

Capacity for Conservation of African Aquatic Biodiversity

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Abstract

The status and trend of African biodiversity is reviewed. The major threats facing the aquatic biodiversity in Africa and the conservation efforts to stem the challenges are discussed including the human, institutional, legislative, and policy level capacities. Prior to the introduction of a new germplasm and/or alien species of fish, it is imperative that thorough and comprehensive autecological and synecological studies are undertaken to understand the possible impacts to the ecosystems at large. The paper also observes that gene ecology and gene technology are new concepts with a number of potential risks especially in the African milieu, and recommends that there is a need to develop appropriate regulatory frameworks and to enhance national technological capacities to implement biosafety procedures for the safe application of biotechnology in the fish industry.

Introduction

Life on earth depends on water. Water comprises 99 per cent of the human body and covers 71 per cent of the earth's surface. Too often, however, the life within water is forgotten. The biological diversity of aquatic ecosystems is neglected in developed countries and developing countries alike, even in coral reefs that rival tropical rain forests in extraordinary diversity of life. Over 20 000 species of fish make up more than half of all vertebrate biodiversity; over 8 000 of these live in freshwater. In summary, nearly 25 per cent of the earth's vertebrates live in less than .001 per cent of the earth's water (Shumway 1999). Despite all these facts, the value of aquatic biodiversity in Africa is only beginning to be realized as countries struggle with natural resource management decisions imposed by socio-economic developments, structural adjustment programs, huge debts, and national environment action plans.

Conservation and sustainable use of water and aquatic resources has been a big challenge in Africa, particularly because of the rapid increase in populations in many countries and associated land and catchment degradation (Cumming 1999). The growing realization that water is a finite resource and if not sustainably managed may diminish in quantity and quality and the life within it has led to the development of programs to manage aquatic biodiversity, all of which are affected by a number of factors including the

human, institutional, legislative, and policy constraints. The purpose of this paper is to review the status and trends of African biodiversity. Also, the paper seeks to discuss the major threats facing aquatic biodiversity in Africa and the conservation efforts being taken to address these challenges. The measures include the building of capacities in dealing with genetic engineering products and gene technology in general in the development of aquaculture.

In recent years, there has been a growing public and scientific debate on the need for capacity building in the developing countries as an essential pre-requisite for sustainable development. An increasing number of international conventions, organizations, and meetings have addressed exotic species issues and associated management capabilities on a global scale. Some of the major events that provide a policy context are:

- Convention on Biological Diversity (CBD);
- Convention on Wetlands of International Importance especially as waterfowl habitat (Ramsar);
- Cartagena Protocol on Biosafety; and
- Global Biodiversity Assessment prepared by UNEP (which includes a major review of invasive species).

Overview of African Aquatic Biodiversity

Various authors (Roberts 1975; Daget 1984) have described most of the African wetlands.

Table 1. Distribution of fish species by province.

Ichthyofauna province	Species richness	Remarks
Zairean	690	80 per cent endemic
Lower Guinean	340	Area poorly studied
Upper Guinean	>200	Deforestation, dams and exotic species have taken a severe toll on these species
Sudanian	200-300	Rivers in Ethiopia are poorly studied; endemic species found in Danakil depression; three endemics live underground
East Coast	100	Medium levels of endemism; forested mountains in Tanzania and Kenya and coastal rivers of southern Mozambique are known to have higher numbers of endemics, but they are poorly studied
Zambezi	150	Zambezi River supports a number of threatened freshwater fish; <i>Tilapia guinasana</i> is a threatened species found in a few sink holes in Namibia
Quanza	110	Endemic cyprinids present in the Lucala River; area poorly studied
Southern (Cape)	33	Contain highly restricted endemics
Maghreb	40	Unknown conservation status

Source: Modified from Shumway 1999.

Hughes and Hughes (1992) in particular, list their major characteristics including fauna, flora, human impact, and utilization. Stiassny (1996) provides the best geographic analyses on the distribution of fish species in Africa and divides the African ichthyofauna into the following provinces (excluding the great lakes): the Zairean province, Lower Guinean province, Upper Guinean province, Sudanian (or Nilo - Sudanian) province, East coast province, Zambezi province, Quanza province, Southern (Cape) province, and Maghreb province. The distribution of fish resources by provinces is summarized in Table 1. Table 2 summarizes freshwater fish species by country.

Threats to African Aquatic Biodiversity

Despite the considerable benefits of freshwater resources to the numerous human populations in Africa, the aquatic biodiversity continues to face mounting threats from human activities. This is especially so, due to the fact that Africa has more semi-arid and desert areas than any other continent, and has a very rapidly increasing human population that exerts pressure on the limited freshwater resources. Threats to the African aquascape are particularly due to a multitude of human-induced stressors such as the introduction of alien species, overuse, the impacts of land use changes in surrounding catchments on the water chemistry, poverty, under-valuation of aquatic resources, and improperly sited aquaculture (Bootsma and Hecky 1993; Lowe-McConnell 1993). Already, 30 out of 46 commercial fish species in the Nile River are either economically or biologically

extinct. Lake Chad has lost 75 per cent of its area in the last 30 years due to water diversion for agriculture and drought (Postel 1995). Table 3 lists African countries with the most threatened fish and amphibian species, from the IUCN Red List of threatened animals (IUCN 1996).

In Lake Victoria, the world has witnessed the largest vertebrate extinction in modern times where the introduction of Nile perch (*Lates niloticus*) has eliminated about 65 per cent of the endemic haplochromine fauna (the cichlids) and caused the loss of about 200 taxa (Goldschmidt et al. 1993; Shumway 1999). Lake Victoria provides an eloquent, if not tragic, example of how a fish fauna, which has taken 750 000 years to evolve, can be decimated within 30 years by the introduction of an alien species. Of all the ecologically damaging factors cited above, the invasion of alien species is considered the second greatest threat to global biodiversity after habitat loss.

Aquatic biodiversity is particularly at risk from introductions of alien species and strains. Alien species of fish have been deliberately introduced into African freshwaters for a number of reasons including fish culture and the need to produce "bigger fish", among other reasons. According to Hamman (1997) 93 aquatic species (70 per cent of which are fish) have been introduced or inappropriately translocated in Southern Africa. In most cases, the economic and biological implications of translocations have not been thought through. For example, we may never know enough to anticipate fully all the risks, particularly the unforeseen and complex interactions of the invading species with the existing food web.

Table 2. Estimated number of freshwater fish species by country in Africa.

Country	Number of freshwater fish species
Algeria	20
Angola	207
Benin	84
Botswana	54
Burkina Faso	99
Burundi	209
Cameroon	342
Central African Rep.	45
Chad	134
Congo	315
Cote d'Ivoire	167
Djibouti	4
Egypt	88
Equatorial Guinea	55
Ethiopia	66
Gabon	169
Gambia, The	93
Ghana	224
Guinea	172
Guinea-Bissau	55
Kenya	255
Lesotho	8
Liberia	115
Libya	9
Madagascar	75
Malawi	361
Mali	123
Mauritania	8
Mauritius	28
Morocco	39
Mozambique	253
Namibia	102
Niger	166
Nigeria	278
Rwanda	42
Senegal	127
Sierra Leone	117
Somalia	35
South Africa	153
Sudan	105
Swaziland	40
Tanzania	682
Togo	60
Tunisia	17
Uganda	291

Table 3. Number of threatened fish and Amphibian species by country.

Country	Threatened fish species	Threatened amphibian species
Uganda	28	0
South Africa	27	9
Cameroon	26	1
Kenya	20	1
Tanzania	19	1
Madagascar	13	1
Seycheles	0	4

Data from the Species Survival Commission (SSC), 1998.

Comparative studies of terrestrial exotic species across taxonomic categories have shown that invading species can affect virtually all ecosystem functions and structural properties, including the alteration of biogeochemical cycling. Studies of aquatic alien species have shown that both predatory and herbivorous species can cause serious ecological damage to endemics, through predation, competition for food or breeding sites, the degradation of habitats and food webs, spreading of diseases and parasites (Leveque et al. 1988). In addition, introduced species can degrade the gene pool, such as hatchery-bred fish, with limited genetic variability, or inter-breed with wild populations. The introductions of alien species in Lakes Victoria, Kyoga and Kivu can provide greater insight on the issue. Despite all these, Africa is still a focus of introductions and there is fairly little attention given to invasive aliens with the exception of water hyacinth and *L.niloticus* in Lake Victoria.

Efforts to Conserve and Sustainably Use Aquatic Biodiversity: the Need for Capacity Building

(i) Conservation Efforts

Efforts to address the many complex and interactive aquatic degradation problems and loss of biodiversity in African countries have a long history. Most countries have established both *in-situ* and *ex-situ* conservation programs. *In-situ* conservation initiatives for biological resources have taken the form of national parks and game reserves. Most of the ecological reserves contain aquatic systems as the most important parts of protected ecosystems. *Ex-situ* conservation programs in Africa have used gene banks and botanical gardens (particularly for aquatic plant genetic resources). In order to ensure effective conservation and development

of biodiversity, appropriate institutional frameworks were developed and people trained to man those institutions. The multiple institutions that are concerned with issues of biodiversity management in general and aquatic resources in particular include:

- Line ministries (with their technical departments and divisions) that deal with the sectoral aspects of natural resource conservation such as forestry, water, wildlife, land, fishery, energy, among others;
- Government parastatal institutions (or environmental agencies) – as semi-autonomous institutions are established by acts of parliaments to deliver specific activities such as technical advisory and coordination roles;
- Environmental non-governmental organizations (NGOs) and community-based conservation groups; and
- Institutions of higher learning that contribute considerably to aquatic conservation through research and training.

Along with the creation of new institutions and strengthening the old ones, a wide range of policy and legislative measures have been taken by African countries to promote the conservation and management of biodiversity in general. The policy and legislative interventions have ranged from specific natural resource laws to broad environmental policies and strategic action plans (National Environmental Action Plans- NEAPs). In most African countries the National Environmental Policies (NEP) are holistic and detail an integrated set of sectoral and cross-sectoral policy objectives, institutional structures, and implementation procedures for environmental management.

Despite these measures, the national capacities of African countries to effectively and efficiently manage the aquatic biodiversity have been constrained by a number of factors. These are:

- The sectoral nature of institutions involved in the conservation of biodiversity. The conservation programs are often created along narrow sectoral lines that ignore the ecosystem and the holistic principles necessary for effective resource management;
- Lack of instituted wetland policies and specific laws to promote aquatic conservation;
- Lack of strong institutions and appropriate institutional arrangements to upgrade and implement the existing sectoral policies and legislation;

- Low technological capacities;
- Lack of up-to-date scientific information and data on aquatic ecosystems and species; and
- Lack of financial resources and motivated, well trained human capital.

(ii) Capacity Building

Capacity building is often misinterpreted as merely the building of skills and abilities or provision of financial resources to a society or a community. Capacity building refers to the dynamic process of creating, mobilizing, utilizing, enhancing or upgrading and adjusting the existing capacities of individuals, local communities, institutions and the country-level policy framework in which individuals and institutions grow, operate and interact with their internal and external environments. It is a process whereby a community is equipped to identify and solve problems or perform functions in an effective, efficient and sustainable manner. The process of capacity building must be aimed not only at training, but also at increasing access to resources, changing the power relationships between the parties involved (for example, officials, technicians, local communities) and improving the overall policy, legislative, administrative and institutional contexts.

Many African countries are party to many international conventions and agreements, which have a set of obligations to be fulfilled. The Cartagena protocol on biosafety is even explicit in capacity building. Paragraph 1 of Article 22 provides that “the parties shall cooperate in the development and/or strengthening of human resources and institutional capacities in biosafety, including biotechnology...” and Paragraph 2 (article 22) explicitly states that “For the purposes of implementing paragraph 1 above, in relation to cooperation, the needs of developing country parties...for financial resources and access to and transfer of technology and know-how in accordance with relevant provisions of the Convention shall be taken fully into account for capacity building in biosafety...”.

Article 6 of the Convention on Biological Diversity (UNEP1992) calls each contracting party to “Develop national strategies, plans, or programmes for the conservation of biological diversity...”. For this purpose, article 18 explicitly calls for strengthening of technological capabilities in research and conservation in the developing nations through international

cooperation. Article 19 of the CBD on handling of biotechnology and distribution of its benefits calls for “each contracting party to take legislative, administrative and policy measures to provide for the effective participation in biological research activities...” and further states that “ the parties shall consider the need for and modalities of a protocol setting out appropriate procedures, including, in particular, advanced informed agreement, in the field of safe transfer, handling and use of any living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity”.

Conclusion and Recommendations

The aquatic biodiversity in Africa is one of the world’s richest treasures. Aquatic ecosystems provide critical services to man and wildlife, to both fauna and flora living on land and in water. However, a critical mass of capacity in such areas as biotechnology, gene ecology, genetic engineering, biosafety, policy analysis, taxonomy, molecular biology, environmental law, and other related technical areas is lacking in the continent. Success in the conservation and management of biodiversity in general, and aquatic biodiversity in particular, will therefore depend on how African countries will organize their institutions, formulate systemic policies and effective legislation, and build the required technological capabilities at local, national and regional levels.

It is, therefore, recommended that in order to effectively manage and develop the aquatic biodiversity, African countries should undertake the following:

- Prior to the introduction of a new germplasm and/or alien species of fish, it is imperative that thorough and comprehensive autecological and synecological studies are undertaken to understand the possible impacts to the ecosystems at large;
- Integrate strategic biodiversity management considerations in science, scientific and technological as well as policy planning to enhance countries’ capabilities to generate technologies such as biotechnology and apply them in aquatic biodiversity management;
- Develop capacity in aquatic biodiversity research, planning and policy analysis; and
- Develop institutional reforms to establish new linkages, establish new institutional set ups, create incentives and promote institutional

collaboration in specific aquatic biodiversity projects so as to mobilize relevant expertise.

In order to be able to identify and solve problems arising from the conservation and sustainable use of aquatic biodiversity, greater understanding is required on the dynamics and processes of capacity building and greater rigor is imperative in the planning, design and implementation of capacity building activities at all levels.

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