

PERSPECTIVES IN WATER WEEDS INFESTATION: THE LAKE CHAD EXPERIENCE

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ABSTRACT

Lake Chad has been witnessing decades of changing hydrology since the drought cycle that commenced in 1962. Being a shallow lake especially the Nigerian sector, any increase in water volume (at flooding period) results in a disproportionately large increase in surface area, accompanied by rapid growth of vegetation on the exposed sediments after recession.

Although the aquatic weeds, *Pistia stratiotes* and papyrus reeds, covering the lake surface have been permanent 'residents' of the lake, this development seems to augur well for the "stake-holders" of the lake at the moment. But if not properly checked now, it may be disastrous later. Incursions of exotic weeds will further worsen the ecological situation of the lake basin.

With a large proportion of the water inlets into the lake being from across international boundaries, the possibility of introduction of water hyacinth into the lake is very high. This paper sounds a note of warning and proffer suggestions on how to prevent the incursions of water hyacinth into the lake and management control measures on the present macrophyte population of the lake.

INTRODUCTION:

The harnessing, development and proper use of water resources have often served as a yardstick for evaluating the extent of socio-economic development of many societies world-wide. Water resources development projects, e.g. creation of dams, reservoirs, irrigation canal systems, etc have often witnessed the development of aquatic vegetation and in some cases, to noxious proportions bringing along havoc, misery, impoverishment and diseases to the indigenous human population in the environment.

Water weeds' growth and development can be desirable or undesirable in an ecology depending on the perceptions of the managers in the ecosystem. "Stake-holders" in an aquatic ecosystem include man, the fin-fish resources, the non-fish resources, the plant and animal communities and the micro-organisms i.e. the exploiters and users of various categories, the resident living resources and the exploited resources. By their interactions the ecology is bound to respond dynamically to changes. Some of these changes can be gradual and beneficial, while others may be drastic and detrimental.

Lake Chad is an inter-national water

body that is highly eutrophied with aquatic macrophytes. As an endorheic lake, that is without outlet, the ecology of the lake seems to favour rapid growth of aquatic vegetation both on the lake surface and its vast marsh land leading to the emergence of various aquatic vegetation. Being located in a semi-arid sahelian climate, the lake is characterised with annual and extremes of long term cycles of fluctuations in its areas and depth. It's shallow nature, especially in the Nigerian side, ensures that any increase in water volume at flooding leads to a disproportionately large increase in surface area, accompanied by rapid growth of macrophytes on the exposed sediments after recession. These developments over the years have led to an array of factors affecting the lake's ecology - some of these with positive impacts and source negative.

Although water hyacinth, is not yet known in the lake, the possibility of its invasion is very high, since 90% of the water inlets into the lake come from international boundaries of countries in the conventional and extended basin. Such a development would lead to a crisis situation for all "stakeholders" of the lake.

CLIMATE AND HYDROLOGY

Lake Chad is situated between latitudes 10° and 16° , 20° N and longitudes 10° and 18° 20° E. The lake has undergone significant ecological changes since the beginning of the eighteenth century and its surface area fluctuated between $6'000\text{km}^2$ and 25000km^2 , since recording started (Beadle, 1981). The sahelian climate is characterised by a hot dry season from March to June (temperatures 29°C to 32°C). A rainy season from June to October (annual rainfall ranges from 200mm in the northern to 500mm in the southern parts) and a cool dry season from November to February

(temperature range 22°c to 24°c). Humidity is highest in August (72 to 81 per cent) but minimum in February and March (23 to 31 percent). Details of the lake's hydrology have been variously described by many authors (Beadle, 1981; Nwoko *et al*, 1985; Bukar, 1985, Bolorunduro and Kwari, 1992).

With a coastline of 288km, its conventional basin, including the lake itself covers an area of $427,300\text{km}^2$. The riparian states T'Chad, Nigeria, Niger and Cameroon share the lake in the approximate proportion of 50%, 25%, 17% and 8% respectively. The extended basin covers an area of about 2.2km^2 including the four riparian states, and Sudan, Central African Republic, Algeria and Libya (LCBC, 1989).

Eighty (80) percent of the water of Lake Chad comes from inflows of Rivers Chari and Logone. Other sources are immediate rainfall on the lake (5-10%), local rains draining among the minor tributaries (4-5%), River Yobe effluents (1%) and River El-beid (4%) (Beadle 1981, Bukar and Bolorunduro 1990).

Being endorheic, and in semi-arid climate most of the water loss (90 - 95%) is from evaporation, including evapotranspiration and the rest by infiltration (Carmonze 1971). Only about one or two percent is used for irrigation (Sagua, 1987).

The annual hydrological cycle involves the onset of flood in October/November attaining a peak in January and falling there after in February/March to lowest levels in August/September of each year.

LAKE CHAD ECOLOGY

The lake is shallow with an average depth of 3m and therefore its volume is small compared to its area. Beadle (1981) used the hydrological state of the lake over

the years to characterise it as follows:

- a) **Greater Chad (1962 - 1965).** Water level height was 283m above sea level, surface area was about 25,000km²; Navigability was easy everywhere;
- b) **Normal Chad (1966-1971).** Water level height was 281m, surface area varied from 15,000 – 200,000 km². The Lake was still navigable from north to south. In this era, the open waters were devoid of vegetation, the reed islands of macrophytes were mainly of papyrus phragmites and *Typha*; and the archipelagoes consisting of thousands of sandy islands.
- c) **Lesser Chad (from 1973).** Water level less than 280m; area less than 10,000km²; north and south basins separated by exposure of the Great Barrier. The North basin has dried up and the lake is reduced to only the south basin on the T'Chadian and Cameroon side mainly and part of the Nigerian portion.

The present landscape of the lake is shown in Figure 1. The area north of the Great Barrier is without vegetation and the northern fringes are dried. In the South-western area around Baga, Kawa and Wulgo in the South, the Lake consists of marsh and swamps with dense macrophyte vegetation which together with other aquatic vegetation impede navigation and fishing activities.

Although hydrological changes over the years have altered the ecological structure of the lake, owing to its relative ecological uniformity, the lake has failed to provide stimulus to divergent specialization of fauna and flora populations. Effects of hydrological changes on the fisheries of the lake have been fully described by some authors (Bukar 1985, Bukar and

Bolorunduro, 1990 and Ita, 1995).

An extensive survey of the Lake in 1990 across the Nigerian portions revealed that 70% of the surface was covered with various aquatic macrophytes, 20% of water used to be the normal Chad area was completely dried, with just about 10% of open waters.

The indigenous aquatic macrophytes consist of extensive mats of water lettuce, *Pistia stratiotes*; the reeds, *Cyperus papyrus* by far the most established in the lake; other reeds - *Phragmites mauritianus*; *Phragmites australis* and *Typha australis* and submergent weeds in irrigated lands, *Cyperus esculentus*, *Cyperus rotundus* and the wild sorghum, *Sorghum aethiopicum*.

Favourable Factors to Macrophyte Growth

Ecological dynamics portray an array of interactions in an ecosystem leading to alterations in the composition. The location of Lake Chad in the fragile semi-arid environment implies intensive utilization of the Lake. Some of the factors favourable to explosive population of macrophytes in Lake Chad include the followings:

i). Arable Agricultural Activities:

Lake Chad ecosystem is of tremendous economic, social and cultural importance to the indigenous human population. The population of the conventional basin subsists mainly on an agricultural economy, which in most cases is still traditional. Due to the hydrological changes in the Lake's water level and area of open water, the annual recession period (March - October) leave behind vast areas of swamps with sufficient

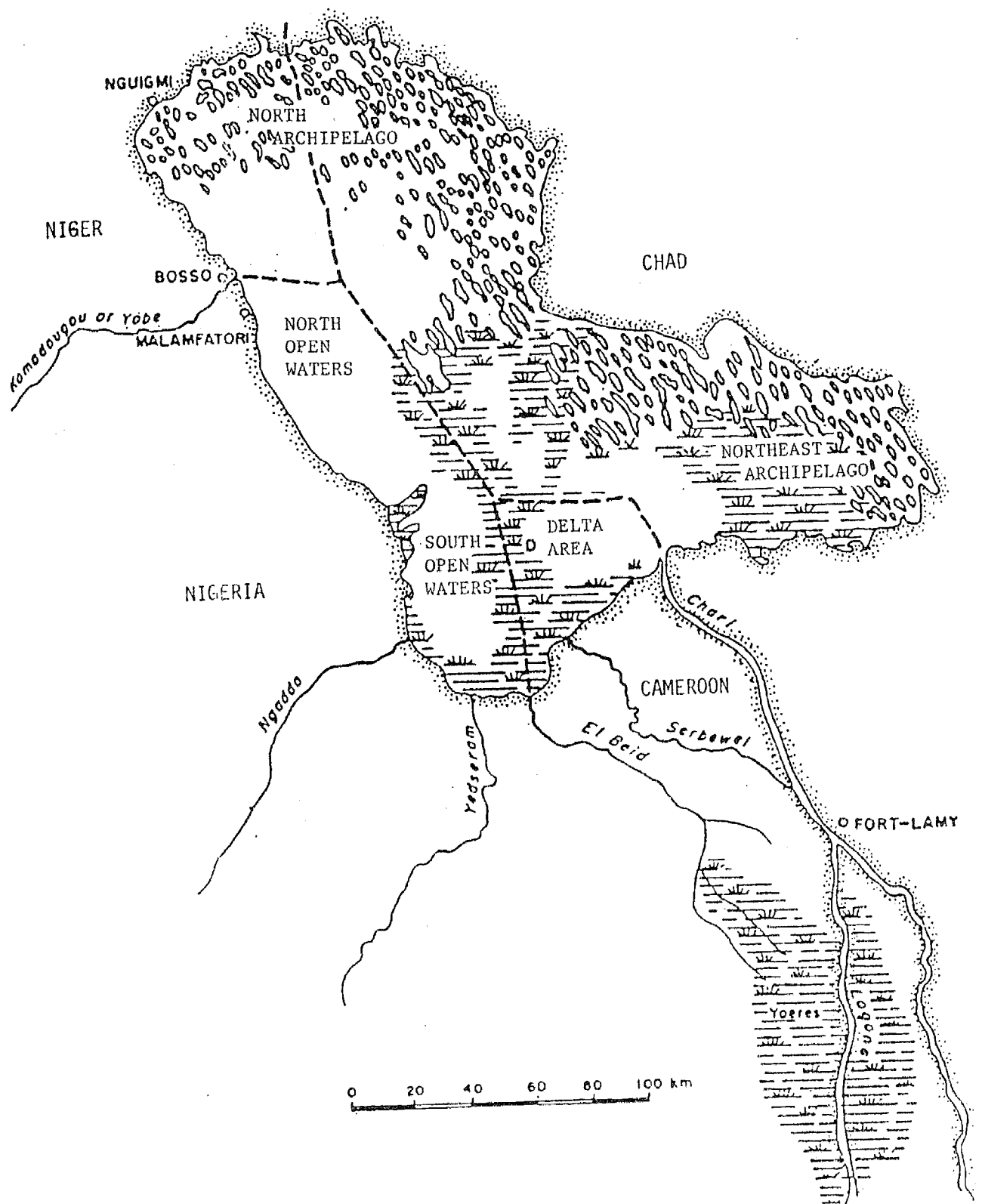


Fig. 1. LAKE CHAD
(Welcomme, 1972)

residual moisture to grow food crops like cowpea, maize, millet, rice, sorghum and varieties of vegetables. The ethnic population therefore leads to diversification of their economic activities such they they are fishermen and fish processors, at high flood season (November - February) and arable farmers in the Lake shores at recession period.

The large-scale irrigation project of Chad Basin Development Authority has contributed significantly to agricultural development in that eco-climatic zone. The consequence of agricultural projects is increased use of fertilizers and organic manures. Being an endorheic lake, high nutrient level discharges from the land is expected and these drain into Lake Chad promoting the proliferation of aquatic macrophytes that thrive and develop best in high nutrient environment.

ii) Livestock Production Activities

The North-East Agro-ecological zone in which the Lake is situated is reputed to be responsible for as much as 90% of cattle supply to the Nigeria consumers. Pastoral nomadism is the major habitat utilization system with isolated cases of sedentary rearing in human settlements. The animals enriches the basin farm lands with their manure that drain into the lake. The pastoral nomads migrate across national boundaries with cattle, sheep, goat and camel in the conventional states and trans-saharan migration is common. These animals are bound to carry seeds of weeds in their hooves and also undigested seeds in their alimentary canals. The droppings of these animals are a major source of weed seeds introduction and growth in the basin.

iii) The Basin's Rich Alluvium Plain

The Lake Chad basin is characterised with

flat alluvium plain that encourages a metamorphosis to large surface area of water volume at flooding and shrinking to the normal boundaries at recession. The implication of this is that residual moisture is left behind in the plain with organic decomposition of compost materials and farm residues. Stagnant pools of swamps are easily populated with reeds and these establish readily throughout the year.

iv). Annual Flooding

As mentioned earlier one of the only unchanging characteristics of the lake is its annual surface area fluctuation due to flooding of its plain as a result of annual increase in water level and subsequent recession. Emergent and submergent plants are favoured by flooding. The large amount of suspended solid and debris encourage the abundance of phytoplankton and aquatic macrophytes. The flooding phenomenon, more serious on the Nigerian portion, has led to more "vegetated" lake on the same national boundary. FFI (1998) reported that higher flood frequency enhances the colonization of aquatic habitats by water hyacinth in the Bengal Province of India.

Siltation and inundation of Lake Chad has been reported to have serious consequence on the macrophyte population growth (Sagua 1987).

v). Shallowness of the Lake

The average depth of Lake Chad is about 3m, with depth ranging from as shallow as 0.5m in Kindigeria in the northern basin to a maximum depth of about 15m in the Great Depression in the Cameroons. The rapid spread of water volume at flooding allows rapid spread of weeds and firm establishment of submergent plants due to shallowness of the water body.

vi). Effluents from Rivers

Almost the whole water inlet is from rivers draining into the lake. Rivers are characterised with effluents carriage. Some of these are industrial, agricultural or domestic in nature. Effluents normally are rich organic materials favourable to growth of aquatic macrophytes. This is partly responsible for the high degree of eutrophication of the Lake especially the Nigerian portion.

vii). Deficient Environmental Protection Enforcement:

The multi-national ownership of the lake presents a peculiar problem in its management as interests of riparian states are bound to differ on the lake even though a Lake Chad Basin Commission (LCBC) exists. No matter the effort of one country in promoting a safe environment from aquatic weeds nuisance, the neglect of responsibility by another state is bound to negate whatever efforts have been put in place since a "flowing boundary" is what exists between states.

IMPACTS OF AQUATIC MACROPHYTES ON THE LAKE CHAD ECOLOGY

The emergence of weeds around the lakeshore and its marginal lands certainly enables water retention in the flood plains at flooding periods. The marginal lands around the lakeshores provide opportunity for residual moisture farming for many months of the year. Common weeds of irrigated lands are *Cyperus esculantus*, *Cyperus rotundus* and *Sorghum aethiopicum*. The annual cycle of recession leaves behind vast areas of swamps that eventually favours the composting of plant residues after harvest. Although reliable statistics on the exact quantity of agricultural produce from

the Lake is non-existent, judging from truck loads of produce of wheat, rice, sorghum, millet, cowpea, maize and cassava, the Lake shores farming contribute significantly to food production in the North-East zone. The establishment of large-scale irrigation project by the Federal Government in the Lake basin is based on the availability of Lake Chad water and its fertile shores. The Chad Basin Development Authority since its establishment in 1972, has been able to provide irrigation water for 87,000ha of farmland by means of long intake channels of about 51.8km.

1. Rich Fish species Diversities.

The constant hydrological changes of the lake resulting in the drying up of the Great Barrier, has led to the migration of fish species to eutrophied Chad with submergent plants. Bolorunduro and Kwari (1991) reported that the annual recession of water leaves behind marsh and swamps, which promote marshy fishery for *Clarias* spp, *Polyperus* spp, cichlids, and the mormyroids. Sagua (1987) reported the dominance of fishes with supplementary respiratory organs such as *Clarias lazera*, *Clarias angularis*, *Polypterus bichir*, *Polypterus senegalus*, *Heterotis niloticus* and *Gymnarchus niloticus* in areas of the lake with reduced dissolved oxygen due to eutrophication. Water weeds are utilized for nesting and food utilization by some of the fish species.

2. Rich Wild Life Sanctuary

The presence of the Lake in an arid environment provides opportunities of water resources utilization by man and animals. Lake Chad and Yobe River with their flood plains support thousands of games. Different aquatic birds, reptiles, and mammals take sanctuary in the flood plains

and shores utilizing submergent plant populations. Such games include elephants, cats, hippopotamus, different reptiles, African migratory birds like water ducks and kingfishers, and the pernicious pest-Quella birds.

3. Fuel/wood For Fish Smoking

The sparse desert fuel wood scarcity encourages the harvesting and utilization of submergent plants in the Lake's flood plain for fish smoking and other domestic utilization. The reeds, when dried are highly inflammable and burn rapidly. This explains why most smoked products from Lake Chad are either soft smoked or charred, since steady supply of fire from reeds is not possible.

THE NEGATIVE IMPACTS

Despite the foreseeable beneficial effects of water weeds, the occurrence in any ecology always bring along some challenges and problems that call for management action. In the Lake Chad Basin such problems include:

1. Navigational Problems

Access to the open lake is greatly hindered since as much as 70% of the lake surface is eutrophied (especially the Nigerian Sector). Research and domestic transport across national boundaries of the lake are greatly hindered.

1. Hindrances to Fishing

Two major nuisance of the preponderancies to aquatic weeds and submergent macrophytes in Lake Chad are restriction to fishermen's movement in gaining access to rich fishing grounds and net entanglement in fishing resulting in additional economic costs to the fishermen. Entangled nets are sometimes not

retrievable. Occasional conflicts have been observed among fishermen due to abandoned net entanglement of outboard engine motors.

3. Escalating Transportation Cost

The lake provides access routes across national boundaries nautically. Cross movement among ethnic residents in its many islands is heavily dependent on good navigational routes. Apart from escalating fuel cost, difficulty of navigation increases the cost of transportation in the Lake. By comparison a nautical kilometre attracts averagely Fifty Naira (₦50.00) in Lake Chad as opposed to Ten Naira (₦10.00) for the same distance in Shiroro fishing island in 1999.

4. Security Patrol Hindrance

Without effective patrol, Lake Chad and its thousands of islands is a security risk to national governments. The protracted Chadian conflicts in the 1970s and 80s were partly aided by islands of the lake serving as gorilla camps for Chadian rebels. Although a Joint Border Patrol Team exists comprising of security forces of the riparian states, supported by individual country's Marine Police, their works are greatly hindered by the navigational problems posed by inaccessibility and improper demarcation of routes.

5. Incidence of Pests and Vectors

Weeds proliferating in the irrigation canals of Lake Chad Basin provide favourable habitats for the growth of *Bulinus* snails, the vector of schistosomiasis. The increase in water surface under irrigation during the dry season also favours breeding mosquitoes, the vectors of malaria parasite. Results of studies undertaken in the South Chad Irrigation Project confirm as significant increase in the incidence of these

diseases among irrigation farmers in the Lake Chad area (Sagua, 1987). Bolorunduro and Kwari (1992) reported the occurrence of pernicious pest, *Cochliomyia hominivorax* or man eater, commonly called "screw worm flies" in the basin eliminating substantial herd of cattle and threatening human population. Also the scourge of arable farmers - the Quella birds find sanctuaries in the flood plains.

6. High Cost of Farming Operations

Whatever their benefits weeds of irrigated land and flood plains need to be controlled in order to derive maximum benefits from farmland. Weeds have an advantage over the cultivated crops that they easily outgrow if not checked leading to substantial yield losses. A combination of weed control measures including mechanical, cultural and chemicals are mostly used in the basin (Sagua and Okafor 1985). The use of pre- and post-emergent herbicides for the control of weeds and of insecticides, rodenticides and other pesticides in the irrigation systems apart from posing potential ecological problems also escalate cost of farming operations.

POSSIBILITY OF WATER HYACINTH INCURSION IN THE LAKE

In the recent past, two false alarms have been raised by media organizations in Nigeria on the presence of water hyacinth, *Eichhornia crassipes*, in Lake Chad. In 1987 and 1996 different teams of scientists sent by the Federal Government debunked the claims to incursions of water hyacinth in the Lake. The duck weed and water lettuce were variously mistaken for the nuisance weed. Will Lake Chad be secured from the hyacinth menace? Presently, high possibilities exist for such incursions and

media alarm to be true in the near future due to the following reasons:

1. International sources of water

The possibility of water hyacinth seeds, stems, or root gaining access by annual discharges of its international tributaries is very high, more so due to the hardiness of the weed to tide over unfavourable condition. And also its competitive advantage over most other aquatic weeds even when it is exotic to that environment.

ii Environmental Negligence Repercussions

International waters are difficult to manage since a nation has limit to her own portion. However joint collaborative efforts by the riparian states to a large extent resolve possible ecological crisis. The present experience with the aquatic macrophytes establishment on the lake without concrete efforts by the Lake Chad Basin Commission (LCBC) - the International Management body of the four countries in the Basin - portray fears of similar neglect in case of a possible water hyacinth nuisance. The unfortunate thing is that the consequence of environmental negligence by a country would be borne by other countries sharing the Lake.

iii Favourable Fertile Basin

Eichhornia crassipes is known to rapidly establish in fertile basin once there is sufficient water to sustain it. The Lake's Basin can be plagued with seeds of the hyacinth through human agents, animal hoofs, wind erosion and residual floods of its tributaries. Quick establishment in the open lake can then be assured.

iv Trans-Saharan Migrations

Trans saharan migrations is highly pronounced in the Lake Chad basin by both

man and animals and this poses threat to ecological stability. By various means, migration of cattle herds can bring along introduction of water hyacinth seeds through hoofs or in animal wastes, since cattle are known to have taste for dried water hyacinth. Human movements and terrestrial and aquatic birds migration are also possible sources.

5. Transportation

Active boat transportation in Lake Chad across nautical national boundaries can promote the spread of the weed through leaf clogging on the boats from one territory to another.

CONCLUSION

Although Lake Chad is presently free of the water hyacinth menace, the present state of its ecology as relates to aquatic macrophyte invasion, poses two challenges to environmentalists and policy makers—controlling the present macrophyte population and preventing incursion of water hyacinth. The Lake is highly prone to weed incursions due to its different sources of water across national boundaries and its international nature.

- This calls for the joint cooperation of the riparian states. The LCBC already provides a forum for effective making and enforcement of environmental laws. The Federal Ministry of Environment in collaboration with relevant agencies can spearhead this move with the LCBC and individual riparian state agency responsible for the environment. Fortunately the Marine Police Force and the Joint Border Patrol can give proper backing to law enforcement.
- Perhaps Nigeria would not have been plagued with water hyacinth menace, if effective monitoring of water bodies

shared with her neighbours had taken place. A pre-emptive monitoring across national boundaries would serve as a preventive measure against incursions of water hyacinth into the lake.

- The responsibility of extension is not only in improving agricultural production and standard of living, but also in ensuring a sound and sustainable environment.
- Environmental extension education can be effected through individual and Group Meetings, print and electronic media. Mobilization of the communities around the lake and in the fishing island and their proper education on environmental conservation and protection measures would help in maintaining ecological stability of the Lake Chad basin.
- The serious implications of the massive cross border movements of nomadic population and their herds can be suitably checked by the use of Quarantine Service posts in the riparian states. This would prevent the likelihood of introduction of water hyacinth seeds through cattle herds into the Lake Chad waters.
- Lake Chad is a fragile ecology being located in the arid zone of Nigeria and controlled by four nations. It is a water body that is already under the scourge of aquatic weeds and other macrophytes. Water hyacinth incursion and multiplication is a possibility and various factors seems favourable to this assertion. Such a situation will further stress the Lake's ecology and will be costly to the "stakeholders". However, it is postulated that effective management strategies will prevent the

possibility of exotic weed menace and redress the present aquatic macrophyte scourge.

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