

Conservation and Management of African Aquatic Ecosystems

An Introduction

Lauren J. Chapman, Colin A. Chapman, Thomas L. Crisman,
and Les S. Kaufman

This edited volume uses an integrative approach that links social and natural sciences to synthesize our current state of knowledge on aquatic conservation and management issues in African fresh waters. The importance of aquatic systems to the people of Africa is clear. These systems provide drinking water, hydroelectric power, water for irrigation, critically needed fish, and much more. But Africa's precious fresh waters and the life they support—much of it unique—are under siege. Africa is not only facing a continent-wide shortage of potable water, but overall water quality has declined markedly during the past decade owing to multiple perturbations including progressive deforestation, exponentially increasing human populations, and urbanization. Both biological diversity and water management objectives are threatened by introductions of exotic plants and fishes into rivers, reservoirs, and lakes throughout the continent, with the most poignant example being Lake Victoria, the largest tropical lake in the world. Fish catches have declined drastically throughout Africa because of overexploitation, declining water quality, and introduction of exotic plants and predators, thus restricting an important protein source for the expanding human population. Forests, crucial regulators of surface-water hydrology, are being rapidly cleared for fuelwood, lumber, and cultivation. Finally, pollution of surface and ground waters is becoming a serious threat, first from deforestation but also from burgeoning human and livestock populations and the rapid development of industry.

A continent-wide plan of attack on these complex water-related issues must be developed, implemented, and continually updated, all in the context of a rapidly expanding human population. Thus, at the American Association for the Advancement of Science (AAAS) annual meeting in 1998, we brought together academics and practitioners from Uganda,

Ethiopia, South Africa, and Ghana and North American counterparts with years of African experience to begin a dialogue that we hoped would form the baseline for developing sustainable management plans for the next century. Participants were selected primarily on the basis of experience but also to represent geographical areas having diverse water management issues.

Clearly, the problems facing aquatic resources differ across the African continent. For example, Ethiopia has limited water resources, and many of its valuable resources are heavily affected by human activities. The most visible water quality problems are in Ethiopian lakes, where the normal course of water flow has been altered for irrigation schemes or industrial use. The impacts from water-diversion schemes are even more dramatically manifested in parts of southern Africa that suffer from continual and serious water scarcity and occasional severe droughts. In the more arid regions of southern Africa where population pressures are particularly high, provision for storage of more than an annual supply of water must be engineered to withstand droughts. Water deficits are greatly exacerbated by declining water quality due to industrial and mine effluents, sewage, runoff of nutrients and pesticides, and salinization. In principle, West Africa currently has adequate water resources. However, most of the region's rivers have been impounded to form reservoirs ranging from small farm dams to multimillion-dollar large dams such as the Akosombo Dam on the Volta, one of world's largest human-made lakes. The vast shifts in hydrology and ecology brought about by water containment and diversion projects, however well intentioned, can have massive impacts on natural systems and services upon which people depend, but often take for granted.

Africa is a study in extremes. A great diversity of problems face water resource managers throughout the continent. There is a tremendous range of aquatic ecosystems, availability of water resources, and human population densities, from barely inhabited to extremely crowded. Given this enormous range of possibilities, we expected to find few concerns and management approaches shared by the representatives from the various geographic regions at this AAAS symposium. However, as was clear from participants' interactions, all regions of the continent did share many similar water management problems and concerns. All were experiencing high human population growth rates, impacts of invasive species, overexploitation of fish stocks, conflicts between laws and tradition, and water quality problems associated with industrial and human wastes, as well as dy-

namic shifts in the function of large freshwater ecosystems. One important issue to emerge from the interactions was that many African lakes are likely to be very sensitive to climatic change. It was clear that the hydrological assumptions of water managers elsewhere in the world did not generally apply to African waters.

There was consensus on the most critical problems, their causes, and conceptual approaches necessary to minimize impacts and begin their resolution. This consensus was encouraging, because it suggested to us that development of general principles would be of value to water resource managers throughout the continent and that continent-wide exchange of knowledge, which is critical to the development of unifying themes, was possible.

To strengthen these generalizations and expand our knowledge base of local and transboundary aquatic resource issues in Africa, we organized a second and larger gathering of African researchers and practitioners. This conference was funded as part of the Gwendolen M. Carter Memorial Lecture Series sponsored by the Center for African Studies at the University of Florida. Here, participants from both the social and natural sciences were invited who had detailed experience in a broad range of African countries. Most contributions to this volume were derived from these two conferences.

We have two objectives in organizing this edited volume. First, we hope to increase awareness of both local and transnational water-resource issues in Africa, the seriousness of the problems facing some inland waters, and their impact on adjacent human populations. In many areas of Africa, water is becoming an increasingly scarce resource, and millions of people do not have access to suitable water for domestic use. Today, an incredible 240 million Africans live where water availability is either just at or below the minimal level required to support human habitation (Engelman and LeRoy 1993, Stiassny 1996; Chapman and Chapman, chapter 11). In other areas, water is more abundant, but eutrophication and various forms of industrial and domestic pollution seriously compromise its quality and value. Local governments and international donor agencies are often surprisingly unaware of these problems and may act only after the problem has become acute and the environmental degradation irreversible without costly intervention.

Our second objective is to illustrate commonalities among countries in approaches used to solve water resource management problems. To achieve our objectives, we have taken a highly integrative approach that

links social and natural sciences in diverse environmental and social settings at different scales of analysis (historical, region, and ecosystem). This interdisciplinary, multiscale approach permits us to identify regional issues and detect general principles, thus providing a baseline for decision making in the twenty-first century.

The edited volume is divided into four parts. The first section provides a historical perspective that assists in understanding changes in aquatic systems. This perspective is presented on two scales. The first chapter reviews our current knowledge of the paleoecology of inland waters, identifying patterns that emerge from historical study of African lakes, characters that set them apart from lakes elsewhere in the world, and the value of paleoreconstructions in predicting future response to global change. The second looks at landscape histories over a millennial time scale and suggests that managers of aquatic systems can be more effective in their planning if they consider lessons from the ancient past, lessons that include the human element of environmental change.

The second section of this volume provides a series of geographically oriented perspectives that review emerging water management issues and conservation challenges in major regions of the continent (Ethiopia, West Africa, southern Africa, East Africa, and Madagascar). These chapters take a very interdisciplinary approach linking human needs and activities to aquatic ecosystem change, water availability, and biodiversity loss. This approach enables us to understand the plethora of issues that affect aquatic systems in different geographical regions and to identify commonalities in approaches used to manage rivers, lakes, and wetlands in very different environmental and social settings.

The next nine chapters (Part 3) describe major aquatic ecosystems in Africa, processes that define systems, and emerging water management issues. Management issues include changes in trophic state (e.g., eutrophication), overexploitation, deforestation, sedimentation, hydrodevelopment, genetic and species diversity or loss thereof, and wetland degradation. These processes and associated anthropogenic changes are often vital to the health and livelihood of millions of people. For example, official estimates of the fish production in rivers and lakes of Africa range between 1 million and 1.4 million tons per year, and official yield statistics probably underestimate the actual catch by about half because they ignore the largely subsistence production from the many smaller watercourses (VandenBossche and Bernascek 1990; Welcomme, chapter 8). In Africa, many, probably most, fisheries have been exploited to levels that have

produced substantial drops in yield and major shifts in species composition toward smaller, less palatable, and less valuable species. These changes are termed the "fishing-down" process and involve the successive loss of larger individuals and species in favor of smaller, faster-growing, and shorter-lived fishes (chapter 8). Collapse of these fisheries is already exacting a devastating toll on the local people and associated economies. Similarly, many tropical countries rely on timber harvest to raise foreign capital. Unsustainable timber harvest resulted in the loss of 10.5% of Africa's forest between 1980 and 1995 (FAO 1999, Chapman and Peres 2001). Each year, sub-Saharan African nations return a mean of 58% of their gross national product (GNP) in repayments of foreign debts, and this value can be as high as 241% of GNP (Stuart et al. 1990). These repayments, coupled with increasing human population sizes, result in increasing demands being placed on the remaining forests. Despite the extent of deforestation and its accelerating rate, very little is known about how deforestation affects aquatic systems, except that most impacts are not good (Pringle and Benstead 2001; Chapman and Chapman, chapter 11).

In the fourth and final part of this volume, we focus on human dimensions of aquatic conservation and management in Africa. Here, contributors investigate how the breakdown of traditional patterns of land use affects aquatic systems; document complex interactions among health-improvement schemes, human settlement patterns, and ecological change; and describe economic drivers of aquatic change. These contributions link previous descriptions of ecological change and activities with human institutions and illustrate that management of aquatic systems demands effective integration of biological and social approaches.

Ultimately, it is our hope that this volume will raise interest in the conservation and wise use of African aquatic systems. In the past, conservation agencies have done an admirable job of raising interest in and awareness of the degradation of terrestrial systems. When the public thinks of urgent conservation issues, they often envision tall tropical trees being cut down by humans. However, aquatic ecosystems are increasingly threatened, and there is little information available to document their change or to understand ways to manage these habitats wisely. Given our dependence on inland waters and the biodiversity that they support, there is urgent need to increase our efforts to understand, conserve, and manage these systems. The difficulty of doing so is immense, but the synthesis of knowledge and its wise application are key tools for achieving that goal.

Above all, it must be clear that the situation is not hopeless. It is just challenging.

We have benefited from the assistance of many people in the logistics of organizing two international symposia and in the production of this volume. Peter Schmidt, John Schoneboom, and Alphonse Bigirimana played vital roles in initiating our efforts and arranging the initial AAAS symposium. Funding for the AAAS symposium was generously provided by the John D. and Catherine T. MacArthur Foundation and the Carnegie Corporation of New York. The next, larger, gathering, in Gainesville, Florida, was made possible by the Gwendolen M. Carter Memorial Lecture Series sponsored by the Center for African Studies, University of Florida. Maria Grosz-Ngate and Michael Chege from the Center for African Studies and Daphne Onderdonk from the Department of Zoology, University of Florida, were key contributors to the success of the symposium. The quality of the chapters in this volume was improved by the hard work of a number of anonymous reviewers, and we thank them for their diligent efforts. Finally, we thank Ashley Seifert, Erin Reardon, and Matt Burgess for technical assistance in draft production and Jennifer Piascik, Skye White, and Ashley Seifert for their work on numerous figures.

Bibliography

- Chapman, C.A., and C. Peres. 2001. Primate conservation in the new millennium: The role of scientists. *Evolutionary Anthropology* 10: 16–33.
- Engelman, R., and P. LeRoy. 1993. *Sustaining water, population, and the future of renewable water supplies*. Washington, DC: Population Action International.
- FAO. 1999. *State of the world's forests*. Rome: FAO.
- Pringle, C.M., and J.P. Benstead. 2001. Effects of logging on tropical river ecosystems. Pages 305–326 in *The cutting edge*, ed. R. Fimbel, A. Grajal, and J. Robinson. New York: Columbia University Press.
- Stiassny, M.L.J. 1996. An overview of freshwater biodiversity: With some lessons from African fishes. *Fisheries* 21: 7–13.
- Stuart, S.N., R.J. Adams, and M.D. Jenkins. 1990. *Biodiversity in sub-Saharan Africa and its islands: Conservation, management, and sustainable use*. Gland, Switzerland: IUCN.
- Vanden Bossche, J.P., and G.M. Bernascek. 1990. *Source book for the inland fishery resources of Africa*. 3 vols. CIFA Technical Paper 18/1. CIFA. Brussels, Belgium.

Conservation, Ecology, and Management of African Fresh Waters

Thomas L. Crisman, Lauren J. Chapman,
Colin A. Chapman, and Les S. Kaufman

2003

University Press of Florida

Gainesville · Tallahassee · Tampa · Boca Raton

Pensacola · Orlando · Miami · Jacksonville · Ft. Myers
