Uganda had water hyacinth specific legislations, regulations, plans and programs. The lessons Kenya can learn from these countries are: it is important for a country affected by water hyacinth to formulate comprehensive, coherent, detailed laws and regulations to govern the weed and its management; there should be an institution established to implement laws and programs put in place to control the weed; IWM should be used to manage water hyacinth as there is evidence to show its success; allocation of adequate funds to implement water hyacinth programs is mandatory and there should be extensive research done before undertaking any program or project regarding water hyacinth.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter encompasses a summary of the findings derived from objectives of the study, conclusion, recommendations and proposals.

6.2 Conclusion

From the study, several conclusions can be inferred. The first one is on the effects of water hyacinth on the Lake and fishing activities and what has caused the weed's proliferation over the years. Water hyacinth has degraded the water of Lake Victoria by lowering the water's quality and quantity; causing the accumulation of poisonous gases like hydrogen sulphide; giving the water a foul smell and a dark colour and reducing the oxygen levels. The weed has also impacted negatively on fishing activities since it damages the fishing gears and hinders the boats from accessing the fishing points. This resultantly leads to an increase in fish stocks as the hyacinth mats prevent overfishing. Pollution control is necessary as the weed's presence and growth is boosted by eutrophication of the Lake. The effluents draining in the Lake provide a favorable environment for water hyacinth which thrives from the nutrients in the effluents. Therefore, to prevent the further spread of water hyacinth in the Lake, pollution of the Lake must be stopped and restorative measures must be put in place so that the Lake's sanitation is promoted.

The second conclusion is the lack of knowledge in laws and information regarding aquatic noxious weeds. It is key for the relevant agencies to educate the people on aquatic invasive weeds. Knowledge on the uses of water hyacinth after harvest is also scanty since the community does not have adequate information on how they can use the weed after its harvest.

The government can conduct trainings to educate the community on the uses of hyacinth and ways in which the community can benefit.

Thirdly, the lack of a proper legal framework on aquatic invasive weeds has made it difficult for the government to come up with an efficient management plan to govern water hyacinth. The main legislation on noxious weeds does not establish any implementation or decision-making body which is a huge risk since lack of an authority downplays the effects of noxious weeds. The implementation of the Act has been left to two persons; the Director of Agriculture and the Inspector who is appointed by the Director. It is quite unfortunate that such a sensitive task of managing noxious weeds in the country rests with two people who might not be experts on noxious weeds. The agencies which have been implementing projects with regard to the management tools, have been doing so blindly and this has resulted to these projects showing little or no success. There is none that has been specifically coordinated and mandated to deal with aquatic invasive species. The lack of establishment of this legal framework, has made it unclear as to which institution bears the responsibility of eradicating water-based invasive weeds and which management options should be used in this quest resulting to an overlap of the mandate in these institutions. Moreover, the absence of a legal framework has resulted to advanced degradation of the Lake's water quality and the threatened extinction of native species. The absence of a single agency/authority has hindered accountability and responsibility since there is no single authority tasked with eradicating aquatic invasive weeds. The importance of having a single authority in charge, is that it will be easier to hold it accountable when there is failure to control the spread of the weed.

From the comparative experience, it is evident that Kenya has a long journey in establishing a comprehensive, coherent and unified legislation on AIS. However, Kenya can learn from the countries discussed therein and take some pointers to assist in drafting new laws and revising

existing laws on noxious weeds. This study recommends a further study on these countries with the aim of identifying and taking care of the gaps present in the country's existing legislation. The study showed that an integrated management of the weed will be suitable and the interventions that would produce favourable results are mechanical control and manual collection. However, Kenya has not had a successful journey with mechanical control with all the machines being purchased lying idle either due to lack of crucial technical components, or lack of political will. To avoid this, there needs to be a research undertaken any time a machine is proposed to be purchased. A Committee of Experts should be included in the discussions prior to purchasing any machine to ensure that the right machines are bought and that these type of machines have registered success in the areas they have already been used.

The challenges facing management of water hyacinth include; lack of political will, lack of a properly constituted body to implement management programmes, the absence of a comprehensive and unified legal framework, high amounts of effluents discharged in the Lake leading to eutrophication, improper land use and purchase of machines without conducting research. Creating an IWM-oriented plan is the best route to take as this will ensure that there is maximum effort and knowledge used. The fact that no comprehensive literature on legal management of aquatic invasive weeds in Kenya has been written, shows that aquatic invasive weeds have not received the required attention. The effects of aquatic invasive weeds such as the water hyacinth have been downplayed for several years now making the community to suffer whenever the hyacinth mats cover the surface of the Lake.

6.3 Recommendations

Based on the findings of this study, the first recommendation would be the development of the legal framework on noxious weeds to include aquatic noxious weeds. To deal with aquatic invasive species, the main legislation which is *The Suppression of Noxious Weeds Act* needs to

be revised and repealed to cover water-based weeds. The Act should also create an Authority which will oversee the implementation of laws on aquatic noxious weeds. Furthermore, the Act should confer powers to this Authority and the appointed officials to make well-informed decisions regarding the aquatic weeds and ensure public participation in all the decision-making processes. The Act should create a sense of responsibility and accountability to the Authority and its officials in controlling aquatic weeds. The Authority should create programs to curb AIS while the government should ensure that adequate funds are made available to implement these programs. There should also be a harmonisation of the sectoral laws that provide for the sanitation of water resources.

The second recommendation would be the creation of a regulatory review committee whose function will be to recognize the prospective for enhanced regulatory coordination, encourage the Authority to formulate an interagency rapid response program, , create and encourage the adoption and implementation of new AIS legislation.

The comparative analysis in this study showed that New Zealand has the most comprehensive legislation on water hyacinth, followed by the USA. Kenya should use the legislations from these two countries as a backdrop against formulating and/or revising the country's own legislation on water hyacinth.

Proper land use will reduce the amount of run-off water from farms to water bodies. In doing so, it would prevent water affected by pesticides and fertilizers to drain into water bodies. Farmers should also be encouraged to plant trees so as to increase land cover and prevent soil erosion. Factories that discharge effluents to water bodies should be shut down and forced to comply before being given licenses. They should also be made to undertake restorative measures and pay for the damage they have caused. There should be an inspection of all

industries in the country to ensure that they have installed waste water treatment facilities. Practice of best waste management practices will also assist in pollution control.

Management of water hyacinth will be easy if the lead agencies were to create awareness and educate the public on proper waste disposal, proper land use and importance of sustainable management of water. The community should also be educated on AIS and watershed management, the study showed that there is limited knowledge on AIS and this was consequential in the management of water hyacinth in Lake Victoria. In terms of management of the weed, the community should be included since they have expressed their interest and willingness to participate in AIS eradication programs.

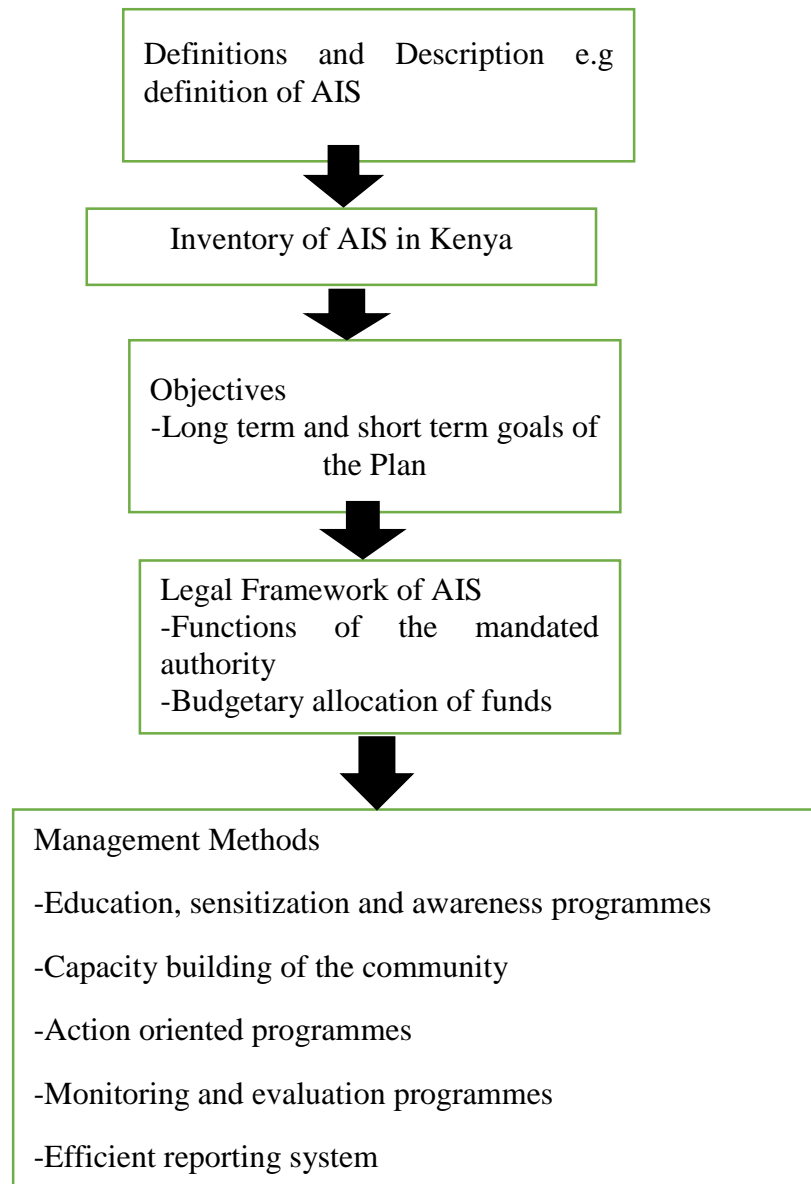
It is vital for the authorities to upscale enforcement actions for individuals and factories undertaking activities that lead to water pollution. The government also needs to repair damaged manholes and ensure that factories have installed waste treatment facilities before issuing licenses. Proper EIA and EA processes should be carried out before any industries are put up. Additionally, no commercial or residential premises should be allowed to be built in riparian reserves. Restoration orders issued by the courts in environmental litigation should be adhered to the letter and follow-ups should be made to ensure that the area in dispute has been restored to its previous state before the occurrence of the environmental degradation.

Since Lake Victoria is a transboundary resource, the countries sharing it should come together to draft a regional legislature on aquatic invasive species. This will ensure that the countries come up with a unified approach in controlling these species through interagency cooperation. These countries should also settle on an ideal integrated approach towards controlling water hyacinth and carry it out on the Lake jointly so as to realize maximum positive results.

Creation of an IWM-oriented plan is the best way to deal with AIS and will include inter alia, early detection and eradication programmes, IWM procedures and objectives and an ongoing

maintenance programme of Aquatic Invasive Species (AIS). The long-term and short-term goals should be aligned to the objectives of the plan. There should be adequate resources to implement the plan so that its objectives are met. Education and awareness is a key component of IWM whereby the relevant agencies should educate the community on the dangers posed by AIS.

Figure 15: Steps in creating an Integrated Weed Management plan (Source: Author's own)



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APPENDICES

APPENDIX I: STUDY QUESTIONNAIRE

This questionnaire seeks to collect information for the purpose of reviewing the legal framework and management options of water hyacinth as an aquatic noxious weed in Kenya's Winam Gulf, Homabay County- Kenya for academic purposes ONLY. Your views are very important; I am kindly requesting that you fill this questionnaire. Please note that the information will be treated with confidentiality where necessary.

QUESTIONS

Section 1: Respondent's Profile

1. Please tick your gender Male () Female ()

2. Age

10-15 () 16-21 ()

22-26 () 27-31 ()

32-36 () 37-41 ()

42-46 () Above 46 ()

3. Marital Status

Married () Widowed () Divorced () Single ()

4. How many children do you have, if any?

1 () 2 () 3 () 4 () More than 4 ()

5. Level of Education

Primary () Secondary () College/University ()

6. What socio-economic activities are you engaged in?

Fishing ()

- Fish trade ()
- Transport business ()
- Tourism ()
- Farming ()
- Carpentry ()
- Tailoring ()

Others (specify)

7. How long have you been in this business?

- Less than 1 year () 1-3years ()
- 4-6years () 7-9years ()
- Above 9 years ()

8. How far is your home from Lake Victoria? Kms ()

8.1	What is your view on the current environmental state of Lake Victoria?	Very good ()
		Good ()
		Degraded ()
		Very degraded ()
8.2	Rank environmental problems in Lake Victoria basin in order of their severity, listing the most severe first (1) and the least severe last (4).	Reduction in fish ()
		Low levels of water ()
		Low water quality ()
		Presence of water hyacinth ()
8.3	How satisfied are you with the government's efforts in preserving the sanitation of Lake Victoria?	Extremely satisfied ()
		Satisfied ()
		Neutral ()
		Extremely dissatisfied ()
		Dissatisfied ()
8.4	Have there been efforts by the County Government in removing water hyacinth from the Lake?	Yes ()
		No ()
		I do not know ()

8.5 When did you first notice water hyacinth on the Lake? Month.....
Year.....

8.6 Which months are the most affected by the presence of water hyacinth at your beach?

Jan	()	Jul	()
Feb	()	Aug	()
Mar	()	Sep	()
Apr	()	Oct	()
May	()	Nov	()
Jun	()	Dec	()

8.7 How many months in a year is the hyacinth in the Lake? ()

8.8 Do you know of any existing legal framework on water hyacinth? Yes ()
No ()

If yes, mention it

Section 2: Respondent's view on the control of water hyacinth

9. What are the effects of water hyacinth on the following:

a) Environmental beauty (aesthetic)

.....
.....

b) Pollution

.....
.....

c) Fishing

.....
.....

10. What steps have the Community, National and County Government taken on removing hyacinth from the Lake?

a. Community

.....
.....

.....

b. National Government

.....

.....

c. County Government

.....

.....

.....

11. What are the challenges that have been faced in removing the weed?

.....

.....

.....

.....

.....

12. Which of these steps have had the most suitable results and why?

.....

.....

.....

.....

13. Which of these steps have had the least suitable results and why?

.....

.....

.....

.....

14. How do you think the law can assist to control/manage water hyacinth?

.....

.....

.....

.....

there is absence of water hyacinth

there is partial presence of water hyacinth

22. Has the water hyacinth limited your movement during fishing in the Lake? If so, how?

23. Have you and the other fishermen made efforts to remove the water hyacinth from the Lake?

24. Which were the methods used and how effective were they?

25. In your opinion, which is the most suitable method in managing water hyacinth and why?

APPENDIX II:

INTERVIEW GUIDE FOR CIVIL SOCIETY ORGANIZATIONS (CSOs)

I am a student of MA Environmental Law at the Centre for Advanced Studies in Environmental Law and Policy (CASELAP), University of Nairobi. I am carrying out research entitled, “A Review of the Legal Framework and Management Options of Water Hyacinth as an Aquatic Noxious Weed in Kenya’s Winam Gulf” for partial fulfillment of the requirement for my MA degree. The information that you will provide in this questionnaire and your personal identification will be kept confidential while using the information for research activities.

DateDay ofYear.....

Name of Interviewer

SECTION A

General Information

1. What is your name?
2. Which organization do you work for?
3. What position do you hold in your organization?
4. How long have you been working at the organization?
5. Which laws govern your organization?
6. What projects has your organization carried out at Lake Victoria?
7. What are the impacts of water hyacinth on the environment?
8. How are the socio-economic activities around the Lake affected by the presence of water hyacinth?

9. Which of the projects your organization has undertaken is associated with controlling water hyacinth?
10. Which laws do you use to implement these projects?
11. What are the challenges your organization has faced in the bid to control water hyacinth?
12. Which are the current efforts made by the County and National Government in eradicating water hyacinth?
13. How effective have these efforts by the Government been?
14. What are your views on the adequacy of the law in resolving challenges arising from water hyacinth?

SECTION B

This section is solely based on the legal framework of water hyacinth

15. Which laws, in your opinion are relevant to managing water hyacinth?
16. How adequate are these laws in controlling the weed?
17. What recommendations and improvements, if any, would you suggest to be made for the law on noxious weeds?

SECTION C

This section is solely based on the management options of water hyacinth

18. What are the management options that are most suitable in controlling water hyacinth and why?
19. What are the management options that are least suitable in controlling water hyacinth and why?
20. What are the challenges facing management options of water hyacinth in Kenya?

APPENDIX III:

INTERVIEW GUIDE FOR FOCUS GROUP DISCUSSIONS WITH FISHERS

ASSOCIATIONS

This focus group discussion seeks to collect information for the purpose of reviewing the legal framework and management options of water hyacinth as an aquatic noxious weed in Kenya's Winam Gulf, Homabay County- Kenya for academic purposes ONLY. Your views are very important; I am kindly requesting that you fill this questionnaire. Please note that the information will be treated with confidentiality where necessary.

QUESTIONS

1. What is the name of your association?
2. How many members are in the association?
3. How have the members been affected by the presence of water hyacinth in the Lake?
4. How has the weed affected the socio-economic activities around the Lake?
5. What has been the impact of water hyacinth especially on fishing and fish trade?
6. What is the effect of water hyacinth on fishing vessels (boats)?
7. Which months are most affected by the presence of water hyacinth?
8. Do you know of any laws governing the management of water hyacinth? If yes, what are they?
9. Are these laws adequate in managing the weed?
10. What steps has the association taken in eradicating the weed?
11. Which methods did the association employ in removing the water hyacinth on the Lake?
12. Which challenges have you faced in the efforts towards controlling the weed?
13. Which has been the most suitable management method from your observation?

14. Have there been any collaborations between the association with the County and/or National Government in managing the hyacinth?
15. Are there any uses of the weed after harvest? If so, what are they?
16. What are your suggestions on how the weed should be managed?

APPENDIX IV:
INTERVIEW GUIDE FOR GOVERNMENT INSTITUTIONS AND LEAD
AGENCIES

Dear Respondent,

This questionnaire seeks information that will help in reviewing the legal framework and management options of water hyacinth as an aquatic noxious weed in Kenya's Winam Gulf to be precise, where you have been selected to help out provide necessary information required in this study. Your views are very important.

Therefore, am kindly requesting for 30 minutes of your time in order to answer some questions pertaining to this study. The following questions will be asked if permission is granted.

QUESTIONS

1. What institutions are responsible for management of water hyacinth?
2. What is the role of the National and County Government in the management?
3. What should the community living along Lake Victoria do to curb the hyacinth infestation?
4. Are there any laws governing the management of water hyacinth?
5. Are these laws adequate to fully manage the weed infestation?
6. What is the role of your institution in water hyacinth management?
7. How is water hyacinth currently controlled?
8. What are the constraints facing technology used to control the weed?
9. What are the internal and external challenges in management of the
water hyacinth?
- 10 What strategies for control of water hyacinth should be in place apart from the existing ones
and why?

**APPENDIX V:
RESEARCH AUTHORIZATION FROM NACOSTI**



**NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION**

Telephone: +254-20-2213471,
2241349,3310571,2219420
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/19/92884/31463**

Date: **20th June 2019**

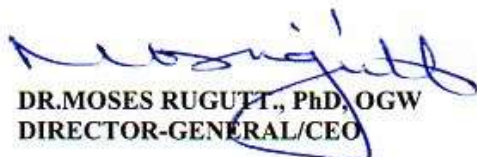
Susan Adoyo Yara
University of Nairobi
P.O Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *“A review of the legal framework and management options of water hyacinth as an aquatic noxious weed.”* I am pleased to inform you that you have been authorized to undertake research in **Homa Bay County** for the period ending **20th June, 2020.**

You are advised to report to **the County Commissioner, and the County Director of Education, Homa Bay County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.


DR. MOSES RUGUTT, PhD, OGW
DIRECTOR-GENERAL/CEO

Copy to:


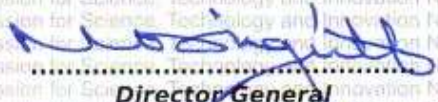
The County Commissioner
Homa Bay County.

The County Director of Education
Homa Bay County.

**APPENDIX VI:
RESEARCH PERMIT**

THIS IS TO CERTIFY THAT:
MISS. SUSAN ADOYO YARA
of THE UNIVERSITY OF NAIROBI,
30848-100 NAIROBI, has been permitted
to conduct research in Homabay
County
on the topic: A REVIEW OF THE LEGAL
FRAMEWORK AND MANAGEMENT
OPTIONS OF WATER HYACINTH AS AN
AQUATIC NOXIOUS WEED
for the period ending:
20th June,2020

.....
Applicant's
Signature



Director General
National Commission for Science,
Technology & Innovation

**APPENDIX VII:
RESEARCH AUTHORIZATION FROM HOMABAY COUNTY**



MINISTRY OF EDUCATION

STATE DEPARTMENT OF EARLY LEARNING & BASIC EDUCATION

Telegrams: "SCHOOLING" Homa Bay

Telephone

When replying please quote

cdehomabay@gmail.com

COUNTY DIRECTOR OF EDUCATION

HOMA BAY COUNTY

P.O BOX 710

HOMA BAY

DATE: 12TH JULY, 2019

REF: MOE/CDE/HBC/ADM/11/VOL.2/163

Susan Adoyo Yara
University of Nairobi
P.O. Box 30197 - 00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "*A review of the legal framework and management options of water hyacinth as an aquatic noxious weed,*" in Homa Bay County for the period ending **20th June, 2020.**

I am pleased to inform you that you have been authorized to undertake research in Homa Bay County for the period ending **20th June, 2020.**

Please submit a copy of your findings both in soft and hard copies to this office.

Thank you in advance.

COUNTY DIRECTOR OF EDUCATION
HOMA BAY COUNTY
P.O. BOX 710-40300, HOMA BAY
Email: cdehomabay@gmail.com

MR. SHEM M. OMBONYO
FOR: COUNTY DIRECTOR OF EDUCATION

Cc.

1. County Commissioner – Homa Bay

