



AU-NEPAD Networks of Centre of Excellence in Water Sciences and Technology

ACEWATER II Project

Human Capacity Development (HCD) Component

Sudan Desk Study

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List of Abbreviations

ACEWATERII	African Centres of Excellence Water Project Phase II
AMCOW	African Minister's Council of Water
AU	African Union
CEANWATCE	Central/Eastern Africa Network of Water Centres of Excellence
CoE	Centre of Excellence
EU	European Union
GDP	gross domestic product
HCD	Human Capacity Development
HYCOS	Hydrological Cycle Observing System
IGAD	The Intergovernmental Authority on Development
IHP	International Hydrological Programme
IOM	International Organization of Migration
JICA	Japan International Cooperation Agency
KETS	Kenana Engineering and Technical Services
MWRIE	Ministry of Water Resources, Irrigation and Electricity
NATCOM	National Commission
NBI	Nile Basin Initiative
NCS	National Comprehensive Strategy
NCWR	National Council for Water Resources
NEPAD	New Partnership for Africa Development
NGO's	Non- Governmental Organization
NSA	Nubian Sandstone Aquifer
NWC	National Water Corporation
NWRC	National Water Research Centre
NWRC	National Water Research Centre
OPEC	Organization of the Petroleum Exporting Countries
RCWH	UNESCO Category 2 Regional Center for Water Harvesting
SDGs	Sustainable Development Goal

TOR	Terms of Reference
UCO	UNESCO Cairo Office
UDWS	The Unit of Drinking Water and Sanitation
UNHCR	United Nations High Commissioner for Refugees
WASH	Water, Sanitation and Hygiene
WMII	Water Management and Irrigation Institute
WRC	Water Research Centre-U of K
WRTO	Water Resources Technical Organ

Executive Summary

This report presents findings of a desk study that identified capacity challenges and training gaps of junior professionals and technicians in the water sector in Sudan. The study was carried out by the Water Research Centre, University of Khartoum within the framework of the Human Capacity Development Component (HCD) of the project ACEWATER II of the AU-NEPAD Network of Centres of Excellence (CoE) on Water Sciences and Technology. The study started with a critical review of the water sector in Sudan and the challenges of water resources management that require training and capacity building at various levels. A comprehensive literature review was then carried out on the previous studies that have been conducted to identify HCD gaps and training needs. In these studies, the major water institutions, research centres and universities, training and capacity building centres, NGOs, and private sector in Sudan have been consulted to identify training gaps through structured questionnaires, visits, and interviews as well as through reviewing existing reports on training needs. It has been found that almost all institutions suffer from inadequate technical and manpower capacities, and they are in urgent need for training and capacity building. Top cross-cutting training areas identified from previous studies include Planning, design, operation, and maintenance of water resources systems, hydro-informatics and data acquisition, water sanitation and hygiene, Irrigation water use efficiency and productivity, Surface and groundwater resources assessment and management, watershed management, climate change , water governance and economics and water diplomacy and cooperation. Within the present desk study a consultation meeting with key Sudan water sector stakeholders was held at the WRC on 29th September, 2018 in which the gaps and training needs as identified from previous studies were discussed and refined. The participants of the consultation workshop were divided into two groups (starting professionals and technicians) and the top three priority training areas for each category were identified according to an agreed upon criteria. It was found from the consultation workshop that, in addition to the key training areas identified for each targeted group, there are similarities in the areas of training for both groups. Therefore, it was recommended to identify within each thematic training area, the components that belong to starting professionals on one hand, and technicians on the other hand. The following step to complete the overall assignment is to develop a framework for Human Capacity Development (HCD) which will consist of the design of training and educational contents, identification of learning objectives and expected outcomes, development of learning material, modality of implementation and the recommended training institutions. The subsequent and most important step is to design a monitoring and evaluation framework. The framework is intended to be effective in assessing the progress in training programs relative to the objectives of the project. Issues that will be discussed thoroughly include identifying methods of monitoring as well as specification of progress indicators.

Chapter 1 : Introduction

1.1 Background

This report presents findings of a desk study for the development of a national Human Capacity Development (HCD) programme that addresses junior professionals and technical level capacity challenges in the water sector in Sudan. The study is carried out by the Water Research Centre, University of Khartoum within the framework of the Human Capacity Development Component (HCD) of the project ACEWATER II of the AU-NEPAD Network of Centres of Excellence (CoE) on Water Sciences and Technology. The project is funded by the EU and the HCD component is coordinated by UNESCO-IHP. The HCD programme is implemented in response to the call of the African Water Ministers' Council's (AMCOW) Declaration in Cairo in 2013, urging the AU-NEPAD Water CoE to develop HCD Programme targeting junior professionals and technicians in the water sector at national level in the CoE countries.

Recent studies on water sector needs assessment in the Sudan have identified a disturbing gap in experienced professionals and qualified technicians in the water sector and emphasized the urgent need for training and capacity building as a fundamental requirement for achieving proper water resources management (Abdo, 2013, 2017). This is particularly important for junior professionals and technicians who don't have the required experience or special training to allow them to function properly. Similar capacity gaps have also been identified in many African countries based on a study on "Africa Water Sector Human Capacity Needs" conducted by Biedler (2013-2014). Therefore, this study is essential in addressing the capacity gaps and priority needs for the Sudan and in enabling the Water Research Centre (WRC), University of Khartoum, as one of the AU-NEPAD CoE to provide its contribution to the Sudan water sector in a more effective and sustainable way. In this context UNESCO-IHP has contracted WRC to carry out the task of establishing a framework for HCD programme for the Sudan.

1.2 Scope of the Desk Study

According to the TOR the purpose of the overall assignment is to develop and validate a national framework for HCD addressing junior professionals and technicians in the water sector, including implementation and monitoring and evaluation frameworks. The first activity to be conducted is to launch a comprehensive desk study to identify the Water Sector's HCD needs in the Sudan. This includes review of previous studies on capacity development needs assessment, surveys, interviews and consultations of national partners and stakeholders to identify their capacity gaps and their training needs to narrow this gap. The findings of this desk study are presented in the report.

1.3 Sudan Human Capacity Profile

According to the functions performed, manpower in the major institutions involved in the water resources management in the Sudan can be categorized into five groups: Top Managers and Directors, Professionals, Researchers, Technicians, and Financial and Administrative Personal.

(i) Top Managers and Directors:

This category represents the civil service leaders, with adequate knowledge and skills to lead a group to achieve the goals of the institution. It is the category responsible for policy formulation, planning and general administration. This category includes: Undersecretaries of Ministries; Advisors; Directors General (DG) of companies, corporations, secretariats of specialized councils, and General Directorates and Directorates in Ministries.

The educational level of this group normally varies from B.Sc. to Ph.D. with working experience of more than 20 years. This group normally acquire high managerial and negotiate skills.

(ii) Professionals:

This category is mostly university graduates (engineers, geologists, scientists, etc....) that carry out the main technical work in water resources institutions including technical studies and reports, planning, design, execution, operation and maintenance. The educational level of this group normally varies from B.Sc. to Ph.D.

(iii) Researchers:

This is the category which conducts applied research in the field of water resources management. The educational level of this group varies from B.Sc. to Ph.D. This group normally has good knowledge of research and training of personal.

(iv) Technicians

This is the category which assists the Researchers and Professionals in research work, programs of construction, field work, laboratory work, etc.... . The educational level of this group varies from above school leavers to Diploma (2years).

(v) Financial and Administrative Staff:

This is the category which preforms clerical, personnel affaires, accounting and store keeping works. The educational level of this group varies from school leavers to B. Sc. And normally have administrative, accounting and typing skills.

The target groups considered in this study are starting professional and technicians. More precise definitions of these target groups were suggested during the consultation workshop as will be discussed in Chapter 4 of this report.

1.4 Overview of the HCD Situation in Sudan

Water is of the greatest strategic importance for Sudan's social and economic development, now and in the future. Its trans-boundary surface and groundwater basins, which are binding the Sudan to 15 of its African neighbor countries, bring an urgent call for cooperation that creates win/win situations. Given the present challenges and the growing projected pressures on water resources in the Sudan, there is an urgent need for increasing the number of competent and well trained water management practitioners especially at the young professionals and technicians levels. The need for training and capacity building at these levels has been highly emphasized in many meetings, conferences, seminars and workshops in order to achieve the sustainable development goal (SDG's) and the corresponding management objectives. There are many examples in the literature of unsustainable water resources projects which have failed as a result of lack of trained staff.

Water resources management is a complex issue since water is connected to many other sectors. Figure 1.1 indicates a simple picture of some of the complex connections of water that needs to be viewed and managed in an integrated holistic manner, and consequently its human resources development should consider these wide links. Sudan is one of the leading countries in HCD in the water sector. This was reflected in establishing in 1977 solid institutes for training the different cadres required for the sustainable development of its water resources. These institutes include the Faculty of Engineering (established in 1939) in the University of Khartoum, as the location for graduating young qualified engineers, the Khartoum Technical Institute to graduate qualified technicians; and a set of centers to graduate skillful laborers. Regrettably, this very logical pyramid with a number of skillful laborers for each technician and a number of technicians for a graduate engineer, following recognized international ratios between these groups, this logical setting has been disturbed considerably through the years with the pyramid being inverted with many engineers against one technician and even much fewer numbers of skillful laborers. Currently considerable number of faculties in the over 130 universities and university colleges graduate each year thousands of young water related graduates with much less number of technicians graduating from these universities or few remaining technician institutes. In spite of this disturbing situation there is an absence of ready statistics on the number of these graduates and technician as well as the qualities of the programs in these universities and institutes. In this respect this project came at the right time to compile the necessary data and information in this very urgent subject, make the necessary analysis and reach appropriate training modules that assist in correcting this worrying situation.

In terms of future water resources development to meet the growing demands, and adapt to climate change, Sudan has many options through better utilization of rain fed agriculture, enhanced water harvesting and artificial recharge technology, improved applications of water conservation , enhanced irrigation efficiency, safe utilization of non-renewable groundwater, and in the wise utilization of non-conventional water resources However, to be able to make use of these opportunities, there should be a well-built capacity to deal with water resources management in a sustainable manner within the framework of an integrated water resources management approach. Therefore, training and capacity building to develop the human resources necessary for the Sudan to meet the above challenges is highly needed. This requires skillful laborers, qualified technicians, appropriate undergraduate and postgraduate training (at B.Sc. MSc and PhD levels), the provision of opportunities for post-doctoral research, continuing professional development, and the opportunity for stimulating careers to attract the most qualified persons to address these challenges.

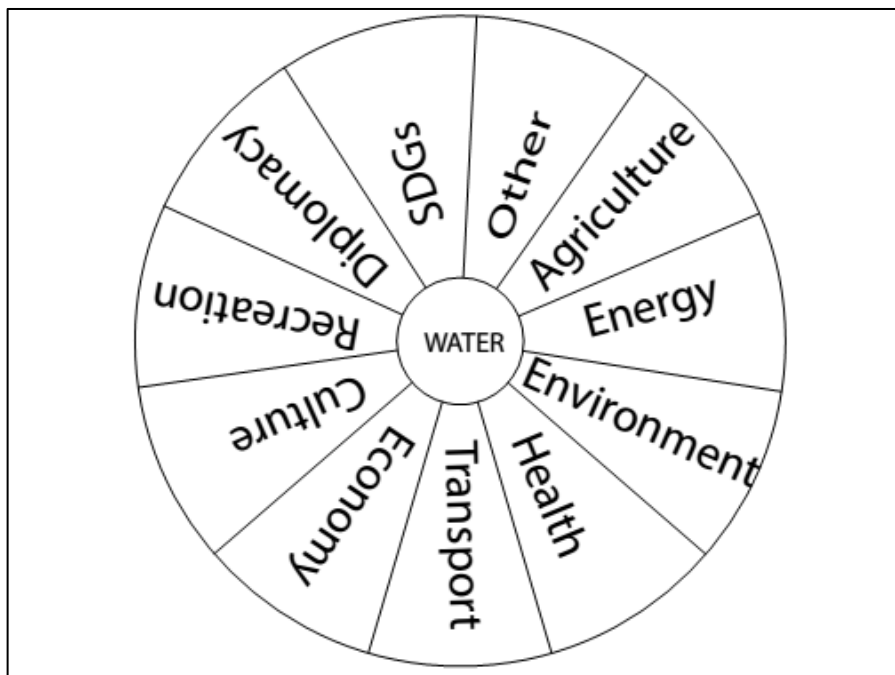


Figure 1.1 Water Links with Important Sectors and Goals

1.5 Structure of This Report

The present chapter gives a general background to the HCD assignment and the purpose of the desk study together with a general overview of HCD situation in Sudan,

Chapter 2 discusses the water sector of the Sudan including water resources and their management challenges, water institutions and their mandates as well as the legal and policy frameworks for water resources management.

Chapter 3 is a literature review on the previous efforts that have been made to identify HCD gaps and training needs. The identified gaps and needs from each of these studies are discussed.

Chapter 4 outlines the findings of the consultation meeting with Sudan water sector stakeholders held at the WRC on 29th September, 2018 to discuss the gaps and training needs as identified from previous studies and refine them to focus on top priority training areas for starting professionals and technicians.

Chapter 5 gives the general conclusions and the way forward to complete the overall study.

Chapter 2 : The Water Sector of the Sudan

Sudan covers an area of about 1.882 million km². According to the 2008 Census, it has a population of about 33 million with an annual increase of 2.8%. More than half that population lives on just 15% of the land along the river Nile. The rest of the population lives in areas away from the Nile. Water has the greatest strategic importance for Sudan's social and economic development, and for the maintenance of peace within its borders. Water resources comprise three main categories, rainfall, surface water and groundwater, all of which are interrelated as part of the natural hydrologic cycle. The Nile River is the primary source of Sudan's surface water. Water resources of the seasonal streams or Wadis (called Non Nilotic Streams) also fall under this category. The sedimentary Nubian Sandstone and Um Ruwaba formations are the main sources of groundwater. The trans-boundary nature of water resources in Sudan makes it an important factor binding Sudan to its international neighbors. Sudan has a unique position in the Nile system, including more than 42 % of the Nile catchment area, and acting as receptor, source and transmitter. The Nile resource is shared between eleven riparian countries, groundwater resources are shared with four other countries, and four seasonal rivers also cross international borders. Some 77% of currently identified water resources come from shared resources with other countries (Seifeldin, 2002).

The flow of the Nile is shared between Sudan and Egypt according to the 1959 agreement on the "full utilization of the Nile waters". This agreement stipulated yearly water allocation for Sudan of 18.5 billion cubic meters (PJTC, 1961). The Sudan would also be allowed to undertake a series of Nile development projects. As Southern Sudan seceded from Sudan, it became the 11th riparian of the Nile Basin, and therefore it will have to decide on how to proceed on succession with respect to the Nile water agreement currently applicable. There are three Scenarios that the new Southern Sudan can decide on the issue of the 1959 Nile Agreement. These scenarios are discussed in some details in this paper together with their future potential implications. The authors view is that if Southern Sudan decides to succeed into rights and obligations of the 1959 agreement, huge benefits could be achieved by the three countries, Southern Sudan, Sudan and Egypt. A brief discussion on potential lines of cooperation that would be beneficial to the three riparian countries is also given in the paper.

2.1 Water Resources in Sudan

2.1.1 Rainfall

Rainfall occurs during 3 to 4 months of the year and varies according to three distinct zones; the desert zone north of latitude 17° with annual rainfall of less than 75 mm, the semi desert zone north of latitude 15° with annual rainfall of 75mm to 300 mm and the Savannah zone between latitudes 9° and 15° with annual rainfall of 300 mm to 900 mm. Typical to arid zone characteristics, rainfall data analysis in many areas of Sudan shows very high seasonality and variability in space and time with annual coefficient of variation ranging from 30% to more than 90 % in the northern desert. Analysis also shows annual rainfall decreasing trend and a marked shift in rainfall isohyets towards the southern part of the country (Yousra & Magdoline, 2009). Furthermore, rainfall records for many stations, show increased frequency of droughts over the past 40 years. In north Darfur for instance, 16 out of 20 driest years on record have occurred since 1972. It appears from the above features that the climate in Sudan is influenced by global climate change (Abdo & Salih, 2011). Such erratic nature of rainfall in Sudan and its concentration in a short season, places Sudan in a vulnerable situation especially with regards to rain fed agriculture which covers by far the largest area of the country.

2.1.2 The Nile System

The Nile Basin is shared by eleven riparian countries, namely: Burundi, D. R. of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Southern Sudan, Sudan, Tanzania and Uganda. The hydrology of the Nile and its tributaries is summarized in Table 2.1. According to the 1956 Nile Water Agreement between Sudan and Egypt, the net average annual flow at Aswan of 74 BCM (Billion Cubic Meters) is shared between the two countries as 55.5 BCM for Egypt and 18.5 BCM for Sudan (20.5 BCM at central Sudan). An amount of 10 BCM is estimated to evaporate annually from the Aswan High Dam reservoir, which was built according to the agreement. The Agreement also established the rights of the other riparian countries for the utilization of the Nile Waters.

Sudan contributes to the flows of the Nile from Bahr El Jebel, Bahr El Gazal and Pibor basins as well as the seasonal streams which join the Nile and its other tributaries. Therefore Sudan could be considered as a source and a path. Furthermore, Sudan's contribution to the Nile could be increased through conservation of the river flow in the wetland areas in Southern Sudan if appropriate political, social and environmental measures are considered. It is worth mentioning that evaporation and evapotranspiration losses in the wetland areas in Southern Sudan are estimated to be within 45 BCM/ year (PJTC, 1961).

Table 2.1 The Flows of the Nile and its Tributaries in the Sudan

Tributary	Total Annual Average Supply (BCM)	Flow Characteristics
Blue Nile	50.7	Average daily peak discharge falls from 535 MCM/day in August to only 11 MCM/day in April
Rahad	1.09	Flow from July to November
Dinder	3.0	Flow from June to November
White Nile	27.8 (at Malakal)	Daily flow falls from 114 MCM/day in November to 54 MCM/day in April
Bahr El Gazal	14	Only 0.5 BCM reaches Malakal (considerable losses in swamps of South Sudan)
Bahr El Jebel	26 at Mongalla	Only 14.0 BCM reaches Malakal (considerable losses in swamps of South Sudan)
Sobat	13.3 reaches Malakal	Losses in Baro and Machar reach 8 bcm. Flows range from 8 MCM/day in April to 66 MCM MCM/day in November
Atbara	12 (7 from Setit and 5 from Atbara branch)	Low regulated flows from February to June
Main Nile	84 (at Aswan)	Average daily peak flow of 690 MCM/day (August-Sept.) and a low flow of 74 MCM/day (April-May)

Modified from Adam and Monshid (1996). (MCM: Million Cubic Meters)

2.1.3 Wadi Waters

There are a large number of seasonal streams (locally called Wadis) which are spread in many regions of Sudan and which are not considered as part of the Nile Basin. The major four of these streams are Gash and Baraka, which are shared with Eritrean, and Azum and Howar which are shared with Chad. Flow from these streams is sporadic and varies considerably from one year to another following the erratic nature of rainfall. They may flow for few days or few hours during the rainy season from July to October, and usually become dry during the rest of the year. The total annual Wadi flow in Sudan is estimated

to vary from 5 to 7 BCM. However, absence of monitoring networks and lack of adequate understanding of Wadi hydrological processes are serious constraints impeding Wadi water resources development in Sudan. The situation is exacerbated by the Decentralization Act of 1994 which shouldered the responsibility of Wadi water resources development and management to the States Governments which often suffer from lack of funds and inadequate capacity.

2.1.4 Groundwater

Sudan has high potential of renewable and non-renewable groundwater resources which are important sources of water supply for domestic, industrial and agricultural uses. It is a key element for human settlement and sustained socioeconomic activities. The most important aquifer in Sudan is the NSA (Nubian Sandstone Aquifer) which is shared between Sudan, Egypt, Libya and Chad, and the Um Ruwaba formation which has recently become a shared resource between Sudan and Southern Sudan. Despite the large number of previous studies on groundwater resources in Sudan, there is no unified value of their estimated strategic storage potential. However, the various estimates given in the literature do indicate that it is huge. Regarding groundwater recharge, there are also differences in the estimated annual volume, yet the figure of 4 BCM/year has been circulating in various reliable sources (Abdo & Salih, 2012)

Groundwater management in Sudan is faced with many challenges. The most obvious of these challenges is the absence of quantitative and qualitative monitoring and scarcity of information on aquifers geometry and their hydro geological characteristics. Another major difficulty is related to the understanding of flow dynamics, recharge sources, volumes and mechanisms for the different aquifers. Fractured aquifers in Sudan cover very large areas and provide an important source of water particularly in rural areas. A major problem encountered in the management of fractured aquifers is the limited understanding of their hydrogeology. The fractures characteristics could be extremely complex making it very difficult to locate areas of productive boreholes with sustainable groundwater yield. Vulnerability and risk of contamination of these aquifers from urban, agricultural and industrial activities are also very high (Abdo & Salih, 2012). Other key challenges facing groundwater management in Sudan are the management of shared non-renewable aquifer resources, lack of comprehensive guiding plans and policies, poor governance and legislative framework, inadequate capacity, and lack of coordination among groundwater sub sectors.

2.1.5 Summary of available water resources and potential threats

Based on the above mentioned estimates, the current annual amount of renewable water available to Sudan is about 30 BCM (Seifeldin, 2002). Historically, Sudan's renewable water resources have exceeded demand, but demand has now increased to match supply, and projections based on future development strategies show large water shortages over the coming years (Seifeldin, 2001). Demand is projected to reach 50 BCM/year by the year 2025, an excess of some 66% over the current demand. This will have severe implications for Sudan, for example in meeting the Millennium Development Goals of providing safe drinking water to all its citizens and the natural habitat. The lack of adequate safe drinking water has negative impacts on human health and social and economic development. Water deficits also have major implications for the agricultural sector of the economy. Agriculture is important in terms of food security, its contribution to the economy and exports which amounts to 34% of the GDP, and its position as the country's main source of employment. Furthermore, the vast fertile land resources of the country and the potential for the conservation of considerable volumes of water resources from the swamps of Southern Sudan have classified Sudan as the basket food of Arab World.

Current estimates of water resource availability take no account of some potential threats to those resources. The likelihood of climate change due to global warming has been confirmed by the 2007 report of the International Taskforce on Climate Change. Its impacts on the Nile water are highly uncertain, but in general, the frequency of extreme floods and droughts is likely to increase. Furthermore, increasing drought frequency would lead to yet more severe water deficits, with potentially devastating effects on domestic water supplies, crops, livestock and the environment. Water resources are also vulnerable to pollution within the country or outside its borders, and to miss-management practices in upstream catchments. Luckily, there are options to meet the water deficiency in the future through better utilization of rain fed agriculture, enhanced water harvesting and artificial recharge technology, improved applications of water conservation, enhanced irrigation efficiency, safe utilization of non-renewable groundwater, and in the wise utilization of non-conventional water resources. However, to be able to make use of these opportunities, there should be an up to date knowledge base and well-built capacity in the framework of an integrated water resources management approach.

2.2 Water Resources Institutions in Sudan

There are many Ministries, Agencies, and Institutions that have a stake in water resources management and use in Sudan. Generally, there are three levels of government institutional authority; National or Federal level, State level and Locality level. At the Federal level the water resources institution responsible for water resources management is the Ministry of Water Resources Irrigation and Electricity. Prior to 1995, water affairs in Sudan were fragmented between different Ministries and Institutions mostly with

conflicting interests and minimum coordination. Realizing this drawback, the Government started in the last decade some major steps for rectifying the situation. One of these major steps is bringing down the responsibility of all the water resources affairs under the umbrella of the Ministry of Water Resources Irrigation and Electricity. Another major step is the formulation of the National Council for Water Resources (NCWR) with the objective of formulating common water resources policies and coordinating the activities of all water sector agencies and stakeholders. The NCWR has the Water Resources Technical Organ (WRTO) as its executing arm. Another major change is the adoption of the Federal system of government through which some of the responsibilities of water resources management were handed to the States and also the irrigated agriculture to the Ministry of agriculture. The Federal system of Government was a major step towards decentralization. The responsibility of water resources is shared between the Federal government and the State. While the regional and inter-state waters are governed by the Federal government, the local surface and groundwater is the responsibility of the State government. Within the State, the water utilization responsibility is divided between two ministries; the Ministry of Physical Planning and Public Utilities and the Ministry of Agriculture.

2.2.1 Evolution of the institutional Framework

The responsibility of water resources monitoring, assessment, development and management in Sudan at the independence time (1956) was under the responsibility of the Ministry of Irrigation and Hydroelectric Power which later became the Ministry of Irrigation and Water Resources. Later in 2012, the irrigation part was transferred to the Ministry of Agriculture consolidating the Ministry of Water Resources to be then for overall management of water resources. Less than six months later, that ministry was combined with Electricity and Dams to form the Ministry of Water Resources, irrigation and Electricity (MWRIE). Now the MWRIE is entrusted for monitoring, assessment, planning and development of the water resources in the country. These resources include surface water, groundwater, water supply, wastewater treatment sewage and sanitation at the national level. Provision of drinking water at the state level is the responsibility of each state. The organizational structure of the then MWRE is given in Figure 2.1. Two important Directorates that are linked to the Ministry and which are both under the Minister's office are:

- i. Water Resources Technical Organ (WRTO).
- ii. The Unit of Drinking Water and Sanitation (UDWS).

Because of the importance of the international waters in the country economy, the ministry established the WRTO to be entrusted for that issue. The WRTO is now part of the MWRIE and it was established in 1992 prior to the National Council of Water Resources (NCWR). It was then considered to be the executive body for the NCWR when it was formulated in 1995. Other duties of the WRTO are to prepare and review the legislations, regulations,

and management framework of the water sector of the country including the shared waters. So the WRTO has close contact with all riparian countries and is responsible for all matters related to bilateral and regional agreements as well as cooperation issues dealing with shared water resources. It also represents the country in negotiations with riparian countries for the realization of joint projects for the development and management of the Nile waters to achieve mutual benefits. In general, the WRTO is responsible for integration and coordination of all aspects and duties pertinent to water resources assessment, demand, management, and development, especially in shared waters. Other related Directorates are:

- General Directorate of polices, planning and projects.
- General Directorate of the Nile affairs and dams.
- General Directorate of groundwater and Wadis.
- General Directorate for operation and maintenance.

These directorates perform their activities at the federal level and put plans for better utilization of the available resources. The main objectives are to develop the national resources, supervise the implementation of the infrastructure, operate and maintain the existing structures like dams, and monitor the different usages among the various sectors. The mentioned directorates coordinate the usage of the water resources among the various states especially for the national cross-states surface and ground waters.

On the other side measurement of rainfall and evaporation is the responsibility of the Meteorological Department which is part of the Ministry of Defense. There is coordination between the MWRIE and the Ministries of Agriculture; Environment, Forestry, and Urban Development; Industry; Meteorology and related academic and research institutions. A high committee for the utilization and optimization of the Blue Nile waters is formed within the MWRIE to regulate and coordinate between the concerned institutions

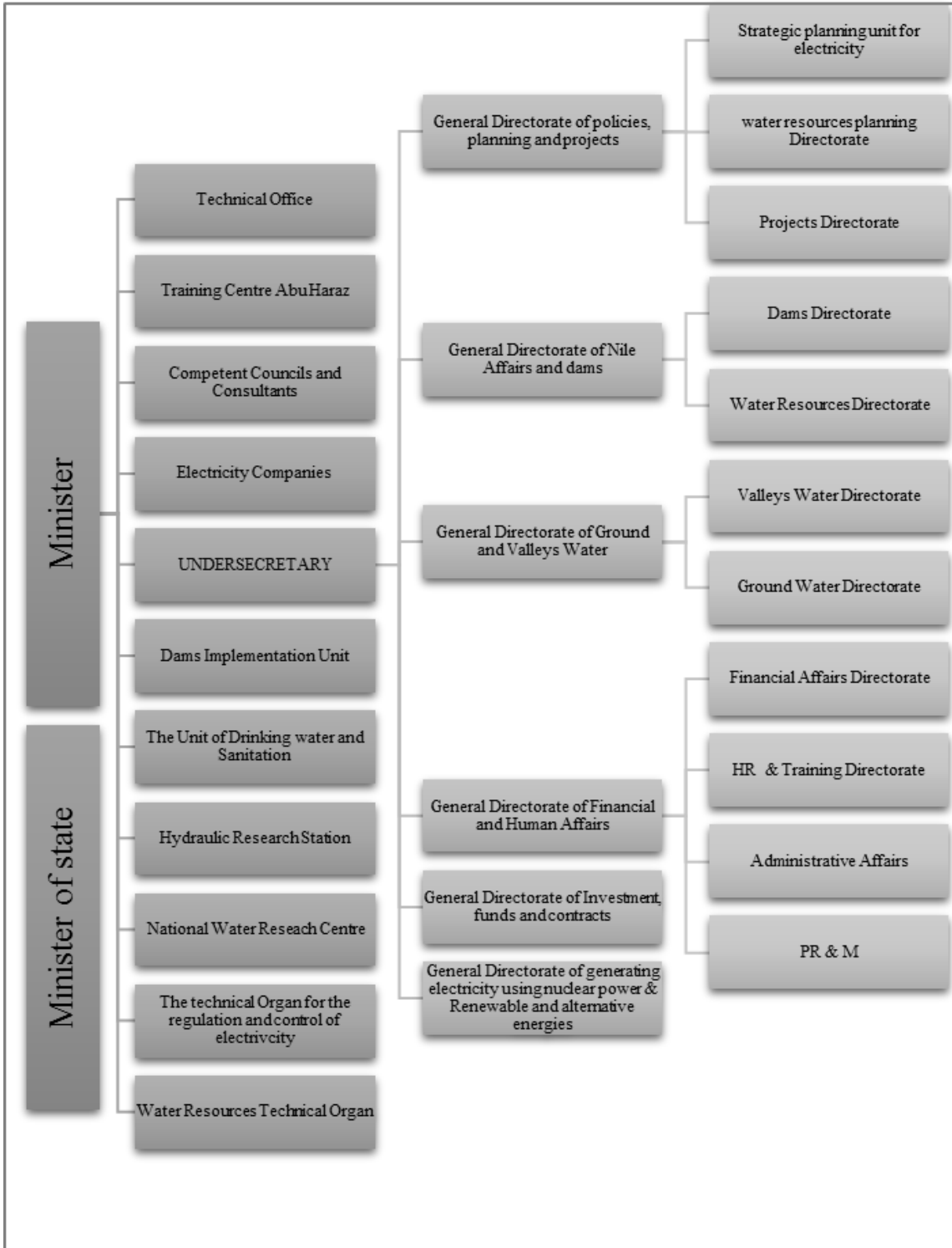


Figure 2.1 Organizational Structure of the Ministry of Water Resources, Irrigation and Electricity (MWRIE)

2.2.2 Other Institutions

In addition to the Ministry of Water Resources and Electricity and its various department outlined above, there are other governmental, nongovernmental institutions and private consultancy firms that deal in one way or another with water resources management. The most important of these are:

A) Governmental

- Federal Ministry of Agriculture and Forestry.
- State Ministries of Agriculture, Animal Resources and Irrigation
- State Ministries of Physical Planning and Public Utilities
- Federal Ministry of Environment
- Federal Ministry of Education (Sudan IHP NATCOM)
- Federal Ministry of Higher Education and Scientific Research (Universities and Research centres)
- Sudan Meteorological Authority
- Agricultural Research Cooperation

B) Non-Governmental Organizations and Private Sector

There is a large number of NGO's working in water resources in various parts of Sudan, mainly in water supply and sanitation. Examples of these are Sogia, Islamic Dawa, Sudanese Environmental Protection Association, UNICEF, UNHCR, Practical Action, UN Environment, IOM and Plan Sudan

Examples of well-known private firms working in water resources management are University of Khartoum Consultancy Corporation, Shoura Consultants, Kenana Engineering and Technical Services, NEWTEC Consulting Group, And YAM Consulting Group

C) Universities and Research Centres

There is big number of Universities and Research Centres that are involved in research in water issues, training for BSc, MSc and PhD in water management as well as professional training. Examples of these institutions are:-

1. Water Research Centre, University of Khartoum
2. Department of Civil Engineering, University of Khartoum
3. Faculty of Geography, University of Khartoum
4. UNESCO Chair in Water Resources, Omdorman Islamic University
5. Water Management and Irrigation Institute (WMII), Gezira University
6. College of Water and Environment, Sudan University of Science & Technology.
7. Faculty of Engineering, Sudan University of Science & Technology.
8. Water Harvesting Centre, University of Nyala

9. Faculty of Engineering, University of Nyala
10. Faculty of Engineering, University of Sennar
11. Faculty of Engineering, University of Kasala
12. Faculty of Engineering, University of Red Sea
13. Faculty of Engineering, Blue Nile University
14. Regional Centre for Water Harvesting, Ministry of Water Resources, Irrigation and Electricity.

2.3 Legal Framework

There is no existing one single legal document that governs the development, management and utilization of water resources in Sudan. However, there are different existing water related legislations which can be regrouped into two groups based on the time of their approval (Seifeldin, 2005):

Prior to 1992: the policies and legislations used to appear in each sub-sector (irrigation, hydropower, domestic, etc...) as these sub-sectors were under different institutions. The major part of water resources policy, strategies, plans, development and management used to be the responsibility of the Ministry of Irrigation and Hydropower (now Ministry of Irrigation and Water Resources).

Post 1992: a comprehensive review of policies and legislations has taken place, under which the MIWR embraced most of the sub-sectors, namely policy making and legislations, planning, and coordination of all the water resources. Consequently, the drinking water became the responsibility of the MIWR. This section provides a brief overview of these developments:

The main water regulations in Sudan are based on the 1951 Regulations, which are licensing regulations for pumping water from the Nile according to the Nile Pumps Control Act 1939 (repealed) (ElMufti, 2002). Recent instruments have modified the 1951 regulations; e.g. the Water Resources Act of 1995 (MIWR, 1995). Another major development in the legislation policy is the Irrigation and Drainage Act of 1990, which regulates irrigation and drainage in Sudan. In addition, there are more than forty pieces of legislation which illustrate a variety of different policies that govern the use and protection of water resources of Sudan (Seifeldin, 2005).

2.4 Policy Framework

According to the National Comprehensive Strategy (NCS) of 1992, the irrigation and water resources institution is considered part of the agricultural sub-sector. The economic sector comprises the agricultural sub-sector and other sub-sectors. The policy objectives and strategies of the water resources institution can mainly be outlined as full and efficient

utilization and development of water resources, construction of dams on the Nile and Wadis, addressing the problem of silt in reservoirs, enlargement of existing reservoirs through heightening and construction of new dams, developing water equipment manufacturing industry and developing economic criteria for the utilization of water in such a manner as to maintain a balance between the cost on one hand and the economic and social return on the other.

Bearing in mind the experiences, limitations and lessons learnt from the implementation of the 1992 Water Policy (MIWR, 1992), and taking into consideration future aspirations of the people and the realities of the world around, the 1992 Water Policy was updated in 2000. The National Water Policy draft of 2000 (Eltom et al., 2000) was a single policy document which had to be improved based on the new country developments. The Integrated Water Policy of 2007 (MIWR, 2007) has been developed based on the Transitional Constitution of Sudan, water policies of 1992 and 2000, and macroeconomic policies and development strategies. The formulation of the Water Policy of 2007 was also based on sound water resources assessment, establishment of effective regulatory framework and capacity for enforcement of approved legislations, promotion of the role of women, and creation of incentives for the sustainable use of water resources.

2.5 Summary of Water Resources Management Priority Areas

From the previous discussion a summary of the priority areas that require HCD are:-

1. Arid Zone or Dry land hydrology (surface and Groundwater)
2. Water Conservation (water harvesting, Management of aquifer Recharge, demand management, non-conventional water)
3. Watershed Modelling and Management
4. Strategic water resources planning and management
5. Hydro-informatics
6. Hydraulics, River Morphology and Sediment Transport
7. Climate change Studies (Impacts and Adaptation)
8. Flood and Drought Management
9. Irrigation Management (irrigated and rain-fed agriculture)
10. Water Supply and Sanitation
11. Trans-boundary Water Management
12. Water-Energy-Food-Ecosystem Nexus
13. Water Economics and Governance
14. Water Diplomacy and Cooperation

Chapter 3 : Literature Review

3.1 Capacity Development in the Water Sector: History and Current Situation

Broadly speaking, several national, regional and international institutions played a role in capacity building and development in the water resources sector in Sudan. The Ministry of Water Resources Irrigation and Electricity (MWRIE), however, had and continues to be the leading institution and the governing body. Through its lifetime, MWRIE operated under different names combining the responsibilities of water resources management, hydropower and, during certain periods, irrigation. Nonetheless, capacity development in the water sector has always been an important part of the Ministry's responsibilities.

Major efforts in capacity development conducted by MWRIE include "The Irrigation School", "Training Unit of MWRE" and "Knowledge and Skill Transfer". The Irrigation School is a program designed to provide newly recruited technicians and engineers with the required knowledge and skill for their positions. It is intended as a preparatory program that facilitates easy integration of employees into the Ministry work. Training Unit of MWRE is an administrative unit under the Ministry mandated to facilitate training and development for employees by providing support for engineers and technicians to obtain higher degrees and professional membership. Finally, "Knowledge and Skill Transfer" is an informal yet a powerful capacity development technique in MWRE where junior engineers and technicians obtain experience and skill from senior individuals on a daily basis.

Furthermore, regional and international institutions have participated over the years in developing human resources for the water sector. Examples of regional programs are the Nile Basin Initiative (NBI) program and the IGAD-HYCOS program, meanwhile in the international level, UNESCO-IHE has provided significant training for capacity development. Organizations such as World Bank, OPEC and JICA played a significant role as well by funding rehabilitation projects (e.g. Gezira Rehabilitation Project funded by OPEC) and establishing training centers such as Training Center of the National Water Corporation (NWC) funded by JICA. The Water Research Center , University of Khartoum WRC (2017) provides a detailed historical overview of the several training initiatives and programs conducted by different national, regional and international institutions.

In recent years, the number of training, academic and research institutions related to the water sector in Sudan has increased significantly. Examples of such centers are the UNESCO Category 2 center "Regional Center for Water Harvesting" (RCWH), Water Research Center at University of Khartoum, Engineering Training Unit at University of

Khartoum and Training Center of UNESCO Chair in Water Resources at Omdurman Islamic University. While the availability of several centers indicates the high potential that can be attained in enhancing the water sector in Sudan including improved capacity development, it also draws attention to the need for collaboration between these different entities. Therefore, identifying key and priority training needs in the field of water resources in Sudan is more than ever needed.

3.2 Previous Efforts in identifying Training Needs for Capacity Development in the Water Sector

Early efforts for identifying training and education needs for personnel in the water sector have been outlined by Salih (1993) where he classified personnel into four categories: Research and Development (R&D) personnel, professionals, technicians and craftsmen. The study identified the required education and training needs for each category in a broad manner.

In 2000, the Ministry of Water Resources Irrigation and Electricity as part of the FAO Regional Project “GCP/RAF/286/ITA” conducted a study in order to formulate a national policy on water resources management. The study defined training needs in the water sector into six key categories and specific areas within each category. Training needs identified in this study are summarized in Table 3.1, while detailed information about training needs is provided in (MIWR 2000).

Table 3.1 Top six thematic areas and their sub-categories for training in the water sector in Sudan as defined by the Ministry of Water Resources Irrigation and Electricity (MIWR 2000)

Key area	Specific Areas
Strategic water resources planning and development	Integrated water sector master planning, Dry-zone hydrology, Risks and uncertainty in water resources, surface and groundwater storage, conjunctive surface, rain and groundwater use, Efficient water allocation, Disaster management, projects formulation and appraisal.
Management	Upgraded basic management skills, corporate planning and management, economic analysis techniques, financial management, construction management, O&M management.
Information Technology	Management Information system, Geographical information system, Engineering Analysis system, Socio-economic information, environmental information, Environmental Impact Assessment.
Water Resources Assessment	Water resources procedures and guidelines, Hydro-meteorological monitoring.
Natural Resources and Environmental Management	Environmental monitoring, Environmental Impact Assessment, Integrated ecosystem management, Environmental protection and conversation.
Research & Development (R&D)	Develop cost effective and appropriate technologies for efficient water use, treatment and sound. Research into sound environmental techniques procedure including potential climate change and its impact on water resources.

According to this study, the total numbers of personal of the MWRIE that need to be trained on each appropriate area for different training periods projected up to year 2020 are given in Table 3.2

Table 3.2 :Total number of personnel of the MWRIE to be trained up to year 2020

Description	Number
- long term (more than 6 months)	444
- medium term (3 – 6 months)	1076
- short term (1 - 3 month)	1800
- Workshops, seminars, and conferences (1-2 weeks)	2500

In 2013 UNESCO Cairo Office UCO in collaboration with WRC organized a workshop on Water Sciences for Peace and Sustainable Development in the Eastern Nile: Perspective of Future Cooperation within the framework of the UNESCO’s International Hydrological Program (IHP) project on “Water Sciences for Peace and Sustainable Development in Africa” (UCO, 2013). A plenary session was organized in which representatives from the four Eastern Nile countries (Sudan, Egypt, Ethiopia and South Sudan) identified key areas where HCD is needed which are summarized as follows

- Climate change, conjunctive use of groundwater and surface water
- Benefit sharing in transboundary water management
- Water sanitation and hygiene
- Water harvesting and management of groundwater recharge
- Water quality management
- Data acquisition, management and dissemination with emphasis on GIS/RS applications

One of the workshop recommendations was to conduct a training needs assessment for each country to define training priorities and gaps. (UCO, 2013)

As a follow up to the workshop recommendation, the Water Research Center at University of Khartoum sponsored by UNESCO Cairo Office conducted a comprehensive study to identify training needs in the water sector in Sudan. The study brought together professionals from a wide variety of institutions including the Ministry of Water Resources Irrigation and Electricity and its various units, other ministries such as the Ministry of Agriculture Animal Resources and Irrigation of Khartoum State and the Ministry of Health as well as academic and research institutions , NGO’s and private sector (Abdo, 2013). The study predefined seven main training categories with each consisting of several sub thematic areas. Data from questionnaires were analyzed to define the main three sub thematic areas within each of the seven categories; detailed results of the questionnaires

are reported in Abdo (2013). Furthermore, the study defined top ten priority areas (Table 3.3) that should be the focus of future training in the water sector in Sudan.

Table 3.3: Top Ten Priority Areas For Training In The Water Sector In Sudan As Defined By Abdo (2013)

Thematic area	Strategic goals
Design and evaluation of hydrological networks (monitoring networks)	To enhance data collection for sustainable management and development of water resources
Hydrological characteristics of arid zones	To provide better understanding of wadi systems and wadi water resources management
Groundwater water resources assessment, development and management	To provide knowledge base for groundwater resources for sustainable use
Enhancement of irrigation water use efficiency	To provide tools for best irrigation practice for improved productivity and food security
Water quality analysis and standards	To set standards for water quality for the different uses and reduce health complications resulting from use of unsafe water
Environmental impact assessment of water projects	To provide tools for judgment of suitability of water projects to safe guard the environment and enhance sanitation development options
GIS and Remote sensing applications in water resources management	To introduce state of the art technology in water management and enhance the use of available spatially distributed RS and GIS database in water management
Sediment management in reservoirs and irrigation schemes	To prevent silting up of reservoirs and irrigation networks thus saving huge financial resources
Design and management of water harvesting systems	To better manage water supply to improve water availability and enhance food security specially for rural areas

In 2017, a study was conducted by the WRC to identify water sector training needs with specific reference to attaining the goals 6 of the Sustainable Development Goals (SDG's): and the themes of UNESCO IHP-VIII (Abdo,2017). The study found that there are interdependencies between the objectives of both SDG6 and IHP-VIII; these interdependencies can be summarized in six overarching themes that define training needs in the water sector in Sudan. Figure 3.1 shows the linkages and inter-dependencies between the goals of SDG6 and the themes of IHP-VIII which can be summarized in 6 main themes for training. Table 3.4 summarizes the final results of this study.

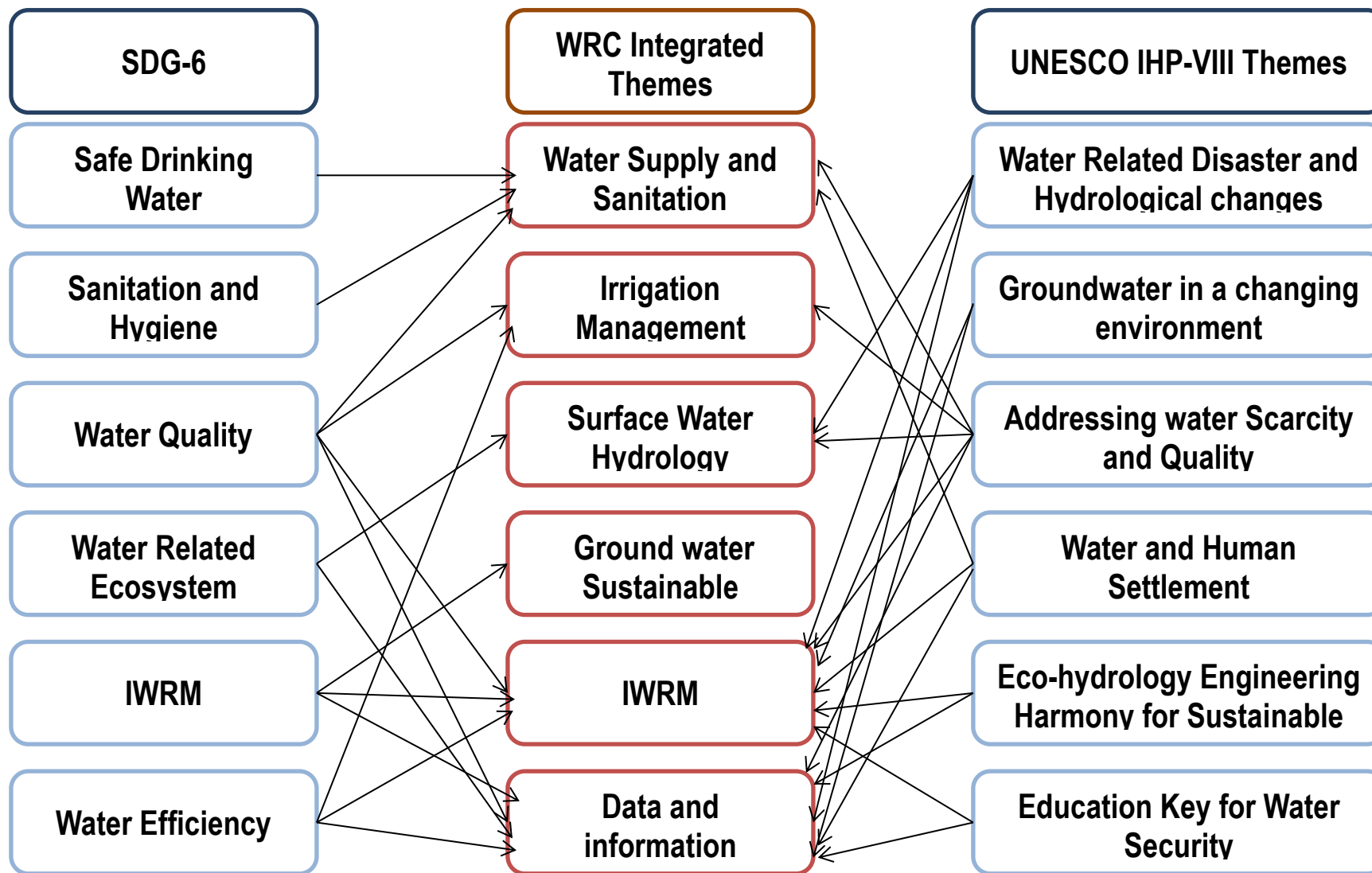


Figure3.1 Linkage And Interdependencies Between The Goals Of Sustainable Development Goal (SDG) 6 And The Themes Of IHP-VIII

Table 3.4 Final Results Of The TNA In The Form Of Suggested Training Modules

Suggested training modules	Covered contents	Target audience
Theme 1: Water Supply and Sanitation		
Water, sanitation and hygiene (WASH)	Planning, design, operation and maintenance of water supply systems (source, treatment and distribution)	Water professionals, and researchers
	Drinking water quality standards and analysis methods	
	Water, sanitation and hygiene (WASH)	Water professionals, researchers, NGOs
	Waste water treatment and reuse	
Theme 2: Irrigation Management		
Design and management of Irrigation Systems	Modern Irrigation Techniques	Irrigation practitioners and private sector professionals
	Design of irrigation systems	
	On-farm irrigation water management	
	Estimation of Crop Water Requirements	
	Enhancing irrigation water use efficiency	Irrigation practitioners, researchers, and private sector professionals
	Improving productivity of Rain-fed agriculture	
	Calibration of irrigation control structures	
Theme 3: Surface Water Hydrology		
Surface water resources assessment and management	Rainfall-runoff modelling and hydrological forecasting	Water professionals, and researchers
	Arid Zone or Wadi Hydrology	
	Design of Small Dams in Wadi systems	Water professionals, researchers, NGOs
	Design, operation and Management of water harvesting systems	
Theme 4: Groundwater Sustainable Management		
Groundwater modelling, design, and operation	Ground water protection and remediation	Groundwater professionals, researchers, private sector practitioners
	Sustainable Management of non-renewable aquifers	
	Groundwater modeling	
	Well design, construction, operation and management	

Theme 5: Integrated Water Resource Management		
Public awareness and community participation for sustainable watershed management	Public Awareness & Community Participation in Water & Environmental management	Water resources professionals, researchers, Socio-economists, Community leaders
	Water-Energy-Food security Nexus	
Climate change impact: adaptation and resilience	Climate change impacts on water resources & adaptation measures	Water resources professionals and researchers
	Echo Hydrology and Echo-system Management	
Water diplomacy and transboundary cooperation	Trans-boundary water resources management	Water resources professionals, researchers, and institutional representatives (such as media, law, hydro-politics, socio-economics)
	Legal aspects of water resources management	
Theme 6: Data Acquisition and Management Tools		
Hydroinformatics and data management	Remote Sensing and GIS in Water Resources Management	Water & IT professionals, researchers, meteorologists
	Data management (processing, storage, retrieval, & dissemination)	
	Design of surface and groundwater monitoring networks	Water professionals, researchers, meteorologists, technicians
	River flow measurements	

Chapter 4 : Consultation Workshop

On 29th September 2018, the Water Research Center organized a consultation workshop with the general objective of establishing a national Human Capacity Development (HCD) Programme addressing training needs of junior professionals and technicians in the water sector of the Sudan. The specific goals of the workshop were to identify three priority research modules for the two groups of young professionals (engineers) and technicians.

4.1 Workshop setup, format and participation

Selection of participants in the consultation workshop was performed to ensure that key Sudan water Sector stakeholders are represented. Participants came from academic and research institutions (e.g. Water Research Center at University of Khartoum, UNESCO Category II center Regional Center for Water Harvesting, UNESCO Chair in Water Resources in Omdurman Islamic University), governmental agencies and ministries such as various units of the Ministry of Water Resources Irrigation and Electricity (e.g. Dams Implementation Unit, Drinking Water and Sanitation Unit), NGOs (e.g. UN Environment) as well as private sector (KETS). A list of participants and their affiliations is provided in Annex 2.

The workshop commenced with a short lecture by Professor Gamal Abdo, the Director of the Water Research Center at University of Khartoum, to provide a background on the AU-NEPAD Centres of Excellence, ACEWATERII project and a summary of the workshop objective as well as previous efforts conducted to identify training needs in the water sector in Sudan. The goal of providing a brief description of previous efforts is to take full advantage of the available literature in training needs assessment. The lecture was followed by a fruitful discussion regarding issues that should be taken into consideration before starting the exercise of identifying training needs. Issues that have been raised include:

- Discussion about the existing national policies that organizes the training of individuals in the water sector in Sudan. Such policies might have been formulated by agencies related to education and training of individuals such as the Ministry of Higher Education and Scientific Research and the Ministry of Water Resources Irrigation and Electricity. The main goal of this discussion was to make sure that if such policies exist, then training needs shall be defined such as to conform to the guidelines of these general governmental policies. The primary outcome of the discussion was that there is a lack of comprehensive national policies regarding the training of personnel involved in the water sector (engineers and technicians).

- Discussion about the criteria used to identify the top three training priorities for each targeted group (young professionals and technicians). Some participants were concerned that in the absence of clear criteria regarding the selection of training needs, experts will be biased towards the selection of thematic areas that are related to their field of expertise. Suggestions for selection criteria brought by participants include giving higher priority to cross-cutting thematic areas that permeates to most if not all other thematic areas. An example of such thematic areas is “Data Acquisition and Information Management” as it is a key area for all categories of water resources management including urban surface water drainage, groundwater management, irrigation, water supply and sanitation and integrated water resources management. Another suggestion was to assign higher priority to thematic areas that suffer from a lack of skilled human resources and are of importance to the daily life of residents in Sudan. These areas include water supply and sanitation with specific focus on pumps and water intakes as well as a focus on urban storm water drainage, an issue of great importance to major cities in Sudan, specifically Khartoum.

In order to conduct the training needs assessment exercise, participants were divided into two groups: the first group goal is to identify three training priority needs for young professionals and engineers meanwhile the second group is to identify three training priority needs for technicians. Lists of participants in each group are provided in Annex 2 and 3.

The two groups have also been asked to discuss related issues such as the challenges facing training of individuals as well as institutions that can host the suggested training modules.

4.2 Outcomes

4.2.1 Training Needs Assessment for Young Professionals

- **Definition of targeted group:** The participants of the consultation meeting defined starting professionals as those who have a bachelor’s degree with less than 5 years of related experience, from any discipline related to water resources and have interest to continue working in the water sector whether they have a M.Sc. degree or not.
Disciplines related to water resources include Civil, Chemical, Agricultural, Water, Environmental, Irrigation Engineering, Hydro-geology, Chemistry, Biology, Water Sanitation and Hygiene (WASH), Agriculture, Water Economics, Water Diplomacy, Water Governance, Geography and Remote Sensing.
- Challenges facing the training of starting professionals in the water sector in Sudan include:
 - Lack of clear government training policies related to water. However MWRIE offers an orientation period for their new staff.
 - High rate of brain drains.

- Great expansion in graduates from different universities, with little focus on practical knowledge and related courses and a disregard to addressing the actual market needs. Lack of specializations in universities in specific tracks of water.
- Suggested Training period:(1-2 weeks);agencies should release their employees for training during this period, and from previous experiences any period longer than this the participants will lose focus.
- Priority training areas for young professionals as recommended during the consultation meeting are given in Table 4.1 together with the rationale behind selection and the subcomponents of the themes.

Table 4.1: Top Three Training Needs For Starting Professionals As Identified By Stakeholders In The Consultation Workshop

Rank	Training Theme	Rationale	Sub components
1	Data Acquisition in Water Resources Management	Hydrological information is essential for planning design and management of water resources systems. Deterioration of monitoring networks, lack of data and poor quality of existing data are major constraints. Open sources data provide a good opportunity for data acquisition. There is lack of capacity in this area and training of professionals is needed.	<ul style="list-style-type: none"> a. Surface and groundwater monitoring networks b. RS/GIS and open source data c. Data management, storage, Preservation, Dissemination and Utilization. d. Data analysis and interpretation.
2	Water Sanitation and Hygiene.	Diseases arising from poor quality water and sanitation are major causes of mortality worldwide. Diseases burden could be effectively reduced by improving water, sanitation and hygiene. Historical background show that improving water, sanitation and hygiene is most effective than medical intervention.	<ul style="list-style-type: none"> a. Water, sanitation and hygiene (WASH) concept. b. Planning, design, operation and maintenance of water supply systems. c. Drinking water quality standards and analysis methods. d. Low cost wastewater treatment technologies. e. On-site waste water treatment systems and pollution control. f. Waste water treatment and reuse.
3	Integrated Water Resources Management	Traditionally, water management in Sudan is taking place in a rather uncoordinated and fragmented institutional approach. Integrated Water Resources Management (IWRM), as a more flexible and comprehensive approach, is now widely recognized as the most strategic approach and preferred way to deal with the various challenges of water resources management. WRC as a multi-disciplinary capacity building institute, training and capacity building in IWRM is one of the priority areas of the WRC. The basic knowledge on IWRM will be disseminated to young professionals	<ul style="list-style-type: none"> IWRM Concept IWRM and Social Dimension IWRM and Economics IWRM and Ecosystems River Basin Planning and Management Water Law and Policy Water Policy and Regulation Stakeholder Participation Water diplomacy and cooperation. Water governance

4.2.2 Training Needs Assessment for Technicians

- **Definition of targeted group:** Technicians are those who have an academic degree of 2-3 years after high school regardless of their age and rank in their agencies (either early or mid-career), however, those who satisfy the education requirements in this definition but are in high management levels are excluded from this definition.
- Challenges facing the training of technicians in the water sector in Sudan include:
 - Lack of training institutions that provides high quality training for technicians.
 - Lack of national policy regarding employment of technicians; examples of this includes strict job requirements where applicants are required to have a high university degree in order to be employed as well as low salaries for technicians.
 - Lack of legislations.
 - Lack of capacity building policies and programs.
- Suggested institutions to host training modules for technicians in the water sector:
 - Engineering Training Unit, Faculty of Engineering, University of Khartoum.
 - Training Center of UNESCO Chair in Water Resources in Omdurman Islamic University.
 - Training Center of the Water National Corporation (NWC).
 - Water Research Center at University of Khartoum.
 - Training Center at Hydraulic Research Station at the Ministry of Water Resources and Electricity.
 - Department of Civil Engineering, Sudan University of Science and Technology.
- Priority training areas for technicians as recommended during the consultation meeting are given in Table 4.2 together with the rationale behind selection and the subcomponents of the themes.

Table 4.2 :Top Three Training Needs For Technicians In The Water Sector Field.

Rank	Training Theme	Rationale	Sub components
1	Data Acquisition in surface and ground water.	Availability of information is of great importance to water resources management and decision-making, therefore, accurate measurement and sampling techniques are highly needed.	<ul style="list-style-type: none"> a. Flow and velocity measurement. b. Suspended and bed load sediment measurement. c. Bathymetric survey. d. Water quality measurement. e. Groundwater water table. f. Well pumping test.
2	Construction and Installation, Operation and Maintenance in Urban surface drainage.	Current situation of storm water drainage structures in major cities in Sudan has deteriorated significantly. Thus, the importance of training of technicians and capacity building in construction and operation of urban surface drainage structures and networks.	<ul style="list-style-type: none"> a. Drainage channels. b. Road drainage. c. Pumping stations. d. Intake structures in water supply systems. e. Borehole construction, Screens and pumps. f. Water harvesting structures maintenance.
3	Water quality monitoring and analysis.	Ensuring that water quality is in accordance to international standards is of great importance to attain high standards of health. Thus, technicians have to be highly qualified in water quality sampling and testing both in the field and laboratory.	<ul style="list-style-type: none"> a. Field measurement and sampling techniques. b. Preservation and transportation of samples. c. Laboratory tests.

4.3 Recommendations and the way forward

4.3.1 Recommendations

The main recommendation of the consultation workshop, in addition to the key training areas identified for each targeted group, is that there are similarities in the areas of training for both targeted groups. Therefore, it is important to identify within each thematic training area, the components that belong to professionals and engineers on one hand, and technicians on the other hand.

Most participants also proposed that training programs might consist of two parts, one for technicians and the second part for professionals. Overall, coordinating the organization of training programs for both targeted groups is very essential to develop effective training programs that address the needs of Sudan in the water sector.

4.3.2 The way forward

- Additional consultation will be conducted with as many stakeholders as possible to ensure wide participation. The following steps will consist of more interviews, visits and questionnaires to identify additional training gaps and challenges regarding young professionals and technicians in the water sector. While conducting these steps, it will be taken into consideration to involve experts in the water sector from agencies and institutes that were underrepresented in the consultation workshop.
- Following additional consultation, the available database will be analyzed extensively to develop a framework for Human Capacity Development (HCD) in the water sector in Sudan, the framework will consist of:
 - Design of training and educational contents.
 - Identification of learning objectives.
 - Identification of expected outcomes.
 - Methods of implementation and time framework.
 - Recommended training institutions.
 - Development of learning material
- The subsequent step and arguably the most important are to design a monitoring and evaluation framework. The framework is intended to be effective in assessing the progress in training programs relative to the objectives of the project. Issues that will be discussed thoroughly include identifying methods of monitoring as well as specification of progress indicators.

Figure 4.1 show the progress of the overall assignment.

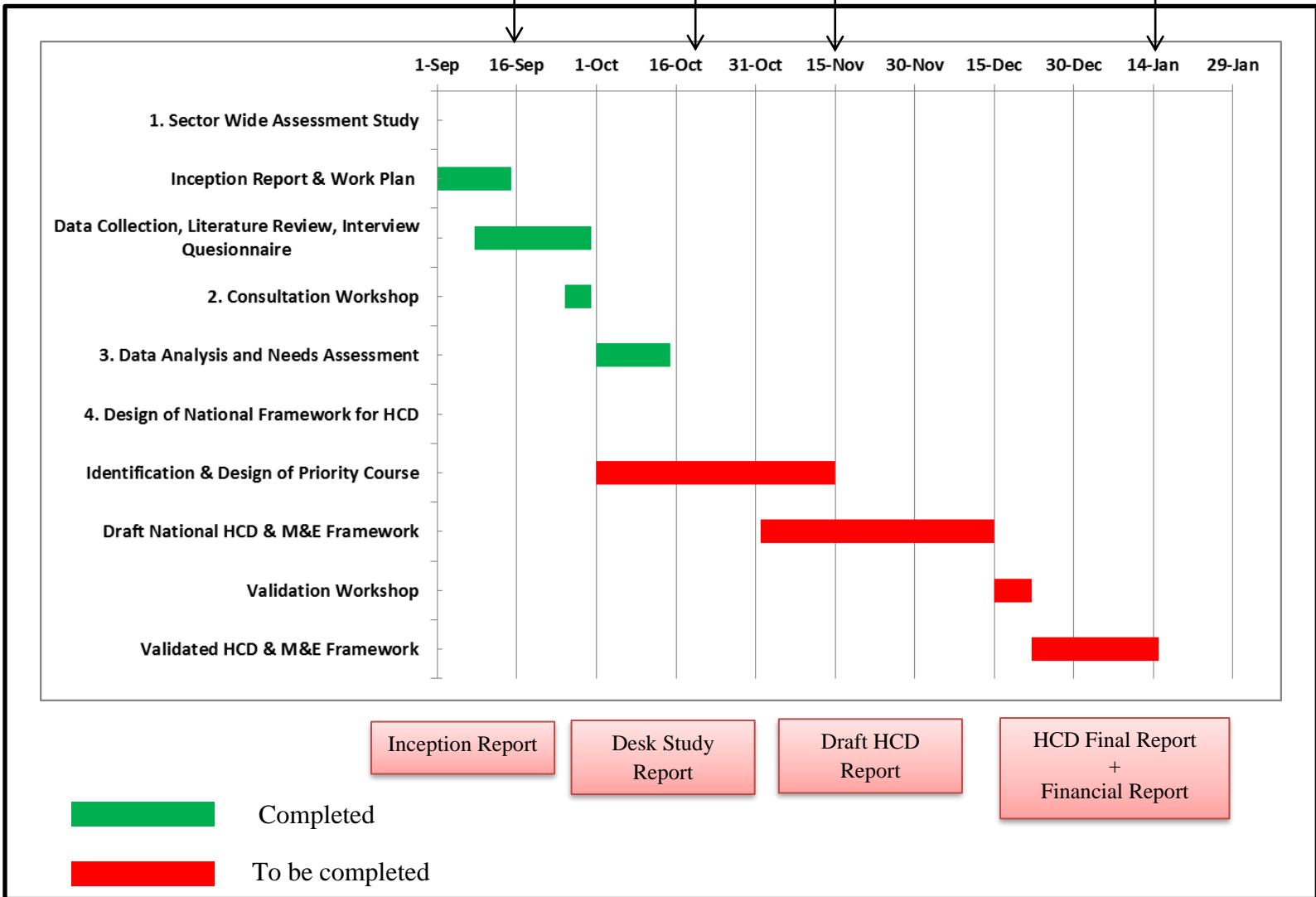


Figure 4.1 Progress of the Overall Assignment

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Annex 1: Meeting Agenda

Time	Topic	Convener
9:00 – 10:00	<ol style="list-style-type: none"> 1. Introduction to AU-NEPAD CoE and ACEWATER2 project. 2. HCD Objectives and activities. 3. Previous efforts for HCD needs assessment and main findings. 	Prof Gamal Abdo
10:00 – 11:00	Discussion	All
11:00 – 11:15	Coffee break	All
11:15 – 12:30	Group work Group1: Starting professional capacity development Priorities Group 2: Technicians capacity development priorities	All
12:30 – 13:00	Group Presentations	Group leaders
13:00 – 14:00	Discussion, refinement of priorities and Wrap up	All
14:00	Lunch	All

Annex 2: List of participants

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Annex 3: Group Formulation

GROUP (A)

Starting Professions Capacity Development Needs:

1. Kamaleldin E. Bashar (Group Leader)
2. Prof. Gamal M. Abdo
3. Dr. Ishraga S. Osman
4. Dr. Babiker I. Barsi
5. Dr. Elfadil A. Azrag
6. Prof. Abdeen M. Ali
7. Dr. Mohammed Ombadi
8. Dr. Zakeeia Mohammed
9. Dr. Adil Mohamed Elkhidir
10. Dr. Maha Abdelgadir
11. Ust. Walid Hashim

GROUP (B)

Technicians Capacity Development Needs:

1. Dr. Hamid Omer Ali (Group Leader)
2. Abdelrahman Saghrour
3. Dr. Mohamed Ahmed Adam Kadam
4. Dr. Dina Mohd. Belal
5. Eatidal Elrayah Malik
6. Atif Ahmed Abdallah
7. Dr. Elsadig Sharfi
8. Eng. Abdelgadir Abdin
9. Ahmed Eltayeb Alhassan
10. Dr. Abdallah M.T Shigidi
11. Azza Nabeil Babikir

Annex 4: Documentation Photographs



Consultation Meeting



Consultation Meeting: Group Work