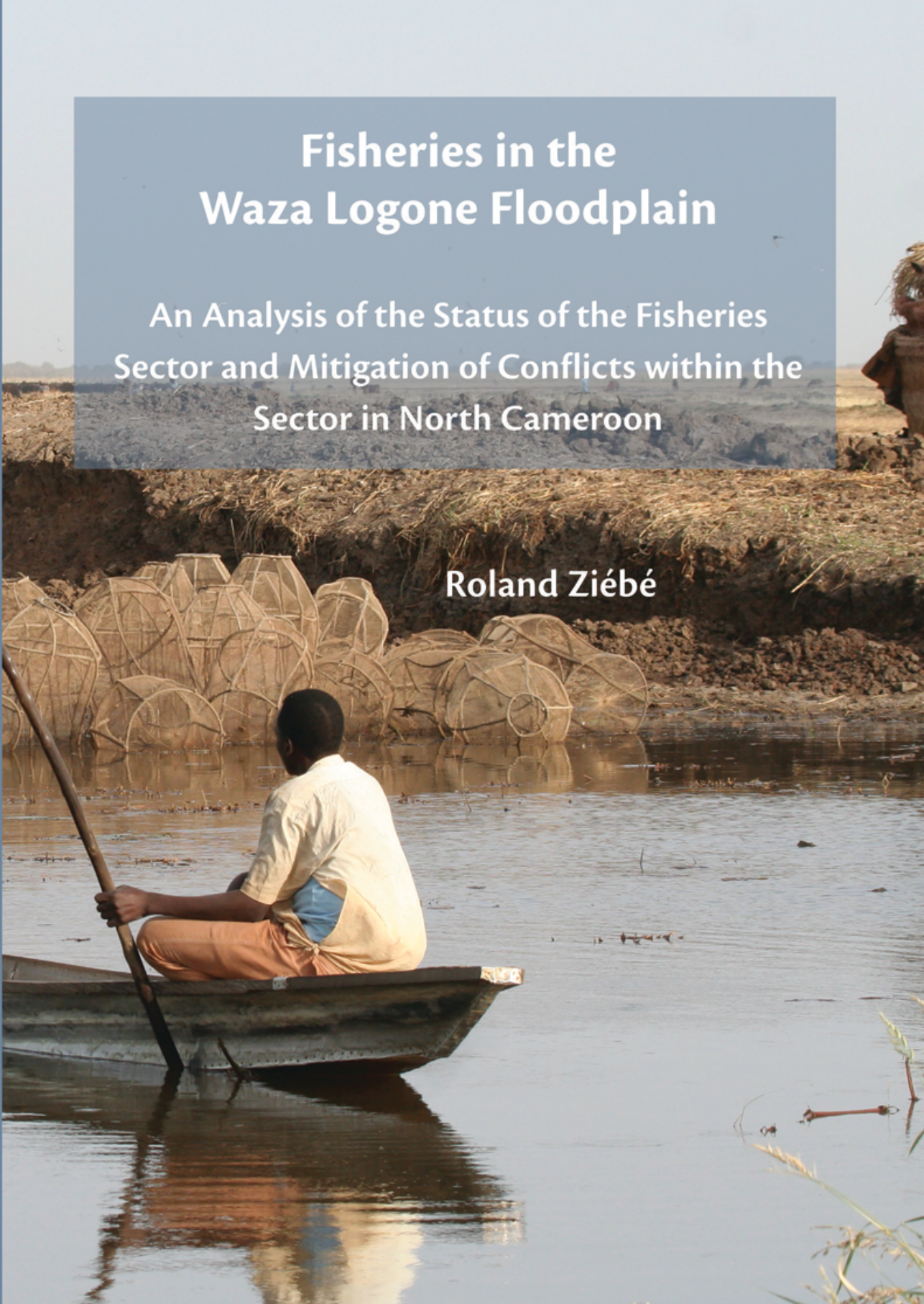
Fisheries in the Waza Logone floodplain : an analysis of the status of the fisheries sector and mitigation of conflicts within the sector in North Cameroon

Ziebe, R.

Fisheries in the Waza Logone Floodplain

An Analysis of the Status of the Fisheries Sector and Mitigation of Conflicts within the Sector in North Cameroon

Roland Ziébé



To my father Waleke Jean,
my uncle Wappi Rene,
and my friend Djelani Oumarou,
who passed away during the period I was undertaking this research.

Research funded by Louwes Fund (Leiden University)

zieberoland@yahoo.fr

Cover photos:
Photos: Roland Ziébé, Gerard Persoon
Lay out: Sjoukje Rienks, Amsterdam
Language corrections: Barbara Croes

ISBN 978-90-5191-176-3

Fisheries in the Waza Logone Floodplain

An Analysis of the Status of the Fisheries Sector and Mitigation of Conflicts within the Sector in North Cameroon

PROEFSCHRIFT

ter verkrijging van
de graad van Doctor aan de Universiteit Leiden
op gezag van de Rector Magnificus prof. mr. C.J.J.M. Stolker
volgens besluit van het College voor Promoties
te verdedigen op donderdag 17 december 2015
klokke 16.15 uur

door

Roland Ziébé

Geboren te Kaele, Kameroen
in 1971

Promotie commissie

Promotor:	Prof. dr. G.A. Persoon (Universiteit Leiden)
Co-promotor:	Prof. dr. ir. H.H. de Iongh (Universiteit Leiden/Universiteit Antwerpen)
Overige leden:	Prof. dr. T. Dietz (Universiteit Leiden) dr. D. van Est (Algemene Rekenkamer) dr. L. Nagelkerke (Wageningen Universiteit)

Table of Contents

List of Tables, Figures and Pictures

Tables

Figures

Pictures

Abbreviations[1]

ACEEN	Cameroonian Association for Environmental Education (Association Camerounaise pour l'Education Envioronnementale)
ACORD	Agency for Cooperation and Research in Development
AIDR	Strengthening Association for Rural Development Initiatives (Association pour l'Appui aux Initiatives de Développememt Rural)
BURCREP	Central Office for Human Census and Studies (Bureau Central des Recensements et des Etudes de Population)
CAR	Central African Republic
CARPA	Centre for Pastoralism and Research (Centre d'Appui à la Recherche et au Pastoralisme)
CBO	Community Based Organization
CBFM	Community Based Fisheries Management
CCRF	FAO Code of Conduct for Responsible Fisheries
CEDC	Centre for Environmental and Development Studies in Cameroon (Centre d'Etude de l'Environnement et de Développement au Cameroun)
CIFA	FAO Committee for Inland Fisheries in Africa
CML	Institute for Environmental Sciences
CORDAID	Catholic Organization for Relief and Development Aid
CPD	Council Development Plan
CPUE	Catch Per Unit of Effort
DC	Developing Country
DFID	Department For International Development
FAO	United Nation for Food and Agricultural Organization
FEM	World Environmental Funds
FIMS	Fisheries Information Monitoring System
FishStat	FAO Fishery Statistics System
GEF	Global Environment Facility
GDP	Gross Domestic Product
GTZ	German Development Agency (now none as Giz)

1 Some abbreviations are translated from French to English.

IUCN	International Union for Conservation of Nature
IUCN-WLP	International Union for Conservation of Nature-Waza Logone Project
ISS-UMa	Higher Institute for the Sahel, The University of Maroua (Institut Supérieur du Sahel, Université de Maroua)
KYB	Komadugu Yobe Basin
LCBC	Lake Chad Basin Commission
MIDIMA:	Mandara Mountains Development Authority (Mission de Développement Intégré des Monts Mandara)
MFI:	Micro-finance Institution
MINEPIA	Ministry of Livestock, Fisheries and Animal Industries (Ministère de l'Elevage, des Pêches et des Indisrtries Animales)
MINEP-DD	Ministry of Environment, Protection of the Nature and Sustainable Development (Ministère de l'Environnement, de la Protection de la Nature et du Développement Durable)
MINEPAT	Ministry of Economy, Planning and Regional Development (Ministère de l'Economie, de la Planification et de l'Aménagement du Territoire)
MINFOF	Ministry of Forest and Fauna (Ministère de la Forêt et de la Faune)
MDG	Millennium Development Goal
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NIFFR	National Institute for Freshwater Fisheries Research
NRM	Natural Resources Management
OA	Open Access
PDRI-CL	Integrated Rural Development Project for the Chari Logone (Programme de Développement Rural Intégré- Chari Logone)
PRSP	Poverty Reduction Strategy Paper
SEMRY	Company for the Modernization and the Extension of Rice Production (Société d'Expension de Modernisation de la Riziculture de Yagoua)
SFLP	DFID/FAO Sustainable Fisheries Livelihoods Programme
SLA	Sustainable Livelihoods Approach

SNV	Netherlands Development Organisation (Stichting Nederlandse Vrijwilligers/Organisation Néerlandaise de Développement)
SOFIA	FAO State of Fisheries and Aquaculture Report
UNDP	United Nations Development Program
UMa	University of Maroua
VSO	Voluntary Service Overseas
WAFRI	West African Fisheries Research Institute
WCED	World Commission on the Environment and Development
WCMC	World Conservation Monitoring Center
WFC	World Fish Center
WLF	Waza Logone Floodplain
WNP	Waza National Park
WWF	World Wildlife Fund

Acknowledgements

Since my first research activity undertaken in 1995 for my DVM degree, I have been fortunate enough to receive several opportunities to continue my studies. In this period, I have learned a great deal, as a veterinary practitioner, researcher, lecturer and as a person. In the villages I have visited, I was both welcomed and educated.

I am greatful for the financial support received from the Louwes Fellowship Fund. This dissertation is a result of all investments from promoters, friends, and family. For this, I want to thank you all sincerely.

I would like to show my gratitude to the Louwes Fund which has financed my research.

My thanks also go to all the staff and my colleagues at the Institute for Environmental Sciences (Faculty of Sciences) and from the Institute of Cultural Anthropology and Development Sociology (Faculty of Social and Behavioral Sciences) at the University of Leiden.

I also wish to thank the people of the Waza Logone floodplain. During my field research, I discovered not only the many and varied aspects of the floodplain, but also of the people who live there. You provided me with vital information and you facilitated my regular research trips. I cannot forget the openness and the active collaboration of the *blamas* and the *manguivinis*.

To my field assistants, especially Beladan Boukar – my right hand while collecting data on fisheries – and Khari Boukar, who carried out his fieldwork on conflict within the framework of my research program, thank you very much.

To the Coordinator of the Centre for Environmental Studies of Cameroon (Dr Jean Pierre Mvondo) and his Homologue (Dr Ralph Buij), I am grateful for your constant advice and support.

I have benefited a great deal from my interactions with ACEEN members and particularly the Coordinator, Aboukar Mahamat; great thanks to all of you.

For statistics maps designed, I received a great contribution of Dr Michel Doumbe, a biostatistician from the Institute for Agricultural Research for Development (IRAD in Yaoundé, Cameroon) and Mr Etouna Joachim from the National Institute for Cartography (INC, Yaoundé, Cameroon); many thanks to them.

For my family, who showed great understanding during my absences, whether it was for fieldwork or during my visits to the Netherlands; this achievement is certainly a fruit of your patience and encouragement. My dear wife, Florentine and girls Eleftheria, Serena and Cindy, special thanks for your kindness and support.

Thanks too, to my European host families (Molenaar and Stellingwerf in Rotterdam, Rosendal in Amsterdam, Tineke in Noordwijk, Shey and van der Ploeg in Leiden, Guebane in Germersheim, Sidi in Brussels, Essam in Cologne. Visiting Leiden to complete this thesis not only afforded me with the opportunity of meeting new friends, the very welcoming atmosphere and productive working environment were essential for the completion of this dissertation.

I would further like to thank my PhD colleagues, Pricelia, Etotepe and Haman. I will never forget our African Room at CML and the memorable moments we shared both in Maroua and Leiden.

Finally, I would like to address the people of the Waza Logone floodplain once more and express the sincere hope that my work will provide a basis for future investigations into improving their livelihoods. My wish is that decision makers at the local, regional and national level will be able to utilize these analyses and recommendations to create a better policy on natural resources management for sustainable development.

1

Introduction and Background

1.1 Introduction

Floodplains are defined as areas of low lying land that are periodically inundated by lateral overflow of water from the rivers or lakes with which they are associated (Junk & Welcomme, 1990). Globally recognized as highly productive environments, floodplains are often referred to as 'the cradles of biological diversity', serving as the source on which numerous species of plants and animals depend on (Chapman *et al.,* 2011). Throughout natural history, floodplains supported high concentrations of birds, mammals, reptiles, amphibians, fish, and invertebrate species, and proved to be critical for the maintenance of adjacent ecosystems through processes such as nutrient flushing, effects on microclimates, water holding capacity and as storehouses for genetic material (Chapman *et al.,* 2011).

Many of the world's floodplains are now considered as potential zones of development, in which they also function as a means for soil hydrology, pasture for livestock and floodplain fisheries. Governments and development agencies throughout the world increasingly become aware of the crucial life supporting role floodplains have (Neiland & Bene, 2003). Their impact on local economical growth and human social organizations is indisputable, especially in developing countries (Neiland & Bene, 2003).

In the face of recent human population growth and associated rising levels of poverty in developing countries, the pressure on floodplains is on the increase. In addition, many inland water bodies are shrinking due to climate change (Wirkus & Boge, 2006). With poor communities becoming more and more dependent on disappearing water resources, it has been predicted that a future world war will be a "Water War". The example of the River Nile shows how this controversy has impacted the ten so-called Nile basin countries: Egypt, Sudan, Eritrea, Ethiopia, Uganda, the Democratic Republic of Congo, Rwanda, Kenya, Tanzania and Burundi. In the year 1929, a colonial treaty between Egypt and the United Kingdom gave all management rights relating

to the Nile River to Egypt (Wirkus & Boge, 2006). The other countries of the Nile Basin are claiming a new water-sharing deal called the Co-operative Framework Agreement, but have failed to reach an agreement. Nowadays, Egypt is still in control of the Nile River and its resources. Any attempt by other countries to go against this sovereignty, inevitably leads to a military response by Egypt.

Sixty-three of the world's 261 international river basins are located on the African continent (Chapman *et al.,* 2001). Wetlands form a habitat of great ecological importance here, but they are extremely distributed and particularly the sub-Saharan zone is impacted by water shortages (Loth, 2004). Although exact estimates of wetland surface area in Africa is largely lacking, mainly due to a lack of scientific investigation and inconsistent mapping policies, wetlands are suggested to cover approximately 1% to 16% of the continent (Koohafkan *et al.,* 1998). In terms of surface area, different rough estimates exist, ranging from 220,000 km² to 1,250,000 km² (Bullock *et al.,* 1998) and covering wetlands of varying type, from saline coastal lagoons in West Africa to fresh and brackish water lakes in East Africa. At present, the most accurate approximation of wetlands in Africa was carried out by the World Conservation Monitoring Center (WCMC) and IUCN (Schuijt, 2002).

1.2 Theoretical Background

1.2.1 The Waza Logone Floodplain

The history of the Waza Logone floodplain shows that the construction of the Maga dam in 1979 had a negative impact on the floodplain ecosystem (Loth, 2004; Scholte, 2007; Scholte *et al.,* 2006). The Waza Logone Project (WLP), implemented by the International Union for Conservation of the Nature (IUCN), restored some of the natural resources and partly rehabilitated the ecosystem. It also proposed a strategy for eco-development. These activities and the pilot flooding would eventually lead to the partial restoration of the floodplain ecology (Sighomnou & Naah, 1997).

A number of positive effects of the pilot flooding have been observed for vegetation and wildlife (Loth, 2004). However, this ecosystem rehabilitation also resulted in a great migration into the region of pastoralists and fishermen (Scholte, 2000a; Scholte, 2000b), which resulted in a sharp increase in local human population numbers and associated pressure on the natural resources. (Scholte, 2005, Scholte *et al.,* 2006). When measures to protect the Waza National Park and its floodplains were greatly compromised during a breakdown of the park management between 2007 and 2010 (De Iongh *et al.,* 2010), the

pressure on resources further intensified, particularly in terms of fisheries and wildlife. For example, the number of lions, which are an indicator species, declined from 40-60 in 2002 to 17-22 in 2008 (Bauer, 2003; De Iongh *et al.,* 2004; De Iongh & Bauer, 2008; Tumenta *et al.,* 2009).

In spite of efforts to practice co-management of the natural resources (De Iongh & Bauer, 2008), conflicts between stakeholders over these resources became evident.

As from 2008, the councils of Waza, Zina and Logone Birni started to play a major role in managing resources as part of a new policy of decentralization. They created an intercouncil partnership known as WAZILOBI for a better management of natural resources, including fisheries, pastoral land and the Waza National Park. A number of local NGOs, such as the Association pour la Conservation et l'Education Environnementale (ACEEN), and the Cellule d'Appui au Développement local Participatif Intégré (CADEPI), have also positioned themselves as major actors in the area over the past decades. With the evolution of multipartism, new laws further permitted the creation of associations and Common Initiative Groups.[2] These groups aimed at ameliorating their primary productions and were benefiting from a couple of advantages given by the government or international NGOs.[3] Planning and development activities related to these groups should preferably build on scientific data, tools and methods in order to canalize development action and achieve the Millennium Development Goals (MDG, Heck *et al.*, 2007). At the same time, laws and regulations need to be reinforced in order to achieve sustainable management of natural resources, while maintaining peace between all these stakeholders and reducing poverty in the area (Loth, 2004).

1.2.2 Fishing practices

Fisheries may be defined as an entity with a broad geographical scope. The concept may relate to all fisheries in a lake, or may apply to a more defined scope, such as those in a single jurisdiction, fishing certain target species or using a specific gear type or a vessel. Studying fisheries may encompass a comparison of fishery methods or a graphical analysis of the time trajectories of individual fisheries. Attributes are selected to reflect sustainability within each discipline and should only be adjusted or replaced if improved information becomes available (Tesfa & Pitcher, 2006).

2 Law n°92/006 of the 14 August 1992 on cooperatives and common initiative groups.

3 Here, we consider communities as such a basic group, organized around their chief, or 'Blama'.

The waterholes or *mares* in the Waza National Park and the other parts of the floodplain may play an important ecological role for the recruitment of the Waza Logone fisheries (Bobo & Boukar, 1997).

Since 1994, many development actions have been executed in the area. Among these are the construction of a small dyke near the village of Zilim in the Logomatya River, in the sub district of Ngoudeni (Figure 2.2) and the partial rehabilitation of the natural flooding regime (Van Ooijen & Haberland, 1991; Loth, 2004; Scholte, 2007). These two actions have created new conditions for fishing and pastoralist activities. The effects of these actions include benefits in terms of re-establishing the ecology of the area and they created better conditions for fish reproduction and for grazing. At the same time, several new fishing methods and innovations of traditional methods were introduced into the Waza Logone floodplain (Bobo & Boukar, 1997). However, these new techniques may be destructive, as the use of nets with a small mesh size and small fishhooks result in catching younger age classes of fish.

1.2.3 Maximum sustainable yield and resilience

Wildlife in general and fish populations in particular may be managed in order to (i) increase or decrease production; (ii) harvest for sustainable yield; or (iii) for preservation (Caughley & Sinclair, 2002). In all these cases, the operation must result in a sustainable offtake; i.e. a yield that can be taken year after year without jeopardizing future yields. In theory, the strategy of harvesting is to harvest the population at the same rate as it seeks to increase (Caughley & Sinclair, 2002).

Any fishery management strategy should thus strive to ensure a Maximum Sustainable Yield (MSY), where MSY is the maximum catch (in numbers or mass) that can be removed from a population over an indefinite period. This concept is used extensively in fisheries sciences and management, and relies on the surplus production generated by a population that is depleted below its environmental carrying capacity (Garcia *et al.,* 1989). MSY has evolved from a fisheries management target to a limit on fishing mortality and biomass depletion and is still widely used as a key paradigm in the fisheries sector. However, its general use and applicability have been challenged (Purt & Smith, 2001).

MSY-based management involves setting the harvest rate (in fisheries, defined in terms of fishing effort) to a level that produces a catch of preferably 20% below the MSY (Caughley & Sinclair, 2002). It is purely a physical measure (not tied to any economic or social and hence political doctrine). Fishing the biomass at the level above MSY has been a traditional definition of biological overexploitation. Any exploitation level below MSY is sustainable. Harvesting at the maximum sustained yield (MSY), should never be contemplated (Caughley &

Sinclair, 2002). It imparts instability to the population dynamics. The MSY can only be taken from the unique density. If the population density has, for reasons such as drought, dropped below that value, then the MSY represents an overharvest and the population's density is reduced further.

A harvest can be controlled either by placing a quota on offtake or by controlling harvesting effort (Caughley & Sinclair, 2002). Measures to regulate harvesting effort may include restrictions on fishing gear and fishing material, defining specific periods in time (i.e. fishing seasons) during which fishing is allowed, or by limiting the number of people harvesting the population. The control of harvest by quota has an intuitive appeal because there is a direct relationship between the prescription and the result. Restrictions in fishing gear and material are generally more difficult to implement (Caughley & Sinclair, 2002).

In fact, the disadvantages of regulation by effort are more conceptual than real. It is usually a safer and more efficient means of regulating a harvest than regulation by quota. Harvesting a constant amount of fish each year is inefficient when the population is subjected to large, environmentally induced swings in density. In such cases, the quota should be set low enough to be safe at the lowest anticipated density. Alternatively the size of the population should be censused each year prior to the harvesting season, after which the quota can be adjusted according to the estimate (Caughley & Sinclair, 2002).

Biologically, the rational scheme for harvesting is to reduce the population to a little above the density allowing MSY and then to take the appropriate yield year after year. But it transpires that the 'obvious' biological strategy is not necessarily leading to maximum economic gain. Clark's (2010) book on the economics of harvesting natural resources shows unambiguously that to arrive at the most optimal combination between the biological strategy on the one hand and the economic strategy on the other, the maximum rate of increase of a population should be relatively high. In Ecology, resilience is defined as the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly. Resilience is also defined as the capability of the ecosystem to deal with climate change and other threats (Glicksman, 2009).

African floodplains are generally resilient ecosystems (Lai, 1994; Paugy *et al.,* 1999; Tockner & Stanford, 2002; Welcomme, 2001; Tockner, 2002; Welcomme, 2003). Nonetheless, fluctuating patterns in ecosystem degradation do have a direct impact on fishery resources. In principle, a fishery that harvests all species at all trophic levels and sizes, at rates proportional to their natural mortality pattern is expected to be sustainable, which is underlying a new paradigm of balanced harvesting (Jul-Larsen *et al.,* 2003). Overfishing at the community level takes place when the total fishery production is in

excess of the overall annual surplus production of the entire fish community in a reservoir. A certain proportion of the fish community could become overexploited when specific investments are directed at that proportion, and fishers continue to catch the species despite the greater effort they need to invest to ensure catches are maintained (Sparre & Venema, 1998). Jul-Larsen *et al* (2003) suggested that such efforts could only be economically viable if fish prices are increased, if efficiency (per unit of labor) is enhanced, or if economic efficiency in distributing fish to consumers is improved.

In the small-scale fishing sector (including African fisheries), fishing gear is usually regarded from a fishing effort point of view: equipment will enhance catches only if combined with manpower (Kolding & Van Zwieten, 2011). In such a context, one can appreciate the socio-cultural significance fishermen hold with regard to their traditional fishing gear (Beuving, 2015). In the Waza Logone Floodplain, shortages in natural resources have led to more competition between different user groups (Fotsing, 2007). Conflicts as a result of this competition over resources have been reported among fishers, among pastoralists and between pastoralists and cultivators (LCBC, 2007). Increasing pressure from resource users also caused soil degradation, mainly by exposing the soils to erosion and a consequent deprivation of organic matter content (LCBC, 2007). This, in turn, has caused declines in income for those people depending on the local resources (Béné *et al.,* 2003a). Molenaar and Van Santen (2006) explained the perceptions of local people of a common spirit named *Maami Waata.* They found that one-third of the local people believe that *Maami Waata* creates fish, and half of them believe this spirit commands fish. They also confirm that three-quarters of the local people think that over the last ten years the catch in the floodplain and Lake Maga has declined (Molenaar & Van Santen, 2006). Forty-four percent believe that this is partly caused by the increasing number of fishermen, and more than half of the respondents blame the shortage of rainfall. Bene *et al.,* (2000) argue that the relation between fishing activities and the wealth (or poverty) level of households is generally not reflected as a one-to-one ratio. The importance of fishing activities rather increases with poverty; i.e. the poorer the people, the more they rely on fishing. In the floodplain (*yaere),* therefore, many people may have been forced to use fishing as an income generating activity of 'last resort'.

During an environmental assessment of the Zilim dyke on the Logomatya, Fotsing (2007) confirmed that a majority of the fishermen belong to lower income groups. In contrast to this finding, he also suggested that some fishing channel owners may be very rich. Such inequality in income and status between users of the same resources often lies at the basis of conflicts (Fotsing *et al.,* 2007) and could also be a major factor contributing to existing problems between user groups in the Waza Logone floodplain. It may compromise the

sustainability of resource use and the resilience of the floodplain as a whole. The current research therefore provides an opportunity to further analyze the factors and processes underlying such conflicts.

I hypothesize that the Waza Logone floodplain ecosystem, under certain conditions, has sufficient resilience to cope with the fishing pressure. Rainfall and flooding are expected to adequately maintain fish production at its normal level. Taking this into consideration, the emergence of conflicts such as the one that occurred in 2007 between Musgoum and Kotoko fishermen in the Waza Logone floodplain (Tumenta, 2012), may either be related to the unsustainable management of the floodplain, to the increase of human populations and the intention to control fisheries in the area, or a combination of these. To know which factors provide the incentive for conflicts between fishers, we need to know the status of fisheries, the impacts of new fishing practices and current means of innovation of traditional methods.

1.2.4 Sustainable development and co-management of natural resources

The concept of 'Sustainable Development' is defined in the report 'Our Common Future' as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (Earth Summit and its Agenda 21 of the United Nation Conference on Ecology and Development, Rio 1992). This definition of sustainability takes into account three dimensions: economy, society and the environment (Figure 1.1).

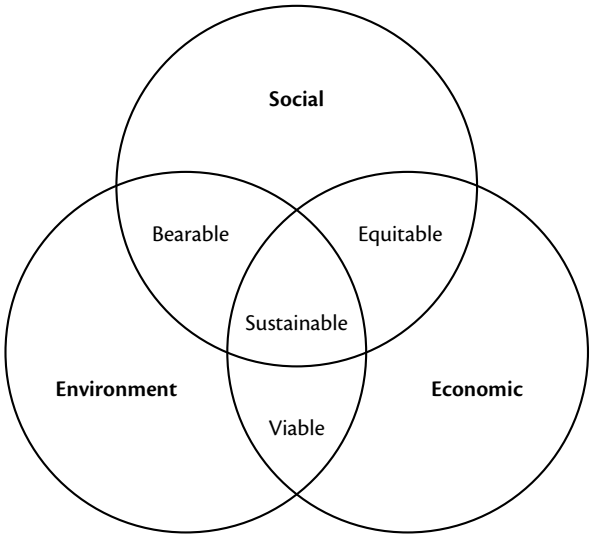


Figure 1.1
Sustainability as an integrated economic, socio-cultural and environmental dimension

Sustainable development is thus primarily a normative concept used to negotiate and establish values and aims in processes of development. According to Hurni and Wiesman (1997), the concept of sustainable development should also focus on values (on what 'ought to be') and on impacts (on what 'is').

In the Waza Logone floodplain, there are several factors that principally influence the sustainability of fisheries. For instance, in Waza National Park and surroundings, a number of artificial waterholes were created between 1976 and 1980 (Loth, 1997). These waterholes support concentrations of fish throughout the dry season and attract people from surrounding villages to organize fishing activities, also inside the Waza National Park where access to resources is subject to regulations (Scholte, 200a).

The Logomatya River is one of the few rivers in the area with flowing water all year around (Naah, 1990). The water in the river largely originates from the local rice scheme and is regulated by a small dam (Van Ooijen & Haberland, 1991). Agro-pastoral and fishery activities were to a large extent linked to this dam, so when it collapsed and the river dried out completely as a result in 2007, the human population along the river suffered a great deal (Fotsing, 2007).

Loth (2004) defined a number of threats to the ecosystem of the Waza Logone Floodplain. Overexploitation of natural resources is a major cause of ecosystem degeneration, especially in fisheries. Destruction of waterholes, collection of firewood, water pollution due to agricultural chemicals used in rice cultivation, hydrological impacts of e.g. fishing channels, and reduced sedimentation due to erosion are also considered to be important human-related pressures impacting the natural floodplain ecosystem (Fotsing, 2007).

To analyze the sustainability of fishery practices, the state of the fish resources should be determined. To make an estimate of the potential production, I reviewed the following references on African floodplains and lakes. Pitcher and Hard (1995), Tockner *et al.,* (2002) give the example of the Pongolo floodplain (South Africa; Heeg & Bren, 1982) and the Hadejia-Nguru floodplain (Nigeria; Hollis *et al.,* 1993). We can also add Merona (1983) (Fresh water of Africa), Welcomme (1986) and Lae (1994) (Central Delta of the Niger River), Paugy *et al.* (1999) (West African riverine), Neiland *et al.* (1990) (Benue River), Ogutu-Ohwayo and Baliowa (2004) (fresh water in Africa), Neiland and Bene (2003) (West and Central Africa fisheries). Also included in my review are textbooks on floodplain fisheries (Welcomme, 1975, 1979) and management books edited by several organizations (FAO, Ramsar secretary, DFID, IUCN and Word Fish Center).

Table 1.1 provides productivity data of some African lakes, compiled by Vanden Bossche and Bernacsek (1990).

Table 1.1
Productivity of some African lakes (from Vanden Bossche & Bernacsek, 1990)

Lake	Altitude (m)	Max depth (m)	Mean depth (m)	Surface (km^2)	Productivity (kg/ha/yr)
Albert	618	58	25	5270	47-65
Chilwa	654	5	2	750	77
Chiuta	620	5	–	200	75
Cohoha	1380	11	5	76	26-37
Edward	914	117	34	2300	61-70
Kariba	485	120	29	5364	30-41
Kivu	1463	489	240	2370	27-42
Malawi	471	758	426	30800	35-45
Mweru	930	37	7	4650	60
Rweru	1350	4	2	100	–
Tanganyika	773	1435	700	32900	90
Turkana	406	73	30	7570	9-16
Victoria	1136	84	40	68000	29-59

Ostrom (1990) demonstrates that the 'tragedy of commons' symbolizes the degradation of the environment whenever many individuals use a resource. Participation and responsibility in using common resources are therefore crucial for sustainability. Management of natural resources is commonly described in literature as an issue for the future (e.g. Bruntlan, 1987; Borrini-Fayerabend, 1997; Borrini-Fayerabend, 2000). Co-management and responsible management are considered to be the two main approaches to control sustainability.

The term co-management is defined by Borrini-Fayerabend (1997) as the sharing of rights and responsibilities between government and citizens. This term is used for several types of management arrangements. The essential common elements are sharing responsibility and institutionalized collaboration in management.

Co-management, as described by Bauer (2003), is related to power relations between government and communities. It includes participation, ownership and sovereignty (Bauer, 2003).The most relevant dimension in co-management is participation. Participation is defined as 'taking part in something.' It is usually presented as a continuum of power sharing between two parties. In the context of the Waza Logone floodplain, the two main parties involved in co-management are government and local communities. This continuum

can be divided into several categories: 'instructive participation', 'consultative participation', 'cooperative participation', 'advisory participation', and 'informative participation' (Bauer, 2003).

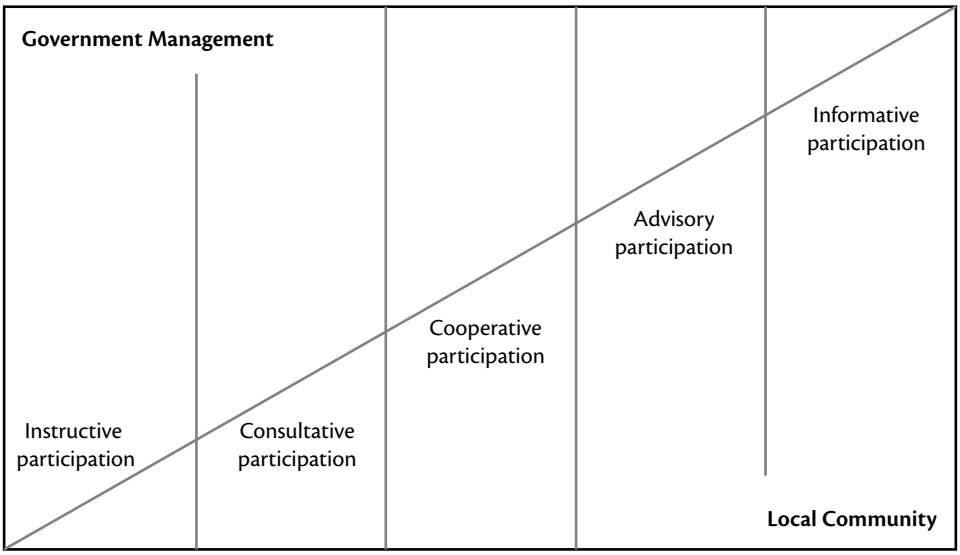


Figure 1.2
Spectrum of co-management arrangement (source Bauer, 2003)

The concept of instructive participation refers to actions at the level of local communities that have been implemented by the government. Consultative participation implies that input from local people is considered, while the final responsibility for analysis, decision-making and evaluation still rests with the government (Borrini-Fayerabend *et al.,* 2004). In cooperative participation, local people and government strive for synergy, consensus or compromise and share responsibility (Evan, 1996). Advisory participation entails that while the government advises a local community, that community has the prerogative of decision-making. Finally, informative participation means that a community is autonomous and informs the government (Evan, 1996).

Co-management implies institutionalized and factual collaboration in the control over a natural area and the organization of its exploitation. Different committees or boards can be involved in this institutionalization and certain statutes or formal contracts may be used to regulate specific issues (generally referred to as 'complementarity'; Evan, 1996). Alternatively, institutionalization could be in the form of verbal agreements and customary law parallel to the style of management discerned by Evan (1996). For a collaboration to be

effective, it should not just be occasional and really has to focus on the management issues.

In Africa, the reasons and arguments for adopting a co-management approach may vary in certain cases. Overexploitation due to the failure of a government to effectively manage capture fisheries, may be one of the most common and widespread reasons for the development of a co-management plan (Mafaniso & Nielson, 2003). In other cases, co-management is used as a means to control fishing effort through the assignment of property rights to some groups in order to forestall future problems of overcapacity. Communities around Lake Kariba in the Republic of Zambia, Lake Nokone in the Republic of Benin and Lake Chiuta in the Republic of Malawi for instance, have all been governed under this form of co-management policy. Furthermore, co-management is sometimes used as a tool in conflict mediation among various stakeholders (Mafaniso & Nielson, 2003).

In general, any government policy affecting rural fishing communities should be implemented to ensure biological sustainability of the natural resources and to conserve biodiversity in a certain area. In this context, it is important to acknowledge that most rural fishing communities previously fished for subsistence (Coburn, 2000). As rural fishing communities became part of market economies, fishery exploitation has shifted much more into the realm of the profit motive. In many countries, this 'neo-liberalism' has progressively led to an inequitable share of incomes between users. Because a higher income inequality leads to lowered social cohesion, conflicts are often inevitable (Coburn, 2000).

Local institutions are generally assumed to be more accountable and more aware of the potential benefits they receive when acting responsible in managing their resources sustainably comparing to official institution (Jentoft, 1994). The efficacy of fishery management strategies is expected to improve where the fishing communities are being involved in the decision-making process for the establishment of a co-management plan. Co-management measures are more effective when practical experiences and field knowledge of resource users are incorporated in their formulation (Jentoft, 1994).

Pinkertin (2003) defined seven key aspects of complete co-management: (i) the government, as a co-manager, plays a key and desirable role and is ideally an engaged partner rather than a delegator, (ii) co-management like management itself involves far more than the control of fishing effort, (iii) sustainable co-management arrangements involve some control by community partners over the terms and conditions of sale to fish buyers, (iv) the successful exercise of rights on one level depends on the exercise of rights to participate in data collection/analysis and setting policy agendas at the highest level, (v) co-management will ideally involve multiple horizontal negotiations leading to coop-

erative activities with other players and potentially greater democratization of civil society, (vi) the power to exclude outsiders from some defined territory is optimal, (vii) complete co-management is based more on the collective rights of a group than on individual rights.

1.2.5 Conflicts in the Waza Logone floodplain

Considering conflicts and violence within and between communities, two schools of thought are often used in literature. The first school of thought argues that more violence may occur in a situation with an abundance of resources and/or when a natural resource has a high commodity-value and is in such abundance at a special location (Collier, 2000; Collier & Hoeffler, 2002). Under such conditions, conflicting parties may gain enormously when they can secure access to that resource. This situation is particularly relevant for conflicts regarding non-renewable resources such as minerals that are scarce at a global level, but abundant in a certain area. It may however also apply to the fisheries sector, in cases where valuable fish commodities are concerned, such as the Blue fin tuna in the Mediterranean (Collier & Hoeffler, 2002).

The second school of thought is based on resource scarcity. An increase of scarcity of renewable or non-renewable natural resources gives rise to conflict that may easily result in violent clashes between user groups when a certain combination of conditions is met (Homer-Dixon, 1999; Bachler, 1999).

In the Waza Logone floodplain, conflicts resulting from limited access to natural resources have occurred in the past and are still considered to play an important role in community interactions (ACEEN, 2007). Some of these conflicts have resulted in homicides and injuries. A recent example involves a dispute about fishing rights in a *mare* (Tchikam) situated within the Waza National Park in 2007 (Tumenta, personal communication).

Between 1995 and 1997, a demographic monitoring survey was undertaken by the IUCN-Waza Logone Project (IUCN-WLP, 1996). This demographic census showed the presence of five main ethnic groups: Musgum (35.9%), Bornouan (22.1%), Peulhs (12.5%), Arab Choa (11.3%), and Kotoko (7.7%). Another census conducted by Bene *et al.,* 2000, from October 1999 to January 2000 in 21 villages in the flooded area, confirmed the dominance of the Musgum group (67%) followed by the Kotoko (10%) and the Massa (10%).

The Musgum people came to the floodplain at the end of the 19th century, during the reign of the Kotoko Sultan of Logone Birni (Van Est, 1999). Initially, the Musgum complied with the authority of the Kotoko who allowed the newcomers to settle on uninhabited small islands in the floodplain under strict conditions. Only in the last decade of the 20th century did the power

base of the Kotoko Sultan decline and the Musgum no longer accepted certain Kotoko privileges and access rights to fishing grounds (Van Est, 1999).

Survey results (IUCN-WLP 1994a, 1994b) further revealed that the average human fertility rate was approximately nine children per woman, and the population growth rate is approximately 2% for the 183,000 resident inhabitants settled in the Waza Logone floodplain. In addition to the resident group, the floodplain is periodically visited by nomadic and transhumant populations; they spend eight months of the year in the area to exploit the dry season grass (Moritz, 2003). Another type of migration is confined to the limits of the floodplain; some local fishermen and agriculturists move within the area in search for zones that are suitable for their respective activities (Scholte *et al.,* 2006). Among the migrant groups, the nomadic pastoralists are the most numerous, followed by nomadic fishermen (Scholte, 2003).

Historically, community leadership has not been evident. Whenever a situation required someone to take the lead, the village elders would organize themselves (Van Est, 1993). Van Est (1993) also suggested that responsibility with regard to the different activities was shared by various people. For fisheries, for example, it was the so called *Mana* who was appointed as a fisheries manager (Van Est, 1993, cited by Bene *et al.,* 2000). Nowadays, these functions have been more or less abolished and are now in the hands of the village headman, the *Blama*. His role could best be described as a representative in dealings with authorities. He would for instance be responsible for taking decisions on opening or closing certain fish reserves.

Moore *et al.,* (1999) demonstrated that food and natural resource shortages are the main factors underlying rural conflicts. Although natural resource management does not usually focus specifically on conflict resolution, it should always be considered in order to guarantee food security for all users (Moore *et al.,* 1999). Food shortages and poverty in general can intensify social unrest. Politics, demographical factors, traditional ways of governing, corruption, overpopulation, inadequate political decisions and climate change can also lead to food insecurity and poverty.

Being confronted with conflict is not necessarily a bad experience for a society. It can boost its evolution if well managed. However, if conflict resolution does not achieve its aim, it can be disastrous for the environment and can even lead to tribal war (Moore *et al.,* 1999).

According to Bennet *et al.* (2001), conflicts between groups have many different causes. Conflicts could arise as the result of an abnormal social structure (the sociological perspective), changes in power relations (the political perspective), or certain rational decision-making by someone who seeks to maximize personal utility given a pool of scarce resources (the economic perspective).

With reference to a social cohesion that can prevent conflicts, Colletta *et al.* (2001) use the term "glue": sticking together promotes harmony, solidarity and commitment to live up to a common good.

Warner (2000) describes four different conditions that could lead to conflicts: (i) demographic change (a sharp influx of newcomers, possibly driven by negative trends in the economic or ecological status of other sectors); (ii) competition over natural resources (competition over space and natural resources as a direct result of an increased dependence upon the resource); (iii) developmental pressures (when government switches its focus from livelihood protection to food production); and (iv) structural injustice by law (legislation in which certain resources are deliberately withheld from dependent groups in society). The situation in the Waza Logone Floodplain shows most resemblance to the latter.

In the Mandara Mountains, situated upstream of the Waza Logone floodplain, Noorduyn (2005) observed that a relative dependency of local communities on natural resources and an uneven distribution of benefits from these resources between more powerful and less powerful actors could cause conflicts.

The Waza Logone Project (IUCN, 1994) included sustainable mechanisms for natural resource management and capacity strengthening of governmental services (Scholte, 2005). Despite the partial recovery of the ecosystem (Sighomnou & Naah, 1997) and the local and regional structures for co-management that were put in place through this project, conflicts between stakeholders increased (Loth, 2004).

The area that had been flooded during the pilot flooding may not have been extensive enough to support the needs of the expanding population (Scholte *et al.,* 2006). A further decline of renewable resources as a result of the Maga dam construction in the Waza Logone area may have aggravated the tensions, as well as the absence of local structures to prevent and resolve any conflicts.

Although conflict situations are commonly linked to the use and management of natural resources, the direct causes and impact of such conflicts are often poorly understood. Study information on conflicts specifically concerning the fisheries sector is available from around the world (e.g. Allison & Ellis, 2001; Bayley, 1988; Bene *et al.,* 2003a; Beuving, 2015; Bullock *et al.*, 1998; Crul, 1992), yet there have been few systematic reviews of the relationship between fisheries and floodplains. This lack of research focusing on fishery dynamics in floodplains particularly applies to tropical fisheries, where the sector has a considerable socio-economic function (i.e. employment, income, and food supply) and in which conflicts consequently affect the poorest members of society (Bene *et al.*, 2009).

To reduce conflicts, organizations and officials encourage community involvement in the management. In the Waza Logone floodplain, some communities have prepared local agreements for the management of fisheries (Loth, 2004).

1.3 Research objective and research questions

In the past, many research activities have been carried out in the Waza Logone floodplain by researchers of the Institute of Environmental Sciences of Leiden University (Van Est, 1999; Bauer, 2003; Moritz, 2003; Loth, 2004; Scholte 2005; Molenaar & Van Santen, 2006; De Iongh *et al.,* 2004), Cameroonian universities (Naah, 1990; Adam, 1994; Bobo & Boukar, 1997; Sighomnou & Naah, 1997; Fokou *et al.*, 2004; Tarla & Bachirou, 2004) and other universities (Benech *et al.,* 1982; Benech, 1992; Neiland & Bene 2003; Bene *et al.*, 2000, 2003). These studies covered fishing methods, and examined local organizations of fishers and herders. Other studies have covered the movement of cattle (Unusa, 2012), the impact of re-flooding on the floodplain ecosystem (Loth, 2004) and the dynamics of wildlife resources in the Waza National Park (Bauer, 2003; Buij, 2013; Scholte, 2000a; Tumenta, 2012).

Reports on the local perception of communities have suggested a decrease in fish stocks in the Waza Logone floodplain (Molenaar & Van Santen, 2006; LCBC, 2007; IUCN-WLP, 1994b). This is in line with continent-wide observations by several authors (Welcomme, 2003; Welcomme & Halls, 2001; Benech, 1992; Paugy *et al.,* 1999; Lae, 1994), who reported that such declines are often influenced by environmental factors and by human interventions such as the construction of dams in the watersheds. In general, increasing numbers of fishers, erosion of traditional fishery management systems and the use of destructive fishing methods could significantly contribute to fish depletion in the Waza Logone floodplain, as has been observed in other floodplains (MFO, 1995).

This study covers the status of fisheries and fishing techniques, the fish productivity and catches in the Waza Logone floodplain, as well as fishing in waterholes and fishing channels. The research focuses on conflicts between different groups of fishers and other groups in the Waza Logone floodplain, and elaborates on how these conflicts relate to established management practices in the area and to the livelihoods of fishers in general.

The main objective is to understand the dynamics of the fisheries sector in the Waza Logone floodplain and specifically the level of fishing effort, diversity of fishing gear and conflicts between fishermen. The following three sub-objectives were defined:

- To assess the current situation of the fishing effort and catches in the Waza Logone floodplain,
- To evaluate the sustainability of fisheries practices, and
- To provide a means to better understand the factors influencing conflicts and conflict resolution between fishers in the Waza Logone floodplain.

The general focus of this research is to study the relationship between the current dynamics of fish production systems and any existing conflicts and conflict management practices that have been put in place within the fisheries sector of the Waza Logone floodplain.

These two interlinked themes (dynamics of fisheries and conflict management) are investigated through both natural science research approaches and socio-economic research approaches. Research questions have been defined as follows:

1 What are the recent dynamics of the fisheries sector in the Waza Logone Floodplain?
   - a What is the state of the fisheries sector in the Waza Logone floodplain during flooding?
   - b What is the state of the fisheries activities in the waterholes inside and outside the Waza National Park during the dry season?
   - c What is the possible ecological role of the waterholes?
   - d What are the main fishing methods used in the Waza Logone floodplain?
   - e What are the differences in catches between types of fishing practices in the Waza Logone floodplain?
2 What is the magnitude of conflicts in the fisheries sector and how are conflicts between fishermen managed in the Waza Logone floodplain?
   - a What is the frequency and magnitude in time and space of conflicts between fishermen?
   - b What are the institutional and organizational arrangements for conflict management for fishermen or communities within the Waza Logone floodplain?

1.4 Terms and definitions

The Waza Logone floodplain is known as *yaere*, the local dialect name for the floodplain.

Mares are large depressions that conserve water during the dry season. Waterholes are man-made water points. Waterholes were initially dug for the livestock outside the Waza National park and for wildlife inside the park.

Fishing reserves in this context are the fishing spots where access is forbidden for a certain period. These reservoirs are usually the property of a specific community. It can be either a waterhole or a part of the river.

In the Sahelian area of Cameroon, almost all rivers dry up after the raining season. They are locally known as *Mayo.*

In local villages, a person called the *manguivini* is traditionally responsible for water and fisheries management, and the *blama* is the traditional chief of the village. Above him in the hierarchy is the chief of the sub-district.

Sub-districts are constituted of villages administrated by a chief of the sub-district. The chief of the sub-district is subordinate to the *sultan*.

The *sultan* is the highest level of traditional authority. He is the representative of the local government. The sultan of Logone Birni and Pouss are the traditional rulers in the floodplain.

1.5 Methodology

For this study, I adapted the Rural Rapid Appraisal (RRA) technique of Fisheries (RAPFISH), which has been developed by Pitcher (1999). Pido (1995) and Pido *et al*. (1997), applied rapid rural appraisal to coastal area management in the Philippines and Indonesia. Recently, Tesfa and Pitcher (2006) used RRA for the Red Sea fisheries and Baeta *et al.* (2005) for the Tagus estuary in Portugal.

I further followed a framework developed by Welcomme (1998) for the development and management of inland fisheries. This framework covers six interlinked areas: (i) policy and planning; (ii) relationships between the fishery, its environment and other users; (iii) assessment of fishery; (iv) management of fisheries under natural regimes; (v) management of intensified fish production; and (vi) monitoring the effects of fishery management upon the fishery. To answer questions related to the dynamics and sustainability of fishery resources, I study (i) gear characteristics and use patterns, including fishing channel and mesh size; (ii) fishing effort (catch per unit effort); (iii) composition of catch by species; (iv) length frequency characteristics of the fish caught; and (v) seasonal and spatial distribution of the fishing spots. The framework is presented in Annex 3.

The results will be used to calculate catch per unit effort (CPUE) and condition factor (K). FAO (1999) defines the CPUE as the quantity of fish caught (in number or in weight) with one standard unit of fishing effort. Changes in CPUE are often considered as an index of fish biomass (or abundance). Condition factor is used as an expression of health and, more generally, the physiological state of the fishes (Paugy *et al.,* 1999). The floodplain is characterized

by two types of water reservoirs: waterholes and *mares.* Their flow towards rivers is often directed through channels, of which some are also present in the Waza National Park. Analyses of fisheries will include both reservoir types. To investigate the role of waterholes inside and outside the Waza National Park and, more specifically to understand the role that the waterholes inside the Waza National Park are playing for the recruitment of the floodplain fisheries, I will use ecological surveys in combination with a topographical assessment.

The Rural Rapid Appraisal of Fisheries Management System Framework (FAPFISH) is composed of four components: the conceptual base, the contextual variables and their attributes, the research or survey steps, and the expected output (Pido *et al.*, 1997).

This framework is applied for the Waza Logone floodplain and is characterized by (i) the willingness for an active commitment and collaboration between stakeholders; (ii) the access to the natural resources within the wetland, which is essential for local livelihood, security and cultural heritage; and (iii) local people that express a strong interest in being involved in the management.

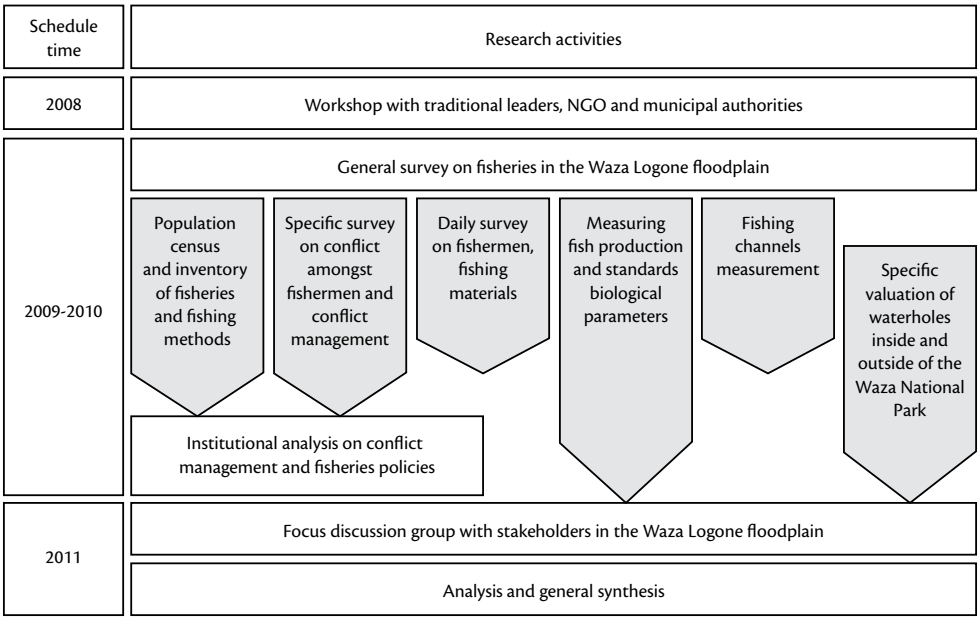


Figure 1.3
Methodology framework and timetable

The design of this study began in 2008 with a participatory workshop aimed at achieving a long-term commitment from stakeholders. A total number of 18 traditional and municipal authorities, as well as leaders of international and national NGOs attended the workshop. They analyzed the history of the area (prior to the building of the Maga dam, after the building, and before and after the pilot reflooding). They discussed the dynamics of the resources (e.g. fish, wildlife, pastoral land, soil and vegetation), social influences (e.g. religion, demography, politics, economy), ecological factors (e.g. climate, landscape dynamics, biodiversity patterns) and actors (i.e. fishermen, farmers, traders, hunters, leaders, traditional authorities, state authorities, municipalities, NGOs and donors). They analyzed the consequences of infrastructure, laws and regulations, and exploitation practices on the functions of the resources and on social relations. Also, a 'Strengths, Weaknesses, Opportunities and Threats' (SWOT) analysis of the councils (as the main actors in the decentralization process) was performed. Strategic planning in general and the SWOT analysis in particular, have their mutual origins in the work of business policy academics (Hill & Westbrook, 1997). The SWOT analysis has been especially influential in popularizing the idea that good strategies are important (threats and opportunities) and have their own internal qualities or characteristics (strengths and weaknesses). The participatory workshop provided a general overview of existing issues, from which the research proposal was drafted and analyzing tools were identified. Following these preparations, I conducted a pilot survey, in which several topics related to this dissertation were initially examined, at several levels of the floodplain communities.

The pilot survey encompassed an interview survey in 91 villages of the Waza Logone floodplain (Annex 1). All permanent *mares* and waterholes were marked by GPS. In each village nine persons (3 adult men, 3 adult women and 3 younger persons around 18 years of age) as well as all the traditional authorities were interviewed about the consequences of the drying out of the Logomatya creek and the role of the Maga dam and the Zilim containment dyke on the livelihoods of the population. The main results are presented in Chapter 2.

Based on the results of the pilot census, household heads were then interviewed in order to better understand conflicts among fishers and subsequent conflict mitigation and management. The details and results of this survey are presented in Chapters 6 and 7.

From August 2008 to June 2009, 13 fishing locations were selected in order to monitor the number of fishermen, the number of canoes, and the type of fishing materials they used. During the monitoring activities, 18 young fishermen (20-30 years of age) were involved as research assistants. They were

trained in interviewing techniques prior to the survey. Figure 2.2 provides more information concerning their position in the study area.

Whenever waterholes were used for community fishing, data on catches were collected. Catch size (weight), fish composition of each catch, the tools that were used and the number of fishermen involved in a catch were recorded once a week, and per fishing location. Some of the dominant fish species were measured (total length, weight) and the number of fish per species, their sex and sexual maturity were documented.

I began by counting fishing channels along the Logomatya River, the Lorome Mazera River and around the Abana natural pond. Thirteen of these channels were selected for a more detailed survey; in the villages of Zina, Zilim, Mazera and Moukak, which were surveyed during the fishing seasons (December to February) from 2008 to 2011. Recorded characteristics of the fishing channels involved measurements on length, depth and level of connection to the river.

Between December 2008 and February 2011 some of the waterholes and *mares* were subjected to some experimental fishing activities, during which biological data were collected. The weight, standard length and biological status were measured for seven species (*Clarias gariepinus, Clarias anguilaris, Schilbe intermedius, Oreochromis niloticus, Sarotherodon sp, Petrocephalus bovei* and *Brienmyrus niger*). These species were selected based on their assumed abundance in the catches. Individual fish were identified using Leveque and Paugy (2006), Paugy *et al.* (2004), Leveque *et al.* (1988) and Durand and Leveque (1980).

In the dry season of 2009, I also conducted a topographic assessment of man-made waterholes and *mares* in the Waza National Park (Tchikam), and surroundings (Lougue/Tchede).

As described earlier, a further 18 young fishermen were involved in data collection. For the survey on conflicts, I worked with Khari Boukar, a student from the Faculty of Agronomy and Agricultural Sciences, University of Dschang (Cameroon). I co-supervised his field research entitled 'Socio-economic impact of fisheries conflicts: the case of the Waza Logone floodplain (Far North Cameroon) from 1985 to 2009'.

The major portion of data collected during fieldwork came from direct observations and interviews.

In close collaboration with resource people and stakeholders in the area, three workshops were organized. The first workshop was organized in July 2008 with the four mayors of the Waza Logone Floodplain and representatives of local NGOs. The general objective was to develop a common vision for the management and exploitation of the Waza Logone floodplain. The second workshop was organized in June 2009 with 12 researchers and four

representatives of technical services of the ministries on the learning process during development actions that took place in the Waza Logone floodplain. The third workshop was organized in September 2009 with 33 participants, mainly livestock owners, in order to set up an urgent action plan for Waza National Park.

Three focus group discussions on conflict issues were organized in the villages of Zina, Malazina and Tchede with fishermen, dignitaries and traditional authorities in May 2010 and April 2011.

All data were organized in a single database created in Excel software. Some specific databases were extracted for useful calculation and analysis. Analyses were largely run in SPSS software.

The current thesis further comprises a review of literature and secondary sources, including official regulations and workshop reports. The discussions I had with specific stakeholders at the national level (decision-makers) and regional level (implementation level) were also used for this analysis.

The currency used to validate fish stock was the FCFA. The FCFA has an invariable value related to the Euro (1 Euro = 655,957 FCFA).

The data used in Chapter 6 originates from fieldwork focusing on the socio-economic impact of fisheries' conflicts in the Waza Logone floodplain.

1.6 Outline of the thesis

The outline of this dissertation is schematically described in Figure 1.4. Based on the framework (Figure 1.4), this dissertation is divided into eight chapters.

Chapter 1 provides general data related to the thesis. It presents the context of the research and is followed by the research objective, the methodology and this thesis outline.

Chapter 2 provides an overview of the study area. The Waza Logone area is presented in terms of climate, vegetation, soils and wildlife. The history of human establishment and data on population surveys are presented in this chapter.

Chapter 3 is dedicated to the fisheries ecology of the Waza Logone floodplain. It gives an overview of fishery resources, fishing materials and fishing methods in the area.

In Chapter 4, I present fish production and fish species composition in space and time in the Waza Logone floodplain. I assess the dynamics of fishery resources in the Waza Logone floodplain and the trends in fish production since 1994. This chapter also discusses a biological analysis of fish species in the Waza Logone floodplain based on previous knowledge.

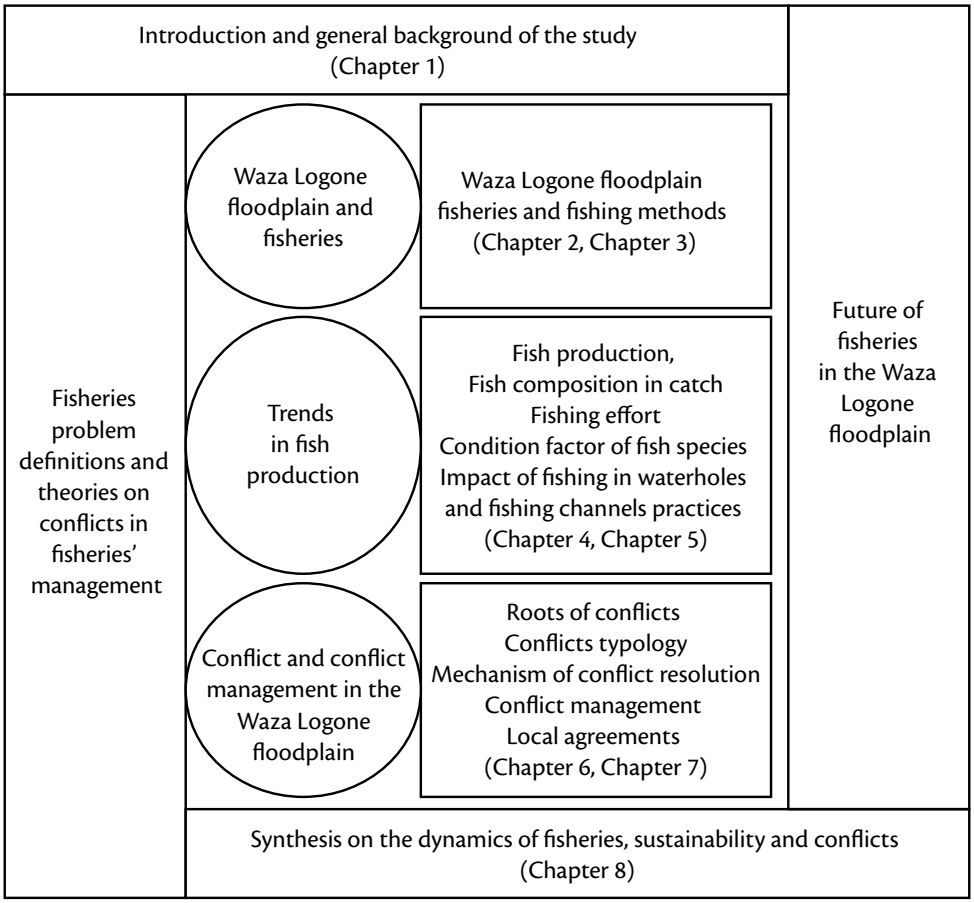


Figure 1.4
Outline of the thesis

Chapter 5 presents the specificity of fishing channels and fishing in waterholes. This chapter provides a physical description of two selected waterholes (one inside the Waza National Park, one outside the park), their link with the draining system and the production of fishes. Their function in terms of the recruitment of sanctuaries for fish in the dry season is also explained in this chapter, as are the main causes and effects of the drying out of fisheries along the Logomatya. This chapter further focuses on destructive methods of fishing in the Waza Logone floodplain. The problem of the fishing channels is presented and discussed.

Chapter 6 mainly focuses on conflicts; more specifically the conflict between the Kotoko and the Musgum in Tchede village. An analysis of the actors, characterization and roots of this conflict is provided at the end of the chapter.

In Chapter 7, I elaborate on the efficiency of conflict resolution mechanisms within the Waza Logone floodplain. Institutions for resolution of conflicts related to fisheries are presented at local, national and supra-national level. It further describes the policies on Cameroonian fishing legislation and the co-management initiatives that have been implemented co-jointly with local agreements for managing fisheries in the Waza Logone floodplain. These conventions and their benefits in terms of social cohesion, economic income for the people, and ecological effects on fish production are also presented here. The final chapter (Chapter 8) provides a broad analysis and synthesis. The answers to my research questions will be translated into recommendations for the research community, the government and local organizations/NGOs. I will conclude by giving my point of view on possible actions that could improve the sustainability of fisheries and enhance the well-being of people living in the Waza Logone floodplain communities.

2

Waza Logone Floodplain within the Sahel Wetlands of West and Central Africa

2.1 Introduction

Situated in Central Africa, Cameroon is a large and diverse space. From the Southern region to the Far North, one passes from equatorial forest to the Sahel. The economy, as in all sub-Saharan countries, largely depends on natural resources, of which fresh water is considered to be the most important (MIDIMA, 2010).

This chapter will present data from literature as well as the results from the 2009 survey.

2.2 Geographic position

In terms of landscape, Cameroon can be divided into four parts: the humid forest area in the South, the savannah area (Adamaoua and East region), the high mountain area (western regions) and the sahelian area (northern regions). The Waza Logone floodplain is part of the Lake Chad Basin and is situated in the central eastern section of the Far North region[4] in the Sahelian area (IRAD, 2008; Figure 2.1).

4 Since 2008, the former 10 provinces became 10 regions. In this thesis, province and region have the same meaning.

Table 2.1
Major floodplain wetlands of the Sahel (West and Central Africa) (Drijver & Van Wetten, 1992)

Wetland	Surface area km²	Country
1 Senegal delta	3,000	Senegal, Mauritania
2 Senegal valley	5,000	Senegal, Mauritania
3 Niger inner delta	30,000	Mali
4 Niger fringing floodplains	3,000	Nigeria
5 Sokoto and Rima valleys	1,000	Nigeria
6 Hadejia-Nguru floodplains	4,000	Nigeria
7 Logone floodplain	11,000	Cameroon, Chad
8 Lake Chad floodplain	10,000	Nigeria, Cameroon, Chad
Total	**67,000**	**West and Central Africa**

It covers 6,000 km² in Cameroon(comprises the Logone floodplain) and represents about 10% of the total surface of major riverine wetlands in West and Central African Sahel (Drijver & Van Wetten, 1992).

The Lake Chad Basin is located in Central Africa, between 6° to 24° N and 8° to 24° E. It comprises a vast expanse of land made up of several catchments that feed Lake Chad.

Table 2.2 summarizes the surface area of adjacent watersheds. According to LCBC (2007), the Lake Chad Basin covers a total surface area of about 966,955 km², which is approximately 8% of the surface area of the African continent. The area is shared territory by Algeria, Cameroon, Central African Republic (CAR), Chad, Niger, Nigeria, Sudan, and Libya. All these countries use the area as a strategic source of fresh water, which is considered as one of the most critical resources to the livelihoods in the watershed.

Table 2.2
Surface area of the sub-watersheds of the Lake Chad Basin among the LCBC member nations (LCBC, 2007)

State	Size of sub-watershed (km²)	% of Conventional Lake Chad Basin	% of National Territory
Cameroon	56,800	6.0	12.12
Niger	162,375	17.0	12.70
Nigeria	188,000	19.0	22.15
Chad	361,980	36.0	28.42
CAR	197,800	22.0	31.75
Total	**966,955**	**100**	**–**

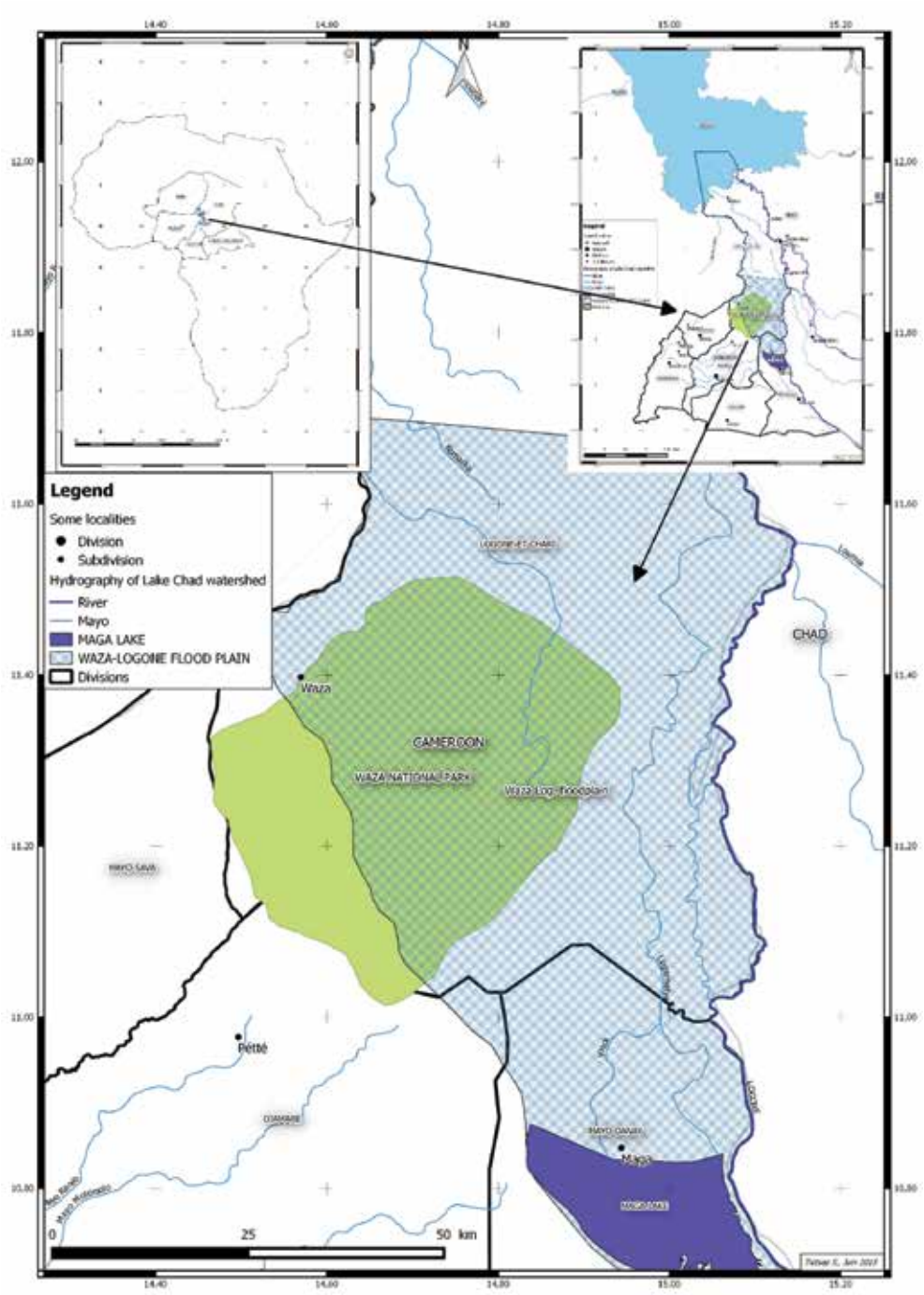


Figure 2.1
Waza Logone floodplain and area within the Lake Chad basin (From NIC data)

Since 1963, a general decline in rainfall in the Lake Chad basin has been observed. In conjunction with a steady degradation of the vegetation cover, this has greatly impacted the environment: the lake dried up, large areas desertified, crops failed and livestock and fish stocks suffered. More than 15 million people in the Lake Chad Basin were affected either socially or economically (LCBC, 2007). In response to this, the Waza Logone floodplain was classified in 2006 as a RAMSAR site (RAMSAR, 2008). Waza National Park, situated in the floodplain, has been recognized as a Man and Biosphere Reserve since 1979 (UNESCO, 2008).

The Waza Logone floodplain is divided into six divisions (Mayo Tshanaga, Mayo Danay, Mayo Sava, Mayo Kani, Diamare and Logone et Chari). Administratively, the floodplain comprises of three councils (Zina, Waza and Logone Birni in the Logone & Chari division, Maga in the Mayo Danay division, and Pette in the Diamare division. The state authorities comprise (i) the governor for the region, (ii) the senior divisional officer for the division[5] and (iii) the sub-divisional officer for the sub-division. Acting as the principal traditional authorities are the Sultan[6] of Logone Birni, the Lamido of Pouss and the Lamido[7] of Pette. Zina is the administrative center of the Waza Logone floodplain (Figure 2.2).

2.3 Population

Since centuries, the annual flooding of the Waza Logone floodplain provides livelihoods, mainly through fishing and farming (Van Est, 1999).

Among the people living in the Waza Logone floodplain are the Kotoko, Musgum and Massa. In the dry season, the area is visited by pastoralists who lead their cattle onto the grassy plains in search for available pasture (Scholte 2006a).

The Kotoko, descendants of Sao, were the first occupants of the land surrounding the Chari and the Logone River. Traditionally, homes of prominent community members are located in the northern section of each town while lower-class families and foreigners reside in the southern part of a town. In between, in the central part of town, the home of the Sultan (Mbaku, 2005) is situated. The Kotoko have always been fishermen, known for their successful use of several fishing techniques, including channel fishing. Although they are

5 A division is an administrative jurisdiction administrated by an official called a Prefect or Senior divisional officer

6 Depending on the traditional organization, the chief of the Fulani people is call Lamido and Sultan in Kotoko people.

7 See footnote 6.

mostly Muslim, they have integrated other traditional worship practices into their daily lives, including the belief in spirits that live in water (Molenaar & Van Santen, 2006).

The Musgum came to the Waza Logone plain several centuries after the Kotoko people. The Musgum settled in the southern parts of the floodplain, which were vacated by Kotoko. Since the independence of Cameroon (in 1960), the Musgum slowly started to migrate towards the northern part. South of where the Musgum settled, is now inhabited by the Massa. The Massa maintain their geographic and administrative center at Yagoua. They are mostly rice farmers. The Fulani people are temporary residents of the floodplain; they are mostly herders and transhumants (Mvondo *et al.,* 2003).

Nowadays, small numbers of other ethnic groups (such as Moudang, Guiziga and Toupouri) are also found in the area. They migrated to occupy positions as civil servants or as general employees in administration offices, mostly in the larger towns (i.e. Yagoua and Waza).

During the last national geographic census, more than 215,400 people were reported to live in an area estimated at approximately 8,293 km^2 (BURCREP, 2010). The density of human occupation is 25 people per km^2 in 2005 (Table 2.3).

Table 2.3
Surface area and population of Waza Logone floodplain (from general population census, 2005)

Subdivision	Surface area (km^2)	Population
Logone Birni	2,261	52,589
Zina	1,169	25,572
Waza	2,604	15,013
Pette	1,233	37,125
Maga	1,026	85,100
Total	8,293	215,399

Other studies broadly estimate the surface area of the floodplain in Cameroon at about 6,000 km^2, with more than 100,000 people using the area's resources (Loth et *al.*, 2004), including migrant people, fishermen and pastoralists. Cattle owners in the area own an estimated number of cattle of up to 200,000 heads during the peak dry season (Scholte *et al.,* 2006).

During the present study, a rapid census was conducted in April 2009 in 91 villages in the floodplain. The list of the villages is presented in Annex 1. The total population was estimated at 41,415 people.

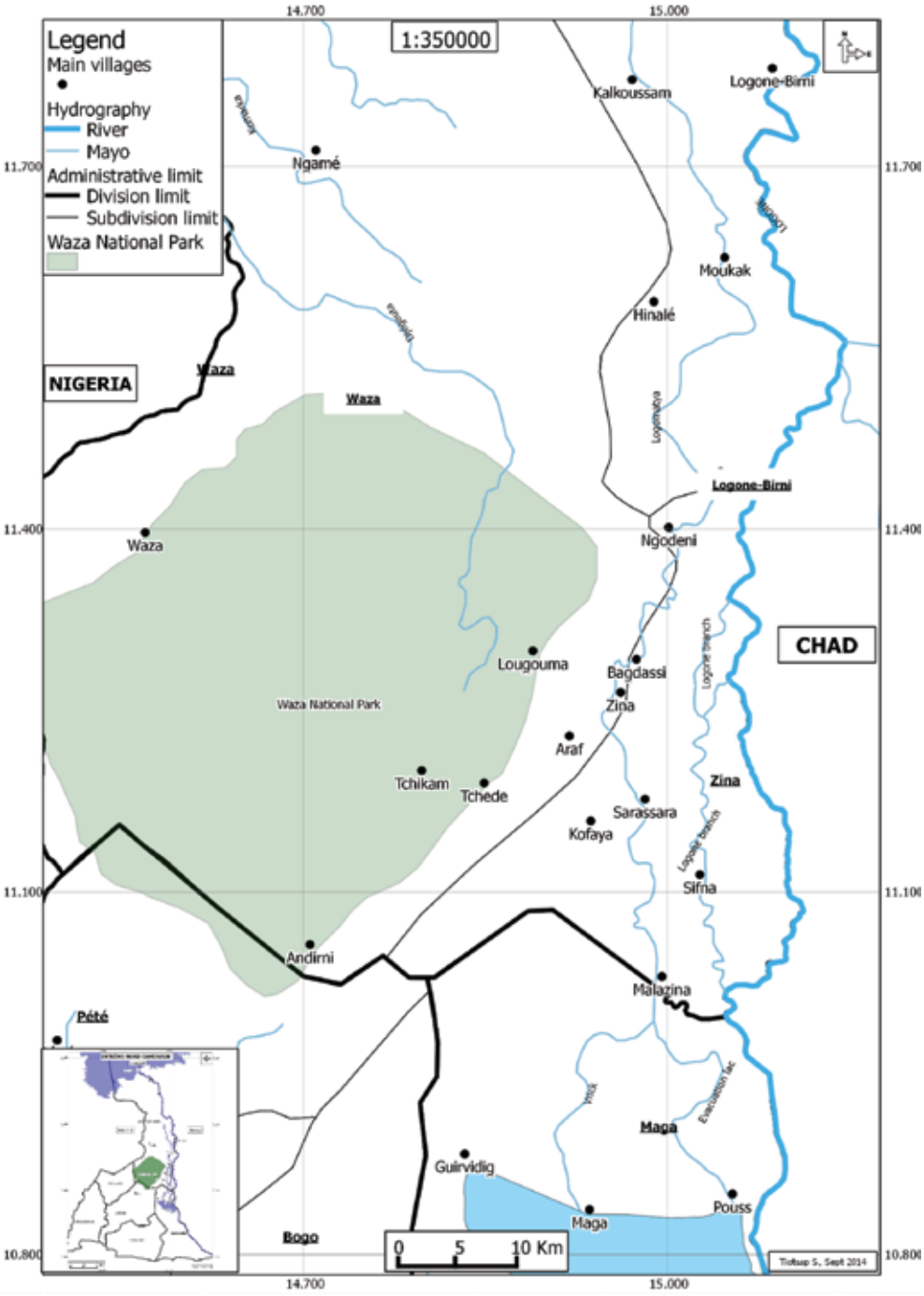


Figure 2.2
Villages and the National Park in the Waza Logone floodplain (NIC and field data)

In April 2010, a second census was conducted to provide details on 19 additional villages. This census was done jointly with interviews of household heads and included questionnaires on conflicts.

Age distribution and migration

Figure 2.3 shows the distribution of respondents according to their age. People aged over 50 years represent about 50% of the surveyed population (47.51%). This could be explained by the fact that a large proportion of the young population (i.e. in the age of 17 and 22) whose income is mainly derived from fishing, leaves the floodplain to seek out other fishing areas or migrates to cities or other area (e.g. Maroua, Lake Chad, Maga, Foumban, Douala, and Lagdo).

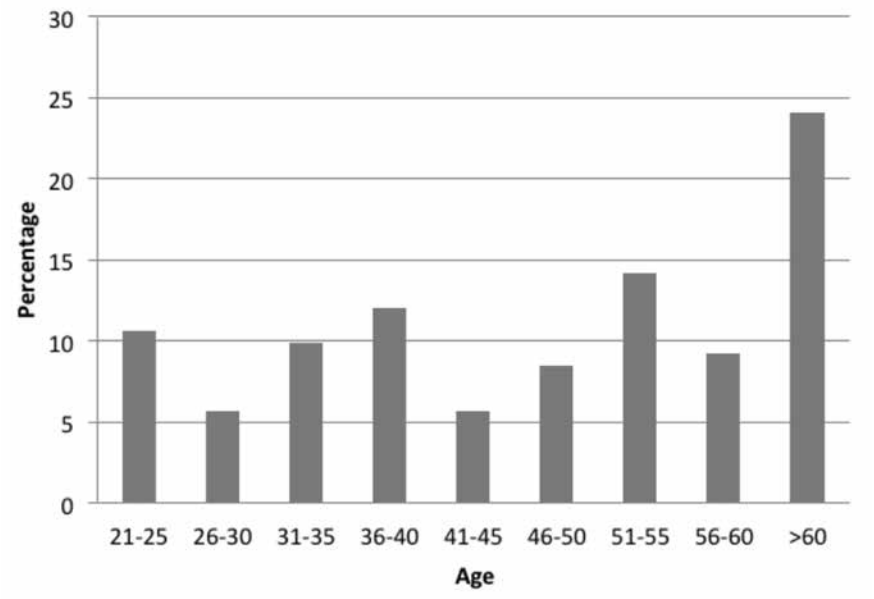


Figure 2.3
Distribution of respondents according to age (n = 143)

As an example, in 2010, 856 heads of households, out of a total of 1,619 (52.8%), left the floodplain after a period of intensive fishing activities. This shows the importance of migration and mobility in the population between the Waza Logone floodplain and other fishing areas.

Main production activities in the Waza Logone floodplain

In the study area, agriculture is regarded as the core business; it ensures household food security (Bauer, 2003). Although fishing generally generates more revenue, it is the second activity after agriculture. In line with this, more

than 20% of the people surveyed are involved in fisheries as a main activity, while it is a second activity of nearly 80% of those interviewed. When fish resources became more scarce after the construction of the Maga Dam (1979), due to reduced flooding of the floodplains, there was a gradual conversion of young fishermen into farmers (ACEEN, 2007). This coincided with a sudden increase in local initiatives to create rice fields between 1980 and 1990 (Fotsing, 2007). Our interviews revealed that a group of 17 of youngsters left the villages of Zina and Sarasara in the district of Mazera in 2006 and 2007 to farm rice crops in North region. This phenomenon of seasonal migration of fishermen characterizes this area and is linked to the hydrological disturbance that occurred after the construction of the Maga Dam in 1979. Since then, fishermen migrate to other areas like the Lagdo man-made reservoir or Lake Chad after the main fishing season (October-January). More details on this migration pattern are provided in Chapter 3 and Chapter 5.

Level of education

In the French part of Cameroon, primary level education ends with the First School Certificate after six years. The Secondary School Certificate may be obtained after four years education at the secondary level, while after seven years a Bachelor's degree could be obtained. In the rural Muslim dominated areas, such as the Waza Logone floodplain, children are often educated in Koranic schools. The teacher has the status of the Imam, a religious authority who has learned the Koran. Figure 2.4 shows the level of education within the population.

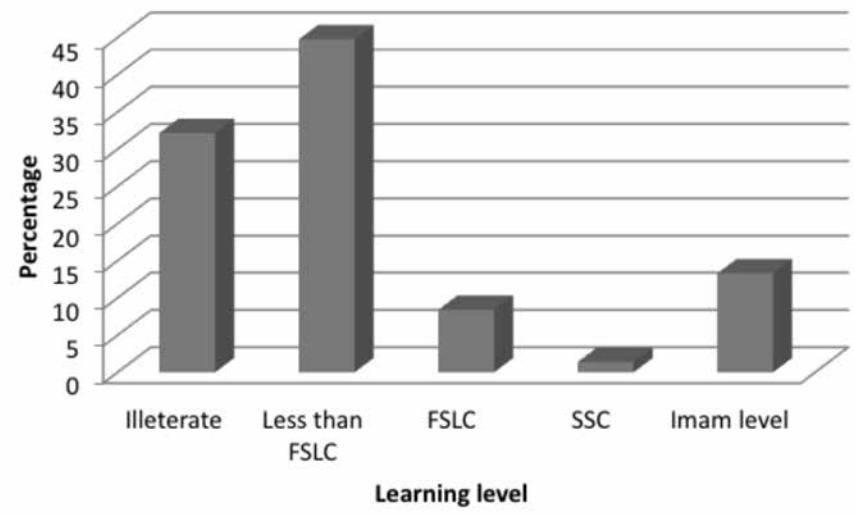


Figure 2.4
Distribution of respondents according to their educational level
FSLC: First School Living Certificate; SSC: Secondary School Certificate

Nearly 70% of the respondents have a formal education (Koranic, French or both systems). Within the French system, over 80% have not attained a First Level Certificate (Figure 2.4). This relatively low educational level could be related to the strong interest the local population attaches to the great fishing season that runs from November to January. As a consequence, the school year does not really start until mid-February, causing children to be deprived from education during more than half of the school year. Moreover, the drop-out rates remain high due to the seasonal migration of parents, particularly fishermen. The fact that the French education system in the area suffers from a lack of school infrastructure and teachers could be a further determinant in this low educational level.

Religious groups

In accordance with geography patterns, Islam is the predominant religion in the Waza Logone floodplain (Table 2.4). Over 90% of the population adheres to this religion, which is reflected in the predominantly Islamic infrastructure in the zone. Mosques are present in most villages and small towns in the floodplain. Churches can only be found in a few small neighborhoods such as Raïnaba, Sifna and Davagan in the sub-district of Lahai.

Table 2.4
Distribution of respondents according to their religion (n=143)

Religion	Numbers	Percentage
Islam	135	94.4
Christian	7	4.9
Animism	1	0.7
Total	143	100.0

Household size

Household size reflects the total need of households in terms of sustenance and is thus a realistic determinant of existing competition risks and pressure on natural resources in a certain area (Bene *et al.*, 2003). Within the surveyed population, the largest household is 28 persons and the smallest household has only one member (Table 2.5). The average size of households in the study area is 10.83 persons. This is twice the average size of a household on national level (4.8 per household) and almost equal to what has been reported for the study area at the start of the Waza Logone project (UICN-WLP, 1994a; 1994b).

Table 2.5
Statistical information on households (n= 143)

Household Statistics	Value
Average number of members	10.83
Standard deviation	5.4
Interval between maximum and minimum size	27
Minimum size	1
MaximumMaximum size	28

The fact that the majority of the population is Muslim and thus generally adheres to a polygamous lifestyle adds to this high average household size; households are often characterized by more than one woman with their children.

2.4 History of development actions in the Waza Logone floodplain

In the 1970s, a 30 km-long earth dam was constructed near the village of Maga in order to collect water (400-1000 km^2) needed for rice production. Due to this construction, the Waza Logone floodplain became deprived of practically all of its natural flood water. The embankments on the west bank of the Logone River intensified this effect and further compromised the ecological potential of the floodplain. Many local people who relied on natural resources for their livelihoods were seriously affected in terms of income due to reducing fish stocks, available land for cultivation, and products such as fuel wood, fruits, medicines and merchandise such as Gum Arabic (Loth, 2004). Table 2.6 summarizes the timeline of events and management interventions that took place in the Waza Logone floodplain since the completion of Maga Dam in 1979.

From 1990 to 2003, the government of Cameroon and the International Union for the Conservation of Nature (IUCN) worked to rehabilitate the degraded Waza Logone floodplain by conducting the IUCN-Waza Logone Project (IUCN-WLP). This project initiated so called 'pilot flooding' by opening the '*petit Goroma'* creek that was cut off by the embankment along the Logone River (Scholte, 2007).

During the last few years, the fishing grounds in the Waza Logone floodplain have been opened to everyone. These developments have resulted in decreased fish yields per household (ACEEN, 2007).

With the exception of a number of waterholes which are managed on the basis of local agreements, most fish resources have shown declines during

recent years (Molenaar & Van Santen, 2006). They are exploited without any regulations and corruption practices have added to the damage. In addition to this, the presence of so called fishing channels, constructions of 20 to 2,000 meters long, which are meant to enhance fishing efficiency, has shown a sharp increase between the late '90s and 2006. Their number grew from 1,188 channels in 1998 (IUCN-WLP report cited by Belal, 2003) to over 3,000 fishing channels on the Cameroonian side of the border in 2006, with an additional 500 channels on the Chadian side (ACEEN, 2007).

Pastoralists have always travelled great distances to benefit from the floodplain's rich resources, particularly in recent decades, which was at the same time characterized by a slowly disappearing water surface and a gradual decline of other resources (Scholte, 2006). The reflooding of the Waza Logone floodplain in 1994 resulted in an increase of the number of pastoralists and herds of cattle. Moritz (2003) estimated the annual growth rate of nomadic herds from 1993 to 1999 at 4.5% per year in the Waza Logone floodplain. During this period, the grazing intensity increased from 27 to 69 cattle per km^2 and pastoralists stayed longer in the floodplain than before (Scholte *et al.,* 2006).

During the 1984-1985 drought in the area, palatable grasses and water for herding cattle became scarce. In response to this, the livestock service of Kousseri, decided to build a small dam in Zilim Village in 1985, on the Logomatya River (Figure 2.2). This dam was developed further by integrating some nearby channels, to function as the SEMRY rice scheme which also inundated a large area for grazing (Oijen & Haberland, 1991). This scheme was still operational in 2010.

An impact assessment conducted in the area by the Dutch Development Organization (SNV) in 2007 showed that the reduction of the flooding area modified the conditions of watering and foddering of animals considerably (Fotsing, 2007).

Since 2006, the Lake Chad Basin Commission (CLBC), SNV and regional services in charge of natural resources have started to develop strategies to tackle these problems and combat the degradation of resources while promoting sustainable practices. CLBC developed a plan with a scope until 2025, targeting the entire basin, but specifically the Waza Logone floodplain. The long-term objective is a floodplain with sufficient water and soil resources (in terms of quality and quantity) to satisfy sustainable development, while creating a framework for equitable sharing of the resources and benefits (LCBC, 2007).

Table 2.6
Chronological description of main events impacting development in the Waza Logone floodplain (adapted and completed from Loth *et al.*, 2004)

SEMRY/Maga dam	Scale	Waza Logone Project and other projects
▪ Construction of the Maga dam ▪ High increase in rice production and extraordinary yields ▪ Creation of a new city (Maga) ▪ Improvement of social infrastructures (education, health, water supply) ▪ Collapse of the floodplain and fisheries ▪ Ecologic disaster.	1979	
▪ Less competitivity of local rice compared to imported rice ▪ Beginning of the economic crisis	1986	
	1988	▪ Feasibility studies of Waza Logone Project ▪ Research and development activities ▪ Participation of populations, traditional leaders and authorities ▪ Creation of enable conditions for the restoration of ecology ▪ Initiation of conservation and co-management of natural resources ▪ Restoration of biodiversity
▪ New orientation of the management of SEMRY (disengagement of the government, abandonment of the commercialization function within the company) ▪ Fall of rice production	1989	
	1992	▪ Law on the right of association ▪ Creation of common groups and associations
▪ Devaluation of FCFA ▪ Grain in competitivity ▪ Remanent economic crisis ▪ Underperformance of the production unit ▪ Sub productivity	1994	▪ First pilot reflooding of the Waza Logone floodplain ▪ Opening of the Aretekele (20 m^3/s)
	1997	▪ Second pilot reflooding ▪ Opening of the Petit Goromo (7-10 m^3/s)
▪ Strike by rice farmers against the SEMRY authority Appointment of new General Director ▪ New contract Plan with the government ▪ Increase in rice production	2000	▪ End of the Waza Logone Project ▪ Set up of the CACID ▪ Process of transferring activities to local organizations ▪ Creation of CFAID, ACEEN, AIDR by the former animators of the Waza Logone Project
▪ Strike by rice farmers against the SEMRY authority ▪ Appointment of a new General Director ▪ Stop in rice production	2007	▪ Broad diagnostic in the Lake Chad Basin by the LCBC ▪ Funding of small grants in the floodplain (GEF/CBLT) ▪ Decision of the Governor concerning measures for the reverse of tendency of degradation of natural resources ▪ Dry up of the Logomatya ▪ Mobilization of several development actors (LCBC, SNV, ACEEN, Councils of the floodplain) ▪ Impact environmental assessment of the rebuilding of the Zilim dam
	2009	▪ Funding of the PRODEBALT ▪ Funding of the PDRP/CL

2.5 Climate

The Waza Logone area comprises 600,000 hectares in the Far North region of Cameroon, and has its geographical location between 10°50' and 12°10' North latitude within the Lake Chad Basin (Figure 2.1 and 2.2), at an altitude of approximately 305 m above sea level. The floodplain, locally known as the *yaere*, stretches over an area of 6,366 km^2 (20% of the Far North region). Temperatures vary between an annual maximum of 41°C to an annual minimum of 13°C. The annual average rainfall varies from around 750 mm in the South to 600 mm in the North (average 687 mm; Figure 2.5).

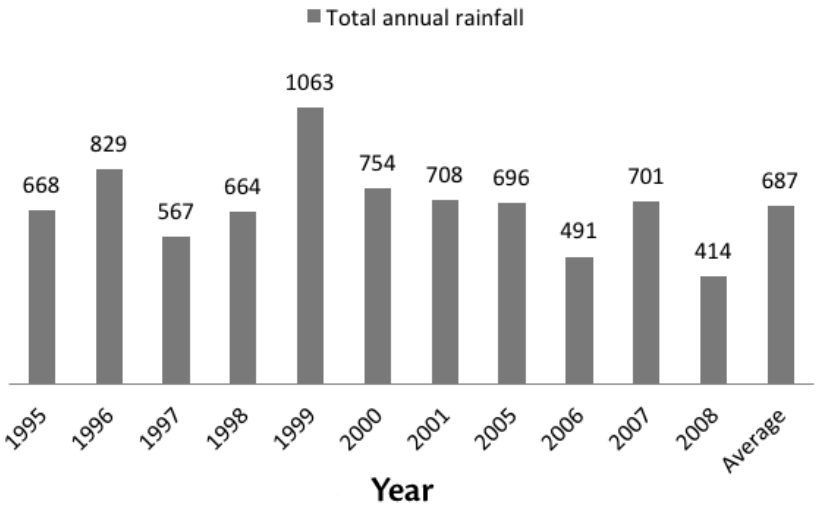


Figure 2.5
Rainfall data (in mm) in the central part of the study area (personal data collected by Mahamat[8], a rainfall monitor in Zina from 1995 to 2008)

The wet season lasts only five months – from mid-May to mid-October, with July (33%) and August (32%) accounting for 65% of the total annual rainfall, while there is little or no rainfall during the rest of the year (MIDIMA, 2010; Figure 2.6).

Recent climatic analyses show a clear space-time variability in the distribution of the rains in the region and reveal a downward trend (Donfack & Seiny, 1997). Due to climatic changes, wet seasons become shorter and precipitation patterns are slowly shifting North, leading to gradual modifications in local hydrology and ecology.

8 Former hydrological Assistant of the Waza Logone Project.

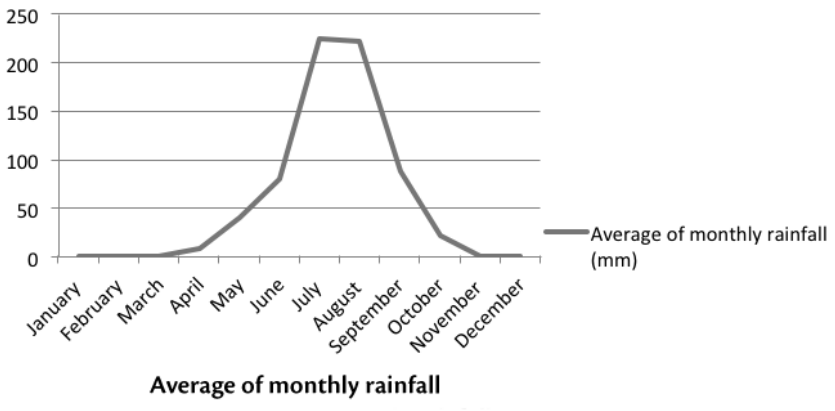


Figure 2.6
Seasonal rainfall dynamics in the Waza Logone floodplain (data collected by Mahamat, a rainfall monitor in Zina from 1995 to 2008)

2.6 Hydrology

The hydrology of the Waza Logone floodplain has been described by several authors, for instance Bouchardeau (1968), Benech *et al.* (1986), Olivry (1986), Naah (1990), and Loth *et al.* (2004). The main river in the area, the Logone River is mainly fed by rain water from the Adamaoua Region, a higher rain fall zone in Cameroon, and from Chad and the Central African Republic. During September and October the peak flow reaches the lower floodplain and, except during exceptionally dry years, the river overflows its banks. Because the area is geographically almost completely flat, the floodwater spreads over a large area into the floodplains. The Logone water splits in the floodplain through a northern (700 m^3/s) axis oriented SE-NW and a southern (1200 m^3/s) axis parallel to the first one (Naah, 1990). The floodplain is heavily flooded when the Logone discharge reaches 1500m^3/s (Benech *et al.*, 1982; Olivry, 1986), so the El Beid River can transfer water from the Logone River to Lake Chad. In 1972 and 1973, the discharge was less than 1500 m^3/s (Olivry, 1986). The flood levels vary between 0.7 and 1m water depth (Naah, 1990).

Hydrological data collected from 1968 to 1978 show that annual fluctuations in flooding play a leading role in the *yaere* hydrology. Local precipitation and the resulting pre-flood in the El Beid River also causes changes in natural resources, such as pasture and water (Loth, 2004).

The Waza Logone floodplain functions as a large natural 'compensation reservoir': the flood level is lowered, and flood flows are distributed more uniformly, over a larger area, thereby channeling large volumes of water into shallow inundations through which flow infiltrates, evaporates and evapo-

transpirates (Naah, 1990). Through this process, pastures can be irrigated, the water table is normalized and suitable habitat is created for fish reproduction and growth. The Waza Logone floodplain can regionally be considered as the most productive in terms of fisheries and non-systematic flood-retreat cropping, but also as an alternative food and water source for livestock and wild animals. After the water recedes, the remaining lakes and waterholes attract fishermen from the surrounding communities (LCBC, 2007).

In the past, two principle seasonal rivers originating from the Mandara Mountains – the Mayo Tshanaga and Mayo Boula – also contributed to the inundation of the Waza Logone floodplain. Nowadays, their entire flow is captured by the Maga dam and their contribution to the flood has been greatly reduced.

After two watercourses, which formed an important connection between the Logone and Logomatya Rivers, were opened in 1994, the hydrological conditions of the floodplain improved. (IUCN, 1994a). Fish production also improved and grazing pastures as well as water availability for both livestock and wildlife were enhanced. The natural vegetation flourished and resident as well as migratory birds arriving from Europe during the winter months were attracted to the floodplains. During a recent flood monitoring survey Westra and Wulf (2005) estimated the average area of the floodplain that becomes flooded at 6,399 km^2.

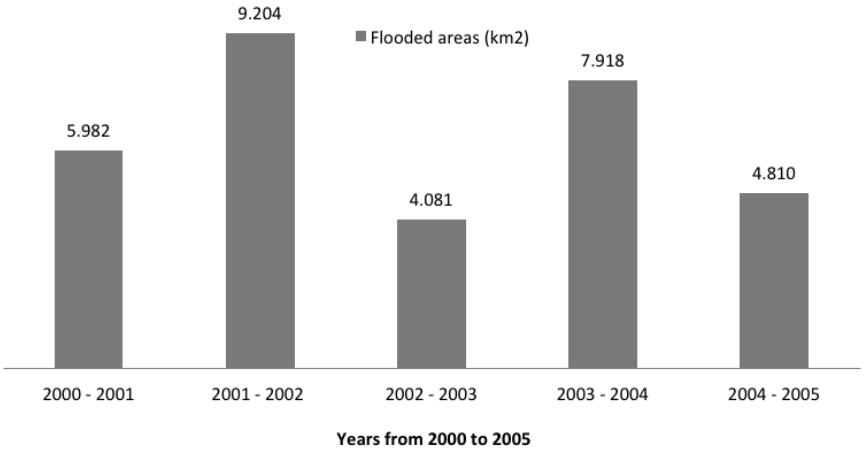


Figure 2.7
Extent of the flooding (km^2) in Waza Logone region (Cameroon and Chad) for different years (Westra-Wulf, 2005)

The annual flooding cycle also greatly influences the vegetation (Scholte *et al.,* 2006).

Naah (1990) investigated the volume of water crossing the Waza Logone floodplain. The contributions of the *mayos* (0.7 km^3/year) and the outflows at Tildé (0.5 km^3/year) appeared to be negligible, while the contributions of precipitation (6.8 km^3/year) and the Logone River (5.3 km^3/year) are globally equilibrated by evaporation (12.3 km^3/year). This evaporated volume is comparable to what was estimated by Gac (1980) over the whole of the Lake Chad Basin (28km^3/year). With a contribution of 44% to the total evaporation, the Waza Logone floodplain is indeed a major source of water in the global balance of Lake Chad (Delclaux *et al.*, 2010).

2.7 Soil

The soils (mostly vertisoils and hydromorphic soils with calcium nodules and slumping) are extremely flat and therefore not susceptible to erosion. Soils are scattered alkaline soils with bands of sandy ferruginous leached soils (LCBC, 2007). Before the construction of dykes and dams the y*aere* collected 850,000 tons of clay, silt and mineral sediment (a 'natural fertilizer') on a yearly basis, from water flowing at more than 1,500 m^3 per second (Benech *et al.,* 1982).

As the soils in the Lake Chad Basin are vulnerable to degradation, large portions of the soils of the conventional Lake Chad Basin have become degraded. Overexploitation and the use of unsustainable harvesting methods, while carrying capacity is limited, in order to meet food requirements has caused this area to be classified now as highly biologically degraded (LCBC, 2007). The widespread erosion and encrustation of allomorphic alkaline soils are clear indicators of this.

2.8 Vegetation

The strong demand for plant based materials such as fuel wood and construction wood, but also livestock fodder, foods and medicines, has strongly reduced the vegetation cover in the Lake Chad Basin (LCBC, 2007). The regeneration of the plant cover is not fast enough to meet exploitation rates, which has severely impacted certain tree species, some of which have gone extinct in this area (LCBC, 2007). Drought also forms a threat for several tree species; numbers of *Terminalia avicennoides, Anogeissus, Leiocarppus, Scleorcarya birrea*, and *Lannea spp* have gone down and, where the water table has dropped, *Acacia nilotica* has become less abundant (LCBC, 2007). On

the leached, ferruginous soils of the south-east, and the isohumid soils of the north trees are also increasingly becoming exposed to these threats.

In the Waza Logone floodplain, grasses include *Eragrotis atroviren*, *Panicum arabaptistrum*, *Hyparhenia rufa*, *Erichloa nubica*, *Vetiveria nigritana*, *Oryza longistamina*, *Pennisetum pedicelatum* and *Sorghum arunditinacum* (IUCN-WLP, 1994b). Pockets of *Echinochloa* are especially important to livestock (Scholte, 2007).

The Waza Logone floodplain has few trees. There are some forested patches or islands with *Balanites aegyptiaca*, *Bauhinia rufescen*s, *Borassus aethiopium*, *Ziziphus mauritiana*, *Calotropis procera*, *Borassus flabeliifer*, *Hyphaene thebaica* and *Acacia seyal* (Adam, 1995; Sighomnou, 2003) and a few domestic species such as *Azachdirachta indica* and *Manguifera indica* (IUCN-WLP, 1994b).

The species-poor perennial grasslands of the floodplain are typical of African seasonally flooded grasslands (Denny 1993). The floodplain contains stands of *Oryza longistaminata* and/or *Echinochloa pyramidalis,* while *Vetiveria nigritana* is more widespread, especially along drainage lines and on higher grounds. Perennial grasses are seldomly encountered on the clay soils above the present flood line, where mostly annual grasses (in particular *Sorghum arundinaceum*) and herbs occur as well as patchy thickets of *Acacia seyal* and *Piliostigma reticulatum* trees (Scholte *et al.,* 2000a).

2.9 Wildlife

The Waza Logone area contains two national parks: The Waza National Park (WNP) and the Kalamaloué National Park (KNP). The Waza National Park (1,600 km^2) has been designated as a Man-and-Biosphere Reserve by UNESCO, and originally retained large numbers of mammals and birds that depend on the annual inundation of the floodplain. The park provides suitable habitat for Elephant *(Loxodonta africana)*, Kob *(Kobus kob)*, Roan antelope *(Hypotragus equinus)*, Tsessebe (*Damaliscus lunatus*), Bohor reedbuck *(Redunca redunca),* Giraffe *(Giraffa camelopardalis)*, Lion *(Panthera leo leo)*, Serval cat (*Felis serval*), Jackal *(Canis aureus* and *Canis adustus),* Hyena *(H. hyaena* and *Crocuta crocuta),* Warthog *(Phacochoerus ethiopicus)*, and three species of primate, in addition to smaller or less abundant species (Scholte *et al.,* 1999; De Iongh *et al.,* 2004; Tchamba & Elkan, 1995). Some 379 bird species have been identified in the park, of which some depend on fish for their alimentation (Scholte *et al.,* 2000b). The Kalamaloué Park is situated in the north of Waza National Park. It covers only 45 km^2 and has become heavily degraded.

3

Waza Logone Floodplain and Fisheries

3.1 Introduction

The sub-Saharan arid zone contains some of the most important inland fisheries in Africa, mainly in seasonally flooded tropical wetlands (FAO, 1995). More than 59% of Cameroon's fresh water resources and 86% of its fresh water area are comprised of floodplains (Emerton, 2005). After the reflooding of the Waza Logone floodplain in 1994 and 1997, the human population increased from approximately 100,000 inhabitants (Scholte *et al.,* 2006; Bauer, 2003) to 145,000 inhabitants (estimation from BURCREP, 2010). Politics have always linked the Cameroonian fisheries sub-sector to the livestock breeding sub-sector, which is also reflected in the name of the ministry that is in charge of these sub-sectors (Ministry of Livestock, Fisheries and Animal Industries). Both sub-sectors contribute significantly to local economics, especially in rural areas. More than 30% of the rural human population has found a means of subsistence in either fishing or livestock husbandry (Mohamadou *et al.,* 2006). The contribution of both these sub-sectors to the Gross Domestic Product (GDP) of Cameroon was estimated at 117.4 billion FCFA for livestock and 65.6 billion FCFA for fisheries in 2001 (MINEPIA, 2002). They account for about 15% of the rural production and constitute a major source of income for nearly 30% of the rural human population.

This chapter summarizes the techniques and tools used for fisheries in the Waza Logone floodplain. It is a first step to evaluate the impact of the fishing efforts and the sustainability of the fisheries in the Waza Logone floodplain.

3.2 Methodology

3.2.1 Rapid Rural Assessment of fisheries in the floodplain

Between March and April 2009 a Rapid Rural Assessment (RRA) was carried out in the Waza Logone floodplain during which socio-economic data on vil-

lages, population, fisheries, community perceptions on the drying out of waterholes and the reduced flow in the Logomatya River was collected (for more details see Chapter 1, General methodology).

3.2.2 Daily survey of selected fishing reservoirs

In order to investigate the dynamics and the complexity of the floodplain fishery status, several known fishing spots were visited on a daily basis. The selection procedure of fishing spots consisted of an initial rapid assessment in the Waza Logone floodplain during the 2008-2009 fishing season, which focused on fisheries, fishermen, fishing materials and fishing methods. Nine fishing spots were selected near/in the river bodies (Logomatya, Lorome Mazera) and in natural waterholes (Table 3.1). The selection procedure considered the geography of the floodplain (see Figure 2.2, Villages and National Park in the Waza Logone floodplain, Chapter 2).

In total, 1781 observation days, with 18 observers, were included in the survey from August 2008 to June 2009. The fishing season was divided into three periods: the flooding period (July to October), the retreat period (November to January) and the dry period (February to April). Anticipating the intensity of the fishing activities, records for some fishing spots began later (November 2008) or ended earlier. Table 3.1 provides the number of recorded observation days for each fishing spot and period.

Table 3.1
Selected fishing spot and period of observation (See GPS locations in Annex 2)

Fishing spot	Observations days		Fishing period	Observations days	
	Number	Percentage		Number	Percentage
Bazi	240	13.48	July-Aug-Sept-Oct	450	25.27
Dagalo	139	7.80	Nov-Dec-Jan.	769	43.18
Kaziré	240	13.48	Feb-March-April	562	31.56
Lahaï	272	15.27			
Malazina	273	15.33			
Moukak	181	10.16			
Sarasara	163	9.15			
Tchouno	92	5.17			
Zina	181	10.16			
Total WLFP	1781	100	Total WLFP	1781	100

Each day, research assistants recorded the number of fishermen, the number of canoes and the type and number of fishing materials used in the fishing spot. The data were grouped in ten-day periods. The first period of the month corresponds to the 1st-10th day of the month (first period of ten days); the second period corresponds to the 11th-20th day (second period of ten days) and the third period corresponds to the 21st-31st (third period of ten days).

3.2.3 Data analysis and statistics

Fisheries data were entered into a Microsoft Excel database and analyzed using statistical software such as SPPS, version 2010. Calculations were directed at fishing spot characteristics and dynamics over time.

3.3 Results

Table 3.2 provides more information on each parameter that was included in the survey. These include type of fishermen, canoe and fishing materials.

Table 3.2
Specification of research parameters

Parameter	Specification
Fisherman	Resident Migrant
Canoe	Wood sheet
	Metal sheet
	Dugout
Gillnet	Measured in yards (1 yd = 0.9144 m) ½, 1, 1.5, 2, 3, 4 inches
Cast net	½, 1, 2, 3, 4 inches
Hook	Sizes 11, 12, 13, 14, 15, 16, 17, 18
Malian trap	No further specification
'Scissor net'	No further specification
'Aring trap'	No further specification
'Touski trap'	No further specification
'Mouman trap'	No further specification

3.3.1 Fisheries in the Waza Logone floodplain

Fisheries in the Waza Logone floodplain are not simply open access but also open exit, meaning that fishermen not only choose between different fishing patterns, they may also choose to enter or to leave the fishery depending on the opportunities it offers in relation to other options, as well as the risks involved in fishing (Van Zwieten *et al.,* 2011).

The floodplain is characterized by fluctuations in fishing water availability which influence the timing of fishing. From September to December, the flooded area could be considered as one large fishing area. People use canoes to move from one village to another. When the water retreats, the remaining, more scattered fishing sources could be divided into several types, as described in the following sections.

River fishing spot

Three main rivers run through the study area: the Logone River, the Logomatya River and the El-beid River (see Figure 2.2 and Figure 3.1). The Lorome Mazera, a short shunt of the Logone River, is less prominent but also provides a fishing resource during a considerable portion of the year.

The Logone River originates from sources in western Central African Republic, northern Cameroon, and southern Chad. It has two major tributaries: the Pende River (Eastern Logone) in the prefecture Ouham-Pende in the Central African Republic and the Mbere River (Western Logone) in the East of Cameroon. The river and its branches are surrounded by numerous large and small swamps (Naah, 1990). The river's total length is about 1,000 km for a basin estimated at 78,000 km^2.

In the eastern part of Cameroon, the Logone River forms a natural geographical boundary between Cameroon and Chad. Its main tributary in the floodplain is the Logomatya, which becomes almost completely dry during the dry season.

The Logomatya River is strongly linked to the SEMRY rice scheme. Before the construction of the Maga dam, it collected water from the Mayo Vrick. After the dam was built, the flow of the Mayo Vrick was blocked and regulated during the dry season. The water flow in the Logomatya was maintained through water from Lake Maga. The Mayo Vrick provides the main reservoir for discharging water in case Lake Maga overflows. Residual water from cultivation is drained into the Logomatya (with a peak between January and May). The collected water is rich in fish stock, which makes the Logomatya River an attractive spot for fishing during the dry season. To control this important fishing spot year round, the Zilim Dyke was built in 1985. Picture 3.1 (from Google Earth, taken on 22 December 2005) shows the Maga Lake and its dam

(in blue), with the Mayo Vrick on the left and the Logone River on the right. Between the Mayo Vrick and the Logone River, the SEMRY rice production scheme is visible (black and green area in square). On the Guirvidig side the rice fields are visible.

Picture 3.1
Hydraulic relation between the Logomatya River and the SEMRY rice production scheme (22 December 2005, downloaded from Google Earth on 12 July 2011)

The El-beid is another small river that connects the floodplain to Lake Chad during periods of high flooding. It dries out during the dry season (Figure 2.2).

Natural waterholes

A number of natural waterholes are present throughout the floodplain, some of which contain water until the end of the dry season. These waterholes are also sometimes used for fishing. Table 3.3 provides an overview of the main natural waterholes present in the area.

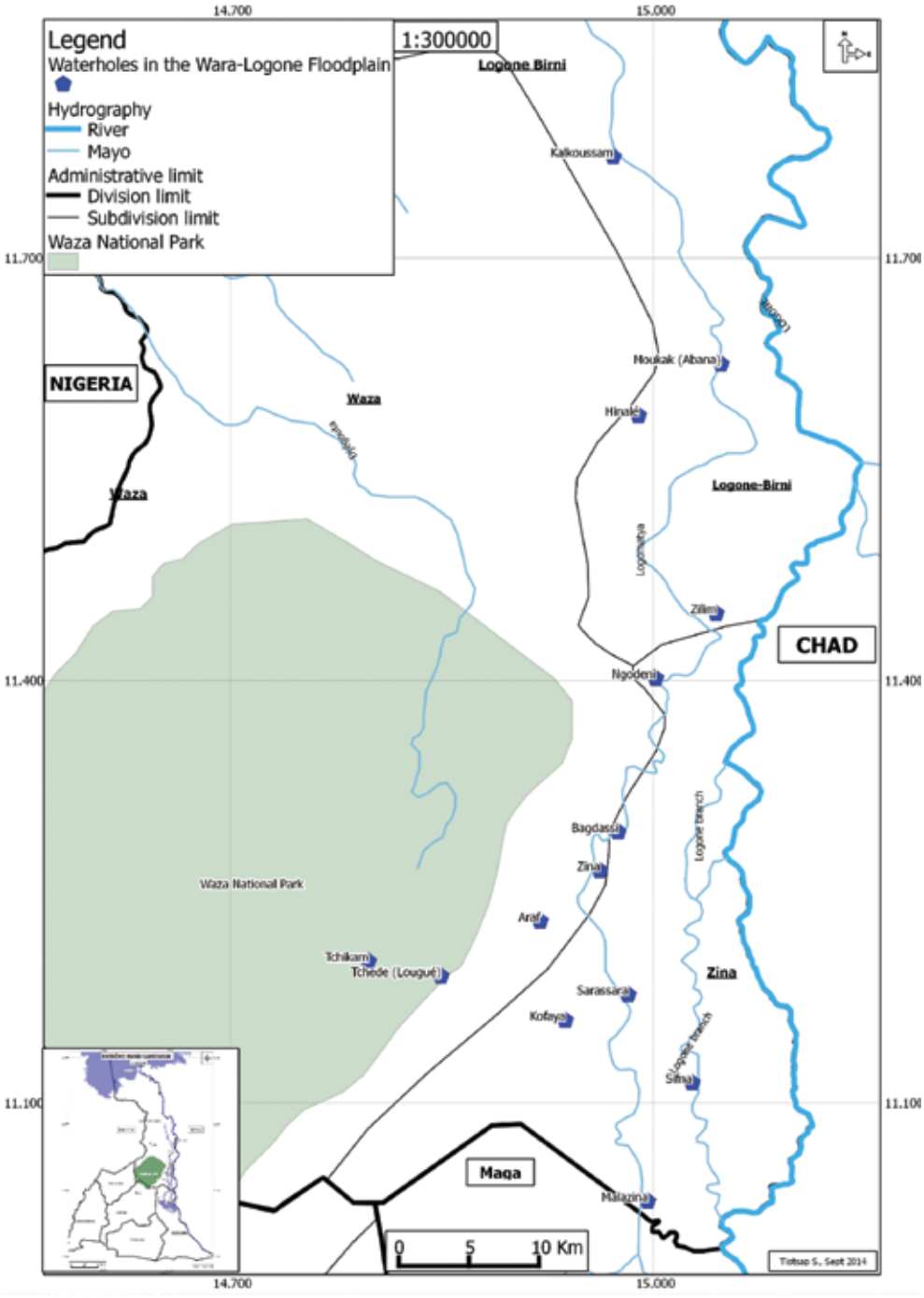


Figure 3.1
Situation of waterholes in villages in the Waza Logone floodplain (NIC and field data)

Man-made waterholes for cattle

Several waterholes have been constructed specifically to provide livestock with a source of water during the dry season (Table 3.4). These waterholes are situated at between 2 and 5 km from the park perimeter and are visited by both resident and transhumant pastoralists. In addition to these waterholes, there are a number of others in the south of the park, which become flooded during the wet season. All of these man-made waterholes are also used for fishing.

Man-made waterholes for wildlife

In the eastern part of the Waza National Park there are a number of waterholes that have been constructed to provide water for wildlife when natural water sources become scarce (Table 3.3). Despite the fact that human activities are prohibited inside the park, fishermen and poachers from adjacent villages have often been observed to use the waterholes for illegal activities. Groups as large as 40 people capture fish in some of the waterholes, or use them for drinking water while staying in small poaching camps close to the waterholes, sometimes for several days.

3.3.2 Fishermen in the Waza Logone floodplain

For the present study, fishermen have been categorized into two groups: resident fishermen and migrant fishermen. Resident fishermen live near their fishing waters, while migrant fishermen have to travel to get to their fishing waters. The latter group brings their family along (sometimes even very small children and elderly) to stay near the fishing spots for a certain amount of time.

Results show that an average of 5.3 resident fishermen (RF) and 9.75 migrant fishermen (MF) visit a certain fishing spot (2008-2009 fishing season). In most fishing spots, with the exception of Moukak, migrant fishermen outnumbered resident fishermen (Figure 3.2). The total number of fishermen observed on the fishing spots at Bazi, Kazire, Moukak and Zina is more than 10 per day. The fishing pressure in Moukak is very high because it has water all year round and therefore a high productivity.

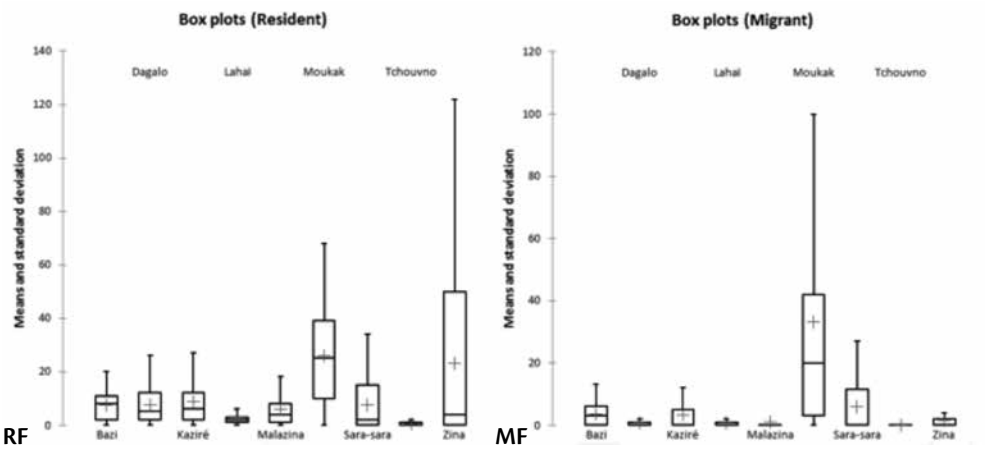


Figure 3.2
Mean number of resident fishermen (RF) and migrant fishermen (MF) per selected fishing spot (2008-2009 fishing season).

Figure 3.3 displays the linear distribution of the number of fishermen during the fishing season.

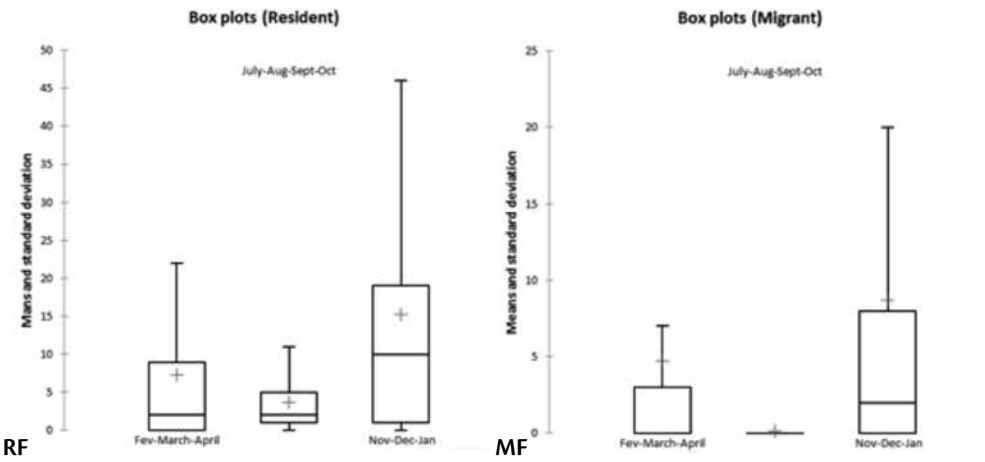


Figure 3.3
Mean number of active fishers (RF and MF) during the 2008-2009 fishing season)

The increase in number of fishermen during December is related to the retreat of water from the floodplain. Water becomes more patchily available and fishermen are more dependent on fishing spots.During the inundation period (July-October), fish are available throughout the floodplain, which is reflected in the low numbers of fishermen visiting the nine surveyed fishing spots.

3.3.3 Fishing canoes

Three types of canoes are used for fishing in the Waza Logone floodplain: wooden sheet canoes, metal sheet canoes and wooden dug out canoes. Wooden dug out canoes are traditional canoes made by local craftsmen. These canoes are carved and usually burnt out from a single tree trunk. They represented 24.8% of the total number of canoes in use during the 2008-2009 fishing season. The majority of canoes used are metal sheet canoes (63.04%). They are the preferred type of canoe throughout the Waza Logone floodplain and are cheaper than the wooden sheet type (27,000 FCFA vs 76,000 FCFA respectively). Metal sheet canoes are made using a second-hand metal sheet.

3.3.4 Fishing materials

Nine main fishing gears are used in the Waza Logone floodplain. Which type of gear is used for fishing, largely depends on the characteristics of the fishing spot and the time of year.

Gillnets

Gillnets have several mesh sizes. The smaller the mesh of the gillnet, the higher the capacity of the catch; i.e. smaller meshed nets also capture small fish species and juveniles. Consistent use of small meshed nets will eventually compromise the viability of the present fish populations.

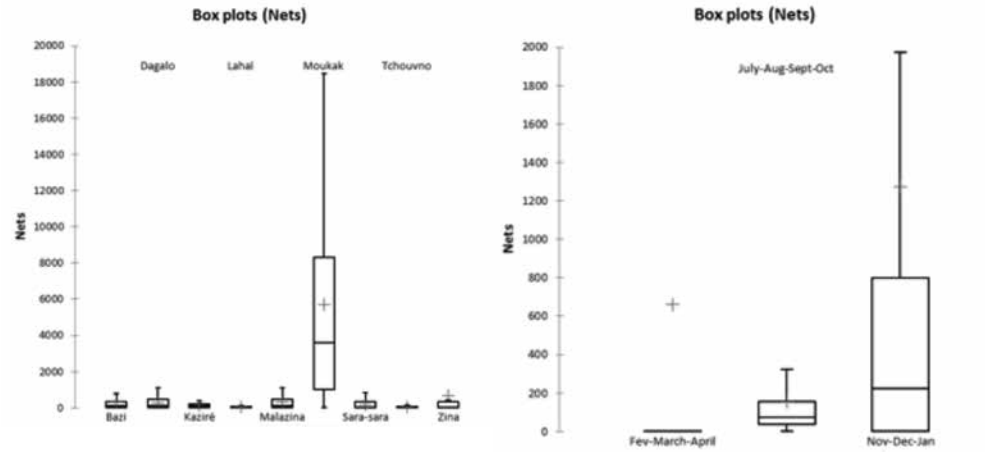


Figure 3.4
Importance of gillnets per fishing spots and fishing period in the study area (2008-2009 fishing season)

The use of differently sized gillnets varied greatly among the surveyed fishing spots (Figure 3.4). In the Moukak fishing spot, the total number of gillnets used is much higher than in other fishing spots, as is the number of small meshed gillnets (5708±6055). At this fishing spot, gillnets are mostly used during the retreat period.

Beach seine

The beach seine is a fishing net that is often used in community fishing. It is a big net with floaters and is used to pull fish from the waterbed to the banks (the beach). A beach seine is a seine net operated from the shore. It consists of a bunt (bag or loose netting) and long 'flaps' which are often lengthened with ropes for towing the seine to the beach. The head rope with floaters remains on the surface, while the foot rope is in permanent contact with the bottom, thus forming a barrier that prevents the fish from escaping from the area enclosed by the net. It is operated by a large group of fishers – sometimes more than a hundred – depending on the length of the beach seine and the predicted size of the catch. This type of net is mainly used when the water level is low.

Picture 3.2
Fishermen employing a beach seine in Zina

In the Waza Logone floodplain, the beach seine is used from December until June (dry season). The total number of beach seines used by fishermen changes over time and varies per surveyed fishing spot (Table 3.4). The mean number of beach seines used per day is 0.12±0.45. The highest number of beach seines was used in Kazire fishing spot (0.29±0.86). No beach seines were used at Moukak fishing spot. Beach seines are mostly used during the dry season (0.26±0.67), with a peak in March, when the water level in the Logomatya River is at its lowest and the water coming from the SEMRY rice scheme is not enough to fill the river.

Table 3.3
Mean number of beach seines used per fishing spot and fishing period (2008-2009 fishing season)

Fishing spot	Means and Sd	Fishing period	Means and Sd
Bazi	0.23±0.48	Feb-April	0.26±0.67
Dagalo	0.029±0.16	July-Oct	0
Kazire	0.29±0.86	Nov-Jan	0.09±0.35
Lahai	0.01±0.12		
Malazina	0.03±0.23		
Moukak			
Sara-sara	0.21±0.5		
Tchouvno	0.01±0.14		
Zina	0.22±0.51		
Total WLFP	**0.12±0.45**	**Total WLFP**	**0.12±0.45**

Fishing hooks

Fish hooks can be defined as devices for catching fish either by hooking them in the mouth or, more rarely, by snagging the body of the fish. There are no international standards for hook sizes, but in general each size has a number, corresponding to a relative size, with size 1 hooks in the middle of the size range. Smaller sizes are indicated by larger whole numbers and larger sizes by increasing whole numbers followed by a slash and a zero. In the study area, size '11' fishing hook is most commonly used, followed by hook size '16' (Table 3.2). While some fishing hooks tend to be used more in November and December, there are some that are used more in March. Fishermen appeared to rarely use bait. Fish hooks are normally attached to a long line which is then traversed over the river, with one fisherman on each bank to hold it.

Cast net

Another type of net that is frequently used in the floodplain is the cast net. The particular type used is a circular net with small weights distributed around its edge. It is thrown by hand in such a manner that it spreads out on the water and sinks. The fisherman can throw it standing in a canoe (Picture 3.3) or simply while standing in the water. Fish are caught in the net when the edges gradually close, as it is hauled back in.

Picture 3.3
Fisherman throwing a cast net in the Logomatya River

Several types of castnets with variable mesh size are used at the surveyed fishing spots. The number of cast nets with the smallest mesh size (½ inch) is highest in Bazi (Figure 3.5) indicating the pressure on the fish populations at this fishing spot is particularly high. Cast nets with a relatively small mesh size are also intensively used in the fishing spots at Bazi, Kazire and Sarasara (Figure 3.5).

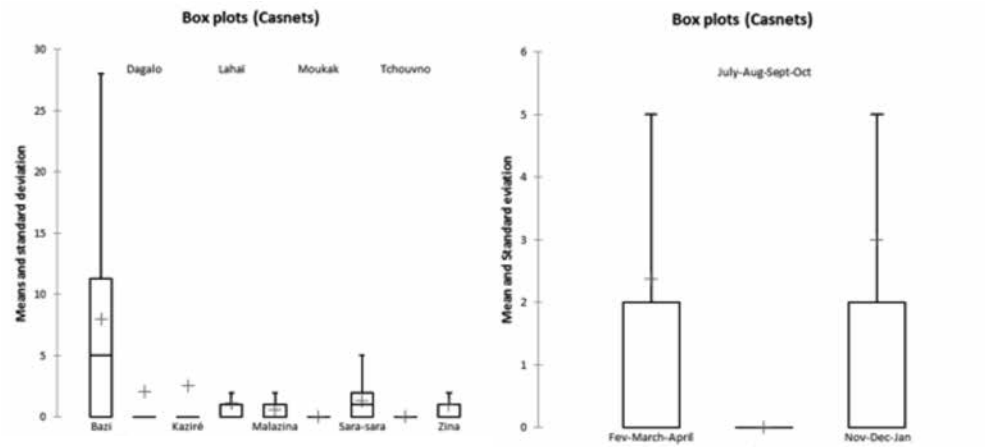


Figure 3.5
Means of cast nets used per day per fishing spot and fishing period (2008-2009 fishing season)

Cast nets were used most frequently in December 2008, January 2009 (end retreat period) and February 2009 (beginning of the dry season).

Scissor nets

The 'scissor net' is a large net held together by two pieces of wood in the shape of a 'V'. It is launched into the water and then gradually raised. The fish are retained in the mesh that forms a bag under the influence of gravity. Picture 3.4 shows a fisherman arranging his scissor net on the bank of the Logomatya.

Picture 3.4
Fisherman with a scissor net in the Logomatya River

Fishing traps

The most common fishing trap used in the study area is the *Malian trap*. The Malian trap is a kind of basket of 1.2 m high and 0.75 m at the base, made from flexible wood and nets. Three or four open gaps at the base allow the fish to enter, attracted by a bait of fried rice bran. The small mesh size of the net (1/2 inch to 1 inch at most) prevents the fish from escaping. Since 1990, the traditional basket nets have been abandoned and replaced by these Malian traps. Picture 3.5 shows a fisherman braiding a Malian trap (3.5a) and a Malian trap with captured fish inside (3.5b).

Picture 3.5a
Malian trap

Picture 3.5b
Malian trap with catch

The *Malian trap* is an effective tool; it is light, modular and it proves to be productive. Their design (dimensions, materials, mesh, and bait) and the skills of the fisherman in setting the traps do however influence their effectiveness. Fishermen at the surveyed sites have been observed to manage more than one hundred *Malian traps* arranged in lines at the same time. A Malian trap is set for several days. The fisherman re-installs the trap in the waterhole as soon as the catch has been removed.

Malian traps are used most frequently in Moukak and Zina fishing spot (Figure 3.6). During the fishing season, *Malian traps* were used most frequently from November 2008 to January 2009 (Figure 3.6) which is consistent with the fact that these traps are mostly used for catching migrating fish.

Fish migrating to the floodplain were in the most advanced stages of sexual maturity for spawning in October 2008. Regardless of any brooding fish that might be caught or the potential damage to fish reproduction, the use of Malian traps reaches a peak during this period, suggesting that the viability of the fish populations is not taken into account by fishermen when choosing their gear or timing their catching season.

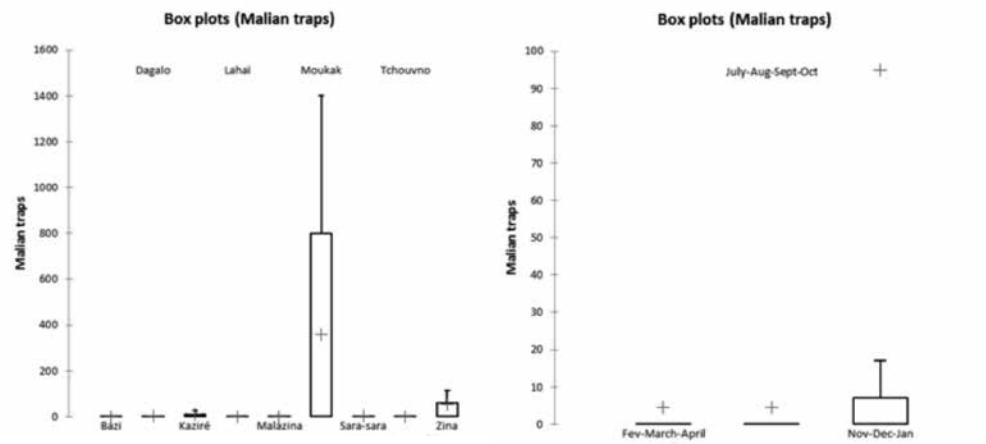


Figure 3.6
Daily use of Malian traps in the selected spots and per period (2008-2009 fishing season)

Moumam traps

The *Mouman trap* is a kind of fence that is placed in shallow water in such a way that the ends of the fence meet, while still allowing for a small entrance (Picture 3.6). After putting bait inside, the trap is gradually filled (a process of several hours) with a variety of fish. Especially at the Moukak fishing spot this type of trap is used frequently.

Picture 3.6
Mouman traps in the Logomatya River

Aring trap

An Aring trap is a plunge basket, mostly used by women and children (Picture 3.7). The basket is held by the top and plunged into shallow water. Trapped fish can be taken out by hand through a small opening in the top. Similar to the Malian traps, the Mouman and Aring traps were used most frequently between November 2008 to December 2009 to catch migrant fish during the retreat of the water from the floodplains.

Funnel nets

Funnel nets are specifically used to capture fish in channels. This net is also used to catch fish during the retreat of the water. The fishing method using funnel nets is described in more detail in Chapter 5.

Although some of the nets discussed here are used in relatively small numbers, their mere presence in the array of nets used in the Waza Logone floodplain is an indication of the complexity of fishing techniques used in this area.

Picture 3.7
Women using the Aring trap in the Logomatya River

3.3.5 Fishing methods

The fishing methods used in the Waza Logone floodplain aim to maximize the catches. Factors such as the biology of the fish species and the hydrology of the floodplain are secondary to factors that maximize the catch, such as type of fishing material, the period of fishing, the cost of the nets and the bait that is used.

Sometimes fishing methods don't need to be advanced to be effective. I noticed a simple fishing method which involves only a single fishing gear that is used in either the river bed or the floodplain, whichever provides the best chances for a good catch.

Other fishing methods consist of a more complex combination of several materials and strategies in order to optimize catches. Among these more complex techniques are the use of fishing channels, fishing grasses and fishing wells with barriers to drain fish into the traps, or the use of multiple barriers in river beds, in conjunction with Malian traps.

I also observed some specific methods that are used during the retreat of the water. These include a combination of a fence and a hole dug in the soil. The fence forms a barrier in the waterway and guides the fish to a well with smooth borders (Picture 3.8).

Picture 3.8
Fence and small hole used for capturing fish around the Tchikam waterhole

3.4 Discussion

Compared to other livelihood forms in the Waza Logone floodplain, such as agriculture and livestock husbandry, fishery is regarded as the most important.

Fishers often take their families along when they migrate along the floodplain. They are often found at completely different parts of the floodplain, within only a few weeks. The case of Moukak (Abana) deserves a special note, especially in terms of the strongly rising human pressure on both the fishing resources and the surrounding ecosystem. This is partly due to a significant increase in the population of the village during the fishing season. People are attracted to the area around Moukak, situated in the North West of the floodplain, because they recognize it as a productive area in terms of fish production. Moreover, water retreats later compared to other areas in the floodplain. Because of the abundant water sources available and the suitable grazing grounds nearby, large numbers of pastoralists lead their livestock through this area at the end of each dry season.

Except perhaps in Lake Victoria, Uganda (Beuving, 2010), where young people are migrating to rural villages to seek jobs, people do not normally migrate to rural areas in great numbers. In that sense, the Waza Logone floodplain is not an exception, where the potential of conflict might also discourage settlers.

In other types of inland water, the complexity of the gear is positively related to the diversity of social practices, with at least three major groups of fishermen or fishermen-farmers who invest their time in different ways, during various seasons (Welcomme, 1999). In these cases, Welcomme (1999) distinguished between professional fishermen who depend completely on the fishery, part-time fishermen who switch between fishery and some other activities seasonally, and occasional fishermen who participate in fisheries only on an irregular or casual basis. This strict classification cannot be applied to the Waza Logone floodplain, as most people are both fisherman and farmer. The extent to which they are involved in one activity versus the other differs, often depending on the expected production from e.g. rice cultivation. Young people become oriented towards farming, while fishing is an activity for rich people who own channels, or poor people who have no other options open to them. In general, fishing is considered as an activity for the poorest of the poor in the Lake Chad Basin, with the exception of some rich fishermen using fishing channels (also refer to Bene *et al.,* 2003b).

In many tropical small water bodies, the intensification of fishing practices is regarded as a potential opportunity to create a new export market with obvious economic benefits (Beuving, 2010). A multitude of local business opportunities grows as a result of the income generated by the fishery, as is also

the case in Lake Victoria, Uganda (Geheb *et al.,* 2008). The case of the Waza Logone Floodplain does not comply with these observed innovative developments in other regions. In the Waza Logone floodplain, the fishing equipment is still traditional, labor is generally still manual, and the processing consists of traditional drying and smoking. Markets created from fisheries in the Far North of Cameroon have remained stable over the past decades, or at least did not follow the sharp intensification of fish resources which did become evident. This is in sharp contract with e.g. the situation around Lake Victoria, in Kenya and Uganda. In the Nile perch fisheries there, successful careers seem to be determined primarily by access to capital (Geheb *et al.,* 2008; Beuving, 2010). Boats and equipment are expensive around Lake Victoria, and new businesses are not easily financed. A small minority of fishermen who are successful in the Nile perch business know how to acquire external financial resources, whereas the great majority lacks the financial basis to become part of this expanding business (Beuving 2010).

Unlike the specialized Nile perch fishing industry in e.g. Lake Victoria, the Waza Logone floodplain is characterized by the combined use of several types of fishing gear. Between 1965 and 1970 there was a gradual change in fishing materials. Traditional fishing practices were replaced with the introduction of nylon nets and the spectacular extension of the number of gillnets (Durant, 1980). Fishermen created new techniques and elaborated on existing techniques, designed to catch more fish. Despite efforts by government to regulate the increased pressure on fish resources, there is little respect for laws or administrative decisions that prohibit the use of materials such as *Malian traps* or nets with small mesh size. The relatively intensive use of cast nets of ½ inch in the fishing spots of Bazi and Kazire imply that fishermen at these fishing spots aim at smaller and younger fish during the catch season. The excessive catch of juvenile fish can be detrimental to the fish stocks (Durant, 1980). The traditional ideas about fisheries management: using minimum mesh sizes, but avoiding fishing on juveniles, is gradually shifting towards using the fish community proportional to its productivity. That means it is possible to harvest juveniles, because juveniles already experience the highest natural mortality. In traditional, low-tech, open-access-easy-exit fisheries with a plethora of gears, the fishery is more or less unselective and proportional to the productivity (Jul-Larsen *et al.,* 2003).

The intensified use of beach seines at the end of the dry season, strongly depletes the remaining breeding stock. The fishing channel practice is used in the same way, during short periods when the water retreats to the river. Fish migrate from the floodplain to the river or to the *mare* to reproduce and are caught when passing through the channels. This practice will be discussed further in Chapter 5.

Even in the waterholes inside the Waza National Park, the fishing effort is oriented towards short term catches and short term gain, while the impact on breeding stock is not taken into account.

Using gear for fishing is by definition selective (Garcia & Csirke, 1989). Fishermen have traditionally developed techniques to increase their catch, but also to select certain species and specific components of fish populations, at different times of the year and in selected areas. In the Waza Logone floodplain, selective fishing is linked to the seasonal hydrology of the floodplain. During flooding, fishing gear is used in certain fishing spots to catch *Alestes spp*. and in waterholes, *Protopterus sp*. is targeted. As noted by Fulton and Smith (2011), the form of fishing used (i.e., the fishing patterns across fish sizes and species) was far more important for fishermen than the type of ecosystem that was fished. However, if fishing was broadly distributed across many species and if fish of all sizes were caught, the yield curve increased linearly with the exploitation rates to high levels. Nevertheless, with this strategy the yields could collapse suddenly (Fulton & Smith, 2011). The issue of selectivity of fishing gear and the practice of its regulation is a complicated issue, which needs tailor made approaches.

Fisheries in inland waters are often extremely complex in terms of both gear and strategies used. Welcomme (1999) distinguished between two main types of fisheries: those that employ only one type of gear, usually gillnets, and those that target a range of fish species in their different life stages through a diversity of static and active gear, which are often deployed seasonally. The Waza Logone fishery belongs to the second category. The variation in fishing systems varies in space and in time. The particularities of these fisheries include man-made waterholes and fishing channels. Many of the waterholes are dug in order to maintain water for livestock grazing outside the Waza National Park and for wildlife inside the Park during the dry season.

In general, each waterhole 'belongs' to a (group of) resident fishers. Migrant fishermen need to get permission from the owner to use a certain waterhole. Waterholes inside the park, are illegally visited by people coming from surrounding villages. Fishers (who often also poach wildlife as a food source) organize themselves in groups and plan their expeditions into the park together as to avoid park guards and poaching patrols. I also observed that they use boats made of reeds when the water is too high and they organize intelligence systems to detect the arrival of the park rangers. The diminished fish stock available to fishing birds (e.g. black-headed heron *Ardea melanocephala*, marabou stork *Leptoptilos crumenifer* and African fish eagle *Haliaeetus vocifer*) as a result of fishing activities inside the park only adds to the human-induced degradation of the park and its resources.

3.5 Conclusion

Fishing in the Waza Logone floodplain is organized as an open access system and people come from several villages to fish. Fishing spots are shared between newcomers (often migrant fishermen) and resident fishermen.

Fishing occurs all year round, but not always at the same intensity. In the flooding period, the Waza Logone represents a unique fishing system: the floodplains transform into a big lake with the villages situated in the non-flooded areas and the higher river banks looking like small islands.

My daily surveys showed that fishermen are very mobile in the floodplain, using different types of canoes and navigating to productive fishing grounds based on their experience. Fishing strategies are generally complex in terms of fishing materials used and the fishing methods adopted by fishermen. This complexity can affect fish yield, fish stocks and can be a source of conflict.

4

Fish Production Patterns in the Waza Logone Floodplain

4.1 Introduction

Cameroon inland waters provide around 180,000 tons of fish annually, of which 75,000 tons is caught by artisanal fishing (Mohammadou *et al.,* 2006). Production is not sufficient to meet the national needs, which are estimated at 298,000 tons per annum (17.9 kg/year/capita). Consequently, Cameroon has to import over 128,000 tons of fish each year to meet the demand. Despite its shortcomings, the Cameroonian fisheries sector does have potential for development. Baybley (1988) investigated 59 tropical fisheries and found that fishing effort is the major determinant of yield.

Originally, fishing efforts in most African lakes were low due to the low number of fishermen, poor fishing crafts, inefficient traditional fishing gear and limited markets (Ogutu-Ohwayo & Balirwa, 2004). The dense hydrogeographical network of some African countries offers possibilities of exploitation of the water levels. It has a total surface area of more than 4 million hectares and is rich in fish of varied species. Fishbase lists a maximum of 566 freshwater fish species for Cameroon (www.fishbase.org).

Despite the richness in fish, local people complain about the declining catches in the Waza Logone floodplain (Molenaar & Van Santen, 2006), which is mostly related to an increase in catch efforts and the impact of the Maga dam (Loth, 2004).

Fishing practices in African countries are generally not science-based. There is insufficient information on the level at which the countless water bodies in Africa are exploited, and whenever data are available, the quality is poor or not used effectively (Mosekele & Kolding, 2003; Neiland & Bene, 2003). In the Benoué River (which flows through the North Province of Cameroon into Nigeria), a marked change in species composition of fisheries has been observed (Neiland *et al.,* 1990). The main parameters determining this change were consumer demand and fishing intensity.

Generalizing the capture of fishery production per water surface area is difficult, because data on exploitation as well as data on water surface area are lacking in many countries. Productive reservoir fisheries, which have been developed in small reservoirs in Africa, produce annual yields of up to 329 kg/ha. To put this into perspective: similar small reservoirs in Latin America and the Caribbean have annual yields of up to 125 kg/ha, whereas they could reach 650 kg/ha in Asia (FAO, 2002). Figures on annual yields further show an average yield of 125 kg/ha/year for reservoirs in Cuba, 29-75 kg/ha/year for reservoirs in the Dominican Republic, 2.1-11.5 kg/ha/year for reservoirs in Brazil, and 4.8-63.2 kg/ha/year for reservoirs in Panama. Van Zwieten *et al.,* 2011 estimated productivity of all Indian reservoirs to range from 11 to 46 kg/ha/year (e.g. Lake Nasser produces an estimated 36.4 kg/ha/year). This is considered to be extremely low, especially compared to the productivity of e.g. Lake Volta (294 kg/ha/year).

Jackson and Marmulla (2001) suggest that large, slow-flowing tropical rivers may provide an average yield of 30-100 kg/ha/year, while in floodplains fish production averages 200-2,000 kg/ha/year. Large reservoirs, subject to moderate to heavy fishing pressure, could produce yields ranging from 27 to 65 kg/ha/year. For medium-sized African reservoirs, the estimated mean yield was 80 kg/ha/year, and for a variety of sub-Saharan small water bodies it was 329 kg/ha/year.

So far, no in-depth studies on fish stocks and fish production have been conducted in the Waza Logone floodplain. Information on the trends of biological resources that can support effective resource use planning in the Waza Logone floodplain is also largely lacking (Mvondo, 2003). The only reliable estimate on fish stocks in the Waza Logone floodplain dates back to the mid 1990's. Bobo and Beladan (1997) calculated fish stocks in the floodplain at 6,190,500 kg, with a remaining stock of 63,800 kg after the retreat of the water in the mares and other water points (Bobo *et al.,* 1996).

In Lake Chad, fish populations have suffered a recent decline due to drought, overfishing, diversion or blockage of stream flows, and increased juvenile catch due to the use of smaller mesh (LCBC, 2007). The most common fish species in Lake Chad is *Alestes baremoze* and the Nile perch (*Lates niloticus*). According to LCBC (2007), *Alestes sp* populations have declined dramatically, whereas the size of *Lates sp* caught has decreased substantially; they seldom exceed 5-8 kg in weight, compared to past weights of over 10 kg. This reduced size of the fish caught could be an indication of overexploitation. However, the threshold at which a population will still be able to recover is a sensitive one and differs greatly among species and locations. Besides, a 'normal' level of exploitation will also naturally lead to a decrease in stock and size

of individual fish, because fisheries are selective. The term 'overexploitation' therefore needs to be carefully defined (see also paragraph 1.3.2).

Research demonstrated that floodplains are the major driving force for the maintenance of fish biodiversity and fish reproduction in river ecosystems (Junk et *al.,* 1989; Tockner *et al.,* 2000). Despite the presence of relatively large and undisturbed floodplains in tropical Africa (e.g. the Okavango floodplain in Botswana, which is the world's largest inland delta with 15,000 km^2), most floodplain fisheries have shown declines in fish production or have completely collapsed during recent decades (Barley, 1995; Nilsson *et al.,* 2005). The Waza Logone floodplain is a complex of many natural dry season lakes or 'mares' which are flooded each year. Several species of fish are found here, which are considered to be important for the overall fisheries production; these species depend on the seasonal floods for reproduction and the dispersal of juveniles. *Alestes spp*., *Labeo spp*. and *Distichodus spp*. are migratory fish, requiring the flooding and floodplains in order to grow and reproduce successfully. Reports from the IUCN-Waza Logone Project (IUCN, 1994a; IUCN, 1994b) acknowledge that the Waza Logone floodplain constitutes a highly productive breeding ground for fish, which are harvested intensively each year. During a socio-economic survey in 1994, fishermen indicated that *Petrocephalus spp, Tilapia spp, Clarias spp, Barbus spp, Synodontis spp, Hydrocyon spp*, and *Alestes dentex* are the most caught species (IUCN-WLP, 1994). Whereas selective fishing methods are generally on the increase throughout the Waza Logone floodplain, the increase in the number of fishing channels and some other innovations in the traditional methods during the past decade (Delclaux *et al.,* 2010) are particularly noteworthy.

This chapter presents the results of (i) an inventory of harvestable fish species and their diversity, (ii) an evaluation of the fish production and the exploitation and (iii) an analysis of the biological parameters of the main fish species.

4.2 Methodology

4.2.1 Study area

As the study area remains the same throughout all chapters, one can refer to Chapter 2 where the study area is broaly described.

4.2.2 Fishing effort and fish catches

The main fisheries in the Waza Logone floodplain were identified with a Rapid Rural Assessment (see Chapter 2 for general methodology). In total, 29

fishing spots were selected in 13 villages (N = 91 villages). The location of the villages within the Waza Logone floodplain is shown in Figure 2.2 and their GPS locations are presented in Annex 2.

From August 2008 to June 2009, catches were recorded from nine fishing channels along the Logomatya River and from community fishing in waterholes. Fishing channels were selected by categorizing the total number of channels counted (see also section 5.2.1 and Table 5.3) into three equally sized samples or components; the upper component (most North), the middle component (central), and the lower component (most South). In each component, one small channel (< 1000 m), one medium channel (1000 m-3000 m) and one large channel (> 3000m) was selected. In addition to the channels along the Logomataya River, I selected one small, one medium and one large channel near the Abana waterhole.

For the daily surveys, catches were divided by the number of fishermen, assuming that the number of gear per fisher is more or less similar (see also Van Oostenbrugge *et al.*, 2002). I calculated Catch Per Unit of Effort (CPUE; the mean of catches per fisherman per day) for each sampling site.

4.2.3 Biological parameters

As part of the research on biological parameters, an experimental fishing study was developed in both natural and artificial waterholes and rivers (Logomatya and Lorome). During August 2008 to June 2009 per experimental study site Standard Length (in cm), Body Weight (in grams), sex (male or female, based on gonads) and sexual maturity (immature, moderate reproductive status and active reproductive status) were recorded. In addition, condition factor K was calculated, based on Standard Length and Body Weight.

The condition factor (K factor) provides an indicative value for fitness and can be calculated according to the following formula (Nash *et al.,* 2006):

$$K = Wx100/L^3 \qquad \frac{W = \text{fish weight in grams}}{L = \text{Standard body length in cm}}$$

To evaluate the effects of the river system (four levels: natural waterhole, artificial waterhole, Logomatya river bed and Lorome river bed), period (July to October; November to January and February to June) and species identity (i.e. its genus) on body weight, standard length and K, I first evaluated the distribution of genera over space and time. It turns out that not all genera were present at each location and/or in each period. Therefore, I evaluated the genera preferences for specific river systems and the preference of specific genera for specific time periods with two Chi square tests. Subsequently, I se-

lected all genera present in both systems and across all periods and ran a Linear Mixed Effect analysis (LME) to determine the effects of genus, river system and period, as well as their interactions with body weight, standard length and K, respectively. Differences among genera were analyzed with a Tukey's post hoc test. Data were log-normally transformed when considered essential for obtaining a normal distribution and a homogeneous variance.

As a control analysis, to evaluate for biases introduced by the dataset selection, I ran LMEs with the complete dataset for each factor individually. None of the main effects deviated strongly for those presented for the subset.

4.3 Results

4.3.1 Catch composition, productivity and fishing effort

Table 4.1 presents the full list of selected fishing spots and villages.

Table 4.1
Distribution of data collected among villages and fishing spots (during August 2008-June 2009)

Villages and fishing spots	Total number of fishing days recorded	Number fishermen recorded	Total catches (kg)
Araf	**6**	**126**	**543**
Artificial waterhole	6	126	543
Avaï lahaï	**30**	**159**	**1,155**
Lorome Mazera Community fishing	5	131	1,104
Lorome Mazera River	25	28	51
Bazi	**124**	**291**	**4,526**
Lorome Mazera River 1	58	143	1,653
Lorome Mazera Community fishing	1	60	2,700
Lorome Mazera River 2	65	88	173
Dagalo	**34**	**264**	**15,685**
Logomatya community fishing	11	230	15,630
Logomatya River	23	34	55
Kazire	**83**	**196**	**1,561**
Lorome Mazera River 1	35	88	549
Lorome Mazera Community fishing	1	38	864
Lorome Mazera River 2	47	70	149

Villages and fishing spots	Total number of fishing days recorded	Number fishermen recorded	Total catch (kg)
Lahaï	**22**	**25**	**62**
Lorome Mazera River	22	25	62
Malazina	**85**	**344**	**2,912**
Logomatya River 1	39	69	157
Logomatya community fishing	6	214	2,687
Logomatya River 2	40	61	68
Moukak	**46**	**389**	**2,901**
Natural waterhole (Abana)	19	99	377
Fishing channels	27	290	2,523
Sarasara	**31**	**69**	**1,442**
Logomatya River	27	52	579
Fishing channels	4	17	863
Tchede	**4**	**66**	**1,727**
Artificial waterhole (Lougue)	4	66	1,727
Tchouvno	**14**	**328**	**334**
Fishing channels	6	150	117
Natural waterhole	8	178	216
Zilim	**11**	**406**	**22,934**
Fishing channels	8	87	5,627
Logomatya community fishing	3	319	17,306
Zina	**88**	**333**	**7,079**
Logomatya River	77	161	786
Fishing channels	8	30	1,052
Logomatya community fishing – Abana	1	30	492
Logomatya community fishing – Dabanga	1	65	1,450
Logomatya community fishing – Sadga	1	47	3,299
Total	**578**	**2996**	**62,860**

During weekly surveys of 29 permanent fishing spots, a total of 578 fishing days were recorded between August 2008 and June 2009.The total catches comprised of 62.86 tons of fresh fish.

Seventy-seven fish species were recorded in the catches in the Waza Logone floodplain. A total of 15 species were identified to contribute to 91.04% of the catches. These species belong to seven families and 12 genera.

The full list of fish species that were found during the survey is presented in Annex 3. Table 4.2 provides the catch composition in terms of the main species. They are grouped by family and genus.

Table 4.2
Main fish species in the Waza Logone floodplain as a % of total weight of the catches (62,860 kg)

Family	Genera	Species	Percentage of total weight in catches
Clariidae *(63.02%)*	Clarias *(56.16%)*	*Clarias gariepinus*	28.80
		Clarias anguillaris	24.37
		Clarias albopuntatus	2.99
	Heterotis	*Heterotis niloticus*	3.47
	Heterobranchus	*Heterobranchus bidorsalis*	3.39
Cichlidae *(13.36%)*	Sarotherodon	*Sarotherodon sp*	9.16
	Oreochromis *(4.2%)*	*Oreochromis niloticus*	2.12
		Oreochromis aureus	2.08
Mormyridae *(10.37%)*	Brienomyrus	*Brienomyrus niger*	7.58
	Petrocephalus	*Petrocephalus bovei*	1.63
	Marcusenius	*Marcusenius senegalensis*	1.16
Schilbeidae *(2.31%)*	Schilbe	*Schilbe intermedius*	2.31
Alestidae (1.58%)	Hydrocynus	*Hydrocynus forskalii*	1.58
Gymnarchidae *(1.29%)*	Gymnarchus	*Gymnarchus niloticus*	1.29
Cyprinidae *(0.99%)*	Labeo	*Labeo tibesti*	0.99
Other family	Other genera	Others species	8.06
		Total	**100**

Fish species in the Waza Logone floodplain are mostly represented by the family of Clariidae (63.03%) and Cichlidae (13.36%) (Table 4.2).

The overall CPUE for the floodplain is 8.3 (±35.05 kg/fisherman/day). The large standard deviation is related to the diversity of fisheries, the fishing materials and the fishing period (Table 4.3).

Table 4.3
Mean CPUE per fishing gear per day (based on a survey from August 2008 to June 2009 (s.d. = standard deviation)

Fishing materials	CPUE (kg/fisher/day)	sd	N
Beach seine	23.27	33.63	51
Funnel nets	62.81	146.66	26
Cast net 0.5 finger	4.82	8.64	45
Cast net 2 fingers	4.81	4.58	27
Hooks 15	4.53	4.09	33
Malian traps	7.88	6.77	45
Nets 0.5	3.54	4.29	45
Nets 1 finger	1.81	1.59	81
Nets 2 fingers	1.97	2.17	95
Nets 3 fingers	2.97	3.73	51
Total WLFP	**8.30**	**35.05**	

With a CPU of above 62 kg/fisher/day (Table 4.3), funnel nets are clearly the most productive fishing gear. However, as funnel nets are only used in fishing channels and for a limited number of days in the year (15-30 days), their contribution to overall productivity is estimated at about 20% of the total catches in the Waza Logone floodplain (see also section 5.3.4, Chapter 5). Beach seines are second in productivity (Table 4.3). They are used for community fishing at the end of the fishing season.

The overall CPUE is highest during December and January (Figure 4.1). This is consistent with a higher catching probability during this period, when water retreats from the floodplains and fish are trapped inside waterholes. From April-May, the decline in CPUE coincides with a reduced exploitation of residual waterholes, which are starting to dry out and become depleted. July to October is marked by (the start of) the wet season and the period before the floods arrive. This is generally a period where fish is only scarcely available in waterholes, which is reflected in the observed CPUEs (Figure 4.1).

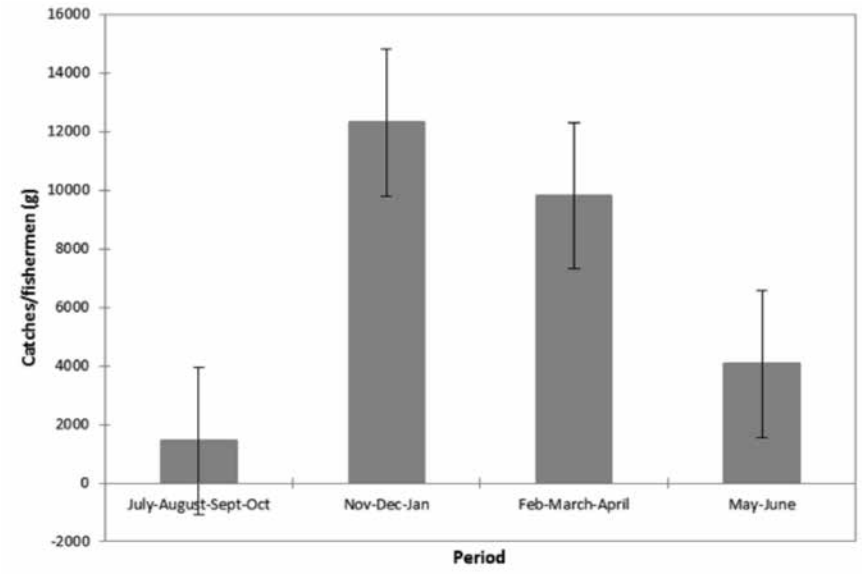


Figure 4.1
Estimated CPUE during the fishing period (error bars represent standard deviation)

The total human population was estimated at 41,415 inhabitants and 3,824 households in 91 villages. Table 4.4 provides an estimate of the fish production in the floodplain. The total catch in the Waza Logone floodplain is estimated at 15,436 tons for the 2008-2009 fishing season.

Table 4.4
Fish production in the study area

Fishing intensity	Fishing period	Number of days	Number of fishermen in the floodplain	Catches (tons)
Intensive fishing period	November-December-January	92	7,036*	8,280
Moderate fishing period	July-August-October February-March	183	3824**	5,800
Low fishing period	April-May-June	91	1,797***	1,356
Total catches of the WLFP				15,436

* There are 1.84 times more migrant fishermen than resident fishers. The number of resident fishers is 2,478
** Fishermen are only resident
*** Fishermen are only resident, 53% of resident fishermen have left the floodplain.

4.3.2 Biological parameters of main fish species

In total, 77 species were recorded in the floodplain (Annex 4). During the experimental fishing survey between July 2008 and April 2009, 31 species (18 genera) have been recorded (Table 4.5).

Table 4.5
Occurrence of individual fish per fish genus per water point and fishing period

Genera	Water points				Fishing period		
	AW	NW	LGR	LRR	July-August-Sept-Oct.	Nov-Dec-Jan	Feb-March-April
Alestes (n = 23)	5	1	8	9	5	18	
Barbus (n = 17)			2	15		17	
Brienmyrus (n = 81)	38	10	22	11	35	20	26
Brycinus (n = 105)	1	9	4	91	20	63	22
Clarias (n = 210)	44	37	76	53	111	44	55
Hemichromis (n = 11)	3	1	4	3	7		4
Hydrocynus (n=49)	24		6	19	39	4	6
Labeo (n = 4)	4				4		
Marcusenius (n = 38)	6	10	3	19	23	7	8
Mormyrus (n = 12)		4	2	6	6	6	
Oreochromis (n = 123)	32	10	35	46	52	22	49
Petrocephalus (n = 86)	6		20	60	4	64	18
Protopterus (n = 19)	9		8	2		19	
Sarotherodon (n = 75)	11	5	16	43	39	9	27
Schilbe (n = 94)	10	5	43	36	49	37	8
Siluranodon (n = 12)			3	9		12	
Synodontis (n = 136)	19	11	40	66	36	79	21
Tilapia (n = 51)	11	13	16	11	27	11	13

AW: Artificial waterhole NW: Natural Waterhole LGR : Logomatya River LRR : Lorome River

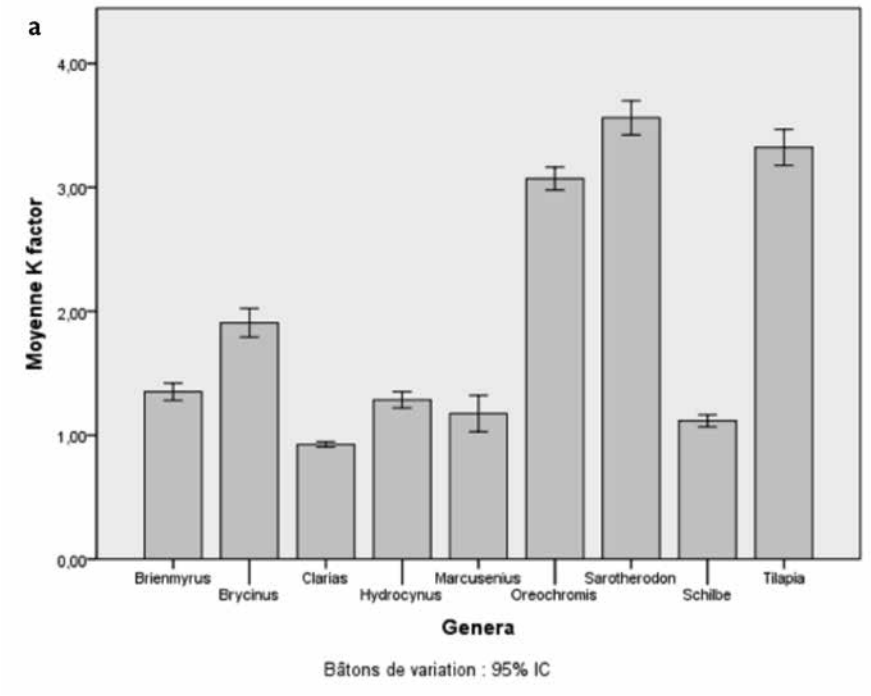
From these 31 species, nine were selected based on their occurrence throughout the year and their presence in all surveyed fishing spots. For these nine species, the average weight, length and K factor is presented in Table 4.6.

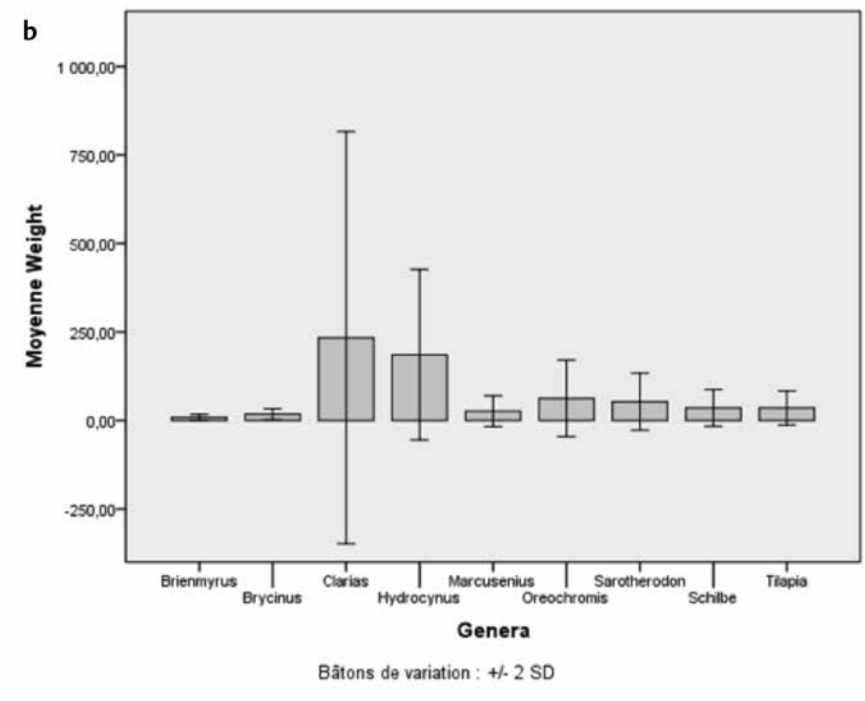
Table 4.6
Mean weight, length and K factor of main fish species (±s.d.)

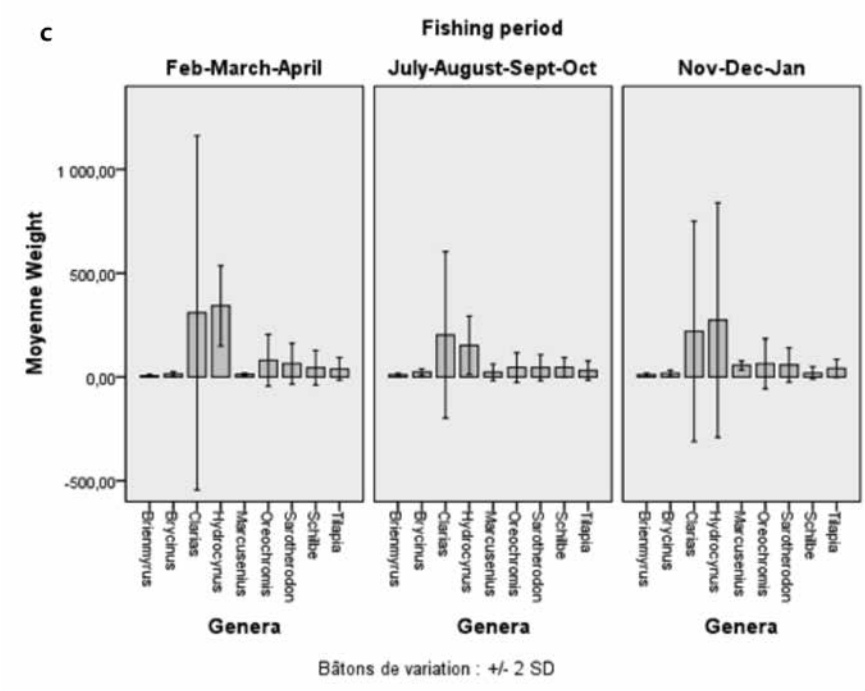
Genera	Weight (g)	Length (cm)	K factor
Brienmyrus (n = 81)	8.71±4.09	8.43±1.25	1.35±0.31
Clarias (n =201)	227.73±280.71	26.1±9.78	0.91±0.17
Oreochromis (n=123)	62.71±54.01	12.00±3.57	3.07±0.54
Petrocephalus (n=86)	3.56±2.47	6.43±1.04	1.21±0.42
Sarotherodon (n=75)	52.29±40.42	11.00±2.61	3.50±0.69
Schilbe (n=94)	35.45±25.86	13.57±3.55	1.11±0.23

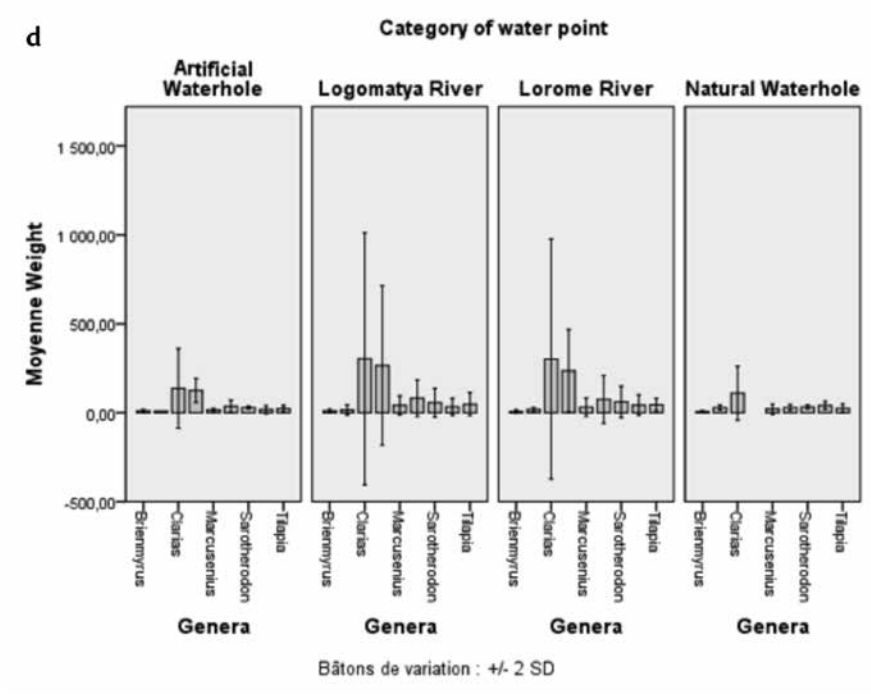
Clarias, the most abundant genus in the floodplain, is also the heaviest one in terms of weight (22.73±280.71 g). Considering the fishing period and the category of fishing spot, they are more heavy at the end of the dry season (February, March and April) and in the river bed (Figure 4.2c and 4.2d).

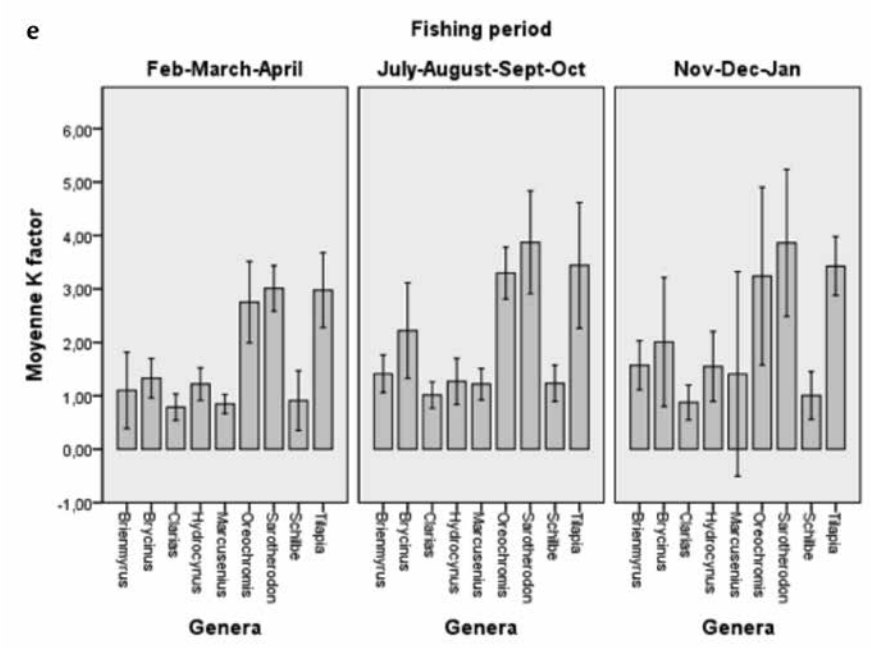
Oreochromis appears to be the dominant genus in terms of the K factor, especially during the flooding and the retreat period (Figure 4.2e). This period coincides with the abundance of the vegetation that constitute the main nutriment for Oreochromis as they are phytophage. In general, K factor is higher for fish in the river beds than in waterholes (4.2f).




b
1 000,00
750,00
500,00
250,00
0,00
-250,00
Moyenne Weight
Brienmyrus
Brycinus
Clarias
Hydrocynus
Marcusenius
Oreochromis
Sarotherodon
Schilbe
Tilapia
Genera
Bâtons de variation : +/- 2 SD


c
Fishing period
Feb-March-April
July-August-Sept-Oct
Nov-Dec-Jan
1 000,00
500,00
0,00
-500,00
Moyenne Weight
Brienmyrus
Brycinus
Clarias
Hydrocynus
Marcusenius
Oreochromis
Sarotherodon
Schilbe
Tilapia
Genera
Genera
Genera
Bâtons de variation : +/- 2 SD


d
Category of water point
Artificial Waterhole
Logomatya River
Lorome River
Natural Waterhole
Moyenne Weight
1 500,00
1 000,00
500,00
0,00
-500,00
Brienmyrus
Clarias
Marcusenius
Sarotherodon
Tilapia
Genera
Bâtons de variation : +/- 2 SD


e
Fishing period
Feb-March-April
July-August-Sept-Oct
Nov-Dec-Jan
Moyenne K factor
6,00
5,00
4,00
3,00
2,00
1,00
0,00
-1,00
Brienmyrus
Brycinus
Clarias
Hydrocynus
Marcusenius
Oreochromis
Sarotherodon
Schilbe
Tilapia
Genera
Bâtons de variation : +/- 2 SD

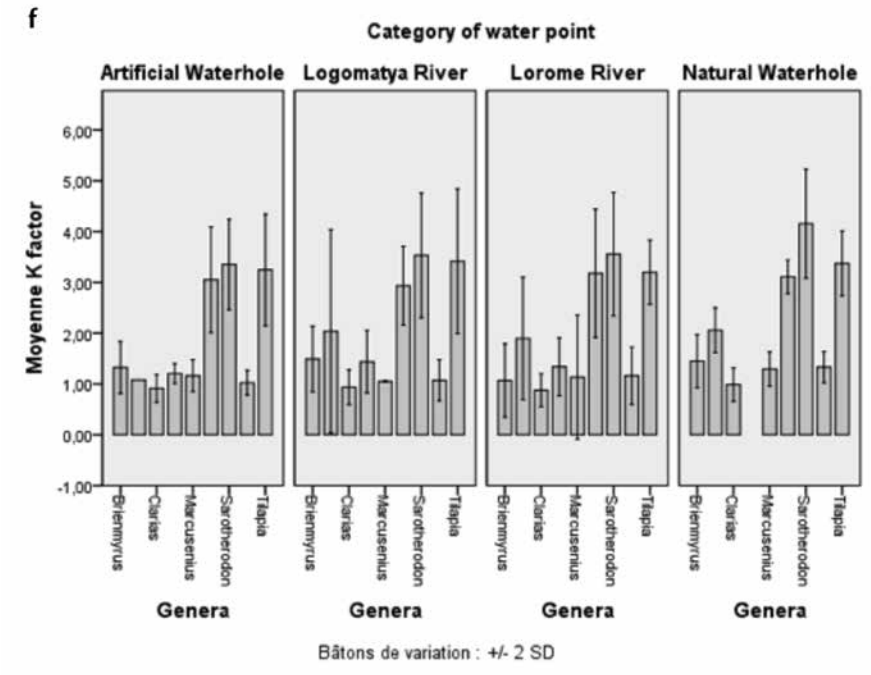


Figure 4.2
Average weight and K factor by fishing period and water point

4.3.3 Impacts of location and fishing period on biological parameters

Calculations on 5 selected genera using a multifactorial Linear Mixed Effect model show certain preferences in fishing period and water point (Table 4.7).

The period during which these data were collected coincided with the period when the number of fishermen and CPUE were highest (see also Chapter 3).

A Newman Keuls test to compare weight and K factor between waterholes and river bed demonstrated significantly higher K factor in the river bed compared to the waterholes ($P < 0.01$).

Table 4.7
Mean weight, length and condition factor of main fish genera per fishing period compared for waterhole and river (±s.d.)

Period	Genera	LGH		WGH		K	
		River	Waterhole	River	Waterhole	River	Waterhole
July-Oct	Clarias	26.27±11.52a	23.35±5.21a	249.65±288.21a	129.24±111.50b	0.88±0.15a	0.88±0.16a
	Oreochromis	12.07±5.26a	10.04±2.08a	69.23±65.04a	35.86±23.29a	3.302±1.23a	3.26±0.43a
	Schilbe	11.57± 2.81a	7.10±0.98b	19.5±14.97 a	3.50±0.70a	1.01±0.22a	0.99±0.21a
	Sarotherodon	11.77±2.95a	9.25±0.35b	54 .00±48.68a	29.375±5.18a	3.08±1.25a	3.72±0.70a
	Brienmyrus	8.35±1.43a	8.35±1.02a	10.00±4.25a	8.56±3.05a	1.57±0.22a	1.40±0.18b
Nov-Jan	Clarias	27.55±9.33a	23.57±4.59b	292.18±257.13a	148.58±81.88b	1.05±0.11a	1.00±0.18a
	Oreochromis	11.37±2.72a	10.02±0.99a	57.87±45.45a	32.93±10.07b	3.37±0.23a	3.17±0.23b
	Schilbe	16.00±2.52a	13.11±1.93b	54.28±20.82a	28.91±14.90b	1.26±14.94a	1.17±0.18a
	Sarotherodon	10.41±2.22a	9.58±0.86a	51.44±35.61a	31.83±4.99a	4.02±0.42a	3.64±0.47a
	Brienmyrus	9.22±1.36a	9.94±0.35a	10.6±3.78b	14.71±1.38a	1.33±1.17a	1.49±0.11a
Feb-April	Clarias	31.70±12.20a	20.26±5.14b	343.11±432.17a	81.45±74.45a	0.77±0.13a	0.82±0.19a
	Oreochromis	14.45±3.99a	10.65±0.91b	95.83±64.03a	33.00±11.59b	2.79±0.36a	2.63±0.41a
	Schilbe	14.34±6.37a	13.40±00a	48.00±43.74a	21.00±00a	0.91±0.30a	0.87±00a
	Sarotherodon	12.42±3.00a	9.85±0.49a	66.84±50.09a	29.00±4.24a	3.02±0.22a	3.01±0.00a
	Brienmyrus	7.63±0.42a	8.16±1.27a	3.62±1.18b	6.88±2.88a	0.81±0.24b	1.22±0.32a

[ab]: Number with similar letter in the same line indicate that there is not significant difference between River or Waterhole ($P < 0.01$).

4.3.4 Sexual maturity

The fish that were caught had their active reproduction period between November and January (Figure 4.3). This is in accordance with existing data on sexual maturity and reproductive status of the nine species studied; reproduction generally takes place during the period of flooding and subsequent retreat.

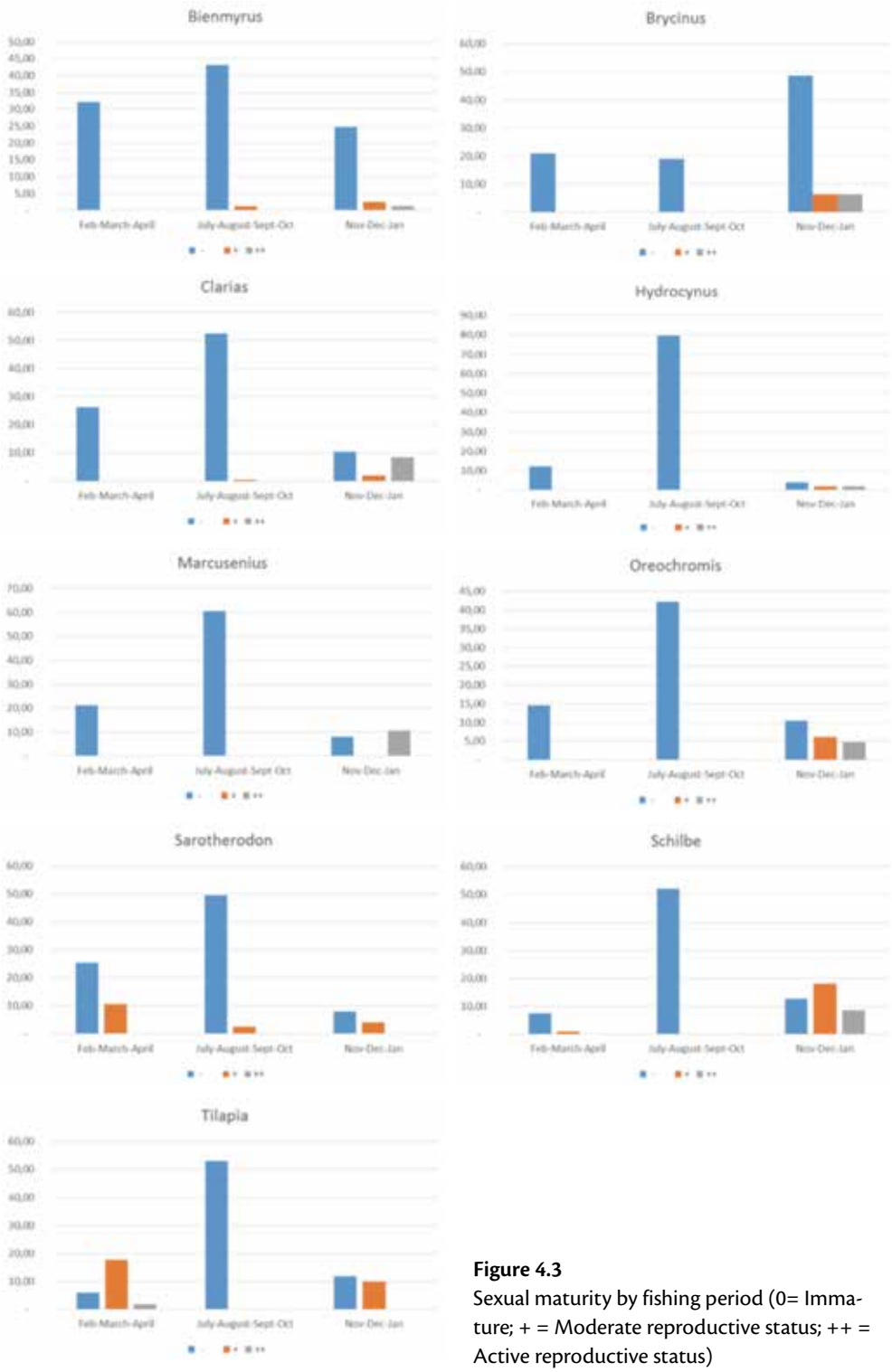


Figure 4.3
Sexual maturity by fishing period (0= Immature; + = Moderate reproductive status; ++ = Active reproductive status)

4.4 Discussion

4.4.1 Fish catch and diversity

The catch composition in the surveyed water points appeared to be variable (Figure 4.2 and Table 4.2). The number of species found during the survey (77, see annex 4) is higher than what was reported by IUCN-WLP in 1996 (66 species) and close to what was reported by Shryock (2009), who found 74 species for the Waza Logone floodplain. It is also more than what was found in other African floodplains, such as the tropical estuary in Benin (68 fish species; Albaret 1994) and lagoons of Benin and Togo (Lai, 1997; Odedeyi *et al.,* 2007), and underlines the importance of the Waza Logone floodplain in terms of fish species diversity.

This relative high species diversity may be related to the regular flooding and the re-inundation pilot that has been conducted by the IUCN Waza Logone project (IUCN, 1994a; IUCN, 1994b). The project intended to restore part of the dried out floodplain by opening two containment dykes at the *petit Goromo* and Tekele (Sighomnou, 2004).

As was expected from canonical distributions of fish assemblages in other African floodplains (Welcomme, 1999), the fish assemblage of the Waza Logone floodplain is dominated by a small number of species (*Clarias gariepinus* and *C. anguillaris* account for more than half of the assemblage). A large number of species was moderately abundant and a few other species only rarely occurred. As members of a genus of predatory fish, both Clarias species are at the end of the food chain. And where other predatory fish, such as *Lates niloticus* need higher levels of water, Clarias is a very hardy genus, able to tolerate very poor conditions of limited water quality and quantity, which gives them an added advantage over other species. Biological surveys show that 89% of stomach content of the *Clarias sp.* is composed of small (< 12 cm body length) fish (mainly Brienomyrus and Cichlidae).

4.4.2 Fish production and Catch Per Unit of Effort (CPUE)

Estimates of CPUE generally integrate the surface area (ha), average depth (m), total dissolved solids (TDS, mg/l) and annual temperature average (°C) (Schlesinger and Rogier, 1982). Taking into account an average flooded area of the Waza Logone of 639,900 (Westra-Wulf, 2005), and based on my estimated CPUE of 8.3 kg/fisherman/day and a total fish production of 15.44 tons a year, the productivity of the Waza Logone floodplain is calculated at 2.412 tons/km^2/year (24.12 kg/ha/year). Compared to an average yield of tropical floodplains in general of 200-2,000 kg/ha/year, this estimate is very low. Com-

pared to other findings (Van den Bossche & Bernacsek, 1990; Van der Knaap, 1994) for African lakes and floodplains, mainly in East Africa however, the productivity of the Waza Logone floodplain seems reasonable. It is also important to realize that comparing data on a yield-per-hectare basis between different study areas is usually not very reliable, as yield is not proportionally related to the size of a lake or reservoir (Kolding & Van Zwieten 2006). They suggested to use a hypothetical 1,000 ha lake from which annual yields are calculated based on log-log regressions of yield and lake area and then use this as a model for direct comparisons between the productivity of the various lakes and reservoirs. Annual average yields can then be calculated based on a selection of water bodies for which information is available. Such estimates have been determined for Asia (e.g. 365 kg/ha for Philippine lakes, 239 kg/ha for Sri Lankan reservoirs, 79 kg/ha for Chinese reservoirs, 74 kg/ha for Thai reservoirs and 65 kg/ha for Indonesian reservoirs) and for South America (e.g. 144 kg/ha for Cuba and 234 kg/ha for Mexico) (Van Densen *et al.*, 1999). By comparison, a hypothetical African lake of 1,000 ha would thus produce 168 kg/ha.

Comparing the fish production during my surveys (24.12 kg/ha/year) to e.g. Lake Turkana (9-16 kg/ha/year), Lake Kivu (27-42 kg/ha/year), Lake Albert (45-65 kg/ha/year), Lake Victoria (29-59 kg/ha/year) and Lake Malawi (35-45 kg/ha/year) (Van den Bosshe & Bernacsek, 1990), also suggests sub-optimal conditions in the Waza Logone floodplain, although less dramatic than is the case for productivity.

Apart from the study by Bobo and Beladan (1997), there is no in-depth study on fish production and fish stocks in the Waza Logone floodplain, and thus no decent database available to compare my findings with. My study confirms the resilience of the Waza Logone floodplain in terms of fish stock. The productivity seems to be stable when ecological conditions do not change drastically. The recent strong increase in the number of fishermen and the decrease of catches per capita should therefore be addressed by reinforcing government regulations, to ensure the fish productivity is not compromised any further, but will be maintained for future generations.

4.4.3 Intra-specific differences in K in time and space

Although the main selected species in my study mostly had a K factor >1, it is not possible to draw conclusions on inter-species differences from this, as the K factor is species specific. In this section I will therefore only discuss intra-species differences.

I found that weight and K factor differ in relation to fishing period and water point. The K factor is significantly higher in the river bed compared to the waterhole in November to January.

Van Zwieten *et al.,* (2011) demonstrate a tendency for fish of larger maximum lengths ($L\infty$) to belong to higher trophic levels in Lake Volta.

In the Waza Logone floodplain, nutrients are mainly provided by grasses and feces from livestock. When fish prey populations are low, e.g. due to overexploitation, predatory species, such as the dominant Clarias spp, are expected to be less fit ($K \leq 1$). Both the dominant *Clarias spp* indeed had a low fitness (0.88 in July-October), indicating that the biomass of small fishes (*Brienmyrus*, *Oreochromis*) is not enough for their need. Considering this, the presented results may be the foundation for an in-depth follow-up of fish condition in the area.

It is remarkable that the higher fishing effort observed in November to January coincided with the period when the K factor of the fish species in the catches is higher compared to other periods and that fishing effort was targeted at species with a higher K factor.

4.5 Conclusion

Regarding intra-species differences in K factor, I conclude that fish condition and fish body weight are better in rivers compared to waterholes and especially during November to January. The fact that fish weight was generally higher in rivers compared to waterholes could be due to shifts in species composition, although analyses were only conducted at the genus level. Alternatively, differences in K factor might be explained by differences in the permanent-nutriment composition and availability in the river bed as compared to the waterholes. With the absence of trends in time and data on changes in species composition, it is however difficult to draw conclusions on the sustainability of the fishing sector. Future research should focus on these current trends to determine how they affect the sustainability of the available fish stocks in the Waza Logone fisheries.

5

Evolution of fishing practices: fishing channels and man-made waterholes

5.1 Introduction

The Waza Logone floodplain, with a flooded area estimated at 6,399 km^2 per year (Westra, 2005), has historically been an important area for fisheries. Kotoko groups established themselves in the area many centuries ago and are experienced and skillful fishermen. Their livelihood is organized around fishing and their income comes from a combination of fisheries and agriculture. Fishing activities are undertaken by the community and they are supervised by the powerful *maginvini*, the responsible guardian of water (Van Est, 1999).

Thus, the Waza Logone floodplain provides ecosystem services that are interlinked with fishing practices as well as other main activities. The arrival of the Musgum ethnic group in the floodplain during nineteenth century gave rise to changes in social organization and impacted the relationships within the population. In 1979, the construction of SEMRY resulted in the settlement of new farmers producing irrigated rice. Some individuals from other ethnic groups as well as civil servants, employed through the developing rice sector, also relocated from other parts of the region to settle in the Waza Logone floodplain.

The Maga dam had a major environmental impact as it was built across the rivers that provided the floodplain with water (Loth, 2004; Sighomnou & Naah, 1997). The embankment (almost 30 km), which was constructed along the Logone River, created a drying out effect throughout the floodplain (Evan 2003; Sighomnou 2003). Aggravated by the general drought in the Sahel in the Eighties, people started to leave the area, which finally resulted in a rural exodus and migration towards other fishing places, such as the man-made reservoir at Lagdo. A number of actions were implemented in order to restore the ecosystem for livestock, wildlife in the Waza National Park and fisheries, but also for rice farmers. New waterholes were created in and around the Waza National Park, a large dam (the Zilim dyke; Drijver & Kouahou, 1995)

was constructed across the Logomatya River in the sub-district of Ngoudeni, and later two outlets (the *Petit Goromo* in 1994 and *Aretekele* in 1997) were opened to re-inundate the floodplain (Loth, 2004). The waterholes were financed by the LCBC and the dyke was built by the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) with a financial contribution from the former Logone-Birni Council. A study of the impacts on the inhabitants through questionnaires and on the environment through hydrological computer simulations (Evens *et al.,* 2003; Loth, 2004; ACEEN, 2007) about 5 years after these measures had been implemented, concluded that all parties were satisfied. It was decided that the configuration of the 1997 re-inundation should be retained. Unfortunately, as it turned out later, the fishermen had never been consulted about the actions, while this succession of events that resulted from these actions did, according to the fishermen, have a great impact on several fisheries practices that were commonly employed in the Waza Logone floodplain.

My study will therefore focus on these impacts. I will focus on man-made waterholes and fishing channels.

Ever since people settled in the Waza Logone floodplain, fishing channels have been utilized as an important tool to enhance their fishing yields. As human population numbers started to increase, these fishing channels became gradually integrated into community activities and the harvest was naturally distributed among all members of the community. In recent years, however, fishing channels have increasingly become a practice limited to a few rich people who receive the majority of the yield and revenues.

The history of fishing channels is linked to the establishment of the Musgum in the area. Blache *et al.* (1962) described that in 1955 there were some rare natural channels in the floodplain. These channels were maintained artificially and barred by means of fences, interspersed with traditional basket nets. At the time Blache *et al.* (1962) were carrying out their study, this type of channel was rare.

The Musgum newcomers dug new channels with the permission of the local *Blama* and over time these activities expanded.

During my fieldwork, I learned that the population was generally not satisfied with certain new regulations that forbid them to dig new fishing channels or to restore old ones (e.g. the provincial decision of May 2006[9]). In spite of the new legislations, some people started digging new channels and this has

9 Arrêté provincial n°5 du 03 mai 2006 portant mesures conservatoires préalables à l'inversion des tendances de dégradation des ressources naturelles de la plaine d'inondation de Waza Logone (Département du Logone et Chari)

become common practice up to today. Each year some fishing channels are illegally being restored.
Considering the popularity of the use of fishing channels in the area, and in view of the fact that other specializing fishing practices are becoming less profitable (Oostenbrugge *et al.,* 2004), I hypothesize that in the Waza Logone Floodplain, only owners of fishing channels have yields that are large and stable enough to provide a decent income throughout the year.

The aim of this chapter is to assess the state of fishing channel and waterhole practices in the Waza Logone floodplain, to compare their productivity and to determine their impact on fishery resources and floodplain ecology.

5.2 Materials and methods

5.2.1 Selected fishing channels and waterholes

The selection methods are the same as those described in Chapter 1. Data collection focused on waterholes and selected fishing channels in the floodplain.

Table 5.1
Overview of fishing channels and waterholes included in the survey of 2008-2009 (see also Figure 5.2. and Annex 2 for GPS position)

Location in the WLFP	Fishing area	Village	Owner
North of the WLFP	Abana	Abana	Adam Abare
North of the WLFP	Abana	Abana	Blama Moukak
North of the WLFP	Abana	Abana	Mahamat
Center of the WLFP	Logomatya	Zilim	Aba Kadir
Center of the WLFP	Logomatya	Zilim	Ahmat Zamakai
Center of the WLFP	Logomatya	Zilim	Alhadji Abkar
Center of the WLFP	Logomatya	Zina	Abagoni
Center of the WLFP	Logomatya	Zina	Djawi
Center of the WLFP	Logomatya	Zina	Kaskala
South of the WLFP	Logomatya	Sarasara	Abdoul Sali
South of the WLFP	Logomatya	Sarasara	Djibrine
South of the WLFP	Logomatya	Sarasara	Moussa Beladan
South East of the WLFP	Tchouvno	Tchouvno	Mazera
South West of the WLFP	Tchikam waterhole	WNP	Waza National Park service (government)
South West of the WLFP	Lougue waterhole	Tchede	Tchede community

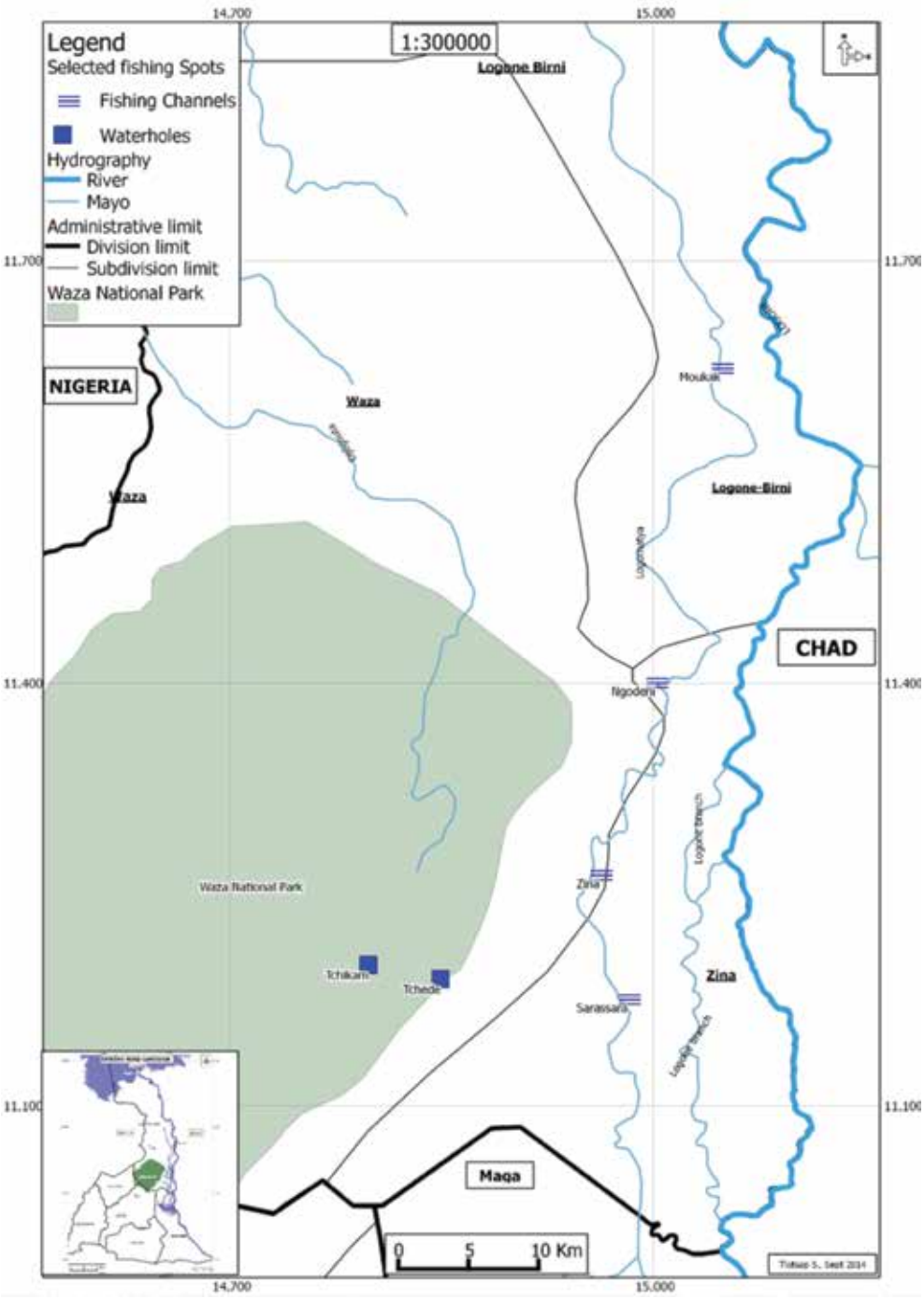


Figure 5.1
Location of selected fishing channels and waterholes (from INC and field data)

An experimental survey targeted two additional man-made waterholes (one inside the Waza National Park and one outside) and 13 fishing channels along the Logomatya River, the Mazera River and in Moukak. Table 5.1 provides an overview of the fishing waterholes and fishing channels. All fishing channels along the Logomatya River, from Tekele in the South to Evie in the North were counted (see also 3.3.1; Figure 5.1).

5.2.2 Topographical assessment of waterholes and the Zilim dyke

A topography assessment aims to gather existing data in the field for their transcription, to scale, on a plane or on a map. Mapping occurs at different scales, the planimetry scale (X and Y) and the altimetry scale (Z axis).

With the support of the regional service of agricultural engineering (Ministry of Agriculture and Rural Development), I was able to perform a topographical assessment in the two man-made waterholes and in the Zilim dyke. During the assessment, the following elements were measured: (i) natural filling channels, (ii) the sedimentation basin, (iii) the retention basin, and (vi) the natural overflow channels. The sedimentation basins and retention basins communicate directly with each other, there is no intermediate space.

5.3 Results

5.3.1 Characteristics of the Tchikam and Lougue man-made waterholes

The original purpose of the Tchikam and the Lougue man-made waterholes was to provide drinking water to wildlife and livestock. Main users were nomadic herders coming from the region and from neighboring countries. Management interventions that were implemented during the Waza Logone Project (1994-2000) to limit human-related impacts on the park assigned the Tchikam waterhole, which is located inside the Waza National Park, for use by wildlife only. The Lougue waterhole (outside the park boundary) was maintained as a drinking water source for livestock. The area surrounding these waterholes was particularly affected by the reduction of flooding caused by the construction of the Maga dam and the containment dyke along the Logone River.

As there is no physical boundary or fence delineating the perimeters of the Waza National Park, both waterholes are openly accessible to humans and animals alike. Table 5.2 below shows the dimensions and the estimated volumes of the waterholes.

Table 5.2
Physical characteristics of Tchikam and Lougue waterholes

Water-holes	Length		Width		Height		Slope bank	Waterhole' capacity		Volume water	Volume sludge
	Li (m)	La (m)	Wi (m)	Wa (m)	Hi (m)	Ha (m)	Pi	Vi (m^3)	Va (m^3)	Vw (m^3)	Vs (m^3)
Tchikam	108	117	54	68	1.2	1.2	0.33	6,300	4,600	4,600	1,900
Lougue	160	180	35	40	4.60	3.80	0.5	20,000	18,000	10,500	3,500

The indices (i) denote the initial dimensions presumed. The indices (a) denote the current estimated size.
Li = Initial length; La = Actual length; Wi = Initial width; Wa = Actual width; Hi = Initial height; Ha = Actual height; Pi = Initial slop bank; Vi = Initial volume; Va = Actual volume; Vw = actual estimated volume of water; Vs = Actual estimated volume of sludge

Although Lougue waterhole is about three times larger than the Tchikam waterhole, both waterholes contain thousands of m^3 of water during the dry season (Table 5.2). The quality of the water in both waterholes has not been determined, yet I observed that during the flooding period (July-September), the water was clear while during the retreat of the water (October-December) it became more turbid. The dried clay soil along the edges provided sufficient nutrients for vegetation, such as wild sorghum, to emerge. At the start of the dry season (January-April), the water in the waterholes was greenish in color and water lilies and other aquatic vegetation started to grow, while at the end of the dry season (May-June) the water was muddy.

5.3.2 Fishing channels

When water retreats from the flood plain, small trenches are formed by the effect of the water current grinding the soil. These may eventually develop into larger channels that carry water back into the rivers or artificial waterholes. Figure 5.2 from a Google Earth view, shows a set of channels linking the ponds on the right side to the Logomatya River.

In general, there has been an exponential increase of fishing channels in the Waza Logone floodplain, especially after the construction of the Maga dam and reservoir (Figure 5.4). During a survey in 2006, a total of 4000 fishing channels were counted throughout the floodplain (ACEEN, 2007).

I counted a total of 413 of fishing channels from the source of the Logomatya River (Tekele Village) to the end where it joins the Logone River (Evie Village).

Figure 5.2
View of fishing channels in the Waza Logone floodplain (From Google Earth taken on 22 December 2005 and downloaded on 16 July 2011)

The channels are not evenly distributed over the landscape (Table 5.3), but rather concentrate near the village of Ngodeni and the Zilim dyke (Figures 5.2 and 5.3).

Table 5.3
Distribution of fishing channels along the Logomatya River

Site	Number of fishing channels
From Tekele to Zina	125
From Zina to Ngodeni	175
From Ngodeni to Zilim dyke	77
From Zilim dyke to Evie	36
Total	**413**

After the water has retreated completely (by mid-January latest), most of the fishing channels are dry, except for two channels near the dyke of Zilim, which still receive residual water from the Logomatya River, released by rice cultivators of SEMRY. These channels have been dug in the North West of the floodplain in order to create better conditions for the water supply of livestock.

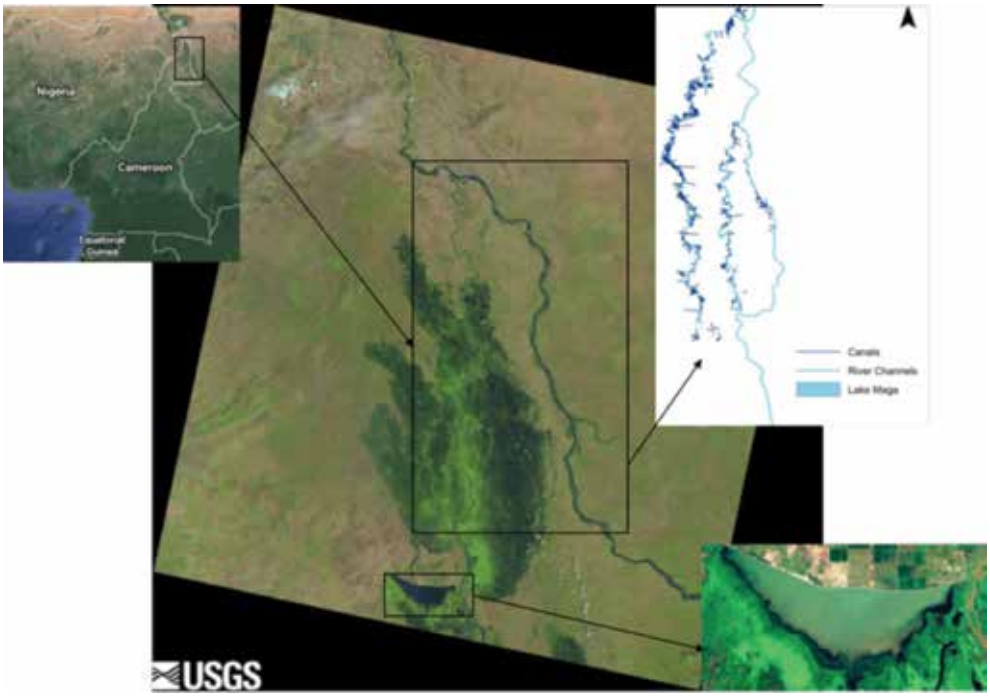


Figure 5.3
Distribution of fishing channels in the Waza Logone floodplain and the Maga Dam

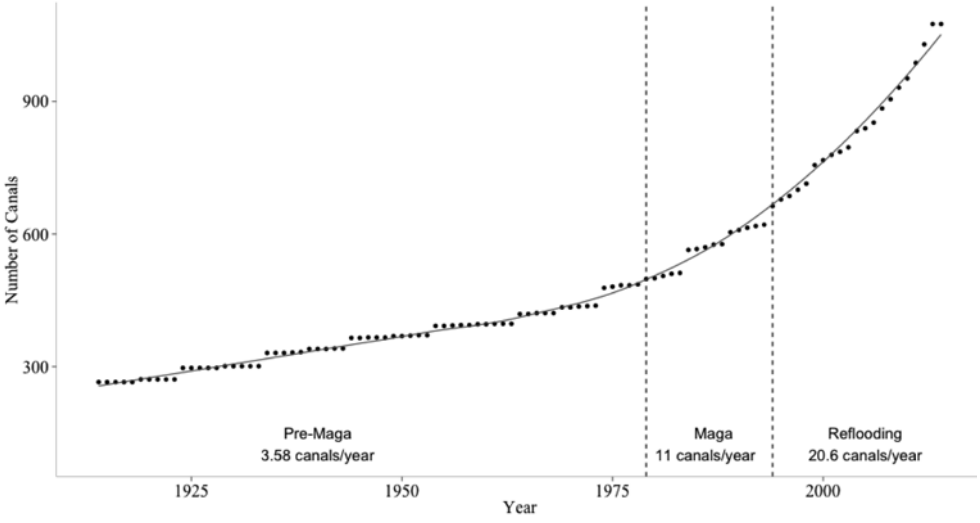


Figure 5.4
Evolution in time of the number of fishing channels before the construction of the Maga dam, after the construction and after the implementation of the reflooding project in 1994 (based on own interview data after 2005, date before 2005 are based on previous interviews during 2005; ACEEN, 2007)

The Zilim dyke is a dam made of a mass of clay-silt material in the form of a trapezoid, perpendicularly embedded in the water course. It is approximately 200 meters long (Figure 5.5).

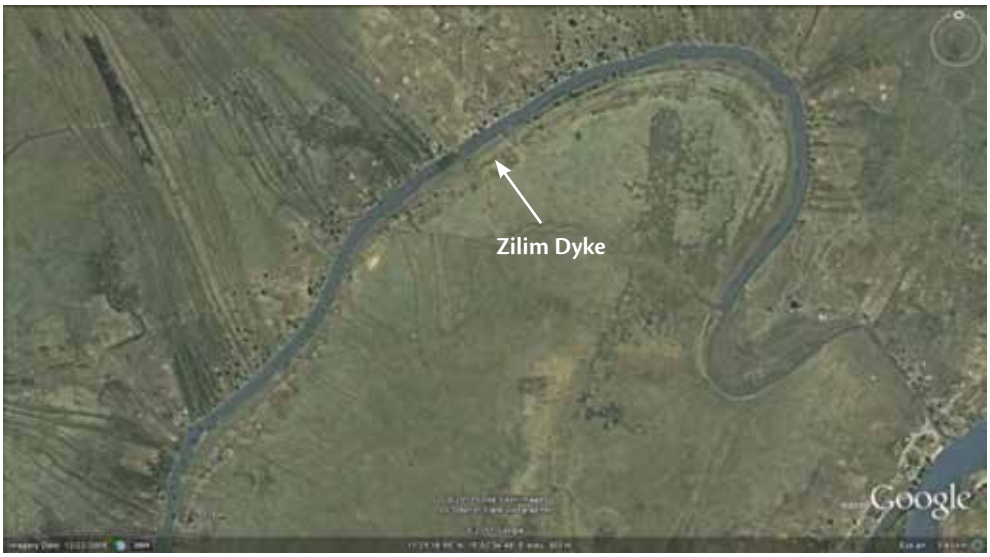


Figure 5.5
Concentration of fishing channels around the Zilim dyke. Source: Google Earth, taken on 22 December 2005 and downloaded on 16 July 2011

The construction has a base width of about 10 meters and reaches a height of five meters at the axis of the water course bed. This barrier was designed to maintain a body of water year round, as a drinking water source for the animals of the nomadic herders. Over the years, fishermen started to catch fish here, and today the Zilim Dam, as well as the numerous fishing channels that have been constructed and now lead up to it (Figure 5.6) mainly serve as fishing waters.

5.3.3 Fishing in man-made waterholes and fishing channels

Fishermen in the study area mainly use cast nets, gillnets, hooks and Malian traps when fishing in man-made waterholes and fishing channels (see also Chapter 3).

The cast nets used are of a similar model, but their sizes vary with the strength and the ability of the fisherman. Cast nets are active fishing gear; the fishermen actively operate the cast nets while fishing. The nets are used

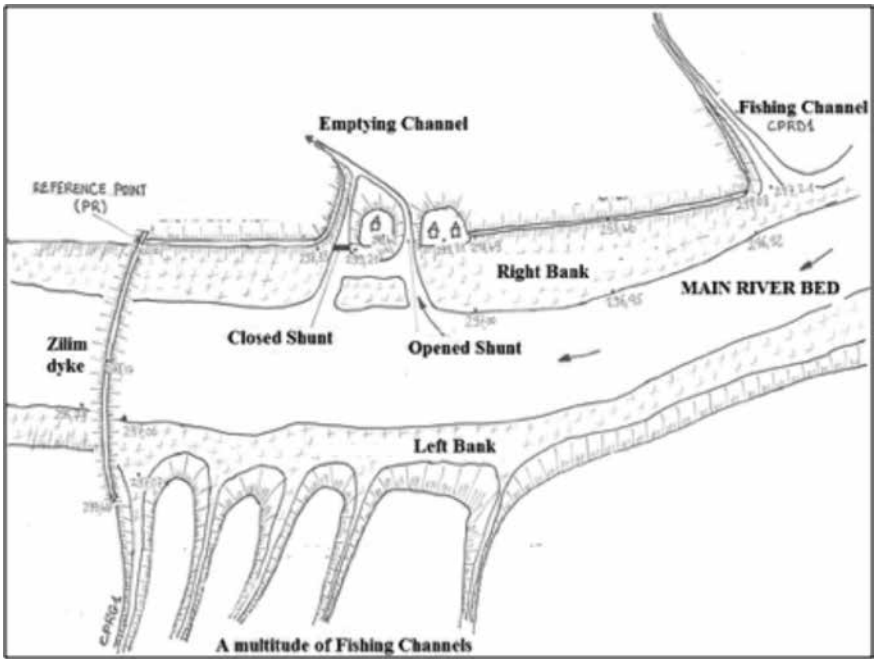


Figure 5.6
Synoptic sketch of the Zilim dyke and the surrounding fishing channels

during periods of low water. Fishing time observed is about 15 minutes (per cast) and each session can be repeated several times during the day.

Gill nets are used passively; the nets are left out, usually overnight, allowing the fish to get caught by the gills in the mesh. The gill nets that are used are made of nylon and are generally two meters deep. When a net is placed in a waterhole during low water (less than two meters deep), it forms a large pocket that can rest on the bottom depending on the ballast. The characteristics of the mesh are the same as those of the cast nets. The Malian trap is the most commonly used trap. I registered an average of 67 Malian traps per fisherman in Lougue waterhole and an average of 53 Malian traps per fisherman in the Tchikam waterhole.

The size of conventional hooks is indicated by the number specified by the manufacturer and generally known to fishermen (Number 15 based on surveys). Its use varies with water level in the waterholes. During periods of low water, the tool is actively used. At higher water levels it is used passively; hooks are then usually placed in the morning. The line and hooks are removed from the water at the end of the day.

In the fishing channels, fishermen often use funnel nets. These nets are placed to completely block the flow of water. The net has a special pocket that

is placed on top of a couple of stakes in the river bed or the waterhole. When the fish leave the fishing channels to enter the river bed or waterhole, they are caught inside the pocket. The pocket can be detached and replaced. This method is particularly effective during the retreat of the water from the flood-plain into the rivers, between the beginning of November and early January, with some slight variations depending on the location (Table 5.4).

Table 5.4
Period of selected fishing channels activities in the study area during November 2005-January 2009

Location	Village	Owner	November				December				January	
			8	15	22	29	6	13	20	27	3	10
Abana	Abana	Adam Abare										
Abana	Abana	Blama Moukak										
Abana	Abana	Mahamat										
Logomatya	Sarasara	Abdoul Sali										
Logomatya	Sarasara	Djibrine										
Logomatya	Sarasara	Moussa Beladan										
Tchouvno	Tchouvno	Mazera										
Logomatya	Zilim	Aba Kadir										
Logomatya	Zilim	Ahmat Zamakai										
Logomatya	Zilim	Alhadji Abkar										
Logomatya	Zina	Abagoni										
Logomatya	Zina	Djawi										
Logomatya	Zina	Kaskala										

5.3.4 Catches and Catch Per Unit of Effort (CPUE)

In the Lougue waterhole, 36 fish species were recorded in the catches. The dominant species were *Protopterus annectens* (59.5%), *Clarias anguilaris* (12.6%), *Clarias gariepinus* (7%) and *Tilapia dageti* (5.2%).

In the Tchikam waterholes, in total 42 fish species were recorded. The dominant species were *Protopterus annectens* (25.7%), *Clarias anguilaris* (20.5%), *Clarias gariepinus* (13.9%) and *Brienomyrus niger* (10.1%).

In the fishing channels, the main species were *Clarias anguilaris* (53.32%), *Clarias albopuntatus* (21.2%) and *Brienomyrus niger* (10.3%). In both Lougue and Tchikam waterhole, *Protopterus s*p., is dominant followed by *Clarias* spp., and species belonging to the families *Cyclidae* and *Mormiridae*. These species

are considered to be resident here. For *Prototerus* sp., waterholes are a suitable environment for hibernation.

The annual total production and CPUE of the Tchikam waterhole (21 tons) are twice as high as that of the Lougue waterhole (10.7 tons; Table 5.5).

Table 5.5
Estimated catches and CPUE for the fishing season 2008-2009 in the selected waterholes and fishing channels

Waterholes and fishing channels	Total catch (tons)	Mean CPUE (kg/fisherman/day)
Lougue	10.7	2.94
Tchikam	21.01	18.78
Fishing channels	0.78	53.24

Productivity in the Tchikam waterhole (4.57 kg/m^3) is more than 7.5 times as high as the productivity in the Lougue waterhole (0.6 kg/m^3). Thus, both CPUE and production greatly differs among these two waterholes. Based on the total number of 4,000 fishing channels in the floodplain (ACEEN, 2007), I estimated a total production of 3,133 tons from the fishing channels, which represents 20.3% of the total catches in the Waza Logone floodplain (15,436 tons for the 2008-2009 fishing season; Chapter 4).

5.4 Discussion

5.4.1 Fishing in man-made waterholes and fishing channels

Fishing strategies in waterholes recently tend to shift towards a specific new strategy using funnels nets and fences in combination with small holes (Table 5.2 and Figure 5.2).

Reports by ACEEN estimate that the number of fishing channels was about 4,000 in 2006 (ACEEN, 2007). Their database (personal communication) shows that 40% of the channels were dug between 1996 and 2006. During my fieldwork, I observed the digging of some new channels and maintenance works of the old ones. Rich fishermen continue to dig new channels despite the prohibition on digging new fishing channels, a decision taken by the Governor in 2006.

5.4.2 Fish ecology in waterholes and fishing channels

In both the Tchikam and the Lougue waterholes, the number of fish species is approximately half the total number for the floodplain (42 forTchikam and 36 Lougue).

For the evaluation of variations on an annual basis or differences within and between floodplains, Welcomme (1977) suggested to use a general index, based on the relation between catch and floodplain ration. However, as noted by Sparre and Venema (1998), it is difficult to model a small scale and diverse fisheries such as the multi-species fisheries in the Waza Logone floodplain. I assume that the ecological role of the waterholes is substantial, since they serve as a source of breeding stock when the floodplain gets flooded. Waterholes are a good environment for hibernation of species such as *Protopterus* sp. and *Clarias* spp. Claridae and Cyclidae may even spawn inside the waterholes (Loth, 2004).

5.4.3 Capture and productivity of man-made waterholes and channels

Although my study indicates that fishing is still highly productive in waterholes (20 tons per annum in the Tchikam waterhole) as well as in fishing channels (3,133 tons estimated during the 2008-2009 fishing season), the proliferation of fishing channels also leads to the early drying out of the mares with which they are connected. During the dry season, only the presence of artificial water-containing waterholes allows for the resident fish species to hibernate and thus sustain a viable fish population.

Fishing channels allow a relatively small number of privileged fishermen to enhance their fish production. In fact, these fishermen spend part of their time managing their channels and they use available labor to dig out the channels, to maintain them and sometimes even to catch the fish. The waterholes and mares form the basis for subsistence fisheries for the majority of fishermen in the floodplain. This is consistent with observations by Bene *et al.,* (2003a, 2003b) and by Neiland and Bene (2003). The Zilim dam in this area maintains water in the Logomatya and thus plays a key role in dry season fisheries in fishing channels. The production around Zilim dam provides a sufficient source of income for few fishing channel owners, while other fishermen in the area need alternative sources of income to cope with the high basic uncertainty associated with the fishery (Oostenbrugge *et al.,* 2004).

In terms of production, the Waza Logone fisheries are comparable with many other African floodplain fisheries, which are highly adaptable and dynamic (Bernasek & Lopes, 1984a). During a monitoring survey in Bangladesh, De Graaf (2003) observed that in permanent water sources about 165±28 kg/

ha of fish was caught annually and in seasonal floodplain 83±23 kg/ha annually. However, he also observed that the fish catch exhibited a strong seasonal variation, with a highest catch when the floodwater recedes towards the river, and the lowest catch during the dry season (De Graaf, 2003; Welcomme 1977). I observed a similar variation during my study; the annual catch varied with the extent of flooding, with high catches in wet years and low catches in dry years.

Although it is difficult to justify conclusions based on a single fishing season, my data suggest that currently deployed fishing practices in the Waza Logone floodplain are non-sustainable. Despite relatively high production rates in the surveyed waterholes, my findings comply with the general definition by Jul-Larsen *et al.* (2003) of non-sustainably harvested fisheries on a few aspects; (i) direct investment, (ii) greater effort catches, (iii) increase in fish price. According to the same authors, overfishing at the community level occurs if the total fishery exceeds the overall annual surplus production of the combined fish community in a reservoir. A specific component of the fish community will be overfished only when specific investments are directed at that component, and fishers continue to fish the species despite the greater effort needed to maintain catches.

5.5 Conclusion

The situation described in this chapter is a cause of concern for the future of the Waza Logone floodplain as part of the vast hydrological system of the Lake Chad basin. A disastrous drop in fishing yields can be expected in the near future when for instance some natural event (e.g. extreme drought) or mismanagement (e.g. through governmental actions) alter the seasonal flooding patterns of the floodplain. Fishing yields almost entirely depend on the seasonal flooding. What is also worrying is the strong increase in the number of fishing channels, in combination with highly selective fishing practices, especially considering that the incomes generated in the area increasingly come from such fishing practices (i.e. using fishing channels and inappropriate techniques).

Eventually, it may be expected that the diminishing fish stocks will lead to more conflicts between people living in the area.

6

Fisheries Conflicts in the Waza Logone Floodplain: Typology and Roots[10]

6.1 Introduction

Broadly speaking, conflict emerges when 'the interests of two or more parties clash and at least one of the parties seeks to assert its interests at the expense of another party's interests' (FAO, 1998). Conflicts do not necessarily have to be violent or highly disruptive. In fact, many conflicts that arise as a result of conflicting interests are low-level, non-violent phenomena (Warner, 2000).

As has been described above, the Waza Logone floodplain is characterized by a great diversity of natural resources, which attracts many users from diverse backgrounds. Historically, disruptions to these resources have led to strong competition and often also to conflicts between users. After the floodplain was partly reflooded, the number of sedentary fishermen in and around the Waza National Park increased rapidly (25% by 1994 and 34% by 1995; Scholte, 2003), and thus the potential for conflict situations.

Studies suggested a 90% decrease in fish production as a result of the hydro-agricultural activities conducted in 1979 under the SEMRY rice project (Loth, 2004: Mvondo *et al.,* 2003; Scholte, 2005; Sighomnou & Naah, 1997). These hydrological disturbances led to the abandonment of traditional systems of natural resource management that guaranteed a relatively sustainable and peaceful mode of operation. Combined with population growth, the decline of fish stocks has resulted in strong competition over fishery resources. The most serious conflict over the past five years in the floodplain occurred in 2007 between the inhabitants of Sifna village and those of Tchede village. It was induced by conflicting interests over the control of a rich fishing waterhole located inside the Waza National Park and very rapidly turned into

10 This chapter is based on research done jointly with Khari Boukar, a student of the University of Dschang (West Cameroon). I was his field supervisor. Sometimes, I use 'we' to underline this participation.

an ethnic conflict between the Kotoko and Musgum. The consequences were enormous: fighting, hundreds of huts burnt down, destroyed fishing equipment, at least forty people injured, a dozen people killed, children who lost an entire school year, while the trade between the two communities came to a complete stop. Economic losses due to this conflict have been estimated at nearly one hundred million FCFA (Sub Prefect of Zina, personal communication). Many people lost everything and, today, the memories of this very unfortunate event are still strong. Despite many external interventions, reconciliation between the two communities was still tentative during the time of my research (2008-2011).

This conflict is an example of the clashes that frequently occur in the Waza Logone floodplain and which are almost always related to conflicting interests over fisheries.

The construction of man-made waterholes is associated with several social issues, as these waterholes are considered by some traditional authorities as private property, and as open access by others. In the village of Araf for example, the local chief *(Blama)* and his family claim an exclusive right to fish in the waterhole. The chief uses a specific method to capture fish during the retreat of the water. At the end of his fishing period, when the community is permitted free access to the waterhole, there are hardly any fish left and, naturally, the fishermen complain about this situation.

Although not directly linked to fisheries, some conflicts arise from competition over access to waterholes for the purpose of watering livestock. Access by pastoralists is often not allowed until the community has organized their fishing activities.

Moreover, both groups (i.e. fishermen and pastoralists) often struggle with rules and limitations imposed by government. We have regularly observed them ignore the restrictions on entering the Waza National park for instance (see also Chapter 3), for which they sometimes get arrested. More often, however, fishermen as well as cattle owners are actively bribing conservation staff members to allow them to access the park. Such cases of 'bad governance' have been reported by the village head *(Blama)* of Hale village; certain individuals from the Ministry of Fauna and Forest had somehow been 'persuaded' to ignore the law and allowing several groups of transhumant fishermen to fish the waterholes inside the park.

According to the Musgum and the Kotoko, fishing channels are also responsible for recurring tensions among fishermen (Harkes, 1993). Their owners sometimes engage in a war over water. They always dig deeper to capture the water of the ponds charged with their stocks of fish. At the ponds themselves, the first people to have connected their channels insist on their

precedence and build dykes several hundred meters long in order to better direct the water into their own channel.

The common rationale of the cases described here, is that conflicting interests always tend to be destructive to the ecosystem and are thus always compromising the sustainable use of natural resources in some way. In terms of the sustainability of fishery resources, it is therefore essential to characterize these conflicts and to investigate their roots. The principal research question is: what are the main sources of conflicts in the Waza Logone floodplain and what are the main factors contributing to conflicts?

In chapter 7, I will elaborate further on the mechanisms of preventing and solving these conflicts, and on the impacts they have in the area.

6.2 Methodology

6.2.1 Study area

This study covers a selection of 19 villages from a total of 91 villages in the Waza Logone floodplain (Table 6.1). They belong to the sub-districts of Mazera, Lahai, and Ngoudeni in the Zina sub-division, the sub-district of Hinale in the Logone Birni sub-division, and the sub-district of Guirvidig in Maga sub-division (see Chapter 2 for a full description of the study area, particularly, Figure 2.2).

6.2.2 Data collection

Preliminary research included a review of several information sources and 10 open interviews with stakeholders. These stakeholders comprised of the sub-divisionnal officer of Zina, two traditional authorities (the head of Tchede village and Malazina village), three *manguivini* (the traditional authority who is responsible for water and fishery management), four local NGO coordinators, the local police officer and the Waza National Park conservator. I further organized three focus group discussions in Tchede, Malazina and Zina in order to gather more information on a number of case studies.

For the interviews in the 19 villages that were surveyed, I used a semi-structured questionnaire containing open and closed questions (Annex 5). A total of 143 heads of household were included in the survey (Table 6.1).

In addition to the heads of household, I conducted interviews with the following local authorities: the sub-divisional officer and the mayor of Zina, the chief of Evie Fishing Centre, the chief of Mazera Fishing Centre, the fishing manager of the Sultanate of Logone Birni, the chief of Hinale Village, the chief

of Ngoudeni Village, the chief of Mazera village, and the Head of the Regional Department of Fisheries of the Far North region in Maroua.

6.2.3 Population and sampling

Study Population

In the Waza Logone floodplain, fishing is an activity mainly performed by men. Women are more involved in post-catch activities (e.g. processing, including drying, smoking and selling) and therefore they are often not directly involved in conflicts related to fishing. In addition, some religious and cultural conventions isolate women from contact with males. For these reasons, our study population consists exclusively of men who are the head of a household and who are involved in management of fishery resources and/or are or have been involved in fishing conflicts in the Waza Logone floodplain.

In order to highlight multiple aspects of a conflict situation, I interviewed people of different status within the community (i.e. three governmental service officers, two traditional leaders, one elected leader, one members of an international NGO, one member of a local association and one anthropologist).

Sampling technique and sample size

To select a representative sample of the study population, I considered a sampling rate of 20% and used a systematic screening method, which included the following three main steps: (i) to establish a complete list of the population (preliminary survey in each village selected) and arrange them in alphabetic order; (ii) to choose a random number N that is then used as a standard interval to select each N^{th} unit on the list from a random starting point; and (iii) to compile a final list of people to interview.

Table 6.1 below shows the situation of our units of analysis per village. The study sample (N = 143) was thus established from the entire study population (N = 763). Table 6.1 provides details of the number of individuals surveyed per village.

Table 6.1
Sample size of households to investigate per village obtained from village chief

Villages	Total number of households	Sample size	Number of heads of household that migrated during the last 10 years
1 Lougouma	25	5	0
2 Mahe	17	3	0
3 Tchede	16	3	10
4 Araf	11	3	0
5 Zouang	17	3	0
6 Zina	230	43	101
7 Hale	18	3	05
8 Mazera	67	13	200
9 Soufna	8	2	12
10 Ngoudeni	76	16	83
11 Patmangaï	22	5	60
12 Davagan	29	4	20
13 Tchoukouf	47	9	200
14 Sifna	62	13	0
15 Malazina (Lahaï)	22	5	100
16 Malazina (Guirvidig)	25	5	30
17 Moukak	36	0	5
18 Zilim	23	5	30
19 Matkeu	12	3	0
Total	**763**	**143**	**856**

6.2.4 Processing and analysis

The data collected were processed manually and coded before being analyzed using Excel Microsoft software and SPSS 17.0 (Statistical Package for Social Science, 2010). Descriptive statistical techniques included representations in tables and calculation of frequency and averages. Certain information and study assumptions were tested using statistical tests such as correlations, T-test and chi-2.

6.3 Results

6.3.1 Categories of conflicts and their manifestation in the Waza Logone floodplain

Conflicts in the area

From the people interviewed, 93% are aware of the existence of conflicts in the Waza Logone floodplain.

The prevalence of conflicts between fishermen can largely be explained by the range, richness and consistency of the fishing activities in the area; as large numbers of fishermen seek out the same area for fishing, it becomes a potential zone of conflict. The interviews revealed that conflicts among fishermen are three times more important than conflicts between fishermen and farmers (Table 6.2).

Table 6.2
Number of conflicts per category in the Waza Logone floodplain

	Category of conflicts present in the community			
	Conflicts among fishermen	Conflicts between fishermen and farmers	Conflicts between fishermen and herders	Conflicts among farmers
Mazera	61	31	31	22
Lahai	33	7	18	6
Ngoudeni	25	1	1	1
Hinale	3	3	0	0
Guirvidig	5	0	1	1
Total	**127**	**42**	**51**	**30**

The intensity of fishing activities is not constant throughout the year. During the flooding time (August-October), the whole floodplain is vulnerable to conflict. After the water starts retreating, any disputes tend to focus around fishing channels and waterholes, and the Logone and Logomatya Rivers.

Of the people interviewed who confirmed that they were involved in conflicts with other fishermen, over 50% had been involved in a fishing conflict at least once in 2009. In some areas, such as Lahai and Guirvidig, respondents were involved in disputes more frequently (64.70% for Lahai and 100% for Guirvidig).

I categorized the conflicts that existed among fishermen into three main types (Table 6.3): the quarrel (65.70%), the breakdown of communication (56.93%) and violence (35.76%). Although all reported conflicts were brief,

temporary, and did not require external intervention, they were said to be disputes which in the long-term often result in a situation of distrust and suspicion. People avoid each other and are sometimes not even on speaking terms. This state of affairs can persist if there are no external factors to change the situation. In the worst case it can evolve into a confrontation between individuals or groups of individuals. If this results in violence or fighting, it may lead to injuries, to materials losses, and sometimes even to fatalities.

Table 6.3
Forms of conflicts among fishermen

	Manifestation of conflict among fishermen (%)			
	No of conflicts with violence / confrontation	No of conflicts with communication breakdown	No of conflicts with quarrels	Others forms
Mazera	20	36	47	2
Lahaï	12	17	23	2
Ngoudeni	12	17	15	0
Hinale	0	3	0	0
Guirvidig	5	5	5	4
Total	**49**	**78**	**90**	**8**
Percentage	35.76	56.93	65.70	2.92

Table 6.3 also shows that over 35.76% of the disputes lead to confrontation or violence between conflicting parties. This violence highlights the importance of fishery resources for the population of the floodplain and the need for a mechanism to prevent and manage these conflicts. According to the sub-divisional officer of Zina, fishery resources are indeed vital for many households, and a poor fishing season can destroy all the efforts of several years. The breakdown of traditional management of fishery resources has given way to uncontrolled access to resources and, consequently, increasing conflict.

Figure 6.1 shows that conflicts among the fishermen have existed for a long time, but they were more localized in certain areas such as the sub-district of Mazera. From the 1990s, these conflicts have spread all over the floodplain, with 40.90% of people surveyed confirming the existence of disputes between fishermen.

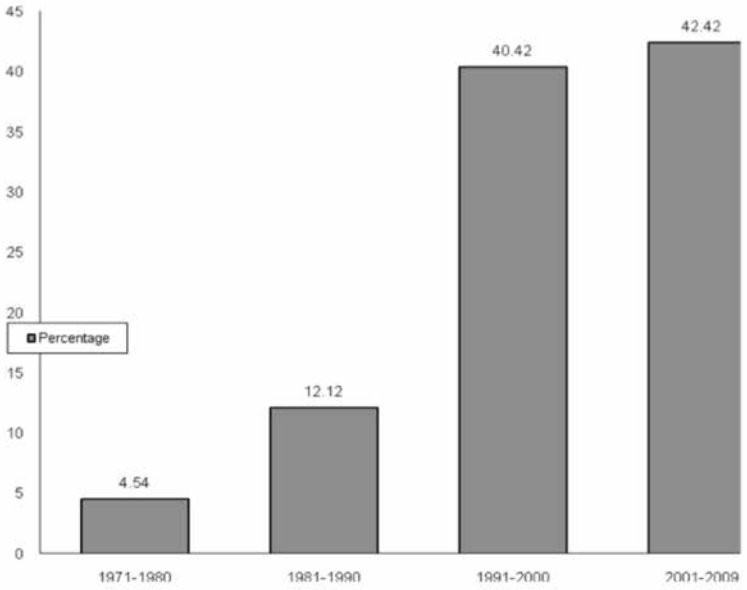


Figure 6.1
Occurrence of conflict over time in the Waza Logone floodplain from 1971 to 2009 (n=143)

People surveyed were asked to give their opinion regarding the annual frequency of conflicts among fishermen (Figure 6.1). 65% of the respondents (from several villages of the floodplain) mention that they were involved in conflicts once a year, during the peak fishing season. In villages along the Logone River and the Logomatya River, where fishing is practiced throughout the year, the conflicts also occur throughout the year. This strong relation between conflicts on the one hand and the seasonal use of fishery resources on the other hand is further supported by the increased numbers of fishermen per fishing spot (37.72 on average) during the peak fishing season.

Influence of reflooding of the floodplain on conflicts among fishermen

During the interviews, people were asked to give their assessment of conflicts among fishermen before and after the partial reflooding of the floodplain undertaken by the Waza Logone Project in 1994 and 1997. Over 80% of respondents mention that the number as well as the intensity of conflicts among fishermen increased considerably after the reflooding.

During the Zina case study, participants suggested that officials involved in the Waza Logone Project encouraged the introduction of fishing permits in the floodplains. As these permits gave fishermen the right to dig fishing channels and to use any destructive fishing method, without limits, they had a

direct influence on the proliferation of unsustainable fishing practices, which is the major source of conflicts among fishermen.

6.3.2 Main conflicts in Waza Logone floodplain over the past five years

The respondents were asked about the conflicts they knew about in the Waza Logone floodplain over the past five years and to name the one which had the greatest impact according to them. Of the twenty-seven conflicts that were mentioned, three appear to have had the greatest impact: the conflict in Tchede village (25.47%) in 2007, the conflicts in the Zina Township (12.26%) and the conflict in Malazina village (8.50%) in 2010. Below, these three major conflicts are summarized as case studies.

Conflict in Tchede village: conflict for the hegemony between the Kotoko and the Musgum

The Kotoko, descendants of Sao, were the first occupants of the Waza Logone floodplain. Because of their precedence in this location, they see themselves as 'indigenous' and as the owners of all the natural resources (land, fish, grazing, water) in the floodplain. Traditionally, the Kotoko are fishermen and they have successfully been operating a number of fishing techniques, including channel fishing.

Several centuries after the Kotoko people arrived, the Musgum people came to the area and were (still are) considered as 'newcomers' by the Kotoko group. The Musgum settled in areas vacated by Kotoko. After several centuries of submission to Kotoko rule, the Musgum people began claiming property rights on certain resources, including fisheries. They often grabbed the possibility to appoint village chiefs. For many years, Musgum groups were prepared to fight with Kotoko people in order to achieve their objectives.

In 2004, the sub-district of Lahai, which had always been administered by a Kotoko chief, was claimed by the Musgum. After several consultations, the Musgum people succeeded in appointing the head of the Lahai sub-district. For the Kotoko, this was an unhappy event.

There have been a number of clashes between Kotoko and Musgum causing injuries and fatalities. A major confrontation was avoided during the official ceremony for the appointment of a newly selected head of the District of Zina (now sub-division of Zina). During this ceremony, which was attended by many people, the new Musgum chief of Lahai demonstrated insubordination and defiance against the Sultan of Logone Birni. The Sultan of Logone Birni, who belongs to the Kotoko ethnic group, is the higher traditional authority in the area and he is greatly respected. For the Kotoko community, the

chief of Lahai's actions were a public insult. This incident further raised the tensions between the two ethnic groups.

Subsequently, the Musgum of Lahai blocked the road through their village to the market of Pouss for several weeks. Pouss is a big market center in the Maga sub-division, near the Maga Lake. For several weeks, economic activities were hindered in Zina. The Musgum group, liberated by their release from the heavy yoke of Kotoko authority, continued to carry out attacks on several locations in the floodplain. According to some of the people interviewed, they had support from certain political authorities and other Musgum people coming from Chad.

In 1997-1998, a conflict had already created tensions between fishermen from Tchede village and those from Soufna village. The dispute centred on the control of waterholes at the periphery of the Waza National Park. Through the intervention of the local government, the conflict was resolved by assigning a waterhole to each community. However, due to the fact that the waterhole inside the Waza National Park is government property where officially no fishing activity is allowed, there is no formal possibility to share this waterhole among the riparian communities.

The Musgum, pursuing their goal of liberation, continued their preparation and mobilization. To prepare the clash, a group of Musgum fighters were installed inside the Waza National Park. In Tchede village, young people were advised to fish in groups and carry weapons with them in order to defend themselves against any attacks. During the 2006-2007 period, when tensions between the Kotoko and Musgum communities became inflamed in response to previous events, some Musgum fishermen from Soufna village destroyed several Malian traps, belonging to Kotoko fishermen from Tchede village, that were installed along the Tchikam waterhole (this waterhole is located inside the Waza National Park). One morning in 2007, a Kotoko fisherman was attacked by a group of Musgum fishermen inside the park. Since fishing was done in groups, the other members of the group came to help their 'brother'. The confrontation ended with one Kotoko fisherman seriously wounded and one Musgum fisherman dead. For the Musgum, this confrontation was 'the straw that broke the camel's back' and consequently the Musgum mobilized some 3,500 of their people and attacked the Kotoko inhabitants of Tchede village (Zina police chairman, personal communication).

For many hours, the Kotoko people of Tchede village defended themselves against Musgum fighters. However, their numbers were not enough to hold them off.

No precautions had been taken by the local government to prevent this event, and the handful of policemen (i.e. a maximum of ten) that were present in the area did not have the power or the means to handle the situation.

The nearest policemen base in Zina Township did not have the possibility to rapidly intervene either, since the area was flooded during the time of the conflict (December-January). As roads are largely inaccessible during this period and communications are hampered, headquarters in Kousseri or in Maroua could not be reached. It took two days for reinforcements to arrive, only after a policeman walked on foot through the water to alert the security authorities.

This conflict caused significant damage. In addition to the loss of life (officially eight people died in the conflict), some 80 to 90 houses were burned down, approximately 1,000 animals (cattle, goats, sheep and donkeys) were stolen or killed, and large quantities of fish were plundered. The total monetary loss is estimated at about 95 million FCFA (€ 144,827), according to the local government.

Besides material losses, there were social consequences, including trauma and injuries. Moreover, the elderly, women and children, desperate to escape the clashes, had to take refuge in the bush for four days. The children lost an entire school year because the teacher, traumatized by the fighting, never returned to the village.

Since this conflict took place, there have been no common activities between the two villages. Even by 2011, four years after the conflict, the trade between the two villages was still not re-instated.

In order to reconcile the two communities and restore peace in the area, many interventions have taken place. After the clashes that took place in Tchikam (WNP), the sub-divisional officer, the security authorities (police and gendarmes) and other dignitaries from Zina visited both Tchede and Soufna villages to try to calm the opposing parties and encourage them to resolve their dispute through negotiation. The divisional officer of the Logone and Chari division, the Governor of the Far North region and the Minister of Territorial Administration and Decentralization visited the affected populations in an attempt to calm them down and seek solutions to the dispute. A commission was established to evaluate the damage and to compensate victims. It was decided to provide assistance to the people who lost everything in Tchede village through some 100 kg of sorghum, two lengths of cloth, seven pieces of soap, 7.5 liters of oil and 50,000 FCFA (€ 75), that were given to each family.

The Cameroon Red Cross has also provided support to the victims. They supplied each household with two lengths of cloth, two pieces of soap, kitchen materials (two pots, one bucket, one cup, four plates), four blankets, a package of 100 hooks, a mattress, 20 liters of oil, 50 kg of sorghum, 50 kg of maize and three sets of clothes for the children of the families. Financial support to the victims came in the form of three million FCFA (€ 4,573), which was raised by relatives and acquaintances.

The governmental commission evaluated the total compensation at 95 million FCFA (€ 144,827); however, until now, many people are still waiting for this compensation.

Despite many interventions, there has not yet been any real reconciliation between the two ethnic groups in the Tchede and Soufna villages and at the level of the floodplain. Although the distrust between the two ethnic groups seems to be ever present, people believe reconciliation efforts by the Sultan of Logone Birni might eventually be successful.

Conflict in Malazina village: Conflict over sharing fishery resources in the same village

Malazina Village, known as a conflict-ridden village, especially between 2008 and 2010, is a large village divided into several quarters, which have gradually become autonomous in their own right. Each quarter has its own *Blama* (the traditional chief of the village). Musgum fishermen from the same ethnic group claim the management of a portion of the Logomatya River that is abundant in fish. In 2009, Musgum people from Malazina North and some from Malazina Centre clashed, resulting in four injured and financial losses that were estimated at nearly three million FCFA (€ 4,573).

Below, I will present three different views of the same conflict: the first is the view of the inhabitants of Malazina North; the second is the view of a number of people from Malazina Centre; and the third describes the view expressed in an interview with a local mediator, known as Dangui David, from outside the village.

View of Malazina North, including their Blama (B. Harouna)

For 17 years, the population of Malazina (who are all Musgum) was a peaceful fishing community, until a dispute arose five years ago within the village. Tensions, due to the fact that people from Malazina North are considered as 'newcomers', while a number of the inhabitants of Malazina Centre are seen as 'indigenous', would have served as the major trigger.

In the beginning, the population of Malazina Centre sought to appropriate definitively the waterholes that provide important quantities of fish each year. As the conflict escalated and became serious, the sub-district chief of Guirvidig was informed, but his intervention was unsuccessful. The local government set up a commission to better understand the conflict and propose an equitable solution. Members of the commission conducted a field visit in order to assess the conflict and hold discussions with the people involved. The commission proposed that the village would choose a date on which the fishermen of both opposing quarters would all fish together, in the presence of the local government members. Both parties agreed on a date, yet the people

from Malazina North were fundamentally against the sharing of resources in the first place.

In early 2010 the two groups clashed. Four people were injured and the local government decided to forbid fishing activities at this waterhole. However, the Blama of Malazina Centre ignored the ban and started to use the waterhole for his own fishing activities. In doing so, he amassed more than two million FCFA (€ 3,049) to line his own pocket.

View of inhabitants of Malazina Centre, including their Blama (B. Brahim)

The population of Malazina Centre has lived on the site for over a century. Those who came later, settled in the North and South of Malazina, in the year 1980. There are four waterholes in the village, each more or less corresponding to the village divisions. Fishing activities in each of the waterholes had always been organized according to the divisions, but due to a decrease in productivity of 'their' waterhole, the people from Malazina North wanted to start sharing fish from the waterhole of Malazina Centre, which was more productive. The first manifestations of conflict started in 2007 and were initially limited to quarrels and public insults, but eventually escalated in 2010 when a serious confrontation between the two groups took place.

Several conflict resolution initiatives, including interventions by friends, traditional authorities, as well as the local government, could not persuade the disputing parties to settle their disagreement.

The divisional officer of Mayo Danay eventually set up a commission in an attempt to solve the conflict. In addition to a 'joint fishing day', during which the parties would fish together, the commission suggested that catches should be divided into four parts: one part to finance children's education (school), one part for Malazina North people and two parts for Malazina Centre people. Malazina North was not happy with this proposition; they tried to bribe the President of the commission who is the sub-divisional officer of Maga sub-division with an amount of 720,000 FCFA (€ 1,097). When one day the fishermen from Malazina North came to harvest the waterhole outside the agreed hours, they were intercepted by people from Malazina Centre and the resulting confrontation resulted in injuries.

View of a neutral and external person (David Bangui), who was involved as a mediator in the resolution of this conflict

This conflict started ten years ago with a dispute over traditional authority. Malazina North and South, which have been under the authority of the *Blama* of Malazina Centre for a long time, sought independence. They received support from a local influential person, the Mayor of Maga.

The problem of leadership quickly transformed into a conflict over the control of the most productive waterholes in the village. The population of Malazina North wanted to participate in the harvesting of the waterholes owned by Malazina Centre. In 2009, the population of Malazina North used its power and relations to get the exclusive right to fish in this waterhole. When they wanted to repeat the same scenario in 2010, there was a confrontation between the two communities. This confrontation resulted in four people being injured, two on each side. Injuries were minor for those from Malazina Centre, but the two people from Malazina North were seriously hurt. They were transferred to a hospital in Maga and then to Maroua, the regional capital of the Far North.

Several attempts to resolve the conflict took place but without success. In addition to mediation attempts by friends from nearby villages, there was an intervention by traditional authorities and local government (sub-divisional officer of Maga and the divisional officer of Mayo-Danay). In 2011 the local government proposed that the waterhole be fished by the residents of Malazina Centre but that the fishery products should be divided into four equal parts. One part should be for the school, one part for Malazina North and two parts for Malazina Centre. However, this solution has never really taken effect because of the violence. The head of Malazina Centre, who was always open to negotiation, is now very reluctant because of the confrontation. At the time of the interview (2011) the case was still in court in the Kousseri, *Logone et Chari* division headquarters.

The conflict is now latent, but the people of Malazina North have lost a great deal and are still unsatisfied, so the conflict could flare up again, especially once the fishing season gets underway.

Conflict in Zina village: conflict between rich (channels owners) and poor fishermen

In the past, fish was abundant and there were hardly any conflicts between fishermen in Zina village. Common fishing activities were peaceful and everyone could find fish to satisfy their needs. Between 2001 and 2007 conflicts between the owners of fishing channels and the other fishermen started to occur much more frequently. Owners of fishing channels are considered to be rich people who harvest a considerable part of the catchable fish, using labor and intensive fishing materials. Compared to the past, when fish was consumed locally, most of the catch is now intended for external markets. Poor people are claiming to have no alternatives for generating an income and accuse fishing channel owners of monetizing the local economy and thus further impoverishing those who are already poor.

Although the problem regarding the polarization of fishing rights gradually aggravated with the expansion of fishing channel fisheries, the conflict has always been mainly restricted to quarrels or a breakdown in communications. Whenever a conflict arises, the people of Zina village prefer negotiations and almost always reach a resolution after preliminary discussions.

Although different in their intensity and solution, the three cases of conflicts over fishery resources discussed above highlight the importance of social conflicts in the Waza Logone floodplain. Fish is a vital resource for the people of this area and its control is a critical factor for every community, even within the same ethnic group.

6.3.3 Conflict actors and roots

Actors

Based on our sample population, stakeholders in conflicts can be divided into two groups: fishermen and other stakeholders. The group of fishermen includes four categories: fisherman-farmers, fulltime fishermen, migrant-fishermen and fish sellers (Figure 6.2).

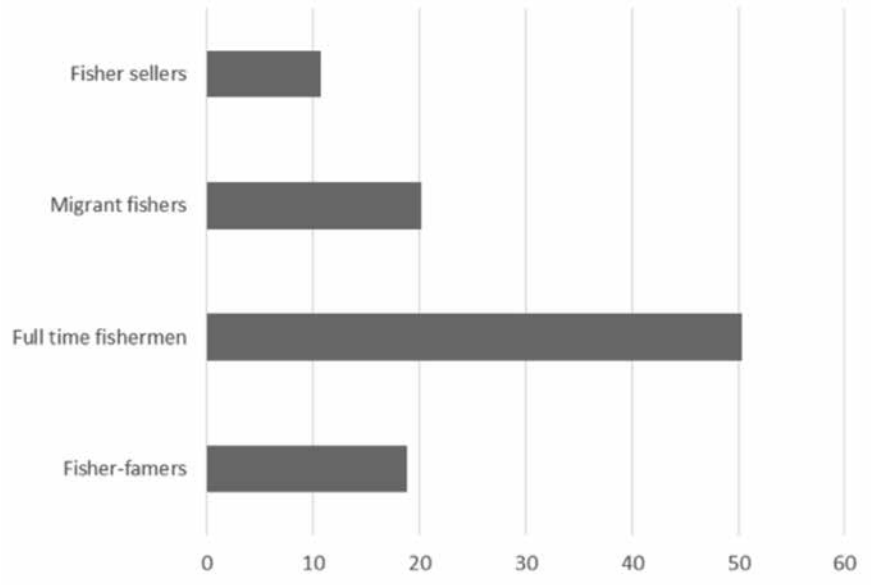


Figure 6.2
Types of actors involved in conflicts within fishers groups (n=143)

These categories of fishermen do not have the same interests and the same range of activities. As a result of their strong presence in the sample (50.30%)

and their complex fishing materials, the fulltime professional fishermen appear to be more significant, in terms of the extent to which conflicts are related to fishery resources, compared to other categories. Moreover, for this category of fishermen, fishing is the main source of revenue. Because of the increase in the commercialization of fish, due to the strong demand coming from Nigeria, fishermen started to improve existing fishing methods, such as the fishing channels. They actively invest in them and are also digging new channels while maintaining the old ones. Owners of fishing channels now have 'exclusive' rights and deprive the 'small' fishers of accessibility to fishery resources.

Second to the fulltime fishermen as actors in conflicts are the migrant fishermen (20.10%). They come from surrounding villages during the intensive fishing period and share fishing spots with resident fishermen. The migrant fishers are accompanied by all their active family members, even children of school age. In the intensive fishing period, there are twice as many migrant fishermen as there are resident fishermen.

In addition to these main actors, an additional four external actors have been identified; these include neighbors, traditional leaders, political leaders and officials of the local government (Figure 6.3).

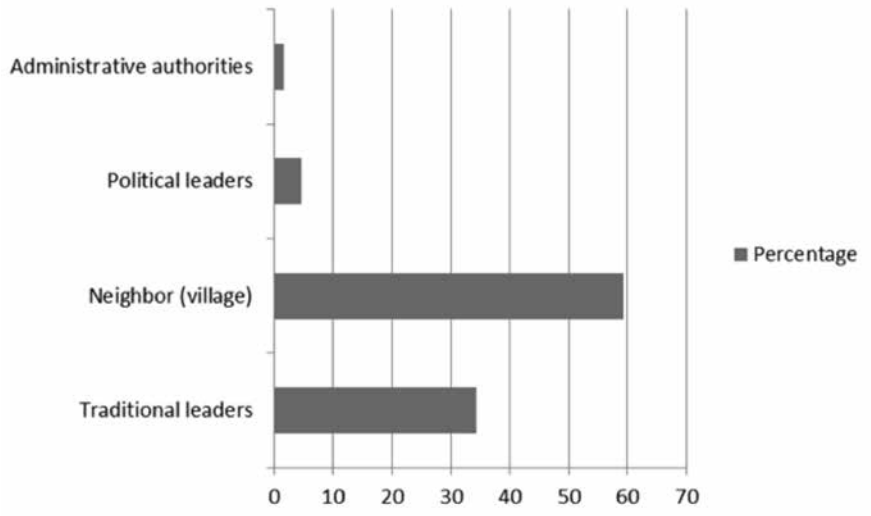


Figure 6.3
External actors involved in fishing conflicts (n=143)

For several years, the villages sharing the same waterholes have attempted to establish a system of community management of resources. The revenues generated are used to implement social and community projects. For various

reasons, the sharing of resources sometimes creates conflicts between neighboring villages (59.4%). Claims of ownership then arise between the villages.

To ease tensions between the villages, the local government has suspended the use of several community waterholes. In 2009-2010, this was the case with waterholes in the villages of Davagan/Patmangaï and Tchoukouf/Soufna.

According to 34.4% of respondents, traditional leaders are the main antagonists in fisheries conflicts in the floodplain. Traditional leaders, who are supposed to represent the collective interests, sometimes take decisions based on their personal interests. They sometimes use the revenues generated by the fishery resources to appropriate the waterhole with the support of the local government for example.

Political leaders also sometimes use conflicts related to fishery resources to achieve their goals. According to the administrative and municipal authorities, the violent conflict that took place in 2007 in Tchede Village is an example of this. The support given by political leaders to a certain ethnic group (e.g. Kotoko/Musgoum in the case of the Tchede Village conflict) is expected to be rewarded by a massive alignment of voters behind their candidacy. Some of the interviewed stakeholders (i.e. heads of the fishing center, responsible for fisheries in the Sultanate of Logone Birni) further concur that conflicts over fishery resources constitute an illegal but important source of revenue for the local government of the floodplain. Considerable sums are often paid by the parties in conflict to the authorities in order to generate their support. Moreover, since 2007, the local government has decided to suspend a number of waterholes at high risk of conflict.

Causal factors of conflicts related to fishery resources

The results summarized in Figure 6.4 indicate the main causal factors in terms of conflicts over resources in the Waza Logone floodplain according to the respondents. Ten causes of varying degrees of importance have been identified.

Practically, all causes are linked to natural resources, with competition over fish stocks (66.43%) being the main contributing factor, followed by the decline of fishery resources (54.34%). The ownership of fishing spots (37.76%) and the propagation of fishing channels (36.36%) are also predominant causal factors. Other relevant factors include human population growth (20.07%), and lack of respect for rules (14%). Attenuation of the authority by traditional leaders (3.5%), manipulation by politicians (2.1%), and lack of alternative (0.7%) are less often considered as a source of conflict.

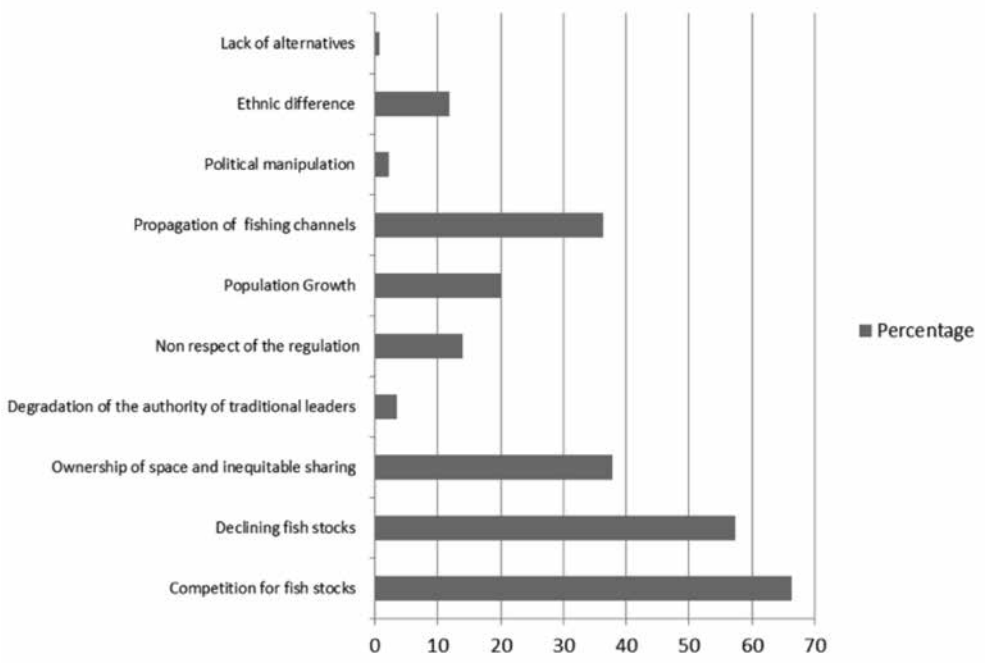


Figure 6.4
Causes of conflicts related to fishery resources according to interviewed people (n=143)

6.4 Discussion

Although conflict is inherent in any society, its amplification and its intensification in the Waza Logone floodplain in recent years has had serious effects on natural resources and on the people living there. Despite numerous studies conducted in the floodplain, reliable and subjective inside-information on the impacts of these conflicts is still limited, and policy makers as well as other development actors are reluctant to adequately act on any information that is available.

My results show that in some areas (i.e. Lahai and Guirvidig), respondents were involved in disputes more frequently. This confirms the statements of the administrative and technical authorities in Zina who believe that these areas constitute pockets of conflict and should merit special attention. The village of Malazina is divided into two parts. One part belongs to the Maga sub-division and the other to the Zina sub-division. This administrative incoherence is a key factor impacting social cohesion in the village and is a reflection of the general understanding that common activities and decisions are always difficult to make and to follow up.

Despite the existence of mechanisms that aim to prevent conflicts between users of natural resources, the number of conflicts in the Waza Logone floodplain has not decreased. On the contrary, conflicts are increasing, have become more violent and increasingly involve multiple stakeholders (Loth, 2004). The Waza Logone floodplain has become an area of conflict between different users of the resources available in the area. Often perceived as inter-ethnic rivalries between Musgum and Kotoko, these conflicts occur in all seasons of the year and most often take place in the territory of the sub-division of Zina and Maga, or sometimes in the sub-division of Logone region-Birni. From the turn of the century, conflicts have resulted in permanent disabilities for a number of people, and even multiple losses of human life. They have also led to the imprisonment of more than a hundred individuals (ACEEN, 2007).

In addition to the four major factors that have been identified to cause conflicts (competition for fish stocks, declining of fish stocks, ownership of space and inequity in sharing fish production and propagation of fishing channels), institutional failure must also be considered as a substantial initiator of conflict. Conflicts resulting from the attenuation of the local traditional power constitute a great deal of the conflicts related to access to fishery resources.

The traditional Kotoko fishermen have lost their supremacy over fishing rights to the benefit of the Musgum ethnic group (Van Est, 1999). This situation has led to human exclusion and the explosion of fishing channels (Loth, 2004).

6.4.1 Conflicts and their manifestation

Our findings confirm the results of previous studies (Mvondo *et al.,* 2003; Loth, 2004; Scholte, 2005), in that agro-pastoral conflicts and conflicts between farmers are less significant than conflicts among fishermen. This can be explained by the fact that agriculture and animal husbandry are both highly localized and seasonal activities in the area, while fishing is practiced widely and more intensive.

My findings reflect those of Sighomnou and Naah (1997), in terms of the impact of reflooding tests in the Waza Logone floodplain; the massive return of people that had fled the desiccation during the 1980s, led to a rapid growth of the population and consequently to increased competition over fishery resources. Some areas that were once abandoned have been reclaimed and fishing practices did not only become more frequent and intensive, the methods and gear that were used by fishermen were replaced for new ones or adapted to become more effective, as was for instance the case with fishing channels and Malian traps. Mitigation measures, which were implemented to limit the

access to fishery resources while at the same promoting their sustainable use, have clearly been inadequate.

6.4.2 Causal factors and actors

Competition over fishery resources

It is generally agreed that fish in the Waza Logone floodplain is a vital resource and that fishing has always been a subsistence activity. While a bad fishing harvest could critically affect a household for the rest of the year (sub-divisional officer of Zina personal communication, 2010), a good fishing season significantly improves the lives of all household members (Mvondo *et al.*, 2003).

Today, money from community fisheries is also used to satisfy other needs (socio-cultural events, marriages, baptisms, etc.), to improve local infrastructure and for the acquisition of better and faster means of transport. The latter two measures have been deployed to better conserve fresh fish and to limit decay during its transport to larger cities such as Maroua in the South or Kousseri in the North. Also, such measures should protect transported goods from bandits (known locally as *coupeurs de route*) who are involved in ambushing traders returning from the market (Saibou, 2010).

Declining fish stocks

Due to the high demand for fish, associated to the strong human population growth and the increased demand for fish for the Nigerian market, fish has become a valuable commodity. People utilize all gear and fishing techniques available to enable them to catch as much fish as possible. As a result, conflicts were frequently reported (37.76%) to have been caused by issues over the appropriation of fishing spots (waterholes, river beds) and the unequal distribution of fish caught in the communitarian waterholes. This was particularly true for conflicts between fishermen in the sub-district of Lahai, where people from certain (sections of) villages appropriate the waterholes for their own interests.

This aspect of bad governance is a typical aspect of Cameroonian society. At every level of responsibility, people in charge of common affairs often primarily focus on their own interests. Inequity and injustice are present at every stage of the decision-making process. This kind of mis-governance and unreliable leadership, as shown by Colletta *et al.* (2001), provides the context for permanent conflicts.

Although such fraudulent affairs are generally linked to local authorities or political actors, local NGOs, such as ACEEN (Association pour la Conservation et l'Education Environnementale) and ACORD (Association for

Cooperative Operations Research and Development) could also potentially become stakeholders to either side of a conflicting situation. These organizations strengthen the capacity of the local community by elaborating new rules for fisheries management and are lobbying for more investment in the Waza Logone floodplain in order to create alternative revenues for the population and for themselves.

Propagation of fishing channels

Fishing channels contribute to increased conflicts, not only between fishermen, but also between fishermen and farmers (see also Chapter 5). The jealousy that results from better profits generated by some, while leaving others deprived from a good catch, has led to many conflicts in the area (Figure 6.6).

Fisheries' regulations

According to those interviewed (14%), some conflicts could have been avoided if existing regulations in the fishing sector were observed. In the past, traditional leaders played an important role in the control of fishing activities, including the prohibition of illegal fishing gear. Nowadays, the traditional regulations over fishery resources have been compromised according to the fishermen. The Technical Fishing Centre, which should ensure compliance with existing regulations, does not have the power to enforce the law and is generally facing resistance from fishermen if it tried to do so. They are said to sometimes even bribe authorities and to often seek the support of elites (Heads of the fishing centers in Mazera and Evie, 2010). This lack of reinforcement and general mismanagement by authorities has also been reported for other developing countries (e.g. Bennett *et al.,* 2001 in relation to fishing conflicts in Ghana, Bangladesh and the Caribbean).

Ethnic differences

Although not a major determining factor in conflict situations, ethnic differences are still sometimes considered to be the cause of conflicts between fishermen (11.9% of those interviewed). Studies on the floodplain (Loth 2004 and Mvondo *al.,* 2003) and the interviews we conducted with the local government and the responsible person in charge of the fisheries sector in the Sultanate of Logone Birni (2010) confirm this. Especially the relation between the Kotoko (who claim to have made great sacrifices to keep fishery resources for many years) and the Musgum (who feel victimized by the traditional rule of the Kotoko for several centuries) is still subject to a lot of tension. Nevertheless, the advent of the democratic system and the numerical dominance of Musgum have partly changed some of the political, social and economic conditions, and the Musgum seem to start liberating themselves from the Kotoko 'yoke'.

Attenuation of the authority of traditional leaders

The conflicts between Musgum and Kotoko have contributed to the weakening of the authority by traditional leaders over the use of natural resources in general, and fisheries in particular. Access to fishery resources became free and rather disorganized, promoting the development of certain illegal fishing gear, other forbidden practices and exclusive ownership of waterholes. This downward spiral of events has, in turn, increased the potential for conflict in the area.

Political manipulation

As is the case in other societies where poverty is pervasive and democracy is weak, authorities tend to act more often for their own benefit than for the common cause (Borrini-Fayerabend *et al.,* 2004). The conflict in the village of Tchede, which quickly developed into ethnic rivalry, has been an illustrative example of the intervention of political leaders in the emergence of conflicts over fishery resources. During the conflict, politicians were backed up by the ruling party to negotiate with 'their population', something that gives them power and a good image. They then used this power to promise better livelihoods for the population.

6.5 Conclusion

Conflicts among fishermen is the most prevalent type of conflict in the Waza Logone floodplain, and more than 50% of those surveyed have been involved at least once every year in a conflict between fishermen. These conflicts between fishermen manifest themselves in the form of quarrels, communication breakdown and violence/confrontation between the opposing parties. Over 50% of disputes usually end in violence between belligerents. The reflooding undertaken by the IUCN Waza-Logone Project, in order to restore the functions of the floodplain and to reduce the intense competition for fish, has had the opposite effect in terms of conflict frequency and intensity. The little attention paid to social aspects during the implementation of the project has contributed to increasing conflicts between fishermen.

The fishermen, neighbors from surrounding villages, traditional authorities, political leaders and local government are the main actors behind conflicts between fishermen in the Waza Logone floodplain. For fishermen, the competition for fishery resources, population growth, declining fish stocks, increasing fishing channels, ownership of land (waterholes and river bed) and lack of respect for existing regulations are the main causes of these conflicts.

7

Co-management and Impact of Conflicts

7.1 Introduction

Co-management should always take into account that, for a natural resource to be managed properly, the users of the resource should be involved, particularly with regard to the formulation of laws and regulation work. Pomeroy and Berkes (1997) refer to co-management or community-based resource management as a 'way of activating social processes at the community level in resource management'. Where, co-management systems are being implemented, they are partnership arrangements that take capacities and interests of local resource users into account and depend on government participation for the necessary legislation, enforcement, and conflict resolution mechanisms.

Borrini-Feyerabend *et al.* (2000) suggest that for the co-management of natural resources to be effective, 'two or more social actors should negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources'. People from around the world have shared water sources for centuries. Whether officially co-managed under certain agreements or not, water has been effectively utilized by people from various backgrounds and cultural habits. Traditional associations for water management are omnipresent and thoroughly studied worldwide (Borrini-Feyerabend *et al.,* 2004).

In Cameroon, fisheries are an important and vital sector both for food and the economy. Fish is the most accessible protein source for Cameroonians, especially for the poorest people. Fish products contribute around 25.5% of the protein food intake in Cameroon. The average fish consumption per head and per year is 17.9 kg, against 13.1 kg/inhabitant for meat (Ngok *et al.,* 2005).

From a social perspective, artisanal fishery (maritime and inland), which accounts for 62.5% of fishing activities, is exclusively a rural practice. It provides direct employment during harvesting and indirect employment in all post-harvesting and related activities. This amounted to around 250,000 jobs in 2003 (65,000 in fisheries and 185,000 in related activities) (Ngok *et al.,* 2005).

In terms of the economic aspect, fisheries contribute to creating wealth through the marketing of fishing gear and tools as well as income from the catch itself. In 2003, fishing activities (including processing and related services) generated a value of 119.4 billion FCFA, which is 1.7% of the total value of the rural sector: 52.4 billion FCFA from maritime and inland artisanal fisheries, 58.4 billion FCFA from processing and related services and 8.6 billion FCFA from industrial fisheries (Ngok *et al.,* 2005).

In Cameroon, the Ministry of Husbandry, Fisheries and Animal Industries (MINEPIA) is in charge of fisheries. Its main tasks in relation to the fisheries sector are: (i) the development, implementation, and the monitoring and evaluation of government policies on fisheries and aquaculture; (ii) the management and sustainable development of fishery resources; (iii) the development, implementation and monitoring of projects in fisheries and aquaculture; (iv) the promotion and development of fish and fish products; and (v) the extension of techniques in fisheries and aquaculture.

The main question in relation to such regulations I would like to answer in this chapter is whether they are adequate and sufficient for current fishery practices in the Waza Logone floodplain and what the impacts of the associated conflicts are on the livelihoods of the human population in the study area.

The basic ingredients of co-management, as suggested by Pomeroy and Berkes (1997), comprise the capacity and interests of the resource users and the capacity of government to provide legislative support for such action or intervention. The question is whether or not examples of co-management can actually be found in the Waza Logone floodplain. The way in which fisheries are controlled and regulated has an effect on food security, livelihoods and poverty alleviation (Bene *et al.,* 2003b). Fishery resources management and the benefits derived from fisheries are hampered by bad or weak policies. Research into the governance of fisheries should therefore include an analysis of existing policies.

7.2 Methodology

Chapter 1 provides a more comprehensive description of the study area. The research methods and materials were selected to obtain both qualitative and quantitative information. The methods included a literature review of secondary information, surveys, case studies and focus group discussions in the villages. I interviewed 143 inhabitants from 19 villages in the Waza Logone floodplain. Table 7.1 provides a summary of the methods used.

Table 7.1
Methods used for the study

Methods	Objective	Participants	Tool and techniques
Literature review	Obtain secondary information	Libraries and institutions	Search and consultations
Interviews	Obtain primary data	Sample people in the village	Questionnaires
Focus group discussion	In-depth information	Resource people in villages	
Statistical analysis	Generate relevant information and illustrative graphics		SPSS Software 17.0 Excel software

7.3 Results

7.3.1 Laws and regulations

In the Waza Logone floodplain, three types of laws and regulations are identified: formal laws, traditional regulations and local agreements.

Laws

The fisheries legislation in Cameroon is based on law nº 94/01 of 20 January 1994 concerning the forest, wildlife and fisheries management and its application decrees (decrees nº 95/413/PM of 20 June 1995 and nº 2001/546/PM of 30 July 2001). The fundamental principle of this code is the conservation of natural resources and the protection of the aquatic environment. Although restrictions on the use of fishing gear are included in this legislation as well as strict regulations regarding the use of nets with a small mesh size, the implementation of these regulations mainly concerns the marine fishing sector. The legislation does for instance include a comprehensive section on coastal trawling. Despite the decision taken by the Governor of the Far North region in 2006, in order to reverse the degradation of the floodplain ecosystem, the implementation of this measures has never really taken effect and existing regulations are still rarely implemented for the small-scale inland fisheries, such as those in the Waza Logone floodplain.

National institutions

Five main ministries are in charge of fisheries and water issues in Cameroon. For inland fisheries, the Ministry of Livestock, Fisheries and Animal Indus-

tries (MINEPIA) defines and implements the government policies of developing fisheries and aquaculture through the Directorate of Fisheries and Aquaculture. As mentioned above, the ministry pays more attention to coastal fisheries than to inland fisheries and other ministries (e.g. the Ministry of Scientific Research and Technology, the Ministry of Environment and the Protection of the Nature, the Ministry of Economy, Planning and Regional Development or the Ministry of Energy and Water Resources), although only indirectly involved in fishery legislation, tend to have the same attitude. At the regional level (Far North region that covers the Waza Logone floodplain), there is one civil servant in charge of the fishery sector. He is based in Maroua, and the population in the floodplain has never seen him there (personal communication). In addition, two so called 'field agents' have been assigned to cover the entire floodplain. They are based in the Evie sub-district and the Mazera sub-district. What is further illustrative of the apparent subordinate position of the fishery sector in the Far North region, are the ruins of a big Fishing Business Centre, which was constructed in 1985 in the Maga sub-division and funded by a Japanese development cooperation. Despite this optimistic investment, the Fishing Centre has never been involved in local efforts to manage fish production, post-harvest losses and building capacities.

The Ministry of Scientific Research and Technology (MINRESI) is another institution that has a potential influence on fishery policy making. It conducts research through the Institute of Agricultural Research for Development (IRAD) on development issues aimed at increasing the availability of fishery resources, while trying to promote conservation of the aquatic environment. Although its research station in Dschang focuses on inland fisheries, there is no representative in the Far North region and the Regional Research Centre based in Maroua does not have a researcher working on fisheries issues.

In addition, the Ministry of Economy, Planning and Regional Development (MINEPAT) and the Ministry of Energy and Water Resources (MINEE), despite claiming to be involved in different aspects of the fishery sector, in reality do not intervene in the Waza Logone fisheries sector.

International institutions

In 1964, the four countries bordering Lake Chad (Cameroon, Chad, Niger and Nigeria), created the Lake Chad Basin Commission (LCBC), charged with the management of water resources in the area known as the 'conventional basin'. They were joined by the Central African Republic in 1994, and the conventional basin was enlarged to include the upper Chari-Logone and Komadugu-Yobe basins. The objective of LCBC is the sustainable management and conservation of Lake Chad and its wetlands by 2025, in order to preserve bio-

diversity, sustainability and equitable use of aquatic resources with the aim of meeting the needs of people in the basin and reducing poverty (LCBC, 2007).

Fisheries management systems and performance

In order to improve the management of Cameroon's fish resources, several laws and regulations have been drafted. Their adoption and implementation have brought mixed results and performances due to, among other things, a top-down approach with very low participation (involvement) of local actors (the resource user) and of civil society.

In 2007, LCBC initiated another process in the Waza Logone floodplain for reversing trends of degradation. This project was funded by the United Nations Development Programme and was the result of a regional decision to reverse the degradation of natural resources. The decision further forbids the appropriation of portions of rivers and other water bodies by individuals or groups of individuals for fishing, the creation of new fishing channels, the use of nets and traps with meshes of less than 40 mm, fishing methods that include building dams across the riverbed, the payment of taxes on fishing channels by individuals, and the maintenance (cleaning, prolonged expansion, deepening) of existing fishing channels and their surroundings.

Traditional regulations

In the Waza Logone floodplain, the villagers used to choose a 'fish manager' (*manguivini)*, who was traditionally responsible for fisheries activities. His authority regarding fisheries superseded that of the head of the village. The *manguivini* is a traditional and cultural characteristic of the Kotoko. With the ongoing modernization process and the aspiration of central government to gain control, there is now a lack of respect for decisions made by the *manguivini*. To enforce their capacity, the idea of local agreements for fish management grew.

Local agreements

Co-management is a partnership arrangement in which government, the community of local resource users and external agents (NGOs, academic and research institutions), and other resource stakeholders share the responsibility, the benefits and the authority for the management of a resource. Power is shared at different levels, and government systems (local as well as centralized) are integrated in such partnerships. At the same time, processes of strengthening and redefining the partnerships should be based on existing policies and legal environment, the political support of government for community-based initiatives, and the capacities of community organizations to become partners.

Since 2006, local NGOs such as ACEEN have been working with fishermen to implement local agreements on fisheries; a process of participation that aims to promote the sustainable use of fisheries. A local agreement is a list of objectives, principles, rules and rights drawn up and decided upon by local parties. Fishermen agree to adopt a certain fishing period and decide to respect a strict temporary fishing closure, while certain destructive fishing materials and methods are banned. One of the basic principles promotes the sharing of one part of a catch between the populations for their consumption, while the other part is sold in order to invest in social projects. Usually, this money is used for the payment of local teacher's fees, for the construction of classrooms or for the construction of mosques. The process ends with a revision mechanism for the agreement, usually after two consecutive years of implementation. The local agreement is signed by the traditional leaders, the local government and the municipalities. Even though this process is local, it is manageable and stakeholders accept and respect it. In contrast to this finding, I have also observed that, in some fishing spots, the traditional authority and the administrative authority put all their efforts into gaining a large part of the revenue coming from fisheries for their own benefit. This inequitable sharing explains why fishermen consider the management of fisheries as a major source of conflicts.

7.3.2 Conflict management

Actors involved in conflict management and efficacy

The results in Figure 7.1 highlight the different stakeholders in charge of the management of conflicts related to fishery resources in the Waza Logone floodplain. According to 63% of respondents, fishermen turn primarily to their traditional authority to manage their differences. Second in line are mediators (26%), followed by the local government (11%).

The Traditional Authority group is mainly represented by local village chiefs, who are generally easily approachable because of their proximity, traditional power, inside knowledge of cultural considerations and their tendency to preserve peace. Mediation through village chiefs is also generally faster and less expensive than other ways of mediation. Friends and mediation groups are less often approached in conflict mediation, yet their influence as 'peace keepers' should not be underestimated. Furthermore, their efforts to help resolving a conflict are generally at no cost. The local government is seldomly approached, but is generally more influential, as it has the means to restore order and enforce its decisions. The efficacy of institutions in the management of conflicts related to fishery resources is crucial if conflicts are to be reduced. Table 7.2 shows that, according to 54.54% of those interviewed,

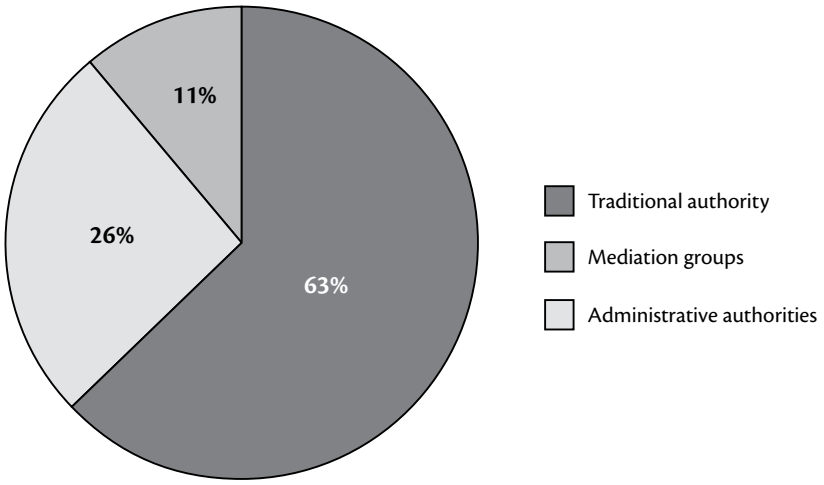


Figure 7.1
Stakeholders involved in the management of conflicts related to fishery resources (n=143)

mediation is the most efficient way to resolve conflicts, followed by the traditional trial. These two kinds of conflict management are more efficient for various reasons, including the preservation of peace, the speed and the low cost of the trial, and the respect for local cultural practices. It is also in this context that the traditional trial is seen as less stressful than the other options. The population has adopted a kind of 'legal pluralism' strategy.

Table 7.2
The most effective methods for resolving conflicts according to respondents (n=143)

	Efficacy of method of resolving conflicts			
	Mediation	**Traditional trial**	**Authority trial**	**Total**
Mazera	41	23	7	71
Lahai	12	18	33	33
Ngoudeni	22	7	2	31
Hinale	3	0	0	3
Guirvidig	0	5	0	5
Total	**78**	**53**	**42**	**143**
Percentage	54.54	37.06	8.39	100

Methods of resolving conflicts in the Waza Logone floodplain

The fishermen of the Waza Logone floodplain have a range of possibilities when it comes to dispute resolution. They can either choose to follow mediation procedures, traditional trial, or administrative trial. The choice of the parties involved is based on several criteria, including the seriousness of the conflict, the people involved, the social networks and the causes of the conflict.

The survey was based on eight different types of conflict: (i) conflicts related to fishing techniques and materials; (ii) less serious or non-violent conflict (iii) conflicts between two people in the same family or neighbors; (iv) conflicts related to the ownership of fishing space; (v) conflicts resulting in a brawl; (vi) conflicts related to fishing channels; (vii) conflicts resulting in fighting and injuries; and (viii) disputes that could not be resolved. The study group was then asked to assign each type of conflict to one of the resolution modes (i.e. mediation within the groups, traditional trial and administrative trial).

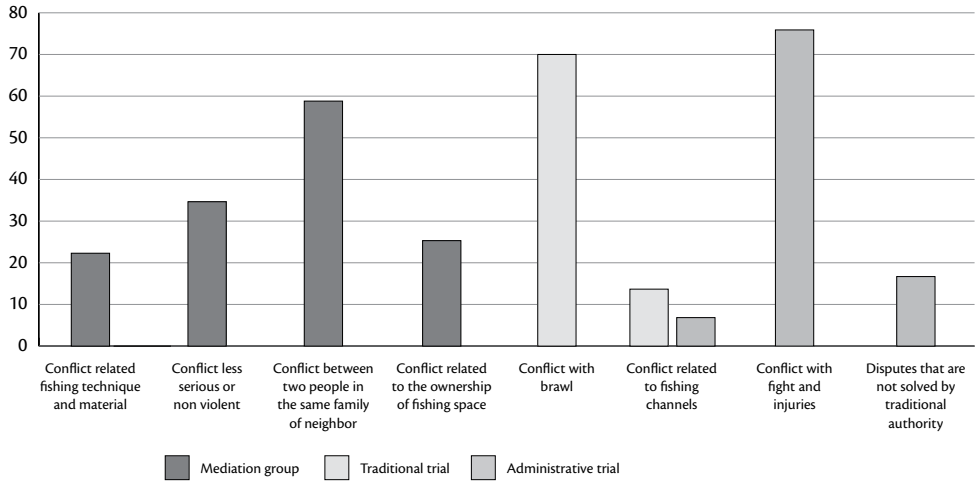


Figure 7.2
Types (in %) of disputes handled by different methods of conflict resolution in the Waza Logone floodplain (n=143)

The mediator group is the most sought after mitigation institution in the case of disputes between family members, friends or neighbors (Figure 7.2). The main reason for this dominant role is that it allows for joint decision-making by the parties, while maintaining their relationships. This form of mediation is however ineffective in cases of serious conflicts (i.e. involving physical fights and possible casualties) and is therefore considered to apply mostly to parties that are willing to negotiate and to implement the decisions they have taken.

About 70% of those interviewed say that the traditional authority can deal with all types of disputes related to fishery resources, including those that result in fighting (Figure 7.2). When conflicts tend to escalate and result in serious fights, the local government is being urged to resolve these (76%; Figure 7.2). In cases where conflicts cannot be resolved by the traditional authority, they had always first been referred to the local government (16%).

Satisfaction of the parties in conflict resolution

Respondents were generally (nearly 80%; Figure 7.3) very satisfied with the judgments by the traditional authority over disputes related to fishery resources. They say the traditional authority would take his time to listen to the conflicting parties and seek the truth, to the satisfaction of all parties. Furthermore, the traditional trial is cheaper and faster than other judgments. The 20% of respondents who were not satisfied with the judgments made by the traditional authority, claimed that decisions were frequently not enforced.

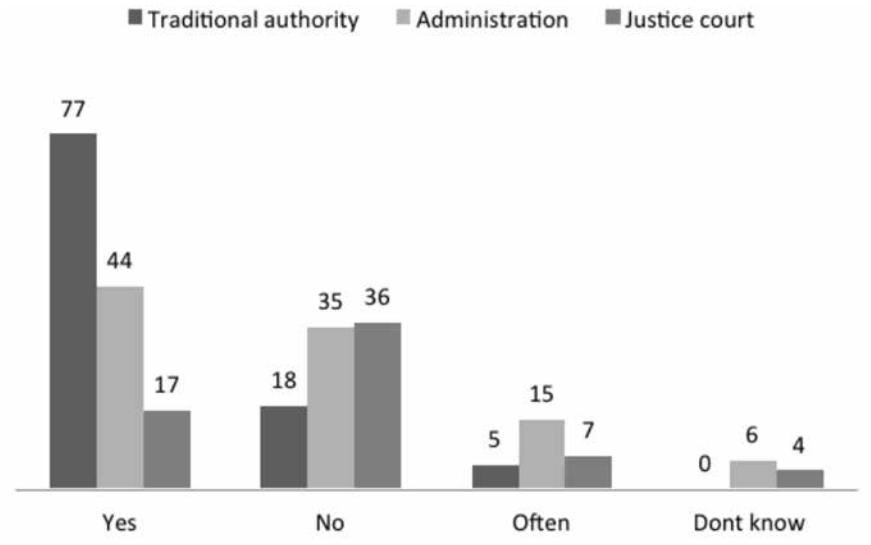


Figure 7.3
Satisfaction (%) of judgments rendered by official institution (n=143)

Whereas 44% of the respondents said they were satisfied with the judgments made by the local government, 35% were not (and 18% were undecided) (Figure 7.3).

The extent to which conflicting parties turn to local government, depends on the distance at which the governmental institution is located. When in close proximity to populations, local government can be a cheaper option for

conflicting parties seeking to resolve their dispute. Only when negotiations fail, parties would take their dispute to a formal court.

The relatively high percentages of dissatisfaction (Figure 7.3) reflects the general reluctance of conflicting parties to listen to each other during trials and the fear respondents say to experience when they have to express themselves in public. They also indicate that the resolution of conflicts is often blocked by local government and that conflicting parties have little influence on the process, other than through methods of corruption. Given these circumstances, it is understandable that some respondents criticized local government decisions for being partial, and were cynical about the process, assuming that bribes had been a part of the conflict resolution.

Figure 7.3 indicates that less than 20% of respondents were satisfied with the ruling of the court, against nearly 40% who expressed their disappointment vis-a-vis the court. About 40% of respondents would not give their opinion. This high non-response rate could partly be explained by the fact that the parties in conflict do not want their case to go to trial in a formal court since this entails great expenses and takes a long time. In addition, the trial process is not considered to be very transparent or accessible (cost, distance, language barrier). Conflict resolution in the court of justice takes place in the town of Kousseri, which is one day travelling from Zina during the flooding period and half a day of travelling during the dry season. People also often have to wait until market day to get a ride by car. This results in critical delays, which may severely impact the income for the whole household.

7.3.3 Impact of conflicts

We asked the people in our study area to classify the impact of conflicts in terms of social, economic and ecological aspects. Respondents mainly indicated to experience consequences from conflicts on their social behavior and common activities, with a high level of impact on vulnerable people (youngsters, women and elderly), but also in terms of losing money and increased poverty, as well as indirectly on the quantity and quality of fish.

Influence of conflict on social harmony and community action

Table 7.3 shows that, according to 81.75% of respondents, conflicts related to fishery resources have jeopardized social harmony as a result of communication breakdown, which, in turn, led to separation and an elimination of relationships between previously close groups (friends, neighbors, etc.).

Table 7.3
Number and % of respondents indicating different impacts of conflict on social harmony (n=137)

Sub districts	Separation, hatred and lack of relationship	Brawl and social exclusion	Does not affect our relationship, if any reconciliation	Total
Mazera	58	3	11	71
Lahai	25	0	8	33
Ngoudeni	21	0	4	25
Hinale	3	0	0	3
Guirvidig	5	0	0	5
Total	**112**	**3**	**23**	**137**
Percentage	81.75	2.19	16.78	100

Such situations are characterized by hatred and fear between the parties and a general disintegration of social cohesion. Intensified by political, structural and economic factors, this can spin off into violence. The conflict in Tchede village is an indicative example. The seven people that were killed, one hundred injured and the extensive material damage, have greatly impacted society; particularly women and youngsters have suffered psychological trauma. The cases of Patmangaï/Davagan and Tchoukouf/Sifna, where many community projects (classrooms, mosques, water points) can no longer continue because of conflicts are also illustrative of situations where conflicts have greatly hindered certain common activities.

Influence of conflicts on vulnerable groups (women, children and elders)

Although conflicts in the Waza Logone floodplain primarily involve men, vulnerable groups such as the elderly, women and youngsters should be considered as major secondary victims, who suffer e.g. psychological consequences.

Figure 7.4 shows that, according to 67% of the respondents, conflicts related to fishery resources affect women through the combined consequences of loss of friendship (25%), various sufferings (39%) and group's dislocation (3%). Women are heavily dependent on men for their needs (nutrition, health and housing) and they may suffer as a result of their husbands' involvement in conflicts. The consequences are hunger, poverty, loss of friendship and, in some cases, complete dislocation of families. When the conflict becomes violent, women may become direct victims; in the Tchede conflict for instance, one woman was even killed in the fighting and a few more were injured. Others suffered great material losses (bedding, dishes and clothes) as a result of fire and plunder during this conflict. Conflict situations where women were said

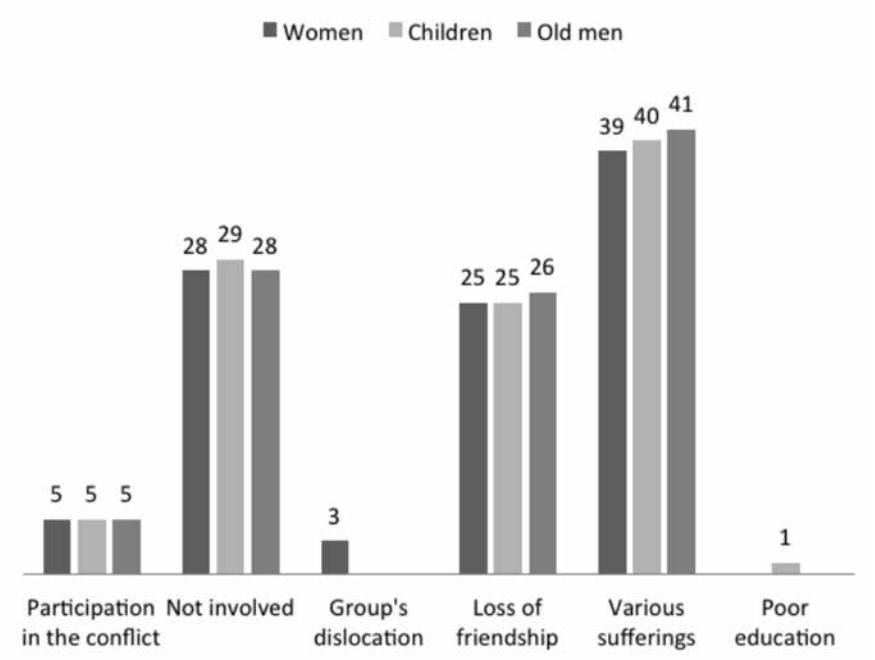


Figure 7.4
Percentage of vulnerable groups affected by conflict (n=143)

to be not involved at all (28%), mostly concerned non-violent quarrels or conflicts that take place in fishing areas far away from the settlement.

Figure 7.4 further shows that according to the respondents, 71% of the conflicts between fishermen have had an impact on their children. Especially children whose parents are involved in conflicts are severely affected, which is most often expressed through various sufferings such as hunger and poor health. In the case of the conflict in Tchede village where riots and fires occurred, children have had traumatic experiences and developed feelings of fear and hatred towards those who triggered or who were involved in the conflict. Although impacts through a lack of education were hardly ever mentioned to affect children, respondents did mention that, in violent conflict situations, children were forced to leave or change school for their safety.

Similar to children and women, old men also often depend on adult men for their nutrition, health and safety. They are thus directly or indirectly affected by conflicts involving male adults. Figure 7.4 shows that in addition to various sufferings (such as hunger, insecurity and poverty), the conflicts related to fishery resources also entail the separation of families, impacting elderly who often develop feelings of hatred towards the opposing party.

Influence of conflicts on fish production

Conflicts between fishermen could affect both the quantity and quality of the fish resources they use, and thus eventually affect the economy. Approximately 61% of the respondents say that conflict has a negative influence on the quantity of fish caught. In a context of conflict, people are stressed, they spend less time in fishing and only active fishing materials are used. Because of these economic implications, political and government stakeholders are probably more likely to invest in the mitigation or prevention of this kind of conflicts.

Still, about 39% of the respondents mention that the decline of fish stocks is not related to any conflict situation but is rather due to reduced flooding as a result of the development of the SEMRY rice scheme project and the population increase after the massive return of migrants following the reflooding pilots in 1994 and 1997.

Money spent on resolving conflicts related to fishery resources

Fishermen generally have several options to settle disputes over fishery resources: mediation, the customary mode of trial, and the rule of formal law. Each option has financial implications for the parties in conflict.

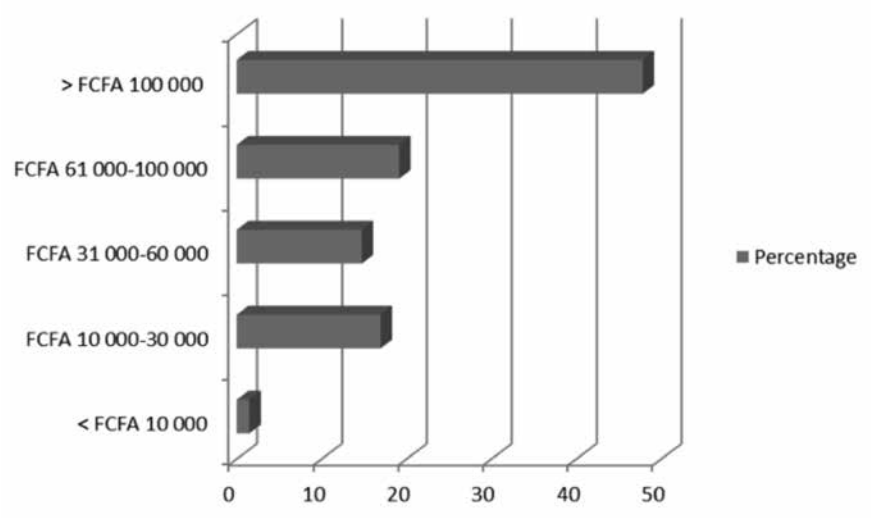


Figure 7.5
Amount of money spent on conflict resolution (n=143)

Of the respondents, 47.8% suggest that the conflicting parties would spend over one hundred thousand francs CFA (152.4 Euros) for the settlement of their conflict (Figure 7.5). This money would be used primarily to bribe authorities to obtain a favorable result. In addition, money would also be spent

on transportation and fines. Disputes over fishing ponds often entail significant costs because the stakes are high. In some cases, the local government will eventually suspend fishing in a disputed waterhole.

The first census I conducted in 2009, and the general human census (BURCREP, 2010), estimate the total population at about 41,415 people. This corresponds to a total number of 3,824 households (an average of 10.83 members per household). In combination with an estimated 1.49 conflict per person, per year (Chapter 6) these figures lead to a calculated average amount spent on conflict resolution per year of 298.5 million FCFA for the Waza Logone floodplain. Additional losses due to the Tchede village conflict, as estimated by the official governmental commission in 2008 amounted to 122 million FCFA (Official evaluation report).

Influence of conflict on children's education

In the sub district of Lahai, where social actions in general and education in particular are financed by the income from common fisheries, conflicts cause disturbances that also affect the education of children. The income from fisheries would normally be used to build classrooms and to support the teachers. Some education projects in the area have been disrupted because of conflicts, such as in Tchoukouf village where a project to establish a Koranic school was abandoned after a conflict.

In the sub district of Mazera, where there were violent clashes, education has been severely affected. For the safety of their children, the Musgum do not want to send their children to the college in Zina where the majority of the population is Kotoko. In Tchede village, the teacher, who has been traumatized by the violence between the Kotoko and the Musgum, had to resign. For a year, the children were left without a teacher. All the Musgum children in the villages around Tchede were unable to attend school for a long time. Some villages had to take the initiative and set up their own schools. In Ngoudeni village, following the conflict between the Kotoko and Musgum due to the control of waterholes and fishing channels, the Kotoko children stayed away from school for two years.

Table 7.4 summarizes the impact of conflicts over fishery resources on the education of children in the Waza Logone floodplain.

Table 7.4
Number and % of respondents indicating different impacts of conflict on children's education (n=136)

Sub districts	Yes		No		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Mazera	24	33.8	47	66.2	71	100
Lahai	20	60.6	13	39.4	33	100
Ngoudeni	7	29.1	17	70.8	24	100
Hinale	1	33.3	2	66.6	3	100
Guirvidig	0	0	5	100	5	100
Total	**52**		**84**		**136**	
Average percentage		38.23		61.76		100

For 38.23% of respondents, conflicts have had a negative impact on education, against 61.76% who affirm the absence of a relationship between conflicts and education in the area.

Influence of conflict on poverty in the area

According to 73% of the respondents, conflict has increased poverty of people in the Waza Logone floodplain. This is a direct result of certain costs that people in conflicts often have to make; conflict resolution entails significant costs. Indirectly, time and fish yields could be lost during a conflict and thus reduce income. Some fishermen reported to have sold their fishing gear or borrowed money from traders to settle their disputes. In an area where income depends primarily on fishing, the potential impact of conflict on poverty is great. When violence occurs, people can lose everything. For example, in the conflict in Tchede village, people lost all their livelihoods: houses went up in flames, cattle were stolen and equipment and gear were destroyed.

Some people believe that the opposite is also true: increased poverty levels would lead to more conflicts, which is a realistic assumption, as the growing poverty in the area drives fishermen to compete for fish resources.

7.4 Discussion

7.4.1 Rules and regulations

In theory and in practice, a number of authorities participate, and overlap to various degrees, in the management of inland fishery resources in Sub-Saha-

ran Africa (Bene *et al*., 2003). These authorities consist of both formal government and informal (traditional) institutions.

In situations of legal pluralism, individuals can make use of more than one legal system to rationalize and legitimize their decisions or their behavior. One does not know in advance which of the several existing laws individuals will use. People in the Waza Logone floodplain have opted for a 'legal pluralism' strategy, as described by Meinzen-Dick and Pradhan (2002).

Since the publication of the Brundtland Commission Report, our 'Common Future' (Brundtland, 1987), the concept of sustainability and its corollary, sustainable development, have become part of the political rhetoric of the 1980s (Dixon *et al.,* 1989). The report was the starting point in raising awareness on nations' collective responsibility for global equilibrium and introducing the concept of *sustainable development.*

After the Rio summit in June 1992, Cameroon has progressively inserted the main recommendations of this summit into its legal system (Bene *et al.,* 2008). In 1994, a national advisory commission for environment and sustainable development and a specific ministerial department responsible for environmental issues were created (decree n° 2004/320 of 08 December 2004). In addition, a new Forest, Fauna and Fisheries Code was adopted as well as a Parent Act on the environment (Douffissa, 2013).

Cameroon does not have a national fisheries co-management policy or a fisheries decentralization policy yet, although a co-management process has been pursued since 2002 on two water bodies and one fish market (Bene, 2008) with the support of the Sustainable Fisheries Livelihoods Program (SFLP). One of the sites was the Maga reservoir in the Waza Logone floodplain.

The general objective of the co-management approach was to manage fish resources through rational exploitation and a sharing of responsibilities, of benefits, and of rights between the different stakeholders and to reduce the number of conflicts (Bondja & Bindzi, 2005). Therefore, an effective co-management of natural resources is a situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources (Borrini-Feyerabend *et al.,* 2000).

The process started at Maga in December 2003 and involved the primary and secondary actors (fishers, female and male processors, transporters, traders), the fisheries administration, the local government (Maga and Kaï-Kaï sub-divisional officers), the police forces, representatives of decentralized services from other ministries (agriculture, forest, fauna, environment), local governments of Maga and Kaï-Kaï as the Decentralized Territorial Community (DTC), traditional institutions, the Company of Growth and Moderni-

zation of the Yagoua rice cultivation (SEMRY), and other water and resource users (Bigombe *et al.,* 2002; Belal *et al.,* 2003).

In many African fisheries, traditional management was present for thousands of years (fishing gear restrictions, a system of closed seasons, habitat modification) and some remnants can still be found. In traditional systems, the elders, the fishers and other user groups collectively choose the best person able to represent the authority, or the best one able to establish and enforce the rules and guidelines concerning the exploitation of adjacent or local fish resources for the general welfare. These rules and guidelines are supposed to be respected by all and to provide the main management approach and measures used to focus on the direct regulation of exploitation, the indirect control of fishing effort, the regulation of catches through quotas and the seasonal closure of the fishery. But in spite of all the efforts made to prepare and adopt these approaches and measures, most of them are not implemented or, in the best case, poorly implemented. This is due to the fact that the main feature of fisheries is free access to resources, which still applies to artisanal fisheries, despite the fast growing fishing effort and the use of productive fishing practices. As shown by Beuving (2013), the fishermen develop a highly individualistic entrepreneurship. This is the outcome of a self-fulfilling prophecy of anticipated deceit, which conditions the entrepreneurs to regard other persons as opportunistic adversaries and subsequently raises conflicts.

In the Waza Logone floodplain, I found three types of conflict management similar to Sarch *et al.* (1997): (i) the first system is the traditional one where the management system is operated by the traditional authorities who enforce regulations to control fishing; (ii) the second type is a mixed system involving the participation (either intentionally or inadvertently) of both the traditional and the modern government administration; and (iii) the third type is the modern system. Under this system, the management is exclusively operated by the central government and fisheries regulations are enforced by officers of the fisheries department. Although the Waza Logone floodplain is a fragile and valuable ecosystem, there is a lack of investment in the fishery sector by the government. Even the ministry in charge of fisheries is poorly represented and in general, the inland fisheries in the Far North region are not getting the attention they deserve.

7.4.2 Conflict management

The emergence and growth of civil society, with key mediating agents between communal groups, government, and markets, is central to a nation's capacity to manage social and economic transformation peacefully and to mediate conflict (Colletta & Cullen, 2000). Diversification of the revenues of

fishermen, by focusing on other productive activities (such as rice and vegetable cultivation) can provide good opportunities in the Waza Logone area. Co-management, as a participatory approach with implications for social actors, could also be one of the solutions. However, co-management has not worked well during the past decades in the Waza Logone area. The inefficiency of conflict management practices in the Waza Logone floodplain could be explained by, among other things, the fact that many people believe that a conflict would cause a divine curse which would result in lower catches. This kind of belief reflects what Molenaar and Van Santen (2006) describe of the *Maami Waata*. The majority of this ethnic group believes that some conflicts have brought the curse of God upon the fishing industry and have caused the extinction of fish species. Others think there is no connection between the decline of fish species diversity and the number of conflicts between fishermen. They believe that the disappearance of certain species of fish can only be explained by the increase of the number of fishermen in the Waza Logone floodplain and consequently the total catches.

In addition, certain rituals practiced in order to solicit the help of God for a successful fishing season would be ignored as a result of the conflict. For others, conflict favors uncontrolled access to fishery resources and the proliferation of fishing material and unsustainable fishing techniques, resulting in overfishing and declining catches per fisherman.

Based on these thoughts, I believe that any future (co-)management plan within the context of the Waza Logone floodplain should involve traditional organizations and traditional rights, as was also suggested by Van Est (1999).

7.5 Conclusion

The conflicts over fishery resources have primarily had a negative impact on the human populations of the Waza Logone floodplain. Socially, these conflicts have undermined the harmony necessary for human welfare and the development process. Hatred and socio-psychological trauma following the clashes, which resulted in injury and loss of human lives, particularly affected vulnerable groups (children, women, elderly). Because of the breakdown of communication and the suspension of fisheries operations inside certain common waterholes following the conflicts, many social actions came to a standstill.

The promotion of the dialogue and mediation mechanisms between fishermen must be encouraged. A capacity building programme for local mediators could provide them with the necessary tools to resolve conflicts. Educating fishers about the harmful consequences of violent conflict and supporting

them in the implementation of alternative productive activities should also ideally be part of any conflict prevention or mitigation program. For common fisheries, local rules for the accessibility and the utilization of fishery resources should be developed.

I further conclude that conflicts are generally not well managed in the Waza Logone area, which may be the result of a lack of coherent policy. My research shows that fisheries policy and policy processes are still largely pursued sectorally, with little or no linkage with other relevant sectors that target inland fisheries. The size of the artisanal fisheries sector underscores the strategic importance of this sector, yet political institutions do not take this into account, or the specificity of floodplain fisheries. Authorities in charge of fisheries are located at the central administration level within the Ministry of Husbandry, Fisheries and Animal Industries and the Ministry of Environment and Nature Protection, far away from where actions targeting the fisheries sector should be implemented.

A policy coherence or synergy between fisheries and other sectors is an essential prerequisite for fisheries to become sustainable and ensuring the long-term use by rural communities that are dependent on them.

Hopefully, the existing lack of coherence between different sectorial policies, due to the absence of a holistic and integrated approach to policy formulation and implementation by government in the Waza Logone floodplain, will be addressed as the process of local agreements and decentralization is ongoing. A more integrated policy body for the floodplain management could easily give coherence to the whole floodplain policy.

For various reasons, the traditional authority would be the most requested and most effective institution in resolving conflicts between fishermen and other stakeholders in the Waza Logone floodplain.

8

General Synthesis on the Dynamics of Fisheries, Sustainability and Conflict Management

In this final chapter, I will summarize the answers to my research questions and discuss their implications for the sustainability of fisheries in the Waza Logone floodplain. I will conclude with recommendations oriented towards the research community at large, the government, the local communities and NGOs who are involved in the Waza Logone fisheries sector.

8.1 Fisheries sector

8.1.1 Dynamics of fisheries sector in the Waza Logone floodplain

Below is an overview of my results related to the research question *"What are the dynamics of the fisheries sector in the Waza Logone floodplain?"*, and specifically "*What is the state of the fisheries sector in the Waza Logone floodplain?"*.

I concluded that the Waza Logone floodplain has been affected by the construction of the Maga dam and its embankments in 1979, which, in combination with the drought in the 1980s reduced the extent of flooding over the floodplain, and resulted in a drastic reduction in fishing activities and livestock rearing. Nonetheless, the overall fish productivity (24.12 kg/ha) is still within the range of African water bodies.

The overall CPUE for the floodplain during my study was 8.3 (±35.05 kg/fisherman/day), which is relatively low compared to the CPUE in other studies in Africa. The large standard deviation is related to the diversity of fisheries, the fishing material and the fishing period. CPUE was present in Chapter 4 by village and by main fishing method. Funnel nets that are used in fishing channels appeared to be the most productive, which explains why it is preferred by fishermen. Apart from the fishing channels, funnel nets are not allowed in other water bodies, as was also the case in the upper valley of Niger.

My study further confirms its resilience as a floodplain: productivity seems to be stable when ecological conditions do not change drastically. One of the main issues to address is related to the increase of the number of fishermen and the decrease of catches per capita.

Regarding the research questions *"What are the main fishing methods used in the Waza Logone floodplain"* and *"What are the differences in catches between types of fishing practices in the Waza Logone floodplain?"* I found that fishermen select and develop fishing methods for productivity and selectivity (Table 8.1).

Table 8.1
Local fishing methods in the Waza Logone floodplain

Name of methods or innovations	Description
Malian traps ("Nasse malieenne")	Baits are put in cylindrical net to attract more fish
Improved fishing channels	Channels are longer, deeper. More small mares are connected
Improved grasses methods	A part of a river is obstructed by nets. Grasses are stock in the river
Using nets with smallest stitch	Smallest stitch sometimes with baits caught even juvenile fish
Dewatering natural mares	Natural mare are dewatered and all fish are caught

The research question *"What is the state of the fish resources in the waterholes inside and outside the Waza National Park"* was answered as follows:

I found that in the Lougue waterhole, located outside the Waza National Park (WNP), 36 fish species were recorded in the catches. The dominant species were *Protopterus annectens 59.5%; Clarias anguilaris 12.6%; Clarias gariepinus 7%; Tilapia dageti 5.2%.*

The annual total production of the Lougue waterhole is 10.7 tons and the productivity is 0.6 kg/m^3. I estimated the annual total production of the Tchikam waterhole at 21 tons, which is 4.57 kg/m^3. In the Tchikam waterhole, located inside the Waza National Park, a total of 42 fish species were recorded. The dominant species are *Protopterus annectens 25.7%; Clarias anguilaris 20.5%; Clarias gariepinus 13.9%* and *Brienomyrus niger 10.1%.*

In the two studied cases (waterholes and channels), the variety of fish species is less compared to the entire floodplain. The main species are *Protopterus sp* in the waterhole and *Clarias sp* in the channels, which confirms the findings of Bobo *et al.* (1996) and Bobo and Boubar (1997). Waterholes are therefore considered to provide good reproduction sites for these species.

8.1.2 Conflicts and conflict management in the Waza Logone floodplain

With reference to the research question *"How are conflicts between fishermen managed in the Waza Logone floodplain?"* and *"What is the frequency and magnitude in time and space of conflicts between fishermen?"* I found that conflicts among fishermen are the type of conflict most prevalent in the Waza Logone floodplain, as opposed to conflicts with other groups. Conflicts between fishermen are manifested in the form of quarrels, communication breakdown and violence/confrontation between the opposing parties. Competition over fishery resources, population growth, declining fish stocks, increasing fishing channels, ownership of land (waterholes and river bed) and a lack of respect for existing regulations are the main causes of these conflicts, according to the fishermen.

In answering the research question *"Which fishermen or community institutional and organizational arrangements are in place within the Waza Logone floodplain for managing conflicts?"* I noticed that conflicts are not well managed. This may be the result of a lack of coherent policy and the poor linkage with other relevant sectors that impact on inland fisheries, despite the strategic importance of this sector nationwide.

The conflict over fishery resources has had a negative impact on human populations in the Waza Logone floodplain. Socially, these conflicts have undermined the social harmony necessary for human welfare and the development process.

The Waza Logone floodplain lacks any form of restrictions for the use of selective fishing gear and fishing practices; access and control of fishery resources are mainly regulated by local and traditional rules, which have been formed along the lines of power relations or ethnic groups (e.g. Kotoko, Musgum). The state plays a minor role in this (Van Est, 1999). Issues that arise from this lack of regulation could easily lead to conflicts.

The history of the Waza Logone area shows that attempts by all of the actors, from the village community to the state institutions, to manage and gain power over resources have always been present (Noorduyn, 2005; Van Est and Noorduyn, 2000), but are clearly increasing. The case of the Tchikam waterhole where access was formally denied, but where Musgoum and Kotoko had violent clashes in 2007 is illustrative. Similar conflicts have been reported with regard to the access to waterholes dug by pastoralists for their livestock, but to which access by fishermen is denied.

Studies have shown that, as civil society grows and becomes more influential, their importance as key mediating agents between communal groups, government, and markets is more often recognized as an essential part of peaceful and effective mediation of conflicts (Bavinck, 2005). My results are in

accordance with this: fishermen tend to turn to such mediating agents more often to resolve their conflicts.

In general, new approaches to fisheries management could prove useful to the Waza Logone floodplain; preferably if they would incorporate traditional as well as modern insights and practices. The local and traditional agreement system as described in my study could provide a strong base to build upon as it is socially accepted and has environmental benefits in terms of sustainable resource use. In such a system, state institutions could function as mere observers, facilitators and regulators, whereas local organizations would be responsible for implementing the co-management process.

8.1.3 Sustainability of the fisheries' resources in the Waza Logone floodplain

In the context of global climate change, vulnerability is defined as the "susceptibility of individuals or groups to be harmed as a result of climate change" (Goulden & Persechino, 2009). Although fisheries can be considered as vulnerable, to measure this in the field remains a challenge. It involves complex processes of defining social dimensions, creating thresholds and unraveling vulnerabilities. Furthermore, translating reality into analyzable data is usually not straightforward. For instance, perceptions of vulnerability, relation to measurement and environmental psychology, and issues of governance addressing equitable participation of vulnerability in decision-making are complex concepts to deal with (Goulden & Persechino, 2009). According to Fussel (2007), three dimensions are essential to describe a vulnerable situation: (i) the system, such as the population, geographic region or human environment; (ii) the attribute of concern, indicating the valued elements that are under threat from exposure to a hazard; (iii) the hazard; and (iv) the temporal reference, being the time or time period of interest.

Measuring the vulnerability of fisheries in terms of biophysical and socio-economic factors at the national level is recognized for its importance in guiding policy and decision-making, which often occurs at this scale (Allison *et al.*, 2009). For the Waza Logone floodplain, potential factors of vulnerability to the fisheries sector could include bio-physical factors such as an increased temperature due to climate change, a reduced rainfall and a reduced river flow causing habitat change and loss of biodiversity (Ovie and Belal, 2012), and socio-economic factors such as perverse incentives, market failure and political instability resulting in conflicts (Noorduyn, 2005).

In Cameroon, where the current process of decentralization is granting rights to local communities, local NGOs have become more attentive to these issues and have been successful in gaining political support for their struggle.

Larger international donor organizations such as the World Bank (WB), the European Commission (EC), and the Islamic Development Bank (IDB), are now also playing a key role in this trend towards new forms of management, as are environmental NGOs such as the World Wildlife Fund (WWF), and the International Union for the Conservation of the Nature (IUCN) (Persoon & Van Est, 2003).

Figure 8.1 provides an overview of what a fisheries management system, as described above, could look like. The entry point is the flooded area and its productivity. The production of fish is linked to the amount of water during the wet season. The increase of the number of fishing channels resulted in a rapid retreat of water from the floodplain (1 in Figure 8.1).

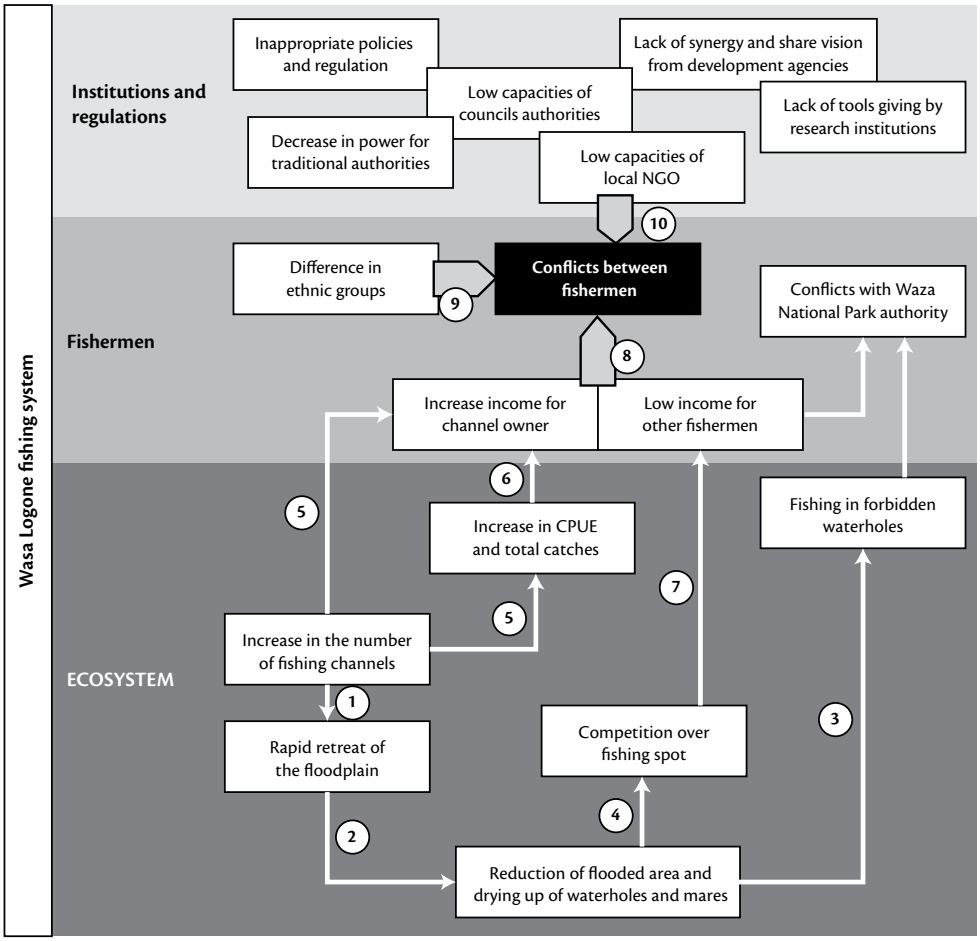


Figure 8.1
Understanding sustainability of fishery resources in the Waza Logone floodplain

These fishing channels belong to a few rich fishermen. They use their means to dig more and more channels, which, in turn, increases their economic and social influence in the village.

The direct effect is the reduction of the flooded area in space and in time and the drying up of waterholes and mares (2 in Figure 8.1).

The reduction of the flooded area and the drying up of mares and waterholes force fishermen to move to the waterholes inside the Waza National Park (3 in Figure 8.1). It also resulted in a higher level of competition for common natural waterholes (*mares*) and man-made waterholes (4 in Figure 8.1). Research into ownership of and access to the productive waterholes, revealed that there are few rich fishermen and a lot of poor fishermen. For the first group, the increase in the number of their fishing channels resulted in an increase of CPUE and total catches (5 in Figure 8.1), and thus in their incomes (6 in Figure 8.1). The other fishermen are forced to share non-productive fishing spots, such as common waterholes and mares. Their incomes are consequently low and decreasing (7 in Figure 8.2).

This growing inequity fosters conflicts, such as those that occurred in Zina and elsewhere in the floodplain (8 in Figure 8.1). The magnitude of conflicts is increasing, as differences between ethnic groups become more extreme (case of Tchede), but are also commonly linked to other social considerations (case of Malazina) (9 in Figure 8.1).

At the policy level in general, laws and regulations seem to be ineffective and could even sustain conflicts (10 in Figure 8.1). Symptoms of this include poorly formulated rules and regulations, and a lack of synergy and common shared vision from development agencies; low capacity of council authorities and local NGOs; a lack of tools provided by research institutions; a decrease in the power of traditional authorities, and a lack of empowerment of local NGOs, councils and traditional authorities. In addition, development agencies who are involved in the area lack synergy or a shared vision with other stakeholders, such as pastoralists, while tools to regulate access to fisheries and to advise stakeholders are absent or poorly utilized.

In 2008, the food crisis that resulted in food price volatility, constituted a global challenge, but in particular for developing countries. The fisheries and aquaculture sector were heavily affected by the crisis (Béné *et al.,* 2009). Fish and fishery products are a vital and affordable source of food and high-quality protein. The Food and Agricultural Organization of the United Nations (FAO) estimated that, at the global level, fish as food reached an all-time high of nearly 17 kg per person in 2009, supplying over three billion people with at least 15% of their average animal protein intake (FAO, 2010). Fisheries and aquaculture support the livelihoods of about 540 million people (8% of the world population). Overall, global markets for fish and fishery products

are expanding, representing a growing source of foreign currency earnings for many developing countries (FAO, 2010).[11]

The fisheries sector therefore has the potential to provide opportunities to improve livelihood prospects, and foster economic growth in developing countries and among some of their poor populations. The increasing demand for fish in Cameroon, however, also highlights the need for sustainable management of aquatic resources. In the Waza Logone floodplain, a clear change in fish production has been observed in recent decades, partly due to human induced floodplain dynamics (e.g. 1990-2000, when flooding was partly reinstated; Loth, 2004).

It is still generally assumed that unmanaged open-access fisheries will overshoot the sustainable carrying capacity of the system and eventually undermine productivity, leading to overfishing and possibly fishery collapse. Small-scale African freshwater fisheries are generally unmanaged in the sense that there are very few restrictions on nominal effort or fishing gear that are actually enforced (Jul-Larsen *et al.,* 2003) and the Waza Logone floodplain is not an exception in this sense. Although this situation is generally perceived and interpreted as the main cause for the overfishing that is almost uniformly claimed in all lakes and reservoirs. Studies on the output of a range of African freshwater fisheries, expressed as annual catch per area, or tons per square kilometer, analyzed the density of operating fishers (numbers per square kilometer), demonstrated that each fisher catches on average 3 tons (range 1-5 tons) irrespective of the system in which they fish, indicating a linear relationship between production and effort (Kolding *et al.,* 2008). In this regard, it is also crucial to realize that the economic outcome and the workload of an activity determine the way in which the activity is organized, together with the investments needed for the activity, the social institutions involved and the economic context that determines wage levels. This organization, in turn, is structuring the livelihood strategy of people involved in the activity. Thus, the economic outcome of the activity is linked to the production patterns of the resource, and the dynamics of the resource affect the livelihood strategies of the people exploiting these resources (Oostenbrugge *et al.,* 2004).

I compared the characteristics of the Waza Logone floodplain ecosystem with other floodplains in West or East Africa like the Central Delta of Niger where fishing is a widespread occupation and annual catches depend, for a large part, on the flow of the current year (Lae, 1994). Though fishing effort has probably increased considerably over the past decade, it seems that it had little negative impact on the total catches in some African floodplains and deltas (Lae, 1994). This has also been confirmed by Paugy *et al.* (1999) dur-

11 ftp://ftp.fao.org/FI/brochure/SOFIA/2010/english_flyer.pdf (Access date: 12-07-2011)

ing twenty years of monitoring fish assemblages in West Africa as part of the Onchocerciasis control programme. At the end of this long monitoring programme, they concluded that the determining factor of fish stock abundance seems to depend both on the extent and the duration of the flooding. This suggests that decreasing fish production can be explained by recruitment in the previous years.

Globally, the Waza Logone floodplain, as an example of traditional African floodplain exploitation, compares very well with modern irrigation schemes in terms of water use and financial costs. Gross earnings of irrigation systems must figure at least three times as much as traditional floodplain production in order to attain the same net margin of profit (Marchand, 1987).

As indicated in previous chapters, since 1979 the Waza Logone floodplain has experienced several development interventions, such as the Maga rice scheme and the Waza Logone Project. Numerous actors were or are still involved in the follow up. For the past ten years, the status of resources has declined in terms of availability, diversity and quality due to heavy exploitation. A sustainable exploitation of fishery resources is critical not only to the long-term survival of traditional fishers who depend on the fish for food, income, and livelihoods but also for the ecosystem as a whole (Figure 8.2). Naturally, an ecosystem is able to adapt to changing circumstances. However, exploitation in the Waza Logone floodplain is intensive, resulting in modifications of the natural habitat (reduction of the flooded area) and a freshwater shortage. The manipulation of the floods has caused radical changes in the floodplain ecology, leading to multiple environmental problems, and affecting the very basis of development (Drijver & Marchand, 1985).

An emerging issue, relevant for future development of the fisheries sector in Cameroon, is climate change. Water resources in the Waza Logone floodplain are under increasing pressure from growing demand and competing uses, and climate change threatens to put further pressure on water resources through an ever increasing variability in rainfall and river flows. Changes in the geographical distribution of water resources will cause some areas to become drier while other areas become wetter (Kundzewicz *et al.,* 2007). In line with global expectations, Goulden *et al.* (2010) predicted an increase in temperature and a decrease of rainfall for the Lake Chad basin during the coming decades. Rainfall data from 1995 to 2008 for the Lake Chad region confirm a high variability in the past, which may only increase in the future due to climate change (Loth, 2004). This trend is expected to continue into the coming decades, aggravated by increasing human populations, changing patterns of water use, increased demands for water both for domestic use and for rice production, which will put even more stress on the resources of the Waza Logone floodplain. Issues related to the increase of fishermen and their use

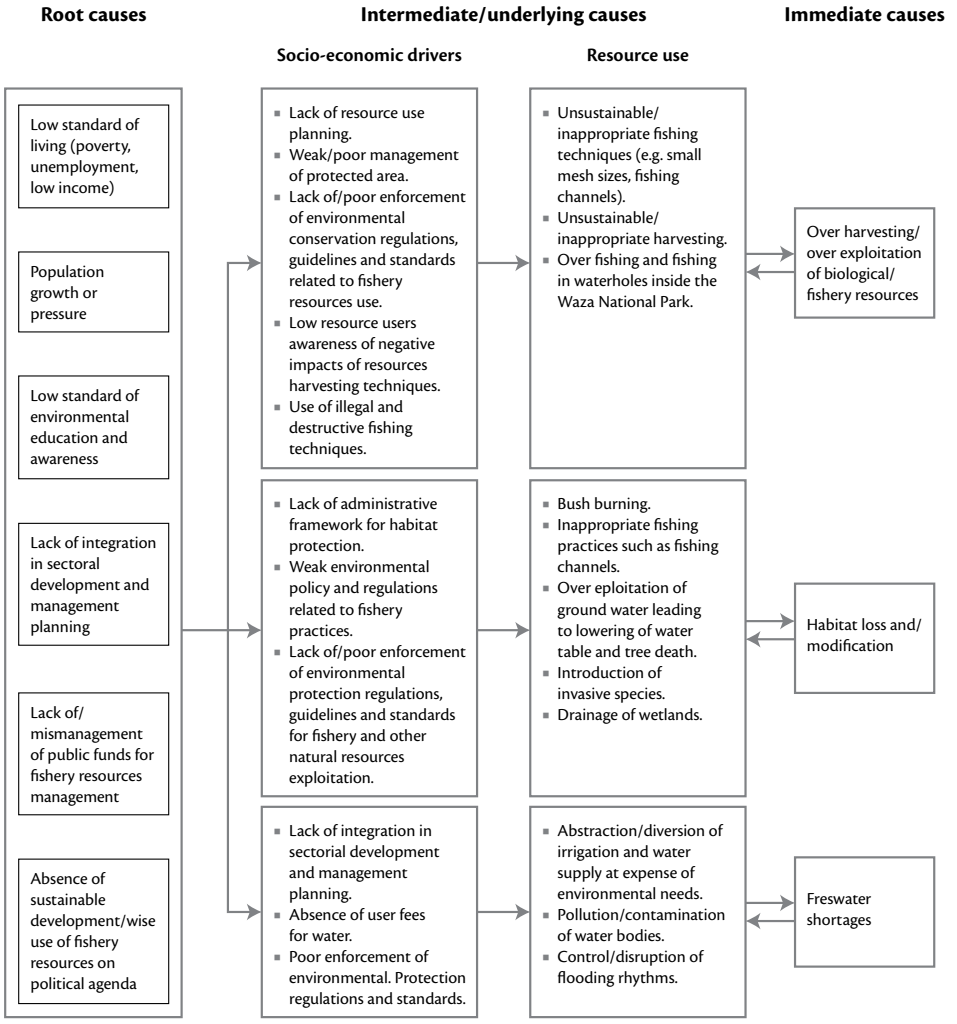


Figure 8.2
Causal analysis for the decreased viability of fish stocks in the Waza Logone floodplain (Adapted from LCBC, 2007)

of highly selective fishing channels that have serious impacts on flooding regimes are very specific to the Waza Logone floodplain and are putting immense strains on the ecosystem.

To address this increasing problem, we need a holistic strategy for adaptation as well as improved legislation and regulations at the local and state level. The efficiency of irrigation needs to be improved, and inter-basin transfers of water through networks of pipes and canals from the Congo basin should ideally be promoted. Water users and water resource management institu-

tions have to adapt to the impact of climate change, and to changes in demand of natural resources. Also, the new local fisheries agreements introduced by the NGO ACEEN could improve the management. Natural resource management efforts that fail to consider the consequences of climate related or human induced disturbances are not likely to succeed in preserving the affected resources in the long-term.

Finally, although the sustainability of the system thus constitutes a major challenge, my study is expected to provide a basis to develop a sustainable fishery sector by using indicators in terms of fish species and catches, conflicts between fishermen, as well as rules, regulations and management of the fisheries.

8.2 Conclusion and recommendations

8.2.1 General conclusions and recommendation

My research points out that people in the Waza Logone floodplain are generally skeptic about the idea of 'working on a sustainable future'. They associate it with strategies and practices that would eventually reduce flooding and thus force them to leave the area (as happened in the 1980s, after the Maga dam was built).

In recent years, sustainability efforts by different development agencies have been rather localized, did not consider existing interventions, and usually did not have a logical sequence. Interventions were often driven by the priorities of specific stakeholders and few projects were based on good stakeholder analysis. During my study, I had the opportunity to look into a few of these projects and, indeed, I can confirm that the stakeholders generally lack an overall vision which could provide guidance to development efforts. Coordination and consultation between stakeholders is poor. During the Waza Logone Project for instance, coordination efforts that had been developed, were never fully put into practice. The governmental project responsible for regional planning, MIDIMA, is another example of a project that never got past the phase of good intentions. In addition, the Lake Chad Basin Commission did not contribute to overall coordination, despite its purpose 'to overcome barriers in concerted management of the basin through well-orchestrated and enhanced collaboration and capacity building among riparian and stakeholders' (LCBC, 2007).

I would recommend developing one 'Umbrella Agency', under which other institutions, NGOs and projects work together for the sustainable development of the Waza Logone floodplain. Governmental or semi-governmental programs and institutions, such as the Company for the Modernization

and the Extension of Rice Production (SEMRY, financed by the World Bank and Cameroonian government), the Lake Chad Basin Commission (LCBC, financed by Global Environment Facility), the Integrated Rural Development Project for the Chari Logone (PDRP/CL financed by the Islamic Bank as donor), and the Maga Fish Centre (Japanese cooperation as funder) should then operate under the guidance of this agency.

International NGOs or donors, such as SNV (Dutch Development Organization), the Agency for Cooperation and Research in Development (ACORD), the International Union for the Conservation of the Nature (IUCN), the World Food Program (WFP), the World Wildlife Fund (WWF), the German Development Agency (GTZ) and DED, the Voluntary Service Overseas (VSO), IUCN Netherlands, and Cordaid should all collaborate with the new Umbrella Agency and together contribute to the strengthening of capacities of local NGOs such as ACEEN, Strengthening Association for Rural Development Initiatives (AIDR) and the Centre for Pastoralism and Research (CARPA).

Their scope of objectives would be manifold and these should be integrated into the three dimensions of sustainable development (Social System, Ecology and Economy), as presented below.

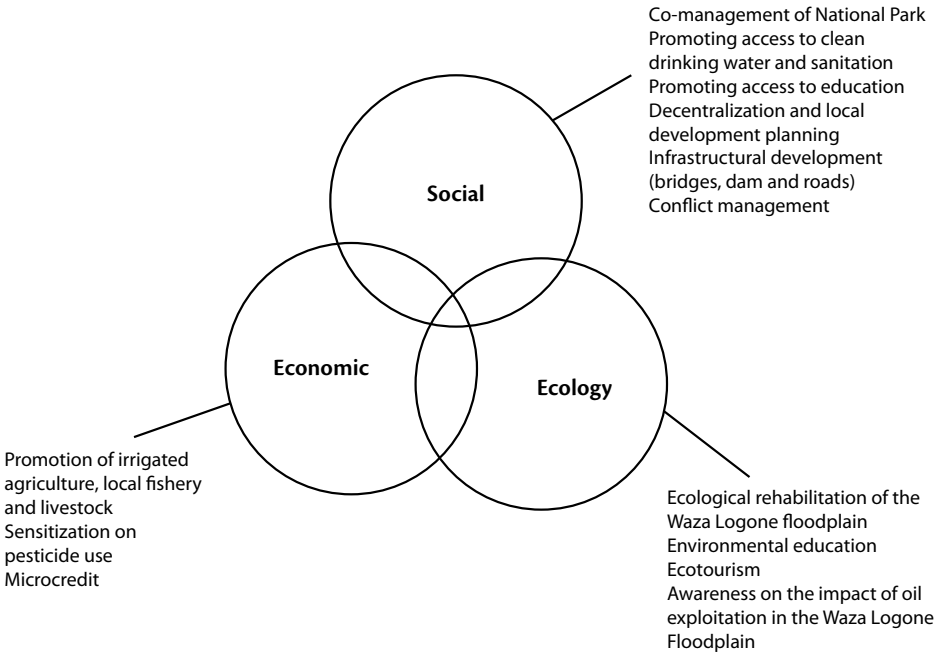


Figure 8.3
Main objectives of the Waza Logone Development Agency integrating the three dimensions of sustainable development

Social plan
- co-management of the Waza National Park
- promotion and facilitation of access to clean drinking water
- promotion and facilitation of access to education
- implementation of decentralization and local development planning
- conflict mitigation and prevention programme

Ecology
- rehabilitation of the floodplain
- reduction of highly selective fishing practices
- promotion of environmental education
- promotion of ecotourism

Economy
- promotion of small-scale irrigated agriculture, fisheries and livestock
- promotion of microcredit units.

8.2.2 Conclusions and recommendations to the research community

In the domain of research, the Centre for Development and Environmental Studies in Cameroon (CEDC) has succeeded in reinforcing the capacity of partner institutions in the areas of environmental sciences, ecology, anthropology and agronomy, covering both research and academic education (De Iongh *et al.,* 2010). The University of Maroua (UMa), created in 2008, with its specialized school in Sahelian issues (the Higher Institute of the Sahel), is likely to play an important role in the future. Decent scientific studies through such institutions are a starting point to improve the development and conservation in the floodplain, although studies should always be developed and implemented based on a mutual understanding of goals and expectations.

Based on my research results, I would propose a number of research topics for further development:
- The development of a model for the monitoring of natural flooding and fishery resources
- The role of fishing channels, the dynamics of fish species, and the hydrological systems of the Waza Logone floodplain
- The impact of climate change on the fishermen's performance
- The development of an innovative aquaculture system in the Waza Logone floodplain, using certain productive fish species such as *Lates niloticus*
- The future of the Waza Logone floodplain, based on its ecological relationship with Lake Chad and in view of the drying up of Lake Chad

8.2.3 Conclusions and recommendation to the central government

An analysis of the major developments in terms of resources and actors during this study shows that the Waza Logone floodplain was impacted by the construction of the Maga dam, and by the interventions of NGOs and the Waza Logone project. Through the latter project, stakeholders have been mobilized and the process of sustainable development has already been initiated, yet stakeholders should participate more if they decide to develop such plans further. A long-term commitment, and good governance by all parties is absolutely essential for any future sustainable development plan to succeed in the Waza Logone floodplain.

Enhance the participation and ownership of local population from beginning to end

Participation of stakeholders has been rather weak during the planning, implementation and evaluation phases of several projects, including the Waza Logone Project. Target groups and crucial stakeholders were often not involved in the project design phase. This is especially true for the larger projects. Sometimes they have an inception phase including a stakeholder survey, but it remains doubtful whether these surveys influence the eventual programme design; they are often designed in offices far away from the implementation site. The Waza Logone project was an exception: objectives and targets were formulated after extensive field research. During its implementation, extensive consultations and surveys with the local population were conducted as an input to various interventions. The principle of co-management was actively promoted, especially around Waza National Park, while at a more regional level, different management mechanisms were established in which various stakeholders were supposed to participate. Nevertheless, there have been aspects of both the development and implementation phase which proved to be less effective in the field. We should take the opportunity to learn from such mistakes and work together to improve any forthcoming projects and interventions in the Waza Logone floodplain.

Developing a long-term commitment to the Waza Logone floodplain

Even if institutions have a mutual vision, if they do collaborate and if coordination is part of their actions, any development effort risks failure without sufficient long-term and clear commitments. In my study, stakeholders also seem to lack a long-term vision and, although difficult to measure, are poorly committed to their proposed actions. This lack of commitment has been one of the main constraints in achieving sustainable development in the past. Several development projects and programmes that have been initiated in the

floodplain had an execution phase of between a few months to three years. Although government programmes usually have longer time spans, they are often very slow during the start-up phase: between one and three years to initialize a government programme, is not unusual. Such programmes are often implemented via local subcontractors, or local service providers, mostly non-profit organizations. Their capacities are generally weak and they do not have specific expertise in terms of the issues on the regions.

It is clear that without strong commitments from the government, large-scale and lasting changes at the ecosystem level are virtually impossible, no matter how long the Waza Logone Project and local civil society organizations remain active.

Nonetheless, the past years showed that continuity and long-term commitment do pay off at certain levels. Particularly organizations that manage projects in collaboration with local communities can be successful. One of the four organizations that were born out of the WLFP (ACEEN for example), can be considered successful. It developed a long-term vision and strategy on specific domains in the region. It managed to stick with this focus and to resist the temptation to launch itself into other opportunities. Partly due to this, ACEEN was able to build good permanent relationships with donors and partners, which again strengthened their capacity. In a way, ACEEN was lucky to find donors and partners who continue to invest through and in them, in line with their own pace of development. Current pressure for concrete outputs in short time frames makes this quite exceptional.

For any future development process for the Waza Logone floodplain, it is thus critical that commitments are well defined and respected. To achieve this, it is recommended to get these commitments from the highest authorities within each organization involved. They should also be incorporated into the strategic planning processes of these organizations. Likewise, they need to be shared within each organization to avoid situations of complete disengagement when one person decides to quit.

Application of good governance in fishery sector

I found that governance of natural resources was generally poor. 'Governance can be seen as the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences. In other terms, it is the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions

and regimes empowered to enforce compliance as well as informal arrangements that people and institutions have either agreed to or perceive to be in their interests' (UNDP 2006). Thus, public authorities are essential for institutions to provide a framework in which they can operate and within which benefits are distributed. They will also establish and maintain hierarchy. The fisheries of the Waza Logone floodplain are an open access system where the lack of good governance has had a major negative influence on the effectiveness of various well-intended interventions. It remains one of the main causes in terms of why relatively few resources have reached the final target groups in many projects (bad project design is another one). It also causes delays at various levels of project execution. Whether it concerns local authorities, governmental services, or local base organizations, bad governance practices have harmed the organization's legitimacy and credibility towards its target population and partners, jeopardizing any future success. For a better future for fisheries, the question of good governance should be taken seriously into account. This requires sound structures and clear and transparent procedures with enough options for control.

Provide human and financial resources for fishery development

My results suggest that investments by the government in the fishery sector have been largely insufficient. More financial resources and technicians are needed for effective and sustainable development. Fortunately, some resources have been and will still be provided by the government via the law for decentralization processes in Cameroon (Law n^0 2004/017 of 22 July 2004 on the orientation of decentralization). The Ministry of Fisheries and Animal Industries, for instance, has set up a basket fund to finance council projects in domains such as fisheries infrastructures, fisheries control, and fishermen organizations.

The Maga Fishing Centre has to be renovated and technicians have to be effective in order to promote new innovative and sustainable fish production and practices in fisheries.

8.2.4 Conclusions and recommendation to community based organizations and local NGOs

Developing and executing local agreements

Some of the communities that participated in my research had some form of local agreement implemented, which proved particularly effective when fishermen and traditional authorities were implicated. These local agreements have to be formal and provide all the dimensions needed for conflict management and to achieve sustainability in fisheries. This can be achieved

by assigning a platform of stakeholders in the villages, through which conflicts could be prevented or resolved and relationships with other users such as pastoralists can be managed.

Developing innovations in fisheries' management

My research confirms that without drastic changes in fisheries management, the Waza Logone cannot be sustainable in the long-term. Infrastructures such as the Maga dam, the Zilim dyke, and waterholes inside and outside the Waza National Park were initially constructed for rice production, and as drinking source for livestock or wildlife. Fish production was never taken into account and none of the nearby land users were consulted before or during their realization. As is generally the case with sparsely distributed but intensively used resources, the waterholes created conflicts of interest. The stakeholders involved in such conflicting interests in the Waza Logone floodplain are many and diverse, and need effective rules and regulations for any sustainable fisheries management system to be successful. This will only be possible through the enforcement of appropriate social and institutional organizations.

The success of an Innovative Fishery Management process can only be achieved through: (1) the firm commitment and participation of local communities, (2) the emergence of a consultative framework between different stakeholders at various levels, and (3) the effective functioning of a local committee in charge of the management of the hydraulic equipment and infrastructures.

The socio-economic survey has revealed the shared interest and commitment of the various social and professional groups. Stakeholders, at the institutional, community and individual level, who seek to profit from the water and its uses are manifold. Their perceptions in terms of the causes of the cessation of the Logomatya and its rehabilitation vary according to their geographic location and their main activities, which should be taken into account during the implementation phase. In addition, the financial contributions by government and other international donors are still very low compared to the estimated needs. It is therefore necessary to involve a larger number of actors to secure funding, but also to facilitate the consultation process. Considering the various projects starting in the Lake Chad Basin, it is essential to clarify expectations and gain firm commitment from various stakeholders for all phases of the planning and management process. Councils in the process of the decentralization can be key actors in planning and mobilizing resources. The diversification of the revenue of fishermen by focusing on other productive activities such as rice and vegetable cultivation could provide a good alternative for the area.

Annex 1

Villages along the Logomatya and its impacted area

N°	Villages	Population[12]	Subdivision
1	Pounfoun	600	Maga
2	Waha	278	Maga
3	Ngoulmoun (Yoko)	210	Maga
4	Bara-Abai	680	Maga
5	Mourla	2,300	Maga
6	Houalaye	1,800	Maga
7	Maouda	1,000	Maga
8	Ngoulmoung Gasbala	700	Maga
9	Ngoulmoung Kalao	1,500	Maga
10	Maouda Poukoum	1,700	Maga
11	Ziam	1,500	Maga
12	Goznak	207	Maga
13	Ziam II	400	Maga
14	Mastafam	250	Maga
15	Moroma	240	Maga
16	Gongui	900	Maga
17	Diga Mousgoum	800	Maga
18	Pakataye Arabe	70	Maga
19	Pakataye Mousgoum	350	Maga
20	Diga Arabe	1,000	Maga
21	Mourna	90	Maga
22	Pitakoï	400	Maga
23	Nouhoï	420	Maga
24	Kounkouma	250	Maga
25	Guidening	55	Maga
26	Siaou Arabe	330	Maga
27	Ourogaou	35	Maga

12 The population has been giving by the head of the village.

N°	Villages	Population[12]	Subdivision
28	Meleme	500	Maga
29	Blamatoko	450	Maga
30	Siaou Mousgoum	300	Maga
31	Margazakaye	90	Maga
32	Vrick	150	Maga
33	Talaye	120	Maga
34	Dawaya	200	Maga
35	Alvakaye	181	Maga
36	Malazina	2,500	Zina
37	Goromo	407	Zina
38	Blamakaï	70	Zina
39	Sifna	1,200	Zina
40	Douieng	500	Zina
41	Douieng bute	40	Zina
42	Maskalaye	150	Zina
43	Kofaya	50	Zina
44	Margoui	200	Zina
45	Sarasara	300	Zina
46	Place	130	Zina
47	Zama	110	Zina
48	Zina	3,000	Zina
49	Daguen	70	Zina
50	Gourpe	150	Zina
51	Misde B	280	Zina
53	Bagdassi	300	Zina
54	Koumbla	250	Zina
55	Garle	105	Zina
56	Moroma II	200	Zina
57	Guidiba	450	Zina
58	Skir	100	Zina
59	Iviye	600	Zina
60	Béré	270	Zina
57	Guidiba	450	Zina
58	Skir	100	Zina

N°	Villages	Population[12]	Subdivision
59	Iviye	600	Zina
60	Béré	270	Zina
61	Ngodeni	2,100	Logone Birni
62	Balgué III	1,400	Logone Birni
63	Zilim II	633	Logone Birni
64	Balgue II	230	Logone Birni
65	Massari	260	Logone Birni
66	Balgue I	105	Logone Birni
57	Guidiba	450	Zina
58	Skir	100	Zina
59	Iviye	600	Zina
60	Béré	270	Zina
61	Ngodeni	2,100	Logone Birni
62	Balgué III	1,400	Logone Birni
63	Zilim II	633	Logone Birni
64	Balgue II	230	Logone Birni
65	Massari	260	Logone Birni
66	Balgue I	105	Logone Birni
67	Dabak	40	Logone Birni
68	Darazi campement	40	Logone Birni
69	Blagana	100	Logone Birni
70	Zoulwe	167	Logone Birni
71	Gho	150	Logone Birni
72	Mandabe	600	Logone Birni
73	Mardia	80	Logone Birni
74	Mahana II	55	Logone Birni
75	Mahana I	207	Logone Birni
76	Kalgoulou	434	Logone Birni
77	Ada	30	Logone Birni
78	Hinale	515	Logone Birni
79	Teneri	83	Logone Birni
80	Moukak	317	Logone Birni
81	Matke	60	Logone Birni
82	Zilim I	300	Logone Birni

N°	Villages	Population[12]	Subdivision
83	Manawadji	200	Logone Birni
84	Mre Kotoko	50	Logone Birni
85	Mre Arabe	150	Logone Birni
86	Mouhli	110	Logone Birni
87	Kalkoussam	515	Logone Birni
88	Gouba	400	Logone Birni
89	Woulad Araï	90	Logone Birni
90	Galam Arabe	106	Logone Birni
91	Kassakia	400	Logone Birni
	Total	**41,415**	

Annex 2

Location of villages and fishing spots in the Waza Logone Floodplain

N°	X	Y	Identification	Village in alphabetical order
396	14.99497	11.54039	Village	Ada
353	15.00329	11.01964	Village	Alvakaye
421	14.97491	11.29236	Village	Bagdassi
490	14.99932	11.44146	Village	Balgue 1
484	15.01116	11.39321	Village	Balgue 2
463	15.00756	11.40183	Village	Balgue 3
327	14.99067	10.99119	Logomatya river	Beginning of the Logomatya River
454	15.05803	11.42059	Village	Bere
493	14.98299	11.45815	Village	Blagana
360	14.98481	11.06763	Village	Blamakai
433	14.59600	10.75900	Sub division head quarter	Bogo
492	14.98301	11.45815	Village	Dabak
402	14.95464	11.26077	Village	Daguen
347	14.97864	11.00128	Village	Dawaya
452	15.05790	11.41665	Village	Evie
382	15.00127	11.45777	Village	Galam Arabe
427	14.97316	11.33377	Village	Garle
495	14.97325	11.47271	Village	Ghounan gare
359	14.98947	11.06298	Village	Goroma
427	14.95887	11.20089	Village	Gouba
430	14.97357	11.20527	Fishing spot	Gouba
403	14.95018	11.24480	Village	Gourpe
404	14.95227	11.24419	Fishing spot	Gourpe
438	14.99367	11.33739	Village	Guidiba
445	15.00662	11.35091	Fishing spot	Guidiba
447	14.99734	11.33455	Fishing spot	Guidiba
400	14.99366	11.58654	Village	Hinale

N°	X	Y	Identification	Village in alphabetical order
398	14.99464	11.55258	Village	Kalgoulou
421	14.96973	11.77344	Village	Kalkoussam
426	14.97137	11.77180	Fishing spot	Kalkoussam
384	14.99927	11.46394	Village	Kassakia
373	14.93729	11.15869	Village	Kofaya
425	14.98710	11.31138	Village	Koumbla
426	14.98708	11.30974	Fishing spot	Koumbla
439	15.05750	11.80690	Sub division head quarter	Logone Birni
436	14.92800	10.85550	Sub division head quarter	Maga
395	14.98372	11.52371	Village	Mahanna 1
394	14.98376	11.52253	Village	Mahanna 2
413	15.02388	11.65408	Village	Mahouli
354	14.99594	11.03005	Village	Malazina
415	15.03222	11.68446	Village	Manawa
392	14.98804	11.49227	Village	Mandabe
393	14.98637	11.51496	Village	Mardia
376	14.98854	11.16050	Village	Margoui
377	14.99031	11.16440	Fishing spot	Margoui
469	15.00861	11.35019	Village	Massari
411	15.07152	11.60556	Village	Matke
415	14.96368	11.29248	Village	Misde
417	14.96187	11.28593	Fishing spot	Misde
430	14.98315	11.33589	Village	Moroma
432	14.98414	11.33545	Fishing spot	Moroma
408	15.04241	11.62313	Village	Moukak
409	15.04788	11.62468	Fishing spot	Moukak
418	15.02793	11.68882	Village	Mre Arabe
420	15.00756	11.70144	Village	Mre Kotoko
459	15.00721	11.39778	Village	Ngodeni
442	14.48040	10.99630	Sub division head quarter	Petté
384	14.96951	11.22318	Village	Place
385	14.97016	11.21896	Fishing spot	Place
381	14.98580	11.17560	Village	Sarasara
382	14.98198	11.17678	Fishing spot	Sarasara

N°	X	Y	Identification	Village in alphabetical order
363	15.02725	11.11428	Village	Sifna
450	15.02727	11.32982	Village	Skir
402	14.98140	11.58322	Village	Teneri
445	14.55840	11.42820	Sub division head quarter	Waza
379	15.01883	11.45992	Village	Woula darai
389	14.98142	11.14175	Village	Zama
392	14.97569	11.13635	Fishing reserve	Zama
376	15.04433	11.44758	Village	Zilim 1
474	15.03765	11.42083	Village	Zilim 2
476	15.04007	11.42361	Shunt for the Zilim dam	Zilim 2
480	15.04213	11.42598	Zilim Dam	Zilim 2
412	15.07403	11.66843	Village	Zimado
393	14.96458	11.26432	Village	Zina
399	14.96216	11.26554	Fishing spot	Zina
408	14.95934	11.25409	Fishing spot	Zina
412	14.96273	11.26296	Fishing spot	Zina
413	14.96240	11.27124	Fishing spot	Zina
414	14.96263	11.27967	Fishing spot	Zina
386	15.00488	11.47823	Village	Zoulwe

Annex 3

Fishery collecting data frame work

Individual census of fishing and fishing tools

Fishing spot	Date	Number resident fishermen	Number of transhumant fishermen

Fishing material

Type of canoes	Number	Length (m)	Age
Wood sheet canoe			
Metal sheet canoe			
Dugout canoe			

Gill nets	Length (m)	Age
1 finger		
1,5 fingers		
2 fingers		
3 fingers		
4 fingers		

Beach Seine	Number	Age

Hooks	Number of hooks	Age
11		
12		
13		
14		
15		
16		
17		
18		

Cast nets	Number	Length (m)/ circumference	Age
0,5 finger			
2 fingers			
3 fingers			
4 fingers			

Traps	Number	Age
Malian trap		
Touksi		
Arung		
Mouman		

V nets	Number	Age

Survey on catches

Fishing spot	Date	Category of fisher

Fishing material	Start time	End time	Frequency of use per day

Fishing material	Unit for measuring	Weight for one unit of measure (kg)	Number of unit of measure	Sample					Observations
				Fish species	Weight (g)	Number of individuals in the sample			
						Juvenile	Medium size	Adults	

Fishermen and fishing tools daily census

Fishing spot	Date	Number resident fishermen	Number of transhumant fishermen

Fishing material

Type of canoes	Number
Wood sheet canoe	
Metal sheet canoe	
Dugout canoe	

Gill nets	Number
1 finger	
1,5 fingers	
2 fingers	
3 fingers	
4 fingers	

Beach seine	Number

Hooks	Number
11	
12	
13	
14	
15	
16	
17	
18	

Cast nets	Number
0,5 finger	
2 fingers	
3 fingers	
4 fingers	

Traps	Number
Malian traps	
Touksi	
Arung	
Mouman	

V nets	Number

Experimental fishing exercises

Fishing spot	Date	Time	Fishing material	Water level

Genera	Fish species	Total weight (g)	Number of individuals in the catch

Biological data

Fishing spot	Date	Fishing material

Fish species	Length (cm)	Weight (g)	Sex	Maturity level	Stomach contents

Annex 4

Fish species as caught in the Waza Logone floodplain in the 2008-2009 fishing season

N°	Fish species	Total weight (kg)	Percentage in catches
1	Alestes baremose	169	0.27
2	Alestes dentex	30	0.05
3	Auchenoglanis biscutatus	161	0.26
4	Auchenoglanis occidentalis	39	0.06
5	Bagrus bayad	189	0.30
6	Bagrus docmack	143	0.23
7	Barbus sp.	83	0.13
8	Brienmyrus niger	4142	6.58
9	Brycinus macrolepidotus	0.705	0.00
10	Brycinus nurse	355	0.56
11	Caecomastacembelus decorsei	2	0.00
12	Campylomormyrus tamandua	0.100	0.00
13	Chrysichthys auratus	2	0.00
14	Citharinus citharus	19	0.03
15	Citharinus latus	0.284	0.00
16	Clarias albopuntatus	1882	2.99
17	Clarias anguillaris	15426	24.51
18	Clarias gariepinus	18126	28.80
19	Clarotes laticeps	0.025	0.00
20	Ctenopoma muriei	16	0.02
21	Ctenopoma petherici	54	0.09
22	Distichodus brevipinnis	240	0.38
23	Distichodus engycephalus	62	0.10
24	Distichodus rostratus	4	0.01
25	Gymnarchus niloticus	809	1.29
26	Hemichromis bimaculatus	8	0.01
27	Hemichromis fasciatus	76	0.12

N°	Fish species	Total weight (kg)	Percentage in catches
28	Hepsetus odeo	4	0.01
29	Heterobranchus bidorsalis	2136	3.39
30	Heterobranchus longifilis	20	0.03
31	Heterotis niloticus	2183	3.47
32	Hydrocynus brevis	120	0.19
33	Hydrocynus forskalii	995	1.58
34	Hyperopisus bebe	41	0.06
35	Hyppopotamyrus pictus	19	0.03
36	Ichtyoborus besse	7	0.01
37	Labeo coubie	44	0.07
38	Labeo senegalensis	94	0.15
39	Labeo tibesti	625	0.99
40	Lates niloticus	54	0.09
41	Malapterus electricus	30	0.05
42	Marcusenius cyprinoides	9	0.01
43	Marcusenius senegalinsis	729	1.16
44	Micralestes elongatus	144	0.23
45	Mochocus niloticus	8	0.01
46	Mormyrops anguilloides	6	0.01
47	Mormyrus hasselquistii	28	0.04
48	Mormyrus rume	61	0.10
49	Oreochromis aureus	1312	2.08
50	Oreochromis niloticus	1331	2.12
51	Parailia pellucid	0.045	0.00
52	Petrocephalus bane	188	0.30
53	Petrocephalus bovei	1028	1.63
54	Pollimyrus isidori	163	0.26
55	Polypterus bichir	267	0.42
56	Polypterus endlicheri	110	0.17
57	Polypterus senegalus	29	0.05
58	Protopterus annectens	55	0.09
59	Raiamas senegalensis	0.485	0.00
60	Sarotherodon sp	5766	9.16

N°	Fish species	Total weight (kg)	Percentage in catches
61	Schilbe intermedius	1455	2.31
62	Schilbe mystus	4	0.01
63	Schilbe uronoscopus	1	0.00
64	Siluranodon auritus	407	0.65
65	Synodontis batensoda	93	0.15
66	Synodontis clarias	76	0.12
67	Synodontis eupterus	17	0.02
68	Synodontis filamentosus	1	0.00
69	Synodontis mabranacus	24	0.04
70	Synodontis nigrita	321	0.51
71	Synodontis ocellifer	2	0.00
72	Synodontis schall	115	0.18
73	Synodontis sorex	11	0.02
74	Tetraodon linaetus	3	0.00
75	Tilapia dageti	330	0.52
76	Tilapia rendali	44	0.07
77	Tilapia zillii	369	0.58
	Total general	**62929**	**100.00**

Annex 5

Survey on conflict framework

Questionnaire to fishermen

A Socio-economic characteristics of respondents

1 Activity

Main activity:
☐ Agriculture ☐ Livestock ☐ Fishing ☐ Trade
Other (name): ☐ _____

Secondary activity:
☐ Agriculture ☐ Livestock ☐ Fishing ☐ Trade
Other (name): ☐ _____

2 How many years have you been in the area?

☐ <5 years ☐ 5-10 years ☐ 11-15 years ☐ 16-20 years ☐ > 20 years

3 What are the reasons for your migration to this area?

☐ Friends ☐ Family Members ☐ Resources ☐ Availability
☐ Other _____

4 Were you educated at school? ☐ Yes ☐ No

5 If yes, in which system were you educated? ☐ Koranic ☐ Francophone

6 How many years did you spend in formal education?

☐ <2 years ☐ 2-4 years ☐ 4-6 years ☐ 7-10 years
☐ 11-14 years ☐ > 14 years

7 What is the diplomas you obtained?

☐ CEP ☐ BEPC ☐ CAP ☐ PROB ☐ BAC
☐ 2 years of University studies ☐ Licence degree ☐ Master's degree
☐ Other _____

8 Marital status

☐ Single ☐ Married ☐ Widow ☐ Separated ☐ Cohabitation

9 Matrimonial regime ☐ Monogamous ☐ Polygamous

10 Number of wives _____ Number of children _____

11 Household size _____

B Awareness of the existence of conflict and its implications

12 Were there conflicts in your community in recent years? ☐ Yes ☐ No

13 Which one (name) _____

14 Have you been involved in a conflict between fishermen in your community?
☐ Yes ☐ No

15 What is the type of conflict that occured ?

☐ Violence / confrontation ☐ Quarrels ☐ Communication breakdown
☐ Other _____

16 Since when have these conflicts been present in your community?

_____

17 What is the frequency of these conflicts?

☐ 1 time/year ☐ 4 times/year ☐ > 5 times
☐ 2 times/year ☐ 5 times/year
☐ 3 times/year

18 What is the frequency of conflicts between fishermen in these periods?

Before reflooding _____ After the reflooding _____
Why? _____

19 Who is the most involved in conflicts? ☐ Men ☐ Women ☐ Children

C Causes of conflict related to fishery resources

20 Why are there conflicts related to fishery resources in your community?

Competition for fish resources	☐
Degradation of the authority of traditional leaders	☐
Lack of regulation	☐
Population growth	☐
Decline of fisherys resources	☐
Proliferation of channels of fishing	☐
Political manipulation	☐
Ethnic difference	☐
Other reasons (list)	_____

21 Who do you think is the cause of these conflicts?

Fisherman-farmer	☐
Professional fisherman	☐
Migrant fisherman	☐
Fisherman-trader	☐
Traditional leaders	☐
Politicians	☐
Other (list)	☐

How and why? _____

D Approaches to conflict management

22 Who should be contacted in case of conflict?

☐ Friends ☐ Group leaders ☐ Traditional Authority
☐ Justice /Sub divisional officer ☐ Other (name) _____
Why? _____

23 Have there been cases of conflicts over fishery resources governed by the following?

☐ Friends ☐ Group ☐ Traditional leaders ☐ Sub divisional officer
Other _____

24 How many cases of resource conflicts were resolved through fisheries?

Traditional Leaders:	2009 _____	2008 _____	2007 _____
Sub divisional officer:	2009 _____	2008 _____	2007 _____
Justice:	2009 _____	2008 _____	2007 _____
Other:	2009 _____	2008 _____	2007 _____

25 What do you think is the most effective way?

☐ Friends ☐ Groups ☐ Negotiation through the traditional leader
☐ Sub divisional officer ☐ Justice
Other means _____

26 Why is that means the most effective?

☐ Preserves peace ☐ Cheaper ☐ Regulations fast
☐ Other reasons _____

27 Are you satisfied with the decisions in relation to conflicts that are made by:

Traditional authority? ☐ Often ☐ Yes ☐ No ☐ Do not know
☐ Why? _____

The sub divisional authority? ☐ Often ☐ Yes ☐ No ☐ Do not know
☐ Why? _____

Justice? ☐ Often ☐ Yes ☐ No ☐ Do not know
☐ Why? _____

28 Did you spend money on the settlement of these conflicts? ☐ Yes ☐ No

For what? _____

29 In your opinion, what should be done to reduce conflicts over fishery resources?

_____

30 What would you do as fishermen to reduce conflicts over fishery resources?

_____

E Impacts

31 What is your perception of conflict? ☐ Normal or Positive ☐ Negative

32 How does conflict affect your relationships with your neighbours?

_____

33 How do these conflicts affect vulnerable groups (women, children, the elderly, ethnic minorities)?

_____

34 Are you currently suffering from something because of these conflicts?

☐ Yes ☐ No

35 List and briefly explain this suffering.

_____

36 Do you think the conflicts have affected the amount of fish caught in the plain?

☐ Yes ☐ No

If so, how? _____

37 Do you think the conflicts have affected the quality of fish caught in the plain?

☐ Yes ☐ No
If so, how? _____

38 How much money do you spend each year on resolving conflicts related to fishing?

0 FCFA	☐
10 000 to 30 000 FCFA	☐
31 000 FCFA to 60 000 FCFA	☐
61 000 FCFA to 100 000 FCFA	☐
≥ 101 000 FCFA	☐

39 Conflicts have influenced your income level? ☐ Increase ☐ Decrease

40 These conflicts have influenced the level of poverty in the area?

☐ Yes ☐ No
If so, how? _____

41 What is the conflict that has had the most impact in the last 5 years?

_____

In what year it happen? _____

What were the causes of this conflict?

_____

What are the consequences / damage caused by the conflict (amount)?

_____

Injured: _____

Arrest (imprisonment) _____

Dead _____

Damage: Canoes Houses _____

Motor Bike _____

Loss of livestock _____

Other: _____

42 Have these conflicts affected your children's education, health and access to drinking water?

☐ Yes ☐ No

How? _____

43 What was the contribution of these conflicts in your life today (or lessons learned)?

_____

F Identification of respondent

44 Location _____

Village _____

Sub district _____

45 Residence ☐ Permanent ☐ Temporary

46 Gender ☐ Male ☐ Female

47 Age (years)

☐ ≤ 20 ☐ 21-25 ☐ 26-30 ☐ 31-35 ☐ 36-40

☐ 41-45 ☐ 46-50 ☐ 51-55 ☐ 56-60 ☐ ≥ 60

48 Ethnic group

☐ Kotoko
☐ Musgoum
☐ Other .....

Thank you for your cooperation.

1 The population has been giving by the head of the village.

Bibliography

ACEEN (2007). Gestion de plaine d'inondation de Waza-Logone. D'une véritable tragédie au redécollage perceptible. Document de capitalisation du Projet de Contribution à la gestion de la plaine d'inondation de Waza-Logone, 101 pp.

Adam, S. (1994). Impact de la ré-inondation de la plaine du Logone sur la pêche: cas particulier des villages riverains du parc national de Waza. Rapport de stage d'insertion professionnel. FASA, Université de Dschang, 114 pp.

Adger, W.N. (2006). Vulnerability. *Global Environmental Change*, 16(3): 268-281.

Albaret, J.J. (1994). Les poissons: biologie et peuplements. In Durand, J.R., Dufour, P., Guiral, D. & Zabi, S.G. (Eds.), *Environnement et ressources aquatiques de Côte d'Ivoire Tome 2. Les milieux lagunaires*, ORSTOM, Paris (1994), pp. 239-279.

Allison, E. & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine policy,* 25: 377-388

Allison, E.H., Perry, A.L., Badjeck, M.C., Adger, W.N., Brown, K., Conway, D., Halls, A.S., Pilling G.M., Reynolds J.D., Andrew N.L. & Dulvy, N.K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries*, 10(2): 173-196.

Anene, A. (2005). Condition Factor of Four Cichlid Species of a Man-made Lake in Imo State, Southeastern Nigeria. *Turkish Journal of Fisheries and Aquatic Sciences,* 5: 43-47.

Anyanwu, P.E., Okoro, B.C., Anyanwu, A.O., Matanmi, M.A., Ebonwu, B.I., Ayaobu-Cookey, I.K ., Hamzat, M.B., Thimekpen, F. & Afolabi, S.E. (2007). Length-Weight relationship, condition factor and sex ration of African Mudcat (*Clarias gariepinus*) reared in indoor water recirculation system tanks. *Res. J. Biol. Scio.,* 2 (7): 780-783.

Bachler, G. (1999). *Violence through environmental discrimination. Causes, Rwanda arena, and conflict model*. Dordrecht: Kluwer Academic Publishers.

Barley, P.B. (1995). Understanding large river floodplain ecosystems. *Biosciences,* 45: 153-158.

Bauer, H. (2003). Local Perception of Waza National Park, Northern Cameroon. *Environmental Conservation*, 30(2): 175-181.

Bavinck, M. (2005). Understanding fisheries conflict in the south: A legal pluralist perspective. *Society and natural Resources,* 18: 805-820.

Bayley, B.P. (1988). Accounting for effort when comparing tropical fisheries in lakes, river-floodplain, and lagoons. *Limnol. Oceanogr.*, 33 (4) : 963-972.

Belal, E. (2003). *Les pêches amplifiées dans la plaine d'inondation de Waza Logone (yaere) Province de l'extrême nord Cameroun in GTZ-PMEDP* (Eds.). Rapport

général de l'atelier international sur l'amplification des ressources halieutiques à travers la gestion participative : Leçons et perspectives. Bobo-Dioulasso, 177 pp.

Belal, E. & Baba, M.O. (2006). *Etude sur l'analyse de la gouvernance des pêches au Cameroun*. World Fish Center, 47 pp.

Béné, C., Mindjimba, K., Belal, E., Jolley, T. & Neiland, A. (2003a). Inland fisheries, tenure systems and livelihood diversification in Africa: The case of the Yaere floodplains in Lake Chad Basin. *African studies,* 62(2): 188-212.

Bene, C., Neiland, A., Jolley, T., Ovie, S., Sule, O., Ladu, B., Mindjimba, K., Belal, E., Tiotsop, F., Baba, M., Dara, L., Zakara, A. & Quensiere, J. (2003b). Inland fisheries, poverty, and rural livelihoods in the Lake Chad Basin. *Journal of Asian and African Studies,* 38(1): 17-51.

Bene, C., Belal, E., Baba, M.O., Ovie, S, Raji, A., Malasha, I., Njaya, F., Andi, M.N., Russel, A. & Neiland, A. (2009). Power Struggle, Dispute and Alliance Over Local Resources: Analyzing 'Democratic' Decentralization of Natural Resources through the Lenses of Africa Inland Fisheries. *World Development,* 37(12): 1935-1950.

Benech, V. (1992). The Northern Cameroon Floodplain: influence of hydrology on fish production. In Maltby, E. Dugan, P.J. & Lefeuwe, J.C. (Eds.), *Conservation and Development: The Sustainable Use of Wetland Resources*. Proceedings of the Third International Wetlands Conference, Rennes, France, 19-23 September, 1988. IUCN, Gland, Switzerland xii + 219 pp.

Benech, V., Quensiere, J. & Vidy, G. (1982). Hydrologie et physico-chimie des eaux de la plaine d'inondation du Nord Cameroun*. Cah. ORSTOM, ser. Hydolo*., 19(1): 15-35.

Bennett, E.M., Carpenter, S.R. & Caraco, N.F. (2001). Human impact on erodible phosphorus and eutrophication: A global perspective. *BioScience,* 51: 227-234.

Bernacsek, G.M. (1984). *Dam design and operation to optimize fish production in impounded river basins*, based on Review of Ecological Effects of Large dams in Africa. CIFA Tech. Pap. No. 11. FAO, Rome.

Bernacsek, G.M. (2001). Environmental issues, capacity and information base for management of fisheries affected by dams. In Marmula, G. (Eds.), *Dams, Fish and Fisheries, opportunities, challenges and conflict resolution.* FAO, Fish Tech. Pap No. 419, FAO Rome.

Bernacsek, G.M. (1986). *Profile of the marine resources of Ghana*. CECAFmCH, 86/71, 118 pp.

Bernacsek, G.M. & Lopes, S. (1984a). *Mozambique: Investigations into the fisheries and limnology of Cahora Bassa Reservoir seven years after dam closure*. Rome: FAO, Sweden Funds-in-Trust, FAO/GCP/MOZ/006/SWE, Field Document 9.

Bernacsek, G.M. & Lopes, S. (1984b). Cahora Bassa (Mozambique). In Kapetsky, J.M. & Petr, T. (Eds.), *Status of African reservoir fisheries*, CIFA Technical Paper, No. 10, FAO, Rome.

Beuving, J.J. (2015). Spatial diversity in small-scale fishing: A socio-cultural interpretation of the Nile perch sector on Lake Victoria, Uganda. *Journal of Economic and Social Geography*, 106 (1): 1-16.

Beuving, J.J. (2013). Chequered Fortunes in Global Exports: The Sociogenesis of African Entrepreneurship in the Nile Perch Business at Lake Victoria, Uganda. *European Journal of Development Research,* 25 (4): 501-517.

Beuving, J.J. (2010). Playing Pool Along the Shores of Lake Victoria: Fishermen, Careers and Capital Accumulation in the Ugandan Nile Perch Business. *Africa,* 80: 224-248.

Bigombé, P. (2002). Rapport général de l'atelier de cogestion de la retenue de la Mapé, 11-14 mars 2002 MINEPIA/PMEDP.

Bobo, K.S. & Boukar, B. (1997). *Estimation de la production péchée dans la plaine d'inondation du Logone*. IUCN/WLP, 157 pp.

Bobo, K., S., Boukar, B. & Didjatou (1996). *Estimation des stocks résiduels de poissons dans la plaine d'inondation du Logone*. Mai-Août 1996 (Rapport interne). PWL Maroua, IUCN.

Bondja, M. & Bindzi, L.S. (2005). *Etude sur la décentralisation et le secteur des pêches au Cameroun*, PMEDP, septembre 2005, 35 pp.

Borrini-Feyerabend, G.M., Pimbert, M.T., Farvar, A., Kothari & Renard, Y. (2004). *Sharing Power. Learning by doing in co-management of natural resources throughout the world*. IIED and IUCN/ CEESP/ CMWG, Cenesta, Teheran.

Borrini-Feyerabend, G.M., Farvar, T., Nguinguiri, J.C. & Ndangang, V.A. (2000). *Co-management of Natural Resources: Organising, Negotiating and Learning-by-Doing*, http://nrm.massey.ac.nz/changelinks/cmnr.html, GTZ, Kasparek Verlag (Germany).

Borrini-Fayerabend, G. (1997). *Gestion participative des aires protégées: l'adaptation au contexte*. IUCN, Gland.

Bouchardeau, A. (1968). *Monographie Hydrologique du Logone.* ORSTOM, Sect. Hydrologie. Paris, 8 vols

Bruntland, G. (1987). *Our common future: The World Commission on Environment and Development*. Oxford, Oxford University Press.

Bullock, A., Gilman, K., McCartney, M., Waughray, D., Blyth, K. and Andrews, A. (1998). *Hydrological Strategy to Develop and Manage African Wetland Resources for Sustainable Agricultural Use.* In 'Wetland Characterization and Classification for Sustainable Agricultural Development', FAO/SAFR

Buij, R. (2013). *Raptors in changing West African savannas: the impact of anthropogenic land transformation on populations of Palearctic and Afrotropical raptors in northern Cameroon*. Institute of Environmental Sciences (CML), Faculty of Science, Leiden University Doctoral Thesis, Leiden University.

BURCREP Cameroun (2010). *Troisième recensement général de la population humaine: Rapport de présentation des résultats définitifs*. BURCREP, 67 pp.

Cardinale, M. & Svedang (2008). Mismanagement of fisheries: Policy or science? *Fisheries Research,* 93(1-2): 244-247.

Cautghley, G. & Sinclair, A. (2002). *Wildlife Ecology and Management*. Blackwell Science, 334 pp.

Chapman, J.L., Balirwa, J., Bugenyi, F.W.B., Chapman, C. & Crisman, T.L. (2001). Wetlands of east Africa: Biodiversity, exploitation and policy perspectives. In Gopal, B., Junk, J. & Davis, J.A. (Eds.), *Biodiersity in wetlands: assessment, function and conservation*. Backhuys Publishers, Leiden, The Netherlands.

Charles, A.T. (1992). Fishery conflicts; a unified framework. *Marine Policy*. 16(5): 379-393.

Clark, C.W. (2010). *Mathematical Bioeconomics: The Mathematics of Conservation*, 3rd edition. Wiley New Jersey.

Coburn D. (20000. Income inequality, social cohesion and the health status of populations: the role of neo-liberalism. *Social Science & Medicine*, 51 (1): 135-146

Colletta N.J. & Cullen M.L. (2000). *Violent conflict and the transformation of social capital: lessons from Cambodia, Rwanda, Guatemala and Somalia*. Conflict Prevention Series. Washington, DC: World Bank.

Colletta, N.J., Lim, T.G. & Kelles-viitanen, A. (2001). *Social cohesion and conflict prevention in Asia, Managing diversity through development*. Washington DC. World Bank. 493 pp.

Collier, P. (2000). *Economic causes of civil conflict and their implications for policy*. Washington DC: World Bank, Development Research group.

Collier, P. & Hoeffler, A. (2002). *Greed and grievance in civil war*. Working Paper Series 2002-01. Oxford: Centre for the study of African Economies, University of Oxford.

Crul, C.M. (1992). Modèle pour l'estimation des rendements potentiels en poisson des eaux intérieures africaines. *CIFA Occas,* 16, 23 pp.

De Graaf, G. (2003). Dynamics of floodplain fisheries in Bangladesh, results of 8 years fisheries monitoring in the Compartmentalization Pilot Project, *Fisheries Management and Ecology*, 10: 191-199.

De Iongh, H.H. & Bauer, H. (2008). Ten years of ecological research on lions in the Waza National Park, Northern Cameroon. *CAT News,* 48: 29-32.

De Iongh, H.H., Bauer, H. & Hamling, P. (2004). Nine years of research on a lion *(Panthera leo)* in the Waza National Park (Cameroon): a review. Game *Wildlife Sci*., 21: 433-446.

De Iongh, H.H., Tchamba, M. & Buij, R. (2010). Waza National Park, a park in peril. In De Iongh, H.H., Persoon, G.A., Buij, R., Mvondo-Awono, J.P., Croes, B. & Tumenta, F.P. (Eds.), *Savannah landscape for the future: celebrating 20 years of environmental research and education in Northern Cameroon*, CML 212 pp.

Delclaux, F., Seignobos, C., Liénou, G. & Gentthon, P. (2010). Water and people in the Yaere floodplain (North Cameroon). In Alvarez, M.A. (Eds.), *Floodplains: Physical geography, ecology and social interaction*. Hanppage (NY)

Denny, P. (1993). Wetlands of Africa. Introduction in Whigham, D.F., Dykyjova & Hejny, S. (Eds.), *Wetlands of the world: Inventory, ecology and management I*. Kluwer Academic Publishers, the Netherlands.

Diaw, M.C. (1986). *Gestion des unités de pêche et apport de production théorique et pratique du système de parts*. Dakar, Séminaire Casamance, Ziguinchor1, 9-25 juin, 28 pp.

Diaw, M.C. (1985). *Formes d'exploitation du milieu, communautés humaine apports de production 1 : première approche dans l'étude des systèmes de production et de distribution dans le secteur de la pêche en Casamance*. Doc. Sei. Cent. Rech. BeQnsgr. Dakar-Thiaroye, 104, 167 pp.

Dixon, J.A. & Fallo, L.A. (1989). The concept of sustainability: Origins, extensions, and usefulness for policy. *Society and Natural Resources,* 2 (1): 73-84.

Donfack, P., Seiny, B.L. & M'Biandoun, M. (1997). *Les caractéristiques du milieu physique. In Agricultures des savanes du Nord-Cameroun: vers un développement solidaire des savanes d'Afrique centrale*. Actes de l'atelier d'échange, Garoua, Cameroun.

Douffissa, A. (2013). *Recueil des textes du MINIPIA*. Troisième édition, 677 pp.

Drijver, C.A. & Kouahou, E. (1995). Ce qu'un petit barrage peut faire: une initiative locale dans la plaine d'inondation du Logone au Cameroun. In Roggeri, H. (Eds.), *Tropical Freshwater wetlands. A guide to current knowledge and sustainable management*, pp. 208-214.

Drijver, C.A. & Marchand, M. (1985). *Taming the floods: environmental aspects of floodplain development in Africa*. CML Leiden, 87 pp.

Durand, J.R. & Lêveque, C. (1980). *Flore et faune aquatique de l'Afrique Sahélo-soudanienne*. ORSTOM, 873 pp.

Ecoutin, J.M., Albaret, J.J. & Trape, S. (2005). Length-weight relationships for fish population of a relatively undisturbed tropical estuary: The Gambia. *Fisheries Research*. 72 (2-3): 347-351.

Efitre, J. Chapman, L.J. & Murie, D.J. (2009). Fish condition in introduced tilapias of Ugandan crater lakes in relation to deforestation and fishing pressure. *Environ Biol Fish* (online).

Emerton, L. (2005). Waza Logone floodplain, Cameroon: economic benefits of wetland restoration. In Emerton, L. (Eds.), *Values and rewards: counting and capturing ecosystem water services for sustainable development*. UICN Water, Nature and Economics Technical paper nº 1, UICN-The World Conservation Union, Ecosystems and Livelihoods Group Asia.

Evan, P. (1996). Government action, social capita land development: reviewing the evidence on synergy. *World Development,* 24: 1119-1132

FAO (2002). *The State of World Fisheries and Aquaculture 2002*. Rome. 150 pp.

FAO (2001). *Promotion de l'aquaculture commerciale durable en Afrique subsaharienne*. Technique sur les Pêches Nos. 408/1, 408/2, 408/3. Rome.

FAO (1999). *Guideline for the routine collection of capture fishery data*. FAO Fisheries technical paper 382, 122 pp.

FAO (1998). *Integrated coastal area management, agriculture, forestry and fisheries*. Rome: FAO.

FAO (1995). *Code of Conduct for Responsible Fisheries*. Food and Agricultural Organization of the U.N., Rome, 41 pp.

Fokou, G., Haller, T. & Zinsstag, J. (2004). A la recherche des déterminants institutionnels du bien-être des populations sédentaires et nomades dans la plaine du Waza-Logone de la frontière Camerounaise et Tchadienne. *Revue de Medecine Tropicale,* 64: 464-468.

Fotsing, E. (2007). *Etude sommaire d'impacts environnementaux pour la réhabilitation de la digue de Zilim sur le cours d'eau Logomatya dans la plaine d'inondation du Logone au Cameroun*. Rapport d'EIE. SNV-CBLT-UICN. 51 pp.

Froese, R. (2006). Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. *J. Appl. Ichthyol.,* 22: 241-253.

Fulton, E.A. & Smith, A.D.M. (2011). Selective versus unselective fishing in modelled ecosystem. In Garcia, S.M. (Ed.), Kolding, J., Rice, J., Rochet, M.-J., Zhou, S., Arimoto, T., Beyer, J., Borges, L., Bundy, A., Dunn, D., Graham, N., Hall, M., Heino, M., Law, R., Makino, M., Rijnsdorp, A.D., Simard, F., Smith, A.D.M. & Symons, D. *Selective Fishing and Balanced Harvest in Relation to Fisheries and Ecosystem Sustainability*. Report of a scientific workshop organized by the IUCN-CEM Fisheries Expert Group (FEG) and the European Bureau for Conservation and Development (EBCD) in Nagoya (Japan), 14-16 October 2010. Gland, Switzerland and Brussels, Belgium: IUCN and EBCD. iv + 33 pp.

Füssel, H.M. (2007). Vulnerability: a generally applicable conceptual framework for climate change research. *Global Environmental Change,* 17(2): 155-167.

Gac, J.Y. (1980). *Géochimie du bassin du lac Tchad*. Paris, France: ORSTOM.

Garcia, S., Sparre, P. & Csirke, J. (1989). Estimating surplus production and maximum sustainable yield from biomass data when catch and effort time series are not available. *Fisheries Research*, 8 (1): 13-23.

Geheb, K., Kalloch, S., Medard, M., Nyapendi, A., Lwenya, C. & Kyangwa, M. (2008). Nile perch and the hungry of Lake Victoria: gender, status and food in an East African fishery, *Food Policy,* 33: 85-98.

Glicksman, R.L. (2009). Ecosystem Resilience to Disruptions Linked to Global Climate Change: An Adaptive Approach to Federal Land Management. *Nebraska Law Review,* 87: 833.

Goulden, M., Conway, D. & Persechino, A. (2009). Adaptation to climate change in international river basins in Africa: a review. *Hydrological Sciences Journal*, 54 (5): 804-828.

Halwart, M. & Van Dam, A.A. (2006). *Integrated irrigation and aquaculture in West Africa: Concepts, practices and potential*. Rome: FAO.

Heck, S., Béné, C. & Reyes-Gaskin, R. (2007). Investing in African fisheries: building links to the Millennium Development Goals. *Fish and Fisheries*, 8 (3): 211-226.

Heeg, J. & Bren, C.M. (1982). *Man and the Pongolo floodplain*. South African National Scientific Report 56, Pretoria, South Africa.

Hill, T. & Westbrook, R. (1997). SWOT Analysis: It's Time for a Product Recall. *Long Range Planning,* 30 (1): 46-52.

Hollis, G.E., Adam, W.M. & Aminou-Kano, M. (1993). *The Hadejia-Nguru wetlands: Environment, Economy and sustainable development of the Sahelian Wetlands*. IUCN Gland Switzerland, and Cambridge England, UK, 244 pp.

Homer-Dixon, T. F. (1999). *Environment, scarcity and violence*. Princeton, New Jersey: Princeton University Press.

Hurni, H. (1997). Concepts of sustainable land management *ITC Journal,* 3/4: 201-215.

Hurni, H, Wiesmann, U. & Schertenleib, R. (2004). *Research for Mitigating Syndromes of Global Change. A Transdisciplinary Appraisal of Selected Regions of the World to Prepare Development-Oriented Research Partnerships.* Perspectives of the Swiss National Centre of Competence in Research (NCCR) North-South, University of Berne, Vol. 1. Berne: Geographica Bernensia, 468 pp.

IRAD (2008). *Plan stratégique de la recherche agricole horizon 2008-2012*. IRAD Cameroun, 75 p.

IUCN-WLP (1994a). *Sondage rapide mené dans la zone prioritaire d'intervention du projet Waza Logone.* Rapport de synthèse, décembre 1994, 127 pp.

IUCN-WLP (1994b). *Rapport de synthèse des études socio-économiques dans la zone pilote du projet Waza Logone*. Août 1994, 89 pp.

IWMI (2007). *Water for food, water for life: A comprehensive assessment of water management in agriculture*. Colombo, Sri Lanka: International Water Management Institute.

Jackson, D.C. & Marmulla, G. (2001). The influence of dams on river fisheries. In Marmula, G. (Eds.), *Dams, Fish and Fisheries, opportunities, challenges and conflict resolution*, FAO Fish Tech. Pap No. 419, FAO Rome, 1-44.

Jul-Larsen, E., Kolding, J., Nielsen, J.R., Overa, R. & Van Zwieten, P.A.M. (2003). Management, co-management or no management? Major dilemmas in southern African freshwater fisheries. Part 1: Synthesis report. FAO Fisheries Technical Paper No. 426/1. Rome, FAO, 127 pp.

Junk, W.J. & Welcomme, R.L. (1990). Floodplains. In Patten, B.C. (Ed.), *Wetlands and Shallow Continental Water Bodies*. The Hague, the Netherlands: SPB Academic Publishers, pp. 491-524.

Junk, W.J., Barley, P.B. & Spark, R.E. (1989). The flood pulse concept in rivers floodplain systems. *Canadian journal of fisheries and aquatic special publication,* 106: 100-127.

Kleiber, P. & Maunder, M.N. (2008). Inherent bias in using aggregate CPUE to characterize abundance of fish species assemblages. *Fisheries Research* 93: 140-145.

Kolding, J. & Van Zwieten, P. (2011). The Tragedy of Our Legacy: How Do Global Management Discourses Affect Small Scale Fisheries in the South? *Forum for Development Studies,* 38: 267-297.

Kolding, J., Van Zwieten, P.A.M., Mkumbo, O., Silsbe, G. & Hecky, R. (2008). Are the Lake Victoria fisheries threatened by exploitation or eutrophication? Towards an ecosystem-based approach to management. In Bianchi, G. & Skjoldal, H.R. (Eds.), *The ecosystem approach to fisheries*, pp. 308-354. Wallingford, UK, CAB International.

Kolding, J. & Van Zwieten, P.A.M. (2006). *Improving productivity in tropical lakes and reservoirs.* Challenge Program on Water and Food. Aquatic Ecosystems and Fisheries Review Series 1, Theme 3 of CPWF. Cairo, WorldFish Center, 139 pp.

Koohafkan, P., Nachtergaele, F. & Antoine, J. (1998). Use of Agro-Ecological Zones and Resource Management Domains for Sustainable Management of African Wetlands. In *Wetland Characterization and Classification for Sustainable Agricultural Development*, FAO/SAFR.

Kreiner, A., Reiner, C.D., Van Der Lingen & Freon, J. (2001). A comparison of condition factor and gonadosomatic index of sardine (*Sardinops sagax*) stocks in the northern and southern Benguela upwelling ecosystem, 1984-1999. In Payne, A.I.L., Pillar, S.C. & Crawford, R.J.M. (Eds.), S. *Afr.* 1. *mar. Sci.,* 23: 23-34.

Kundzewicz, Z.W., Mata, L.J., Arnell, N.W., Döll, P., Kabat, P., Jiménez, B., Miller, K.A., Oki, T., Sen, Z. & Shiklomanov, I. (2007). Freshwater resources and their management. In Parry, M.L., Canziani, O.F., Palutikof, J.P., Van der Linden, P.J. & Hanson, C.E. (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, pp. 173-210. Cambridge University Press, Cambridge, UK.

Laë, R. (1994). Effect of Drought, Dams and Fishing Pressure on the Fisheries of the Central Delta on the Niger River. *Journal of Ecology and Environmental Sciences,* 20: 119-128.

Lai R. (1997). Does overfishing lead to a decrease in catches and yields? An example of two West African coastal lagoons. *Fish Manage. Ecol.,* 3: 101-116.

LCBC (2007). *Transboundary diagnostic analysis of the Lake Chad Basin*. LCBC-FEM report, 147 pp.

Levêque, C. & Paugy, D. (2006). *Les poisons des eaux continentales africaines: diversité, écologie, utilisation par l'homme*. Editions IRD.

Leveque, C., Fairhurst, C.P., Abban, K., Paugy, D., Curtis, M.S. & Traore, K. (1988). Onchocercociasis control programme in West Africa: ten year monitoring of fish populations. *Chemosphere*, 17(2): 421-440.

Loth, P. (2004). Consequence of the dam and drought. In Loth, P. (Ed.), *The Return of the Water: Restoring the Waza floodplain in Cameroon*. UINC, Gland, Switzerland and Cambridge, UK. xvi + 156 pp.

Loth, P., De Iongh, H. & Bauer, H. (2004). The natural resources of the Waza Logone Floodplain. In Loth, P. (Ed.). *The Return of the Water: Restoring the Waza floodplain in Cameroon*. UINC, Gland, Switzerland and Cambridge, UK. xvi + 156 pp.

Mafaniso, H. & Nielson, J.R. (2003). Experiences with fisheries co-management in Africa. In Wilson, D.C., Nielson, J.R. & Degnbol P. (Eds.), The fisheries co-management experience accomplishments, challenges and prospects. *Fish and fisheries*, 26.

Marchand, M. (1987). The productivity of African floodplains. *International Journal of Environmental Studies,* 29 (2-3): 201-211.

Mbaku, M.J. (2005). *Culture and custom of Cameroon*. Greenwood Press. Westport, USA, 241 pp.

MFO (1995). F*isheries in developing countries. Towards sustainable use of living aquatic resources. Sectorial policy document of development cooperation*. Development cooperation information department, The Hague, Netherlands, 99 pp.

MIDIMA (2010). *Schéma directeur régional d'aménagement et de développement du territoire pour l'Extrême Nord*, MIDIMA, 96 pp.

MINEPIA (20020. *Stratégie sectorielle de l'Elevage, des Pêches et des Industries Animales*, MINEPIA, 93 pp.

Mohamadou, H., Sahmo, S.J.B. & Edima, N. (2006). *Profil post-capture Cameroun-Pêche artisanale. Programme pour les Moyens d'Existence Durable dans la Pêche en Afrique de l'Ouest*. FAO/DFID, 51 pp.

Molenaar, J.W. & Van Santen, J.C.M. (2006). Maami Waata's underwater kingdom: Perceptions of water in a changing hydrological and ecological context: the case of the Logone floodplains in Cameroon. *The Geographical Journal,* 172 (4): 331-347.

Moore, K., Kaboré, D., Gnoumou, B. & Bertelsen, M. (1999). *Conflit et gestion des ressources naturelles dans les systèmes agraires et pastoraux des régions arides et semi-arides de l'Afrique de l'Ouest*. SANREM, West Africa.

Mosepele, K., Moyle, P.B., Merron, G.S., Purkey, D.R. & Mosepele, B. (2009). Fish, Floods, and Ecosystem Engineers: Aquatic Conservation in the Okavango Delta, Botswana *BioScience,* 59(1).

Mosepele, K. & Kolding, J. (2003). Fish stock assessment in the Okavango Delta: Preliminary results from a length-based analysis. In Bernard, T., Mosepele, K., Ramberg, L. (Eds.), *Environmental Monitoring of Tropical and Subtropical Wetlands*. Maun (Botswana): Harry Oppenheimer Okavango Research Center. Okavango Report Series No. 1, 363-390.

Moritz, M. (2003). *Commoditization and pursuit of piety: the transformation of an African pastoral system*. Dissertation, University of California. Los Angeles. xv + 491 pp.

Moritz, M. (2006). The Politics of Permanent conflict: Herder-Farmer Conflicts in the Far North of Cameroon. *Canadian Journal of African Studies,* 40 (1), 20 pp.

Mvondo, J.P., Demba, H., Oyo, J.P. & De Iongh, H. (2003). *Inondation et fonctionnement d'un écosystème: besoins de recherche pour la plaine du Logone*. CDEC/CML, 210 pp.

Naah, E. (1990.) *Hydrologie du grand Yaéré du nord Cameroun. Yaoundé*, Cameroon: Thèse de doctorat ès sciences, Université de Yaoundé.

Nash, D.M.R., Valencia, H.A. & Geffen J.A. (2006). *Fisheries,* 31(5): 236-238.

Neiland, A. & Bene, C. (2003). *Review of river fisheries valuation in West and Central Africa. A contribution to the water, ecosystems and fisheries review workshop*, World Fish Center, Phnom Penh, 64 pp.

Neiland, A.E., Goddard, J.P. & Reid, G.M. (1990). The impact of damming, drought and overexploitation on the conservation of marketable stocks of the River Benue, Nigeria. *J. Fish. Biol.,* 37: 203-205.

NEPAD (2005a). *Inland fisheries in Africa: Key issues and future investment opportunities for sustainable development***.** Technical review paper. Midrand, Johannesburg: New Partnership for Africa's Development.

NEPAD (2005b). *Hidden harvests: Unlocking the potential of aquaculture in Africa*. Technical review paper. Midrand, Johannesburg: New Partnership for Africa's Development.

Ngok, E., Ndjamen, D. & Dongmo, J.V. (2005). *Contribution économique et sociale de la pêche artisanale aux moyens d'existence durables et à la réduction de la pauvreté*, rapport provisoire, août 2005, 45 pp.

Nilson, C., Reidy, C.A., Dynesius, M. & Revenga, C. (2005). Fragmentation and regulation of world's large river systems. *Science,* 308: 405-408.

Njifonjou, O. (1998). *Dynamique de l'exploitation dans la pêche artisanale des régions de Limbe et de Kribi au Cameroun*. Thèse de doctorat d'université (PhD thesis), Université de Bretagne Occidentale, Brest, France, 347 pp.

Noorduyn, R. (2005). *The assertion of rights to agro-pastoral land in North Cameroon: a cascade to violence?* African Studies Centre Research report 76/2005. Leiden: African Studies Centre.

Nwanic, C.D. (2006). Length-weight relationship and condition factor of Distiochodus species of Anambra River. *Animal Research International,* 3(2): 461-465.

Odedeyi, D.O., Fagbenro, O., Bello-Olusoji, O. & Adebayo, O. (2007). Length-weight relationships and condition factor of the elephant fish, Mormyrus rume (Valenciennes, 1846) in River Ose, Southwestern Nigeria. *Animal Research International,* 4(1): 617-620.

Offem, O.B., Samsons, Y.A. & Omoniyi, I.T. (2009). Length-weight Relationship, Condition Factor and Sex Ratio of Forty Six Important Fishes in a Tropical Flood River. *Res. Fish. & Hydrobiol.,* 4(2): 65-72.

Ogutu-Ohwayo, R. & Balirwa, J.S. (2006). Management challenges of freshwater fisheries in Africa. *Lakes & Reservoirs: Research and Management,* 11: 215-226.

Olivry, J.C. (1986). *Fleuves et rivières du Cameroun*. Collections monographiques Hydrologiques ORSTOM n° 9, ORSTOM Paris.

Olurin, K.B. & Aderibigbe, O.A. (2006). Length-Weight Relationship and Condition Factor of Pond Reared Juvenile Oreochromis niloticus. *World J. Zool.,* 1(2): 82-85.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press, Cambridge.

Ovie, S.I. & Emma, B. (2012). Identification and reduction of climate change vulnerability in the fisheries of the Lake Chad Basin. In De Young, C., Sheridan, S., Davies, S. & Hjort, A., *Climate change implications for the fishing communities in the Lake Chad Basin. What have we learned and what can we do better?* FAO/ Lake Chad Basin Commission Workshop, 18-20 November 2011, N'Djamena, Chad, pp. 23-84. FAO Fisheries and Aquaculture Proceedings No. 25. Rome, FAO, 84 pp.

Ovie, S. & Raji, A. (2006). *Fisheries co-management in Nigeria and analysis of the underling policy process*. NIFFR-Word Fish Center, 31 pp.

Paugy, D., Fermon, Y., Abban, K.E., Diop, M.E. & Traoré, K. (1999). Onchocerciasis Control Programme in West Africa: a 20-year monitoring of fish assemblages Aquat. *Living Resour.,* 12(6): 363-378.

Paugy, D., Lévêque, C. & Teugels, G.G. (2004). P*oissons d'eau douce et saumâtres de l'Afrique de l'Ouest*. IRD Editions, publications du Museum, MRAC, Vol I et II (CD-ROM).

Paugy D., Leveque C. & Teugels G.G. 2003. Les poissons d'eau saumâtres de l'Afrique de l'Ouest Tome 1, 457 pp. IRD.

Pauly, D. (1985). Quelques méthodes simples pour l'estimation des stocks de poissons tropicaux. *FAO Doc. Tech. Pêches,* 234, 56 pp.

Pauly D. (1976). The biologie, fisherie and potential for acquaculture of *Tilapia melanotheron* in a small West African logoon. *Aquaculture,* 7: 33-49.

Persoon, G.A. & Van Est, D.M.E. (2003). Co-management of natural resources: The concept and aspects for the implementation. In Persoon, G.A., Van Est, D.M.E. & Sajise, P.E. (Eds.), *Co-Management of Natural Resources in Asia: A Comparative Perspective*. Nordic Institute of Asia Studies, 80 pp.

Pido, M.D., Pomeroy, R.S., Carlos, M.B. and Garces, L.R. (1996). *A handbook for rapid appraisal of fisheries management systems* (version 1). ICLARM Educ. Ser., 16, 85 pp.

Pinkerton, E. (2003). Forwards specificity in complexity: understanding co-management from a social science perspective. In Wilson, D.C., Nielson, J.R. & Degnbol, P. (Eds.), The fisheries co-management experience accomplishments, challenges and prospects. *Fish and fisheries*, 26.

Pitcher, T.J. (1999). *Rapfish: a rapid appraisal technique for fisheries, and its application to the code of conduct for responsible fisheries*. FAO Fisheries Circular No. 947, 47 pp.

Pitcher, T.J. & Hart, P.J.B. (1995). The impact of species changes in African lakes. *Fish and Fisheries*, 18. Chapman & Hall, 567 pp.

Promeroy, R.S. & Berkies, F. (1997). Two to tango: The role of government in fisheries co management. *Marine Policy*, 21(5): 465-480.

Purt, A.E & Smith, D.M. (2001). The gospel of maximum sustainable yield in fisheries management: birth, crucifixion and reincarnation. In Reynolds, D.J., Mace, G.M., Redford, K.H. & Robison, J. (Eds.), Conservation of exploited species. *Conservation biology*, 6: 41-66.

Quesniere, J. (1994). *La pêche dans le Delta Central du Niger, approche pluridisciplinaire d'un système de production halieutique*, Volume I. IER/ORSTOM (IRD), Editions Karthala, 495 pp.

Quesnière, J., Poncet, Y., Fay, C., Morand, P., Kassibo, B., Rey, H., Baumann, E., Bénech, V., Bousquet, F., Dansoko, D., Lae, R., Niaré, T., Raffray, J., Troubat, J-J. & Weigel, J-Y. (1994a). *Crise halieutique et surexploitation. La pêche dans le Delta Central du Niger, approche pluridisciplinaire d'un système de production halieutique*, Volume I. ER/ORSTOM (IRD), Editions Karthala, pp. 417-426.

Ramsar (2008). www.ramsar.org/sitelist.pdf.

Reuchlin, M. (1991). *Précis de statistique*. Présentation notionnelle, Paris Puf.

Richter, H., Lückstädt, C., Focken, U.L. & Becker, K. (2000). An improved procedure to assess fish condition on the basis of length-weight relationships. *Arch. Fish. Mar. Res.,* 48(3): 226-235.

Rokshanara, M.P. & Mortuza, M.G. (2008). Notes on Length-Weight Relationship and Condition Factor of Fresh Water Fish, Labeo boga (Hamilton) (Cypriniformes: Cyprinidae). *Univ. j. zool. Rajshahi Univ.,* 27: 97-98.

Saibou, I. (2010). *Les coupeurs de route: histoire du grand banditisme rural et transfrontalier dans le bassin du lac Tchad*. Kartalla, 2016 pp.

Saliu, J.K., Joy, O. & Onwuemene, C. (2007). Condition factor, fat and protein content of five fish species in Lekki Lagoon, Nigeria. *Life Science Journal*, 4(4)

Scholte, P. (2007). Maximum flood depth characterizes above-ground biomass in African seasonally shallowly flooded grasslands. *Journal of Tropical Ecology*, 23: 63-72.

Scholte, P. (2005). Floodplain Rehabilitation and the Future of Conservation and Development. Adaptive management of success in Waza-Logone, Cameroon. *Tropical Resource Management Paper*, 67, 342 pp.

Scholte, P. (2003). Immigration: A Potential Time Bomb under the Integration of Conservation and Development. *Ambio,* 32 (1).

Scholte, P. (2000a). Towards consensual park management planning in Africa. *Oryx,* 34: 87-89.

Scholte, P. (2000b). Towards collaborative management in Waza National Park: The role of its Management Plan. In Bauer, H. & Madi, A. (Eds.), *People, parks and wildlife. Contribution from Cameroon.* Proceedings of the Park-People Conference, Maroua, CEDC.

Scholte, P., Saidou, K., Moritz, M. & Prins, M. (2006). Pastoralist Responses to floodplain Rehabilitation in North Cameroon. *Human Ecology,* 34 (1): 27-51.

Sighomnou, D. (2004). *Analyse et redéfinition des régimes climatiques et hydrologiques du Cameroun : perspectives d'évolution des ressources en eau*, Thèse Doc. d'Etat, Univ. Ydé I, 270 pp.

Sighomnou, D. (2003). *Cameroun: Gestion intégrée des eaux de crue: cas de la plaine d'inondation du fleuve Logone.* Associated Program on Flood management (WMO/WGP) September 2003, 9 pp.

Sighomnou, D. & Naah, E. (1997). Gestion des ressources en eau et développement durable. Un exemple dans la Province de l'extrême nord du Cameroun. *Regional Hydrology: Concepts and Models for Sustainable Water Resource Management. IAHS Publ.*, 246: 355-364.

Schleisinger, D.A. & Rogier, H.A. (1982). Climatic and morphoedaphic indices of fish yields from natural waters. *Transactions of the American Fisheries Society,* 111: 141-150

Schuijt, K. (2002). *Land and water use of water in Africa: Economic values of African Wetlands*. International Institute for Applied Systems Analysis, 46 pp.

Shryock, A. (2009). *Folk knowledge of fish among the Kotoko of Logone.*

Smith, R. (1970). The Canoe in West African History. *The Journal of African History*, 11: 515-533.

Sparre, P. & Venema, S.C. (1998). Introduction to tropical fish stock assessment. Part 1. Manual. FAO Fisheries Paper. N° 306.1, Rev. 2 Rome, FAO. 407 pp.

Tarla, F.N. & Bachirou, M. (2004). Co-management of the natural resources in the Waza National Park area in Northern Cameroon**.** *Game and Wildlife Science*, 21 (3): 237-247.

Tchamba, M.N. & Elkan, P. (1995). Status and trends of some large mammals and ostriches in Waza National Park, Cameroon. *African Journal of Ecology*, 33: 366-376.

Tesfamichael, D. & Pitcher, T.J. (2006). Multidisciplinary evaluation of the sustainability of Red Sea fisheries using Rapfish. *Fisheries Research,* 78: 227-235.

Tiotsop, L., Zakara, D.A. & Quensiere, J. (2003). Natural resources Institutions and property rights in inland African Fisheries: The case the Lake Chad Region, *International Journal of Social Economics,* 30 (3): 275-301.

Tockner, K. & Stanford, J. (2002). Riverine floodplains: present state and future trends. *Environmental Conservation,* 29(3): 308-330.

Tockner, K., Malard, F. & Ward, J.V. (2000). An extension of the floodplain pulse concept. *Hydrological Processes,* 14: 2861-2883.

Tumenta, P.N., Kok, J.S., Van Rijssel, J. C., Buij, R., Croes, B.M., Funston, P.J., De Iongh, H.H. & Udo de Haes (2009). Threat of rapid extermination of the lion (Panthera leo leo) in Waza national Park, Northern Cameroon. *Afr. J. Ecol*.

UNEP (United Nations Environment Programme) (2006). *Marine and Coastal Ecosystems and Human Well-being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment*. Nairobi UNEP.

UNESCO (2008). www.unesco.org/mabBRList2008.pdf (read the 2008, 17 July).

Unusa, H. (2012). *The new pastoralism: absentee owners, new technologies, economic change and natural resource management in the Sahelian region of far north Cameroon*. Institute of Cultural Anthropology and Development Sociology, Faculty of Social and Behavioral Sciences, Leiden University Doctoral thesis, Leiden University.

Van Est, D.M.E. (1999). *Vissen in Andermans Vijver. Beheer en Strijdige Belangen onder Mousgoum en Kotoko in de Logone Overstromingsvlakte van Noord-Kameroen*. Institute of Environmental Sciences (CML), Leiden University, 345 pp.

Van Est, D.M.E. & Noorduyn, R.E. (2000). Management of natural resource conflicts: a case from thee Logone floodplain in North-Cameroon. In De longh, H.H. & Prins, H.H.T. (Eds.), *Managing the dry African savanna. Options for conservation and sustainable use.* Mededelingen no. 36. Nederlandsee Commissie voor Internationale Natuurbescherming. (Dutch Commission for Inter-national Nature Protection), pp. 53-62.

Vanden Bosshe, J.P. & Bernacsek, G.M. (1990). Sources book for the inland fishery resources of Africa: *CIFA Technical Paper,* 18 (1), 204 pp., FAO Rome.

Van Densen, W.L.T., Kechik, I.B.A., Balayut, E.A., Chookajorn, T., Moreau, J., Sarnita, A.S. & Yap, S.Y. (1999). Fish production, catch composition and changes in the freshwater fish communities in ASEAN lakes and reservoirs. In W.L.T. van Densen & M.J. Morris, eds. Fish and fisheries of lakes and reservoirs in Southeast Asia and Africa, pp. 229-244. Otley, UK, Westbury Publishing.

Van der Knaap, M. (1994). Status of fish stock and fisheries of thirteen medium-size African reservoirs. *CIFA Technical Paper,* 26: 107 pp., Rome FAO.

Van Oigen, J. & Haberland, B. (1991). *Une digue en terre, effets socio-écologiques de la digue de Zilim*. Série Environnement et Développement au Nord Cameroun. CML/CED, 180 pp.

Van Oostenbrugge, J.A.E., Van Densen, W.L.T. & Machiels, M.A.M. (2004). How the uncertain outcomes associated with aquatic and land resource use affect livelihood strategies in coastal communities in the Central Moluccas, Indonesia. *Agricultural Systems,* 82: 57-91.

Van Zwieten, P.A.M., Bene, C., Kolding, J., Brummett, R. & Valbo-Jorgensen, J. (2011). *Review of tropical reservoirs and their fisheries: The cases of Lake Nasser, Lake Volta and Indo-gangetic basin reservoir*. FAO Fisheries Technical Paper n° 557. Rome, FAO. 165 pp.

Warner, M. (2000). *Conflict management in community-based natural resource projects: experiences from Fiji and Papua New Guinea*. Working Paper, 135, London: ODI.

Welcomme, R.L. (2003). River fisheries in Africa: their relationship to flow regimes. NAGA, *WorldFish Center Quarterly,* 26(3): 22-26.

Welcomme, R.L. & Halls A. (2001). Some consideration on the effects of differences in flood patterns on fish population. *Ecology & hydrobiology*, 1(3): 313-321.

Welcomme, R.L. (1999). A review of model for qualitative evaluation of exploitation levels in multi-species fisheries. *Fisheries Management and Ecology*, 6: 1-19.

Welcomme, R.L. (1979). *Fisheries Ecology of Floodplain Rivers*. Longman, London and New York.

Welcomme, L.R. & Hagborg, D. (1977). Towards a model of a floodplain fish population and its fishery. *Env. Biol. Fish,* 2 (1): 7-24.

Welcomme, R.L. (1985). *River fisheries*. FAO Technique paper, 262, 330 pp.

Westra, T. & De Wulf, R.R. (2005). *Monitoring floodplain dynamics in the Sahel region to detect land degradation processes. Remote sensing and geoinformation processing in the assessment and monitoring of land degradation and desertification*, Trier, Germany, 8 pp.

Williams, J.E. (2000). The Coefficient of Condition of Fish. In Schneider, J.C. (Eds.), *Manual of fisheries survey methods II: with periodic updates*. Michigan Department of Natural Resources, Fisheries Special Report 25, Ann Arbor.

Wirkus, L. & Boge, V. (2006). Transboundary water management on Africa's international rivers and lakes: current state and experiences. In Scheumann, W. & Neubert, S. (Eds.), *Transboundary water management in Africa: challenges for development*.

World Fish Center (2005). Fisheries and the Millennium Development Goals: Solutions for Africa, and Fish and food security in Africa. Penang, Malaysia.

Summary

This PhD dissertation covers the dynamics of floodplain fisheries in the Waza Logone floodplain (Far North region, Cameroon) and conflicts between fishers. The main objective is to understand the dynamics of the fisheries sector in the Waza Logone floodplain and specifically the level of fishing effort, diversity of fishing gear and conflicts between fishermen. It's aims to (i) assess the current situation of the fishing effort and catches in the Waza Logone floodplain, (ii) evaluate the sustainability of fisheries practices, and (iii) provide a means to better understand the factors influencing conflicts and conflict resolution between fishers in the Waza Logone floodplain. Methodology consisted mainly of a rural appraisal technique and included an open workshop with 18 traditional and municipal authorities, leaders of international and national NGOs, an interview survey in 91 villages and a daily survey on fishermen, canoes and fishing materials, between August 2008 and June 2009 in 13 fishing spots. In addition, fishing channels along the Logomatya River, the Lorome Mazera River and around the Abana natural mares were counted, after which thirteen (13) of them were selected for a more detailed survey. It also included an institutional analysis on conflict management and fisheries policy in Cameroon and the Central and West African region.

Results show a general decline in rainfall in the Lake Chad basin, and degradation of the vegetation cover over a period of about four decades, which has led to drastic changes in the environmental conditions of the Lake Chad Basin. The total population is estimated at 41,415 people and fishing is the second activity after agriculture. Man-made waterholes were dug for wildlife and pastoralists both inside and outside the Waza National Park, which are now all used for fishing. Resident and migrant fishermen are involved in fishery activities. Nine different types of fishing material are used in the Waza Logone floodplain, depending on fishing spot and fishing season (*gillnets* of several mesh sizes, *beach seines*, *hooks*, *cast nets*, *traps* such as the *Malian trap*, *"Touksi traps"*, *"Aring traps"*, and *"Mouman traps"*). In general, the peak for fishing activities in the floodplain is between November 2008 and January 2009. Fishing in the Waza Logone Floodplain is organized as an open access system where people come from several villages.

Seventy seven fish species were recorded in the catches during the study. Fish catches mainly comprise of the family Clariidae (63.03%) and Cichlidae (13.36%). Within the Clariidae, 56.16% belong to the genus Clarias (28.8% *Clarias gariepinus*, 24.37% *C. anguillaris* and 3% *C. albopuntatus*). Sarotherodon (9.16%) and Oreochromis (4.2%) are the main genera of Cichlidae family. The CPUE calculated as the mean catch per fishermen per day is 8.3 (±35.05) kg/fisherman/day. The large standard deviation is related to the diversity of fisheries, the fishing material and the fishing period. The total floodplain catches are estimated at 15,436 tons for the 2008-2009 fishing season, with 3,133 tons from the fishing channels.

Waterholes and mares constitute a crucial factor in the emergence of conflicts between fishermen. Ten causes of varying degrees of importance have been identified. The main causes are related to natural resources (competition for fish stock, decline of fishery resources, propagation of fishing channels). Several legal texts have been elaborated. They have brought mixed results and performances probably because of, among other things, a top-down approach with very low participation (involvement) of local actors (the resource user) and of civil society.

Since 2006, local NGOs are working with fishermen on the implementation of local agreements of fisheries, in which objectives, principles, rules and rights are drawn up and decided upon by all parties involved. The efficacy of institutions in the management of conflicts related to fishery resources is crucial to reduce conflicts. Mediation is the most efficient way, followed by the traditional trial. These two kinds of conflict management are more efficient for various reasons, such as the preservation of peace, the speed of trial, the low cost of the trial and the respect for the local cultural practices. It is also in this context that the traditional trial requires less effort and is not as stressful as compared to other practices. The population now has adopted a kind of legal pluralism strategy.

The impact of conflicts in the Waza Logone floodplain can be expressed in terms of social, economic and ecological aspects. The influence on social behavior and common activities, the effect on the vulnerable people (youngsters, women and elderly), the quantity and the quality of fish, losing money and poverty are the main impacts the people experienced. In general, conflicts are not well managed, which may be the result of a lack of coherent policy.

The main conclusion for this research is that the Waza Logone fisheries form a complex ecosystem which is overexploited, resulting in conflicts among fish-

ers. There is a need for civil society to become more influential as mediator between communal groups, government, and markets. This is central to a nation's capacity to manage social and economic transformation peacefully and mediate conflict.

My main recommendation is to create an 'Umbrella Agency' for the sustainable development of the Waza Logone floodplain. The central government should enhance the participation and ownership of the local population from beginning to end, develop a long-term commitment for the Waza Logone Floodplain, apply good governance in the fishery sector and provide human and financial resources for fishery development and community based management. Local NGOs have to develop and implement local agreements, and work on innovations in fisheries' management.

Key words
Waza Logone floodplain, Fish species, Catch per Unit of Effort, Sustainability, Conflicts, Far North Cameroon

Samenvatting

Deze dissertatie gaat over de dynamiek van de visserij in de vloedvlakte van het Waza Logone gebied in het noorden van Kameroen en over de conflicten tussen de vissers. Het voornaamste doel van het onderzoek is het analyseren van de duurzaamheid van de visserij in de Waza-Logone vloekvlakte en specifiek de impact van de toegenomen druk op de vispopulatie en de conflicten tussen de vissers. Het onderzoek beoogt ten eerste een inschatting te geven van de status van de visserij sector, ten tweede hoopt het onderzoek een bijdrage te leveren aan het betere begrip van de manier waarop conflicten tussen vissers worden opgelost en ten derde wordt met het onderzoek getracht de duurzaamheid van de visserijpraktijken te evalueren.

De methodologie bestond vooral uit een zgn. *rural appraisal* techniek en omvatte een open workshop met 18 traditionele en gemeentelijke autoriteiten, leiders van internationale en nationale NGOs, een survey in 91 dorpen en veld observaties van vissers, vistechnieken en vismaterialen tussen augustus 2008 en juni 2009 op 13 vislocaties. Verder werden de viskanalen langs de Logomatya Rivier, de Lorome Mazera Rivier en rond de natuurlijke *mares* van Abana geteld, waarna er 13 werden geselecteerd voor een meer gedetailleerde studie. Het onderzoek omvatte ook een institutionele analyse van het beheren van conflicten en van het visserijbeleid in Kameroen in het bijzonder en van Centraal en West Afrika meer in het algemeen.

De resultaten laten een algemene teruggang in regenval zien in het stroomgebied van het Tsjaad Meer en een degradatie van de vegetatie over een periode van ongeveer vier decennia, hetgeen tot drastische veranderingen in de natuurlijke omstandigheden in het stroomgebied van het Tsjaad Meer heeft geleid. De totale populatie van het gebied wordt geschat op 41.415 mensen. De visserij is het tweede middel van bestaand na de landbouw. Water reservoirs zijn zowel binnen als buiten het Nationale Park Waza gegraven voor de vee kuddes van de herders, maar deze reservoirs worden ook allemaal gebruikt door vissers. Zowel lokale als gemigreerde vissers zijn betrokken bij deze visserij activiteiten. Negen verschillende soorten visserijmaterialen worden gebruikt in de vloedvlakte van de Waza Logone, afhankelijk van de specifieke visplaats en het visseizoen (kieuwnetten met verschillende maasgrootte, oeverzegens, haken, werpnetten en fuiken zoals de *Malian* -, de *Touksi*-, de *Aring*- en de *Mouman*-fuiken). In het algemeen is het hoogtepunt van de vis-

serijactiviteiten tussen november en januari. In de vloedvlakte van de Waza Logone is de visserij georganiseerd als een open access systeem waar mensen uit verschillende dorpen komen.

Zevenenzeventig vissoorten werden gevonden in de vangsten tijdens het onderzoek. De visvangst bestaat vooral uit vissen die tot de familie van de *Clariidae* (63,03%) en de *Cicliden* (13.36%) behoren. Binnen de *Clariidae*, behoort 56,16% tot de soort *Clarias* spp. (28,8% *Clarias gariepinus*, 24,37% *C. anguillaris* en 3% *C. albopuntatus*). *Sarotherodon* sp. (9,16%) en *Oreochromis* sp.(4,2%) zijn de belangrijkste soorten van de *Cicliden* familie. Met behulp van CPUE methode (Catch Per Unit Effort) is berekend dat de gemiddelde vangst per visser per dag: 8,3 kg/visser /dag is (+/- 35,05 kg/visser/dag). De grote standaarddeviatie is gerelateerd aan de verscheidenheid aan visserijtechnieken, het vismateriaal en de visperiode. Het totaal van de vangsten in de vloedvlakte wordt geschat op 15.536 ton voor het seizoen 2008-2009, met een bijdrage van 3.133 ton voor de viskanalen.

Waterreservoirs en *mares* vormen een belangrijke factor in het voorkomen van conflicten tussen vissers. In totaal werden tien oorzaken van conflicten van verschillend belang geïdentificeerd. De belangrijkste oorzaken zijn gerelateerd aan de natuurlijke hulpbronnen (competitie voor visvoorraden, achteruitgang van vispopulaties, toename van de viskanalen. Verschillende juridische teksten zijn onderzocht. Zij hebben gemengde resultaten opgeleverd vanwege onder andere een top- down benadering met zeer weinig betrokkenheid van de lokale actoren (de gebruikers van de natuurlijke hulpbronnen) en van maatschappelijke organisaties.

Sinds 2006 werken lokale NGOs met de vissers aan de implementatie van lokale visserij-overeenkomsten waarin doelen, principes, rechten en regels zijn opgenomen en waarover door alle betrokken partijen wordt besloten. De effectiviteit van instituties in het managen van conflicten die gaan over visserijzaken is cruciaal voor het verminderen van conflicten. Mediatie is de meest efficiënte methode, gevolgd door een traditionele rechtspraak. Deze twee manieren van het beheersen van conflicten zijn om verschillende redenen meer efficiënt. Ze bevorderen of handhaven de vrede, een conflict is sneller opgelost, er zijn minder kosten mee gemoeid en ze werken beter dan andere methoden vanwege het respect voor de lokale culturele praktijken. Het is ook in deze context dat de traditionele manier van rechtspraak minder inspanning vereist en minder spanningen oplevert vergeleken met andere manieren van conflictbeheersing . De bevolking heeft nu gekozen voor een strategie van een soort *legal pluralism*.

De impact van conflicten in de vloedvlakte van de Waza Logone kan worden uitgedrukt in termen van sociale, economische en ecologische aspecten. De invloed op sociaal gedrag en gemeenschappelijke activiteiten, het effect op de kwetsbare mensen (jonge mensen, vrouwen en ouderen), de hoeveelheid en de kwaliteit van vis, het verlies aan geld en de toegenomen armoede zijn de voornaamste gevolgen waarmee mensen geconfronteerd worden. In het algemeen worden conflicten niet goed beheerd, wat het resultaat zou kunnen zijn vangebrek aan een coherent beleid.

De voornaamste conclusie van dit onderzoek is dat de visserij in de vloedvlakte van de Waza Logone een complex ecosysteem vormt, waarbij sprake is van over-exploitatie, hetgeen kan leiden tot conflicten tussen vissers. Er is behoefte aan dat de maatschappelijke organisaties invloedrijker worden als mediator tussen verschillende groepen, de overheid en de marktpartijen. Dit is van cruciaal belang voor de mogelijkheden van het land om sociale en economische veranderingen aan te kunnen en aan conflictbeheersing te doen.

Onze belangrijkste aanbeveling is een overkoepelende instelling in het leven te roepen voor de duurzame ontwikkeling van de vloedvlakte van de Waza Logone. De centrale overheid zou de participatie en het gevoel van betrokkenheid van de lokale bevolking van begin tot eind moeten verstevigen, waarbij een lange termijn commitment voor de vloedvlakte van Waza Logone wordt ontwikkeld en waarbij goed bestuur en beheer over de visserij sector wordt toegepast waarvoor voldoende menskracht en financiële middelen voor de visserij ontwikkeling en beheer door de gemeenschap ter beschikking worden gesteld. Lokale NGOs moeten lokale overeenkomst ontwikkelen en implementeren en weken aan innovaties in het beheer van de visserijsector.

Kernwoorden
Waza Logone vloedvlakte, visserij, duurzaamheid, conflicten, Noord-Kameroen.

Résumé

Cette thèse de Doctorat (PhD) porte sur la dynamique de la pêche et les conflits entre pêcheurs dans la plaine d'inondation de Waza Logone (région de l'Extrême-Nord, Cameroun). L'objectif principal est comprendre la dynamique du secteur pêche dans la plaine d'inondation du Logone, particulièrement la diversité des ressources des techniques et méthode, de pêche, l'effort de pêche et les facteurs conflictuels. Elle vise (i) l'évaluation de l'état des ressources halieutiques et l'effort de pêche, (ii) la durabilité des techniques de pêche, (iii) proposer les outils permettant une meilleures comprenhension des facteurs conflictuels et les mécanismes de résolution.

La méthode de recherche participative a été utilisée principalement. Elle a consisté en un atelier avec 18 autorités traditionnelles et municipaux, dirigeants des ONG nationales et internationales, une enquête dans 91 villages et un suivi quotidien des pêcheurs, matériels de pêche entre Août 2008 et Juin 2009 dans 13 sites de pêche. En plus, les canaux de pêche le long de la rivière Logomatya et de la mare naturelle "Abana" ont été identifiés et treize (13) d'entre eux suivis. Une analyse institutionnelle sur la gestion des conflits et la réglémentation danss le sous-secteur pêche au Cameroun, en Afrique Centrale et de l'Ouest a été faite.

Depuis environ quatre décennies, on constate une baisse générale de la pluviométrie dans le bassin du lac Tchad, et la dégradation du couvert végétal qui a conduit à des changements radicaux dans les conditions environnementales du bassin. La population totale est estimée à 41.415 personnes et la pêche est la deuxième activité après l'agriculture. Les points d'eau artificiels creusés pour l'abreuvement du bétail et de la faune sont tous utilisés pour la pêche y compris ceux se trouvant dans le parc national de Waza. Les pêcheurs résidents et les pêcheurs migrants sont notés dans la plaine. On note une grande diversité de matériels de pêche en fonction des sites de pêche et de la saison de pêche (filets maillants, senne de plage, épervier, des pièges comme les nasses maliennes, "Touksi", "Aring", et "Mouman"). En général, le pic des activités de pêche dans la plaine d'inondation se situe entre Novembre et Janvier. La pêche dans la plaine d'inondation de Waza est organisée comme un système d'accès ouvert où les pêcheurs viennent de plusieurs villages.

Soixante-dix-sept espèces de poissons ont été enregistrées au cours de l'étude appartenant à 7 familles et 12 genres. On note principalement des espèces appartenant à la famille de Clariidae (63,03%) et Cichlidae (13,36%). Parmi les Clariidae, 56,16% sont des Clarias (28,8% de *Clarias gariepinus*, 24,37% de *C. anguillaris* et 3% de *C. albopuntatus*). Sarotherodon (9,16%) et Oreochromis (4,2%) sont les principaux genres de la famille des Cichlidae.

L'effort de pêche calculé comme la moyenne des captures par pêcheur et par jour est estimé à 8,3 (±35,05) kg/pêcheur/jour. Les captures totales de la plaine d'inondation ont été estimées à 15.436 tonnes pour la saison 2008-2009 dont 3.133 tonnes provenant des canaux de pêche.

Les mares et les canaux de pêche constituent des facteurs cruciaux dans l'émergence de conflits entre pêcheurs. Dix causes majeures ont été identifiées dont la mal gouvernance dans la gestion des ressources naturelles (compétition pour les stocks de poissons, déclin des ressources halieutiques, multiplication des canaux de pêche). Plusieurs textes de loi ont été conçus dans le secteur de la pêche. Ils ont eu des effets et des résultats mitigés probablement parce que l'approche "top-down" a été utilisée avec une très faible participation (implication) des acteurs locaux (utilisateur des ressources) et des organisations de la société civile.

Depuis 2006, des ONG travaillent avec des pêcheurs à la mise en œuvre des conventions locales de pêche qui sont une liste d'objectifs, de principes, de règles et des droits établis par les parties prenantes locales. L'efficacité des institutions dans la gestion des conflits liés aux ressources halieutiques est essentielle pour réduire les conflits. La médiation est le moyen le plus efficace, suivi par les "procès traditionnels". Ces deux types de gestion de conflits sont plus efficaces par qu'elles permettent une préservation de la paix, elles sont diligentes, moins coûteuses et respectent les pratiques culturelles locales. Elles sont également moins stressantes. Généralement, les populations adoptent une sorte de stratégie de pluralisme juridique.

L'impact des conflits dans la plaine d'inondation de Waza Logone se traduit sur le plan socio-économique et écologique. Les conflits influencent le comportement social et les activités communautaires. Ils affectent les personnes vulnérables (jeunes, femmes et personnes âgées), la quantité et la qualité des poissons et entrainent une perte d'argent et la pauvreté.

La principale conclusion de cette étude est que, les pêcheries de la plaine d'inondation de Waza Logone constituent un écosystème complexe et sont

surexploitées, d'où l'exacerbation les conflits entre pêcheurs. Il y a nécessité qu'émerge une société civile performante capable d'assurer la médiation entre les groupes communautaires, les communes et les autorités administratives. Elle est essentielle pour la capacité d'une nation à assurer son développement socio-économique, et pour la transformation pacifique des conflits.

Notre principale recommandation est donc de créer une agence pour le développement durable de la plaine d'inondation de Waza Logone. Il faudrait renforcer la participation de la population locale dans le processus de développement de la plaine, l'élaboration d'une vision de développement à long terme basée sur une bonne gouvernance dans le secteur de la pêche. Des ressources humaines et financières devront accompagner la structuration des communautés à la base et renforcer les capacités des ONG locales dans l'implémentation des conventions locales et des innovations dans la gestion des pêcheries.

Mots clés
Plaine d'inondation de Waza Logone, Poisson, Effort de pêche, Durabilité, Conflits, Extrême nord Cameroun

Curriculum vitae

Roland Ziébé was born in 1971 in Kaele in Cameroon. After his primary education he went to the governmental higher school in Garoua. After he obtained his general certificate he went to the Faculty of Sciences at the Cheik Anta Diop University of Dakar in Senegal to obtain a preparatory certificate for veterinary Studies. He continued his education at the Inter-States School for Veterinary Sciences and Medicine. In 1996 he graduated as veterinary doctor. The following year he was selected by the Netherlands Development Organization (SNV) and the Diocesan Development Committee (Diocese of Maroua) as a consultant for a specific project to support small farmers in Northern Cameroon. In 2001, he was selected by the Institute of Tropical Medicine in Antwerp (Belgium) for a specialization in Tropical Health and Animal Production. He defended his master thesis in Antwerp in 2003 after which he returned to Cameroon to work in various projects all of which were related to natural resource management.

In 2008 he was selected as a PhD candidate at Leiden University within the framework of the Louwes Fund for Research on Water and Food.

At present, he is a lecturer at the High Institute of the Sahel (University of Maroua, Cameroon) and engaged in various research projects related to sustainable livestock systems and improvement of agricultural productivity and food security.