

Lessons for Effective Management of Water Hyacinth (*Eichhornia Crassipes* (Mart.) Solms) in Kenya

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Abstract

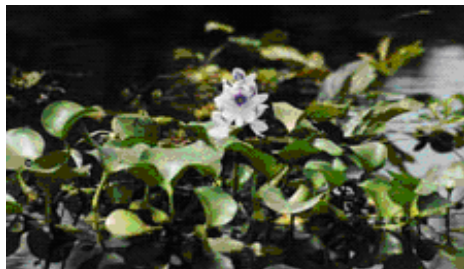
Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) is an invasive aquatic macrophyte associated with major negative economic and ecological impacts. Although water hyacinth continues to cause serious disruptions in the use of water bodies in Kenya, the government has not promptly moved to contain the spread of this weed. In view of this, this paper identifies the weaknesses related to access of information on water hyacinth, implementation of control mechanisms, and lack of research on certain aspects as the issues that explain why Kenya is not swiftly taking measures to control water hyacinth whenever it invades its water systems. These shortcomings call for action to effectively mobilize, organize, and equip decision-makers, researchers, and representatives of communities, along with their organizations and institutions, to improve their response to the water-hyacinth problem.

Keywords: Water hyacinth, Environment, Biological Control, Kenya

Introduction

The negative consequences of the activities of man on the biological conditions in fresh water ecosystems are becoming more and more pronounced. Introductions of alien plants and animals into the lentic hydrosystems are common occurrence in Kenya and also in many parts of the world. In many cases, this has led to the disappearance of natural vegetation and growth explosion of some other plant species. In Africa, for example, excessive establishment of aquatic weeds has been enhanced by the increased enrichment of water bodies by nutrient runoffs from human and agricultural wastes. This leads to proliferation of aquatic weeds over the water bodies. Their physical presence hinders human activity and interferes with the ecological functioning of the water ecosystems. The most severe problems are caused by free-floating species that are able to form moving, impenetrable mats. The most deleterious of these free floating plant species and listed among the ten most notorious weeds in the world is the water hyacinth (*Eichhornia crassipes* (Mart) Solms-Laubach (*Pontederiaceae*) (Pieterse, 1990a) (Plate 1). This weed is commonly known as the “queen flower” because of its attractive rosette leaves (Plate 2) and beautiful pale violet flowers (Plate 3). The plant has continued attracting the attention of aquarists world-wide because of its ornamental value. The weed has, however, caused considerable damage to lakes and rivers around the world (Little, 1969) and it still remains the world’s most problematic water weed despite widespread and various approaches to its control (Heard and Winterton, 2000).

Water hyacinth occurs in habitats of widely different nutrient status. They range from shallow temporary ponds, marshes and sluggish flowing waters to large lakes, rivers and reservoirs. A broad spectrum of physico-chemical environments characterizes these habitats. In temporary water bodies, the plants often have to survive on moist mud for prolonged periods, or pinnate in the form of seeds (Gopal, 1987). In permanent lakes and reservoirs the plants are subjected to large water level fluctuation and wave action. In riverine habitats, seasonal variations in the flow velocities are crucial in explaining changes in the mass of water hyacinth for given points of time.

Plate 1: Water hyacinth plants**Plate 2: Water hyacinth leaves****Plate 3: Water hyacinth flower**

Before the intervention of man, the natural habitats of water hyacinth were restricted to tropical South-America and parts of Central-America (Sculthorpe, 1967). The plant is thought to have been introduced to its new areas around the world in the 1930s by aquatic botanists and water gardeners (Little, 1975). At present the water hyacinth occurs in warm regions all over the world. For instance, in South and Middle America the water hyacinth occurs in many lakes such as Brokopondo Lake in Surinam (Leentvaar, 1975), Lake Apanas in Nicaragua (Little, 1965) and Lake Rio Lempa in El Salvador (Bayne and Castro-Butter, 1975). In the Caribbean, the water hyacinth is found on many islands (Gangstaad, 1977), while it is also widely spread in Mexico (Ramirez *et al.*, 1971). In the USA, it occurs in the southern states along the Gulf Coast (Penfound and Earle, 1948, Blackburn, 1975; Gilligam, 1976) and in California (Bock, 1966; 1969). The water hyacinth is also found in India (Ambasht and Ram, 1976), Pakistan (Robson, 1976), Sri Lanka (Kotolowala, 1976), Malaysia (Backer, 1951) and in Indonesia (Dhahiyat, 1975).

In Africa, the first introduction of water hyacinth was in Egypt in about 1880 (Warnimont, 1965). Spread has been especially rapid during the last 10-15 years with exceedingly serious problems developing in the equatorial zone. In North Africa water hyacinth causes serious problems in the Nile River basin. In Sudan it has reduced substantially through the establishment of biological control agents between 1979 and 1980 (Beshir and Bennet, 1985; Julien, 1992).

In West Africa annual flooding of coastal rivers infested with water hyacinth results in huge quantities being carried into coastal lagoon systems in Cote d'Ivoire. The socioeconomic structure, food supply and health of up to several million people are seriously disrupted (Eppelle and Farr, 1993, de Graft-Johnson, 1993, Harley 1993, Thielen van 1993). Massive problems are known to exist in the Congo River but details are not available. In East Africa the most serious problems are in the equatorial zone, especially in the catchment of Lake Victoria, the upper Nile River (Uganda) (Twongo, 1993) and the lower Shire River (Malawi) (Terry, 1991, Harley, 1993; Laisi, 1993).

However, all other countries in the sub-region are infested and there is considerable potential for water hyacinth to increase to cause serious damage. In lakes Kyoga, Albert and Victoria massive growths of water hyacinth are causing serious disruption to commercial fishing due to its obstruction of fishing and landing sites (Plate 4). It is also believed that its presence along the shores has had a major impact on tilapia nesting, through lowering the dissolved oxygen above such sites and shading. In the early 1990s the worst affected areas have been on Lake Kyoga (FAO, 1993a), but by 1996, in the Uganda sector of Lake Victoria, the weed extended an average of 15 m from the shore, covering almost 80% of the country's 1 000 km of shoreline. Near Kampala, the capital of Uganda, the weed was 30 m wide. Prevailing winds from the south pushed most of the weeds to Uganda, but in 1996 the weed almost encircled the 3 000 km of shoreline (Anderson, 1996). Luckily, the situation has dramatically changed for the better, and by January 2000 it was reported that water hyacinth had been reduced by 80% on Lake Kyoga and 70% on Lake Victoria (Wendo and Ngatya, 2000). In Lake Victoria only 16% of the shoreline remains infested. This reduction is believed to be the result of the success of biological control using two weevil species, i.e. *Neochetina bruchi* and *Neochetina eichhorniae* (Plate 5), released on Lake Victoria since 1996, and on Lake Kyoga since 1994.

Plate 4: Water Hyacinth mats blocking the Port of Kisumu

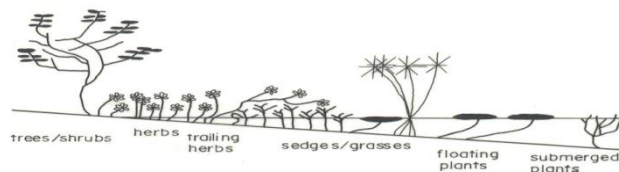


Plate 5: *Neochetina Bruchi* (Left) and *N. Eichhorniae* (Right) adults



The first case of water hyacinth in Kenya was reported in Lake Naivasha in 1988 (Njuguna, 1991). By early 1989 the plant had progressively spread in the lake and in 1992 it became the dominant weed species (Harper *et al*, 1992). So far, the weed has adversely affected lake transport and the fishing industry. Water hyacinth has the ability to root in damp mud and so in Lake Naivasha, as in other locations that it has colonized, the littoral zone is overwhelmingly dominated by both floating plants of *Eichhornia crassipes* in the shallow water and rooted plants on the shore edge (Adams *et al.*, 2000). The dominance has a physical stability, for, as water level changes, rooted plants can float and *vice versa*. It is thus possible that the classic zonation of vascular plants from land to the open water, described for Naivasha by Gaudet (1977), has been altered. Gaudet classified 108 plant species in a primary successional sequence from lake edge to dry land after a period of naturally low water levels that occurred between 1971 and 1973. The zones were: the seedling zone dominated by *Nymphae nouchali*, seedlings that did not survive further drying; the sedge zone dominated by *Cyperus papyrus*, the composite zone dominated by *Conyza*, *Gnaphalium* and *Sphaeranthus* (Figure 1).

Figure 1: Hydrosereal Succession of Plant Species around the Shore of Lake Naivasha in the 1970s. After Gaudet (1977)



The water hyacinth has therefore become a problem wherever it occurs (Plate 6). This is basically due to its high growth rate that exceeds dry biomass of any fresh water plant (Ntiba *et al.*, 2000). The high density of the weed leads to degradation of water quality, dramatic changes in wetland animal and plant communities and interference with water circulation, *inter alia*. However, various countries of Eastern Africa, efforts to effectively combat it have always been initiated late. In almost all cases, people have taken action only after the spread of the weed has become a crisis. A fresh example is Lake Victoria, where water infestation has been going on for quite some time now. Only, recently did Kenya, Tanzania and Uganda seem to be agreeing on a co-coordinated effort to solve the problem. In mid-1997, the World Bank, through the Global Environmental facility (GEF) and the International Development Association approved funding for LVEMP in these three countries. To tackle the water hyacinth problem the three countries have attempted to harmonize their approaches on a whole-lake basis. They are now achieving this harmonization, but with difficulties. Supported by GEF coalition, LVEMP has provided a forum and an opportunity to effect this coordination among the three countries.

Although water hyacinth continues to cause serious disruptions in the use of water bodies in Kenya, the government has not promptly moved to contain the spread of this weed. In view of this, this paper identifies the weaknesses related to access of information on water hyacinth, implementation of control mechanisms, and lack of research on certain aspects as the gaps that explain why Kenya is not swiftly taking measures to control water hyacinth whenever it invades its water systems. These gaps call for action to effectively mobilize, organize, and equip decision-makers, researchers, and representatives of communities, along with their organizations and institutions, to improve their response to the water-hyacinth problem.

Plate 6: Water hyacinth causes problems in many regions



Access to information on water hyacinth

Many research organizations in Kenya have a wealth of water-hyacinth information, but this information is not easily accessible to key decision-makers, policymakers, researchers, and representatives of affected communities.

Although they might need it to mobilize and execute effective control of water hyacinth and evaluate their own programs, they have difficulty accessing information on such aspects as the following:

- The actual water-hyacinth problem and the type and magnitude of its socioeconomic and environmental costs;
- The available alternatives for control of water hyacinth, their effectiveness and costs, and what to expect from their adoption.

Implementation of control

Currently there are serious problems that are affecting the implementation of effective water-hyacinth control in the infested water systems in Kenya. The major weaknesses identified as impeding prompt and effective response are:

- Lack of policies on water-hyacinth handling nationally that:
 - Acknowledge water hyacinth as a problem and promote its control,
 - Specify institutional responsibility for water-hyacinth management, and
 - Identify and allocate financial, human, and material resources for the establishment of control programs;

- Lack of strategies for effective and prompt response to water-hyacinth infestations; and
- Lack of coordination within communities, agencies, and organizations affected by water hyacinth infestations

Lack of research on certain aspects

Whereas it's acknowledged that a lot of research has been conducted on water hyacinth in Kenya, significant gaps still persist on specific aspects of the weed, such as the following:

- ***Effectiveness of available control methods*** — Available methods for water-hyacinth control are based on biological, chemical, and physical measures. Although these methods have been variously used, it is not precisely known of their relative effectiveness in various situations. Furthermore, each one of these approaches has strengths as well as weaknesses. Although there is consensus on the need to combine more than one of these methods in an integrated strategy, no one has undertaken research to develop this integrated approach in Kenya.
- ***Quantification of the socioeconomic and environmental consequences of water hyacinth*** — although water hyacinth causes serious disruptions in the use of water bodies, the exact magnitude of the social, economic, and environmental problems it causes is poorly understood in Kenya. Research is urgently needed to quantitatively define what infestations of the weed represent in various water systems in the country and to prompt action.

Recommendations for effective management of water hyacinth problem in Kenya's water ways

Establishment of an information centre

It is recommended that a Water Hyacinth Information Clearinghouse be established in Kenya, to address issues of water-hyacinth information, its accessibility, and the interaction of key players. The mandate of the clearinghouse should be the following:

1. Collate and disseminate national, continental and global information on water hyacinth.
2. Develop a database on activities related to water hyacinth across Kenya and their objectives, expertise, and support.
3. Assist in organizing meetings on water hyacinth, such as seminars and workshops.
4. Complement and support other information-flow mechanisms, such as a Kenyan water-hyacinth newsletter and water-hyacinth websites.
5. Commission studies in gap areas, such as the quantification of the socioeconomic impacts of water hyacinth, especially on riparian communities.

Initially, the Water Hyacinth Information Clearinghouse should be hosted in National Environmental Management Authority (NEMA) (at least for the first 3 or 5 years) until a suitable location is identified based on centrality, cost-effectiveness, and reliable funding. During the establishment and operation of the clearinghouse, NEMA should develop partnerships with other donors interested in water hyacinth and with continental centers of expertise in information issues, such as CABI, university systems, ICIPE, the International Union for the Conservation of Nature, IITA, the International Organisation for Biological Control (IOBC), ECOWAS, SADC, and the East African Community. The clearinghouse should develop and maintain links with global organizations concerned with the environment, such as FAO and the United Nations Environment Programme (UNEP), and the Organization of African Unity (OAU); and with global centres of expertise in water-hyacinth control, such as the University of Florida's Aquatic Weeds Centre and CSIRO.

Research issues

Addressing the issues of research is an important medium- to long-term step in effectively dealing with the problem of water hyacinth in Kenya. The recommendations for research include firstly those on policy so as to consider local, national and regional technology policy and transfer in relation to water-hyacinth control mechanisms currently in use. At each of these levels, those concerned should identify, develop, and implement policy on water-hyacinth control. Secondly, seek to identify key stakeholders in water resources and entrust them with control of water hyacinth (once identified, they should be key participants in water-hyacinth research and control). Other recommendations include:

- Determine whether water-hyacinth control should be government-based, community-based, or co-managed with a strong component of community participation.

- Develop mechanisms for early recognition of impending water-hyacinth infestations and problems, using local and national surveys and monitoring. Use these mechanisms to send early warnings of impending water-hyacinth infestations. At the moment water hyacinth is invading more water systems in Kenya at an alarming rate.
- More research to be conducted on the role of early-warning mechanisms in the evaluation of programs already in operation across Kenya. Document the success or failure of control efforts and implementation and disseminate this information to key players in water-hyacinth control across the country in good time.

Available control options

Implementation of the available water-hyacinth control options should be intensified. The following approaches are recommended:

Biological control

1. Release proved natural enemies immediately, as soon as water-hyacinth infestations are identified and confirmed in a new water system.
2. Accelerate the exploration and evaluation of new natural enemies of water hyacinth.
3. Investigate the efficiency of multiple releases of natural enemies in the control of water hyacinth.

Physical control

Physical-control methods include manual removal, mechanical harvesting, and use of floating barriers, such as cables and booms. It is recognized that these methods have an important role to play as stop-gap measures in water-hyacinth control, especially in strategic places such as "fish landing sites" (sites where fishing boats unload fish), boat-launching sites and ports.

1. Identify alternative methods, their costs, and effectiveness.
2. Conduct Environmental Impact Assessments. Because water hyacinth may contain up to 95% water, environmental consequences of the removed and decomposing weed must be evaluated and elucidated. Furthermore, where manual removal is being done particular attention must be paid to water hyacinth's association with harmful organisms, such as snails, which are intermediate hosts of schistosomiasis. One should understand the implications of manual removal for human health and ensure adequate protection for those handling the weed.
3. Use physical barriers, such as cables and booms, for immediate, short-term control across infested water systems in Kenya. Support these barriers with other control methods, such as removal of the accumulated weed, release of biological control agents, or use of herbicides.

Integrated control

Kenya needs to develop management plans for water hyacinth. The plans should focus on integrated control and integrated management of water hyacinth with biological control as the first line of attack and long-term solution to the weed problem.

Utilization of the weed

People have investigated possible uses for water hyacinth for a long time. Although it is not considered a control option, it may play an important role where communities use physical removal. They should be warned, however, not to transport the plants to non-infested areas.

Community participation

Riparian communities in infested water systems in the country should be involved in appropriate control strategies. Particular attention should be given to community mobilization, access to information, and coordination of community-based activities. Communities should also have a role to play in water-hyacinth monitoring and the creation of early-warning systems. These aspects should be covered in training programs.

Watershed management

The infestation and proliferation of water hyacinth in Kenya's water systems is as a result of it having eutrophic waters. This is a catchment management problem. Causes of the enrichment of waters, such as pollution, should be investigated and corrected to reduce the likelihood of re-infestation and proliferation of the weed.

Furthermore, other causes of re-infestation, such as seed banks, should be addressed as part of an integrated management plan for the weed. Watershed management should be included in a broader environmental-awareness agenda in the country.

Priorities in research

A glaring gap in the literature exists on the lack of quantification of the socioeconomic and environmental consequences of water hyacinth in Kenya. In addition, evaluations of control efforts have so far been inadequate. As a result, the real problems caused by the weed are poorly understood, and so are the ameliorating effects of control. The gap can easily be bridged if studies will be done to:

1. Determine socioeconomic impacts of water hyacinth on riparian communities.
2. Investigate the environmental impacts of water hyacinth, including effects on aquatic biodiversity and the abundance of aquatic organisms.
3. Determine acceptable threshold levels for water hyacinth.
4. Disseminate the results of all these studies.

Implementation strategies

A lack of structures for implementation of control at the local and national levels has partly impeded the handling of the water-hyacinth problem. Other implementation problems relate to the lack of awareness at top political and decision-making levels of the dangers of water hyacinth and the urgency of the need for effective control or management. The recommendations for implementation strategies are as follows:

1. Establish local institutional structures for handling the water-hyacinth problem, with linkages at national, regional and global levels.
2. Assign responsibility for water-hyacinth control to a single ministerial department, but maintain full and effective liaison with other government departments, institutions or organizations, and communities with an interest in water-hyacinth control.
3. Solicit the goodwill of politicians to support water-hyacinth control and clearly indicate the expected effectiveness of proposed control efforts. Enhance this effort, if necessary, with public-information and public-awareness campaigns, including reference to reports on the social, economic, and environmental consequences of water hyacinth.

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