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Document Sheet

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The purpose of the technical report series is to support informed stakeholder dialogue and decision making in order to achieve sustainable socio-economic development through equitable utilization of, and benefit from, the shared Nile Basin water resources.

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The Nile Basin Initiative (NBI) Secretariat (Nile-Sec) had conducted a Strategic Water Resources Analysis (SWRA) in 2015 with the aim of developing various sustainable options for satisfying the growing water needs in the Nile riparian countries, and subsequently to mitigate current and future water stress. The Nile-Sec has recently identified data gaps in its previous SWRA study, particularly due to the lack of integration economic modeling of water use to assess the value of irrigation water. A limitation of the SWRA study was that the impact of increased water productivity on food security and water use was not analyzed across the basin. Furthermore, the SWRA assessment did not analyze the impact of optimal planning of cropping patterns on specific climate and soil conditions.

This second phase study was commissioned with the objective of refining the 2015 estimates of agricultural water demand/use and projections. It is envisaged that this study will support sustainable and efficient investment planning to meet the growing water demand in line with the Nile-Sec's plan. The phase II study consists of six components. This report refers to Component-I of this phase II project: 'Contribute to improving baseline irrigation water demand and actual use'. This component was required to review the data and results of irrigation water demands estimation from the first phase of the SWRA study and identify areas for further refinement and improvement. This report aims to inform agricultural water management policies by presenting water saving options, such as adoption of improved irrigation technologies and optimization of cropping patterns across the basin among others. The compilation of the baseline database was based on a desk-based review of secondary information. The sources of information include existing NBI data, master plan of member countries, study documents and expert inputs.

The SWRA 2015 Phase-I study in perspective

- **Area irrigated and equipped for irrigation**: The 2015 study shows that about 5.4 million hectares were equipped for irrigation in the Nile Basin. The figures were supposed to be larger than what was reported in the Food and Agriculture Organization (FAO) Aquastat (2016), which represents data of earlier years. However, figures presented in the 2015 study baseline dataset are not consistent with the FAO Aquastat (2016) dataset. The former under-reported 'area equipped for irrigation' for Egypt, Ethiopia, Kenya, and Tanzania. There is also a discrepancy in the value of cropped area between the two datasets. The possible causes for the discrepancy are the following: (i) the 2015 phase-I report is limited to the Nile Basin (NB) whereas the Aquastat data presents national level data (including areas not geographically contained within the NB) and (ii) estimates might differ because of different reporting procedures and prevailing poor data management systems in the country. The latter challenge reflects capacity constraints in the area of information management.

- **Crop parameters**: The crop growth parameters and the method used to estimate crop water requirement in the phase-1 report were consistent with the information in FAO's technical guidelines, the world's most commonly used approach when conducing feasibility studies and management of irrigation schemes. The cropping pattern data were gathered from previous country-specific studies, and thus are applicable to the agro-ecologies and practices of the respective schemes.

- **Irrigation technology**: The Phase-I baseline data (2015) rightly identified that most of the irrigation schemes in the Nile Basin use surface irrigation methods. It is noted that Egypt is home to a higher proportion of sprinkler and drip irrigation, respectively, amounting to 5% and 6% of the area equipped for irrigation (which was based on Aquastat, 2009). The Phase-I baseline report assumed that all canals were unlined; however, consultations made with practitioners in the field suggest that there is a growing trend in lining of canals. The problem is that the countries do not keep record of the canal improvements, the associated water savings and the resultant impact on crop production.

- **Irrigation efficiency**: The phase I baseline study of 2015 rightly adopted realistic irrigation efficiencies consistent with FAO publications[1 2] in estimating the baseline crop water requirements for all countries, except Sudan. Caution was taken not to overestimate the magnitude of crop water requirements by avoiding allowance for leaching requirement. This assumes that the inevitable inefficiencies would be sufficient to offset the leaching requirement, which is in line with existing technical guidelines. However, the irrigation efficiency values adopted for Sudan in the Phase-I baseline study appear to be on the upper limit. According to FAO publications, an upper limit to the conveyance efficiency values should only be assigned to well-maintained canals. However, this is not the case with the canal conditions and surface irrigation management in Sudan as explained in more detail in subsequent sections. The canals in Sudan are characterized by siltation and weed growth; and the surface irrigation management is rated as poor according to previous studies. Poorly maintained canals retard water flow and causes spillage and/or high evaporation losses. This statement is a challenge to the claim for having high irrigation efficiency in Sudan.

Summary of findings in Phase- II (2018) Baseline Report

This report contains a mix of datasets up to 2018. With this in mind, the data in this report is referred to as '2018 Baseline Data' with reference to the year data was collected, where available. However, the actual base year for each dataset is indicated whenever quoted.

- **Area irrigated and equipped for irrigation**: According to documents published until 2018, the total area irrigated (cropped) and equipped for irrigation in the Nile Basin (NB) is about 8.53 and 6.6 million ha, respectively. The total cropped and equipped area in the NB increased by 34.2% and 22.2%, respectively, compared to the 2015 baseline data. The cropped area in Egypt is 174% of the area equipped for irrigation, implying that about 74% of the area is used for at least two or three croppings per year. In Ethiopia, Kenya, Sudan and Tanzania, the irrigated (cropped) area is less than the area equipped for irrigation due to a mismatch between the available water supply and the demand.
- **Crop parameters:** This study has gathered new cropping pattern information for some schemes in Ethiopia, South Sudan and Sudan. For all other countries, data compiled in the 2015 baseline dataset could still serve its purpose. A review showed that crop parameters used for the estimation of crop-water requirements in all countries were derived from FAO publications and not from local studies. Recent information on crop growth parameters is identified for Egypt. The data show slight differences in planting dates and crop coefficients as compared to the Phase-I baseline data.
- **Irrigation technology:** Irrigation technology in this paper was defined as the use of infrastructure and/or practice aiming to improve land and water productivity. Egypt is the only country engaged in the application of improved irrigation technologies, such as pressurized irrigation, at a massive scale. There are also trends of canal lining in some of the countries according to consulted practitioners. Such trends of canal lining have significant implications for the enhancement of water use efficiency. However, documented evidence on the magnitude of the ongoing canal lining work was not available. It is recommended that the location and magnitude of canal lining is continuously updated by the respective countries.
- **Irrigation efficiency**: Research on irrigation efficiency and the subsequent investment on water saving interventions have been implemented at a massive scale in Egypt, compared to the other riparian countries. The success is attributed to the concerted effort of the government, research and academic institutions. However, in the other NB countries, the agenda for irrigation efficiency improvement was intermittent and limited to academic and research communities with little or no participation of other key stakeholders. Moreover, the research is focused on adaptive trials of existing technologies already in practice elsewhere in the world. Consequently, many research outcomes are often shelved. There is little evidence showing the attempts made to quantify irrigation efficiencies in some countries. Where conducted, studies reveal irrigation efficiencies close to those noted in FAO publications. Moreover, reviewed feasibility studies and design documents show that schemes are designed using irrigation efficiency values recommended in FAO publications.

[1] FAO 1989

[2] Savva, A.P; Frenken, K. 2002

Recommendation and concluding remarks

Egypt is noted to be progressing in the right direction in promoting water saving technologies. This is attributed to the concerted effort of policymakers, practitioners and research institutions. Such effective institutional coordination must be considered as a best practice to be replicated in the other riparian countries. Therefore, the benchmarking[3] study under Component-5 of this assignment can be used as a vital entry point to coordinate with relevant institutions, to join planning efforts, implementation and evaluation of improvement works on existing irrigation schemes. Moreover, the forthcoming benchmarking exercise must be planned and implemented in schemes having the potential to yield maximum impact by influencing many other schemes suffering from poor performance.

The Nile Basin countries do not have sufficient documented information in the area of irrigation and associated fields. One of the key tasks of the Nile-Sec is helping member countries by devising strategies aiming to balance the available water in the basin with the ever-increasing irrigation water demand. To this effect, the Nile-Sec should initiate a program to enhance the capacity of relevant institutions of member countries in the area of information collection, storage and sharing.

[3] Component 5: Develop a basin-wide approach for benchmarking irrigated agriculture performance

1. INTRODUCTION

1.1 Overview

The Nile Basin (NB) is shared by 11 countries and is home to a total population of over 257 million people. The total population is estimated at 487.3 million out of which 20.3% (99.4 million) and 18.77% (91.5 million) people live in Ethiopia and Egypt, respectively (NBI 2016). The average annual population growth rates between 2010 and 2015 ranged from 1.6% in Egypt to 2.7% in Ethiopia and 3.3% in Uganda[4]. Fast-growing population could exacerbate the prevailing water stress if current land and water management practices persist. As such, land degradation and the resultant sedimentation of reservoirs are expected to increase while natural groundwater recharge and stream flow rates are expected to decline. However, population growth also provides opportunities in terms of workforce for economic development and local market. At present, more than 75% of the labor force is engaged in subsistence agriculture and about 40% of the population lives below a poverty line of US$1.25 per day[5]. Hence, the NB countries are expected to expand irrigated agriculture to improve livelihoods, food security and economic growth in the region.

The NB is endowed with renewable mean annual surface water (long term average annual surface water) of 92 – 93 billion m^3 (BCM); the contributing subbasins are: 55 BCM from Blue Nile (including 5 BMC contribution from Dinder and Rahad rivers), 12 BCM is from Tekeze-Atbara, and 25 - 26 BCM from White Nile (measured just upstream of the White-Blue Nile confluence – out of which 12 – 13 BCM is from Baro-Akobo-Sobat subbasin)[6]. The NB countries are also endowed with abundant groundwater resources stored in 12 transboundary aquifers covering an area of 4,489,458 km^2 (out of which 30% is located in the Nile Basin). Despite the abundance of water, the NB is on the verge of facing critical water shortages. The annual water requirement of the 6.4 million ha irrigated in 2011 was noted by two different sources as 85 BMC[7] and 84 BMC[8], respectively; the latter estimate is a sum of 73 BMC (87%) gravity irrigation schemes and 11 BMC (13%) for schemes with pressurized systems, mostly in Egypt. The annual irrigation water requirement was projected to increase to 123 BMC, assuming an additional irrigated area of 3.8 million ha is developed by 2050 and the prevailing poor irrigation infrastructure condition persists (i.e., no improvements in irrigation efficiency)[9]. The projected water demand is more than the current annual surface water yields of the Nile Basin; hence, posing a critical challenge for the NB countries. The contribution of groundwater in minimizing the anticipated water deficit is unknown. Under different irrigation efficiency improvement scenarios, the above study predicted the NB would remain in a state of perpetual water deficiency by a magnitude of 5 to 29 BMC per year. This calls for urgent and continuous efforts to improve water conservation and water use efficiencies through the adoption of improved practices and technologies[10]. Technical assistance and extension to disseminate practices promoting water conservation and efficient water use can significantly mitigate future water stress, while increasing agricultural productivity and farm income.

Accordingly, the Nile Secretariat (Nile-Sec) intends to support member countries by developing options for water saving, such as measures for the adoption of improved irrigation technologies and optimization of cropping patterns across the basin. To achieve this, an up to date baseline assessment of existing irrigation infrastructure, cropping program, irrigation technologies and efficiencies are required.

The NBI-Sec had issued a baseline data report in 2015 that was compiled from documents published between 1998 and 2014. Documents published up to 2018 were used to verify and complement previous baseline dataset. Where data could not be verified or no recent data were available, NBI's 2015 baseline data was adopted.

[4] NBI 2016.
[5] NBI 2016
[6] NBI 2016.
[7] NBI 2016.
[8] Multsch, S.; Elshamy, M.E.; Bataresh, S.; Seid, A.H.; Frede, H.G.; Breuer, L. 2017
[9] Multsch, S.; Elshamy, M.E.; Bataresh, S.; Seid, A.H.; Frede, H.G.; Breuer, L. 2017
[10] Multsch, S.; Elshamy, M.E.; Bataresh, S.; Seid, A.H.; Frede, H.G.; Breuer, L. 2017

1.2 Scope of this Assignment

The NBI Secretariat (Nile-Sec) conducted a Strategic Water Resources Analysis (SWRA) in 2015 with the aim of developing various sustainable options for satisfying the growing water needs in the Nile riparian countries, and subsequently to mitigate the current and projected water stress. The Nile-Sec identified data gaps in its previous SWRA study, particularly in relation to the lack of integration of economic modeling of water use to assess the value of irrigation water. A limitation of the SWRS study was that the impact of increased water productivity on food security and water use was not analyzed across the basin. The assessment did not analyze the impact of optimal planning of cropping patterns on specific climate and soil conditions. Therefore, this study was commissioned to refine current estimates of agricultural water demand/use and projections. It is envisaged that the study will support sustainable and efficient investment planning to meet the growing water demand in line with the Nile-Sec plan. This report aims to inform agricultural water management policies by presenting water saving options, such as improved irrigation technologies and optimization of cropping patterns across the basin among others.

This report refers to Component 1 of the project: 'Contribute to improving baseline irrigation water demand and actual use'. This component reviewed data of irrigation water demand estimates from the first phase of the SWRA and identified areas for further refinement and improvement. The sources of information were existing NBI data, master plans of member countries, study documents, and expert inputs. The activities carried out as part of Component 1 were:

i. Together with the NBI review the database, modeling approach and estimates of irrigation water demands and identified areas of further refinement and improvement;

ii. Refine NBI's data on existing area equipped for irrigation, cropped area, irrigation technologies in irrigation schemes) and estimates of irrigation efficiencies;

iii. Refine NBI's crop database by updating the cropping calendar based on agro-ecological zones, crop characteristics and corresponding crop water requirement;

iv. Review and provide recommendations to update data on cropping patterns for the various irrigation schemes in the NBI's database;

v. Submit the improved database to the NBI to update the NB water resources model and thereby refine estimates of current irrigation water demand and actual use.

vi. Review the updated estimates on irrigation water requirements with the NBI team;

vii. Produce a technical report on existing irrigation technologies, irrigation efficiencies, crops and cropping patterns in irrigated agriculture in the Nile Basin;

viii. Facilitate a regional consultation workshop with agricultural experts from the Nile Basin to validate the updated databases and set future directions with respect to irrigated agriculture development. The aforementioned workshop was held from February 23–25,2019 in Kigali, Rwanda and the feedback obtained from the participants is incorporated in this report.

1.3 Linkages with other Components

This component (Component-1) aimed at: (i) reviewing and updating baseline data from the first phase of the strategic water resources analysis of the NBI and (ii) identifying of areas for further refinement and improvement. The data and results generated under Component-1 are fed into Component-2: 'Projection of Irrigation Water Demand'. Component-4: 'Economic Value of Water for Irrigation' and Component-5: 'Irrigation Benchmarking'. All components will deliver their own outputs based on the data received from this component (Component-1) and through additional data collection, assumptions and analysis. Component-2 would integrate the data inputs and subsequently generate and describe potential scenarios for improvements in cropping patterns, irrigation, and water use efficiencies. The output data on optimum water saving options (Component-3) will guide the irrigation benchmarking approach (Component-5) as well as contribute to the preparation of the policy document.

1.4 Structure of the Document

The report is structured around five main chapters. Chapter one has presented background information of the project and scope of the assignment. Chapter two describes data gaps and related uncertainties in the Nile Basin. The third chapter presents an overview of the Phase-I baseline data.

Chapter four presents phase-II baseline data – the key output of this assignment. Chapter four is a collection of tables supported by explanatory notes. The information can be used as input to the estimation of current and projected agricultural water demand. The report ends in chapter five by presenting recommendations for upgrading the Nile Basin countries' capacity in the documentation of information on irrigation management. Issues to be considered in planning the irrigation benchmarking approach are also presented. Details of the country-specific datasets for each of the relevant parameters are presented in the annexes. The relevant tables are also presented in excel format in a separate attachment.

2. DATA GAPS AND UNCERTAINTIES IN THE NILE BASIN

This assignment involved updating NBI's 2015 baseline data through a desk-based review of secondary information. In due course of the assignment, it was observed that the relevant institutions lack sufficient documented information in the area of irrigation and associated fields. The master plans for some countries were outdated at the time of this study and, as such, lacked relevant updated information compared to the 2015 inventory.

Hence, in this study information available at NBI (Nile Basin Initiative), IWMI (International Water Management Institute), new master plan studies, on-line sources, and limited study documents from some of the countries were used. Where possible, consultations were held with staff from local agencies to get new information or validate existing data as in-depth scoping missions to each country was outside the scope of this study. For example, in Ethiopia consultations were made with officers of Abay (Blue Nile) Basin Authority, engineers in the Ministry of Water, Irrigation and Energy, Bureau of Agriculture in Tigray (Tekeze Subbasin), etc. Similarly, in Uganda, Sudan and South Sudan current and ex-officials and experts of water and irrigation institutions were consulted.

Despite the abovementioned limitations, the database, presented in this report, provides a consolidated update of the most recent available information on the Nile Basin since 2015. The verification and addition of most recent available information (up to 2018) enables the revision of current and projection of future water demands in the Nile Basin.

3. SUMMARY OF PHASE-I BASELINE DATA

a. Phase-I (2015) Irrigation Infrastructure Data

The Phase-I baseline study was based on a desk-based review of secondary information from 1998 to 2014. These documents included: previous NBI works, national plans and published materials, including FAO's Aquastat dataset of 2009. The study also used data obtained from NB countries. The Phase-I (2015) baseline showed that about 5.4 million hectares were equipped for irrigation in the Nile Basin.

b. Phase-I (2015) Crops and Cropping Pattern Data

The crop growth parameters and the method used for crop water requirement estimations in the phase-1 report were directly adopted from FAO technical guidelines, which is a commonly used approach. Data on cropping patterns for all countries were gathered from previous country-specific studies and, therefore, are applicable to the agro-ecologies and practices of the respective schemes.

c. Phase-I (2015) Irrigation Technology Data

The Phase-I baseline data (2015) rightly identified that most of the irrigation schemes in the Nile Basin use surface irrigation methods. Its brief discussion on irrigation technology focused only on pressurized irrigation. It is noted that Egypt is home to a higher proportion of irrigated area under sprinkler and drip irrigation amounting to 5% and 6%, respectively (which is based on Aquastat 2009). In Ethiopia, the area irrigated using sprinkler irrigation was reported as 2% (or 2,680 ha) of the then 134,000 ha total irrigated area. However, Ethiopia had already one scheme (Fincha Sugar Estate) equipped with sprinkler irrigation covering an area of 20,145 ha in 2014/15. The other two countries practicing pressurized irrigation noted in the Phase-I report were Kenya and Uganda; whereas Sudan with the second highest area under pressurized irrigation was not recognized.

The Phase-I baseline report assumed that all canals were unlined; however, consultations made with practitioners in the field suggest that there is a growing trend in lining of canals. The problem is that the countries do not keep record of the canal improvement works, the associated water savings and the resultant impact on crop production.

d. Phase-I (2015) Irrigation Efficiencies Data

The NBI baseline study of 2015 rightly adopted realistic irrigation efficiencies developed by the FAO in estimating the baseline crop water requirements for all countries, except Sudan. Caution was taken not to overestimate the magnitude of crop water requirement by avoiding allowance for leaching requirement. This is based on the assumption that the inevitable inefficiencies would be sufficient to offset the leaching requirement, which is in line with existing technical guidelines. Values of irrigation efficiencies adopted in the Phase-I baseline study (2015) are shown in Table 1. However, the irrigation efficiency values adopted for Sudan in the Phase-I baseline study appear to be on the upper limit; that is 68% for gravity-fed surface irrigation (which is the product of: application efficiency 80% and conveyance efficiency 85%), 75% for pumping and gravity, 76% for pumping and flooding, and 86% for pumping. According to FAO publications[11] [12], an upper limit of the conveyance efficiency values is assigned only to well-maintained canals in dug soils. However, this is not the case with the canal conditions and surface irrigation management in Sudan as explained in more detail in section 4.3.5 (c). The canals in Sudan are characterized by *siltation and weed growth* and the surface irrigation management is rated as *poor* according to previous studies[13]. Poorly maintained canal retards water flow and causes spillage and/or high evaporation losses. Besides, low infiltration capacity of the vertisol coupled with plain topography and leveled fields are conducive to stagnation of the irrigation water on the surface, the consequent of which is high loss of water by evaporation. This implies low irrigation efficiency. Crop productivity, in most schemes in Sudan, is low due to lower number of irrigation events than recommended and long distance to the water source, which results conveyance losses, waterlogging and limitations in agronomic practices[14]. These statements are challenges to the claim for having high efficiency in Sudan.

Table 1: Irrigation efficiency values adopted in the Phase I Baseline Study

Irrigation Method	Application Efficiency,%	Conveyance Efficiency, %
Surface	50 - 70	40 - 70
Sprinkler	55 - 75	60 - 90
Drip	70 - 95	70 - 95

Source: NBI baseline dataset of 2015 and reference therein

[11] FAO 1989
[12] Savva, A.P. and Frenken, K., 2002
[13] Ahmed, A.S. (nd).
[14] Adam, B.A. et.al. 2017

4. DESCRIPTION OF PHASE II BASELINE DATA

4.1 Overview

This report updated the NBI-Sec baseline data from 2015 and included verifiable data up to 2018. The phase-II baseline data, just like its predecessor, was prepared using secondary information sources from Nile-Sec, consultations, and other relevant sources up to 2018. Explanatory notes on the source and year of the dataset are presented hereunder, which also include highlights on the differences between the 2015 and current available datasets.

Debate over designating wetland agriculture as irrigated agriculture

Agricultural experts drawn from the NB countries to participate in the 2nd phase of SWRA workshop held from February 23 – 25, 2019 in Kigali, Rwanda, debated on whether or not wetland crop production system is irrigated agriculture and should be included in the database. In light of the below definitions of both systems, the recommendation is that wetland systems, though supporting agricultural production cannot be considered as irrigated agriculture and thus must not be included in the NBI water demand modeling.

Wetlands are defined as places where the land is permanently or seasonally flooded or rarely flooded but the soil remains saturated for a period long enough to support wetland plants.[15 16 17] They provide important ecosystem services and support people's livelihoods[18 19]. For centuries and in many parts of the world, they have been used to produce crops during the dry season and/or all year round with or without the help of drainage facilities.[20 21 22] The source of water is either surface water during flooding events or rising groundwater tables.

On the other hand, irrigation is defined as the application of a controlled amount of water to plants at needed intervals by means of various structures and equipment required for diverting, conveyance or application of it.[23 24 25] The conclusion is that the water utilized under wetland crop production system could have been lost even with no cultivation by evaporation, seepage and/or transpiration by wild wetland plants.

An important issue that must be linked with the abovementioned debate is the level of the NB stakeholders' knowledge of the impact of the ongoing wetland crop production system on the sustainability of the other wetland ecosystem services. The latter entails the provision of water; regulation of hazards (e.g., floods, drought, land degradation and disease); soil formation and nutrient cycling; cultural values, etc.[26] According to Article 3 of the Ramsar Convention on Wetlands[27], the signatories are required to promote conservation of wetlands integrated with plans and actions for "wise use of wetlands" so as to ensure sustainable benefits for human and the ecosystem. However, human interventions on the wetlands in the Nile Basin have been predominantly skewed towards a single ecosystem service (crop production) rather than considering the full range of the potential benefits attributable to a given wetland[28 29]. Though the wetlands are supporting millions of people for their livelihoods, many of them are not sustainably managed and yet the problem is not addressed by the NB stakeholders due to lack of adequate information on their current status and fate of existence[30 31]. Therefore, it would be imperative to protect the wetlands from further deterioration. This calls for the NB countries to assess their current wetland management systems and draw action plans in accordance with the Ramsar Convention on Wetlands. This may be preceded by updating previous studies on characterization and classification of wetlands in the NB to facilitate evidence based on dialogue among the respective countries, and reach a consensus on the restoration and sustainable management of the wetlands.

15 UNESCO 1994.
16 WWF (World Wildlife Fund) 2019.
17 The Wetlands Initiative (nd),
18 Ramsar Convention Secretariat (2014).
19 Millennium Ecosystem Assessment 2005
20 Department of the Environment 2016
21 Verhoeven, J.TA.; Setter, T.L. 2009
22 IWMI 2014
23 FAO 1997
24 Oxford Dictionary 2019
25 Encyclopedia Britannica (nd).
26 Millennium Ecosystem Assessment 2005
27 UNESCO 1994.
28 Millennium Ecosystem Assessment 2005
29 FAO SAFR 1998.
30 Rebelo, L-M.; McCartney, M.2012
31 FAO SAFR 1998.

Table 2: Irrigated area and area equipped with Infrastructure in the Nile Basin

Country	2014/15 Baseline Data Area, '000 ha Cropped	Equipped	% Area Cropped	Updated 2018 Baseline Data Area, '000 ha Cropped	Equipped	% Area Cropped
Burundi	15.0	8.7	172.0	14.9	8.8	169
DR. Congo		-	-		-	-
Egypt	5,021	3,447	145.7	6,529.6	3,823.7	171
Ethiopia	134	91	147.3	455.4	547.4	83
Kenya	20	47.8	41.8	33.2	61.3	54
Rwanda	7	7	100.0	7.7	8.9	87
South Sudan	0.2	0.5	30.0	111.3	111.3	100
Sudan	1,146.7	1,764.6		1,381.3	2,023.8	68
Tanzania	6	19.8	30.4	32.1	33.4	96
Uganda	9.7	9.7	100.0	14.7	21.2	69
Total	**6,359.5**	**5,396.1**		**8,580.2**	**6,639.8**	
% increase of area cropped and equipped compared to 2015				34.9	23	

Source: Compiled from various sources shown in the respective tables for each country; (a): NBI baseline dataset of 2015
Source of percentage area cropped compared to area equipped for irrigation: division of the former by the latter

4.2 Irrigated Land and Area Equipped for Irrigation

According to documents published until 2018, the total area irrigated (cropped) and equipped for irrigation in the Nile Basin countries is about 8.53 and 6.6 million ha, respectively (Table 2); the total cropped and equipped area increased by 34.2% and 22.2%, respectively, compared to the 2015 baseline data. Detailed data by country are presented in Annexes A-1 through A-9. The cropped area in Egypt is 174% of the area equipped for irrigation implying that about 74% of the area is used for two or three cropping per year. In Ethiopia, Kenya, Sudan and Tanzania, the area irrigated (cropped) is less than the area equipped for irrigation due to a mismatch between the available water supply and the demand.

4.2.1 Existing irrigated area in Burundi

There are no new data on area cropped or equipped for irrigation for Burundi. However, the sum of the area 'cropped' and 'equipped' was incorrectly swapped in the 2015 baseline data; thus, the corrected area irrigated (cropped) and equipped for irrigation in 2015, was 14.9 and 8.8 million ha, respectively. Moreover, the 171 ha cropped of the Muramya Scheme were inconsistently reported as 312 ha. The corrected figures for Burundi are presented in Annex A-1. Note: paddy fields on marshlands in Burundi are considered as irrigated areas because irrigation water is delivered during the dry season to grow a third crop as explained in a subsequent section.

4.2.2. Existing irrigated area in Egypt

According to annual statistical bulletin for 2015/16 published in January 2018 by a government agency[32], the total area cropped and equipped for irrigation in Egypt is about 6.59 and 3.78 million ha, respectively. The total area cropped and equipped for irrigation has increased by 1.57 million ha (or 31%) and 0.33 million ha (or 10%), respectively, compared with the 2015 baseline report. Detailed information is presented in Annex A-2 and also in a spreadsheet annexed separately to this report.

Remark on the 2015 baseline data

The spreadsheet annexed to the 2015 baseline main report shows the cropped area for Egypt as 5.47 million ha – overstating the then cropped area by 0.45 million ha. The source of error was associated with two schemes (governorate), namely Cairo (Al Qahirah District) and Elsalam Canal East (Shamal Sina District). According to the indicated spreadsheet, the percentages of the cropped areas to areas equipped for irrigation in the two schemes equals to 1,176% and 723%, respectively. However, the cropped areas of Cairo and Elsalam Canal East schemes were rightly reported as 8,105 ha and 41,834 ha, respectively, in the 2015 baseline main report; and the respective percentages of the

[32] Central Agency for Public Mobilization and Statistics (CAPMAS), 2018

cropped areas to areas equipped for irrigation are equal to 117% and 72%.

4.2.3 Existing irrigated area in Ethiopia

Irrigation schemes in Ethiopia are categorized by size as large scale (greater than 3,000 ha), medium scale (200 – 3,000 ha) and small scale, sometimes referred to as smallholder (less than 200 ha per scheme)[33]. Under the medium and large scale category, the total area cropped and equipped for irrigation amounts to 66,278 ha and 66,964 ha, respectively[34]. According to the line ministries, smallholder irrigated area in Ethiopia (within and outside the NB) had increased from 197,250 ha in 1998[35] to 853,000 ha in 2009/10[36] and to 2.3 million ha in 2014/15[37]. However, the latter figure is highly exaggerated because (i) many irrigation schemes are fully or partially nonfunctional[38] (Table 3) and (ii) there are indications of double counting according to consultations held in the country. The most recent data on irrigated area reported by line government departments were found to be inconsistent. For example, the 2016 irrigated area reported in Amhara and Tigray (both predominantly within the Nile Basin) was 859,250 ha and 233,000 ha[39], respectively. No verification was found for the Amhara Region data; but Tigray Bureau of Agriculture conducted GPS-assisted field measurement of Tigray's irrigated fields in 2017/18 and found out that the actual irrigated area was 50,083 ha[40] (or 21.5% of what was reported the previous year) from which 37,976 ha is within Tekeze-Mereb subbasin, which is part of the NB. The figure obtained from Tigray Bureau of Agriculture is consistent with the findings of International Water Management Institute (IWMI) as explained in subsequent paragraphs.

Cognizant of the abovementioned limitations, the IWMI undertook a satellite based estimation of irrigated areas in Ethiopia for 2015 in January 2018, and found out that the total irrigated area in the Nile Basin part of the country is equal to 489,000 ha. The IWMI used Landsat 2015/2016 and Modis NDVI to map irrigated and rain-fed areas. Methodologies such as analysis of seasonality, Fourier analysis, time lagged regression, refinement using moisture status were applied. The IWMI's estimation of irrigated area almost matches with that of a recent (2018) study[41] (i.e., 455,421 ha), which was based on a combination of Google and GPS based measurements. Details of the information compiled are presented in Annex A-3. Apart from the abovementioned information, realistic scheme-wise disaggregated data on 'irrigated area' and 'equipped area' were not available. Thus, the 'area equipped for irrigation' for the scattered schemes in Ethiopia was estimated indirectly, assuming that the cropped (irrigated) area is 81% of the equipped area (Annex A-3). This assumption stems from the fact that the average irrigation cropping intensity (number of crops by irrigation per year) in a number of schemes is 81 – 143%[42]; where the lowest figure indicates that on average 19% of equipped area of 'functional' schemes is not cropped and the upper limit indicates that some

Table 3: Indications on the status of irrigation schemes in five regions of Ethiopia

Region	Performing Well, %	Performing below Capacity, %	Non-functioning, %
Tigray	70	20	10
Oromia	15	55	30
SNNP(**)	59	31	10
Amhara	91	8	1
Gambella	15	55	30

Source: MOANR; MOWIE; ATA. 2016. (Draft) National Smallholder Irrigation and Drainage Strategy. Ethiopia

Note: The table is reportedly based on data from regional officers with no field verification. It would have been more informative if the percentage was accompanied by irrigated area.

(**): SNNP = South Nations, Nationalities and People Region

[33] Awulachew, S. B.; Yilma, A. D.; Loulseged, M.; Loiskandl, W.; Ayana, M..; Alamirew, T. 2007
[34] Abay Basin Authority, Bahrdar, Ethiopia
[35] MOWR 2001.
[36] MOFED 2010.
[37] NPC (National Planning Commission) 2016.
[38] MOANR; MOWIE; ATA. 2016.
[39] FDRE, Federal Policy Study and Research Center and Addis Ababa Technology Institute, 2017
[40] Based on direct communication with the Tigray Bureau of Agriculture
[41] GIRDC 2018

schemes are able to have a second cropping by irrigation on 43% of the area equipped with infrastructure.

The abovementioned assumption on the proportion of the area cropped (irrigated) to equipped for irrigation can be considered as the upper limit because, as indicated in Table 3, a number of irrigation schemes are noted to perform below[43] design capacity, primarily due to the reduction of stream flow and well- yield and sedimentation of reservoirs. The indicated dry season stream flow reduction is among the salient features of the entire basin. It is apparent that the Blue Nile is highly seasonal with about 70% of its flow occurring in the months July – September. The other major tributaries of the Nile River (Tekeze, and Baro Akobo) are also characterized by high seasonality with peak flow occurring between July and August[44].

Taking the seasonality of the stream flow into account, the construction of reservoir dams is believed to have some contribution to the promotion of irrigated agriculture in Ethiopia. The number of *small and medium scale reservoir dams* constructed in the country during the last four decades is about 150[45] [46]. However, reports[47] reveal that only few of the existing dams are in a satisfactory condition and most of them are either operating below their design capacity or nonfunctional, mainly due to untimely sedimentation[48], seepage, and low catchment yield. The untimely heavy reservoir sedimentation is attributed to the human activity in the catchments, because the livelihood of the rural population is entirely dependent on the land resources.

4.2.4 Existing irrigated area in Kenya

The 2015 NBI irrigation database for Kenya consists of 130 schemes with a respective irrigated and equipped area of 20,057 ha and 47,483 ha, respectively. The 2018 updated number of schemes in the NB is 138 with the total cropped and equipped area of 31,168 ha and 58,614 ha, respectively (Annex A-4)[49].

4.2.5 Existing irrigated area in Rwanda

The updated irrigated (cropped) area in the Nile Basin part of Rwanda is 7,698 ha (Annex A-5) as compared to 7,053 ha in 2015. As indicated above, out of the total 26 irrigation schemes, 13 schemes (i.e., 4,627 ha out of 7,698 ha or 60%) are marshland-based schemes used for growing rice over two seasons in a year (locally called season A and season B), and then in the dry season (called season C) for producing mostly vegetables. The marshland-based schemes are equipped with canal infrastructure of moderate investment costs[50] and thus are considered in this paper as irrigated areas.

4.2.6 Existing irrigated area in South Sudan

A total of 111,355 ha in South Sudan are equipped with irrigation infrastructure and also fully under irrigation (production)[51] as of 2018 (Annex A-6). It is to be recalled that the 2015 NBI database for South Sudan consists of only one scheme with the cropped and equipped area of 150 ha and 500 ha, respectively.

4.2.7 Existing irrigated area in Sudan

The total number of schemes in Sudan remains the same at 24 as compared to the 2015 NBI database. However, the cropped and area equipped for irrigation has increased to 1,271,700 ha and 2,049,245 ha respectively[52], as shown in Table 4 and in Annex A-7.

4.2.8 Existing irrigated area in Tanzania

The 2015 NBI irrigation database for Tanzania consists of 65 schemes with cropped and equipped area of 6,464 ha and 19,753 ha, respectively. The

[42] Agide, Z. et al. 2016
[43] MOANR; MOWIE; ATA,.2016.
[44] NBI 2016.
[45] FDRE Federal Policy Study and Research Center and Addis Ababa Technology Institute, 2017
[46] Woldearegay, K.; Van Steenbergen, F. 2015
[47] Baert, R. 2011
[48] Ermias, A.; Solomon, A; Alemu, E. (no date)
[49] Source: NBI baseline dataset of 2015 with additional data from Kenyan participants of the 2nd Phase of SWRA Workshop held from February 23 – 25,, 2019 in Kigali, Rwanda
[50] ICRAF (World Agroforestry Center) et.al., 2010.
[51] Compiled from different sources: (a) Ministry of Irrigation (1979). Nile Waters Study, Volume 3, Supporting report IV Irrigation; (b) MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan. (2015). PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN (IDMP) IN THE REPUBLIC OF SOUTH SUDAN. FINAL REPORT (ANNEXES, PART I); (c) Dr. Ahmed A. Kabo. White Nile Pump Schemes Group-ing. Ministry of Irrigation and Water Resources - Sudan. Personal communication
[52] compiled from different sources:
(a). Ministry of Irrigation -Sudan (1979). Nile Waters Study, Volume 3, Supporting report IV Irrigation, page 2 - 25
(b). Ministry of Planning-Sudan (1980). New Halfa Rehabilitation Project Phase II. Volume 1: Support annex 1 - 8, pages 12 - 15
(c). Personal communication with Ahmed, T.M. on Abu Naama Scheme.

Table 4: Data of area cropped and equipped in Sudan in 2018 as compared to 2015

Year	Cropped, ha	Equipped, ha
2015 (NBI Data)	1,144,843	1,760,344
2018 (updated)	1,381,337	2,023,837

2018 data show a total of 127 schemes with a total cropped and equipped area of 32,974 ha and 26,127 ha, respectively (Annex A-8), which is based on the National Irrigation Master Plan (2018) of Tanzania.

4.2.9 Existing irrigated area in Uganda

The 2015 baseline data shows that the irrigated (cropped) and area equipped for irrigation in Uganda were the same at 9,700 ha. The updated (2018) irrigated and equipped area in the Nile Basin part of Uganda is 16,487 ha and 16,509 ha, respectively (Annex A-9)[53]. The 2015 dataset for some schemes was verified and thus holds true. However, the equipped area of one scheme, namely Nyamugasani, was deleted in the current data set because it was only a planned scheme in 2015 and not yet implemented.

Note: Map showing the locations of all irrigation schemes in the Nile Basin countries is presented in Annex C.

4.3. Irrigation Technology

4.3.1. Overview

Irrigation technology in this report was defined as the application of infrastructure and/or practice aiming to improve land and water productivity. In this regard, the prime technology considered refers to the use of pressurized irrigation methods. The area equipped for pressurized irrigation in the Nile Basin is shown in Table 5, which is already counted under Section 4.2. The table shows that Egypt is the leading country in the NB engaged in the application of improved irrigation technologies at a massive scale while Sudan is the other country next in line.

There are also trends of canal lining in some of the Nile Basin countries, according to consulted practitioners, which can, depending on scale, significantly increase conveyance efficiency. However, documented evidence on the magnitude of the ongoing canal lining work was not available. The NB countries are also applying one or a combination of the following water saving measures: land leveling; use of improved crop varieties; and, water management. However, no documentation was available on the extent of such measures and the associated impact on water productivity.

4.3.2. Irrigation technologies in Egypt

Documented evidence shows that Egypt has been implementing water saving technologies on a large scale over the years, under government and private sector initiatives (Table 5, Box 1 and Box 2). The implementation of intensive water saving technologies on a large scale can be considered as an exemplary benchmark for the other riparian countries. The technologies include the following: land leveling; canal improvement; crop diversity in response to level of water salinity; use of gated and perforated pipe system; sprinkler/drip irrigation methods; new and rehabilitation of water infrastructures; and, planting in raised seed beds. A summarized note on the technologies applied in Egypt is presented in Box 1 and Box 2.

4.3.3. Irrigation technology in Sudan

Sprinkler irrigation is practiced on a total of 57,000 ha land in Sudan mainly in the vicinity of major cities. Moreover, Kenana Sugar Estate – a private irrigation scheme – had installed a gated pipe irrigation system on 34,020 ha[54]. As a result, the scheme is noted to have a conveyance and on-farm efficiency of 93% and 84%, respectively.

[53] Wanyama et al. 2017; MWE 2015; MWE 2011; FAO 2016 and NBI baseline dataset of 2015 with additional data from Uganda participants of the 2nd Phase of SWRA Workshop held from February 23 – 25, 2019 in Kigali, Rwanda

Table 5: Area equipped for sprinkler and drip irrigation in the Nile Basin

Country	Scheme Name	Total Area Equipped	Area Equipped for Irrigation		
			Gravity	Pressurized	
		ha[a]	%[b]	%[b]	ha
Egypt	Aswan	80,503	100		
	Qina	145,106	100		
	Sohag	145,919	100		
	Asyiut	144,613	100		
	Fayyum	161,031	100		
	Al Jizah	139,778	44a	56	78,276
	Al Minya	210,408	100		-
	Beni Suwayf	126,814	100		-
	Al Bahayrah	560,681	66a	34	190,632
	Al Daqahliyah	306,130	93a	3	9,184
	Al Gharbiyah	169,288	100		-
	Al Minufiyah	166,414	100		-
	Al Qalyubiyah	79,967	80	20	15,993
	Ash Sharqiyah	364,378	73	27	98,382
	As Ismailiyah	74,354	39	61	45,356
	Dumyat	54,354	100		-
	Kafr-El-Sheikh	244,606	100		-
	Matruh	135,296		100	135,296
	Cairo/Al Qahirah	6,889	99	1	69
	Al Iskandariyah	65,940	27	73	48,136
	Elsalam Canal West/Bur Said	6,973		100	6,973
	Elsalam Canal East/Shamal Sina	57,831		100	57,831
Sudan		1,764,635	95	5	60,000 (b)
South Sudan			100		
Ethiopia[c]	Fincha Sugar Estate				20,145
Kenya		47,483	38	62	29,439
Tanzania			100		
Rwanda			100		
Uganda		12,016	73	27	3,244
Total		5,190,904			798,956

Source: (a): NBI baseline dataset of 2015 and reference therein

(b): Multsch, S.; Elshamy, M.E.; Bataresh, S.; Seid, A.H.; Frede, H.G.; Breuer, L..2017. Improving Irrigation Efficiency will be Insufficient to Meet Future Water Demand in the Nile Basin. Journal of Hydrology: Regional Studies. ELSSEVIER; (http://creativecommons.org/licenses/BY-NC-ND/4.0/) and reference therein

(c): Communication made with Abay Basin Authority, 2018. Bahirdar Ethiopia

Box 1: Water saving irrigation technologies in Egypt

Land leveling

Land leveling can help to improve water application uniformity over a field; hence, avoiding over- or under-irrigation. Uniform water application contributes to increased crop production. In Egypt, land leveling is practiced on a large scale either by the government, public and/or private sector. The government subsidized laser leveling in sugarcane fields by about 50% of the cost. Land leveling was also implemented in paddy fields using animal traction to minimize deep percolation losses.

Crop diversity

In response to changes in water quantity and quality along the Nile system, the Egyptian Government introduced strategies for crop diversity. The strategy for Upper Egypt was production of sugarcane integrated with the establishment of sugar factories; and rice for Northern Delta where the land is affected by a high water table and saline irrigation water.

Tertiary canal improvement project (New Mesqa)

Replacement of the old tertiary canals was considered among major initiatives for reduction of water seepage losses; hence, improving irrigation performance. The older canal system (old Mesqa) used to be an unlined channel, where water was abstracted unregulated at multiple points. The newly introduced types of conveyance systems were: (i) lined canal with the normal water level at 15 cm above the field and (ii) low pressure pipe buried one meter below the surface and provided with raisers at a spacing of 100 m. Flow from each raiser is controlled by an alfalfa valve.

Gated and perforated pipe system for sugarcane fields

The government initiated a program for improvement of on-farm water management in sugarcane fields through a package of land leveling, use of gated pipes, increasing furrow spacing and soil fertility management. As a result, irrigation application losses dropped to almost nil and the crop yield increased by 25% in pilot areas. According to the source document, there was a plan for scaling up the bundle of technology/practices.

Sprinkler/drip irrigation

Sprinkler and drip irrigation methods were introduced in the fringes of the Nile Delta and Valley, particularly in areas having soils characterized by relatively higher permeability. The source document indicated that in 2005, the area under modern irrigation system was about 202,937 ha (483,185 feddans), which about 6% of the total irrigated area.

Source: Allam, M.N.; El Gamal, F.; Hesham, M., 2005.

Box 2: Raised-bed: A water saving irrigation technology in Egypt

Research on irrigation water management has identified raised-bed systems as an important component for improved wheat production. Advantages of raised-bed planting (based on the average of 2011, 2012, 2013 and 2014, in Egypt) were:

- 30% increase in grain yield,
- 25% saving in irrigation water, and
- 74% increase in water use efficiency

Source: ICARDA 2016. Raised-bed planting in Egypt: An affordable technology to rationalize water use and enhance water productivity. Science Impacts. http://www.icarda.org/publications-resources

4.3.4. Irrigation technologies in the other NB countries

(a) Irrigation water conveyance and application technology: Surface irrigation with open canal water delivery system is predominantly practiced in most of the other NB countries (excluding Egypt as indicated above). The exceptions in this regard where sprinkler irrigation is practiced are as follows (Table 5):

- Ethiopia: 20,145 ha land irrigated at the Fincha Sugar Estate,
- Kenya: 29,439 ha used by flower and vegetable producers, and
- Uganda: 3,244 ha land irrigated by producers of sugarcane seedlings, flower and vegetables.

The pressurized irrigation schemes are concentrated in the vicinity of major cities and are owned and operated by skilled entrepreneurs with well-established market links.

(b) Improvement of crop varieties: Research on improved crop technologies conducted in the other NB countries is not comparable to that of Egypt. However, the issue is briefly discussed below to highlight the efforts being made in some of the other NB countries.

Research on the development of improved crop varieties is among the predominant initiatives in Ethiopia geared towards enhancing both land and water productivity. Newly developed varieties are noted to perform better than the former ones, in terms of yield and resistance to diseases. There is a requirement for the new varieties to be evaluated for their attributes by a National Variety Release Committee. A total of 85 crop varieties were released in 2017 and the cumulative figure to date is 1,198 (Table 6). A detailed agronomic and morphological description for each new crop variety is documented in the 'Crop Variety Register' publication.[55]

(c) Irrigation water management research initiatives: This section aims at presenting a couple of research examples in Ethiopia in the field of irrigation water management (Box 3 and Box 4). The research focused on adaptive trials of existing technologies that are already in practice elsewhere in the world. However, the research outcomes are often shelved.

4.3.5. Irrigation efficiencies in the Nile Basin

This study aimed at capturing the overall irrigation efficiency as well as its components – conveyance and application efficiencies. Information on irrigation efficiency was obtained for Egypt, Ethiopia, Sudan and Tanzania.

Research on irrigation efficiency and the subsequent investment on water saving interventions

Table 6: Summarized number of crop varieties released in 2017 and before in Ethiopia

Crop Category	Number of new crop varieties released by category		
	In 2017	Before 2017	Total
Cereals	34	387	421
Pulses	16	207	223
Oil Crops	3	108	111
Tubers, Roots, and Vegetable Crops	12	221	233
Condiments and Medicinal Plants	7	42	49
Fruit Crops	3	41	44
Forage and Pasture	10	38	48
Fiber Crops	-	30	30
Stimulant Crops (Coffee)	-	39	39
Total	85	1,113	1,198

Data Source: MoANR 2017

[54] Mamoun, I.D. 2008. Best Practices for Water Harvesting, Community Managed Irrigation and Public/Private Managed Irrigation in the Sudan. Efficient Water Use for Agricultural Production Project (EWUAP). NBI

[55] MoANR 2017.

Box 3: Alternate furrow irrigation research on potato fields[56] in Oromia, Ethiopia

The research was conducted on a 6 m by 10 m farm block aiming at comparison of furrow irrigation techniques as a function of their respective potential for: water saving; increase water productivity; water use efficiency; and, crop yield. The research was conducted in the humid climate of western Ethiopia, particularly in the West Shoa zone of Oromia region. Results confirmed that irrigation treatments significantly influenced yield, water productivity and water use efficiencies of potato as shown in the table below.

Attributes of alternate furrow irrigation compared to other furrow methods: Research findings

Parameter	Furrows with farmer practice	Every furrow irrigation	Fixed furrow irrigation	Alternate furrow irrigation
Average Field Application Efficiency, %	34	52	61	67
Potato Tuber Yield (kg/ha)	30,098	33,369	30,177	33,198
Water Productivity Kg/m^3	4.1	6.1	10.7	11.2
Distribution Uniformity, %	"Low"	85.3	75.4	89.3

Typology considered in the research:

» Every furrow irrigation (EFI): furrows with blocking at the end and water delivered to every furrow;
» Fixed furrow irrigation (FFI): furrows with blocking at the end and water applied only to odd furrows (1, 3, 5 and 7) throughout the growing season; and
» Alternate furrow irrigation (AFI): furrows with blocking at the end and odd numbered furrows (1, 3, 5 and 7) received water at first irrigation event and even numbered furrows (2, 4, 6 and 8) received water in the next irrigation event; sequence repeated throughout the growing season.
» Furrows based on Farmers Practice (FFP): furrows made by farmers with no blocking at the end; and water delivered to every furrow with farmers' irrigation interval;

Data Source: Eba A.T (2018)

Box 4: Deficit irrigation research in Gondar, Ethiopia

The study compared the difference in productivity level of three irrigation depths namely: 0%, 25% and 50% deficit irrigations – all with an irrigation frequency of 2 days based on CROPWAT result. The study found that applying 75% of full irrigation depth (i.e., 25% deficit) throughout the whole season resulted in a comparable marketable potato yield (25.6 tons/ha) and higher water productivity (4.54 – 5.06 kg/m^3) as compared to 0% deficit irrigation (26.33 tons/ha) with an excess water of 157mm/season.

The research confirmed that deficit irrigation practiced in many parts of the world has significant potential for increasing water productivity in areas prone to water scarcity.

Source: Meta, K.M. 2013

[56] Eba, A.T. (2018)

have been implemented at a massive scale in Egypt compared to the other riparian countries as shown in Section 4.3.2. The success is attributed to a concerted effort made by the government and research and academic institutions. However, in the other NB countries, the agenda for irrigation efficiency improvement was intermittent and limited only within the circles of academic and research communities, with little or no participation of other key stakeholders as shown in Section 4.3.4.

Reviewed feasibility studies and design documents show that irrigation schemes were designed using irrigation efficiency values recommended in FAO publications. Limited documents were also found that show attempts made to quantify irrigation efficiencies in some NB countries with results similar to those noted in FAO publication, with the exception of some outliers. The most commonly used efficiency values given in FAO technical guidelines are:

- 50 – 70% for application efficiency
- 40 – 70% for conveyance efficiency,

Some of the updated information on irrigation efficiency values is presented below.

(a) Irrigation efficiencies in Egypt: Average conveyance efficiencies estimated in Egypt were 82.4%, 92.7%, and 98.38% for traditional earthen, lining and buried pipes conveyance systems, respectively (Eddin et al. 2016). The average of application efficiencies in Egypt was reported as 81.5 % under 'improved on-farm surface irrigation' (i.e., with precision laser land leveling) compared to 59% under 'traditional surface irrigation' (Eddin et al. 2016) (i.e., with no land leveling).

b) **Irrigation efficiency in Ethiopia:** A number of schemes in Ethiopia are characterized by inefficient water use. Such inefficiency commences right from the source where water in excess of the requirement (for crops and allowable losses) is delivered into the conveyance system[57 58] (Table 7). The indicated excessive diversion /pumping/ is attributed to lack of capacity in water management and water measuring/control facilities.

The abovementioned conveyance efficiency is comparable with that of Meila (74.48%), Haiba (53.2%) and Mai Nigus (58.26%) schemes, respectively[59]. The loss of water in the conveyance and distribution system is attributed to poor construction and maintenance of canals and related structures. In a number of schemes, water control structures are either lacking or nonfunctional due to neglect or misunderstanding of their uses. Conveyance losses are noted to be the major causes for low irrigation cropping intensity (reduction of the irrigable areas)[60].

Table 7: Irrigation water loss per unit canal length at the Haleku MelkaTesso Scheme

Type	Water Loss/meter; l/s/m		Conveyance Efficiency, %	
	Lined	Unlined	Lined	Unlined
Main Canal	0.01 - 0.03	0.04 - 0.23	91 - 96	67 - 85
Secondary Canal		0.02 - 0.32		66 - 89
Tertiary Canal		0.04 - 0.22		40 - 95

Source: Beshir, K. L. 2008. Note: The higher side of the conveyance efficiency is applicable to the head reach of the canals.

Application efficiency measured in 10 locations across Ethiopia (5 of which were within the Nile Basin) show that farmers at the head reaches received on average 14% more water than their requirement, while those at the middle and tail end reaches were undersupplied on average by 18% and 48%, respectively[61].

Many small-scale irrigation farms are characterized by short furrow length with closed end. This arrangement is believed to contribute to higher application efficiency: for example, 89% in Haleku Melka Tesso Scheme, 72.84% in Meila, 64.7% in Haiba, and 85.4% in Mai Nigus Scheme (Tekeze Basin)[62]. On the other hand, furrows with open end

[57] Agide. et.al. 2016

[58] Beshir Keddi Lencha 2008

[59] Mintesinot et al. 2005

[60] Agide et al. 2016

[61] Agide. et al. 2016

[62] Mintesinot et al. 2005

were found to have an application efficiency of as low as 36% in Haleku Melka Tesso Scheme. Another reported cause of low efficiency was the loss of water by deep percolation resulting from prolonged water application by farmers situated at the head reach. For example, analysis of soil moisture measurement data collected from Geray[63], (Gojam, Abay Basin) shows that the farmers at the head reach applied 74% – 253% more water to their respective plots than the requirement. On the other hand, many downstream farmers abandoned irrigation due to shortage of water although the main canal had a flow of 1.1m^3/s, which is adequate enough for the entire scheme. Hence, the area under irrigation was unnecessarily reduced to 215 ha (which is 47% of the 454 ha equipped with infrastructure).

C) **Irrigation efficiency in Sudan**: There are contradictory reports on the irrigation efficiency values obtained from Sudan. According to Ahmed, A.M.Tiffen, M. (1986), surface irrigation efficiencies in Sudan are a function of two water application systems namely (i) long furrow and (ii) level furrow-basin (locally called *Angaya*) systems.

Long furrow irrigation is practiced mainly in sugar schemes, e.g., Kenana, Guneid, Asalaya and New Halfa Sugar Scheme and other furrow-based schemes – with 85% and 80% conveyance and application efficiencies, respectively, or with a 68% overall irrigation efficiency. An overall irrigation efficiency of 78% (conveyance and application efficiency of 93% and 84%, respectively) is reported for Kenana Sugar Estate (34,020 ha), which is a private irrigation scheme where irrigation water is delivered through a closed gated pipe system[64]. (Note: it was not possible to verify the information given the lack of additional documents).

Level furrow-basin (*Angaya*) system is the predominant system practiced in large schemes in Sudan, such as Gezira, New Halfa, etc. The 'level furrow-basin (*Angaya*)' system is constructed by preparing furrows parallel to the length of the field (280 m length). Then, the field is divided into 16 *Angaya* by water courses called *Gadwals*. Each *Angaya* (280/16=17.5 mx150 m) is further divided into eight basins (or locally called as '*Hods*') of (17.5 mx150/8=18.75 m). Ahmed, A.M.; Tiffen, M. (1986)[65] reported an application efficiency of 75% under this system due to the fact that it merges the merits of furrow and basin systems, i.e.,

- The furrows inundate only part of the surface and allow faster water distribution and less percolation losses due to reduced advance and wetting time resulting in less water used.
- The basins are very small 17.5 m x 18.75 m with no likelihood of waterlogging.

It appears that the above information could have been the basis for the 2015 NBI baseline study to adopt high overall irrigation efficiency for Sudan, which is 68% (for gravity), 75% (pumping and gravity), 76% (pumping and flooding), and 86% (pumping). The overall efficiency for the gravity system (68%) is the product of conveyance efficiency of 85% and application efficiency of 80%.

The abovementioned high efficiency figures could have been valid for Sudan if, and only if, the canals were well maintained[66]. It should be noted that the application and conveyance efficiency values for Sudan are higher than what was applied for the other countries, which are 50% – 70% and 40% – 70%, respectively. The indicated conveyance efficiency values are applicable only to well-maintained canals in dug soils according to FAO publications.

It is evident that water loss by deep percolation is insignificant in most of the irrigation schemes in Sudan due to the impermeable nature of the soil and subsoil (vertisol)[67]. Moreover, it is apparent that land leveling and the nearly plain topography might have contributed to uniform water delivery across the command area[68]. However, the indicated 'negligible deep percolation loss' and 'uniform water distribution' parameters alone can mislead judgment on the performance of the irrigation schemes in Sudan. Low infiltration capacity of the vertisol coupled with plain topography and leveled fields indicate the potential stagnation of the irrigation water on the surface, the consequent of which is high loss of water by evaporation - by extension low irrigation efficiency. In other cases, irrigation schemes operating under substantial water stress could have 'high irrigation application efficiency', but land and water productivity could be low due to inadequacy of the available water supply.

[63] Chekol, G. 2007
[64] Mamoun, I.D. 2008.
[65] Ahmed, A.M.; Tiffen, M. 1986
[66] Plusquellec, H. 1990
[67] Mamoun, I.D. 2008

Coping mechanisms applied in water stressed areas are either to apply the available water thinly over the entire command area or cut irrigation supply to a portion of the command area. In both options, overall production is low. According to two research reports[69 70], the 10-year-average hydraulic water use efficiency (net crop water requirement divided by the total water applied) in the Gezira Scheme (which encompasses nearly half Sudan's irrigation area) was 82% for cotton, 59% for sorghum, 73% groundnut and 87% for wheat fields. The denominator in the hydraulic efficiency is 'total water applied' not 'total water stored in the root zone'. Thus, the 'hydraulic efficiency' parameter alone cannot give a conclusive proof of the application efficiency (or performance) of the Gezira Scheme. The water productivity (yield in (kg/ha) divided by the water applied in (m^3 /ha)) is 0.07 kg/m^3 for cotton, 0.34 kg/m^3 for sorghum, 0.3 kg/m^3 for groundnut and 0.12 kg/m^3 for wheat[71 72]. Such a low productivity level is reportedly attributed to using lower number of irrigations than recommended, long distance of the water source from the farms, waterlogging and limitations in agronomic practices[73].

Another study[74] in the Gezira Scheme, confirmed that water productivity at the scheme level is very low (less than 0.2 kg/m^3 of applied water with the major crops namely: cotton, sorghum, ground nuts and wheat). Yields of cotton and wheat were noted as two to three times below the yields achieved in the research stations[75]. This is partly attributed to two reasons namely: (i) *water is not delivered at the right time with the right quantity due to poor canal condition caused by siltation and weed growth* and (ii) *poor management of irrigation water at the field level*[76]. Reports also show that some irrigated fields were out of production because conveyance capacity of the water supply canals was reduced by heavy siltation[77]. Poorly maintained canals retard canal flow and causes spillage and/or high evaporation losses. These statements are challenges to the claim for the exaggerated efficiency in Sudan.

It appears that due to the prevailing water shortage, the cropping intensity in Gezira was designed for a cropping intensity of 75% with a five-course crop rotation of: cotton, sorghum, groundnuts, wheat and one fallow in between. However, the actual cropping intensity over the years was 50% involving an eight-course rotation of: cotton, fallow, fallow, cotton, fallow, sorghum, *lubia*, and fallow[78]. The most recent estimated cropping intensity for all irrigation schemes in the country is 65% and it is attributed to water scarcity[79]. Therefore, the abovementioned arguments call for considering one of the schemes in Sudan as a candidate in the forthcoming benchmarking exercise.

d) **Irrigation efficiencies in Tanzania**: The estimates of irrigation efficiencies for Tanzania, adopted from the National Irrigation Master Plan for Tanzania are presented in Table 8. The master plan does not show any explanation on how the efficiency figures were determined. Moreover, no literature was found to verify the methodology adopted in quantifying the efficiencies. However, the indicated figures appear to be consistent with the FAO guidelines. According to a previous study[80], the actual irrigation efficiency is much lower than what is noted in the Tanzanian Irrigation Master Plan 2018. Tanzania had launched a World Bank financed project (2001 – 2004) aiming to raise irrigation efficiency from about 15% to an average of 30% through technical interventions. The result of the intervention was that the average overall irrigation efficiency increased from a baseline of 11% to 27%.

[69] Ali Widaa et.al. 2011
[70] Adam et.al. 2017
[71] Ali Widaa et.al. 2011
[72] Adam et.al, 2017
[73] Adam et.al. 2017
[74] Plusquellec, H. 1990
[75] Plusquellec, H. 1990
[76] Ahmed, A.S. (nd).
[77] Plusquellec, H. 1990
[78] Mamoun, I.D. 2008.
[79] NBI 2016
[80] Sokoine University of Agriculture, 2008

Table 8: Irrigation efficiencies in Tanzania

Upland Crop	Traditional scheme (unlined canal)						Improved and new irrigation scheme (lined canal)					
	Em	Eb	Ed	Et	FA	IE	Em	Eb	Ed	Et	FA	IE
Large scheme	0.7	0.7	0.7	0.7	0.7	0.17	0.9	0.9	0.9	0.8	0.7	0.41
Medium scheme	0.7	0.7		0.7	0.7	0.24	0.9	0.9		0.8	0.7	0.45
Small scheme	0.7	–	–	0.7	0.7	0.34	0.9	–	–	0.8	0.7	0.5
Drip scheme	–	–	–	–	–	–	0.95	–	–	–	0.9	0.86
Sprinkler scheme	–	–	–	–	–	–	0.95	–	–	–	0.8	0.76

Where:
Em: Efficiency of main canal
Eb: Efficiency of branch canal
Ed: Efficiency of distribution canal
Et: Efficiency of tertiary canal
FA: Efficiency of field application
IE: Irrigation efficiency
IE = Em x Eb x Ed x Et x FA

Source: JICA 2018. National Irrigation Master Plan for Tanzania

4.4. Cropping Baseline Data (2018)

4.4.1. Overview

In this report, 'cropping data' refers to crop types, crop growth parameters, cropping patterns, cropping intensity and cropping calendar data. Attempts were made to collect the indicated parameters though available information was rather limited. Hence, country wise discussions in the following sections are a reflection of the type of the newly compiled datasets.

In general, the data on crop growth parameters for all countries compiled by the NBI in 2015 were still applicable in 2018. A systematic review showed that crop growth parameters used to estimate crop water requirements in all countries were derived from FAO publications. For some countries new cropping parameters were obtained and presented in the respective annexes.

4.4.2. Burundi cropping baseline data

The predominant crop in Burundi is paddy rice, which is grown on marshlands[81]. According to FAO (2016) –AQUASTAT dataset, rice constitutes 47% the cropping pattern in both wet seasons. During the dry summer months (Season C as shown in Table 9), irrigation water is delivered to the marshlands to grow vegetables thus permitting a third crop in a year. During the dry season, irrigation is practiced using furrows and watering hose pipes and buckets. Main crops grown are commercial crops (sugarcane and palm) and food crops (tomatoes, onions, corn, and potatoes)[82]. The other crops indicated above are grown in the two wet seasons (namely Season A and Season B as shown in Table 9) outside of the marshlands (Table 9)[83].

The abovementioned cropping pattern is more or less consistent with the 2015 NBI baseline data, which indicated paddy rice as the predominant crop grown in the irrigation schemes of Burundi.

[81] Niyongabo, H. 2008.
[82] Niyongabo, H. 2008.
[83] Collins et al. 2013.

Table 9: Crops and cropping calendar in Burundi

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Climate	Short wet				Long wet				Long Dry			
Season A	P	P P		Y	Y Y	Y						
Season B						P	P P		Y	Y Y	Y	
Season C	Y Y	Y Y	Y Y						P	P P	P P	

Key: P = Planting Y=Harvesting

Crops associated with each cropping season are:

- Season A – maize, sweet and Irish potato, sorghum, banana, groundnut
- Season B – beans, Irish and sweet potato, vegetables
- Season C – rice, maize, Irish and sweet potato, beans

Source: Collins et al. 2013

The average cropping intensity for Burundi adopted from the NBI (2015) baseline is 153% (Table 10)

Table 10: Burundi cropping intensity

District	Cropping Intensity, %
Gitega	151%
Karusi	128%
Kyanza	150%
Kirundo	257%
Muramya	92%
Muyinga	214%
Mwaro	75%
Ngozi	157%
Average	**153%**

Source: NBI baseline dataset of 2015

4.4.3. Egypt cropping baseline data

The most recently (2018) published data on crop growth parameters are presented in Annex B-1 through Annex B-5. The data includes new data on dates of growth stage, crop coefficients and water consumptive use for 17 crops disaggregated by each of the five agro-climatic zones of Egypt (Figure 1). For comparison, NBI's 2015 information on crop-specific information is also presented in Annex B-6. The difference between the two datasets (as shown in Table 11) is a discrepancy of planting dates of many crops by about 15 days, and also a slight difference in crop coefficients. The effect of disaggregating the crop growth parameters by agro-climatic zone is reflected in the water consumptive use as shown in Table 11. The cropping pattern for Egypt compiled in the NBI's 2015 dataset remains valid (Annex B-7).

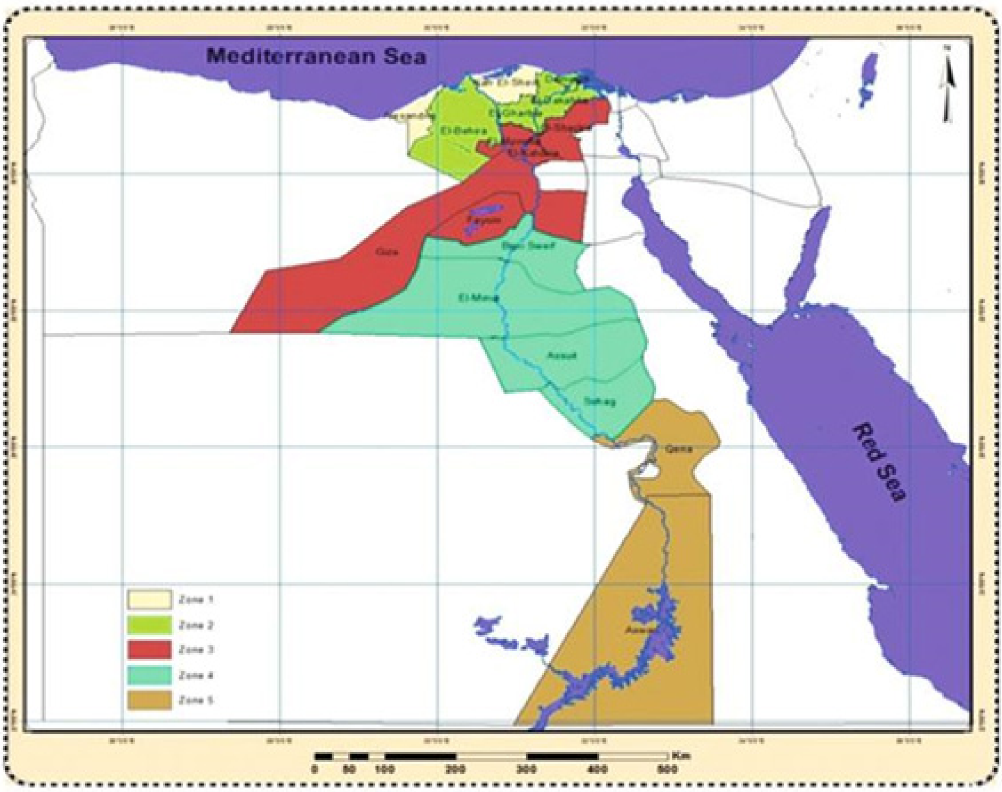
Table 11: Comparison of previous and current crop growth parameters and cropping calendar for Egypt

Crop	NBI 2015 Baseline Planting date	Planting date	Harvest date	Water Consumptive Use by Agro ecological Zones, mm				
				Zone-1	Zone-2	Zone-3	Zone-4	Zone-5
Wheat	1-Nov	15-Nov	18-Apr	363	385	409	431	451
Faba bean	1-June	25-Oct	25-Mar	338	355	375	392	413
Clover	1-Nov	15-Oct	1-Apr	526	558	598	623	659
Onion	1-Nov	15-Nov	15-May	615	663	707	750	787
Tomato	1-Nov	1-Oct	1-Mar	313	343	364	378	400
Potato	1-Nov	1-Nov	1-Feb	199	206	216	222	239
Sugar beet	1-Nov	15-Oct	12-Apr	508	541	577	604	645
Cotton	1-Mar	15-Mar	1-Sep	725	792	830	905	643
Rice	1-Jun	15-May	16-Sep	667	722	740	643	577
Maize	1-Jun	15-May	1-Sep	535	579	597	638	538
Soybean	1-Nov	15-May	25-Aug	530	572	592	574	743
Sunflower	1-Nov	15-May	15-Aug	474	509	530	524	2,028
Tomato	1-June	1-May	1-Sep	611	451	473	735	1,792
Citrus*	1-Jan	15-Feb	14-Feb	1,412	661	6791	,971	1,463
Olive*		15-Feb	14-Feb	1,155	1,532	1,607	1,735	1,097
Grape*		15-Feb	14-Feb	874	1,253	1,314	1,416	451

*End of the agricultural year

Source: Ouda and Zohry 2018

Figure 1: Map of agro-climatic zones of Egypt using 10-year of ETo values



Source: Ouda and Zohry 2018

4.4.4. Ethiopia cropping baseline data

The crop growth parameters (Annex B-8) and cropping pattern data (Annex B-9) compiled by NBI in 2015 are still valid for 2018. An additional category of cropping pattern data was obtained for Ethiopia corresponding to the newly identified irrigation schemes in each of the agro-ecological zones of the country (Annex B-10 through Annex B-15). Ethiopia's cropping pattern is a dynamic process, which is primarily governed by the prevailing market. Irrigation schemes situated very close to urban areas grow more vegetables as compared to those in remote areas where cereals are the dominant crops.

The prolonged dry season in Ethiopia is favorable for having two additional growing seasons (in other words for having an irrigation cropping intensity of at least 200%). However, the average irrigation crop intensity in Ethiopia is in the range of 81% - 143%[84]. Some of the reasons for not fully utilizing the irrigable area for production during the dry season are either one or a combination of the following[85]:

- the base flow of the streams declines as of November (i.e., 3 months after the end of the rain season) caused by low catchment yield and/or diversion of the water by upstream users;
- water conveyance capacity of the canal network could be reduced due to damage or poor maintenance;
- amount of water stored in reservoir dams could be below the design capacity due to shortage of rainfall, seepage or sedimentation;
- Prolonged time gap between harvesting of the rain-fed crop (carried out in Sept. – Nov.) and commencement of preparation for irrigation (Dec. – Feb.). On the other hand, farmers' reason for the delay in the commencement of irrigation is the risk of frost that occurs during November through December. By extension, there is a gap in introducing frost resistant crop varieties and approaches:
- In some parts of western Amhara (West Goajm Subbasin), the irrigable area is poorly drained; thus, farmers have to wait until the land gets workable in Dec – Jan;
- In many irrigation schemes, the rain-fed crop varieties used require a long (>150 days) growing length. Thus, the schemes are planted fully with one rain-fed cropping and partly with a second irrigated cropping in a given year. There is a lack of crop varieties that require a short growing length.

4.4.5. Kenya cropping baseline data

Three new schemes are identified in the Lake Victoria Basin (with respective irrigated areas of 1,047, 22 and 702 ha) that grow paddy rice in the first season and other crops (such as soybean, watermelon, maize, tomatoes, sorghum and cowpeas) in the second season. The details are presented in the attached annexes. Apart from this, there is no new information on cropping data for Kenya. Thus, crop growth parameters and cropping pattern for Kenya are adopted from the NBI (2015) baseline database and are presented in Annex B-16 and Annex B-17.

4.4.6. Rwanda cropping baseline data

New data on crops and cropping pattern for Rwanda were not found. According to the indicated NBI data, rice accounts for 100% of the cropping pattern in Rwanda. This could be valid for the two wet seasons in a year (Season A and Season B), where 88.9% and 84.3% of the farmers are engaged in rice production (NISR 2016). However, vegetables are the dominant crops during the dry season. Of the total of 26 irrigation schemes identified, 13 schemes (i.e., 4,627 ha out of 7,698 ha or 60%) are swamp-based schemes used for growing rice over two seasons a year; and then the schemes are used for producing mostly vegetables in the dry season (locally called Season C) (Table 12).

Crop growth parameters for Rwanda are presented in Annex B-18.

[84] Agide et.al, 2016
[85] Leul, K.G. 2009.

Table 12: Crops and cropping calendar in Rwanda

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Climate	Short wet		Short dry			Long wet			Long dry			
Season A	P	P P	G G	Y Y	Y Y	Y						
Season B						P P	P P	P G	G G	Y Y	Y Y	
Season C	Y Y	Y Y								P P	P P	G G

Note: P = Planting, G= Growing; Y=Harvesting periods

4.4.7. South Sudan cropping baseline data

Crop growth parameters for South Sudan are presented in Annex B-19. A new cropping pattern (2018) for South Sudan is obtained as shown in Annex B-20. There is a significant variation between the Phase-I and phase-II cropping dataset of South Sudan in terms of crop types and cropping pattern (Table 13).

Table 13: Comparison of Phase-I (2015) and Phase-II cropping dataset of South Sudan

NBI 2015 Dataset			Updated 2018 Dataset**		
Cropping Pattern ID	Crop Type	% of Equipped Area	Pattern ID	Cropping Crop Type	% of Equipped Area
SSD1	Wheat SD	17.90%	SSD1	Groundnut SD/SSD	16.90%
	Sorghum SD	23.80%		Maize	28.70%
	Vegetable SD	23.80%		Sorghum SD	28.20%
	Rice SD	23.80%		Vegetable SD	16.60%
SSD2	Sugar SD/SSD	50.00%		Sesame	9.60%
SSD3	Sorghum SD/SSD	59.50%	SSD2	Sugar SD/SSD	100.00%
	Vegetable SD/SSD	31.70%	SSD3	Sorghum SD/SSD	20.90%
	Rice SD/SSD	39.70%		Vegetable SD/SSD	29.70%
	Fodder SD/SSD	9.50%		Rice SD/SSD	39.70%
	Rice SD/SSD	100.00%		Fodder SD/SSD	9.70%
SSD4	Sugar SD/SSD	100.00%	SSD4	Rice SD/SSD	100.00%
SSD5	Rice SD/SSD	100.00%	SSD5	Cotton SD/SSD	50.00%
				Sorghum SD/SSD	50.00%
			SSD6	Cotton SD/SSD	50.00%
				Groundnut SD/SSD	50.00%

Source: ** (1) Ministry of Irrigation (1979). Nile Waters Study, Volume 3, Supporting report IV Irrigation. Sudan

(2) MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan (2015). PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN (IDMP) IN THE REPUBLIC OF SOUTH SUDAN. FINAL REPORT (ANNEXES, PART I).

4.4.8. Sudan cropping baseline data

Crop growth parameters for Sudan are presented in Annex B-21 (obtained from NBI 2015 baseline data). The NBI cropping pattern baseline data of 2015 is still valid for 2018 and, is presented in Annex B-22 with one additional category of cropping pattern data. The historical cropping pattern for one of the largest irrigation schemes in Sudan - Gezira Mangil – is presented in Table 14. The table shows that the cropping intensity of the scheme in 1997 and 2014 was 65.8% and 69.7%. Such low cropping intensity is a reflection of the scheme's low performance most probably attributed to water shortage and poor irrigation management as explained above.

The predominant crops grown in the irrigation schemes of Sudan are cotton, groundnuts and sorghum in the summer and wheat in the winter. Experience from the Gezira Scheme could be considered as representative for Sudan, because its share in the country is 46% of the irrigated area, 95% of cotton production, 100% of sugarcane production, 36% of sorghum and 32% of ground nut production[86]. Cropping intensity in Gezira was designed for a cropping intensity of 75% with a five-course crop rotation of: cotton, sorghum, groundnuts, wheat and one fallow in between.

However, the actual cropping intensity is 50% involving an eight-course rotation of: cotton, fallow, fallow, cotton, fallow, sorghum, *lubia*, and fallow[87]. The most recent (NBI 2016) data on cropping intensity in Sudan is 65%.

4.4.9. Tanzania cropping baseline data

Crop growth parameters (Annex B-23) and cropping pattern (Annex B-24) for Tanzania are adopted from NBI's 2015 baseline database. The most recent cropping pattern disaggregated by regions is presented in Table 15, which is obtained from the National Irrigation Master Plan for Tanzania (JICA 2018).

4.4.10. Uganda cropping baseline data

Crop growth parameters for Uganda are adopted from the NBI's 2015 baseline (Annex B-25). Irrigated cropping patterns in Uganda include: rice (70% of total equipped area), sugarcane (23%), flowers (2%), fruits (1%), maize (1%), sesame (1%), and vegetables (1%) (FAO 2016), which is consistent with the cropping pattern of Uganda reported in the NBI's 2015 baseline data (Annex B-26).

Table 14: Historical cropping pattern of Gezira Managil Irrigation Scheme – Sudan

Crop	Area (Ha)		% of Equipped Area	
	1997	2014	1997	2014
Sugarcane SD		0	0.00	0.00
Cotton SD; Medium Stable	79,380	22,260	9.45	2.65
Cotton SD; Long Stable	42,420		5.05	0.00
Wheat SD	153,720	222,600	18.30	26.50
Groundnut SD	90,720	94,920	10.80	11.30
Sorghum SD	186,480	170,100	22.20	20.25
Win Vegetables SD;		21,000	0.00	2.50
Summer Veg		25,200	0.00	3.00
Fodder SD1			0.00	0.00
Forest; Per Gardens		29,400	0.00	3.50
	552,720	585,480	65.80	69.70

Source: Adopted from the excel file of the NBI baseline dataset of 2015

Table 15: Cropping pattern for regions in the Lake Victoria Basin of Tanzania

Region	Maize (%)	Paddy (%)	Other major field crops* (%)	Vegetables** (%)	Perennial crops (%)	Others (%)
Shinyanga	38	27	15.5	0.5	2	17
Kagera	30	4	21	0	8	37
Mwanza	46	18	13	2	8	13
Mara	50	2	22	2	10	14
Simuyu	50	5	17	0	0	28
Geita	42	10	23	1	11	13

* Other major field crops include: sunflower, groundnut, beans, sesame, sorghum and sweet potato

** Vegetables include: tomato, okra, onion, watermelon, pumpkin, cabbage and amaranths

*** Perennial crops include: cassava and cashew nut

Source: JICA 2018

[86] Mamoun, I.D. 2008.

[87] Mamoun, I.D. 2008

5. CONCLUSION AND RECOMMENDATIONS

This baseline study aimed at updating the information on irrigation infrastructure, irrigation technology, efficiency and crops cultivated for the current (2018) and future (2050) irrigation water use projections as part of the irrigation benchmarking study. The general limitation of this assignment was that it relied on a desk-based review of secondary information. The consulted institutions in the Nile Basin countries lack sufficient documentation in the area of irrigation. Thus, a substantial part of the data was collected from online sources and partly from the NBI and the IWMI. When recent information was lacking, the study verified and adopted information from the NBI baseline dataset of 2015 as well as from other earlier publications. For some schemes in Ethiopia and Tanzania, the missing data on 'area equipped for irrigation' were derived from the respective cropped area in consultation with practitioners.

Attempts were made to review multiple sources to determine the validity of the collected data. A regional consultation workshop with agricultural experts from the Nile Basin (NB) was conducted from February 23 – 25, 2019 in Kigali, Rwanda, to validate the updated databases. Therefore, the baseline data and information collected and/or verified through this assignment can be used for the scheduled subsequent actions of estimation of current (2018) and projected irrigation water demand.

Documentation on water saving technologies in the NB is limited to pressurized irrigation system. However, according to the consulted practitioners from the NB countries, various efforts are being undertaken to implement additional water saving measures such as: canal lining, land leveling, use of improved crop varieties and other water management practices. These efforts, when at scale, could have significant implication on the water use efficiency in the NB. However, to date, information on the extent of such measures as well as the associated impact on water productivity is limited. It is, therefore, recommended that the NBI set up a program to monitor and collect relevant information of implemented and ongoing initiatives undertaken in the respective countries.

As far as irrigation technology and efficiency is concerned, the study identified that Egypt is excelling by implementing many water saving practices and, thus, may serve as a benchmark for upstream countries. Egypt's success is attributed to the concerted effort of policymakers, practitioners and research institutions. Such effective institutional coordination must be considered as a best practice to be adapted and scaled to other riparian countries as well. The irrigation benchmarking approach to be proposed under Component-5 can provide a vital entry point for the NBI to coordinate with relevant institutions to initiate and consolidate joint planning, implementation and evaluation of improvement works on existing irrigation schemes.

Moreover, the irrigation benchmarking exercise (anticipated to be initiated through recommendations of Component-5) must be planned and implemented in schemes having the potential to yield maximum impact by influencing many other schemes suffering from poor performance. In this regard, the priority candidate schemes recommended for benchmarking exercise are discussed below:

- As explained above, the Gezira Scheme in Sudan is one of the largest irrigation schemes in the world. Its performance is low. Therefore, it could be considered as the first candidate for benchmarking in view of its low water and land productivity and the potential impact it may bring to itself and other large irrigation schemes in the vicinity;
- Next to Sudan in terms of area equipped for irrigation and also having low water and land productivity is Ethiopia. Ethiopia has been striving to expand irrigated agriculture, managing to do so at a very slow pace. Though these efforts have contributed to improving food security and income of many rural households, the productivity is still very low. The yield of the irrigated crops is 30% – 50% of the yield actually obtained in research and demonstration plots[88]. The productivity of most average farmers is two to three times lower than that of the best performing farmers, which is attributed to skill differences among the farmers[89]. Moreover, observations made by practitioners reveal that most schemes lack a proper operation and maintenance system, which is another cause for low water and land productivity.
- A third scheme could be selected from Tanzania where average overall irrigation efficiency is less than 30%[90].

[88] EARO (Ethiopian Agricultural Research Organization). 2004.
[89] MOFED 2010.
[90] Sokoine University of Agriculture,2008

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7. ANNEX OF ALL COUNTRY LEVEL DATA

Annex A: Area Irrigated/Cropped and Area Equipped for Irrigation in the Nile Basin

Annex A-1: Area irrigated/cropped in the Nile Basin part of Burundi

District	Cropped (ha)	Equipped (ha)	Water Abstraction (CM)	Abstraction per cropped area (CM/ha)	Cropping Intensity, %
Gitega	1,789.5	1,186.5	3,353,233.8	1,873.84	151%
Karusi	2,373.0	1,857.0	5,387,275.0	2,270.24	128%
Kyanza	1,805.0	1,200.4	3,391,130.0	1,878.74	150%
Kirundo	3,794.5	1,477.5	4,076,475.0	1,074.31	257%
Muramya	171.0	185.4	523,755.0	1,678.70	168%
Muyinga	1,567.0	731.5	2,066,487.5	1,318.75	214%
Mwaro	15.0	20.0	56,500.0	3,766.67	75%
Ngozi	3,370.0	2,144.0	6,796,102.5	2,016.65	157%
Total	14,885.0	8,802.3	25,650,958	1,985	163%

Source: NBI baseline dataset of 2015

Annex A-2: Area irrigated/cropped and area equipped for irrigation in Egypt

	Scheme Name	Area, ha Cropped	Equipped	Water Source Type	Name	Cropping Pattern
1	Alexandria	117901.56	73127.33[(a)]	Canal	Nubariya	EGY1
2	Assiut	276746.82	153675.90	Canal	Naga Hammadi	EGY2
3	Aswan	113899.38	69025.74	River	Nile	EGY3
4	Behera	1405323.36	652482.18	Canal	Beheria Rayah	EGY4
5	Beni Suef	240581.46	119650.44	Canal	Ibrahimia	EGY5
6	Cairo	8295.84	6721.68	Canal	Ibrahimia	EGY6
7	Dakahlia	532109.34	334407.36	Canal	Tawfiki Rayah	EGY7
8	Damietta	88121.46	60726.12	Canal	Sahel Belamoun	EGY8
9	Fayoum	334892.88	170041.62	Canal	Bahr Yousef	EGY9
10	Gharbia	306432.84	169410.36	Canal	Menufia	EGY10
11	Giza	170138.22	121978.92	Canal	Ibrahimia	EGY11
12	Ismailia	165990.72	144141.48	Canal	Ismailia	EGY12
13	Kafr El Sheikh	460201.56	301926.24	Canal	Menufia	EGY13
14	Matrouh	95632.32	99139.0[(b)]	Canal	Nubariya	EGY14
15	Minya	364023.66	221131.68	Canal	Bahr Yousef	EGY15
16	Menoufia	295142.82	172995.90	Canal	Menufi Rayah	EGY16
17	Kalyubia	128310.42	103892.46	Canal	Sharkawia	EGY17
18	Qena	225303.96	196331.5 [(c)]	Canal	Asfoun and Kalabyiah	EGY18
19	Port Said	45675.84	89889.2[(d)]	Canal	Elsalam Canal East	EGY19
20	Suez	22001.70	6221.46	Canal	Elsalam Canal West	EGY20
21	Sharqiah	676635.54	379565.34	Canal	Ismailia	EGY21
22	Suhag	265060.32	156368.52	Canal	Naga Hammadi	EGY22
23	New Valley	191191.56	20885.7[(e)]	GW	Deep GW	EGY23
	Total	**6,529,614**	**3,823,736**			

Source of cropped area and cropping pattern: Central Agency for Public Mobilization and Statistics (CAPMAS), 2018. Annual Bulletin of Statistical Crop Area and Plant Production 2015/2016. Ref No 71_22122_2016. Egypt

Source of Equipped area: Central Agency for Public Mobilization and Statistics (CAPMAS), 2017. Bulletin of Agricultural Boundaries and Properties 2017. Ref No 75_221210_2017. Egypt

(a) Value given in CAPMAS (2017) combines Matruh and Alexandria. In the final selection Matruh was taken out separately and the value for Alexandria (73127) was taken from Nile-sec feedback

(b) Matrouh data was combined with Bereha in the 2017 Arable land report. The indicated value is obtained from Alexandria (CAPMAS, 2017) arable land column minus Alexandria equipped: 172266.4- 73,127.33 = 99139.03

(c) Luxor and Qena combined: Same water source and cropping pattern,

(d) It combines Sina irrigation schemes

(e) This is the area on west of Nile river (The chain of oases—Kharga, Dakhla, Farafra, and Baharia—to the west of the Nile Valley)

Annex A-3: Estimate of Irrigated Area in the Nile Basin Part of Ethiopia
Category I: Large Scale Irrigation Schemes

	Scheme Name	District	Irrigation Area, ha Cropped	Equipped	Water Source Type	Name	Cropping Pattern	Overall efficiency, %
1	Koga	Merawi	6,318	7,004	Dam	Koga	ETH1	50
2	Fincha Sugar and Amerti Nesh	Abay Chomen	20,145	20,145	Dam	Fincha/ Amerti	ETH3	65
3	Tana-Beles	Kunzila	25,000	25,000	Lake	Tana	ETH3	50
4	Megech Serba Pump	Dembia	4,300	4,300	Lake	Tana	ETH1	50
5	Abobo	Abobo	10,515	10,515	Dam	Alwero	ETH6	50
	Total, Large Scale Schemes		**66,278**	**66,964**				

(Source: IWMI 2018*)*
Source of cropped/equipped area: Abay Basin Authority, Bahrdar, Ethiopia

Category II: Cumulative of scattered small scale Irrigation schemes by subbasin

	Basin	Subbasin	Name	Area, ha Cropped	Equipped	Coordinates x	y	Water Source Type	Name	Cropping Pattern
1	Abbay	Belles	upper Beles	15,519.2	19,160	224,955	1,273,056	Lake Tana and Belles River		ETH11
2	Abbay	Belles	Asinwara	451.7	558	279,711	1,302,372	River		ETH11
3	Abbay	Belles	Begusta	2,871.1	3,545	223,638	1,251,472	River		ETH11
4	Abbay	Belles	SW Dangila	952.7	1,176	241,948	1,235,123	River		ETH11
5	Abbay	Beshilo	Ashenat	2,201.4	2,718			River		ETH12
6	Abbay	Dabus	Upper Dila	216.4	267	93,968	1,033,414	River		ETH15
7	Abbay	Dabus	Asosa	1,252.7	1,547	14,330	1,113,424	River		ETH15
8	Abbay	Dabus	North Asosa	4,900.1	6,050	14,186	1,121,556	River		ETH15
9	Abbay	Dabus	Baro	7,152.3	8,830	23,342	1,111,581	River	Baro	ETH15
10	Abbay	Dinder		0	0					
11	Abbay	Guder	Kale	80.7	100	361,745	1,032,163	River		ETH17
12	Abbay	Jemma	Robi	1,142.6	1,411	5,17,073	1,073,114	River		ETH17
13	Abbay	Jemma	Dinbaro	563.6	696	5,68,579	1,074,189	River		ETH17
14	Abbay	Jemma	Degolo	1,016.3	1,255	531,684	1,153,987	River		ETH17
15	Abbay	Jemma	Debora Guracha	1,847.3	2,281	533,294	1,158,590	River		ETH17
16	Abbay	North Gojam	Tis Abay	5,465.3	6,747	336,980	1,271,961	River		ETH19
17	Abbay	North Gojam	upper Tisisat	1,824.9	2,253	325,981	1,271,400	River		ETH19
18	Abbay	North Gojam	Zegye	989.0	1,221	328,586	1,288,443	River		ETH19
19	Abbay	Rahad		0	0					
20	Abbay	Tana	Genda	1,463.5	1,807	314,851	1,367,784	River		ETH12
21	Abbay	Tana	upper Gilgel Abay	3,737.1	4,614	293,490	1,230,561	River		ETH12
22	Abbay	Tana	NW Tana	3,911.2	4,829	286,731	1,349,380	Lake	Tana	ETH12
23	Abbay	Tana	lower Gilgel Abay	495.5	612	284,562	1,260,310	River		ETH12
24	Abbay	Tana	NE Tana	3,358.5	4,146	350,711	1,340,813	Lake	Tana	ETH12
25	Abbay	Tana	SW Tana	521.6	644	285,369	1,311,459	Lake	Tana	ETH12
26	Abbay	Tana	South Chula	6,399.7	7,901	299,949	1,362,848	River		ETH12
27	Abbay	Tana	SE Genda	1,919.4	2,370	315,310	1,361,757	River		ETH12
28	Abbay	Tana	Asinwara	12,812.5	15,818	286,116	1,299,695	River		ETH12
29	Abbay	Tana	Megach	2,466.2	3,045	315,563	1,358,376	River		ETH12

30	Abbay	Tana	Fogera	14,311.4	17,668	346,244	1,322,546	Dam	Rib	ETH12
31	Abbay	Tana	Chach	1,691.2	2,088	294,964	1,357,715	River		ETH12
32	Abbay	Tana	Gumara	9,692.3	11,966	352,024	1,314,186	River		
33	Abbay	Tana	West Yifag	890.0	1,099	358,005	1,334,971	River		ETH12
34	Abbay	Tana	East Yifag	1,051.6	1,298	362,890	1,336,153	River		ETH12
35	Abbay	Tana	SE Aboa	6,533.3	8,066	362,063	1,326,987	River		ETH12
36	Abbay	Tana	North Koga	3,026.7	3,737	303,078	1,261,557	River		ETH12
37	Abbay	Tana	SE Koga	2,158.2	2,664	304,042	1,253,859	River		ETH12
38	Abbay	Tana	Aberge	9,134.1	11,277	310,525	1,289,844	River		ETH12
39	Abbay	Tana	Zegye	376.9	465	330,050	1,295,085	River		ETH12
40	Abbay	Tana	Demeka	405.5	501	307,646	1,306,935	River		ETH12
41	Abbay	Tana	Wembreya	580.8	717	281,551	1,315,706	River		ETH12
42	Abbay	Tana	Bardo	3,113.0	3,843	301,056	1,301,961	River		ETH12
43	Abbay	Tana	Sciovele	6,996.2	8,637	294,229	1,292,931	River		ETH12
44	Abbay	Tana	Debir Duba	1,942.5	2,398	303,949	1,291,867	River		ETH12
45	Abbay	Tana	Giahana Gheorghis	420.9	520	283,610	1,283,591	River		ETH12
46	Abbay	Tana	NW Delache	597.4	737	283,367	1,278,766	River		ETH12
47	Abbay	Tana	NE Delache	1,759.6	2,172	288,092	1,280,222	River		ETH12
48	Abbay	Tana	Tuhuwa Hana	328.2	405	303,783	1,349,779	River		ETH12
49	Abbay	Tana	Debre Tsehay	17,348.1	21,417	290,560	1,264,599	River		ETH12
50	Abbay	Tana	Weyna	7,957.6	9,824	326,894	1,363,622	River		ETH12
51	Abbay	Tana	SW Leyin	5,256.1	6,489	336,555	1,362,295	River		ETH12
52	Abbay	Tana	East Fisa	412.1	509	334,149	1,296,227	River		ETH12
53	Abbay	Tana	SE Dangla	340.4	420	283,144	1,238,185	River		ETH12
54	Abbay	Welaka	Debora Guracha	1,165.0	1,438	530,183	1,157,400	River		ETH12
55	Abbay	Wonbera		0	0					
56	Abbay	South Gojam	Midle Birr	19,578.8	24,171	310,751	1,176,020	River		ETH19
57	Abbay	South Gojam	Chemoga	762.3	941	345,973	1,111,704	River		ETH19
58	Abbay	South Gojam	Lemene	34,211.0	42,236	383,854	1,130,715	River		ETH19
59	Abbay	South Gojam	Lower Birr	6,942.8	8,571	295,485	1,157,608	River		ETH19
60	Abbay	South Gojam	Azena	8,805.3	10,871	256,336	1,174,976	River		ETH19
61	Abbay	South Gojam	Chagni	2,075.6	2,562	220,459	1,206,745	River		ETH19
62	Abbay	South Gojam	East Agew Gimjabet	1,686.8	2,082	275,033	1,199,543	River		ETH19
63	Abbay	South Gojam	West Gudera Bahir	750.1	926	293,950	1,208,039	River		ETH19
64	Abbay	South Gojam	SW Gish Abay	255.0	315	292,413	1,213,105	River		ETH19
65	Abbay	South Gojam	North Gudera Bahir	1,081.2	1,335	303,842	1,205,940	River		ETH19
66	Abbay	South Gojam	Fafa	10,428.1	12,874	267,522	1,203,857	River		ETH19
67	Abbay	South Gojam	Mukusan	3,348.2	4,134	284,051	1,166,927	River		ETH19
68	Abbay	South Gojam	Bure	1,529.0	1,888	290,535	1,180,845	River		ETH19
69	Abbay	South Gojam	West Gumar	869.3	1,073	267,493	1,161,858	River		ETH19
70	Abbay	South Gojam	East Gumar	1,981.8	2,447	277,946	1,159,232	River		ETH19
71	Abbay	South Gojam	West Basi	74.3	92	282,029	1,171,856	River		ETH19
72	Abbay	South Gojam	West Kidamaja	53.1	66	244,876	1,222,125	River		ETH19
73	Abbay	Anger	Anger	539.8	666	246,999	1,071,201	River		ETH15
74	Abbay	Anger	Leku	12,265.7	15,143	200,900	1,038,888	River		ETH15

75	Abbay	Anger	Nekemete	31,018.1	38,294	234,141	1,037,853	River	ETH15
76	Abbay	Muger	Hemocho	1,752.1	2,163	428,849	1,025,345	River	ETH17
77	Abbay	Muger	Ela	1,710.4	2,112	423,204	1,035,045	River	ETH17
78	Abbay	Didessa	Arjo Dedesa	4,665.3	5,760	218,270	952,969	Dam	ETH15
79	Abbay	Didessa	Dediga	8,943.9	11,042	195,987	1,014,381	River	ETH15
80	Abbay	Didessa	Leku	9,958.5	12,294	196,634	1,029,664	River	ETH15
81	Abbay	Didessa	Nrgeso	8,039.3	9,925	255,766	990,151	Dam	ETH15
82	Baro Akobo	Upper Pibor East		0	0				
83	Baro Akobo	Upper Akobo	Kilu	1,343.3	1,658	131,281	730,240	River	ETH6
84	Baro Akobo	Upper Akobo	Awaya	2,134.9	2,636	29,959	751,808	River	ETH6
85	Baro Akobo	Upper Akobo	Akobo	1,186.4	1,465	104,600	700,070	River	ETH6
86	Baro Akobo	Lower Akobo		0	0				
87	Baro Akobo	Lower Pibor		0	0				
88	Baro Akobo	Machar Marshes - Adar incl Yabus	North Asosa	17.5	22	10,462	1,120,748	River	ETH6
89	Baro Akobo	Gilo		0	0				
90	Baro Akobo	Baro d/s Birbir Confluence	Poko	6,482.0	8,002	1,327,571	906,854	River	ETH15
91	Baro Akobo	Baro d/s Birbir Confluence	NW Acado	254.3	314	1,316,837	911,992	River	ETH15
92	Baro Akobo	Baro d/s Birbir Confluence	SE Poko	136.4	168	1,331,730	901,594	River	ETH15
93	Baro Akobo	Baro d/s Birbir Confluence	Gilawo	1,232.8	1,522	1,309,494	904,738	River	ETH15
94	Baro Akobo	Birbir		0	0				
95	Baro Akobo	Geba		0	0				
96	Tekeze	Er-Tekeze Basin	SE Himora	67.7	84	244,429	1,573,298	River	ETH25
97	Tekeze	Er-Tekeze Basin	lower himora	58.6	72	239,096	1,576,959	River	ETH25
98	Tekeze	Er-Tekeze Basin	N Himora	297.7	368	246,301	1,582,315	River	ETH25
99	Tekeze	Lower Tekeze	SE Himora	261.1	322	249,136	1,570,757	River	ETH20
100	Tekeze	Lower Tekeze	River irrig	69.7	86	347,203	1,556,886	River	ETH20
101	Tekeze	Lower Tekeze	Birkuta	2,253.4	2,782	319,056	1,567,017	River	ETH20
102	Tekeze	Lower Tekeze	W Birkuta	4,933.9	6,091	309,881	1,558,890	River	ETH20
103	Tekeze	Sibta	River irrig	327.0	404	354,632	1,545,189	River	ETH20
104	Tekeze	Sibta	NE May Tsemere	1,093.6	1,350	407,267	1,503,399	river	ETH20
105	Tekeze	Gheba	Aba Gerima	221.8	274	496,041	1,565,137	River	ETH24
106	Tekeze	Gheba	West Feresmay	645.1	796	510,872	1,568,506	River	ETH24
107	Tekeze	Angereb	S Abdurafi	41.3	51	233,299	1,477,348	River	ETH20
108	Tekeze	Zarema	River irrig	505.5	624	354,463	1,543,072	River	ETH12
109	Tekeze	Zarema	Welkait	2,135.3	2,636	347,609	1,539,417	River	ETH12

110	Tekeze	Zarema	NW May Tsemere	833.2	1,029	400,068	1,499,246	River	ETH12
111	Tekeze	Zarema	NE May Tsemere	0.9	1	405,092	1,500,811	River	ETH12
112	Tekeze	Middle Tekeze		0	0				
113	Tekeze	Tserare		0	0				
114	Tekeze	Goang	SE Maganan	804.3	993	223,303	1,409,633	River	ETH20
115	Tekeze	Belesa		0	0				
116	Tekeze	Upper Tekeze		0	0				
117	Mereb	Mereb	East Gelila	582.2	719	440,772	1,568,582	River	ETH25
118	Mereb	Mereb	Enticho	127.7	158	517,165	1,578,436	River	ETH25
119	Mereb	Mereb	Enticho2	20.6	25	517,658	1,583,701	River	ETH25
120	Mereb	Mereb	Wukro	91.0	112	453,661	1,566,891	River	ETH25
121	Mereb	Mereb	West Gelila	245.5	303	433,496	1,565,847	River	ETH25
122	Mereb	Mereb	Semema	303.7	375	429,414	1,568,046	River	ETH25
123	Mereb	Mereb	Gelila	4,086.7	5,045	439,558	1,563,543	River	ETH25
		Total		**389,143**	**480,426**				
	Total (Large plus small scale)			**455,421**	**547,387**				

Source for cropped area: GIRDC 2018; Source for equipped area: Assumption: 81% of equipped =cropped

Source of water resources: Communication with officers from Abay Basin Authority and Tigray Bureau of Water Resources

Annex A-4: Existing Irrigated Area in Kenya (NBI 2015)

ID	Count	Scheme Name	District	Cropped	Equipped	Type	River Name	Crop Pattern	X	Y	Alt
10	1	Charachani	Nyamira	50.00	134.00	River	Awach Kibuon	KEN7	34.9233	-0.5866	1942
70	2	Mong'A Swam	Nyamira	85.00	120.00	River	Awach Kibuon	KEN1	34.9324	-0.5144	1803
72	3	Monsore	Nyamira	55.00	75.00	River	Awach Kibuon	KEN4	34.9055	-0.5234	1804
82	4	Nyabioto	Nyamira	56.00	80.00	River	Awach Kibuon	KEN1	34.8785	-0.6046	1925
83	5	Nyabomite	Nyamira	70.00	120.00	River	Awach Kibuon	KEN13	34.9332	-0.5776	2003
92	6	Nyamusi	Nyamira	150.00	180.00	River	Awach Kibuon	KEN4	34.9682	-0.4784	1690
116	7	Sironga	Nyamira	70.00	70.00	River	Awach Kibuon	KEN1	34.9189	-0.5975	1957
19	8	Ekerubo	Nyamira	400.00	480.00	River	Itare	KEN13	35.0594	-0.8295	1808
20	9	Ekerubo/Get	Nyamira	65.00	100.00	River	Itare	KEN1	35.0594	-0.8295	1808
27	10	Isoge	Nyamira	300.00	540.00	River	Itare	KEN13	35.0577	-0.7853	1795
44	11	Kineni	Nyamira	400.00	680.00	River	Itare	KEN4	35.0935	-0.7853	1777
51	12	Lietego	Nyamira	400.00	460.00	River	Itare	KEN13	35.0146	-0.8439	1887
58	13	Manga	Nyamira	650.00	740.00	River	Itare	KEN4	35.0218	-0.8142	1827
69	14	Mogusi	Nyamira	180.00	200.00	River	Itare	KEN4	35.0559	-0.6969	1816
94	15	Nyansiongno	Nyamira	200.00	300.00	River	Itare	KEN4	35.0173	-0.7672	1861
108	16	Riomega	Nyamira	65.00	65.00	River	Itare	KEN13	35.0310	-0.5055	1690
33	17	Kanyumba	Siaya	75.00	75.00	River	L_Nzoia	KEN15	34.2085	0.2389	1220
39	18	Kathieno B	Siaya	60.00	1,440.00	River	L_Nzoia	KEN21	34.3169	0.2435	1214
56	19	Magoya	Siaya	50.00	3,700.00	River	L_Nzoia	KEN20	34.3321	0.2381	1222
57	20	Mahawa	Siaya	90.00	120.00	River	L_Nzoia	KEN15	34.1146	0.1343	1151
123	21	Usula	Siaya	185.00	185.00	River	L_Nzoia	KEN22	34.2515	0.2389	1229
137	22	Bunyala	Busya	702	702	River	L_Nzoia	KEN1	34.0680	0.0992	1144
2	23	Alara	Migori	80.00	320.00	River	L_Sare	KEN24	34.5289	-0.7658	1330
6	24	Angogo	Migori	90.00	310.00	River	L_Sare	KEN24	34.5558	-0.7325	1343

15	25	Chunge	Migori	50.00	110.00	River	L_Sare	KEN25	34.4347	-0.8658	1333
31	26	Kanga	Migori	50.00	350.00	River	L_Sare	KEN24	34.6014	-0.8029	1469
32	27	Kanyimach	Migori	50.00	400.00	River	L_Sare	KEN24	34.6048	-0.9337	1493
46	28	Kodero Obar	Migori	120.00	200.00	River	L_Sare	KEN7	34.6185	-0.7533	1480
48	29	Komenya	Migori	400.00	600.00	River	L_Sare	KEN24	34.5377	-0.8344	1395
64	30	Minyenya	Migori	50.00	300.00	River	L_Sare	KEN7	34.6230	-0.6938	1435
73	31	Mori	Migori	50.00	330.00	River	L_Sare	KEN9	34.4570	-0.8884	1431
88	32	Nyamaura	Migori	50.00	400.00	River	L_Sare	KEN24	34.5961	-0.6991	1394
91	33	Nyamuga	Migori	60.00	95.00	River	L_Sare	KEN19	34.5692	-0.7127	1370
98	34	Nyasore	Migori	80.00	80.00	River	L_Sare	KEN20	34.6274	-0.7713	1524
103	35	Opapo	Migori	60.00	60.00	River	L_Sare	KEN8	34.5558	-0.6946	1355
105	36	Ranjira	Migori	180.00	180.00	River	L_Sare	KEN7	34.5109	-0.8975	1459
107	37	Rinya	Migori	300.00	300.00	River	L_Sare	KEN7	34.5735	-0.9021	1454
109	38	Saberi	Migori	80.00	80.00	River	L_Sare	KEN24	34.4974	-0.8280	1331
119	39	Thimlich	Migori	80.00	80.00	River	L_Sare	KEN22	34.3227	-0.8792	1274
130	40	Waware	Migori	400.00	400.00	River	L_Sare	KEN24	34.5825	-0.8931	1480
133	41	Yago (Bongu)	Migori	200.00	200.00	River	L_Sare	KEN24	34.5735	-0.8705	1494
13	42	Chiga	Kisumu	50.00	130.00	Lake	Lake Victoria KN	KEN19	34.8124	-0.0907	1165
43	43	Kimira Oluchi	Homa Bay	340	340	River	Lake Victoria KN	KEN14	34.5875	-0.3757	1154
63	44	Maugo Rice	Homa Bay	200.00	300.00	Lake	Lake Victoria KN	KEN14	34.5703	-0.4790	1223
84	45	Nyachira	Kisumu	70.00	70.00	Lake	Lake Victoria KN	KEN14	34.6090	-0.1030	1279
90	46	Nyamthoe	Kisumu	900.00	900.00	Lake	Lake Victoria KN	KEN19	34.7891	-0.1173	1147
93	47	Nyamware N	Kisumu	10.00	10.00	River	Lake Victoria KN	KEN19	34.7981	-0.1669	1143
101	48	Omiti	Migori	50.00	50.00	Lake	Lake Victoria KN	KEN17	34.1972	-0.9512	1146
112	49	Sinyolo Tog	Kisumu	60.00	60.00	Lake	Lake Victoria KN	KEN19	34.6600	-0.0345	1365
132	50	West Kano	Kisumu	680.00	680.00	Lake	Lake Victoria KN	KEN14	34.8092	-0.1916	1140
9	51	Bulimbo	Butere-Mumias	80.00	470.00	River	M_Nzoia	KEN8	34.5112	0.3770	1307
18	52	Ekama	Butere-Mumias	100.00	300.00	River	M_Nzoia	KEN8	34.5023	0.3698	1278
29	53	Kamuli	Kakamega	50.00	270.00	River	M_Nzoia	KEN7	34.6138	0.4240	1368
30	54	Kamusinga	Bungoma	70	70	River	M_Nzoia	KEN19	34.7591	0.8139	1714
42	55	Kiambaa	Uasin Gishu	75.00	150.00	River	M_Nzoia	KEN7	35.2964	0.4722	2157
45	56	Kisaluni	Bungoma	100.00	300.00	River	M_Nzoia	KEN8	34.6509	0.5747	1471
50	57	Lelmolok	Uasin Gishu	60.00	90.00	River	M_Nzoia	KEN7	35.3314	0.3395	2169
62	58	Matawa	Butere-Mumias	340.00	1,360.00	River	M_Nzoia	KEN7	34.4253	0.3247	1266
114	59	Sirare	Bungoma	65.00	65.00	River	M_Nzoia	KEN8	34.5989	0.6450	1547
134	60	Yalili	Bungoma	100.00	100.00	River	M_Nzoia	KEN1	34.6984	0.5116	1431
1	61	Achuth	Migori	50.00	200.00	River	Migori	KEN24	34.5465	-1.0193	1442
7	62	Arambe	Migori	50.00	350.00	River	Migori	KEN7	34.5733	-1.0329	1463
59	63	Manyatta	Migori	190.00	300.00	River	Migori	KEN24	34.5599	-1.0572	1539
97	64	Nyarongi	Migori	50.00	300.00	Lake	Migori	KEN23	34.4435	-1.0012	1457

100	65	Ogada Girib	Migori	50.00	50.00	Lake	Migori	KEN23	34.3134	-1.1092	1334
104	66	Oruba	Migori	50.00	50.00	Lake	Migori	KEN25	34.4568	-1.0688	1420
110	67	Sagegi	Migori	60.00	60.00	River	Migori	KEN25	34.6180	-1.1142	1486
111	68	Siling	Migori	50.00	50.00	River	Migori	KEN16	34.5688	-1.0690	1546
118	69	Thim Jope	Migori	50.00	50.00	River	Migori	KEN7	34.5644	-1.0112	1447
122	70	Ulanda	Migori	80.00	80.00	River	Migori	KEN24	34.5985	-0.9878	1507
124	71	Waloma	Migori	50.00	50.00	River	Migori	KEN24	34.5823	-1.0600	1509
129	72	Wasio	Migori	60.00	60.00	River	Migori	KEN7	34.5061	-1.0869	1463
3	73	Alungo B	Nyando	70.00	100.00	Lake	Nyando	KEN22	34.9863	-0.1173	1172
4	74	Amira	Kisumu	30.00	30.00	Lake	Nyando	KEN14	34.8769	-0.2346	1142
8	75	Awach Kano	Nyando	140.00	200.00	River	Nyando	KEN14	34.9872	-0.2347	1159
16	76	Dakrao	Kisumu	65.00	65.00	River	Nyando	KEN14	34.8760	-0.1985	1148
24	77	Gem Nam	Nyando	50.00	150.00	River	Nyando	KEN21	34.9002	-0.2437	1144
25	78	Gem Rae	Nyando	90.00	90.00	River	Nyando	KEN22	34.9029	-0.2346	1145
28	79	Kamayoga	Kisumu	70.00	70.00	River	Nyando	KEN14	34.9530	-0.1180	1165
36	80	Kapondo	Kisumu	40.00	40.00	River	Nyando	KEN14	34.8966	-0.1715	1151
38	81	Kasim-Kolal	Nyando	80.00	100.00	Lake	Nyando	KEN22	34.9002	-0.1444	1155
49	82	Kore	Nyando	104.00	200.00	Lake	Nyando	KEN22	34.9007	-0.1354	1154
61	83	Masume	Nyando	100.00	150.00	River	Nyando	KEN14	34.9890	-0.1805	1159
66	84	Miruka	Nyando	119.00	119.00	River	Nyando	KEN18	34.8993	-0.2933	1141
85	85	Nyachoda Ri	Nyando	50.00	55.00	River	Nyando	KEN14	34.9047	-0.2392	1143
86	86	Nyakalewa	Kisumu	66.00	66.00	Lake	Nyando	KEN14	34.8751	-0.1173	1152
102	87	Ondilla	Kisumu	70.00	70.00	River	Nyando	KEN14	34.8751	-0.2256	1142
121	88	U Kotieno	Kisumu	43.00	43.00	River	Nyando	KEN14	34.9560	-0.1200	1165
126	89	Wasare Nam	Nyando	100.00	100.00	River	Nyando	KEN18	34.9002	-0.2888	1146
127	90	Wasare Rice	Nyando	120.00	120.00	River	Nyando	KEN18	34.9002	-0.2888	1146
128	91	Wasare Sian	Nyando	170.00	170.00	River	Nyando	KEN18	34.9002	-0.2888	1146
135	92	Ahero	Kisumu	1,047	1690	River	Nyando	KEN14	34.9318	-0.1592	1157
136	93	Arombo		22	22	River	Nyando	KEN14	34.8993	-0.1800	1151
138	94	South-West Kano	Nyando	900	900	River	Nyando	KEN14	34.8963	-0.2557	1142
22	95	Esisari	Butere-Mumias	120.00	1,080.00	River	Sio	KEN17	34.3903	0.4581	1226
65	96	Mirere	Butere-Mumias	50.00	220.00	River	Sio	KEN3	34.4368	0.4564	1266
79	97	Namamali	Butere-Mumias	50.00	1,200.00	River	Sio	KEN17	34.4261	0.4753	1261
81	98	Namulungu	Butere-Mumias	150.00	1,450.00	River	Sio	KEN17	34.4754	0.4600	1282
113	99	Sio	Bungoma	120.00	120.00	River	Sio	KEN8	34.5488	0.5557	1409
115	100	Siritinyi	Bungoma	60.00	60.00	River	Sio	KEN8	34.5559	0.5863	1450
117	101	Soilo	Butere-Mumias	340.00	340.00	River	Sio	KEN17	34.4162	0.4654	1264
5	102	Amuka	Trans Nzoia	120.00	160.00	River	U_Nzoia	KEN4	34.9587	1.0650	1855
11	103	Chepkorok	Trans Nzoia	127.00	169.00	River	U_Nzoia	KEN4	34.8511	1.0739	1879
12	104	Chepsalei	Trans Nzoia	160.00	540.00	River	U_Nzoia	KEN8	34.8511	1.0829	1872
26	105	Goseta	Trans Nzoia	140.00	240.00	River	U_Nzoia	KEN4	34.9587	1.0650	1855
35	106	Kapomboi	Trans Nzoia	100.00	500.00	River	U_Nzoia	KEN8	35.0305	1.0245	1893
47	107	Koiebei (Koitoboss)	Trans Nzoia	30	50	River	U_Nzoia	KEN19	35.0367	1.0651	1818
52	108	Liyavo	Trans Nzoia	590.00	690.00	River	U_Nzoia	KEN4	34.9587	1.0650	1855
53	109	Mabusi	Bungoma	50.00	70.00	River	U_Nzoia	KEN7	34.9653	0.7572	1661
54	110	Machungwa	Trans Nzoia	50.00	200.00	River	U_Nzoia	KEN1	35.0484	1.0832	1861
60	111	Maridadi	Trans Nzoia	150.00	250.00	River	U_Nzoia	KEN1	34.9587	1.0650	1855
77	112	Mucharage	Trans Nzoia	195.00	261.00	River	U_Nzoia	KEN4	34.8511	1.0739	1879

80	113	Namanjalala	Trans Nzoia	200.00	600.00	River	U_Nzoia	KEN15	34.9587	1.0650	1855
87	114	Nyakinywa	Trans Nzoia	112.00	148.00	River	U_Nzoia	KEN1	35.0751	1.1735	1892
125	115	Wamwini	Trans Nzoia	120.00	120.00	River	U_Nzoia	KEN1	35.0305	1.0290	1878
131	116	Wehonia	Trans Nzoia	80.00	80.00	River	U_Nzoia	KEN4	34.8511	1.0739	1879
14	117	Chirichiro	Kisii	310.00	400.00	River	U_Sare	KEN1	34.9097	-0.7725	1958
21	118	Enunda	Nyamira	80.00	80.00	River	U_Sare	KEN13	34.9233	-0.6381	1960
23	119	Gekano	Nyamira	80.00	100.00	River	U_Sare	KEN13	34.9277	-0.6895	1873
37	120	Karantini	Nyamira	50.00	70.00	River	U_Sare	KEN13	34.9609	-0.7220	1899
40	121	Kebuku	Nyamira	60.00	100.00	River	U_Sare	KEN13	34.9628	-0.6228	1974
41	122	Kiamasalimu	Nyamira	50.00	70.00	River	U_Sare	KEN13	34.9161	-0.6949	1856
55	123	Magombo	Nyamira	60.00	88.00	River	U_Sare	KEN13	34.9161	-0.6521	1954
67	124	Mobamba	Nyamira	300.00	380.00	River	U_Sare	KEN13	34.9771	-0.6499	1930
68	125	Mochenwa	Nyamira	180.00	300.00	River	U_Sare	KEN13	34.9591	-0.7040	1900
71	126	Mongoni	Nyamira	80.00	150.00	River	U_Sare	KEN13	34.9161	-0.7040	1864
74	127	Moromba	Nyamira	100.00	148.00	River	U_Sare	KEN13	34.8651	-0.6227	1906
75	128	Mosobeti	Nyamira	300.00	380.00	River	U_Sare	KEN13	34.9735	-0.6796	1893
76	129	Mriri	Nyamira	150.00	200.00	River	U_Sare	KEN13	34.9089	-0.6769	1954
95	130	Nyantaro	Nyamira	60.00	80.00	River	U_Sare	KEN13	34.9520	-0.6670	1876
96	131	Nyanturago	Kisii	250.00	500.00	River	U_Sare	KEN1	34.8443	-0.7959	1765
99	132	Nyaturubo	Kisii	50.00	50.00	River	U_Sare	KEN9	34.8766	-0.7490	1901
106	133	Rigoma	Nyamira	100.00	100.00	River	U_Sare	KEN13	34.9367	-0.7130	1880
17	134	Yala Swamp (Dominion)	Siaya	8000	8000	River	Yala	KEN14	34.1155	-0.0217	1182
34	135	Kapchorwa T	Nandi	150.00	167.00	River	Yala	KEN11	35.2911	0.0993	2103
78	136	Mugona	Siaya	50.00	50.00	River	Yala	KEN15	34.1871	0.0243	1154
89	137	Nyamninia	Siaya	3,000.00	12,000.00	River	Yala	KEN15	34.5095	0.1082	1471
120	138	U Kamayoga	Kisumu	70.00	70.00	River	Yala	KEN14	34.9570	0.1090	1869
121	139	Agolot		50	50		VN_ Malaba-KN	KEN12	34.144	0.4688	
122	140	Osarete		150	150		VN_ Malaba-KN	KEN12	34.2871	0.6222	
123	141	Apokor		150	150		VN_ Malaba-KN	KEN12	34.314	0.6222	
124	142	Kamolo		400	400		VN_ Malaba-KN	KEN12	34.314	0.5771	
125	143	Kwangamol		500	500		VN_ Malaba-KN	KEN12	34.323	0.5862	
126	144	Kokare		100	100		VN_ Malaba-KN	KEN12	34.3409	0.6132	
127	145	Mara		650	650		Mara-Kn	KEN4	35.26227	-1.15994	
		Total		33,167	61,256						

Note: NBI, 2015 data: Cropped = 20, 057 ha and Equipped = 47,483 ha

Annex A-5: Area Irrigated/Cropped in the Nile Basin Part of Rwanda

ID	Command area	District	Cropped ha	Equipped ha	Water Source Type	Water Source Name	Cropping pattern
24	Rwamagana	Rwamagana	1000	1000	River		RWD1
7	Gashora hill side	Bugesera/East	15	15	River		RWD1
10	Kajevuba	Gasabo/MVK	95	95	River		RWD1
11	Kanyonyomba marshland	Gatsibo/East	600	600	River		RWD1
19	Ntende	Gatsibo/East	25	120	River		RWD1
6	Cyarubare	Huye/South	40	40	River		RWD1
22	Rusuli-Rwamuginga marshland	Huye/South	170	121	River		RWD1
25	Rwasave marshland	Huye/South	100	1000	River		RWD1
15	Mukunguli marshland	Kamonyi/South	250	250	River		RWD1
9	Gisunzu hill side	Karonge/West	50	50	River		RWD1
18	Ntaruko, Ndaba & Rubengera	Karonge/West	100	100	River		RWD1
13	Kinnyogo	Kihere/East	53	53	River		RWD1
17	Ngugu	Kihere/East	50	50	River		RWD1
12	Kibaya-Cyunuzi marshland	Kihere/West	196.5	196.5	River		RWD1
20	Rugeramigozi marshland I and Biringanya marshland	Muhanga/South	129	66	River		RWD1
21	Rugeramigozi marshland II	Muhanga/South	121	63	River		RWD1
23	Rwabikwano & Kiruhura	Ngoma/East	358.5	358.5	River		RWD1
5	Codervam 2 & 3	Nyagatare/East	220	460	River		RWD1
14	Matimba & Kagitumba hillside	Nyagatare/East	900	900	River		RWD1
16	Muvumba marshland	Nyagatare/East	2435	2435	River		RWD1
1	Agasasa marshland	Nyanza/South	180	180	River		RWD1
2	Base	Ruhango/South	65	170	River		RWD1
3	Bugarama-Nord marshland	Rusizi/West	205	205	River		RWD1
4	Bugarama-Est marshland	Rusizi/West	240	240	River		RWD1
8	Gatandara-Kabirundwe I & II	Rusizi/West	100	100	River		RWD1
			7698	8868			

Source: Feedback from Nile-Sec: National Institute of Statistics of Rwanda, 2019.

Annex A-6: Existing Irrigated Area in South Sudan

	Scheme Name	State (Level 2)	Cropped		Equipped		Water Source		Cropping Pattern	Type of Irrigation Technology
			Feddan	Ha	Feddan	Ha	Type	Name		
1	Aweil	N. Bahr el Ghazal	28,000	11,760	28,000	11,760	River	Lol	SSD4	Pumps
2	Mongala (Sugar)	Easter Equatoria	23,000	9,660	23,000	9,660	River	Bahr el-Jebel	SSD2	Pumps
3	Pengko	Jonglei	50,000	21,000	50,000	21,000	River	Nile	SSD1	Pumps
4	Melut (Sugar)	Upper Nile	35,000	14,700	35,000	14,700	River	Nile	SSD2	Pumps
5	Malakal (rice)	Upper Nile	10,000	4,200	10,000	4,200	River	Nile	SSD4	Pumps
6	Fewar North	N. Upper Nile	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
7	Fewar South	N. Upper Nile	600	252	600	252	River	Nile	SSD5	Pumps
8	Khor Hajaz	N. Upper Nile	600	252	600	252	River	Nile	SSD5	Pumps
9	Bandit	N. Upper Nile	1,050	441	1,050	441	River	Nile	SSD5	Pumps
10	Latbior	N. Upper Nile	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
11	Joandit	N. Upper Nile	600	252	600	252	River	Nile	SSD5	Pumps
12	Majak	N. Upper Nile	840	353	840	353	River	Nile	SSD5	Pumps
13	Mulbok	N. Upper Nile	10,000	4,200	10,000	4,200	River	Nile	SSD5	Pumps
14	Melut	N. Upper Nile	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
15	Abu Khadra	Renk North	9,000	3,780	9,000	3,780	River	Nile	SSD5	Pumps
16	Mangarra	Renk North	1,650	693	1,650	693	River	Nile	SSD5	Pumps
17	Gaiger	Renk North	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
18	Teiba	Renk North	2,250	945	2,250	945	River	Nile	SSD5	Pumps
19	Birkat El Agab	Renk North	17,250	7,245	17,250	7,245	River	Nile	SSD5	Pumps
20	Remula South	Renk North	2,265	951	2,265	951	River	Nile	SSD5	Pumps
21	Remula North	Renk North	690	290	690	290	River	Nile	SSD5	Pumps
22	Hamdok	Renk North	2,250	945	2,250	945	River	Nile	SSD5	Pumps
23	Goz Famay	Renk North	1,650	693	1,650	693	River	Nile	SSD5	Pumps
24	Bushara	Renk North	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
25	Wad Dakona	Renk North	2,250	945	2,250	945	River	Nile	SSD5	Pumps
26	Lol Amara	Renk North	3,000	1,260	3,000	1,260	River	Nile	SSD5	Pumps
27	Biar Kadok	Renk North	1,650	693	1,650	693	River	Nile	SSD5	Pumps
28	Debbat Alali	Upper Nile State	2,250	945	2,250	945	River	Nile	SSD6	Pumps
29	Other small schemes	upper Nile State	44,286	18,600	44,286	18,600	River	Nile	SSD6	Pumps
	Total		265,131	111,355	265,131	111,355				

Compiled from:

Ministry of Irrigation (1979). Nile Waters Study, Volume 3, Supporting report IV Irrigation (for cropped area for scheme no. 1,2,3,4, 5 and 31; for Equipped area for scheme no.3)

MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan (2015). PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN (IDMP) IN THE REPUBLIC OF SOUTH SUDAN. FINAL REPORT (ANNEXES, PART I) (For cropped area of all schemes except schemes no. 1 through 5)

Dr. Ahmed A. Kabo. White Nile Pump Schemes Grouping. Ministry of Irrigation and Water Resources - Sudan. Personal communication (for area equipped for all Irrigation schemes, except schemes nos. 3, 6, 10, 14, 18, 28, 29 and 31)

Annex A-7: Existing Irrigated Area and Area Equipped with Infrastructure in Sudan

Count	Scheme Name	State (Level 2)	Cropped Ha	Equipped Ha	Cropping Pattern	Type of irrigation technology	Water delivery method verified
BN1	Abu Naama (Private scheme since 2008, Abu Naama Food Production Scheme)... operational	Blue Nile	12600.00	12600.00	SDN17	Surface (gravity)	Pumping
BN2	Pump schemes u/s of Sennar (including Shashena)		142380.00	189840.00	SDN1	Surface (gravity)	Pumping
BN3	Hurga and nour-el-deen (Pump schemes as part of Gezira)		9347.52	42000.00	SDN1	Surface (gravity)	Pumping
BN5	Guneid (Sugar)		16380.00	21840.00	SDN12	Surface (gravity)	Pumping
BN7	Seleit		8400.00	12600.00	SDN16	Surface (gravity)	Pumping
BN8	Small Private Pump Schemes (throughout blue Nile)		75000.00	100000.00	SDN8	Surface (gravity)	Pump + Floods (river overflow)
BN9	Waha (Blue Nile)		9450.00	12600.00	Fodder (alfalfa for export)	Sprinkler	Pumping
BN10	Gezira - Managil (Al Jazira); canal capacity is 32 Mill cubic meter/day; if requirement is more, equitable allocation of water	Gizera	588000.00	874310.64	SDN1	Surface (gravity)	Gravity
BN11	Rahad I	Gizera/ Gadarif	113311.(a)	142854.(a)	SDN5	Surface (gravity)	Gravity + Pumping
BN12	Suki Scheme (Old and new)	Sennar	32400.(a)	48562.(a)	SDN8	Surface (gravity)	Pumping
BN13	NW Sennar Sugar Scheme	Sennar	13860.00	20639.64	SDN12	Surface (gravity)	Pumping
BN14	Guneid Extension (Haddaf/Wadel Faddul)	Gizera	14290.61	19054.14	SDN1	Surface (gravity)	Pumping
BN15	NW Sennar (non-Sugar) Scheme	Sennar	7140.00	7140.00	SDN5	Surface (gravity)	Pumping
WN1	Kenana Sugar Scheme	White Nile	34500.00(b)	45000(c)	SDN12	Surface (gravity)	Pumping
WN2	Kenana - mixed crop	White Nile	4725.00	6300.00	SDN5	Surface (gravity)	Pumping
WN3	Asalaya (sugar)	White Nile	14175.00	18900.00	SDN12	Surface (gravity)	Pumping
WN4	White Nile Pump Schemes	White Nile	113250.00	151000.(d)	Fodder if close to Khartoum ; far away from Khartoum - like Rahad	Surface (gravity)	Pumping
AT1	New Halfa;	Kasala/Gadarif	74866.(a)	152283.(a)	SDN2	Surface (gravity)	Gravity + Pumping
AT2	New Halfa Sugar	Kasala/Gadarif	12600.00	15750.00	SDN12	Surface (gravity)	Gravity + Pumping
MN1	Merowe - Dongola; Main Nile Pump schemes	Northern	31500.00	59682.00	SDN6	Surface (gravity)	Pumping + Flood
MN2	Hasanab - Merowe	River Nile	8400.00	11200.00	SDN9	Surface (gravity)	Pumping + Flood
MN3	Khartoum_Tamaniat_Hasanab	Khartoum/ River Nile	44761.50	59682.00	SDN10	Surface (gravity)	Pumping + Flood
			1,381,337.47	2,023,837.45			

Sources:
Nile Waters Study, Volume 3, Supporting report IV Irrigation;
Ministry of Planning-Sudan (1980).
New Halfa Rehabilitation Project Phase II. Volume 1:
(a): Key2 Market, 2018. Sudan Seeds Sector Study. Key2Market
(b): FAO. 2019. FAO Crop and Food Supply Assessment Mission to the Sudan – Special Report. Rome. 38 pp. Licence: CC BY-NC-SA 3.0 IGO.
(c): (2018) THE FIRST STATE OF ENVIRONMENT AND OUTLOOK ...Chapter 4
(d): FAO book "Irrigation Management Transfer: pp 461

Annex A-8: Area Irrigated and Equipped with Infrastructure in the Nile Basin Part of Tanzania

Scheme Name	DISTRICT	Region	Cropped	Equipped	Type	Name	Crop Pattern	X	Y
Kagera Other IS < 1	Kagera	Kagera	15.00	211.00	River	Ruvubu	TZN5	31.116	-1.641
Kagera Sugar Limited	Bukoba	Kagera	15000.00	15000.00	River	Kagera	TZN3	31.302	-1.237
Ikimba (Ngono project)	Bukoba	Kagera	50.00	50.00	Lake	lower Kagera	TZN6	31.366	-1.646
Kiijongo-nyakigando (Ngono Project)	Bukoba	Kagera	60.00	60.00		Kagera	TZN6	31.338	-1.248
Kazinga (Ngono Project)	Bukoba	Kagera	15.00	15.00	River	Kagera	TZN6	31.319	-1.278
Mwisa	Karagwe	Kagera	300.00	300.00	Perenial river	Kagera	TZN5	31.176	-1.571
Ngarama (Ngono Project)	Bukoba	Kagera	17.00	17.00		Lake Ikimba/lower Kagera	TZN6	31.350	-1.270
			15457.00	15653.00					
Biswari	Tarime	Mara	87.00	87.00	Dam	Biswari	TZN7	34.270	-1.462
Buswahili	Musoma Rural	Mara	50.00	210.00	River	Mara	TZN5	34.139	-1.628
Mara Others IS <	Mara	Mara	223.00	1192.00	River	Mara	TZN7	34.456	-1.696
Mesaga	Serengeti	Mara	100.00	100.00	Dam/river	Mara	TZN5	34.270	-1.708
Nyamitita	Serengeti	Mara	92.00	92.00	River		TZN9	34.464	-1.631
			552.00	1681.00					
Baraki Sisters	Rorya	Mara	50.00	50.00	Dam	Baraki sisters	TZN4	33.963	-1.359
Chereche	Rorya	Mara	300.00	45.00	Dam	chereche	TZN1	34.076	-1.376
Irienyi	Rorya	Mara	350.00	350.00	Dam	irenyi	TZN10	33.958	-1.413
Kirogo	Rorya	Mara	50.00	50.00	River	Mara	TZN6	34.017	-1.356
Minigo Sola	Mara	Mara	10.00	10.00	River	Mara	TZN4	34.000	-1.170
Nyathorogo	Rorya	Mara	300.00	300.00	Dam	nyathorogo	TZN4	34.141	-1.412
Ochuna	Rorya	Mara	120.00	60.00	Dam	Uchuna	TZN4	34.142	-1.412
RIFA (Ryang	Rorya	Mara	16.00	16.00	River	Mara	TZN4	34.020	-1.130
Uwachero	Rorya	Mara	120.00	120.00			TZN5	34.019	-1.217
Rwang'enyi	Rorya	Mara	100.00	100.00	Dam	Eastern shore streems	TZN5	33.960	-1.195
			1416.00	1101.00					
Chela	Nyang'hwale	Geita	10.00	5.00	River	Isanga	TZN5	32.554	-3.542
Mpera	Kahama	Shinyanga	40.00	100.00	River	Isanga	TZN1	32.730	-3.920
Shyinianga Others IS <	Shyinianga (all districts)	Shinyanga	30.00	150.00	Lake	Lake Victoria	TZN5	32.939	-3.416
Amani	Muheza		700.00	700.00	Dam			32.924	-3.345
Igenge	Misungwi	Mwanza	52.00	30.00	Dam	Isanga	TZN5	32.839	-2.941
Ilujamate	Misungwi	Mwanza	185.00	185.00	River	Isanga	TZN5	32.846	-3.010
Isholoło Dam Scheme	Shinyanga rural	Shinyanga	60.00	60.00	Dam		TZN9	33.155	-3.745
Kahanga	Kahama	Shinyanga	56.00	56.00			TZN5	32.434	-3.840
Lowa	NONE		600.00	5.00	Dam	Lake victoria	TZN6	32.453	-3.869
Iwelyangula	NONE		200.00	200.00	River		TZN9	33.451	-3.685
Masengwa Dam Scheme	Shinyanga	Shinyanga	337.00	337.00	Dam/river		TZN9	33.414	-3.807
Mwamashele	Shinyanga	Shinyanga	339.00	339.00			TZN8	33.458	-3.756
Nyakasaluma	Mbogwe	Geita	40.00	40.00		Malagarasi	TZN7	32.204	-3.730
Nyida	Shinyanga rural	Shinyanga	450.00	300.00	river		TZN7	33.048	-3.945
			3099.00	2507.00					

Bukangilija	Maswa	Simiyu	307.00	307.00	River	Moame	TZN6	33.574	-3.193
Bukigi	Maswa	Simiyu	196.00	800.00	River	Moame	TZN6	33.494	-3.142
Kimiza Dam Scheme	Kwimba	Mwanza	163.00	163.00	River	Moame	TZN10	33.464	-3.026
Luhala	Kwimba	Mwanza	160.00	160.00	River	Moame	TZN6	33.478	-3.153
Mahiga	Kwimba	Mwanza	245.00	245.00	River	Magogo	TZN6	33.350	-3.000
Malya	Kwimba	Mwanza	200.00	200.00	Dam	Malya	TZN6	33.520	-2.980
Manawa	Misungwi	Mwanza	100.00	100.00	River	Moame	TZN6	33.089	-2.993
Shilanona	Kwimba	Mwanza	201.00	300.00	River	Moame	TZN6	33.280	-2.870
Shilanona I	Kwimba	Mwanza	100.00	200.00	River	Moame	TZN6	33.338	-2.917
Sumve	Misungwi	Mwanza	80.00	80.00	River	Moame	TZN6	33.259	-2.781
Sumve Lugulu	Misungwi	Mwanza	90.00	90.00	River	Moame	TZN6	33.206	-2.745
Ijinga	Maswa	Mwanza	416.00	416.00	River		TZN10	33.587	-3.146
Igongwa	Misungwi	Mwanza	220.00	220.00	river	Magogo maome	TZN7	33.210	-2.931
Nyambeho Irrigation Scheme	Misungwi	Mwanza	187.00	187.00	River	Magogo maome	TZN9	33.175	-2.880
Nyang''homango	Misungwi	Mwanza	75.00	75.00	Seasonal river	Isanga	TZN7	33.094	-2.854
Nyashidala	Misungwi	Mwanza	220.00	220.00	River	Magogo maome	TZN9	33.008	-2.978
			2960.00	3763.00					
Buhangaza	Muleba	Kagera	100.00	100.00	River	Rubale	TZN9	31.640	-1.679
Buyaga	Muleba	Kagera	80.00	87.00	River	Ngono	TZN5	31.654	-1.735
Kafunzo (Ngono project)	Sengerema	Mwanza	100.00	100.00	Lake	Lake Victoria	TZN10	31.605	-1.131
Kyakakera	Misenyi	Kagera	60.00	162.00	Lake	Lake Victoria	TZN5	31.470	-1.330
Nkenge	Missenyi	Kagera	400.00	32.00	River	Ngono East	TZN9	31.608	-1.228
			740.00	481.00					
Bugelela Farm Project	Serengeti	Mara	80.00	5.00	River	Rubana	TZN8	34.472	-1.961
Maliwanda	Bunda	Mara	220.00	220.00	Dam	Gurumeti	TZN3	34.151	-1.986
			300.00	225.00					
Bigombo	Ngara	Kagera	80.00	15.00	River	Ruvubu	TZN3	30.646	-2.724
Rwinyana	Karagwe	Kagera	10.00	10.00	Lake	Lake Victoria	TZN3	30.500	-2.830
Mpanyula	Ngara	Kagera	231.00	231.00	River	Lower Kagera	TZN5	30.691	-2.713
Mugozi	Ngara	Kagera	100.00	100.00		Lower Kagera	TZN5	30.653	-2.626
			421.00	356.00					
Ikungulyambeshi	Bariadi	Simiyu	58.00	58.00	River	Bariadi	TZN6	33.761	-2.560
Kasoli	Bariadi	Simiyu	200.00	200.00	Dam	Kasoli	TZN5	33.705	-2.599
Nyawa Farm	Shinyanga	Shinyanga	40.00	40.00	River	Simiyu	TZN10	34.220	-2.420
Mwasubuya	Bariadi	Simiyu	165.00	165.00	Dam		TZN8	33.772	-2.576
			463.00	463.00					
A.M. Farm	Bunda	Mara	10.00	10.00	River	Grumeti	TZN5	33.680	-2.100
Bugorola	Ukerewe	Mwanza	200.00	74.00	Lake	Lake Victoria	TZN5	33.032	-1.985
Butiama	Butiama	Mara	41.00	350.00	Dam	Kiarano	TZN7	33.972	-1.813
Chumwi	Butiama	Mara	30.00	30.00	Lake	Lake Victoria	TZN4	33.550	-1.830
Kalukekele	Bunda	Mara	50.00	50.00	Lake	Lake Victoria	TZN5	33.529	-2.046

Kisorya	Butiama	Mara	160.00	160.00	Lake	Lake Victoria	TZN5	33.220	-2.100
Lubana Farm	Bunda	Mara	50.00	100.00	Strems	kyota	TZN5	33.850	-2.080
Masinono	Musoma Rural	Mara	300.00	300.00	Dam	masinono	TZN5	33.598	-1.982
Nakatunguru	Ukerewe	Mwanza	25.00	25.00	Lake	Lake Victoria	TZN5	33.070	-2.100
Nansimo	Bunda	Mara	80.00	50.00	Lake	Lake Victoria	TZN5	33.351	-2.141
Nyatwali	Bunda	Mara	120.00	160.00	Lake	Lake Victoria	TZN5	33.842	-2.151
Rwamugango	Musoma Rural	Mara	300.00	300.00	Lake	Lake Victoria	TZN5	33.680	-1.700
Suguti Valley	Butiama	Mara	100.00	100.00	River	Suguti	TZN5	33.837	-1.884
Suguti/kataryo	Butiama	Mara	5.00	5.00	Lake	Lake Victoria	TZN5	33.764	-1.818
Tamau	Bunda	Mara	2.00	60.00	Lake	Lake Victoria	TZN5	33.832	-2.122
Balili	Bunda	Mara	40.00	40.00	dam/resevior	Grumeti	TZN7	33.865	-2.038
Bunda Oil Industries	Bunda	Mara			Lake		TZN3	33.837	-2.054
Kisangwa	Bunda	Mara	40.00	78.00	Dam	Lake victoria	TZN5	33.929	-1.950
Kibara Busambara	Bunda	Mara	10.00	50.00	pumping	LV/Easten Shre streems	TZN3	33.431	-2.154
Miyogwezi	Ukerewe	Mwanza	40.00	40.00		Lake victoria	TZN6	32.948	-1.987
Namhula	Bunda	Mara	40.00	40.00		Eastern shore streems	TZN10	33.492	-2.079
Rubana Farm	Bunda	Mara	50.00	100.00	River	Grumeti		33.870	-2.093
Suguti/kataryo	Musoma	Mara	40.00	40.00	Seasonal river	Eastern shore streems	TZN6	33.764	-1.818
			1733.00	2162.00					
Buzirayombo	Muleba	Kagera	20.00	20.00	Lake	Lake Victoria	TZN9	31.781	-2.780
Ibanda	Geita	Geita	1000.00	1000.00	Strems	Ibanda catchment	TZN6	32.495	-2.778
Kasela	Sengerema	Mwanza	150.00	150.00	Dam	Kasela	TZN5	32.100	-2.870
Kyamyorwa	Muleba	Kagera	100.00	100.00	River	Ngono West	TZN9	31.570	-2.058
Kyota	Muleba	Kagera	120.00	300.00	Strems	kyamorya	TZN5	31.649	-2.115
Luchili /nyakasungwa	Sengerema	Mwanza	4.00	40.00	Lake	Lake Victoria	TZN5	32.502	-2.539
Nyisanzi	Chato	Geita	80.00	80.00	Dam	nyisanzi	TZN5	31.737	-2.429
Buziba	Geita	Geita	50.00	50.00	Seasonal river	Malagarasi	TZN5	32.101	-2.119
Ichwankima	Chato	Geita	210.00	210.00		Southern shore streems	TZN5	31.533	-2.631
Imalanguzu	Geita	Geita	120.00	120.00	Seasonal river	Malagarasi	TZN5	32.006	-3.126
Kaniha	Biharamulo	Kagera	160.00	160.00	Seasonal river	Malagarasi	TZN5	31.468	-3.276
Luhuha/inyala	Geita	Geita	120.00	120.00	Seasonal river	Southern shore streems	TZN6	31.950	-2.913
Magurukenda	NONE		120.00	120.00	Dam/river	Southern shore streems	TZN5	32.485	-2.516
Makurugusi Valley 2	Chato	Geita	600.00	600.00		Southern shore streems	TNZ6	31.751	-2.920
Migango	Biharamulo	Kagera	450.00	450.00	Seasonal river	Malagarasi		31.382	-2.815
Nampangwe	Bukombe	Geita	150.00	90.00		Malagrasi		31.630	-3.326
Nyakabango	Muleba	Kagera	10.00	10.00	River	Lake victoria	TZN5	31.655	-2.113
Nyarubanga East	Geita	Geita	100.00	100.00		Southern shore streems	TZN5	32.206	-2.611
Nyarubanga West	Geita	Geita	85.00	85.00		Southern shore streems	TZN6	32.187	-2.613
Nzera/nyamboje	Geita	Mwanza	200.00	200.00	Dam	Southern shore streems	TZN5	32.110	-2.571
Sukuma	Sengerema	Mwanza	200.00	100.00	Dam	Southern shore streems	TZN10	32.406	-2.539
			4049.00	4105.00					
Kalemela	Busega	Simiyu	40.00	40.00	Lake	Lake Victoria	TZN5	33.751	-2.305
Luchelele	Nyamagana	Mwanza	3.00	3.00	River	Grumeti	TZN6	32.880	-2.620
LWANIMAHA	Magu	Mwanza	3.00	3.00	Lake	Lake Victoria	TZN5	32.970	-2.630

Nyamadoke	Bunda	Mara	18.00	18.00	Lake	Lake Victoria	TZN5	32.980	-2.520
Shinembo	Mwanza	Mwanza	50.00	50.00	Lake	Lake Victoria	TZN5	33.348	-2.546
Bugelenga	Bukombe	Geita	150.00	96.00	River	Lake Victoria/isanga	TZN5	32.898	-2.503
Chabula	Magu	Mwanza	50.00	50.00	Lake	Lake Victoria	TZN5	33.156	-2.484
Katunguru	Sengerema	Mwanza	600.00	600.00	Lake	Southern shore streems	TZN10	32.670	-2.480
Lutubiga Dam Scheme	Magu	Mwanza	50.00	50.00	Dam	Lake Victoria	TZN6	33.839	-2.299
			964.00	910.00					
Total			32154.00	33407.00					

Sources: Japan International Cooperation Agency (JICA), 2018. The Project on the Revision of National Irrigation Master Plan in the United Republic of Tanzania National Irrigation Commission, Ministry of Water and Irrigation; the United Republic of Tanzania.

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Annex A-9: Area Irrigated/Cropped and Equipped for Irrigation in the Nile Basin Part of Uganda

Scheme Name	District	Area (ha)		Water Source	
		Cropped	Equipped	Type	Name
Mubuku	Kasese	516.00	560.00[a]	River	Rivers Sebwe and Mubuku
Olweny swamp	Dokolo	500.00	600.00[a]	Swamp	Olweny swamp
Lugazi Sugar	Buikwe	322[b]	2,000.00	River	River Sezibwa
Agoro	Lamwo	130.00	620(a)	River	Agoro River
Kakira Sugar	Jinja	6,800.[b]	10,000.[b]	Lake	Lake Victoria
Doho	Butaleja	830.00	1053[b]	River	River Manafwa
Total Roses/total greenhouses in the Lake Victoria area	Wakiso / Mukono/ Kampala/ Mpigi	230.00	280.00	River	Lake Victoria
Ateri	Apac	430.0[b]	809.00[a]	River	ki-er Nile
Kiige	Kamuli	60.00	369.00	Lake	Lake Nabigaga
Odina	Soroti	365[b]	365[a]	Lake	Lake Kyoga
Labori	Serere	284[b]	284[a]	Lake	Lake Kyoga
Ongom	Alebtong	300[b]	300[a]	Reservoir	Ongom and Owameri dams
Kibimba	Bugiri	3900[b]	3900[a]	Reservoir	Kibimba Dam
Muhokya	Kasese	50.00	50[a]	River	River Nyamwamba
Total Uganda, Nile Basin		**14,717.0**	**21,190.0**		

Sources:

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(a): Ministry of Finance, Planning and Economic Development (MOFPED), 2018: Modernization of Agriculture in Uganda. How much has government done through irrigation BMAU BRIEFING PAPER (6/18). Uganda

(b): feedback from NILE-SEC

ANNEX-B: Detail Data on Crops and Cropping Pattern in the Nile Basin Countries

Annex B-1: Dates of each growth stage and crop Coefficients in the first agro-climatic zone of Egypt in 2015

Growth Stage	A-B		C		D		E		Water
Crop	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	consumptive use (mm)
Wheat	15 Nov-16 Dec	0.34	23-Jan	1.09	11-Mar	1.09	18-Apr	0.21	363
Faba bean	25 Oct-30 Nov	0.31	24-Dec	0.96	12-Mar	0.92	25-Mar	0.22	338
Clove	15 Oct-26 Oct	0.29	4-Dec	1.15	15-Mar	1.15	1-Apr	1.15	526
Onion	15 Nov-3 Dec	0.33	1-Jan	1.20	31-Mar	1.20	15-May	0.54	615
Tomato	1 Oct-8 Nov	0.28	16-Dec	1.10	30-Jan	1.10	1-Mar	0.64	313
Potato	1 Nov-19 Nov	0.31	12-Dec	1.09	12-Jan	1.09	1-Feb	0.68	199
Sugar beet	15 Oct-11 Nov	0.29	4-Jan	1.15	8-Mar	1.15	12-Apr	0.95	508
Cotton	15 Mar-9 Apr	0.31	26-Apr	0.95	7-Aug	0.95	1-Sep	0.49	725
Rice	15 May-14 Jun	0.4	30-Jun	1.02	30-Aug	1.02	16-Sep	0.78	667
Maize	15 May-6 Jun	0.26	30-Jun	1.04	5-Aug	1.04	1-Sep	0.58	535
Soybean	15 May-4 Jun	0.27	30-Jun	1.10	5-Aug	1.10	25-Aug	0.4	530
Sunflower	15 May-2 Jun	0.27	25-Jun	1.09	28-Jul	1.09	15-Aug	0.38	474
Tomato	1 May-1 Jun	0.27	2-Jul	1.10	8-Aug	1.10	1-Sep	0.65	611
Citrus	15-Feb	0.3	15-Jun	1.00	17-Oct	1.00	14-Feb	1	1,412
Olive	15-Feb	0.3	15-Jun	0.80	17-Oct	0.80	14-Feb	0.8	1,155
Grape	15-Feb	0.37	28-Apr	0.80	20-Sep	0.80	14-Feb	0.35	874

Source: Ouda and Zohry 2018

Annex B-2: Dates of each growth stage and crop coefficients in the second agro-climatic zone of Egypt in 2015

Growth Stage	A-B		C		D		E		
Crop	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Water consumptive use (mm)
Wheat	15 Nov-16 Dec	0.33	23-Jan	1.09	11-Mar	1.09	18-Apr	0.20	385
Faba bean	25 Oct-30 Nov	0.30	24-Dec	0.96	12-Mar	0.96	25-Mar	0.21	355
Clover	15 Oct-26 Oct	0.28	4-Dec	1.15	15-Mar	1.15	1-Apr	1.15	558
Onion	15 Nov-3 Dec	0.32	1-Jan	1.20	31-Mar	1.20	15-May	0.54	663
Tomato	1 Oct-8 Nov	0.27	16-Dec	1.10	30-Jan	1.10	1-Mar	0.64	343
Potato	1 Nov-19 Nov	0.30	12-Dec	1.09	12-Jan	1.09	1-Feb	0.68	206
Sugar beet	15 Oct-11 Nov	0.28	4-Jan	1.15	8-Mar	1.15	12-Apr	0.95	541
Cotton	15 Mar-9 Apr	0.30	26-Apr	0.95	7-Aug	0.95	1-Sep	0.49	792
Rice	15 May-14 Jun	0.38	30-Jun	1.02	30-Aug	1.02	16-Sep	0.78	722
Maize	15 May-6 Jun	0.25	30-Jun	1.04	5-Aug	1.04	1-Sep	0.58	579
Soybean	15 May-4 Jun	0.25	30-Jun	1.10	5-Aug	1.10	25-Aug	0.40	572
Sunflower	15 May-2 Jun	0.25	25-Jun	1.09	28-Jul	1.09	15-Aug	0.37	509
Potato	1 Aug-25 Aug	0.23	24-Sep	1.10	2-Nov	1.10	28-Nov	0.69	451
Tomato	1 May-1 Jun	0.26	2-Jul	1.10	8-Aug	1.10	1-Sep	0.65	661
Citrus	15-Feb	0.30	15-Jun	1.00	17-Oct	1.00	14-Feb	1.00	1532
Olive	15-Feb	0.30	15-Jun	0.80	17-Oct	0.80	14-Feb	0.80	1253
Grape	15-Feb	0.37	28-Apr	0.80	20-Sep	0.80	14-Feb	0.35	955

Source: Ouda and Zohry 2018

Annex B-3: Dates of each growth stage and crop coefficients in the third agro-climatic zone of Egypt in 2015

Growth Stage	A-B		C		D		E		
Crop	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Water consumptive use (mm)
Wheat	15 Nov-16 Dec	0.31	23-Jan	1.08	11-Mar	1.08	18-Apr	0.19	409
Faba bean	25 Oct-30 Nov	0.28	24-Dec	0.96	12-Mar	0.96	25-Mar	0.20	375
Clover	15 Oct-26 Oct	0.27	4-Dec	1.15	15-Mar	1.15	1-Apr	1.15	598
Onion	15 Nov-3 Dec	0.30	1-Jan	1.20	31-Mar	1.20	15-May	0.54	707
Tomato	1 Oct-8 Nov	0.26	16-Dec	1.10	30-Jan	1.10	1-Mar	0.64	364
Potato	1 Nov-19 Nov	0.28	12-Dec	1.09	12-Jan	1.09	1-Feb	0.68	216
Sugar beet	15 Oct-11 Nov	0.27	4-Jan	1.15	8-Mar	1.15	12-Apr	0.95	577
Cotton	15 Mar-9 Apr	0.28	26-Apr	0.95	7-Aug	0.95	1-Sep	0.49	830
Rice	15 May-14 Jun	0.36	30-Jun	1.02	30-Aug	1.02	16-Sep	0.78	740
Maize	15 May-6 Jun	0.24	30-Jun	1.04	5-Aug	1.04	1-Sep	0.58	597
Soybean	15 May-4 Jun	0.24	30-Jun	1.10	5-Aug	1.10	25-Aug	0.40	592
Sunflower	15 May-2 Jun	0.24	25-Jun	1.09	28-Jul	1.09	15-Aug	0.37	530
Potato	1 Aug-25 Aug	0.23	24-Sep	1.10	2-Nov	1.10	28-Nov	0.69	473
Tomato	1 May-1 Jun	0.24	2-Jul	1.10	8-Aug	1.10	1-Sep	0.65	679
Citrus	15-Feb	0.29	15-Jun	0.8	17-Oct	0.8	14-Feb	0.8	1,607
Olive	15-Feb	0.35	15-Jun	0.8	17-Oct	0.8	14-Feb	0.35	1,314
Grape	15-Feb	0.29	17-May	0.95	15-Nov	0.95	14-Feb	0.95	996

Source: Ouda and Zohry 2018

Annex B-4: Dates of each growth stage and crop coefficients in the fourth agro-climatic zone of Egypt in 2015

Growth Stage	A-B		C		D		E		
Crop	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Water consumptive use (mm)
Wheat	15 Nov-16 Dec	0.31	23-Jan	1.08	11-Mar	1.08	18-Apr	0.18	431
Faba bean	25 Oct-30 Nov	0.28	24-Dec	0.96	12-Mar	0.96	25-Mar	0.2	392
Clover	15 Oct-26 Oct	0.25	4-Dec	1.15	15-Mar	1.15	1-Apr	1.15	623
Onion	15 Nov-3 Dec	0.30	1-Jan	1.20	31-Mar	1.20	15-May	0.54	750
Tomato	1 Oct-8 Nov	0.24	16-Dec	1.10	30-Jan	1.10	1-Mar	0.64	378
Potato	1 Nov-19 Nov	0.28	12-Dec	1.09	12-Jan	1.09	1-Feb	0.68	222
Sugar beet	15 Oct-11 Nov	0.25	4-Jan	1.15	8-Mar	1.15	12-Apr	0.95	604
Cotton	15 Mar-9 Apr	0.28	26-Apr	0.95	7-Aug	0.95	1-Sep	0.49	905
Maize	15 May-6 Jun	0.23	30-Jun	1.04	5-Aug	1.04	1-Sep	0.58	643
Soybean	15 May-4 Jun	0.23	30-Jun	1.10	5-Aug	1.10	25-Aug	0.4	638
Sunflower	15 May-2 Jun	0.23	25-Jun	1.09	28-Jul	1.09	15-Aug	0.37	574
Potato	1 Aug-25 Aug	0.22	24-Sep	1.10	2-Nov	1.10	28-Nov	0.69	524
Tomato	1 May-1 Jun	0.23	2-Jul	1.10	8-Aug	1.10	1-Sep	0.65	735
Sugarcane	15-Mar	0.21	22-Jun	1.2	3-Sep	1.2	1-Mar	0.62	1,971
Citrus	15-Feb	0.27	15-Jun	0.8	17-Oct	0.8	14-Feb	0.8	1,735
Olive	15-Feb	0.34	15-Jun	0.8	17-Oct	0.8	14-Feb	0.35	1,416
Grape	15-Feb	0.27	17-May	0.95	15-Nov	0.95	14-Feb	0.95	1,082

Source: Ouda and Zohry 2018

Annex B-5: Dates of each growth stage and crop coefficients in the fifth agro-climatic zone of Egypt in 2015

Growth Stage	A-B		C		D		E		
Crop	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Growth stage period	Crop coefficient	Water consumptive use (mm)
Wheat	15 Nov-16 Dec	0.30	23-Jan	1.08	11-Mar	1.08	18-Apr	0.18	451
Faba bean	25 Oct-30 Nov	0.27	24-Dec	0.96	12-Mar	0.96	25-Mar	0.19	413
Clover	15 Oct-26 Oct	0.25	4-Dec	1.15	15-Mar	1.15	1-Apr	1.15	659
Onion	15 Nov-3 Dec	0.29	1-Jan	1.20	31-Mar	1.20	15-May	0.54	787
Tomato	1 Oct-8 Nov	0.24	16-Dec	1.10	30-Jan	1.10	1-Mar	0.64	400
Potato	1-Nov	0.27	12-Dec	1.09	12-Jan	1.09	1-Feb	0.68	239
Maize	15 May-6 Jun	0.21	30-Jun	1.03	5-Aug	1.03	1-Sep	0.58	645
Soybean	15 May-4 Jun	0.22	30-Jun	1.10	5-Aug	1.10	25-Aug	0.4	643
Sunflower	15 May-2 Jun	0.22	25-Jun	1.09	28-Jul	1.09	15-Aug	0.37	577
Potato	1 Aug-25 Aug	0.22	24-Sep	1.10	2-Nov	1.10	28-Nov	0.69	538
Tomato	1 May-1 Jun	0.23	2-Jul	1.10	8-Aug	1.10	1-Sep	0.65	743
Sugarcane	15-Feb	0.21	18-Apr	1.20	21-Oct	1.20	14-Feb	0.62	2,028
Citrus	15-Feb	0.27	15-Jun	0.80	17-Oct	0.80	14-Feb	0.8	1,792
Olive	15-Feb	0.33	15-Jun	0.80	17-Oct	0.80	14-Feb	0.35	1,463
Grape	15-Feb	0.27	17-May	0.95	15-Nov	0.95	14-Feb	0.95	1,097

Source: Ouda and Zohry 2018

Annex B-6: Crop growth parameters for Egypt

Crop Type	Growing Period (days) Init	Dev	Mid	Late	Total	Kc Init	Mid	Late	Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
Wheat EG	30	30	120	30	210	0.4	1.15	0.3	1	0.55	1.5	1-Nov
Maize EG	30	30	60	30	150	0.3	1.2	0.6	1.8	0.5	1.5	1-Jun
Barley EG	30	30	120	30	210	0.3	1.15	0.25	1	0.55	1.25	1-Nov
Sorghum EG	30	30	60	30	150	0.3	1.1	0.55	1.8	0.55	1.5	1-Jun
Potatoes EG	30	30	120	30	210	0.5	1.15	0.75	0.6	0.35	0.5	1-Nov
Sweet Potatoes EG	30	30	120	30	210	1	1	1	0.4	0.65	1.25	1-Nov
Sugarcane EG	30	30	275	30	365	1	1	1	3	0.65	1.6	1-Jan
Pulses EG	30	30	60	30	150	0.4	1.15	0.55	0.4	0.45	0.75	1-Jun
Fruit EG	60	60	185	60	365	1.2	1.2	1.2	3.5	0.5	1.5	1-Jan
Vegetables EG1	30	30	120	30	210	0.6	1	1	0.5	0.4	1	1-Nov
Banana EG	60	60	185	60	365	1	1	1	4	0.35	0.7	1-Jan
Citrus EG	60	60	185	60	365	0.75	0.75	0.75	4	0.5	1.2	1-Jan
Groundnut EG	30	30	120	30	210	0.3	1.2	0.6	0.4	0.5	0.75	1-Nov
Sunflower EG	30	30	120	30	210	0.35	1.1	0.35	2	0.45	1.2	1-Nov
Sesame EG	30	30	120	30	210	0.35	1.1	0.35	1	0.6	1.25	1-Nov
Cotton EG	30	30	152	30	242	0.3	1.2	0.6	1.35	0.65	1.4	1-Mar
Corn EG	30	30	60	30	150	0.3	1.2	0.6	1.8	0.5	1.5	1-Jun
Alfaalfa EG	60	60	185	60	365	1	1	1	0.7	0.55	1.5	1-Jan
Clover EG	30	30	120	30	210	0.4	1	0.9	0.6	0.55	0.75	1-Nov
Sugar beet EG	30	30	120	30	210	0.35	1.2	0.7	0.5	0.55	1	1-Nov
Soybean EG	30	30	120	30	210	0.4	1.15	0.5	0.75	0.5	1	1-Nov
Root Crops EG	30	30	120	30	210	1	1	1	0.6	0.35	0.5	1-Nov
Rice EG	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Jun
SCTL (Short-term variety of clover)	20	30	50	20	120	0.4	1	0.9	0.6	0.55	0.75	1-Nov
Vegetables EG2	30	30	60	30	150	0.6	1	1	0.5	0.4	1	1-Jun
Date Palm EG	60	60	185	60	365	1.2	1.2	1.2	8	0.5	2	1-Jan

Source: NBI baseline dataset of 2015

Annex B-7a: Egypt Cropping Pattern 2016/2016

Scheme	Fruits	Palm Dates	Vegetable	Field crops (except sugarcane)	Sugarcane	Newly proposed Code
Alexandria	4.0	0.2	38.9	56.9	0.0	EGY1
Assuit	5.2	0.1	2.1	92.6	0.2	EGY2
Aswan	6.5	9.2	3.9	48.6	31.8	EGY3
Behera	8.8	0.7	16.5	74.0	0.0	EGY4
Beni Suef	3.3	0.0	7.9	88.7	0.1	EGY5
Cairo	91.7	4.0	2.5	1.7	0.1	EGY6
Dakahlia	1.1	0.1	8.1	90.7	0.0	EGY7
Damietta	3.9	0.0	11.1	85.0	0.0	EGY8
Fayoum	3.8	0.1	4.3	91.7	0.1	EGY9
Gharbia	3.7	0.0	8.5	87.8	0.0	EGY10
Giza	10.8	5.2	35.0	48.5	0.4	EGY11
Ismailia	48.5	0.4	15.2	36.0	0.0	EGY12
Kafr-El Shei	0.6	0.5	9.9	89.0	0.0	EGY13
Matruh (2)	50.4	3.7	30.6	15.4	0.0	EGY14
Menia	4.4	0.1	7.5	83.7	4.3	EGY15
Menoufia	10.2	0.0	13.8	76.0	0.0	EGY16
Qalyoubia	14.0	0.2	9.3	76.4	0.1	EGY17
Qena	2.7	0.3	3.0	60.8	33.2	EGY18
Port Said	0.3	0.0	4.1	95.6	0.0	EGY19
Sharkia	7.4	0.0	14.0	78.6	0.0	EGY20
Suez	50.4	0.9	16.0	32.7	0.0	EGY21
Suhag	1.1	0.1	2.5	94.0	2.2	EGY22

Source: CAPMAS, 2018

Note: CAPMAS (2018) aggregated the cropping pattern data of Egypt in four categories namely, fruits, palm dates, vegetables and crops. In this table, the "crop" category is splitted in to two (i.e. field crop and sugarcane) in view of the noticeable differences in water consumption. This table also shows that the cropping pattern of each Governorate is unique and thus each must be assigned a unique code contrary to what was noted in the NBI baseline dataset of 2015.

Annex B-7b: Egypt Cropping Pattern 2014/2015

CP-ID	Crop Type	% of Equipped Area	CP-ID	Crop Type	% of Equipped Area	CP-ID	Crop Type	% of Equipped Area
EGY1	Wheat EG	39%	EGY4	Banana EG	0.45%		Wheat EG	39.40%
	Maize EG	25%		Barley EG	0.11%		Clover EG	18%
	Barley EG	0.09%		Citrus EG	1.77%	EGY7	Fruit EG	12%
	Sorghum EG	37%		Clover EG	24.40%		Maize EG	20%
	Potatoes EG	0.32%		Cotton EG	12.70%		Wheat EG	9%
	Sweet potatoes EG	0.02%		Groundnuts EG	0.60%			
	Sugar beet EG	0.10%		Maize EG	38%		Citrus EG	3%
	Sugarcane EG	0.67%		Other root crops EG	0.10%		Clover EG	34%
	Pulses EG	11%		Potatoes EG	1.60%		Cotton EG	12%
	Vegetables - EG-1	6.30%		Pulses EG	0.50%		Maize EG	21%
	Banana EG	0.61%		Rice EG	0.03%		Potatoes EG	24%
	Citrus EG	3.04%		Sesame EG	1.37%	EGY8	Pulses EG	2%
	Soybean EG	0.09%		Sorghum EG	1%		Rice EG	36%
	Groundnuts EG	0.75%		Soybean EG	0.50%		Sugar beet EG	2%
	Sunflower EG	2.50%		STCL EG	11.50%		Vegetables - EG-1	4%
	Sesame EG	1%		Sugar beet EG	0.60%		Wheat EG	31%
	Cotton EG	8%		Sugarcane EG	0.60%			
	Other root crops EG	0.40%		Sunflower EG	1.13%		Banana EG	7%
	Clover EG	25%		Sweet potatoes EG	0.20%		Barley EG	5%
				Vegetables - EG-1	10.20%		Citrus EG	12%
EGY2	Wheat EG	9.60%		Wheat EG	38.70%	EGY9	Clover EG	36%
	Maize EG	4.30%					Cotton EG	8%
	Sugarcane EG	41.20%	EGY5	Clover EG	23.80%		Pulses EG	5%
	Alfalfa EG	6.10%		Cotton EG	7.40%		Rice EG	57%
	Clover EG	6.50%		EGY5			STCL EG	9%
	Wheat EG	28%		Fruit EG	5.25%		Vegetables - EG-1	1%
	Maize EG	13%		Maize EG	52.80%		Wheat EG	22%
	Barley EG	0.60%		Sugarcane EG	6.70%			
	Sorghum EG	6.90%		Wheat EG	36%		Banana EG	0.02%
	Potatoes EG	0.01%					Barley EG	0.01%
	Sweet potatoes EG	0.00%		Barley EG	2.90%		Citrus EG	0.80%
	Sugarcane EG	50%		Citrus EG	1.50%		Clover EG	41.60%
	Pulses EG	1.70%		Clover EG	38%		Cotton EG	9.80%
	Fruit EG	0.40%		Cotton EG	7%		Maize EG	2.60%
EGY3	Vegetables EG1	10.00%		Fruit EG	8.30%		Potatoes EG	2.60%
	Banana EG	2.00%		Groundnuts EG	0.10%		Pulses EG	4.60%
	Citrus EG	0.60%		Maize EG	11.20%	EGY10	Rice EG	44.70%
	Groundnut EG	0.10%		Potatoes EG	0.01%		Sesame EG	0.00%
	Sunflower EG	0.00%	EGY6	Pulses EG	1.02%		STCL EG	8.10%
	Sesame EG	2.41%		Rice EG	6.15%		Sugar beet EG	2.30%
	Cotton EG	0.10%		Sesame EG	1.01%		Suga cane EG	0.02%
	Corn EG	6.10%		Sorghum EG	15.40%		Sunflower EG	0.00%
	Clover EG	12.30%		Sugar beet EG	0.80%		Sweet potatoes EG	4.80%
				Sugarcane EG	0.18%		Wheat EG	16%
				Sunflower EG	2.36%			
				Sweet potatoes EG	0.01%			
				Vegetables - 1 EG	14.50%			

Annex B-7b: Egypt Cropping Pattern 2014/2015 (Continuation)

CP-ID	Crop Type	% of Equipped Area
	Banana EG	0.02%
	Barley EG	0.73%
	Citrus EG	0.50%
	Clover EG	32.80%
	Cotton EG	19.70%
	Groundnuts EG	0.00%
	Maize EG	8.70%
	Potatoes EG	0.20%
	Pulses EG	4.20%
EGY11	Rice EG	47.10%
	Sesame EG	0.00%
	Soybean EG	0.01%
	Sugar beet EG	14%
	Sugarcane EG	0.04%
	Sunflower EG	0.00%
	Sweet potatoes EG	0.83%
	Vegetables - EG-1	5.60%
	Wheat EG	29.50%
	Banana EG	2%
	Barley EG	1%
	Citrus EG	10%
EGY12	Clover EG	21%
	Cotton EG	11%
	Fruit EG	22%
	Groundnuts EG	7%
	Maize EG	14%
	Potatoes EG	4%
	Pulses EG	14%
	Rice EG	17%
	Sesame EG	2%
	STCL EG	13%
	Sunflower EG	1%
	Sweet potatoes EG	1%
	Vegetables - EG-1	41%
	Wheat EG	29%
	Banana EG	25%
	Cotton EG	10%
EGY13	Date palm EG	60%
	Sesame EG	31%
	Banana EG	2%
	Barley EG	17%
	Clover EG	6%
	Date palm EG	25%
EGY14	Groundnuts EG	42%
	Other root crops EG	2%
	Pulses EG	11%
	Sesame EG	19%
	Vegetables - EG-2	22%
	Clover EG	26%
	Fruit EG	10%
EGY15	Maize EG	21.90%
	Rice EG	31%
	Wheat EG	38%
	Banana EG	0.04%
	Barley EG	2.50%
	Citrus EG	5.70%
	Cotton EG	0.63%
	Fruit EG	38.80%
EGY16	Groundnuts EG	9.31%
	Maize EG	23.60%
	Potatoes EG	6.90%
	Pulses EG	1.36%
	Rice EG	2.90%
	Sesame EG	4.20%
	Sugar beet EG	0.12%
	Sugarcane EG	0.00%
	Sunflower EG	0.05%
	Vegetables - EG-1	9.30%
	Vegetables - EG-2	21.9
	Wheat EG	20%
	Barley EG	8.30%
	Citrus EG	0.01%
	Date palm EG	1.64%
	Fruit EG	28.30%
	Groundnut EG	0.18%
	Maize EG	1.58%
EGY17	Potatoes EG	0.03%
	Pulses EG	2.28%
	Sesame EG	0.05%
	Sunflower EG	0.08%
	Vegetables EG1	4.52%
	Wheat EG	15.70%
	Date palm EG	27%
EGY18	Fruit EG	57%
	Maize EG	8%
	Clover EG	19%
	Fruit EG	9%
EGY19	Maize EG	11%
	Vegetables EG1	62%
	Wheat EG	34%
	Wheat	44%
	Maize	33%
	Barley	0.10%
	Sorghum	34%
	Potatoes	0.50%
	Sweet potatoes	0.04%
	Sugar beet	0.01%
	Sugarcane	6%
EGY20	Pulses	1%
	Vegetables - 1	5%
	Banana	0.30%
	Citrus	1%
	Soybean	0.01%
	Groundnuts	1.40%
	Sunflower	0.10%
	Sesame	0.80%
	Cotton	2.30%
	Wheat	13%
	Rice	33%
	Maize	2%
	Barley	9%
EGY21	Sugar beet	1%
	Sesame	0%
	Cotton	2%
	Clover	41%
	Wheat	0%
	Barley	14%
EGY22	Vegetables - 1	12%
	Fruit	66%
	Date palm	8%

Source: NBI baseline dataset of 2015

Annex B-8: Crop growth parameters for Ethiopia

	Growing Period (days)					Kc			Crop		Max	
Crop Type	Init	Dev	Mid	Late	Total	Init	Mid	Late	Height (m)	Depletion Fraction	Root Depth (m)	Sowing Date
Castor-beans ET	30	90	60	30	210	0.75	1.17	0.3	0.3	0.5	1.5	1-Nov
Cotton dry ET	60	30	62	60	212	0.45	1.15	0.75	1.35	0.65	1.4	1-Oct
Cotton ET-TA	60	30	62	30	182	0.4	1.25	0.5	1.35	0.65	1.4	1-May
Cotton wet ET	60	30	62	60	212	0.45	1.15	0.75	1.35	0.65	1.4	1-May
Fruit ET	30	60	215	60	365	0.8	0.8	0.8	3.5	0.5	1.5	1-Jan
Fruit ET-Abobo	30	30	90	30	180	0.3	1.2	0.6	3.5	0.5	1.5	1-Nov
Grapes ET	60	120	95	90	365	0.45	0.75	0.6	1.8	0.4	1.5	1-Apr
Groundnut dry ET	30	60	30	30	150	0.45	1.05	0.6	0.4	0.5	0.75	1-Dec
Groundnut ET-Abobo	30	30	60	30	150	0.3	1.2	0.6	0.4	0.5	0.75	1-Nov
Groundnut wet ET	30	60	30	30	150	0.45	1.05	0.6	0.4	0.5	0.75	1-Jun
Maize dry ET	30	60	60	30	180	0.4	1.1	0.3	1.8	0.5	1.5	1-Nov
Maize ET-Abobo	30	30	90	30	180	0.3	1.2	0.6	1.8	0.5	1.5	1-Nov
Maize wet ET	30	60	60	30	180	0.4	1.1	0.3	1.8	0.5	1.5	1-May
Noug ET	30	60	30	30	150	0.25	1.2	0.7	1.5	0.5	1.5	1-May
Onion ET	30	30	60	30	150	0.4	1.1	0.9	0.4	0.3	0.5	1-Dec
Potatoes ET	30	30	60	30	150	0.75	1.05	0.7	0.6	0.35	0.5	1-Dec
Pulses dry ET	20	30	40	30	120	0.4	1.05	0.95	0.4	0.45	0.75	1-Dec
Pulses wet ET	20	30	40	30	120	0.4	1.05	0.95	0.4	0.45	0.75	1-Jun
Red Pepper ET	30	30	90	125	275	0.4	1	0.6	0.6	0.3	0.75	1-May
Sesame early ET	20	30	40	30	120	0.4	1.2	0.8	1	0.6	1.25	1-Feb
Sesame dry ET	20	30	40	30	120	0.4	1.2	0.8	1	0.6	1.25	1-Nov
Sesame wet ET	20	30	40	30	120	0.4	1.2	0.8	1	0.6	1.25	1-Aug
Sorghum dry ET	30	30	30	30	120	0.4	1.15	0.8	1.8	0.55	1.5	1-Dec
Sorghum wet ET	30	30	30	30	120	0.4	1.15	0.8	1.8	0.55	1.5	1-May
Sorghum-Teff ET	30	30	30	30	120	0.3	1.1	0.7	1	0.4	0.8	1-Jun
Soybean dry ET	30	30	60	30	150	0.8	1.1	0.4	0.75	0.5	1	1-Jan
Soybean ET-Abobo	30	30	30	30	120	0.4	1.15	0.5	0.75	0.5	1	1-Jan
Soybean wet ET	30	30	60	30	150	0.8	1.1	0.4	0.75	0.5	1	1-Jul
Sudan Grass ET	60	60	180	65	365	1	1	1	1.2	0.55	1.25	1-Jan
Sugarcane ET	120	30	180	35	365	0.8	0.9	0.8	3	0.65	1.6	1-Dec
Sugarcane ET-TA	30	120	150	65	365	0.6	1	0.65	3	0.65	1.6	1-Apr
Sunflower dry ET	30	60	30	30	150	0.25	1.2	0.7	2	0.45	1.2	1-Dec
Sunflower wet ET	30	60	30	30	150	0.25	1.2	0.7	2	0.45	1.2	1-Jun
Tobacco ET	30	30	60	30	150	0.1	1.1	0.3	1.2	0.5	0.8	1-Dec
Vegetables dry ET	20	30	40	30	120	0.5	1.15	0.9	0.5	0.4	1	1-Dec
Vegetables ET-Abobo	20	20	20	30	90	0.6	0.85	0.9	0.5	0.4	1	1-Nov
Vegetables wet ET	20	30	40	30	120	0.5	1.15	0.9	0.5	0.4	1	1-Jun
Wheat dry ET	30	30	60	30	150	0.8	1.1	0.25	1	0.55	1.5	1-Dec
Wheat ET-Abobo	30	30	60	30	150	0.4	1.15	0.3	1	0.55	1.5	1-Dec
Wheat wet ET	30	30	60	30	150	0.8	1.1	0.25	1	0.55	1.5	-Jun

Source: NBI baseline dataset of 2015

Annex B-9: Cropping pattern Ethiopia

Crop Pattern	Crop Type	% of Equipped Area	Crop Pattern	Crop Type	% of Equipped Area
ETH1	Sunflower dry	30%	ETH4	Sorghum Teff	25%
	Cotton	20%		Maize dry	20%
	Maize dry	20%		Maize wet	20%
	Maize wet	20%		Fruit	10%
	Noug	20%		Grapes	10%
	Sorghum Teff	20%		Groundnut summer	10%
	Sugarcane	10%		Groundnut winter	10%
	Fruit	5%		Noug	10%
	Onion	5%		Soybean dry	10%
	Potatoes	5%		Wheat wet	10%
	Red Pepper	5%		Wheat dry	10%
				Onion	5%
ETH2	Sorghum Teff	20%		Red Pepper	5%
	Sunflower dry	20%	ETH5	Sorghum Teff	25%
	Soybean dry	10%		Maize dry	20%
	Sugarcane	10%		Maize wet	20%
	Noug	5%		Noug	15%
	Potatoes	5%		Fruit	10%
	Red Pepper	5%		Grapes	10%
	Tobacco	5%		Soybean	10%
				Wheat wet	10%
ETH3	Sugarcane	60%		Wheat dry	10%
	Groundnut summer	10%		Onion	5%
	Maize dry	10%		Potatoes	5%
	Maize wet	10%		Red Pepper	5%
	Noug	10%		Sugarcane	5%
	Red Pepper	5%	ETH6	Fruit Abobo	25%
	Sudan Grass	5%		Maize Abobo	25%
				Groundnut Abobo	12%
				Soybean Abobo	12%
				Vegetables Abobo	12%
				Wheat Abobo	12%
ETH7	Cotton	20%	ETH9	Cotton TSA	30%
	Maize dry	20%		Sesame winter	30%
	Maize wet	20%		Sesame early	30%
	Sunflower dry	20%		Sesame late	30%
	Sunflower wet	20%		Sugarcane TSA	20%
	Groundnut Summer	10%		Pulses summer	10%
	Groundnut winter	10%		Pulses winter	10%
	Potatoes	10%		Sorghum summer	9%
	Red Pepper	10%		Sorghum winter	9%
	Sorghum Teff	10%		Vegetables winter	1%
	Sugarcane	10%		Vegetables Summer	1%
	Onion	5%	ETH10	Maize wet	40%
ETH8	Cotton TSA	40%		Cotton wet	25%
	Sesame winter	40%		Sorghum summer	20%
	Sesame early	40%		Cotton dry	15%
	Sesame late	40%		Groundnut winter	15%
	Sorghum winter	13%		Maize dry	15%
	Pulses summer	6%		Sorghum winter	10%
	Pulses winter	6%		Soybean dry	10%
	Sorghum summer	6%		Soybean wet	10%
	Vegetables winter	1%		Sorghum Teff	5%
	Vegetables summer	1%		Sugarcane	

Source: NBI baseline dataset of 2015

Annex B-10: Cropping pattern in West Gojam/Wet Weyna Dega/, Tana/Moist Weyna-dega/ and West Gojam/Weyna Dega/ Subbasins

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
	Wet Season		
	Teff	40%	
	Wheat	30%	
	Chick pea	30%	Subbasin: West Gojam
ETH11	**Dry Season**		Agro-ecology: Wet Weyna Dega
	Potato	50%	
	Onion	30%	Amhara Design and Supervision
	Garlic	20%	Works Enterprise (ADSWE), 2010a.
	Wet Season		
	Rice	35%	
	Teff	20%	
	Sorghum	15%	Subbasin: Tana
	Two-row barley	25%	
	Pepper (spice)	5%	
	Dry Season		
	Cabbage	10%	Moist Weyna-Dega
ETH12	Onion	15%	
	Tomato	10%	
	Black cumin	20%	
	Fenugreek	30%	*Source:* Amhara Design and Supervision
	Maize (green cob)	15%	Works Enterprise (ADSWE), 2017.
ETH13	**Wet Season**		
	Maize	30%	
	Wheat	30%	
	Teff	20%	
	Noug	10%	
	Pepper	10%	Subbasin: West Gojam.....Bure town
	Dry Season		
	Onion	30%	
	Garlic	30%	Agro-ecology: Weyna Dega
	Maize	20%	
	Tomato	10%	Bureau of Water Resources
	Carrot	10%	Development (BOWRD), 2008a.

Annex B-11: Cropping pattern in Awi/Dega/, Awi/ Weyna Dega/ and West Gojam-Guder/wet Weyna Dega Subbasins

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
	Wet Season		
	Potato	20%	
	Pepper	20%	
	Onion	20%	
	Carrot	10%	
	Sugarcane	10%	
	Coffee	20%	
	Dry Season		
ETH14	Potato	20%	Subbasin: Awi--....... Gojam)
	Pepper	20%	
	Onion	20%	
	Carrot	10%	Agro-ecology: Dega
	Sugarcane	10%	Water Resource Development
	Coffee	20%	Bureau, 2010
	Wet Season		
	Maize	25%	
	Teff	25%	
	Millet	20%	Subbasin: Awi--.... Gojam)
	Noug	15%	
ETH15	Potato	15%	
	Dry Season		
	Onion	25%	Agro-ecology: Wet Weyna Dega
	Garlic	25%	
	Potato	20%	
	Carrot	15%	Bureau of Water Resource
	Maize	15%	Development (BOWRD), 2008b
ETH16	**Wet Season**		
	Maize	30%	
	Millet	30%	
	Teff	25%	
	Wheat	15%	Subbasin: West Gojam- Guder.
	Dry Season		
	Potato	32%	Agro-ecology: Wet Woina Dega
	Onion	24%	
	Garlic	12%	Amhara Design and Supervision
	Carrot	12%	Works Enterprise /ADSWE/, 2010b

Annex B-12: Cropping pattern in Guder-Ambo/Wet Weyna Dega/ and Megech Seraba-Tana/ Wet Weyna-Dega/ Subbasins

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
	Wet Season		Subbasin: Ambo-Guder- Upper Guder:
	Wheat	25%	
	Tef	14%	Agro-ecology: Wet Woina Dega
	Maize	6%	
	Faba Beans	10%	
	Tomato	10%	Water Works Design and Supervision Enterprise, 2015.
	Potato	15%	
	Noug	10%	
	Avocado	5%	
	Forage crops	5%	
	Dry Season		
ETH17	Wheat	20%	
	Maize	25%	
	Faba Beans	15%	
	Tomato	5%	
	Potato	15	
	Noug	10	
	Avocado	5%	
	Forage crops	5%	
	Wet Season		Subbasin: Tana
	Rice	50%	
	Nigger seed	15%	Megech Pump (Seraba) Irrigation and Drainage Project
	Teff	25%	(MPIDP).
	Finger millet	10%	
	Dry Season		Ethiopia Ministry of Water Resources (MoWR), 2018.
	Vegetables / spices	20%	
	Cereals	20%	
	Oil crops	29%	
ETH18	Pulses	20%	
	Cotton/Kenaf	20%	
	Maize	20%	
	Tomato	10%	
	Carrot	10%	

Annex B-13: Cropping pattern in East Gojam/Weyna Dega/ Lower Tekeze/Dry Weyna Dega/ and Middle Tekeze/dry Kola/ Subbasins

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
	Wet Season		
	Maize	30%	
	Wheat	30%	
	Teff	20%	
	Noug	10%	
	Pepper	10%	
	Dry Season		
	Onion	30%	Subbasin: East Gojam
	Garlic	30%	
	Maize	20%	Agro-ecology: Weyna Dega
	Tomato	10%	Jedeb Irrigation Project
ETH19	Carrot	10%	Bureau of Water Resource Development, (BoWRD), 2009.
	Wet Season		
	Sorghum	40%	
	Sesame	30%	
	Sunflower	20%	
	Haricot bean	10%	
	Dry Season		
ETH20	Maize	40%	Subbasin: Lower Tekeze
	Onion	30%	
	Pepper	20%	Agro-ecology: Dry -Weyna Dega
	Chickpea	10%	Woldemariam, G. Hiwot, 2010a.
ETH21	**Wet Season**		
	Groundnut	40%	
	Sesame	30%	
	Sunflower	20%	
	Dry Season		
	Maize	40%	Subbasin: Middle Tekeze
	Onion	30%	
	Pepper	20%	Agro-ecology: Dry Kola
	Tomato	10%	Woldemariam, G. Hiwot, 2010b.

Annex B-14: Cropping pattern in Middle Tekeze/Dry Weyna Dega/, Lower Tekeze/Dry Weyna Dega/, and Middle Tekeze/Weyna Dega/ Subbasins

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
ETH22	**Wet Season**		
	Maize	40%	
	Pepper	30%	
	Fenugreek	10%	
	Garlic	20%	
	Dry Season		
	Onion	40%	Subbasin: Middle Tekeze
	Tomato	30%	
	Cabbage	20%	Agro-ecology: Dry Weyna Dega
	Carrot	10%	Woldemariam, G. Hiwot, 2010c.
ETH23	**Wet Season**		
	Maize	30%	
	Sunflower	30%	
	Fenugreek	15%	
	Sesame	25%	
	Dry Season		
	Maize	40%	Subbasin: Lower Tekeze
	Onion	25%	
	Pepper	20%	Agro-ecology: Dry Weyna Dega
	Tomato	5%	
	Chickpea	10%	Woldemariam, G. Hiwot, 2010d.
ETH24	**Wet Season**		
	Shallot	40%	
	Pepper	30%	
	Sweet potato	10%	
	Garlic	20%	
	Dry Season		
	Onion	30%	
	Tomato	10%	
	Cabbage	10%	Subbasin: Middle Tekeze
	Pepper	30%	Agro-ecology: Woina Dega
	Maize	20%	Woldemariam, G. Hiwot, 2010e.

Annex B-15: Cropping pattern in Upper Tekeze/Dry Kola/ Subbasin

ID	Crop by Season	Cropping Pattern, %	Remark and source of information
ETH25	**Wet Season**		
	Groundnut	40%	
	Sesame	30%	
	Sunflower	20%	Subbasin: Upper Tekeze
	Haricot bean	10%	
	Dry Season		
	Maize	40%	Agro-ecology: Dry Kola
	Onion	30%	
	Pepper	20%	
	Tomato	10%	Woldemariam, G. Hiwot. 2010f

Annex B-16: Crop Growth parameters for Kenya

	Growing Period (days)					Kc			Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
Crop Type	Init	Dev	Mid	Late	Total	Init	Mid	Late				
Banana NEL	120	60	180	5	365	1	1	1	4	0.35	0.7	1-Jan
Beans NEL	30	30	60	30	150	0.3	1.2	0.6	0.4	0.45	0.7	1-Apr
Citrus NEL	60	90	120	95	365	0.75	0.75	0.75	4	0.5	1.2	1-Jan
Maize NEL1	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Apr
Maize NEL2	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Mar
Maize NEL3	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Sep
Millet NEL	30	30	60	30	150	0.3	1.2	0.65	1.5	0.55	1.5	1-Apr
Rice NEL1	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Apr
Rice NEL2	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Sep
Rice NEL3	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Nov
Roses NEL	60	90	120	95	365	0.75	0.75	0.75	1	0.5	1.2	1-Feb
Sugarcane NEL	30	30	275	30	365	1	1	1	3	0.65	1.6	1-Jan
Tea NEL	30	30	275	30	365	1.05	1.05	1.05	1.7	0.4	1.2	1-Jan
Tobacco NEL	30	30	60	30	150	0.5	1.2	0.8	1.2	0.5	0.8	1-Oct
Vegetables NEL1	30	30	60	30	150	0.6	1	1	0.5	0.4	1	1-Oct
Vegetables NEL2	30	30	120	30	210	0.6	0.9	1.1	0.5	0.4	1	1-Mar
Vegetables NEL3	30	30	60	30	150	0.6	1.1	0.9	0.5	0.4	1	1-Jun
Vegetables NEL4	30	60	245	30	365	1.1	1.1	1.1	0.5	0.4	1	1-Jan

Source: NBI baseline dataset of 2015

Annex B-17: Cropping pattern baseline data for Kenya

Cropping Pattern - Kenya			Cropping Pattern - Kenya		
KEN1	Maize	40%	KEN13	Maize	40%
	Vegetables NEL1 + Vegetable NEL2	30%		Millet	40%
KEN2	Beans NEL	33.3%	KEN14	Rice	80%
	Maize NEL1	33.3%			
	Millet NEL	33.3%	KEN15	Maize	85%
KEN3	Beans NEL	20.0%	KEN16	Banana	10%
	Maize NEL1	20.0%		Maize	50%
	Rice NEL3	20.0%		Vegetables	10%
	Sugarcane NEL	20.0%		Sweet Potato	10%
	Vegetables NEL3	20.0%			
			KEN17	Sorghum	33%
KEN4	Beans NEL	20%		Maize	33%
	Maize NEL1	20%		Vegetables	33%
KEN5	Rice NEL1	50%	KEN18	Rice	20%
	Vegetables NEL1+ Vegetables NEL2	50%		Beans	20%
				Maize	20%
KEN6	Bananas NEL	33.3%		Vegetables	20%
	Maize NEL1	33.3%			
	Rice NEL1	33.3%	KEN19	Horticulture	75%
KEN7	Maize NEL1	33.3%	KEN20	Maize	60%
	Sugarcane NEL	33.3%		Banana	20%
	Vegetables NEL1 + Vegetables NEL2	33.3%			
			KEN21	Vegetables	70%
KEN8	Beans NEL	33.3%			
	Maize NEL1	33.3%	KEN22	Rice	50%
	Vegetables NEL1+ Vegetables NEL2	33.3%		Maize	20%
				Sorghum	20%
KEN9	Maize NEL1	33.3%			
	Rice NEL3	33.3%	KEN23	Cassava	10%
	Sugarcane NEL	33.3%		Maize	30%
				Beans	15%
KEN10	Beans NEL	33.3%		Rice	30%
	Maize NEL1	33.3%			
	Vegetables NEL1+ Vegetables NEL2	33.3%	KEN24	Sugarcane	20%
				Banana	10%
KEN11	Maize NEL1	23%		Maize	20%
	Tea NEL	77%		Vegetables	20%
				Sorghum	20%
KEN12	Maize NEL2 + NEL3	33.3%			
	Rice NEL1+NEL2	33.3%	KEN25	Tobacco	30%
	Vegetables NEL4	33.3%		Maize	20%
				Sorghum	20%
				Vegetables	10%

Source: NBI baseline dataset of 2015

Annex B-18: Crop growth parameters for Rwanda

Crop Type	Growing Period Days					Kc			Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
	Init	Dev	Mid	Late	Total	Init	Dev	Mid				
Rice NEL 1	30	30	60	30	150	1.2	1.1	0.8	0.2	1	1	1-Apr
Rice NEL 2	30	30	60	30	150	1.2	1.1	0.8	0.2	1	1	1-Sept
Vegetables NEL 1	30	30	60	30	150	0.6	1	1	0.5	0.4	1	1- Oct
Vegetables NEL 2	30	30	120	30	210	0.6	0.9	1.1	0.5	0.4	1	1- Mar
Beans NEL	30	30	60	30	150	0.3	1.2	0.6	0.4	0.45	0.7	1- Apr
Maize NEL 1	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1- Apr
Vegetables NEL 3	30	30	60	30	150	0.6	1.1	0.9	0.5	0.4	1	1- Jun
Millet NEL	30	30	60	30	150	0.3	1.2	0.65	1.5	0.55	1.5	1- Apr
Rice NEL 3	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1 Nov
Sugarcane NEL	30	30	275	30	365	1	1	1	3	0.65	1.6	1- Jan
Tobacco NEL	30	30	60	30	150	0.5	1.2	0.8	1.2	0.5	0.8	1- Oct
Banana NEL	120	60	180	5	365	1	1	1	4	0.35	0.7	1- Jan
Tea NEL	30	30	275	30	365	1.05	1.05	1.05	1.7	0.4	1.2	1- Jan
Citrus NEL	60	90	120	95	365	0.75	0.75	0.75	4	0.5	1.2	1- Jan
Roses NEL	60	90	120	95	365	0.75	0.75	0.75	1	0.5	1.2	1- Feb
Mazie NEL 2	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1- Mar
Mazie NEL 3	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1- Sep
Vegetables NEL 4	30	60	245	30	365	1.1	1.1	1.1	0.5	0.4	1	1- Jan

Source: NBI baseline dataset of 2015

Annex B-19: Crop growing parameters for South Sudan

Crop Type	Growing Period (days)					Kc			Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
	Init	Dev	Mid	Late	Total	Init	Mid	Late				
Rice SD	40	20	60	30	150	1.1	1.24	1.2	1	0.2	1	1-Nov
Sugarcane SD	60	90	155	60	365	1	1.1	1	3	0.65	1.6	1-Jan
Cotton SD	30	60	62	90	242	0.5	1.2	0.7	1.35	0.65	1.4	1-Jul
Wheat SD	20	30	40	30	120	0.5	1.1	0.5	1	0.55	1.5	1-Nov
Groundnut SD	20	60	40	30	150	0.5	1.1	0.8	0.4	0.5	0.75	1-Jun
Sorghum SD	20	30	40	30	120	0.5	1.1	0.8	1.8	0.55	1.5	1-Jul
Vegetables SD	60	30	155	60	305	0.5	1	0.5	0.5	0.4	1	1-Jul
Fodder/Perennials SD1	20	20	30	20	90	0.88	1.01	0.91	1.2	0.55	1.25	1-Aug
Fodder/Perennials SD2	60	60	120	35	275	0.95	0.95	0.95	1.2	0.55	1.25	1-Nov
Sunflower SD	20	30	40	30	120	0.56	1.4	1.06	2	0.45	1.2	1-Nov
Sesame SD	20	60	40	30	150	0.5	1.1	0.8	1	0.6	1.25	1-Jun

Source: NBI baseline dataset of 2015

Annex B-20: Cropping pattern for South Sudan

Crop Pattern	Crop Type	% of Equipped Area	Number of Schemes and Cropped Area
SSD1	Groundnut SD/SSD	16.90%	1 Scheme: 21,000 ha
	Maize	28.70%	
	Sorghum SD	28.20%	
	Vegetables/ SD	16.60%	
	Sesame	9.60%	
SSD2	Sugar SD/SSD	100%	1 Scheme: 9,660 ha
SSD3	Sorghum SD/SSD	20.90%	1 Scheme: 18,600ha
	Veget. SD/SSD	29.70%	
	Rice SD/SSD	39.70%	
	Fodder SD/SSD	9.70%	
SSD4	Rice SD/SSD	100.00%	2 Schemes: 15,960 ha
SSD5	Cotton SD/SSD	50.00%	23 Schemes: 31,435 ha
	Sorghum SD/SSD	50.00%	

Source: (i): Ministry of Irrigation (1979). Nile Waters Study, Volume 3, Supporting Report IV Irrigation
(ii) MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan (2015). PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN (IDMP) IN THE REPUBLIC OF SOUTH SUDAN. FINAL REPORT (ANNEXES, PART I).

Annex B-21: Crop growth parameters for Sudan

Crop Type	Growing Period (days)					Kc			Crop	Depletion	Max Root	Sowing
	Init	Dev	Mid	Late	Total	Init	Mid	Late	Height (m)	Fraction	Depth (m)	Date
Rice SD	40	20	60	30	150	1.1	1.24	1.2	1	0.2	1	1-Nov
Sugarcane SD	60	90	155	60	365	1	1.1	1	3	0.65	1.6	1-Jan
Cotton SD	30	60	62	90	242	0.5	1.2	0.7	1.35	0.65	1.4	1-Jul
Wheat SD	20	30	40	30	120	0.5	1.1	0.5	1	0.55	1.5	1-Nov
Groundnut SD	20	60	40	30	150	0.5	1.1	0.8	0.4	0.5	0.75	1-Jun
Sorghum SD	20	30	40	30	120	0.5	1.1	0.8	1.8	0.55	1.5	1-Jul
Vegetables SD	60	30	155	60	305	0.5	1	0.5	0.5	0.4	1	1-Jul
Fodder/Perennials SD1	20	20	30	20	90	0.88	1.01	0.91	1.2	0.55	1.25	1-Aug
Fodder/Perennials SD2	60	60	120	35	275	0.95	0.95	0.95	1.2	0.55	1.25	1-Nov
Sunflower SD	20	30	40	30	120	0.56	1.4	1.06	2	0.45	1.2	1-Nov
Sesame SD	20	60	40	30	150	0.5	1.1	0.8	1	0.6	1.25	1-Jun

Source: NBI baseline dataset of 2015

Annex B-22: Cropping pattern for Sudan

CP ID	Crop Type	% of Equipped Area)	CP ID	Crop Type	% of Equipped Area)
SDN1	Cotton SD; Medium stable	2.65%	SDN7	Sugarcane SD	60.2%
	Wheat SD	26.50%			
	Groundnut SD	11.30%	SDN8	Cotton SD; Long Staple	33%
	Sorghum SD	20.25%		Wheat SD	16%
	Win Vegetables SD;	2.50%		Groundnut SD	3%
	Summer Veg	3.00%		Sorghum SD	42%
	Forest; Per Gardens	3.50%		Summer Veg	2%
				Forest; Per Gardens	2%
SDN2	Cotton SD	16.2%			
	Sugarcane SD	0.0%	SDN9	Vegetables SD	24.5%
	Wheat SD	16.3%		Fodder SD	21.0%
	Groundnuts SD	12.9%		Forest + garden Perennials SD	19.3%
	Sorghum SD	19.3%	SDN10	Win Vegetables SD (onions)	26.0%
	Vegetables SD	9.7%		Fodder/Perennials SD1	38.9%
SDN3	Cotton SD	19.8%			
	Wheat SD	1.8%	SDN11	Sugarcane	53.4%
	Sorghum SD	9.2%		Vegetables	11.1%
	Vegetables SD	9.2%			
			SDN12	Sugarcane SD	80.0%
SDN4	Wheat SD	6.7%			
	Groundnuts SD	19.0%	SDN13	Sugarcane SD	12.4%
	Sorghum SD	19.0%		Sorghum SD	19.3%
	Vegetables SD	5.2%		Vegetables SD	6.4%
SDN5	Cotton SD; Long Staple	15%			
	Wheat SD	13%	SDN14	Cotton	24.7%
	Groundnut SD	13%		Groundnuts	9.0%
	Sorghum SD	30%		Sorghum	19.2%
	Win Vegetables SD;	2%		Vegetables	6.7%
	Summer Veg	2%			
	Forest; Per Gardens	4%	SDN15	Sugarcane SD	31.7%
				Wheat SD	23.8%
SDN6	Wheat SD	38.9%		Vegetables SD	25.4%
	Sorghum SD	11.1%			
	Vegetables SD	5.6%	SDN16	Fodder	75%
	Fodder/Perennials SD1	3.3%		**Abu Naama Food Production Scheme**	
	Forest, perm gardens (mainly date trees)	22.3%	SDN17	Cotton	33.3%
				Sorghum	13.3%
				Soya bean	13.3%

Source: NBI baseline dataset of 2015 (except for SDN17)

Annex B-23: Crop growth parameters for Tanzania

Crop Type	Growing Period (days)					Kc			Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
	Init	Dev	Mid	Late	Total	Init	Mid	Late				
Rice NEL1	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Apr
Rice NEL2	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Sep
Vegetables NEL1	30	30	60	30	150	0.6	1	1	0.5	0.4	1	1-Oct
Vegetables NEL2	30	30	120	30	210	0.6	0.9	1.1	0.5	0.4	1	1-Mar
Beans NEL	30	30	60	30	150	0.3	1.2	0.6	0.4	0.45	0.7	1-Apr
Maize NEL1	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Apr
Vegetables NEL3	30	30	60	30	150	0.6	1.1	0.9	0.5	0.4	1	1-Jun
Millet NEL	30	30	60	30	150	0.3	1.2	0.65	1.5	0.55	1.5	1-Apr
Rice NEL3	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Nov
Sugarcane NEL	30	30	275	30	365	1	1	1	3	0.65	1.6	1-Jan
Tobacco NEL	30	30	60	30	150	0.5	1.2	0.8	1.2	0.5	0.8	1-Oct
Banana NEL	120	60	180	5	365	1	1	1	4	0.35	0.7	1-Jan
Tea NEL	30	30	275	30	365	1.05	1.05	1.05	1.7	0.4	1.2	1-Jan
Citrus NEL	60	90	120	95	365	0.75	0.75	0.75	4	0.5	1.2	1-Jan
Roses NEL	60	90	120	95	365	0.75	0.75	0.75	1	0.5	1.2	1-Feb
Maize NEL2	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Mar
Maize NEL3	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Sep
Vegetables NEL4	30	60	245	30	365	1.1	1.1	1.1	0.5	0.4	1	1-Jan

Source: NBI baseline dataset of 2015

Annex B-24: Cropping pattern for Tanzania

ID	Crop Type	(% of Equipped Area)
TZN1	Beans NEL	50%
	Vegetables NEL3	50%
TZN3	Beans NEL	33.30%
	Maize NEL1	33.30%
	Rice NEL3	33.30%
TZN5	Beans NEL	25.00%
	Maize NEL1	25.00%
	Rice NEL3	25.00%
	Vegetables NEL3	25.00%
TZN6	Beans NEL	33.30%
	Rice NEL3	33.30%
	Vegetables NEL3	33.30%
TZN7	Rice NEL3	100.00%
TZN8	Beans NEL	25.00%
	Maize NEL1	25.00%
	Rice NEL3	25.00%
	Vegetables NEL3	25.00%
TZN9	Beans NEL	33.30%
	Maize NEL1	33.30%
	RIce NEL3	33.30%
TZN10	Beans NEL	33.30%
	Rice NEL3	33.30%
	Vegetables NEL3	33.30%

Source: NBI baseline dataset of 2015

Annex B-25: Crop growth parameters for Uganda

Crop Type	Growing Period (days)					Kc			Crop Height (m)	Depletion Fraction	Max Root Depth (m)	Sowing Date
	Init	Dev	Mid	Late	Total	Init	Mid	Late				
Rice NEL1	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Apr
Rice NEL2	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Sep
Vegetables NEL1	30	30	60	30	150	0.6	1	1	0.5	0.4	1	1-Oct
Vegetables NEL2	30	30	120	30	210	0.6	0.9	1.1	0.5	0.4	1	1-Mar
Beans NEL	30	30	60	30	150	0.3	1.2	0.6	0.4	0.45	0.7	1-Apr
Maize NEL1	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Apr
Vegetables NEL3	30	30	60	30	150	0.6	1.1	0.9	0.5	0.4	1	1-Jun
Millet NEL	30	30	60	30	150	0.3	1.2	0.65	1.5	0.55	1.5	1-Apr
Rice NEL3	30	30	60	30	150	1.2	1.1	0.8	1	0.2	1	1-Nov
cane NEL	30	30	275	30	365	1	1	1	3	0.65	1.6	1-Jan
Tobacco NEL	30	30	60	30	150	0.5	1.2	0.8	1.2	0.5	0.8	1-Oct
Banana NEL	120	60	180	5	365	1	1	1	4	0.35	0.7	1-Jan
Tea NEL	30	30	275	30	365	1.05	1.05	1.05	1.7	0.4	1.2	1-Jan
Citrus NEL	60	90	120	95	365	0.75	0.75	0.75	4	0.5	1.2	1-Jan
Roses NEL	60	90	120	95	365	0.75	0.75	0.75	1	0.5	1.2	1-Feb
Maize NEL2	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Mar
Maize NEL3	30	30	60	30	150	0.3	1.2	0.65	1.8	0.5	1.5	1-Sep
Vegetables NEL4	30	60	245	30	365	1.1	1.1	1.1	0.5	0.4	1	1-Jan

Source: NBI baseline dataset of 2015

Annex B-26: Cropping pattern for Uganda

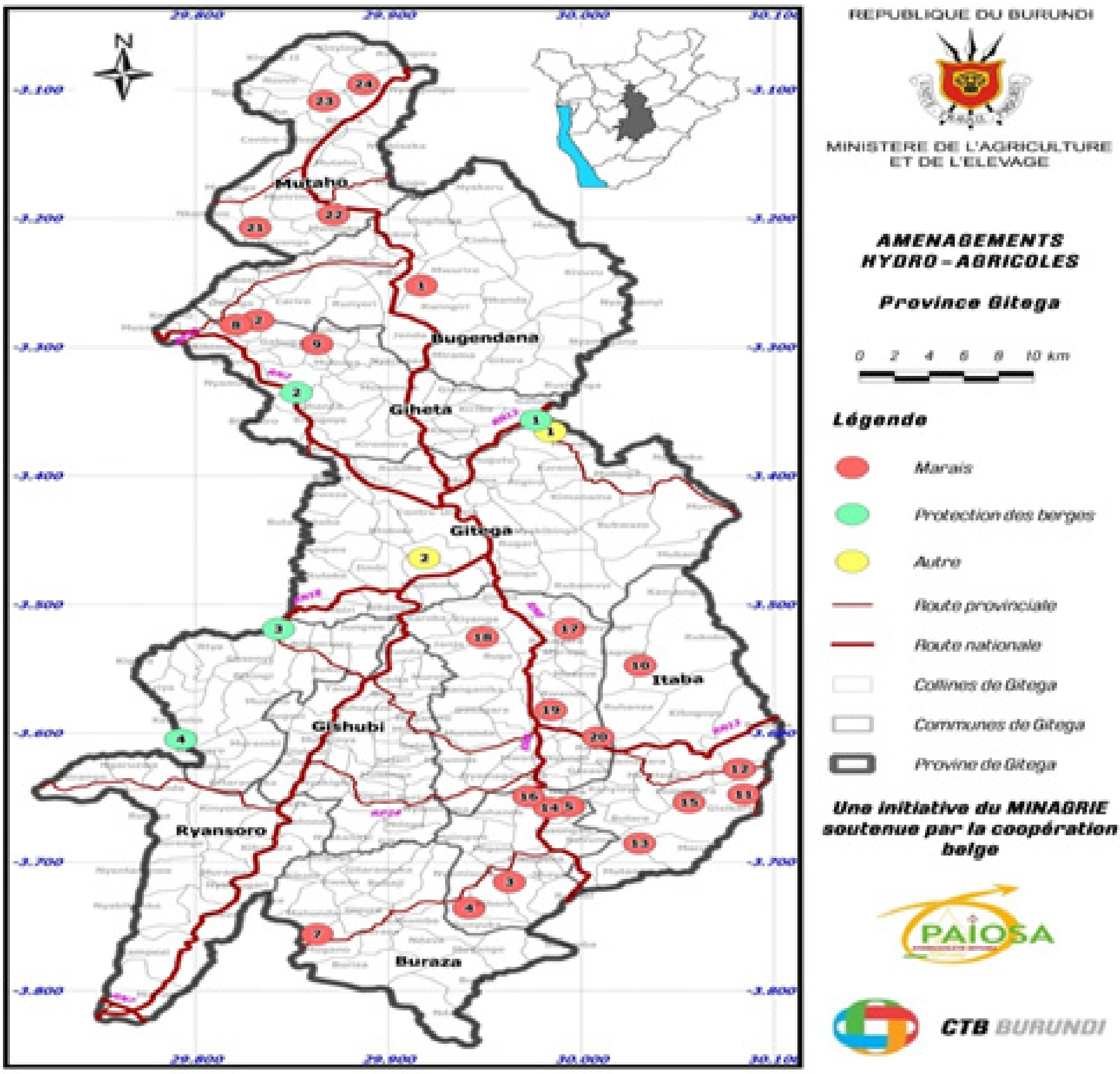
Crop Pattern	Crop Type	% of Equipped Area	Number of Schemes and Cropped Area
UGA1	Rice NEL1 + NEL2	100%	3 Schemes;53,406ha
UGA2	Vegetables NEL1+ NEL2	100%	1 Scheme; 516 ha
UGA3	Sugarcane NEL Citrus NEL Roses NEL	86% 10% 4%	5 Schemes; 8,121ha
UGA4	Citrus NEL Rice NEL1+ NEL2	100% 50.00%	4 Schemes; 11,110ha

Source: NBI baseline dataset of 2015

Annex C: Location of Irrigation Schemes in the Nile Basin Countries

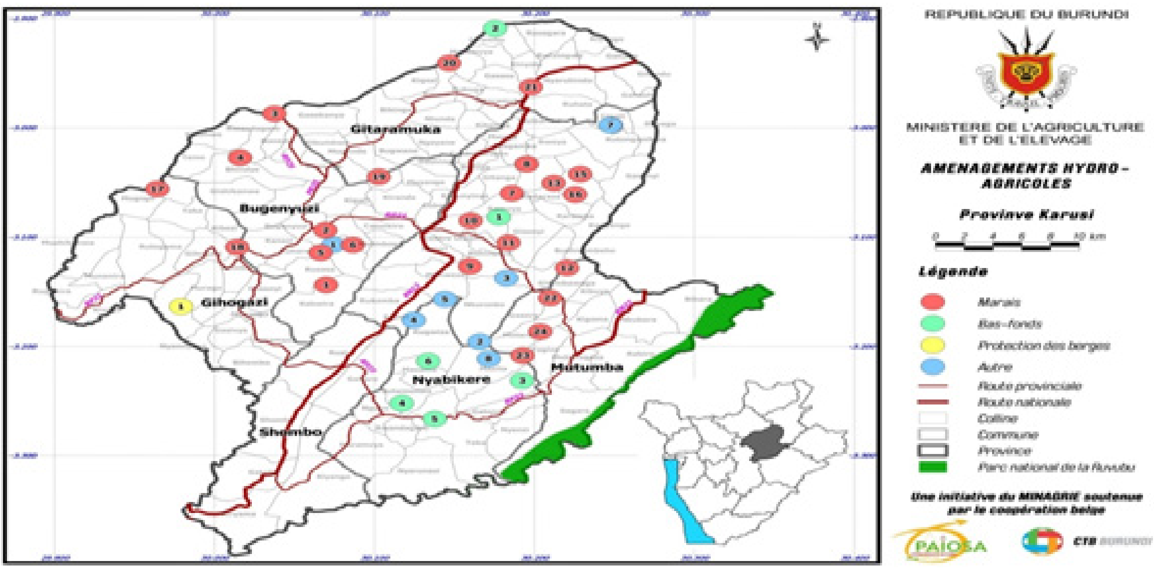
Annex C-1: Location of irrigation schemes in Burundi

Annex C-1 (a): Location of irrigation schemes in Gitega Region in Burundi



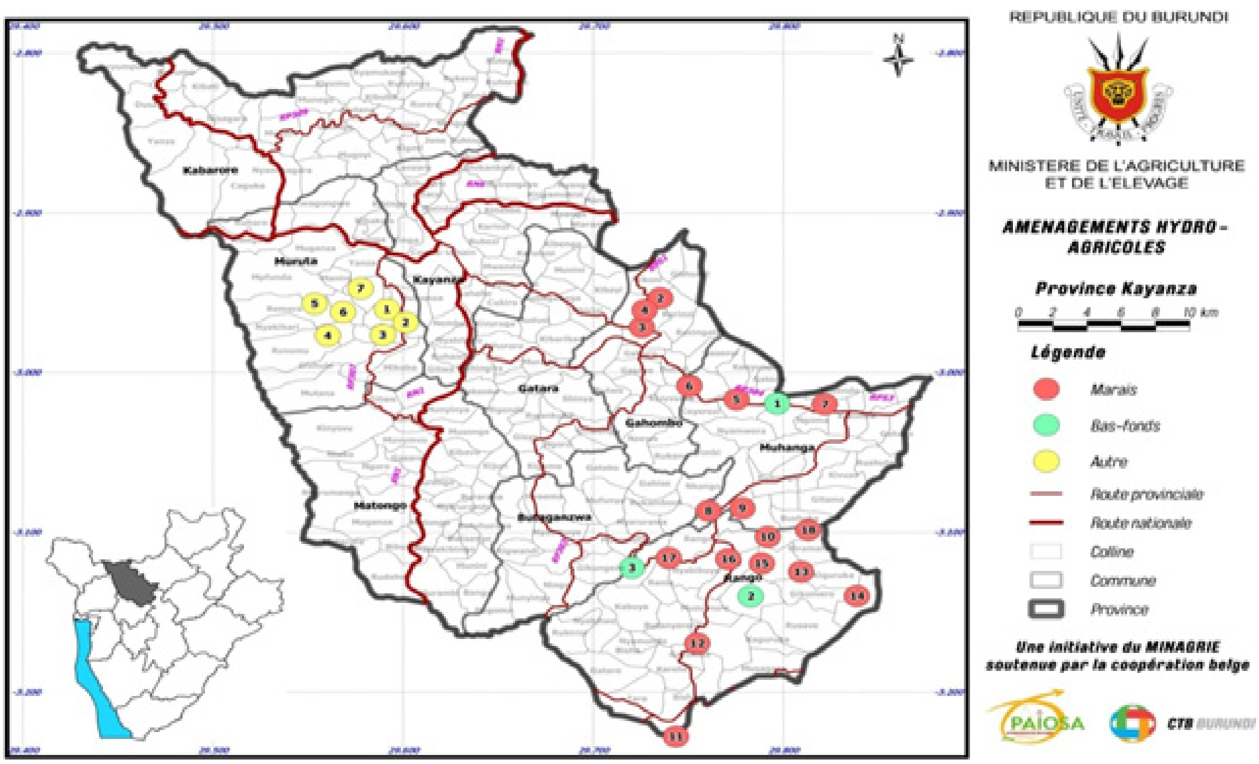
Source: NBI baseline dataset of 2015

Annex C-1 (b): Location of irrigation schemes in Karusi Region in Burundi



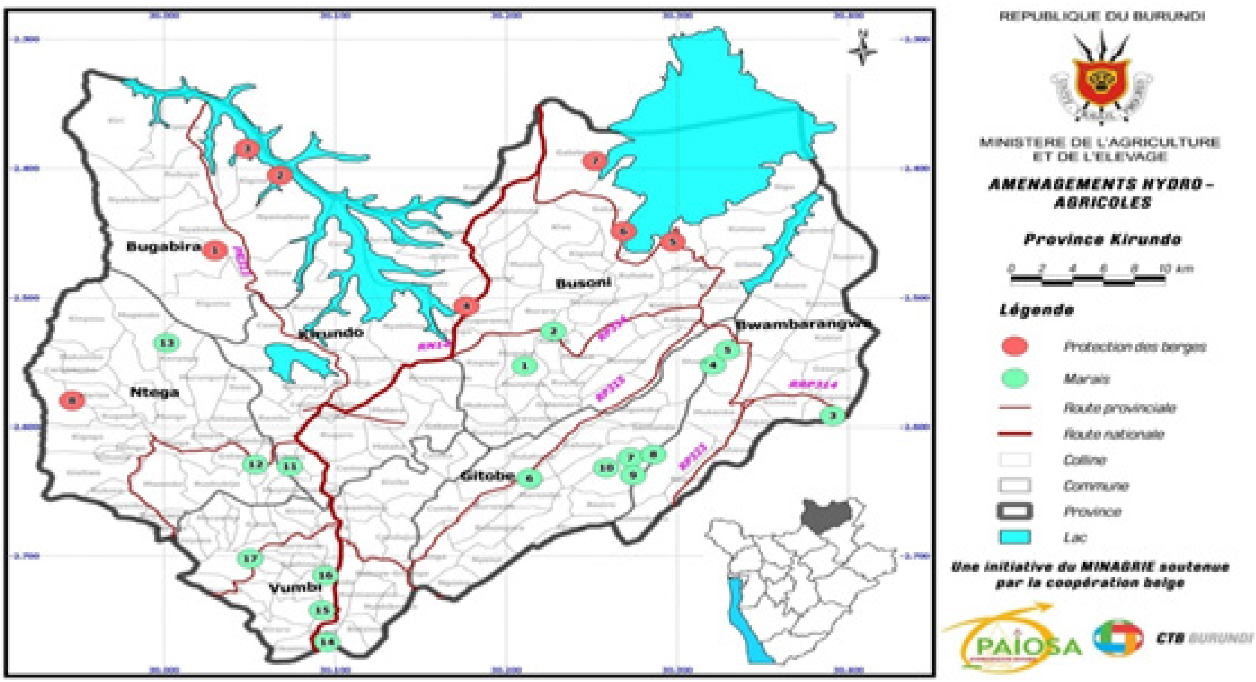
Source: NBI baseline dataset of 2015

Annex C-1 (c): Location of irrigation schemes in Kyanza Region in Burundi



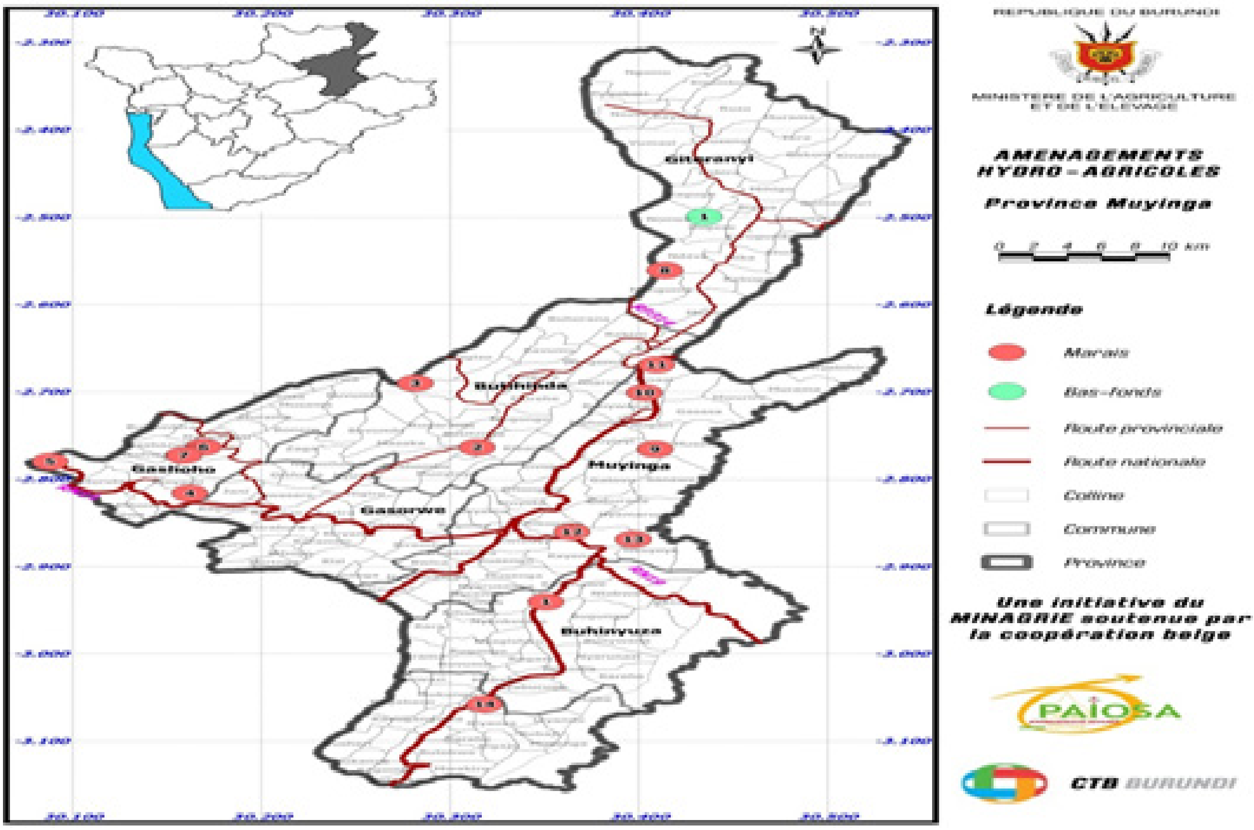
Source: NBI baseline dataset of 2015

Annex C-1 (d): Location of irrigation schemes in Kirundo Region in Burundi



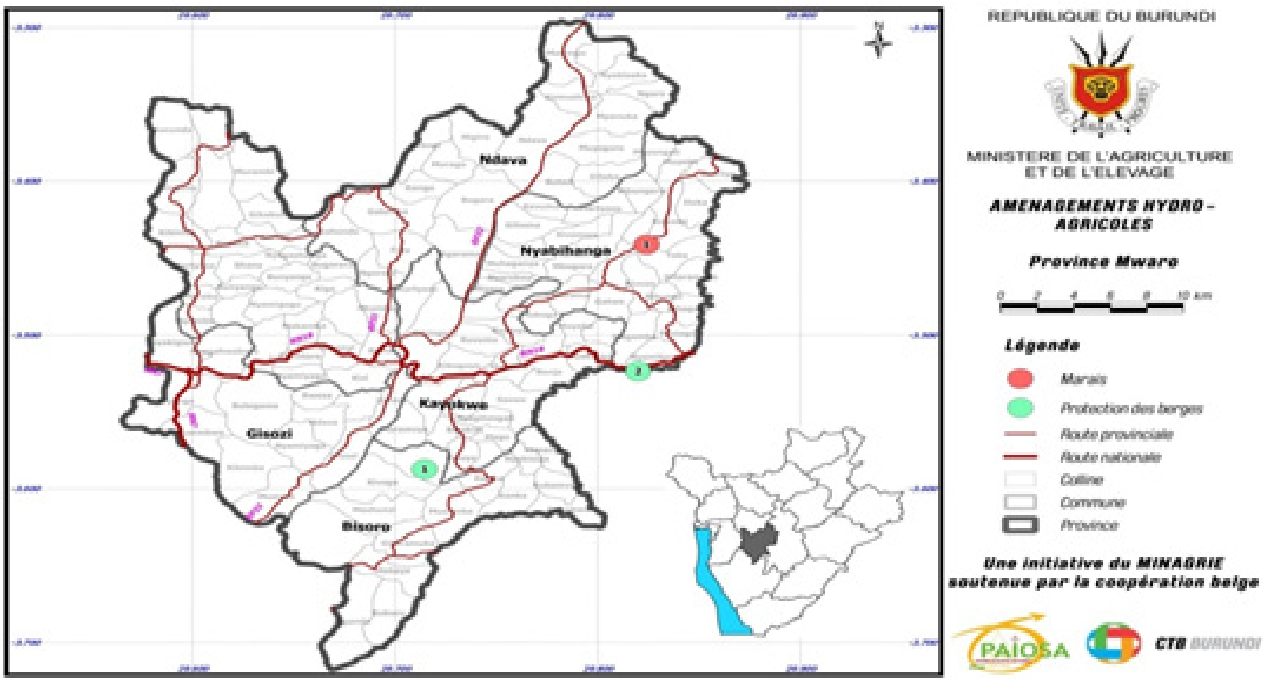
Source: NBI baseline dataset of 2015

Annex C-1 (e): Location of irrigation schemes in Muyinga Region in Burundi



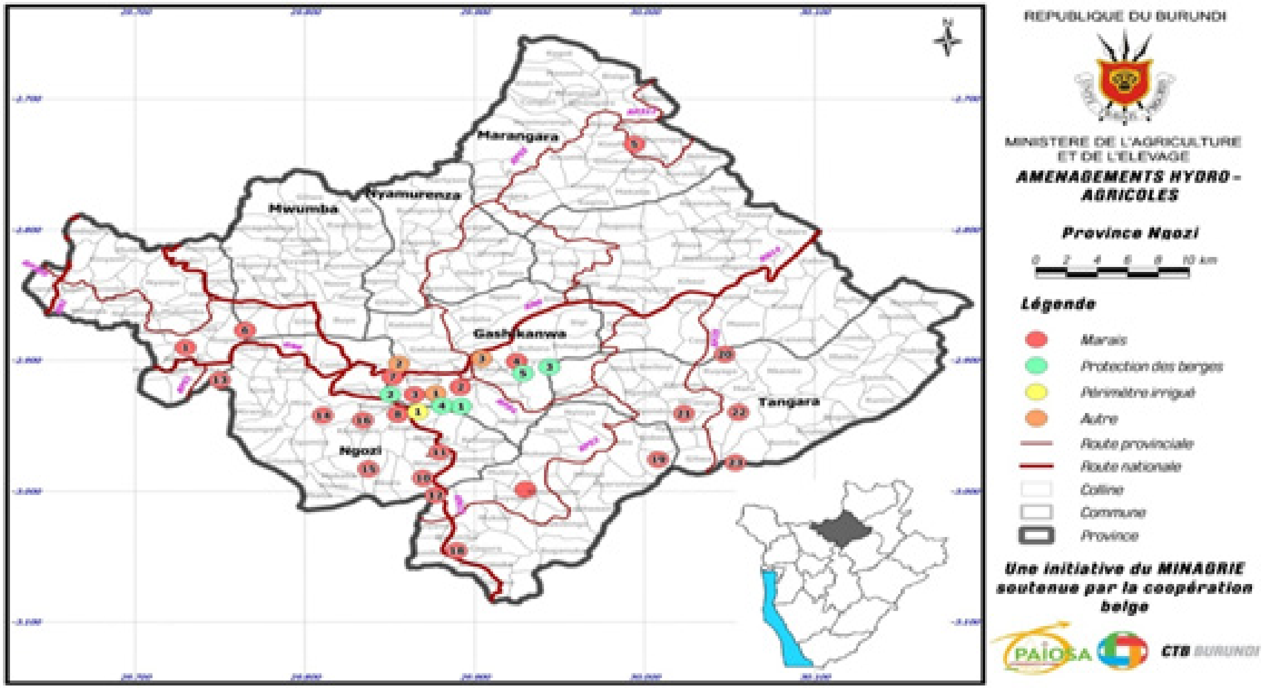
Source: NBI baseline dataset of 2015

Annex C-1 (f): Location of irrigation schemes in Mwaro Region in Burundi



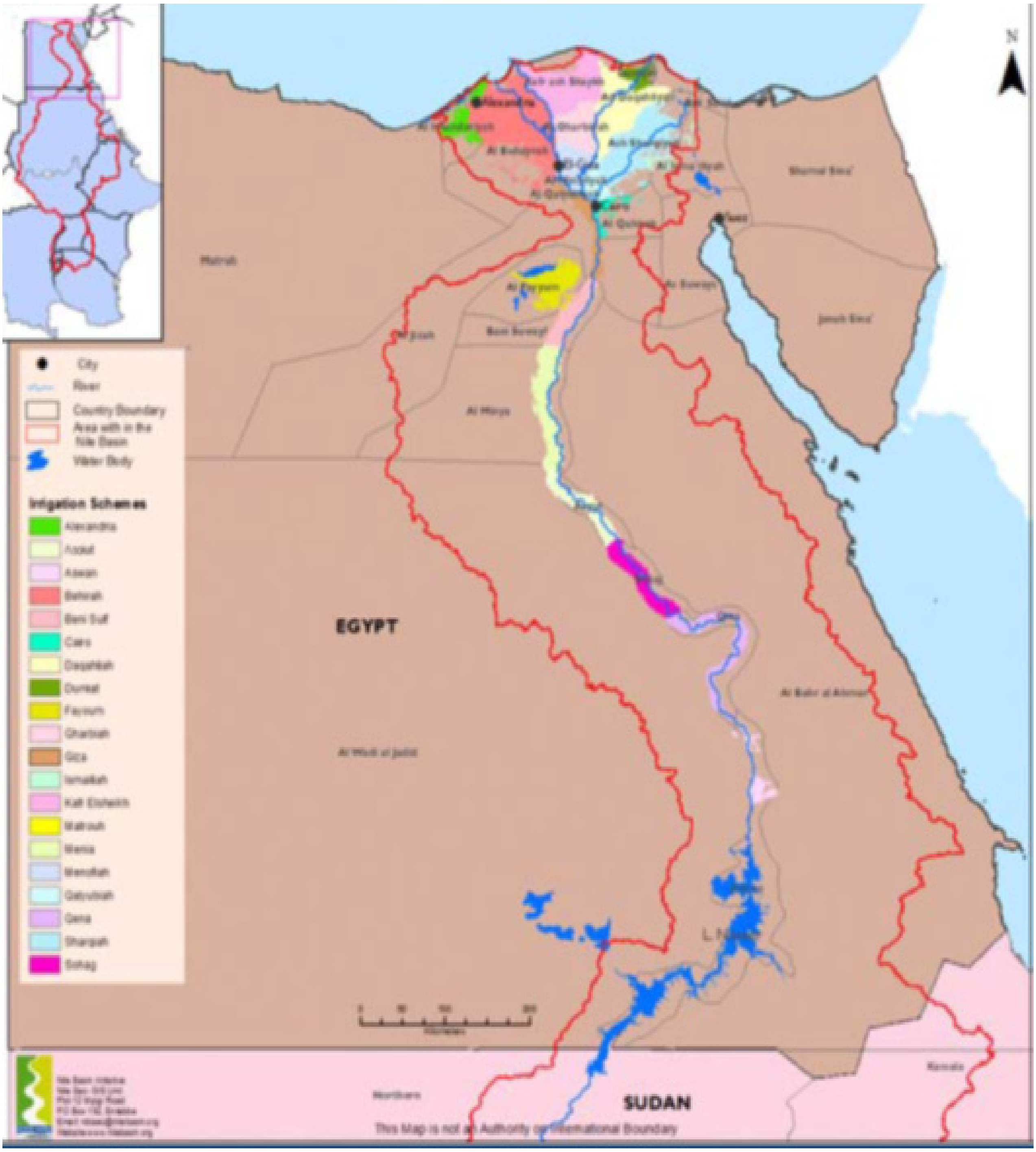
Source: NBI baseline dataset of 2015

Annex C-1 (g): Location of irrigation schemes in Ngozi Region in Burundi



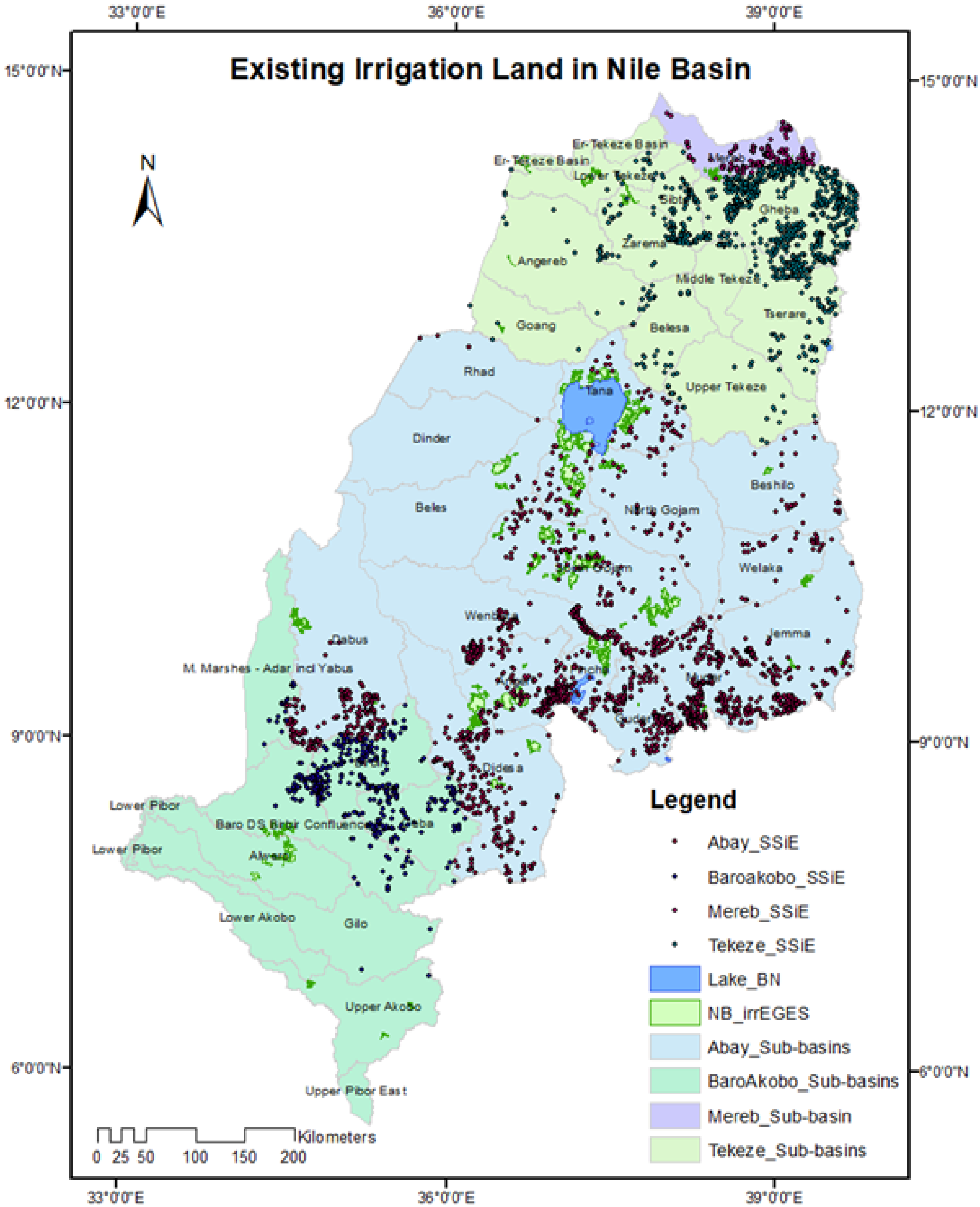
Source: NBI baseline dataset of 2015

Annex C-2: Location of irrigation schemes in Egypt



Source: NBI baseline dataset of 2015

Annex C-3: Location of irrigation schemes in the Nile Basin part of Ethiopia



Source: Generation Integrated Rural Development Consultants (GIRDC), 2018. (draft) Assessment of National Water used and Demand Forecast: Part II: Water uses and Demand Forecast: II-C: Agricultural Sector Water use and Demand Forecast. Ministry of Water, Irrigation and Drainage and Energy. Addis Ababa.

Annex C-4: Location of irrigation schemes in Kenya

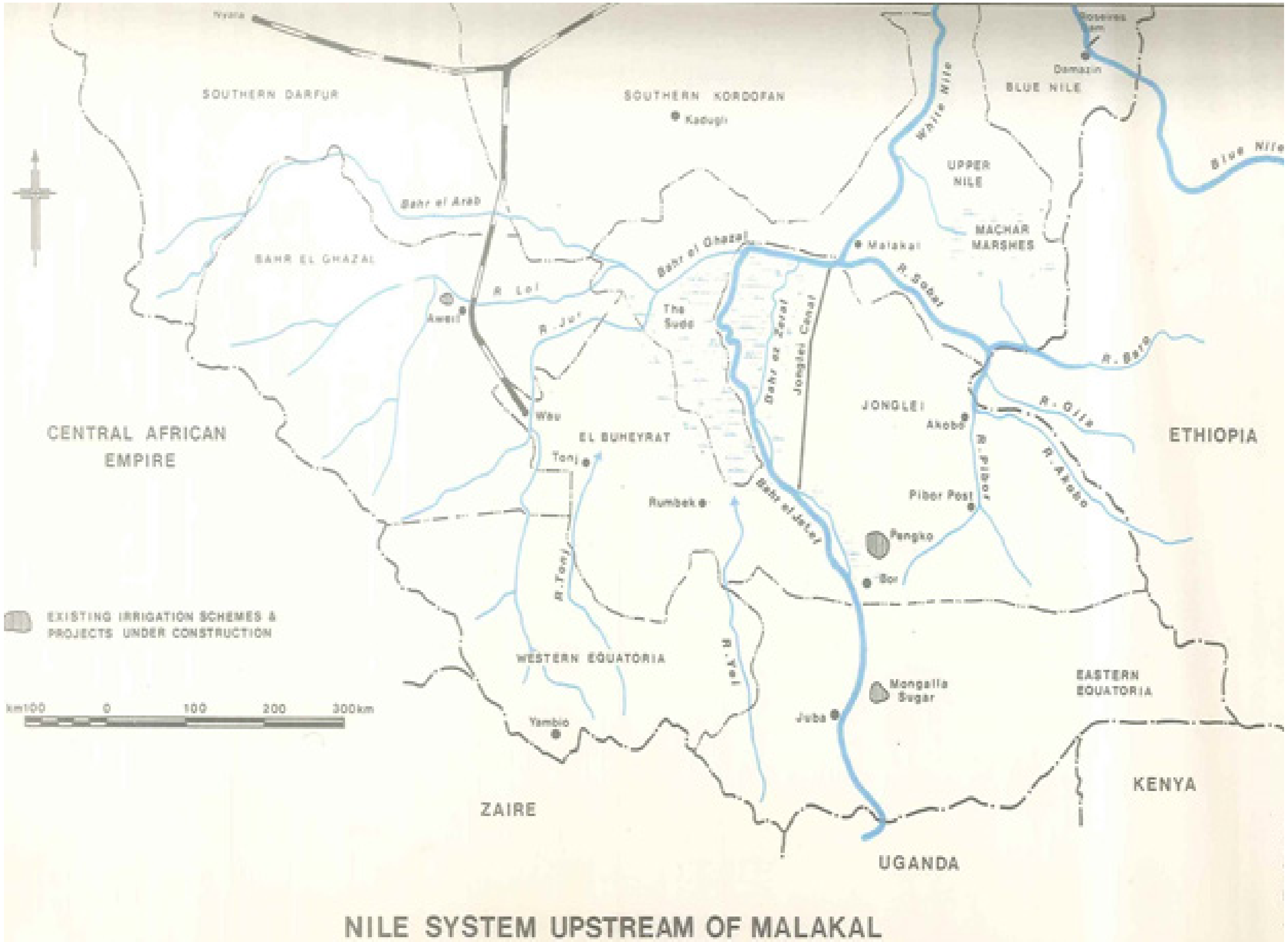
Source: NBI baseline dataset of 2015

Annex C-5: Location of irrigation schemes in Rwanda

Source: NBI baseline dataset of 2015

Annex C-6: Location of irrigation schemes in South Sudan

Annex C-6 (a): Location of irrigation schemes in the South Sudan – Upstream of Malakal



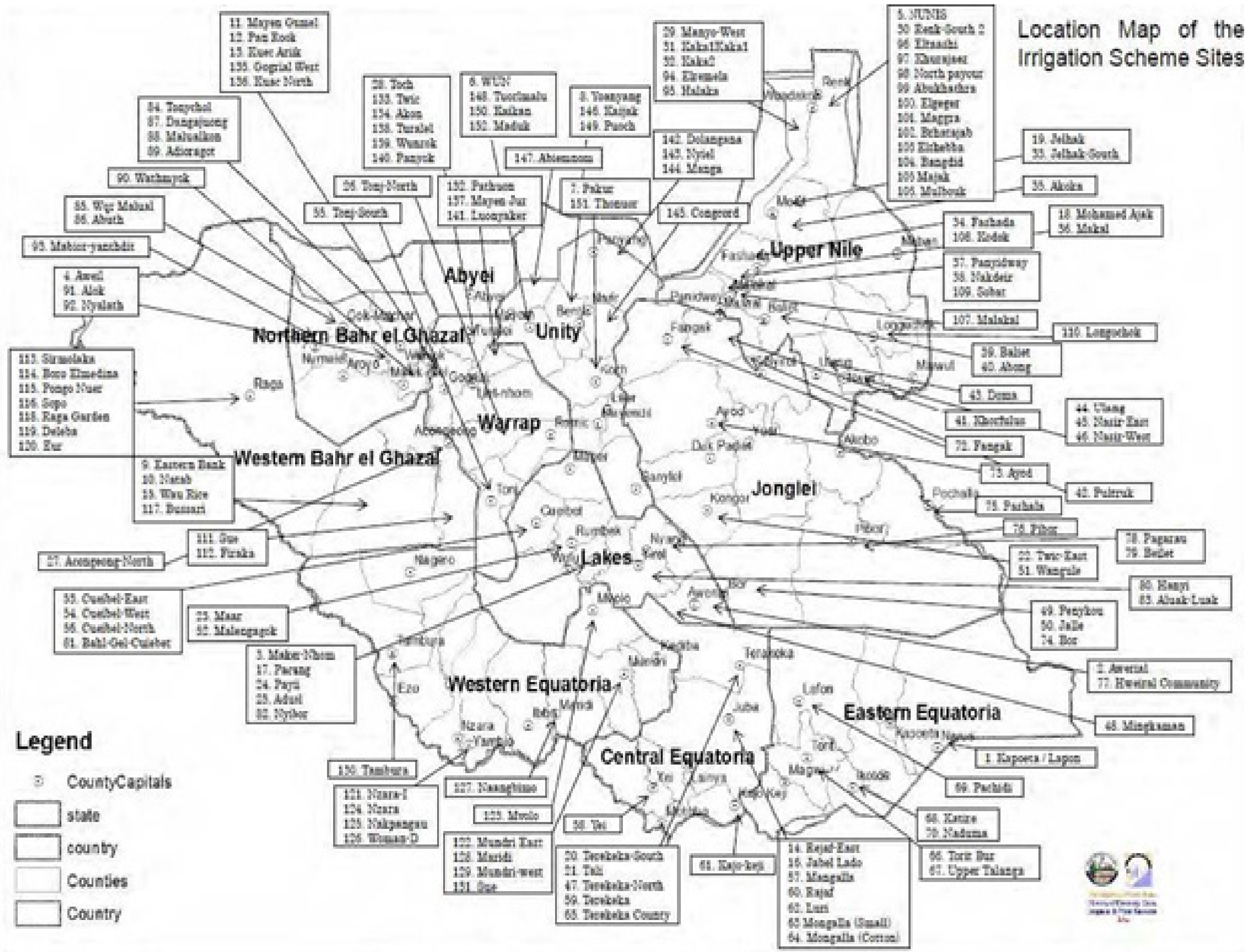
Compiled from:

MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan (2015). Project for Irrigation Development Master Plan (IDMP) in the Republic of South Sudan. Final Report (ANNEXES, PART I).

Aquastat http://www.fao.org/nr/water/aquastat/countries_regions/SSD/

Cross checked by data for the White Nile Pump Schemes Grouping - Ministry of Irrigation Sudan.

Annex C-6 (b): Location of existing and potential irrigation schemes in the South Sudan



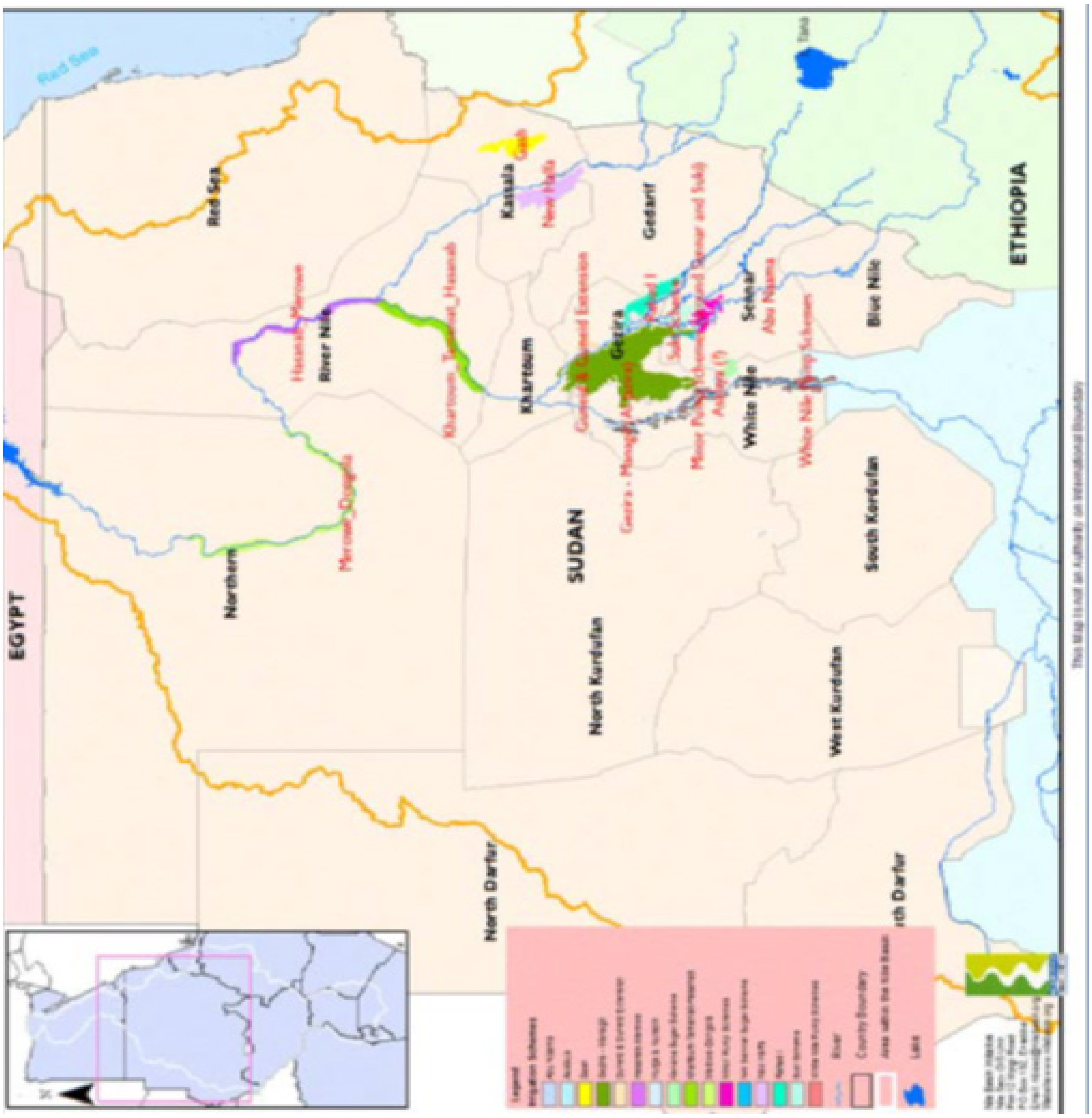
Compiled from:

MEDIWR, Ministry of Electricity, Dams, Irrigation & Water Resources, The Republic of South Sudan (2015). Project for Irrigation Development Master Plan (IDMP) in the Republic of South Sudan. Final Report (ANNEXES, PART I).

Aquastat http://www.fao.org/nr/water/aquastat/countries_regions/SSD/

Cross checked by data for the White Nile Pump Schemes Grouping - Ministry of Irrigation Sudan.

Annex C-7: Location of irrigation schemes in Sudan



Source: NBI baseline dataset of 2015

Annex C-7 (a): Coordinates of the irrigation schemes in Sudan

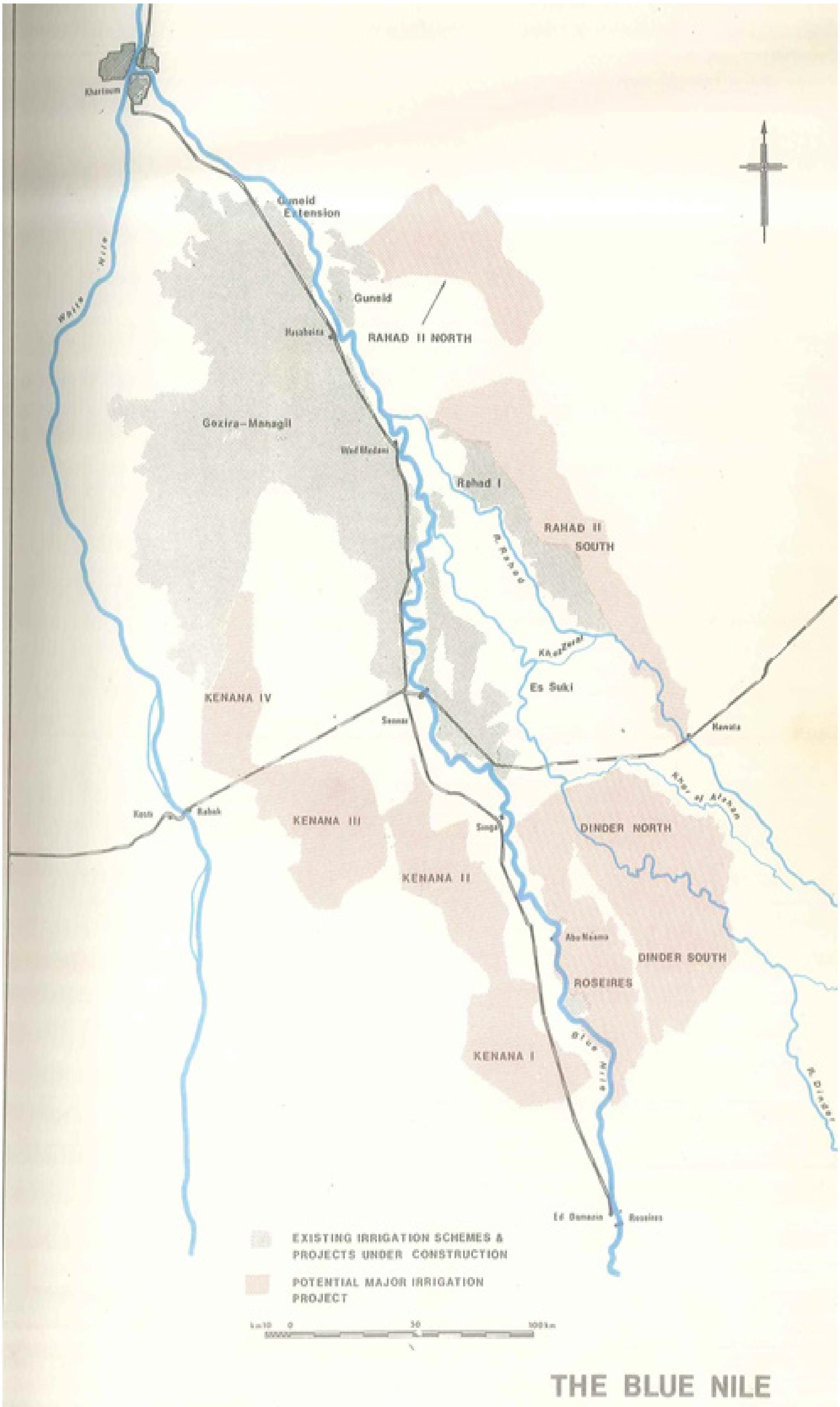
Count	Scheme Name	Latitude N	Latitude N	Longitude E	Longitude E
Blue Nile System					
1	Abu Naama (Private scheme since 2008)	12.62	12.72	33.99	34.11
2	Pump schemes u/s of Sennar (including Shashena)	11.85	13.42	along the Blue Nile between Sennar and Roseires reservoir	
3	Hurga and nour-el-deen (Pump schemes as part of gezira)	14.26	14.40	33.57	33.70
4	Guneid (Sugar)	14.78	15.00	33.28	33.38
5	Seleit	15.54	15.61	32.64	32.72
6	Small Private Pump Schemes (throughout blue Nile)			along the Blue Nile between Roseires and Khartoum	
7	Waha (Blue Nile)	15.29	15.41	32.90	33.00
8	Gezira and Managil	13.50	15.00	32.25	33.75
9	Rahad I	13.75	14.58	33.60	34.00
10	Suki Scheme (Old and new)	13.00	14.00	33.00	34.00
11	NW Sennar Sugar Scheme	13.50	13.75	33.41	33.60
12	NW Sennar (non-Sugar) Scheme				
13	Guneid Extension (Haddaf/Wadel Faddul)	14.94	15.14	33.27	33.48
White Nile System					
14	Kenana Sugar Scheme	13.28	13.00	32.83	33.19
15	Kenana - mixed crop				
16	Asalaya (Sugar)	13.20	13.38	32.65	32.88
17	White Nile Pump Schemes	13.33	14.76	32.15	32.65
Atbara System					
18	New Halfa;	15.02	15.95	35.30	35.90
19	New Halfa Sugar				
Main Nile System					
20	Hasanab - Merowe - Dongola; Main Nile Pump schemes	17.67	19.71	along the Main Nile	
21	Khartoum_Tamaniat_Hasanab	15.62	17.67	32.05	33.98

Source: Generated from Google Earth by Professor Younis Gismalla; email: hrs_younis@hotmail.com

Annex C-7 (b): Location of Atbara Irrigation Schemes in Sudan

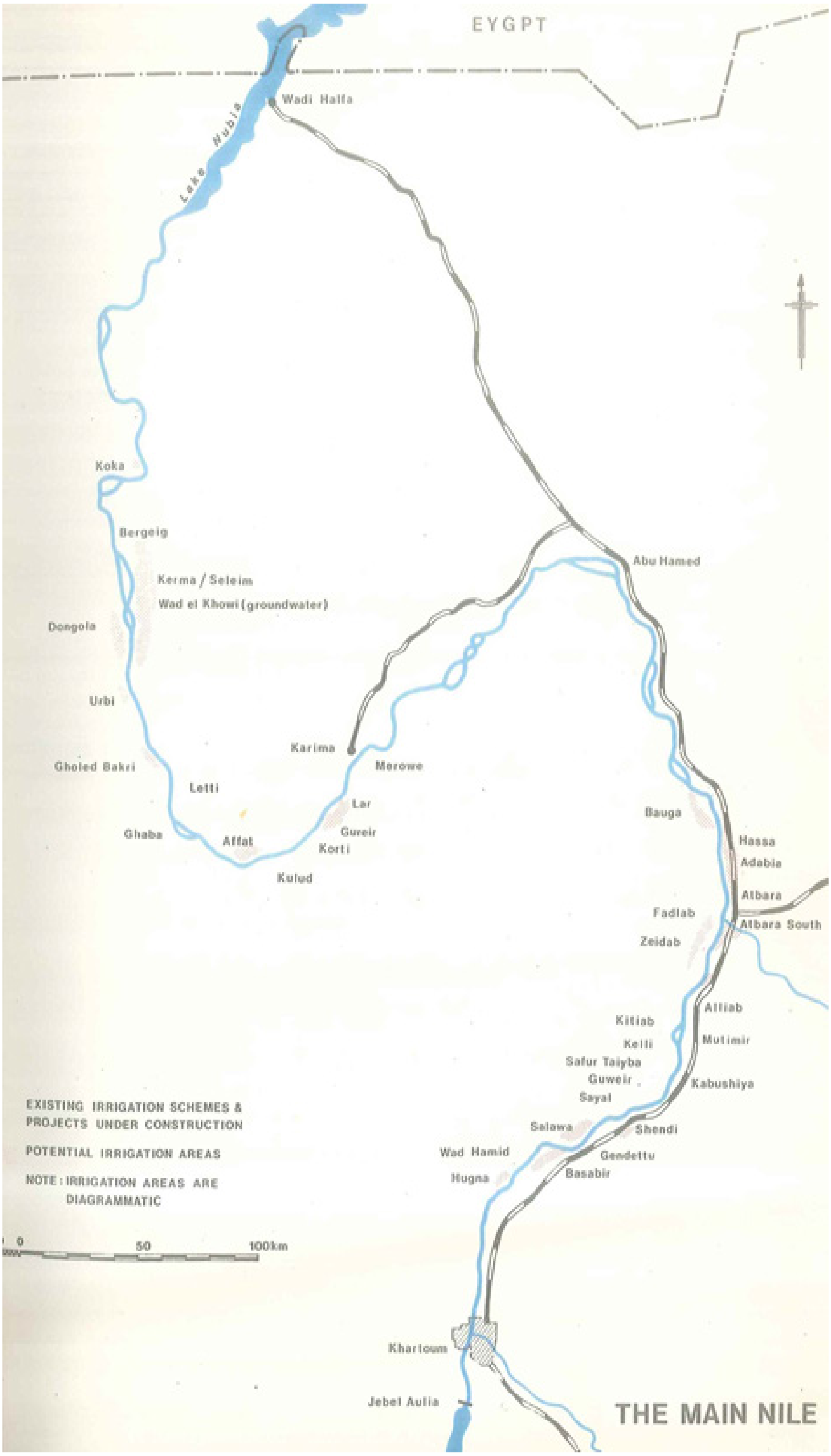
Source: Ministry of Planning-Sudan (1980). New Halfa Rehabilitation Project Phase II. Volume 1: Support annex 1-8; and Nile Waters Study, Volume 3, Supporting report IV Irrigation

Annex C-7 (c): Location of irrigation schemes in the Blue Nile of Sudan



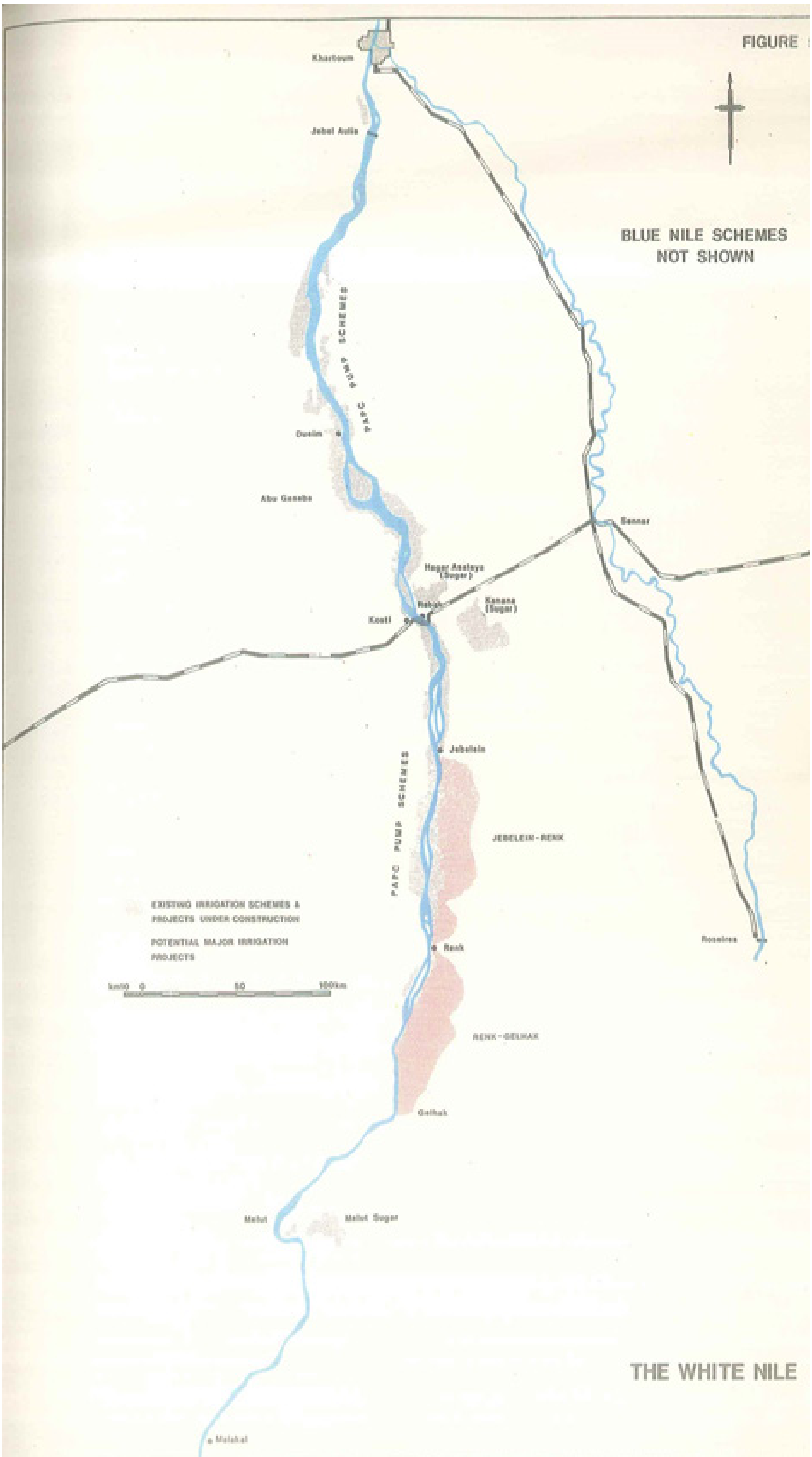
Source: Ministry of Planning-Sudan (1980). New Halfa Rehabilitation Project Phase II. Volume 1: Support annex 1-8; and Nile Waters Study, Volume 3, Supporting report IV Irrigation

Annex C-7 (d): Location of irrigation schemes in the Main Nile of Sudan



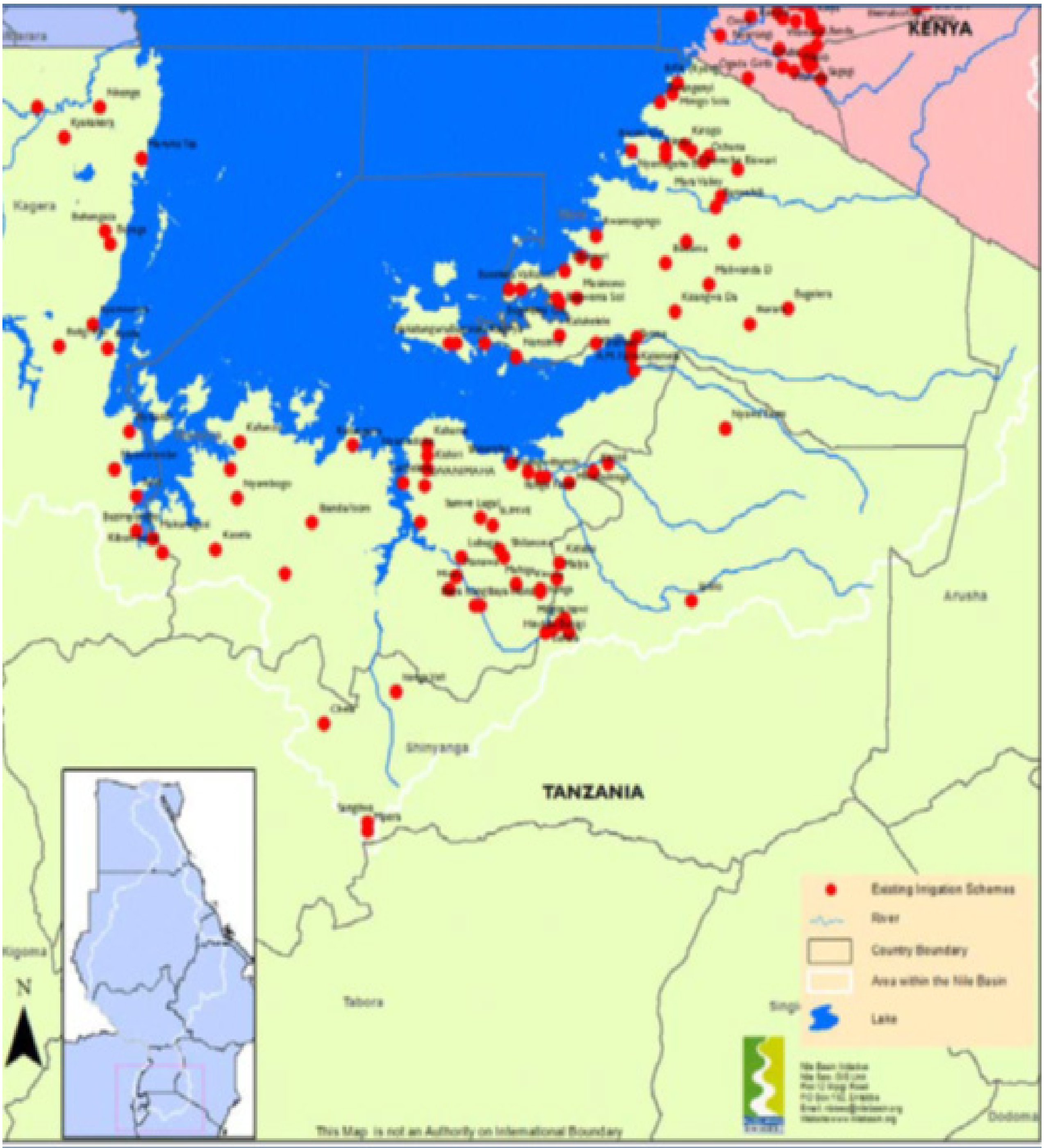
Source: Ministry of Planning-Sudan (1980). New Halfa Rehabilitation Project Phase II. Volume 1: Support annex 1-8; and Nile Waters Study, Volume 3, Supporting report IV Irrigation

Annex C-7 (e): Location of irrigation schemes in the White Nile of Sudan



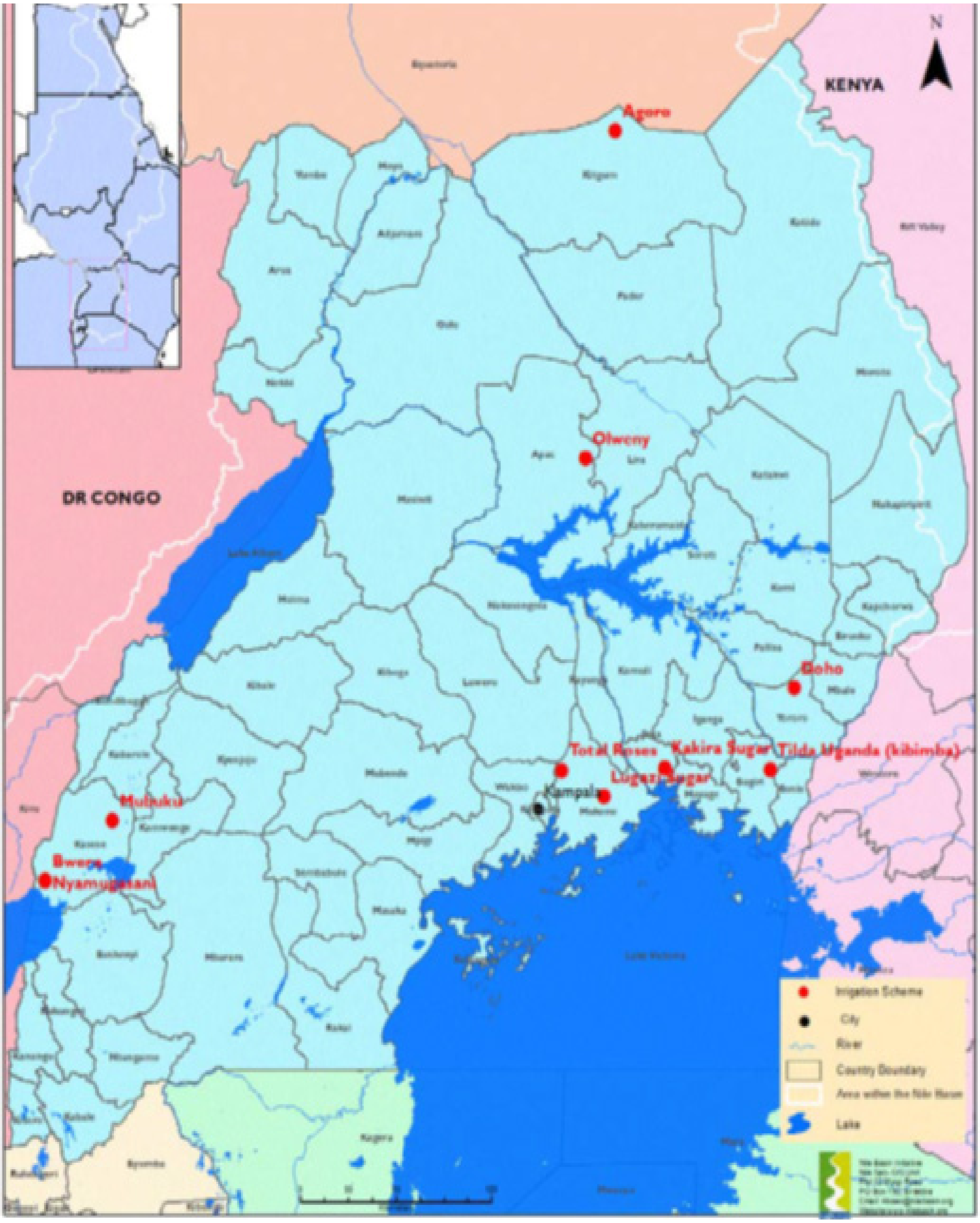
Source: Ministry of Planning-Sudan (1980). New Halfa Rehabilitation Project Phase II. Volume 1: Support annex 1-8; and Nile Waters Study, Volume 3, Supporting report IV Irrigation

Annex C-8: Location of irrigation schemes in Tanzania



Source: NBI baseline dataset of 2015

Annex C-9: Location of irrigation schemes in Uganda



Source: NBI baseline dataset of 2015

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