Current status of the water hyacinth problem in Uganda

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Executive summary

Water hyacinth was first reported in Uganda about ten years ago when it was found in Lake Kyoga in 1988 and Lake Victoria the following year. Over the years the water weed developed two patterns of distribution namely the stationary mat formation along the shores and extensive mobile mats resident in sheltered bays. The rate of infestation of the stationary mats peaked between 1993 and 1995 when the water weed covered an estimated 2,200 ha, 570 ha, and 500 ha of the shores of Lake Victoria in Uganda, Lake Kyoga and of River Nile, respectively. The stationary weed formation had covered about 80%, 60% and 80% of the length of the respective shorelines.

The rate of multiplication of the mobile water hyacinth problem peaked between 1994 and 1995. Cover estimates of 1,112 ha; 1,673 and 1,793 ha of the weed were made in the lake in 1994, 1997 and May1998, respectively. However, reproductive capacity of mobile mats declined significantly after 1995 in the main infested bays except in the enriched Murchison Bay east of Kampala City. A significant mobile water hyacinth problem occurred on Lake Kyoga only between 1994 and 1995, in scattered mats whose area was difficult to estimate. On Lake Albert, mobile mats of the weed remained virtually confined to the northern and southern tips of the Lake by the violent wind regimes.

A profound change towards control of the water hyacinth problem in Uganda has been underway since1995. First, an invasion of the stationary mats through systematic succession which eventually displaced the water weed with native water plants dominated by one called hippograss has to date (October 1998) replaced the cover of water hyacinth around lakes Victoria and Kyoga by up to 90%. Secondly, the effects of seasonal wind regimes progressively gathered and eventually confined the huge biomass of the mobile water weed into three bays namely Thruston and Hannington to the north east of the lake and Waiya bay to the western side of the Entebbe peninsular, for up to five years with diminishing supply of nutrients. In May 1998 the weed cover in the respective bays was 800 ha , 750 ha, 140 ha. The effects of this confinement combined with the impacts of biological control of water hyacinth using the weevils introduced in the lake in 1995 progressively overcame the mobile water weed in the Uganda portion of Lake Victoria. The reproductive index (number of young shoots per plant) of the mobile mats in the three bays has remained at zero for the last five months as the number of weevils per plant escalated. The condition of the water weed steadily declined, the root system rotted away and the plants continued to loose buoyancy.

In October, 1998 the mobile weed cover in three confinement bays "crashed" and sank, leaving about 30 ha, 300 ha and 20 ha in Thruston, Hanning and Waiya bays respectively. The changes in water hyacinth cover due to ecological succession of stationary mats and to nutrient stress and effects of biological control on the mobile cover, have led to effective control of the first

round of infestation with the water weed. However, the water weed is a symptom of an enriched water environment and Lake Victoria remains so. Long term management of the water weed will remain subject to strict vigilance, scientific surveillance and timely, appropriate control actions.

Introduction

Water hyacinth, *Eichhornia crassipes* (Mart) Solms, the free floating water weed native to Amazania in South America is a normal plant in its home range, kept in check by its natural enemies and the regular fluctuation in water levels. However, the plant has become one of the most noxious water weeds wherever it is introduced in tropical and subtropical environments. Water hyacinth is wide spread in most African countries (Harley 1993). The water weed is said to have gained access to the River Nile basin between 1972 and 1892 (Gopal and Sharmer 1981) and has occurred in the Sudan in River Nile and in the Democratic Republic of Congo since the early 1950s. Water hyacinth appeared in Ghana, Benin and Nigeria during the first half of the 1980s. The water weed was first reported in Uganda in two areas of Lake Kyoga in May 1988 (Twongo 1991, Annex 1a). The source of the infestation has to-date not been established although a claim has been made (personal communication) that water hyacinth occurred in a man made pond (later drained) within the Kyoga watershed near Ngora in Kumi District during the early 1950s. The water weed was first reported in Lake Victoria in Uganda, in December 1989, along the lake shores west of Entebbe (Annex 2). The infestation originated from the catchment of River Kagera which empties into the lake (Tailor 1993).

While aspects of the spread and impacts of the noxious weed in Uganda have been well reported (Twongo 1991; Thompson 1991, Taylor 1993; Twongo 1993; Willoughby et al 1993; Twongo and Balirwa, 1996 and Wanda, 1997), the purpose of this Sectionr is to highlight the current state of the water hyacinth problem in Uganda. The principle objective of the paper was to provide updated information on the global aspects of distribution, cover and the effectiveness of biological control effort. The the current status of the water hyacinth problem is portrayed against the background of cumulative data and information gathered from lakes Victoria, Kyoga, Albert and the River Nile.

Survey methodology

The information was gathered during periodic surveys using a strategy modified from Twongo et al (1995). Monitoring focused on shore areas with a potential for infestation with water hyacinth as identified by Twongo et al (1995). Surveys covered mainland shores of the lakes as well as fringes of the islands. To estimate extensive areal cover of stationary water hyacinth along the shore, the extent (length) of the infestation was demarcated on a map while the width was averaged from several approximations by different people. Large mobile fields of the water weed were similarly mapped in the evening when strong landward breezes had piled it at the shoreline; the area covered was then estimated from the map. The area of smaller water hyacinth

mats was calculated from estimated dimensions: the width across the mat to the shore was often averaged from four independent estimates made by eye; the length was obtained from a timed steady run by canoe and outboard motor whose speed was established under prevailing weather conditions. The area of the water weed along sparsely infested lakeshores was estimated by averaging visual estimates of several observers. The average width of the weed fringe along the Nile was estimated while sailing down portions of the river and the total length of the fringed shorelines was determined from map dimensions, based on identified features indicting portions of the river with potential for infestation with water hyacinth (Twongo et al 1995). A complete survey of the river in 1992 had established that shore environments with that potential had been fully infested with water hyacinth.

Water hyacinth distribution

Water hyacinth spread rapidly along Lake Kyoga aided by the general east to west water flow regime and established presence in most suitable sites along the lake-shores (Annex 1b); by 1990 the water weed had reached southern lake Kwania while small mats and individual plants had infested River Nile and drifted to Lake Albert and the Albert Nile. In 1989, clusters of water hyacinth were confined to the shores of Lake Victoria in Uganda west of Entebbe (Annex 2). However, the water weed spread rapidly along the lake-shores aided by the interaction between the diurnal 'land and sea' breeze which oscillated weed propagules to and from the shoreline and by the prevailing southerly/south easterly winds which distributed the mats north east wards along the shore. By 1991 small mats of the water weed were present in most sheltered sites throughout the shoreline in Uganda.

Water hyacinth was reported in Mwanza -Tanzania in 1991 and in the Kenya waters of the lake by 1992. The general distribution of the water weed in Uganda is indicated in in Fig.Annex 3. However, water hyacinth has been reported elsewhere in Uganda including in River Ruizi near Mbarara Town, in water pools towards Lake Mburo National Park and near Mbale Town. Further out-breaks in other parts of Uganda are expected and they could only be minimised by intensive sensitisation of communities associa ted with water environments throughout the country.

Water Hyacinth Cover

During the early 1990s water hyacinth spread rapidly to form continuous mats in the water environments it had invaded. Two distributional formations of the water weed namely the stationary fringes along the shores and the mobile mats propelled about by waves and water currents were distinguished. Stationary water hyacinth developed when the translocated propagules which settled in sheltered shallow water environments up to a depth of 5 m, often with muddy bottoms, reproduced and coalesced. However, some shoreline fringes resulted when mobile mats forced ashore were firmly anchored by the heavy load of mud and debris often gathered by the water weed. The linear and lateral dimensions of the stationary fringes of the water weed were influenced primarily by available cover from offshore and along-the-shore

winds. Soil type and the general nutrient content of the water at the site were secondary factors.

The maximum cover of the stationary fringe of water hyacinth in Lake Kyoga was attained by 1994 when the water weed covered about 60% of shoreline length (Annex 4). The fringe averaged about 5 to 10 m in width and was estimated to cover 570 ha. Maximum cover of stationary mats along the banks of River Nile was also estimated in 1994 to fringe about 80% of shoreline length with a mat averaging 5 m wide and covering an estimated 500 ha. In Lake Albert the water weed was confined to the northern and southern extremities of the lake probably due to the turbulent nature of the lake and the absence of extensive sheltered, shallow banks along other shores where water hyacinth could attach. In the Uganda portion of Lake Victoria the stationary fringe of the water weed stabilised in 1995 when the linear length stretched to about 80% of the shoreline (Annex 5) with an average lateral width of 10 - 15 m (much wider in some well sheltered bays). The fringe averaged 5 m around the islands and at forested shores of the mainland. The maximum total area covered by the stationary water weed was estimated at 2,200ha .

Ecological succession

Ecological succession, the progressive displacement of one or more species of plants (and animals) by another or others, affected stationery water hyacinth mats profoundly. Pure mats of the water weed were invaded initially by aquatic ferns and/or sedges, often to be followed progressively by hippograss which invariably, eventually, dominated and shaded out the water hyacinth. The successional association between the water weed and hippograss often started from the land-ward border of the mat and was, initially, mutually beneficial because it promoted the lateral expansion of both plants towards the open water. However, as the canopy of hippograss thickened, the water weed was progressively shaded out towards the open water interface. Ecological succession was first noted in Lake Kyoga in 1991 at the landward side of some stationary fringes and appeared later in sections along River Nile. By 1996 over 90% of the linear length of the weed fringe along the eastern arm of Lake Kyoga had been replaced by hippograss as the dominant vegetation. Active succession was under way among other stationary mats in Lake Kyoga and along the banks of River Nile. A survey of the lake in April 1998 revealed almost complete immobilisation the of stationary water weed by hippograss. The width of the ecological succession had increased markedly to average 20 to 25 m and the linear spread of the fringe was more continuous because adjacent strips had joined up. Total area of the entire hippograss dominated succession was estimated at 1,000 ha but the water hyacinth component occupied less than 20% of the fringe area and most of the weed plants were in poor condition.

In the Uganda portion of Lake Victoria, ecological succession started in 1992 from the eastern riparian shore districts but proceed more slowly than in Lake Kyoga. The mutual lake-ward expansion of water hyacinth and hippograss

was not as extensive as in Lake Kyoga. By April 1998 domination by hippograss had covered about 70% of the linear length of the stationary fringe. Extensive die-off of the water weed in the fringe had occurred in the older successions in the districts of Busia, Iganga and Jinja, leaving an interface strip of less than 5m where water hyacinth still co-existed with hippograss. However, this a portion of fringe where the water weed was dominant was virtually eliminated when the lake level rose in response to the el Nino rains of 1998/99, and floated away he water hyacinth.

Mobile Water hyacinth

The major sources of mobile water hyacinth in Lake Kyoga Uganda was shedding from stationary fringes along the lakeshores and river banks; rapid multiplication in sheltered bays rich in essential nutrient reserves; and input from rivers (the Kagera for Lake Victoria and the upper Victoria Nile for Lake Kyoga). Lake Kyoga had a significant mobile water weed problem only between 1990 and 1994 when the rate of weed growth and shedding at the interface with open water was highest. The problem declined to insignificance by 1996 due to three main factors namely: continuous flushing of mobile mats down the River Nile; cessation of shedding of weed mats after the ecological succession with hippograss virtually immobilised and dominated the stationary fringe up to the open water interface; and, the effective destruction of mobile water hyacinth by the impacts of *Neochetina* biological control weevils. However, the upper Victoria Nile which was missed out during the release of the weevils was fringed with the water weed which constantly shed considerable mats down the river into Lake Kyoga. The mats were dispersed over the lake rendering their impact on fishing and transportation minimal at the time (August 1998)

In Lake Victoria, shedding of mobile mats from the stationary fringe was enhanced by the input of water hyacinth from River Kagera which was fragmented by the violent waves in the vicinity of the river mouth. Initially, the viable components of the fragmented water weed sprouted and multiplied under shelter along the shore line and eventually contributed mobile mats. However, when suitable nursery sites along the shoreline were saturated by the stationary weed fringe fragmented water hyacinth from River Kagera did not find shelter and simply floated about the lake and eventually rotted and sunk. Therefore, River Kagera became even more important as one of the major point sources of nutrients and debris from the catchment into Lake Victoria. The most important source of mobile water hyacinth in Lake Victoria was rapid reproduction in large, sheltered bays namely Murchison, Macdonald, Hannington, Thruston, Pringle and Waiya. These bays all of which are fringed by extensive papyrus swam and receive inflows from the catchment, contained a reserve of essential nutrients. However, the supply of nutrients appeared to have run out by from the other bays accept in Murchison Bay by 1993. The nutrient enrich Murchison Bay, particularly the well sheltered inner portion, continued to be the most important production centre for water hyacinth in the Uganda portion of Lake Victoria. In 1994 the water weed in the bay had a reproductive index of 3 to 4 young suckers per

plant and during the same year a record 877 ha of mobile water hyacinth was estimated in the bay in spite of the annual evacuation of a large proportion of the weed biomass since 1992. By 1998, the weed production potential of Murchison Bay had considerably declined such that the reproductive index of the mobile water weed averaged only 0.5 young suckers per plant. The decline was probably related to the annual export of nutrients in form of weed biomass and, certainly partly due to the effects of *Neochetina* biological control weevils introduced into Lake Victoria in 1995/1996.

Water hyacinth movement and fragmentation

In Lake Kyoga the distribution of mobile water hyacinth was controlled by diurnal wind storm and the general east to west water current in the lake imposed by the River Nile. This flow pattern constantly removed the mobile water weed from Lake Kyoga down the Nile into Lake Albert. Most of the water hyacinth biomass was however, fragmented at the Karuma and Murchison falls such that, mostly, fragmented biomass of the water weed reaches Lake Albert and the Albert Nile. In Lake Victoria, on the other hand, distribution of mobile water hyacinth is controlled by seasonal storms and prevailing winds. Hence the cover of the mobile water weed in a given bay may fluctuate greatly from year to year. Over all, the following distribution pattern of mobile water hyacinth emerged: during the first six months of the year the water weed was resident in sheltered bays executing limited diurnal oscillations. During the last six months, particularly between August and December, violent storms intermittently evacuated water hyacinth from shelter to the open lake and across to Kalangala district and beyond. Prevailing winds eventually reverse the movement of the water weed and relocated the mats into sheltered bays mainly to the north of the lake. The entire cycle usually lasting only two weeks or less and was repeated several times during the six months. Through the above annual dynamics, there was been a net transfer of mobile water hyacinth mats principally from Murchison Bay the most prolific production centre, to Waiya Bay west of Entebbe Peninsular as well as to Thruston and Hannington Bays to the north east (Table 1). In the process, Murchison Bay was progressively evacuated of mobile water hyacinth. Therefore, the three bays effectively locked up large quantities of the waterweed under a regime of the declining nutrients status and mounting stress. A small fraction of the mobile water hyacinth in the two north eastern bays had every year since 1992, periodically escaped during the second half of the year and floated to the Owen Falls Dam on River Nile.

Considerable quantity of mobile water hyacinth was fragmented on Lake Victoria by strong waves during translocation across the open water (Annex 6). This process was enhanced since1997 by the severe stress on the plants due to the effects of biological control weevils. Large quantities of weed debris have been recovered in some zones of the lake bottom by the experimental trawler of the Fisheries Research Institute (FIRI). The impacts of this biomass on the water environment and resources of Lake Victoria, other than aggravation of nutrient enrichment and possible smothering of benthic fauna, are unknown.

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Effects by biological control.

Two types of biological control weevils, *Neochetina bruchi* and *Neochetina eichhorniae*, were introduced in Lake Kyoga in mid 1993 and in Lake Victoria in 1995 and. The weevils successfully established and spread to cover the entire infestation of water hyacinth within 1.5 years. Population build up was faster on mobile water hyacinth than among the stationary mats. In Lake Kyoga the impact of biological control was evident in 1995. The cover of mobile water hyacinth on the lake became insignificant by 1996 due to a combination of three factors namely continuous flushing of the weed mats down the River Nile; cessation of shedding of weed mats after the succession with hippograss immobilised and dominated the stationary fringe up to the open water interface; and the effective destruction of the water weed by the impacts of the biological control weevils.

The effects of biological control on Lake Victoria were fast and severe most probably because the mobile water weed in Thruston, Hannington and Waiya bays and to a certain extent, Murchison Bay were confined under a regime of declining essential nutrients. The combined effects overwhelmed mobile water hyacinth: the reproductive index (number of young shoots per plant) of the weed in the three bays remained at zero since early this year (91998) as the number of weevils per plant escalated (Table 2); the condition of the waterweed steadily declined and the root system rotted away (Annex 7 and 8) and the plants lost buoyancy. However, water hyacinth is a symptom of an enriched water environment and Lake Victoria remains so. Therefore, its long term management of will depend on strict vigilance and scientific surveillance.

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