

MANAGEMENT AND SOCIO-ECONOMIC ASPECTS FOR JEBEL
AULIA DOWNSTREAM FISHERY KHARTOUM STATE

By:

Anthony Julu Michael Matere

B. Sc. (Honours) 1990, College of Natural Resources and Environmental
Studies, Fisheries Science

University of Juba

A Thesis submitted for Partial Fulfilment of Master Degree in Environmental
Science

Institute of Environmental Studies

University of Khartoum

Supervisor: Prof. Zuheir Nour El Dayem mahmoud

July 2007

Table of Contents

	Page
Table of Contents	i
Dedication	iii
Acknowledgement	iv
List of Tables	v
List of Appendices	vi
Abstract	vii
Abstract in Arabic	viii
Chapter One: Introduction	1
Objectives of the Study	2
Chapter Two: Literature Review	3
2.1 Fisheries as a Natural Resource	3
2.2 Status of Fisheries Production in the World	4
2.3 Status of Fisheries Production in the Sudan	5
2.4 The Role of Fisheries in the Socio-Economic Development of the Sudan	10
2.5 Fisheries Development in the Sudan	12
2.6 Prospects of Fisheries Development in the Sudan.....	14
2.7 General Problems of Fisheries Management	16
2.8 Ecological, Socio-Cultural and Economic Aspects of a Fishery	17
2.9 Fisheries as a Human Phenomenon	18
2.10 Fish Production in Khartoum State	19
2.11 Fishing Gears and Crafts	22
Chapter Three: Materials and Methods	24
3.1 Study Site	24
3.2 The Method	25
Chapter Four: Results	27
4.1 Fish Production	27
4.2 Population	27
4.3 Educational Status	27
4.4 Demographic and Socio-Economic Aspects	28
Chapter Five: Discussions	33

Chapter Six: Conclusions and Recommendations36
Chapter Seven: References38
Appendices43

DEDICATION

To all those who never hesitated to give me a helping hand in times of need; my parents, brothers, sisters, wife, children and friends by and large; I owe them so much gratitude.

ACKNOWLEDGEMENT

The author is grateful to Professor Zoheir Nur El Dayem Mahmoud, for his support, encouragement and advice during the entire supervision of this research.

During the field trips, I have benefited a lot from the friendship and cooperation of the fishers and to them I owe an enormous debt.

I am most thankful to several persons who helped me in one-way or the other to finish the M Sc. Course. Top on the list is the Ministry of Agriculture, Animal Resources and Rural Development, Western Bahr El Ghazal State for sponsoring the study. Without their assistances I would have not accomplished the task.

Also I extend my appreciation and thanks to the staff of the following institutions: Institute of Environmental Studies, Institute of Natural Sciences and Department of Zoology-Faculty of Science (University of Khartoum), Arab Organization for Agricultural Development (AOAD), Fisheries Research Centre, Fisheries Training Centre, Faculty of Science, (University of El Nilein), and St. Vincent de Paul Society for rendering their facilities at my disposal.

Finally, I express my deep heartfelt gratitude to my parents, brothers, sisters, wife and children for their patience, tolerance, love, encouragement and support. I thank them for their perseverance and wish them all life's prosperity.

List of Tables

Table	Page
1. The Distribution of World Catch According to their Different Usages	3
2. Fish Stock, Production and Reserve of the Sudan (Quantities in tons).....	6
3. Number of Fish Producers and Fishing Crafts in the White and Blue Niles	7
4. Exports of Fresh and Wet-salted Fish (Fassiekh) during the Period 1991-1997 (in tons).....	8
5. Total Fish Consumed in the Sudan 1987-1997 (in 1000 tons)	9
6. Age Group of Fish Producers (years)	28
7. Fishing Duration (years)	28
8. Marital Status of Fish Producers	29
9. Educational Levels of Fish Producers	29
10. Percentages of Family Members engaged in fishing.....	29
11. Percentages of Fish Producers Receiving Services from the Fisheries Administration	30
12. Types of Fish Producers	30
13. Percentages of the Types of Fishing Crafts	30
14. Percentages of the Types of Fishing Gears	30
15. Percentages of Fish Quantity caught Daily	31
16. Percentages of Fish Producers Daily Income	31
17. Prices of Fishing Gears (in Sudanese Pounds)	32

List of Appendix

1. Questionnaire on the Socio-economic Status of Fish Producers at Jebel Aulia43

ABSTRACT

The research was carried out to investigate some management and socio-economic conditions affecting fish producers of Jebel Aulia reservoir downstream fishery.

The methodologies applied include questionnaires, field trips to the study site as well as individual and group discussions with members of the fishing community.

The results showed that, some of the management policies impact negatively on fish production thus affecting the socio-economic status of fish producers drastically. This is practically observed in the dominance of unconventional capture methods, application of illegal gear material (monofilament nylon threads) and mesh size (2x2 cm), lack of modern post harvest infrastructure, absence of institutions and producer organizations, insufficient extension services, no clearly defined marketing systems etc....

The study recommends that, policy makers and fisheries officials (Research as well as Administration) should extend their tasks from the management of natural resources to that of fishers through their incorporation in decision making processes to enhance rational governance of the fisheries sector.

Moreover, the research recommends the establishment of network of fish producers' associations and groups to be assisted by the development agencies as well as the private sector, institution of production and market group. Availability of credit cooperatives, provision of reliable and timely information on the fisheries status and trends, extension packages to impart scientific advices for sustainable development of the fishery and the availability and accessibility of hygienic fish markets to consumers in populous areas to ensure relatively affordable prices and continuous fish supply all the year round (food security) are recommended as a key point for the development of the fishery.

الخلاصة

اجري هذا البحث لدراسة بعض الجوانب الادارية والاقتصادية والاجتماعية التي تؤثر علي صائدي الاسماك في منطقة خزان جبل الاولياء (مصائد منطقة أدني النهر).

الطرق التي استخدمت في إجراء البحث شملت الاستبانات, الزيارات الحقلية لمنطقة الدراسة إضافة للمناقشة مع أفراد ومجموعات من مجتمع الصيادين بالمنطقة.

أوضحت الدراسة أن بعض السياسات الادارية تؤثر سلبا علي إنتاجية المصايد من الاسماك وبالتالي تؤثر بشدة علي الوضع الاقتصادي والاجتماعي. عمليا بنيت هذه النتيجة علي : أن استخدام وسائل صيد غير سليمة مثل استخدام شباك مصنوعة من النايلون (العصب) احادي الفتلة واستخدام شباك ذات فتحاتغير قانونية (عين اثنين 2x2 سم) عدم توفر أنمذج لمعاملات مابعد الحصاد. عدم توفر مؤسسات ومنظمات لمنتجي الاسماك ,عدم توفر الخدمات الارشادية وعدم وجود نظام تسويق واضح للمنتج.

أوصت الدراسة بان يقوم متخذي القرار ومركز بحوث الاسماك وادرة الاسماك بتوسيع أهدافهم من ادارة المصدر الطبيعي (الاسماك) الي ادارة صائدي الاسماك من خلال إشتراكهم في إتخاذ القرارات المتصلة بالموارد لتحسين المورد والارتقاء به.

كذلك أوصلت الدراسة بانشاء شبكات للمنتجين تدعم بواسطة المنظمات العاملة في مجال التنمية والقطاع الخاص ومؤسسات الانتاج والتسويق. كما أوصت بتوفير تسهيلات للحصول علي القروض,توفير المعلومات في وزقتها عن حالة المصايد السمكية.توفير الحزم الارشادية لتوصيل المعرفة العلمية لمجتمع الصيادين.نادت الدراسة بضرورة لضمان إستادة الموارد .كما نادت الدراسة بتوفير أسواق لبيع الاسماك تتوفر فيها الشروط الصحية,تباع فيها اسماك بالسعر المعقول وعلي مدار العام.

التوصيات التي قدمت في مجملها هي حجز الزواية في النهوض بقطاع الاسماك كمورد والصيد كمهنة.

CHAPTER ONE: INTRODUCTION

Thomas Robert Malthus, in an essay on the principle of population, first published in 1798, stated that, the growth of human population follows a geometric mode while that of food production follows an arithmetic mode. This very basic fact initiated several attempts towards increasing food production. The poor results attained during the past have lead to increase of the awareness of politicians, economists and environmentalists and adoption of sustainable utilization of resources. Recent international concerns were towards the endeavor of new resources and policies to ensure adequate production of food and equitability in sharing the resources. Of these trials are:

1. Control of human birth rates through the efforts of the World Health Organization (WHO) and a number of Non Governmental Organizations (NGO's) in practically every nation in the world.
2. Go into and rapture local food culture, habits and knowledge in order to secure diversification of food resources. At the same time extension service towards improving the quality and the minimization of post harvest loss is also catered for.
3. Tapping untraditional sources of food.
4. Introduction of genetic engineering as an integral component of cultivation and agricultural practices.
5. Improvement of animal husbandry practices and livestock races through genetics and the introduction of the concepts of integrated farming.

Despite these variable efforts food from the aquatic resources has been looked upon as the most promising solution to fill the gap between the amounts of food needed and that produced as compared to that from land.

Humans also exploit biodiversity from the oceans for other purposes. Such biodiversity, archaism of characters, organizational and behavioral patterns make these marine organisms an excellent reservoir for identifying and extracting very interesting pharmacological (anti-cancer, antibiotics, antiviral, immunostimulating, immunosuppressive, growth factors, bone regenerators, molecular tools as polymerases, fluorescent proteins ...)

and cosmetic molecules (>5000 today) and/or to present very pertinent “models” for basic and applied research (Boeuf, 2008).

Water, which constitutes about 71.0% of the Earth’s surface, (Royce, 1972) has always been an important actual and potential food sources. At present, the explosive increase in human population, especially those of the developing countries and the repeated cycles of drought and other calamities that greatly reduce food production aggravated the imbalances between food availability and consumption resulting into acute food shortages. As a result, food is becoming a limiting factor in many countries.

From ancient times, fishing like any hunting activities has been a major source of food for humanity (Souma, 1989).

Food security, defined as the certainty that every human being in each country will have an adequate and nutrient food supply and diet has recently become a case for concern amongst top-level decision makers (Khaled *et al*, 1985).

The interest in food security at a country level, lead to the execution of several conferences, summits and meetings at different official and technical levels as well as the presidential scale as exemplified by the Food Summit which was held at Rome in 1992.

Objectives of the Study

The objectives of this partial fulfillment piece of work are to:

1. Demonstrate the need and importance of socio-economic studies in effective fisheries development and management.
2. Investigate some factors that affect the livelihood of the fish producers in the study area.
3. Shed light on some of the environmental and management problems facing fisheries development.

CHAPTER TWO: LITERATURE REVIEW

2.1 Fisheries as a Natural Resource:

Fisheries resources constitute capital assets from the social and economic aspects similar to man-made capital assets such as factories and machineries.

Fisheries resources are capable of producing a stream of returns to societies through time. The management task is to allocate these streams of returns in order to maximize expected benefits. And when the physical potential of renewable resources is tempered by the requirements, its use must be allocated over time to give equal opportunity to future generations (Judith, 1995). This is also in harmony with Reo declaration of 1991.

Fish ranks as one of the world's major food commodities. In 1996, the Food and Agricultural Organization of the United Nations (FAO), estimated the overall world's production at about 95 million tons as illustrated in Table (1); 70% is consumed as food by humankind, the balance is used as animal feeds and other purposes.

Table 1. The Distribution of World Fish Catch According to their Different Usages:

Type of usage	Human consumption		
	Amount in millions	Percentage	Percentage of Production
Marketed	19.9	30.00	20.29
Frozen	22.0	33.00	23.16
Canned	11.3	17.00	11.89
Cured	13.3	20.00	14.00
Sub total	66.5	100.00	70.00
Other purposes			
Oils and Meals	27.17	95.33	18.60
Miscellaneous	1.33	4.67	1.40
Sub total	28.5	100.00	30.00
Total	95.00		100.00

Source: Fishery yearbook, FAO (1996)

2.2 Status of Fisheries Production in the World:

Capture fisheries were once regarded as the greatest food resources of the future with the potential for an almost unlimited increase in yield. Today, however, wild fish resources are considered to be exploited at their maximum sustainable levels throughout the world.

Although aquaculture contributes only about 10% of the world's fish production at present, it has tremendous potential for making fish more available in the developing world (FAO, 1996).

Fisheries are an important sector in the economy of many developing countries although they rarely attain the high profile of agriculture or manufacturing. About 12 million people are employed in fishing worldwide and an equivalent number in fish processing, marketing and other related activities (FAO, 1996).

The fisheries sector is divided into three major sub-sectors: industrial and artisan, which together make up the capture fisheries and aquaculture. Industrial fisheries are large scale, highly organized (similar to agro-industrial firms), relatively capital intensive, provider of higher incomes for both boat owners and crew than artisan fisheries, suppliers of most canned and frozen fish. By contrast, artisan fisheries are smaller, disperse and often fragmented in organization, sometimes part of other overlapping activities such as agriculture, animal husbandry and aquaculture and highly labour intensive and capital investment. According to estimates by the Food and Agriculture Organization, more than 25 million people work in artisan or small scale fisheries which produces half of the fish eaten world wide.

Out of the total catch for human consumption, 30% is sold fresh; 33% frozen; 17% manufactured into canned products and the balance (i.e. 20%) is processed into cured salted (fassiekh), dried, smoked etc....

The world's fisheries production destined for human consumption has increased according to FAO, 1996 statistics almost three folds over the past 50 years. This increase was due to new technologies and material science introduced.

The developing countries now account for more than half of the world's catch. Unlike fisheries in the industrialized countries, they are dominated by small-scale or artisan producers.

Fish produced by artisans account for more than 25% of the world's catch. 40% of the total fish production is characterized by

high levels of labour, low capital investment, low level of mechanization and frequent use of passive fishing methods (Patti, 1989).

2.3 Status of Fisheries Production in the Sudan:

The natural fisheries in the Sudan are divided into two main sectors; the inland fisheries (freshwater fisheries) and the marine fisheries.

The inland fisheries are carried out on the Niles, (the White and Blue Niles) and their tributaries which cover 6500 kilometers long. The reservoirs formed by the dams on these rivers; the Jebel Aulia reservoir, on the White Nile, the Roseiries and Sennar, on the Blue Nile, the Khasm el Girba, on the Atbara River and Lake Nubia (the Sudanese portion on the Nasiri reservoir) and the Sudd region are the main production sites. Lake Nubia and the Sudd region (in the upper part of the White Nile) are the richest sources of fish production in the Sudan.

On the other hand, the marine fisheries are situated along the Sudanese coastline on the Red Sea extending to about 720 kilometers with a continental shelf of about 9800 km². This is unsuitable for trawling due to its irregular coral beds (Souness, 1978). This area is endowed with finfishes, shellfishes, crabs, crustaceans, shrimps and lobsters (Osman *et al.*, 1990).

The total sustainable fish stock of the Sudan is about 110,000 tons (Fisheries Department Statistics, 1995) as shown in Table (2). About 68% of the total stock is found in the Southern states (especially in the Sudd region). This is a result of the existence of favourable natural conditions for fish production and growth where the water covers about two million hectares. Total water cover of the Sudan is about twenty million hectares.

Most of the catch is consumed fresh; the balance is being crudely sun dried without salting and in case of *Hydrocynus* spp. (Kass), *Alestes* spp. (Kawara) and *Labeo* spp. (Dabs), wet-salting is the profitable practice. Fish quality is very low, but prices are high relative to animal meat, which is widely available. The Sudanese are amongst the least fish eating people with a per capita consumption of 1.3 kilograms per annum (Mahmoud *et al.*, 1998).

**Table 2. Fish Stock, Production and Reserve of the Sudan
(Quantities in tons):**

Location	Fish stock		Production		Fish Resource	
	Quantity	%	Quantity	%	Quantity	%
Jebel Aulia	15,000	13.45	12,000	26.23	3,000	4.56
Lake Nuba	5,000	4.48	1,000	2.19	4,000	6.10
Sennar reservoir	1,000	0.90	1,000	2.19	-	0.00
Roseries	1,700	1.52	1,500	3.28	0,200	0.30
Khasm el Girba	0,800	0.71	0,500	1.09	0,300	0.45
River Nile	2,00	1.78	1,500	3.28	0,500	0.76
Southern states	75,00	67.28	23,500	51.36	51,500	78.32
Irrigation canals & hafeers	1,000	0.90	0,750	1.64	0,250	0.38
Red Sea	10,000	9.00	4,000	8.74	6,000	9.12
Total	111,500	100.00	45,750	100.00	65,750	100.00

Source: Fisheries Department Statistics, 1995

2.3.1 Fish Producers:

Fish producers are considered in most of the developing countries as one of the most neglected and poorest groups within the society. They usually have traditional inherited fishing methods not adapted to the modern fishing methods or gears (defined by Hodgson, 1998, as any net, trap, sieve, line, spear or other implement or tool used for fishing), fish handling and preservation. Actually the same conditions do prevail in the Sudan. Thus there is a huge gap between the world's modern fisheries and the traditional fisheries of our country.

2.3.2 Fishing Crafts:

In the Sudan, most of the fishing boats are wooden crafts with few steel and fiberglass ones. Fiberglass boats are preferred at the Red

Sea. Generally, there is low motorization level and most engines are as a matter of fact used by fish collecting boats and seldom engaged in fishing operations (Bellmans *et al.*, 1998). The number of fishermen per boat is between 2 to 3 in the most productive areas in Sudan (Table 3).

Table 3. Number of Fishers and Fishing Crafts in the White and Blue Niles:

Area	Number of		
	fishermen	fishing vessels	fishermen per boat
Jebel Aulia	7736	2684	2.88
Sennar reservoir	1077	594	1.81
Roseiries reservoir	9247	3686	2.51

Source: Catch Assessment Survey Report, 1998.

2.3.3 Fishing Gears:

The main types of fishing gears are: gillnets; driftnets; trammel nets; beach seine nets; cast nets with occasional use of hooks and long lines (sarena). In the case of subsistence fisheries, spears, harpoons and baskets are also used (Amirthalingham and El Khalifa, 1965).

The making of the different types of nets is essentially the same with only difference in their application. The material used is often nylon twine but in some areas, nylon monofilaments are also found (Keisuke, 1981). Fishing materials are imported, as they cannot be locally manufactured. This indirectly adds to the price of fish.

2.3.4 Landing Site Facilities:

Landing site facilities, which include clean water, ice factories; cold stores, processing units and marketing facilities are of the most important services that should be provided to fish producers and their boats at the landing sites. However, all of these or some of them are hardly available, making most of the landing sites in real need of vital fishing facilities (Moursy, 1987). The lack of these facilities contributes substantially to availing low quality fish in the market at the major consumption cities.

2.3.5 Fish Processing:

Fish processing in the Sudan is limited to the traditional methods of drying and salting. The production of frozen fish fillets is only limited to fish exporters and when required by a customer. There are no fish canning industries existing in the Sudan. The trading statistics (Table 4) with respect to fisheries are incomplete and can best be described as very poor.

Table 4. Exports of Fresh and Wet – salted Fish (fasseikh) during the Period 1991 – 1997 (Quantities in tons):

Year	Fresh	Wet – salted
1991	0.0	129
1992	0.0	39
1993	0.0	0.0
1994	26	0.0
1995	103	0.0
1996	162	0.0
1997	136	0.0

Source: Foreign Trade Statistics Digest, Bank of Sudan, 1991 – 97.

2.3.6 Fish Consumption:

Fish consumption in the Sudan is generally concentrated in towns and coastal areas of the inland and marine waters. The ratio of consumption of local to imported fish indicated that the people prefer local to imported fish (Table 5). Total consumption is affected by the consumer's preference to fresh fishes rather than frozen. The per capita consumption of fish in the Sudan is about 1.3 kilograms per year and it is considered to be very low in comparison to that of the world, which is about 13 kilograms according to FAO, 1996 statistics.

Table 5. Total Fish consumed in the Sudan 1987–1997 (Quantities in 1000 tons).

Year	Local Production	Imported Quantity	Local: Imported	Total
1987	29.2	1.109	26.33:1	30,309
1988	29.6	0.046	643.48:1	29,646
1989	28.0	0.007	4000:1	28,007
1990	29.0	0.010	2900:1	29,010
1991	31.0	0.014	2214.29:1	31,014
1992	34.9	0.042	830.95:1	34,942
1993	36.0	0.0	0.0	36,000
1994	40.0	0.023	1739.13:1	40,023
1995	44.9	0.048	935.42:1	44,948
1996	49.8	0.094	529.79:1	49,894
1997	* 54.9	0.040	1372.50:1	*54,940

* *Estimated. Source: Fisheries Department (1998)*

2.3.7 Fish Marketing:

Khartoum city (the national capital) is considered as the main fish market. The daily supply (according to Khartoum state Fisheries Department, 1997) is about 15 tons and the annual supply is estimated at 5400 tons. Fish trading activities particularly on small-scale or petty retail sizes are characterized by relatively open access to any one due to low capital and operating requirements (Reynolds, 1993).

The marketing services are traditional and inefficient resulting in the wastage of a large portion of the total production. This is attributed to lack of ice plant at the major fishing sites, inadequate insulated trucks for fish transportation and the unavailability of other fish preservation facilities. All these contribute to the high degree of fish perishability.

2.3.8 Fish Farming:

Although capture fisheries shall continue to make a major contribution to the world's fish supplies, aquaculture (the farming of fish and aquatic plants) is expected to bridge the gap between the demand and supply. According to FAO, Fisheries Department, Facts

File, 1998), the aquaculture sector's contribution to the total fish supply in the world is about 29% and most of this production is from South East Asia.

The Sudan is potentially qualified to expand in aquaculture due to the availability of the essential inputs such as land, water and agricultural by-products (which are the main ingredients of fish feeds). Moreover, the irrigation canals, natural pools and hafers can be used as fish farms Mahmoud *et al*, 1998). In the Sudan, the first fish farm was established in 1952. Since then and up to date, the sector is witnessing a horizontal increase in the number and size of farms. There are 147 registered farms in the states of Khartoum, Gezira, Kassala and White Nile. Khartoum state alone has a total of 138 farms and the remaining 09 are spread in the other states above mentioned (George, 1975). The sizes of these farms range between 0.5 and 30 feddans. Mainly the farms were used for recreation and personal consumption and not for economic purposes. The average annual production per feddan is expected to be 04 tons of Tilapia species (Osman, 1993). It is worth mentioning that, extension services are almost lacking.

Most of the farms were constructed of earth basins with some trials in the natural pools (e.g. Rahad in Western Sudan) and in cages (e.g. Jebel Aulia dam site) besides the oyster farms at Dongonab Bay in the Red Sea.

The main reasons for the failure of this sector were not institutionally treated in addition to lack of equipments and skillfully trained staff. Moreover, power supply was also a problem.

2.4 The Role of Fisheries in the Socio-Economic Development of the Sudan:

The role of fisheries in a country's economic development is amply evident. It generates employment for a large sector of the riparian and coastal populations, raises the nutritional standards, increases food supply and earns foreign currency.

2.4.1 Fisheries Development Strategy in the Sudan:

Fisheries development strategy in the Sudan is designed to meet three major targets:

1. Increase production to meet protein requirements.
2. Develop export potentials.
3. Improve the socio-economic conditions of the fish producers.

2.4.2 Contributions of the Fisheries sector:

2.4.2.1 Food Supply:

On the average the per capita yearly consumption of fish has been 1.3 kg (Mahmoud *et al*, 1998). Fish culture has the potential to raise this due to its on-the-spot food characteristics, balanced nutrients and above all, affordable price.

2.4.2.2 Raising Nutritional Standards:

Fish is considered rightly as the poor man's diet. It is an almost zero-carbohydrates food, good for diabetics and other such patients. It is a rich source of proteins, vitamins and minerals with approximate composition as crude proteins 14.2 – 22.8%: fat 0.6 – 2.4% and energy 76 –162 kcal/100 grams. A special feature of fish flesh is the content of vitamin B₁₂, which is absent in plant foods and also a good source of calcium and vitamin A, Love (1970). Fish also contains polyunsaturated fatty acids, which are known to provide protection against cardio-vascular diseases. This has got advantages over the other flesh foods like meat. Fish has a better biological value (BV) and protein efficiency ratio (PER) than other meat foods. Fish has a BV, net protein utilization (NPU) and PER of 80; 74 and 3.5 respectively to meat, which has 74; 76 and 3.2 (Love, 1970; Borgstrom (1962).

2.4.2.3 Employment Opportunities:

Due to poor fishery statistics, the employment opportunities provided for full-time or part-time fisher cannot be estimated. This also holds true for some fisheries related activities which include: fishing, marketing, net making, fish curing and processing.

2.4.2.4 Income Generation:

Fisheries have impact on the creation of limited industries at the local level such as packaging, ice plants, cold storage, transport by insulated vans etc...Fish farmers, artisan fishers engaged in fish culture, fishing from natural waters and those involved in the processing, transport and marketing etc.... are all points in the marketing chain of this commodity. Thus they should be involved in any extension service aiming at development of this sector.

2.5 Fisheries Development in the Sudan:

According to recent nutritional studies, the average adult requires from 20 to 25 grams of animal proteins per day. In the third world countries, the majority of the poor do not consume animal proteins even once a week. That is why in such countries malnutrition and undernourishment are serious problems. This is, of course, a condition not unique to Sudan, but typical of many countries where there is widespread poverty and unemployment.

This lack of adequate diet is one of the fundamental reasons for designing and developing an artisan fishery program, since fish can supply the badly needed proteins.

2.5.1 Objectives of Fisheries Development in the Sudan:

The main objectives of development and management plans for fisheries in the Sudan are:

- 1) The production of maximum quantity of food at an appropriate price.
- 2) The maintenance of the quality of fish caught.
- 3) The provision of employment.
- 4) The improvement of the standard of living of the fishers' community.

Such objectives are usually in conflict. For example, the production of maximum amount of cheap fish can only be at the expense of fish quality and wellbeing of the fishers' community. Alternatively, regulating access to the fishery reduces employment opportunity but increases the economic returns from the fishery.

The strategy for successful development and management should contain guidelines and principles for management as well as adapting programs for actions. The strategy should bring out the importance of fisheries in fulfilling the social, economic and nutritional needs and deals with every aspect for fishery management

and the need to raise the economic and social levels of the fishers and their families.

It should also deal with the need for research including adequate facilities and statistical data and the need of management with particular emphasis on training at all levels of scientific and managerial staff. Moreover, it should pinpoint the importance of international cooperation in resource assessments, the working out of management options and the formation and implementation of management policies.

2.5.2 Capture Methods:

In the majority of cases, the methods of capture, equipment and the fishing vessels are inefficient. There is need for improvement of fishing gears, crafts and post harvest facilities. Equipment although not produced locally, could be easily introduced with least custom duties. Such basic requirements should be given a high priority.

2.5.3 Infrastructure:

Improvement in the distribution of fish would generally strengthen all food distribution channels. The catching and landing systems in particular should be upgraded; very few of them were designed to meet the needs of the fishing industry and even fewer were designed to fulfill the requirements of the artisan fishers.

2.5.4 Institutions and Producer Organizations:

An important attribute for development of the sector is the existence of efficient and powerful institutions and producer organizations. Due support from ministries, banks and all concerned governmental units will boost the contribution of the fisheries sector in food security and job creation.

2.5.5 Expertise:

The fishery sector lacks people with sufficient expertise who could analyze investment opportunities and assist fishers directly. Skilled people are needed, who are ready, willing and able to work with fish producers.

2.5.6 Cooperatives:

Cooperative societies and other organizations, which involve the active participation of the fishers, such as “credit cooperatives” and “market group cooperatives”, are required. This type of working together is valuable not only because it improves the efficiency of equipment and provides systems, but also it gives the fishers a certain negotiating power pertaining to prices and loan facilities.

A cooperative can discuss and set policies in collaboration with government officials and others.

The fishers need to be organized and should be aware of the value of united action. The government should work to encourage and facilitate such organizations otherwise many of the potential benefits will be lost.

2.5.7 Distribution System:

The nutritional levels of the diets of people in many developing countries could be substantially improved if the distribution systems were more efficient. For example, the selling places (markets) to be made accessible to the consumers in the populous areas. These markets assure a relatively cheap and continuous supply of fish. It is necessary to provide a clean, healthful, fresh product to improve the nutritional value of the daily diets. At the same time improve exportation facilities. Most marketing sites are not specifically equipped to handle fresh fish and adequate display and storage arrangements for products in whatsoever the form are the exceptions rather than rules (Raymond, 1993).

2.6 Prospects of Fisheries Development:

The efforts of the FAO (2006) and other organizations that recognize the need to develop artisan fishery should be directed to the problems that really exist. Also encouraging is the involvement of various governments in assisting the underdeveloped small-scale fishers.

2.6.1 Aquaculture Potential:

From the technical point of view, aquaculture has great potential but will require expertise, capital and experimentation to be successful.

It is an almost immediate accessible resource that should be tapped and one that should be developed fundamentally for the benefit of the small – scale producers, whether as individuals or groups.

Although production remains predominantly Asian and is based on small-scale operations, there is a wide consensus among many that aquaculture has the potential to the growing global demand for nutritious food fish and to contribute to the growth of national economies, while also supporting the livelihoods of many communities.

Aquaculture plays an important role in global efforts towards eliminating hunger and malnutrition by supplying fish and aquatic products rich in protein, essential fatty acids, vitamins and minerals. Aquaculture can also make significant contributions to development by improving incomes, providing employment opportunities and increasing the returns on resource use (FAO, 2006). With appropriate management, the sector appears ready to meet the expected shortfalls in fish supplies for the coming decades and to improve global food security.

2.6.2 Fisheries Policy and Management:

The management of a fishery remains a key issue in the drive for sustainable use of natural resources. Management involves the design and implementation of resources to monitor and control the amount, type and seasonality of fishing operations. It touches upon a number of interrelated biological, technical, economic, social and frequently political issues. The goal of fisheries management is to establish integrated approaches that will rehabilitate, enhance and sustain the fisheries resources indefinitely (Patti, 1991).

Most countries have similar management objectives, although the emphasis differs between the developed and developing nations. Developed countries are usually faced with fully or over exploited stocks, so their management objectives concentrate on stock rebuilding and capacity reduction, although most countries also have significant aims regarding markets and social conflicts. The most urgent objective is to scale fleet sizes so that they become commensurate with sustainable exploitation of the resources.

In contrast, developing countries tend to concentrate on fisheries development in terms of new resources and technology.

Although it is recognized that some stocks are over fished, objectives are concentrated more on enhancement and diversifying

fisheries rather than on limiting fishing efforts. This is perhaps because the underlying concern for many countries is the relatively important role fisheries play in employment and food security for some of their poorest people. More specific aims include building infrastructure (particularly for processing to reduce post harvest losses and increase the value added); fishery enhancement through restocking and reducing social conflicts, not only among different fisher groups, but also between fishers and other groups.

Policies and objectives appear more realistic (over the years), concentrating more on development and making the best social use of resources.

Sustainable fisheries and aquaculture development require informed decisions and actions at all levels, from policy-makers to individual fishers, as well as environmentalists who are increasingly concerned about fisheries, consumers, the public and the unbalanced utilization of the resources.

Decision-making based on the best scientific evidence requires relevant and timely information about the stocks, captured fisheries and fishing effort.

2.7 General Problems of Fisheries Management:

The greatest problem facing the African freshwater fisheries administrators is the lack of reliable long-term scientific data on which to base management decisions.

Most countries in Africa have been independent for a relatively short period of time, and prior to this scientific research consisted in many cases of short-term expeditions by scientists from colonial powers. These scientists often produced excellent results (Lowe, 1975) and Jackson *et al.*, (1971), but there was rarely any consistent follow up.

Since independence, countries relied on expatriates' help until indigenous personnel could be trained. Short-term research programs were, therefore, the rule.

Furthermore, when research is being funded as part of an aid project, when the project comes to an end there is often neither the money nor the equipment and personnel available to continue monitoring.

Even now, however, with the development and expansion of the fisheries department activities, competent research personnel may find

themselves promoted to positions where administrative pressures leave them with little time for research.

2.7.1 Methods of Controlling Fishing Efforts:

Fishing effort must be controlled in order to achieve economic efficiency. There are three main methods that could be used to regulate fishing efforts:

2.7.1.1 Catch Quotas:

It is the most direct and reliable method of controlling the utilizations of fish stock by limiting annual catch quota system.

2.7.1.2 Licensing Limitations:

This is a much more commonly utilized method. However, problems encountered in the application of this method arise due to the fact that, fishing effort is multidimensional; a unit fishing effort if measured, is produced by applying equipments of various types; boats with different characteristics; fishing gears and manpower. Practically, only one or few easily observable dimensions of the effort are usually subjected to control.

The efficiency of such controls, therefore, depends on how easily the effort may be extended along uncontrolled dimensions.

2.7.1.3 Special Resource Tax:

Resource tax can be levied on fish catch in principle at any level from the consumer down to the producer (fisher). The tax is effective because it reduces the profitability of fishing. The main problems facing this method are the difficulties encountered in calculating precisely the optimal level of the tax coupled with the economic and environmental conditions, which are constantly changing that, may need corresponding changes in the rate of the resource tax.

2.8 Ecological, Socio-Cultural and Economic Aspects of Fisheries:

The social and cultural aspects of every society evolve in the context of certain interacting ecological and economic characteristics particular to it.

The ecological and related resource determinants are characteristics that tend to exhibit a fair degree of stability since they are significantly nature-determined. The demographic, technologic and

economic variables seem to undergo a greater degree of change, as they are products of human enterprise.

The social and cultural aspects, which arise from historical nature–human interaction, take effect within a workday routine of livelihood and provide the element of specificity to the society. They accumulate overtime and form a corpus of certain behavioral facets of a people.

In the more ancient societies, such as those in Asia, these socio-cultural traits have been handed down largely through learning –by–doing and oral traditions of songs, stories and sayings. They evolve to present a “world view” of the communities and represent in a succinct fashion a coherent “practice– knowledge–belief” system (Gadgil *et al.*, 1999).

An overwhelming majority of the world’s fishing people are members of small–scale fishing communities that make valuable contributions to humanity’s food supply. To enhance the well being of these people, it should be essential for fisheries officials to understand how these communities are organized and function, what their important value orientations are, and how they could be strengthened and protected.

2.9 Fisheries as Human Phenomenon:

Over the course of its development, much of fisheries management science, both in theory and practice have had a misplaced emphasis. Whereas its first concerns should have been the human beings who utilize fisheries resources, its cornerstones were instead laid mainly by biologists, economists, administrators and politicians whose priorities were usually the conservation of important species followed by allocating fisheries resources and maximizing the economic benefits from them.

This state of affairs is understandable when we recall when modern fisheries science was born, around the end of the 19th century. The scientific disciplines of biology and economics were already well advanced while the social sciences were still in their infancy. The legacies of these early beginnings can still be seen in much of contemporary fisheries management.

What needs more emphasis in fisheries management science, practice and theory is that the fisheries are a human phenomenon. Essentially, the fisheries are places where human activities are linked with aquatic systems and renewable resources. Indeed human fishing

activity is the defining attribute of a fishery, since without it there would only be an aquatic realm where various species live. Clearly, then, the fisheries are much more than geographic regions, fishing methods, types of fishing gears, particular fish species, natural resources, or economic domains, but something much more human.

Therefore, it is essential that fisheries officials extend their tasks from management of natural resources, to management of the fishers (FAO, 2001).

If fisheries management is to be more successful in the future, it should integrate social and cultural concerns with the heretofore more traditional, biological and economic ones. And ultimately, the measure of its success will rest upon how well it promotes the fisher communities.

2.10 Fish Production in Khartoum State:

Khartoum, the national capital, according to its area, population and consumption of products is considered the major center that attracts huge economic and commercial activities (including the largest fish markets, Khartoum central market and El Mourada, (AbdelRahman, 2003).

Although currently fish availability is decreasing, there is great demand by consumers.

Other than the aforementioned fish markets, fish can be found in small quantities within the residential areas such as Bahri (Khartoum North), El kalakla, Buri and Shaggara markets (Khartoum South).

Fisheries production in Khartoum state is characterized by being seasonal, mostly from Jebel Aulia (about 400 tons per year from an estimated number of boats of about 300). Traditional methods of fishing are used. Fishing is also carried out in isolated areas like Khor FitiHab, El Mourada, El Kalakla, Northern Omdurman, El Shegeyi, El Sabaluka and El Gereif (on the Blue Nile).

The quantity of fish produced from these areas is estimated to be about 600 tons per year (Abbas, 2000).

It is reported that the potential natural production of the states surface water as a whole is about 15,000 tons per year (Fisheries Administration report, 2000)

Aquaculture is contributing to the state's fish production at a low rate. The number of registered fish farm is 138. Out of this only 4 are operational. Usually the sizes of the fish farms vary from 5 to 30

feddans. Most of the earthen ponds use the Nile water. A common factor associated with fish farm is the lack of economic feasibility studies were carried out prior to their establishments (Mahmoud *et al*, 1998).

Average consumption of fish in the state is about 3 kg per year compared to that of the country, which is about 1 to 2 kg (Mahmoud *et al*, 1998).

Whereas agricultural production is expected to increase by 50% of the gross domestic product (GDP), of which the animal resources' contribution is about 10%, that of the fisheries sector is decreasing greatly below 01% (Mahmoud *et al*, 1998).

2.10.1 Internal Sources of Fish Production in Khartoum State:

Khartoum state is characterized by inland fisheries that depend on the Nile and its tributaries within the state (or the two Niles, the White and Blue Niles in the south, besides the River Nile itself in the north of the state). Most of the fishing activities are carried out behind and below the Jebel Aulia dam and other stagnant waters widely distributed along the Nile channel within the state (Jebel Aulia, El Kalakla, Fiteh alagaleen, that contribute about 90% of the total fish production (Mahmoud *et al*, 1998).

2.10.1.1 Jebel Aulia:

The Jebel Aulia reservoir that resulted due to the construction of the Jebel Aulia dam in 1937 on the White Nile is situated 45 kilometers south of Khartoum. It has an average depth of about 2.3 to 6.0 meters and total surface area ranging between 600 to 1500 km² (Welcomme, 1972). And from the point of production, the actual present production is estimated to the limit of 8000 tons per year (FAO, 1998). It was found out that, the northern part of the reservoir, which is on the Western part of the state, is maximally exploited or has reached the stage of maximum exploitation. The most important commercial fish species from the reservoir accepted by consumers are: *Lates niloticus* (Igil) *Bagrus bayad* (Bayad), *Oreochromis niloticus* (Nile Bulti) and those of fewer acceptances include: *Synodontis* spp. (Gargour), *Labeo* spp. (Dabs), *Clarias* spp. (Garmout), *Hydrocynus* spp. (Kass) and *Alestes* spp. (Kawara) as salted fish (Neimat, 2003).

2.10.1.2 El Kalakla and El fiteh Alagaleen:

El Kalakla area is in the second position after Jebel Aulia according to the total local production comprising 27% (of the yearly production of 370 tons). Elfiteh Alagaleen follows this with 26% and actual production of 357 tons for the period 2002–2003 (Abd el Rahman, 2003).

2.10.1.3 Others:

Other areas include the Blue Nile (El Gireif) and the River Nile (El Shageyi, El Sabaluka) contributing with insignificant percentage to the local production (totaling less than 10%), Fisheries Administration report, Khartoum State, 2000).

2.10.1.4 Fish Farming:

Fish farming started in Khartoum state since the 1940s of the past century in Gordon's Shaggara. Since that time up to the present, many fish farms were established. But as a result of lack of proper management, most of them were closed (Fisheries Administration report, Khartoum state, 2000). There are many proposed fish farm projects with contributions ranging about 2500 tons per year (in their initial stages of production) as shown in Table 6.

2.10.2 External Sources of Fish Production in Khartoum State:

2.10.2.1 The White Nile:

According to estimations, the fisheries resource from the inland waters in the Sudan is about 100–110 thousand tons per year of which the White Nile represents 82.2%. The Dam area alone contributes about 70–75 thousand tons per year and the remaining portion of the White Nile contributes about 15–20 thousand tons per year, which are expected to reach the state (Fisheries Administration report, Khartoum State, 2000).

Statistics from the Fisheries Administration, Khartoum state shows that, the average export of fish from the White Nile to Khartoum state for the years 1999–2003 is at the range of 67% (Table ..., Figure ...). It also follows that, the percentage of fish landings from the White Nile to the central market in Khartoum is in the range of 82%, El Mourada, market, 61%.

2.10.2.2 The Blue Nile:

It is known that the production percentage of inland fisheries of the Sudan from the Blue Nile as a whole is about 11.2%. The fisheries of the Blue Nile are basically concentrated in the dams, Sennar and El Damazin. The actual production estimate from both is in the region of 1000 tons per year (Abdel Rahman, 2003)

According to estimates from the Fisheries Administration, Khartoum state: the average fish landings from the Blue Nile to the state for the years 1999–2003 is about 14%: concentrated during summer periods, i.e., the months of April, May, June and July. According to Abdel Rahman (2003) the percentage of fish landings to the central market, Khartoum State, from the Blue Nile is about 13%; El Mourada market about 16.5%; El Damazin contributes about 29% to the central market and Sennar about 4.5% and 9% to El Mourada market.

2.10.2.3 Lake Nuba:

The estimated fish production potential of Lake Nuba is about 5000 tons per year. Practically, the actual rate of production does not exceed 20% of the given quantity (Ref).

Important commercial species include: *Late niloticus* (Igil), *Bagrus* spp (Bayad); *Bagrus docmac* (Kabarus); *Oreochromis niloticus* (Nile Bulti); *Labeo niloticus* (Dabs); *Labeo* (kudn), *Barbus bynni* (binii), *Synodontis schall* (Gargour); and *Mormyrus spp* (Khasm el banat); that represent 90% of the total fish landings. This is besides the fish for fassiekh: *Hydrocynous spp* (Kass) and *Alestes spp* (Kawara), (Ali, 1977). The highest rate of production occurs during the two seasons of summer (March to June) and flood (August to October).

It follows from Abdurrahman, (2003) that, the total landings to Khartoum Central Fish Market and El Mourada Fish Market is 6% and 9% respectively (Table 2).

2.11 Fishing Gears and Crafts:

The majority of the fishers in Khartoum state operate traditional canoes especially those in the northern parts of the White Nile, the main Nile and the Blue Nile. Available statistics put the number of boats to approximately 240–300 in the state. The main fishing crafts are planked canoes and Eight-meter long thick board boats with oars.

The fishing gears used include: cast nets, drift nets with different mesh sizes and twines, hooks and long lines etc. The main fishing method is the overnight setting of the hand braided fishing gears (Ali, 1975).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Site:

The study site was Khartoum State. And the fieldwork was carried out at the vicinity of Jebel Aulia dam, 45 kilometers south of Khartoum city.

3.1.1. Khartoum State:

Khartoum State is situated at the center of the Sudan. The capital, Khartoum city, lies on the western bank of the Blue Nile and the Eastern bank of the White Nile. It is triangular in shape. Its population has grown to over 5 million people. Together with Omdurman and Khartoum north (Bahri), Khartoum city constitute the national capital of the republic of the Sudan (Sudan Embassy in South Africa, 2004).

The climate is mainly tropical. During summer (March-June), the temperature is quite high with an average of 38° C (May, being the hottest month of the year). Autumn starts from mid July and ends in September. Total rainfall is 167-mm. Khartoum state is characterized by abundant sandstorms. Winter starts in October and ends in March (endowed with moderately dry and healthy weather). The average temperature in winter is 24° C (Sudan Embassy in South Africa, 2006).

3.1.2 Jebel Aulia Dam:

The main fisheries resources of the state are represented by the White Nile, Blue Nile and the main Nile. The man-made fish farms and reservoirs (as Jebel Aulia) are considered as the main productive sources of fish within the state (Ministry of Animal Resources and Fisheries of the Sudan, 2006).

Jebel Aulia dam was constructed in 1937 across the White Nile. This resulted in the formation of a large shallow lake covering an estimated area of about 12000 hectares. The dam stores about 3.5 milliards cubic meters of water. The maximum depth of the reservoir is about 15 meters during high floods (late August to mid September), while the minimum depth of 5 meters is attained in May when the reservoir is nearly emptied to a normal river. The reservoir extends to over 500 kilometers upstream, 50 kilometers of which is the reservoir proper (Rzoska *et al.*, 1955). The length of the lake from Jebel Aulia dam to Kosti, (about 275 kilometers upstream), is considered to be the

most productive part of the reservoir. Within this area major fishing sites (Um Shaba, Geteina, and Kosti etc) are located on both banks of the lake.

The average depth of the lake is 2.3 – 6 m, (maximum 12m). Total surface area ranges between 600 – 1500 km², capacity 3.5 x 10⁹m³. Rate of flow to volume is 8:1. Inflow river: White Nile. Outflow River: White Nile. Length: about 629 km up to the town of Renk in South Sudan. The dam has 60 sluices but only 50 are operational. There are 80 turbines to generate electricity recently constructed between 2003 and 2005 (Bihlmayer, 2005).

Because of its proximity to the national capital, Khartoum, where most of the research institutions and universities are situated, Jebel Aulia dam reservoir has been and still is the major site of numerous research studies.

3.1.2.1 Objectives for the Construction of the Dam:

It was constructed for the following purposes:

- i) Irrigation.
- ii) Control of aquatic weeds.
- iii) Navigation.
- iv) Main source for the provision of fresh fish for Khartoum and nearby areas throughout the year.

Because of its proximity to the national capital, Khartoum, where most of the research institutions and universities are situated, Jebel Aulia dam reservoir has been and still is the major site of the major site of numerous research studies.

3.1.2.2 Physical and Chemical Characteristics:

Temperature ranges from 16⁰C to 31⁰C. pH ranges from 7.6 - 8.6 (high values recorded after floods, i.e., Nov. and Dec. and least values before the flood). Transparency ranges from 12.5 - 52 cm (high values in Dec. and Jan. and least values in June and July). Conductivity is from 160- 330 Mmh/cm at 30⁰C. It rises after the floods (summer) and drops in July and August.

3.2 The Method:

3.2.1 Desk Work:

Collection of information about the research topic was based on deskwork; from references, journals and some reports deposited at the following libraries: library of the Department of Zoology, library of

the Institute of Environmental Studies, library of the Institute of Natural Sciences and the Sudan library (University of Khartoum); library of the Fisheries Research Center (Ministry of Science and Technology); library of the Fisheries Training Center (Ministry of Animal Resources and Fisheries); library of the Arab Organization for Agricultural Development and the library of the Arab League for Agricultural Development as well as the web sites.

3.2.2 Questionnaire:

A questionnaire was designed to furnish a guideline towards generation of field data (appendix Table 1)

3.2.3 Sample Size:

A total of thirty fishers were selected randomly as sample for the study.

3.2.4 Study Constraints:

These included the following:

- Difficulties in obtaining information from the respondents.
- In availability of sufficient literature on the research topic.
- Financial constraints faced by the researcher.

3.2.5 Data Analysis:

Statistical Package for Social Sciences (SPSS) was used to analyze the data collected on the fish producers to assess their socio- economic conditions and highlight the problems confronting them that hinder their effective contribution to the sustainable development of the fisheries.

CHAPTER FOUR: RESULTS

4.1 Fish Production:

Mainly artisan fishers living at the vicinity of the reservoir carry out fish production. The main fishing method is the overnight setting of the hand braided gill nets, cast nets and occasionally hooks and long lines.

For fish composition, around 54 species belonging to 28 genera and 13 families are found (Ahmed, 1985). Important fish species accepted and favored by consumers include *Lates spp.*, *Oreochromis spp.*, and those of less favor and acceptance include: *Synodontis spp.*, *Hydrocynus spp.*, and *Alestes spp.*, for fashiekh.

Various estimates of fish production were made. Henderson (1975) stated a range from 7000 to 8000 tons per year with potential yield of 15000 tons. The Food and Agricultural Organization of the United Nations, FAO (1982) stated an annual yield of 8216 tons. Kapestsky and Peter (1984) calculated an annual yield of 55 kg/ha/yr for the period 1981–1982. Abdel Rahman (1985) estimated the maximum sustainable yield (MSY) to range from 7363 to 8600 tons/year. Saeed *et al.*, (1993) estimated the annual productivity to be 8216 tons/yr.

Jebel Aulia reservoir plays a vital role in supplying fresh and chilled fish to Khartoum state and cured fish for many parts of the Sudan.

The reservoir fisheries support financially many households in Jebel Aulia and the White Nile state along the White Nile stretch.

4.2 Population:

The population of Jebel Aulia is approximately 450,000 (Ministry of Agriculture, Animal resources and Irrigation, Khartoum State, report, 2002).

4.3 Educational Status:

There are 59 kindergartens, 66 basic schools 15 secondary schools and two universities (College of Agricultural Technology and Fish sciences, University of El Nilein and Faculty of Education, University of Khartoum).

4.4 Demographic and Socio-Economic Aspects:

The results are the analysis of the demographic, social and economic aspects of the fishing community obtained through individual interviews with fishers operating at the downstream fishery at Jebel Aulia.

Fishers' ages ranged between 21 and 90 years. The highest age group was between 41 and 50 years with a percentage of 34%. The least age group was between 81 and 90 years (Table 6).

Table 6. Age Groups of Fishers (years)

Age group (years)	Frequency	Percentage
10 – 20	0	0.0
21 – 30	3	10
31 – 40	6	20
41 – 50	10	34
51 – 60	4	14
61 – 70	3	10
71 – 80	3	10
81 – 90	1	2

Table 7 indicates that 44% of the fishers of Jebel Aulia had spent from 10 to 20 years in the fishing trade. The fishers with 41 to 50 years duration scored the least percentage.

Table 7. Fishing Duration (years)

Fishing duration (years)	Frequency	Percentage
10 – 20	13	44
21 – 30	6	20
31 – 40	6	20
41 – 50	2	6
51 – 60	3	10

It is clear from table (8) that, 84% of th fishers interviewed are married. Amongst the 84%, 80% have number of children between 5 and 10; 4% have only one child and 16% are childless.

Table 8. Marital Status of the Fishers

Marital status	No.	%	Number of children					
			None	%	5-10	%	>11	%
Married	25	84	4	10	20	80	1	4
Unmarried	5	16	0.0	0.0	0.0	0.0	00	0.0

Table (9) below illustrates that 50% of the fishers attained basic education; 10% are intermediate leavers; 20% attended secondary education; 3.33% (only one) university graduate and 16.6% of them were illiterate.

Table 9. Educational Level of the Fishers

Educational level									
Illiterate		Basic		Intermediate		Secondary		Tertiary	
No.	%	No.	%	No.	%	No.	%	No.	%
0	16.6	15	50	3	10	6	20	1	3.33

From table (10) it can be deduced that 60% of the fishers have no family members engaged in the trade. While table (11) indicated that, 30% of the fishers received services from the fisheries administration whereas 70% do not.

Table 10. Percentage of Family Members engaged in Fishing

Number of fishers family members engaged in fishing					
<1	%	1 – 4	%	5 – 10	%
18	60	11	37	1	3

Table 11. Percentages of Fishers who Receive Services from the Fisheries Administration

Number of fishers who			
Receive services	%	Don't receive	%
9	30	21	70

According to table (12), 80% of the fishers encountered are permanently engaged in fishing and don't have any other activity throughout the year.

Table 12. Types of Fishers

Type of fisher			
Permanent		Temporal	
Number	%	Number	%
24	80	6	20

77% of the boats operating in the study area were made of iron sheets as clearly observed in table (13)

Table 13. Percentages of Types of Fishing Crafts

Types of fishing crafts			
Wooden boat		Iron boat	
Number	%	Number	%
7	23	23	77

The study also revealed that, 54% (16) of the fishers at the downstream fishery owned boats whereas 46% (14) of them don't. This means that, they hire the boats they operate. There was no out boat engine boats encountered during the survey period.

The study indicated that 67% of th fish producers use castnets for fishing; 10% use hook and lines and 23% use set nets (Table 14).

Table 14. Percentages of Types of Fishing Gears

Type of fishing gear used					
Cast nets		Hook & lines		Set nets	
Number	%	Number	%	Number	%
20	67	3	10	7	23

The most suitable season preferred by the fishers for fishing with good economic returns was summer. This maybe attributed to water temperature being warmer and the migration of most fish species towards the water surface therefore increasing fish quantities produced.

All fish produced in the study area are sold fresh. None of the fishers was interested doing additional effort to preserve fish even by the conventional methods such as salting or drying.

Table (15) shows that 53.33% of the fishers catch between 11 and 20 kgs of fish daily. 23.33% of them catch between 21 and 30 kg; 20% catch up to 10 kg per day and 3.33% can afford to produce between 31 and 40 kgs of fish in a day.

Table 15. Percentages of Quantities of Fish caught Daily

Fish quantities (kgs)	Frequency	Percentage
0 – 10	6	20
11 – 20	16	53.33
21 – 30	7	23.33
31 – 40	1	3.33

It can be dissipated from table (16) that, 41 to 60 Sudanese pounds is the most frequent daily income.

Table 16. Percentages of Fishers' Daily Income.

Fishers income (SDG)	Frequency	Percentage
< 20	1	3
21 – 40	7	23
41 – 60	14	47
61 – 80	4	14
81 – 100	3	10
101 – 120	1	3

From the table (17), 66% (20) of the fishers use fishing gears costing less than 150.00 SDG. 20% of them said they buy fishing gears costing them between 151.00 and 300.00 SDG. 10% can afford

to buy fishing gears that cost 301.00 to 450.00 and only 4% are able to purchase fishing gears for 600.00 SDG.

Table 17. Prices of Fishing Gears (in Sudanese pounds)

Price in SDG	Frequency	%
< 150	20	66
151 – 300	6	20
301 – 450	3	10
451 – 600	1	4

Wooden boats encountered during the study period costed the fishers between 1000 and 1800 SDG whereas the cost price of those made of iron ranged from 2000 to 3700 SDG.

Dominant fish species in order of their catch ability include: *Oreochromis niloticus* (Bulti); *Hydrocyon spp* (Kass); *Synodontis schall* (Gargur); *Labeo niloticus* (Dabs); *Alestes dentex* (Kawara); *Bagrass bayad* (Bayad); *Lates niloticus* (Ijil); *Clarias anguilloides* (Garmut); *Eutropius niloticus* (Shilbaya); *Bagrass docmac* (Kabros); *Auchenoglanis biscutats* (Zomar); *Malepterus electricus* (Barad); *Citharinus spp* (Bitkoya) and *Tetradon fahaka* (Timbera).

CHAPTER FIVE: DISCUSSIONS

Socio-economic studies are vital to fisheries managers to enable them understand the people they are managing. The results of this research demonstrated the need and importance of applying social and economic concepts and evaluation methods for fisheries development and management. Such information is necessary for planning, policy formulation and decision making for sustainable and equitable development of a fishery.

The downstream fishery of Jebel Aulia is dominated by small-scale artisan fish producers. Artisan fishery is characterized by high levels of labour, low capital investment and frequent use of passive fishing methods (Patti, 1989).

The study revealed that, most of the fishers in Jebel Aulia are between the ages of 41 and 50 years. This confirms the findings of (Omer, 2007). This indicates that, the fishing activity is solely carried out by youngsters due to marginalization of people in terms of other occupations (Pauly, 1994, 1997). According to Pauly, the small-scale fisheries have become a “last resort” and the accumulation of destitute people in this sector ultimately leads to Malthusian overfishing.

However, in most fisheries people don't only move into fisheries, but equally move out of them as well. Therefore, fisheries are occupations that people can join and leave whenever they judge they need to. This is true about the fishers in the study area.

The research findings showed that, 44% of the fishers encountered during the study period spent between 10 to 20 years in the profession and the least percentage was scored by those who had spent between 40 to 50 years. This is in agreement with (Pauly, 1994, 1997).

It was found out during the study that, 87% of the fish producers in the study area are married with number of children between 5 to 10. Very few of them have more than eleven children, i.e., 4%. The unmarried comprised 16%.

Very few of the fishers' at Jebel Aulia downstream fishery engage their relatives in the fishing trade. This shows that, they hate to see members of their families involved in the business. This is likely due to the absence of extension services as 70% of them don't receive any form of assistance from the fisheries administration, Khartoum State. Elsewhere women and children are engaged in fishing industry

for household consumptions. Moreover, they have special responsibility for the marketing of fish, especially if it is to be sold beyond the local community (Lawson, 1972).

It is also to be noted that, some of the women in Jebel Aulia (Dar es Salam, Peace camps) are engaged in fish trade. They buy fish from the fishers and smoke them for sale in their residential areas. Also some women come from El kalakla for the same purpose and they are engaged in wet salting of *Hydrocyon* spp., *Alestes* spp. and *Labeo* spp.

Though the technique used by relatively unmodified fisheries are very similar, the economic organization of the communities that fish varies significantly in the downstream fishery at Jebel Aulia reservoir. The study revealed that, most of the fishers are permanent (full time). This is in agreement with the findings of (Basheer, 2003) who reported that, only full-time fishers dominate the fishing industry at Jebel Aulia. The minority (part-time fishers) combines occasional fishing with other activities like agriculture, livestock management; menial works like operating car repair works and wage labour. Temporal fisher folks concentrate their fishing activities during certain seasons of the year with intensification during downturns in agriculture or other activities.

Most of the fishers are illiterate or basic school drop outs, i.e., 50%. This maybe attributed to the fact that, the fishing community has fundamental mistrust about education which they assume as lacking credibility.

Fishers are considered in most of the developing countries as one of the most neglected (marginalized and poorest group within the society having traditional inherited fishing methods which are not adapted to modern fishing methods (Hogson, 1998).

According to the results of this study, the main fishing gears used in fishing operations include; gillnets, hooks and line and castnets. This result confirmed that of Henderson, (1975).

The results of the study also proved that, wooden boats are mostly being used compared to a few iron boats. Practically, not a single inboat or outboat engined fishing crafts were encountered. This greatly affects the mobility of the fishers. Moreover, they also reported that, the catches, sizes of fish and income from fishing had all declined in recent years, and that more time was needed and larger areas covered to catch the same number of fish as in the past.

The most abundant fish species observed during the study period according to their catchability include: *Oreochromis niloticus* (Bulti); *Hydrocyon spp* (Kass); *Synodontis schall* (Gargur); *Labeo niloticus* (Dabs); *Clarias anguilloides* (Kawara). This result agrees with that of Basheer, (2003). According to Basheer, the most abundant genera include: *Oreochormis*; *Bagrass*; *Labeo* and *Clarias*.

It was found out that, prices of wooden boats ranged from 1000 to 1800 SDG whereas that of iron boats between 2000 and 3700 SDG. The high prices of the iron boats compelled fishers to either buy wooden boats or hire from boat owners.

The study showed that, prices of fishing gears were between 150 and 600 SDG.

Though fish can be marketed by the fishers themselves, in most cases fishmongers become established especially in areas like Jebel Aulia where fish markets are located at distances far from the fishing grounds. This is demonstrated by the findings of the research. The dominance of these fishmongers negatively affects the incomes of the fishers because they usually bargain by the lot. As a result, the poor fisher often falls prey to the fishmongers. The presence of the fish mongers all the time also facilitate selling of fish fresh, thus contributes in their disinterest in preservation practices and at the same time help in cutting down the cost of ice or selling stands.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

Although some improvements are taking place in the fisheries sector in the Sudan, yet there are some underlying issues such as economics, human demand and interest, institutional aspects and a wide variety of factors unrelated to the resource potential that retard the expected standards of development and management.

The study concludes that:

1. There is no improvement on the traditional methods of fishing and dominance of un motorized boats in Jebel Aulia downstream fishery.
2. The fishers lack the capacity to procure fishing inputs such as gears and crafts from own financial resources.
3. There are no fish preservation facilities resulting into spoilage and/or wastage (post harvest loss) of fish particularly at times of bumper catch.
4. There is no insurance coverage for the life of the fishers and their fishing equipment.
5. There is dissatisfaction about the existing method(s) of licencing used by Khartoum State Fisheries Administration.
6. There is limited if any extension services and programs to motivate the fish producers.
7. Effective productive/marketing cooperatives is absent in the study area.
8. There is absence of institutional credit facilities.
9. There is high dependence of fishers on traders, fishmongers and boat owners for loans at usurious rates of interests.
10. There is great influence of fishmongers on the fishers in selling their produce.

Recommendations:

1. Provision of improved fishing gears and crafts.
2. Policy-makers to emphasize the use of better governance of the fisheries sector by involving fish producers to participate in decision making and regulation processes.
3. Provision of appropriate support to the fisheries sector in form of loans, credit cooperative and market group cooperative societies.
4. Availability of reliable and timely information on the fisheries status and trends.
5. Establishment of networks of producer associations and groups to be assisted by the private sector as well as donor and development agencies.
6. Provision of scientific advice for sustainable exploitation and management of the fishery.
7. Fish markets to be made accessible to consumers in the populous areas to assure relatively cheap, timely and continuous fish supply.

CHAPTER SEVEN: REFERENCES

Abd el Rahman, M.E (2003). A study on Catch Assessment in the Northern part of Jebel Aulia resevoir. M Sc. Thesis, Department of Zoology, Faculty of Science, University of Khartou..

Abd el Rahman, N.M. (2003). Some aspects of Primary Production and Biology of some Nile Fishes at Jebel Aulia reservoir. M Sc. Thesis. Department of Zoology, University of Khartoum.

Abu Gideiri, Y.B. (1984). Fishes of the Sudan. University of Khartoum Press. The Democratic Republic of the Sudan.

Ali, M.T. (1975). Gill Net Selectivity and Fish Populations in Gebel Aulia Reservoir. M Sc. Qualifying Desertation, Department of Zoology, Faculty of Science, University of Khartoum.

Ali, M.T. (1977). Studies on Gill Net Selectivity in Lake Nubia Fishery. M Sc. Thesis. Zoology Department, Faculty of Science, University of Khartoum.

Amirthalingham, C. and Khalifa, M.G., (1965).Aguide to the Commercial Freshwater Fishes in Sudan. Game and Fisheries Dept., Republic of Sudan, 197 pp.

Bellemans, M. and Khalid, A.B. (1998). Project TCP/SUD/3rd Mission Report, 15th October to December 1998.

Boeuf, G. (2008). Ocean Biodiversity as Reservoir for Food Production, Pharmaceuticals and Research models. Proceedings of the International Conference on the Economic Importance of Fisheries and their Impact on Public Health, 8-10 March 2008, Muscat, Sultanate of Oman, p55.

Borgstrom, G. (1962). Fish in World Nutrition, Chap. 7 in Borgstrom, G. (ed.). Fish as Food V. 11, Academic press, New York, pp276-360.

Catch Assessment Survey Report, 1998.

Eddie, G.C. (1983). Support and Development of the Retail Trade in Perishable Fishery Products. Fish Utilization and Marketing Division. FAO Fisheries Technical Paper No. 235. 53p. Rome, Italy.

FAO, (1996). Fisheries Technical Paper, Rome, Italy.

FAO, (1998). Fisheries Department Facts File, Rome, Italy.

FAO, (2000). FAOSTAT: <http://apps.fao.org/fisheries/prod.1-e.htm>.

FAO, (2001). Fisheries Technical Paper. 401. Understanding the Cultures of Fishing Communities. A Key to Fisheries Management and Food Security.

Fisheries Administration Directorate , Department of Statistics (1995).

Fisheries Administration Report. (2000). Khartoum State. (In Arabic).

Foreign Trade Statistics Digest, Bank of Sudan, 1991-97.

Gadgil, M. (1993). Ecological, Socio-cultural and Economic Aspects of Fisheries.

George, T.T. (1975). The History and Status of Fish Culture in Sudan and Urgency of Experimental Projects for its Development into Industry. A Review Paper presented at FAO/CIFA symposium, pp. 11-130.

Henderson, H.F. (1975). The Fisheries of the Reservoir of Central Sudan, Cairo, FAO Report, New East Regional Office. 5p.

Hodgson, S. (1998). An Assessment of the Situation and Proposal for the Future with Emphasis on the Inland Fisheries. FAO Fisheries Circular No. 901, Sudan Fisheries. Rome- Italy. P.5-26.

Jackson, R.I. (1971). The Importance of Fish Inspection in the Rational Utilization of Fisheries Resources. In Krewzer, R. ed. "Fish Inspection and Quality Control". Fishing News. Book 1 limited, London. Pp 2-6.

Kapesky, J.M. (1986). Management of Fisheries on Large African Reservoirs. An Overview. In: G.E. Hall and M.J. Van den Avyle (eds.). Reservoir Fisheries Management; Strategies for the 1980s. Reservoir Committee, Southern Division. American Fisheries Society, Bethesda, Maryland.

Keisuke, A.M. (1981). Basic Design Study Report on the Development of Jebel Aulia Reservoir Fisheries in Sudan. Tokyo, Japan.

Khaled, A.B. and Hariri, K.I. (1985). Fisheries Development in the North West Indian Ocean. The Impact of commercial Fishing Agreements. Ithaca Press, London.

Lawson, R.M. and I.I. Kwei. (1974). African Entrepreneurship and Economic Growth: A case Study of the Fishing Industry in Ghana. Accra, Ghana University Press, 26p.

Love, R.M. (1970). The Chemical Biology of Fishes. Academic Press, New York, London.

Lowe-McConnell, R. (1975). Fish communities in Tropical Freshwaters. Longman New York, 373p.

Ministry of Animal Resources and Irrigation, Khartoum State, Report, 2002 (In Arabic).

Mohammed, M.O.O. (2006). The Effect of Gillnets on Jebel Aulia and Kalakla Fisheries in Khartoum State. M Sc. Thesis, Sudan Academy of Science.

Mahmoud, Z.N.; Ali, M.E.; Mahmoud, B.F.; Yousif, F.M. and Abdul Gabar, H.E. (1998). A contribution Towards the Promotion of Aquaculture through Feeds from Non-conventional Sources. A Study for Ford Foundation and Institute of Environmental Studies, University of Khartoum., 31pp.

Moursy, A.M. (1987). Management of Fish Resources Economics. Ministry of Animal Wealth, Khartoum- Sudan.

Osman, M.S. (1993). Economic Feasibility of Fish Culture. Report of the Fisheries Research Center. Khartoum-Sudan (in Arabic).

Osman, M.S. (1990). The Obstacles and Horizons for Fishery Sector Development in the Sudan. Cited in the Animal Wealth Development Conference. Khartoum-Sudan.

Patti, R. (1989). Strategy and Action Programs for fisheries. Fish for Food and Development. FAO Publications, Rome, Italy.

Pauly, D. (1994). On Malthusian Overfishing: p 112-117. In D. Pauly. On the Sex of Fish and the Gender of Scientists: Essays in Fisheries Science, Chapman & hall. London.

Pauly, D. (1997). Small Scale Fisheries in the Tropics: Marginality, Marginalization and Some Implications for Fisheries Management. P40-49. In E.K. Pikitch, D.D. Huppert and M.P. Sissenwine (eds.). Global Trends: Fisheries Management. American Fisheries Society Symposium 20, Bethesda, Maryland.

Reynolds, J.E. (1993). Marketing and Construction of Fish in Eastern and Southern Africa. Selected Studies. FAO Fisheries Technical Paper. No.332, Rome, Italy, 194pp.

Royce, W.F. (ed.). (1972). Introduction to Fishery Science. Academic Press, Inc. New York, 351pp.

Saeed, O.M., Abdel Gabar, S. and Farah, O.M. (1993). Fisheries Research Center, Departmental Documentation. 14pp.

Souma, E. (1989). Introduction cited in the Strategy and Action Programs for Fisheries. Fish for Food.

Souness, J.A.R. (1978). Red Sea Shrimp Fishing Survey in the waters of Sudan. Red Sea Foods (International). Under Assignment of the Overseas Development Of the Government of the United Kingdom.

Sudan Embassy in South Africa (2004). Report. A Source of Population and Climate data.

Sudan Embassy in South (2006). Report. A Source of Population and Climate data.

Welcomme, R.L. (1972). The Inland Fisheries of Africa. CIFA Technical Paper. Doc. (1): 117pp.

University of Khartoum
Institute o Environmental Studies
Khartoum – Sudan

Questionnaire on the socio – economic status of fish producers

1. Fishing /area:
2. Name of fisher:
3. Age:
4. Duration in fishing:
5. Marital status:
6. Number of children:
7. Level of education:
8. Number of members of the family engaged in fishing:
9. Is the fisher permanent () or temporal ().
10. Does the fisher get services from the State Fisheries Administration? Yes () or No ().
11. When is the season with high production? Winter () or summer ().
12. Which type(s) of fishing gear(s) are used by the fisher?.....
.....
.....
.....
13. What is the price of a new fishing gear?
14. Which type(s) of fishing craft(s) are being used by the fisher?.....

.....
.....

15. What is the price of a new fishing craft?

.....

16. Does the fisher own a fishing craft? Yes () or No ().

17. Which are the dominant fish species?

.....
.....
.....
.....
.....
.....

18. Market condition of fish: Fresh (); salted () or dried ().

19. Prevalence of fishmongers: Present () or absent ().

20. Fish preservation: Ice- cold () or Not ice-cold ().

21. Are fish sold on stands () or on the ground ().

22. What is the daily quantity of fish produced?

23. What is the fisher producer's daily income?

Interviewer's name:

Supervisor's name: