WATER GRABBING AND CONFLICT IN THE NILE RIVER BASIN:

A FOCUS ON ETHIOPIA

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Geography)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

May 2016

Abstract

The phenomenon of large-scale land investments for agricultural production – also referred to as land grabbing[1] – has grown in recent years all over the world, especially after the 2007-2008 international food price crisis. Ethiopia is among the most targeted countries by foreign investors concerning farmland demand. But not only that, the Ethiopian Government is actively promoting and encouraging private sector participation in large-scale farming, especially in the low land border areas of the country that are part of the Ethiopian Nile River basin. The development of land transferred to investors in these areas will necessarily result in an increase of Ethiopia's Nile waters use. The intensification of Nile waters consumption in Ethiopia, in turn, may challenge the existing arrangement at the basin level, where Egypt has historically acted as the hydro-hegemon opposing any water resources development in the upstream countries. Thus, in this research I explore the implications of land grabbing on water resources as well as the ways in which specific ideas about water configure different power geometries at different scales. By using the agronomic model CROPWAT, I estimate the amount of water required to bring into production all the land that has been transferred to investors in the Ethiopian Nile River basin. Results from CROPWAT show that large-scale farming development could increase the pressure on water resources in some areas to unsustainable levels, as it is the case of the Pibor – Akabo – Sobat sub-basin. It could represent as well, a decline up to 3.4 % of Egypt's Nile waters share – up to 10.2% in the case of Sudan – clearly challenging the existing hydro-hegemony in the basin. Furthermore, by interrogating different notions of water – those of the state, private investors and

[1] Throughout this document the concepts "land grabbing" and "water grabbing" are used in the same sense they have been defined by Franco et al. (2013b, 2014); as processes or phenomena involving the capturing of power to control land and water resources in order to control the benefits of its use.

local communities – through the hydrosocial cycle framework, this research reveals how water discourses configure social structures and power relations at different scales; and how water injustices reveal or conceal themselves depending on the scale of inquiry.

Preface

This thesis is an original and unpublished work carried out independently by the author, Eva Crego Liz, in the Department of Geography (UBC) between September 2013 and May 2016 under the supervision of Professor Marwan Hassan.

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CWR:	Crop Water Requirement
Eff. Rain:	Effective Rainfall
ET:	Evapotranspiration
ET_0:	Potential Evapotranspiration
ET_c:	Crop Evapotranspiration or Crop Water Requirement
$ET_{C\text{-}MAX}$:	Evapotranspiration corresponding to the crop with higher ET_c
$ET_{C\text{-}MIN}$:	Evapotranspiration corresponding to the crop with lower ET_c
ET_{C-S1}^{Post}:	Evapotranspiration for Scenario 1 in the post-development situation
ET_{C-S2}^{Post}:	Evapotranspiration for Scenario 2 in the post-development situation
ET_{C-S1}^{Pre}:	Evapotranspiration for Scenario 1 in the pre-development situation
ET_{C-S2}^{Pre}:	Evapotranspiration for Scenario 2 in the pre-development situation
IWR:	Irrigation Water Requirement
IWW:	Irrigation Water Withdrawal
K_c:	Crop Coefficient
P:	Precipitation
R:	Groundwater recharge
S1:	Scenario 1
S2:	Scenario 2
RO:	Direct runoff and interflow
WRR:	Water Requirement Ratio

ΔET_{C-MAX}: Maximum change in ET between the pre-development and post-development situations

ΔET_{C-MIN}: Minimum change in ET between the pre-development and post-development situations

ΔS: Changes in soil moisture storage

List of Abbreviations

CFA:	Cooperative Framework Agreement
FAO:	Food and Agriculture Organization of the United Nations
FDI:	Foreign Direct Investment
GERD:	Grand Ethiopian Renaissance Dam
GTP:	Growth and Transformation Plan
HAD:	High Aswan Dam
ITCZ:	Inter-Tropical Convergence Zone
MENA:	Middle East – North Africa
NBI:	Nile Basin Initiative
NRB:	Nile River Basin
TRWR:	Total Renewable Water Resources
WB:	Water Balance

Acknowledgements

I would like to express my gratitude to Professor Marwan Hassan for its academic supervision and the confidence he has placed in me during all this process. I extend my thanks to Dr. Leila Harris for agreeing to be the second reader of this work.

I would like to thank as well the Department of Geography and the Faculty of Graduate Studies at UBC for their financial support without which this research would not have been possible.

To the 99%

WATER, is taught by thirst.
Land — by the Oceans passed.
Transport — by throe —
Peace — by its battles told —
Love, by Memorial Mold —
Birds, by the Snow.

Emily Dickinson

Chapter 1: Introduction

In recent years, capital investments in agricultural land have increased exponentially, especially all over the Global South (Anseew et al., 2012). Corporate entities, mainly from the Global North, are acquiring large-scale tracts of land in less "developed" countries where it is considered that land is "abundant" and "unoccupied". In spite of the fact that most of the attention has been placed on Foreign Direct Investment (FDI), domestic investors and national elites play also a central role in large-scale land acquisitions. These acquisitions materialize in the form of land purchases or, most often, in the form of long-term leases on government-owned land, as it is the case of Ethiopia (Cotula, 2012; White et al., 2012).

The rush for land is not necessarily a new phenomenon. Large-scale land enclosures and privatization of land rights have occurred historically all over the world (Cotula, 2012; White et al., 2012; Baumgartner, 2013; Franco et al., 2013b; Wily, 2013). However, the scale and the pace at which the current global land rush is taking place distinguish it from the past. White et al. (2012) see the current process of large-scale land acquisition as part of the dominant neoliberal capitalism, to which privatization and financialization are central. In this sense, market forces have played, and continue playing, a fundamental role in boosting investment in agricultural land. Market mechanisms that have contributed to this global phenomenon include an increasing demand for agricultural commodities, volatile fuel prices and the financialization of agriculture. Population growth and increasing rates of urbanization, with more people depending on food purchases through the market, changing diets, the rise in energy demand along with volatile fuel prices, demand for agricultural commodities for industrial use (e.g. rubber, cotton), all these factors have contributed to the growing interest in land acquisition for food, biofuel and/or "flex crops[2]" production. These same mechanisms, coupled with other factors, have led to the financialization of land and agriculture, by making land investments attractive to financial capital. So, land is acquired not only for direct agricultural production but for speculative purposes (Cotula, 2012; White et al., 2012). In accordance with all these factors, large-scale land acquisitions experienced a global surge following the 2007-2008 food price crisis (Anseeuw et al., 2012; Baumgartner, 2013).

However, market forces are not the only factors influencing large-scale land investments. Different sets of policies at the international and national level enable and promote this trend: carbon trading policies, energy policies promoting renewable energy production and/or energy security, bi-lateral or multi-lateral trade agreements, policies oriented to ensure national food security (Cotula, 2012; White et al., 2012). National policies in the targeted country may also play a major role in attracting private capital by creating a "desirable" investment environment, as it is the case or Ethiopia (Cotula, 2012; Lavers, 2012; Baumgartner, 2013).

Since 2009, right after the global food price crisis of 2007-2008, the Land Matrix Global Observatory[3] has been collecting and verifying data on large-scale land acquisitions worldwide, with the aim to promote transparency and to enhance decision making and accountability over land investments (Anseeuw et al., 2013). Regarding the information collected in its database, Ethiopia is amongst the most targeted countries for large-scale land acquisition, both in terms of cumulative size of the investments as well as number of intended projects (Anseeuw et al.,

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[2] "*Flex crops are crops that have multiple uses (food, feed, fuel, industrial material) that can be easily and flexibly inter-changed: soya (feed, food, biodiesel), sugarcane (food, ethanol), oil palm (food, biodiesel, commercial/industrial uses), corn (food, feed, ethanol)*" (Franco et al. 2013b).
[3] The Land Matrix Global Observatory is an independent initiative formed by the Centre for Development and Environment (CDE) at the University of Bern, Centre de Cooperation International en Recherche Agronomique pour le Développement (CIRAD), German Institute of Global and Area Studies (GIGA), Gesellschaft für Internationale Zusammenarbeit (GIZ) and the International Land Coalition (ILC) (Anseeuw et al. 2013).

2012). The Ethiopian Government is also actively promoting private investment in large-scale farming as an essential part of its national developmental vision (MoFED, 2010).

Intimately linked to large-scale land acquisition for agricultural production is the access and control over water resources. Water, as much as land, is indispensable for the production of agricultural commodities, and thus for the profitability of the investment. In this sense, different authors have highlighted the importance of water, both as a driver and as target of large-scale land investments (Bossio et al., 2012; Cotula, 2012; White et al., 2012; Franco et al. 2013a 2013b, 2014; Rulli and D'Odorico, 2013; Rulli et al., 2013). Therefore, the high demand for agricultural land in Ethiopia – coupled with the large amount of "empty" land that the Ethiopian Government is making available for investors – is expected to have a significant impact on the country's water resources in general, and on the Ethiopian Nile River basin in particular as much of the land being "released" by the government lays within its boundaries (Lavers, 2012).

For many years now, Ethiopia has affirmed its right to develop the Nile waters and the importance of this development to the wealth of the country and its citizens. On the other hand, Egypt has persistently appealed to its "historical" and "legal" right to the Nile waters to oppose any water resources development by the upstream riparian countries (Milas, 2013; Kimenyi and Mbaku, 2015). The governance of the Nile River basin has been historically characterized by the role of Egypt acting as the hydro-hegemon. Egypt has used its advantageous power position – not only militarily, but politically, economically, technologically, in terms of knowledge and discourse production – to impose the "rules of the game" in the trans-boundary governance of the Nile (Zeitoun and Warner, 2006). However, it seems that in recent years the existing hydro-hegemonic status-quo is slowly shifting to a more cooperative benefit-sharing arrangement. The establishment in 1999 of the Nile Basin Initiative (NBI) by all Nile riparian states[4] (Figure 1.1), except Eritrea, can be considered the first step in this new direction. The NBI was created as a transitional institution to provide riparian countries with a "*regional platform for multi stakeholder dialogue, information sharing as well as joint planning and management of water and related resources in the Nile Basin*" until the Cooperative Framework Agreement (CFA) – a permanent legal and institutional framework – was enacted. Its vision is "*to achieve sustainable socio-economic development through equitable utilization of, and benefit from, the common Nile Basin water resources*" (NBI, 2016). In spite of the fact that the "sustainable" and "equitable" utilization of the Nile waters is one of the main objectives of the NBI, Egypt, and to a lesser extent Sudan, have consistently rejected to engage in negotiations about a different water allocation formula than the one established by the 1959 Nile Waters Agreement (Milas, 2013; Kimenyi and Mbaku, 2015). The "Agreement for the Full Utilization of the Nile Waters" signed in 1959 between Egypt and Sudan[5] – through which the two countries agreed on the construction of the High Aswan Dam (HAD) – allocates 55.5 cubic kilometers per year to Egypt and 18.5 to Sudan from the total mean annual flow of the Nile at Aswan, estimated in 84 cubic kilometers (evaporative losses at Lake Nasser are estimated in 10 cubic kilometers per year) (UNTS, 1963). Notwithstanding that none of the upstream riparian countries recognize neither the legal validity nor the binding effects of the 1959 Agreement, Egypt and Sudan maintain that it is the only legal and valid framework for the allocation of the Nile Waters. It is precisely the disagreement

[4] Currently, the Nile River basin is shared by 11 countries: Burundi, DR Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda.

[5] Sudan and South Sudan were part of the same country when the Agreement was signed. International law on succession of treaties gives the right to South Sudan to either recognize or renounce the 1959 Nile Waters Agreement. For further details on South Sudanese independence and its legal implications on the 1959 Nile Water Agreement refer to Katz (2013).

between the downstream (i.e. Egypt and Sudan) and the upstream countries about the legal legitimacy of the 1959 bi-lateral agreement that prevents Egypt and Sudan from singing the Cooperative Framework Agreement (CFA). The CFA has been signed by Ethiopia, Kenya, Rwanda, Tanzania, Uganda and Burundi and ratified by Ethiopia, Rwanda and Tanzania. The Article 43 of the CFA establishes that at least six of the eleven riparian countries should ratify the framework so it enters into force. To date, only three countries have done so. However, the fact that the upstream Nile riparian countries have shown their willingness to move forward with the CFA, even without the consent of Egypt and Sudan, represents an important challenge to the existing status-quo. Another important challenge to Egypt's hydro-hegemony is the construction of the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile River. The Ethiopian Government unilaterally undertook the construction of the GERD in 2011, without previous consultation with the downstream countries (Milas, 2013; Kimenyi and Mbaku, 2015). In light of these events, Egypt seems to have softened its stance, and in 2015 signed an agreement on the GERD project with Ethiopia and Sudan recognizing that "*the three countries shall utilize their shared water resources in their respective territories in an equitable and reasonable manner*" (Horn Affairs, 2015). However, Egypt's position regarding its "historic" right to the share of the Nile waters established in the 1959 Nile Waters Agreement remains unchanged. In this sense, the increase in water consumption that inevitably will be associated with the development of large-scale farming in the Ethiopian Nile River basin may constitute another element of conflict that challenges the existing governance arrangements within the basin.

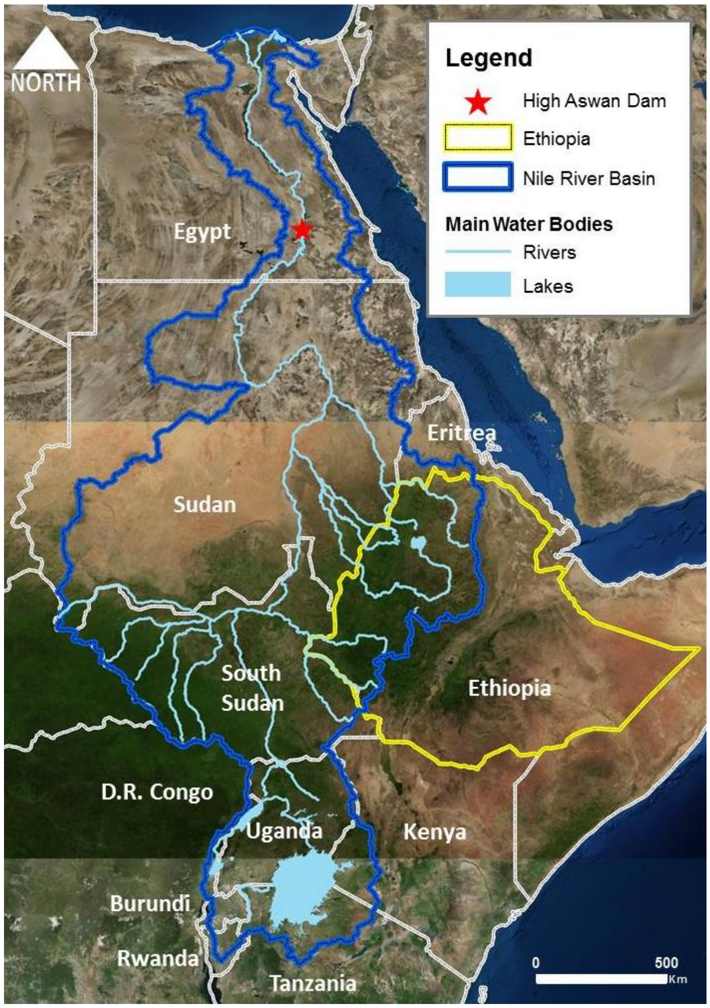

Figure 1.1 The Nile River Basin

All the aforementioned constitutes the context in which the research questions of this study arise. First, I am interested in assessing the impact on water resources availability of the expected increase in agricultural water use in the Ethiopian Nile River basin associated with large-scale land acquisitions. Bossio et al. (2012) addressed the same question, but focusing exclusively on Foreign Direct Investment (FDI) in Ethiopia, not taking into account large-scale land acquisitions by domestic investors. The methodology and dataset used by Bossio et al. (2012) as well as the analysis performed differs from the one carried out in the present studio.

So, it is expected that the results from this research would add new insights to this topic that has not been fully explored yet. Other authors have addressed the water implications of large-scale land acquisitions at the global level (Rulli and D'Odorico, 2013; Rulli et al., 2013). Secondly, I am interested in exploring the socio-political implications of this phenomenon at different scales, spanning from the local to the regional and global level. My interest lays in analyzing the role of power and knowledge in determining water flows, as well as the conflicts and water injustices these flows may shape.

The present document consists of different chapters and sections as follows. Chapter 2 introduces the reader to the geo-political context on which the study focuses, describing briefly the main geographic characteristics of the Ethiopian Nile River basin, as well as the political and socio-economic environment in which large-scale land investments take place. Chapter 3 discusses the dataset of large-scale land deals used in the present study. Chapter 4 reports the methodology adopted for the quantitative assessment of the water requirements of large-scale land acquisitions in the Ethiopian Nile River basin. Chapter 5 summarizes the most relevant results obtained with regard to water consumption associated with large-scale land investments and discusses the implications this increase in water use may have on water resources availability in the Nile River basin. Chapter 6 examines how different discourses and knowledges about water inform different social and power configurations at different levels and how water injustices reveal or conceal themselves depending on the scale at which the focus of inquiry is placed. Finally, Chapter 7 draws some relevant conclusions from all the explored aspects of large-scale land investment and its water implications in the Ethiopian Nile River basin.

Chapter 2: Study Area – Geographical and Political Context

The present chapter briefly discusses the characteristics and trends of large-scale land investment in Ethiopia, as well as the policy environment enabling and promoting it. The most relevant hydrologic and climatologic features of the Ethiopian Nile River basin are also introduced.

2.1 Large-Scale Land Investment in Ethiopia: Context and Trends

As discussed in the previous section, there exist global drivers that in recent years have fueled the demand for land worldwide. However, in the case of Ethiopia, the role of the state in enabling and promoting large-scale land acquisitions is particularly relevant (Lavers, 2012; Baumgartner, 2013). The influence of government policies in large-scale land investment trends can be observed in the evolution of the total annual land demand by foreign investors in Ethiopia. The global food price crisis in 2007-2008 prompted a spike in farm land demand globally. However, the request for land by foreign investors in Ethiopia started to increase a few years before, in 2004, when it exceeded the 500,000 hectares of land requested. Baumgartner (2013) relates this sharp increase in land demand by foreign investors to a series of proclamations issued by the Ethiopian Government in the previous years (2002 - 2003) that were aimed to attract foreign investment. Some of the strategies included in Ethiopia's market-oriented agricultural development policy to encourage investment are tax exemption, low land lease costs[6], a very flexible labor and wage policy and ease for foreign investors to repatriate capital and profits (Lavers, 2012; MoA, 2013).

[6] For land plots 700 km away or more from Addis Ababa, rent price is 111 birr/ha (around 5 USD) or 158 birr/ha (around 7 USD) depending if the land has access to irrigation water or not. For land plots closer to the capital city, price will increase regardless of whether the production will be rainfed or irrigated (MoA 2013). However, lower lease prices have been reported in specific case studies (OI 2011a).

Another important aspect that determines the state influence in large-scale land investment trends is the fact that all land is state-owned. In this regard, the Ethiopian Constitution from 1995 declares that land "*(…) shall not be subject to sale or to other means of exchange*" (FDRE, 1995: Art. 40.3) being its administration one of the state powers and functions (FDRE, 1995: Art. 52.2). Therefore, the government has exclusive authority to grant access to the land, both to smallholders and to private investors, through the distribution of usufructs rights. These rights should be conceded without payment to Ethiopian peasants and on the basis of payment arrangements established by law to private investors (FDRE, 1995: Art. 40.4 and 40.6). The duration of the lease contract, in the case of private investors, depends on the type of crop intended to be grown, ranging from 25 years for annual crops to 45-50 years for perennial crops (MoA, 2013; OI, 2015a). Thus, the government's unique power to decide how much land is available and where clearly defines large-scale land investment spatial patterns in Ethiopia. Large scale farming development is being promoted and encouraged in lowland areas where it is believed that "abundant extensive land" exists (MoFED, 2010). Accordingly, large extensions of land have been identified and made available to investors through Land Banks in lowland border regions like Gambella and Benishangul-Gumuz (nearly 2,000,000 hectares identified) as well as Amhara (Figure 2.1). Much of the identified "available" land is located in areas where the main livelihoods are pastoralist and agro-pastoralist (Medhin, 2011; Lavers, 2012), meaning that the erroneously considered "unused" land is in fact being used by local communities for grazing and/or shifting cultivation. In this sense, the government's conception of "empty" and "available" land it is coherent with its expressed idea of pastoralism being an unsustainable and not desirable activity; and with its plans for the "voluntary resettlement" of pastoralists in villages (Lavers, 2012).

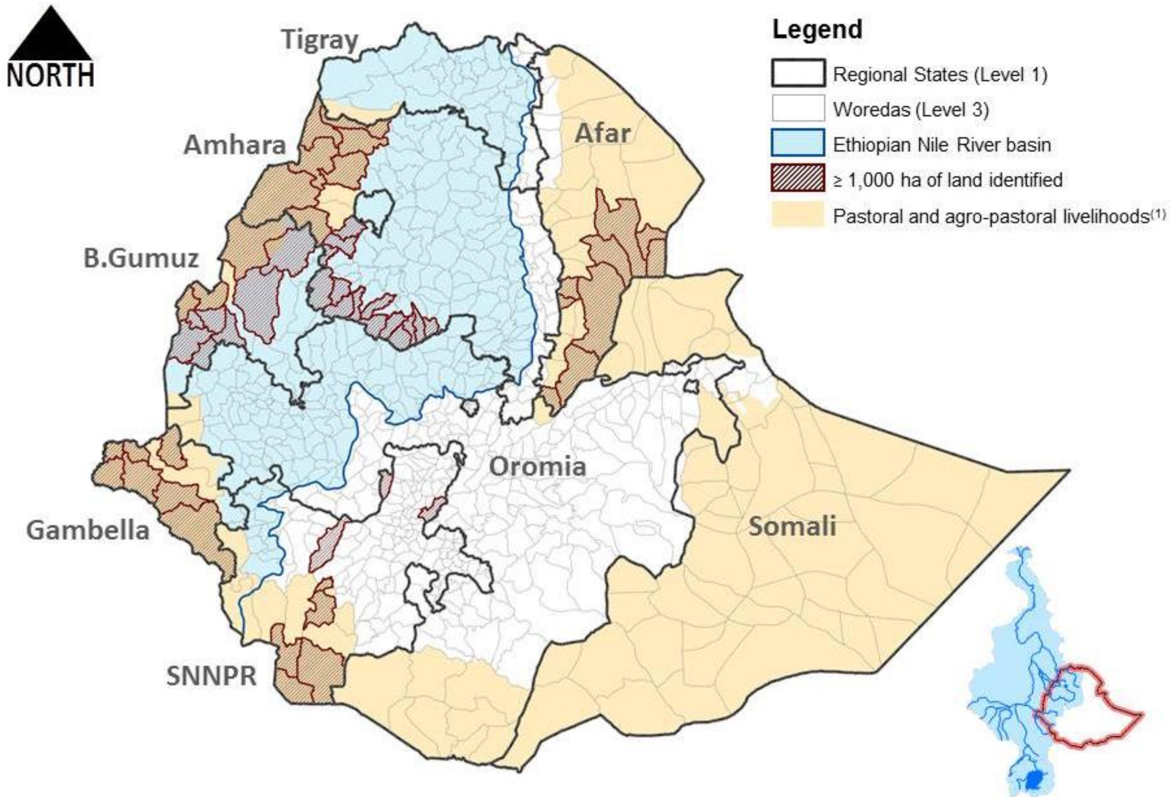

Figure 2.1 Woredas[7] where land for investment (≥ 1,000 hectares) has been identified (modified from Lavers, 2012)

(1) Medhin (2011)

So, it is clear how large-scale land investments in Ethiopia are not only caused by external political and economic forces but actively promoted by the Ethiopian Government in a way that serves its agenda of market-oriented agrarian development. In this sense, and although major emphasis has been given to foreign direct investment, the role played by domestic investors is growing in importance and cannot be neglected (Cotula, 2012; Baumgartner, 2013).

[7] Ethiopia is administratively divided into National Regional States (Level 1), Administrative Zones (Level 2), Woredas or Districts (Level 3), Kebeles (Level 4) and two Chartered Cities which are Addis Ababa and Dire Dawa (http://www.ethiopia.gov.et/web/pages/regional-states).

2.2 The Ethiopian Nile River Basin

As mentioned in the previous section, lowland border areas are very much targeted by large-scale land investments, as the Ethiopian Government is promoting the development of large-scale farming in these areas. This border region is part of the Ethiopian Nile river basin, which is the focus of this study (Figure 2.1).

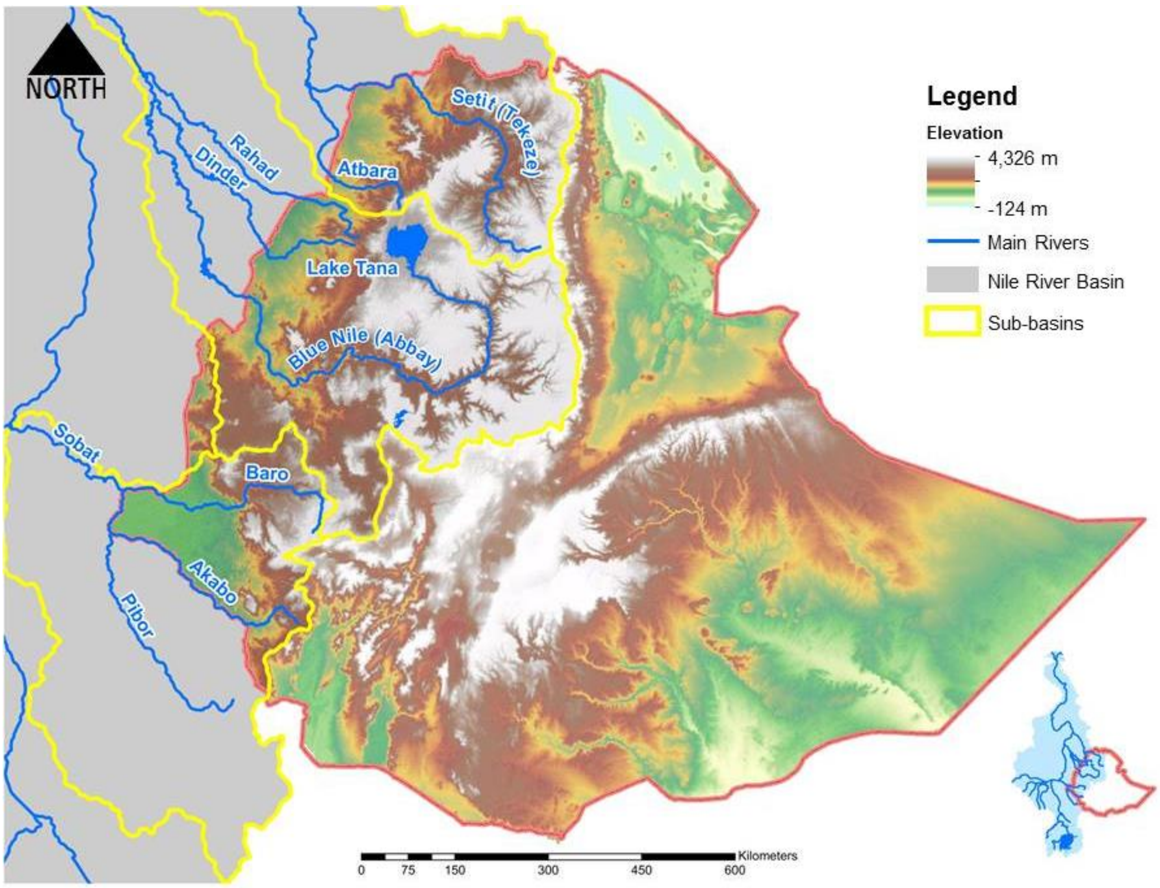

Figure 2.2 The Ethiopian Nile River basin

Three major sub-basins have their headwaters in the Ethiopian highlands: the Atbara, the Blue Nile (known as Abbay in Ethiopia) and the Pibor – Akabo – Sobat (Figure 2.2). These river systems are major contributors to the Nile waters, with 86% of the Nile annual river flow generated within Ethiopian territory (Abtew and Melesse, 2014). From the total annual contribution of Ethiopia, 12% (8.62 km^3/yr) is drained from the Atbara sub-basin, 67% (49.23 km^3/yr) from the Blue Nile and 21% (15.14 km^3/yr) from the Pibor – Akabo – Sobat system (FAO 2011).

The climate in the Ethiopian Nile River basin is highly correlated with altitude, with higher temperatures and potential evapotranspiration (ET_0) in the lowlands as well as less precipitation. The average annual rainfall over the Ethiopian Nile catchment is estimated in 1,184 mm/yr (New et al., 2002). The precipitation pattern is determined by the migration of the Inter-Tropical Convergence Zone (ITCZ) which causes a marked rainy season that expands from June to September. Consequently, the Ethiopian Nile tributaries present a high seasonality in their flows, especially the Atbara and the Blue Nile which present similar flow patterns with high flows occurring from July to October (FAO, 2011). The hydrology of the Pibor – Akabo – Sobat system is more complex, with overflows from the Baro during high flows inundating the adjacent Machar marshes and/or eventually returning to the river system through secondary channels (Sutcliffe and Parks, 1999).

The current dominant land cover in the Ethiopian Nile River basin is cropland (49%) followed by grassland (31%). By sub-basins, the dominant land cover in the Ethiopian catchment of the Atbara and Blue Nile continues to be cropland, with a 59% and 53% of their area destined for crop cultivation respectively. By contrast, only 23% of the Ethiopian Pibor – Akabo – Sobat area is cultivated, being grassland the most extended type of land cover (41%) (Latham et al., 2014). In this sense, and following the Ethiopian Government logic of considering grassland or pastures as "available" and "unused" land, the Pibor – Akabo – Sobat would have a great potential for large-scale farming development. In fact, we will show further bellow that this area is the most targeted by private investors within the Ethiopian Nile River basin.

Chapter 3: Data – Large-Scale Land Investments in the Ethiopian NRB

Data on large-scale land investments within the Ethiopian Nile River basin has been obtained from the Land Matrix Global Observatory (2014) database. As mentioned before, the Land Matrix is a global and independent land monitoring initiative that aims to promote transparency and accountability in decisions over land and investment. Its database provides information about large-scale land investments (200 hectares in size or more) worldwide that includes: location of the land investment, the investor's name and country of origin, the intention of the investment (e.g. to grow food crops, biofuels, non-food agricultural commodities), the negotiation status of the land lease agreement (i.e. intended, concluded, failed), the amount of land that has been leased or that it is intended to be leased, and the type of crops to be grown. For the purpose of this study, only concluded land investments – in which a contract has been signed between the private investor and the Ethiopian Government – that are located within the Ethiopian Nile River basin have been considered. In this sense, 26 large-scale land investments have been taken into account, representing a total of 689,883 hectares of land transferred to private investors (Appendix A). Land investments appear to be mainly concentrated within the Ethiopian Pibor – Akabo – Sobat and Blue Nile sub-basins, with only two of them located in the Atbara sub-basin (Table 3.1).

Sub-basin	Land Deals (No.)	Total Area (Ha)
Atbara	2	4,500
Blue Nile	12	300,000
Pibor – Akabo - Sobat	12	385,383
TOTAL	**26**	**689,883**

Table 3.1 Total area leased to private investors in the Ethiopian Nile River basin by sub-basin (Based on Land Matrix Global Observatory, 2014)

Most of the 26 large-scale land agreements considered have been signed from 2007 onwards. Their location by woreda is in accordance with the most targeted areas presented in Figure 2.1, as most of them are located in lowland border districts. Most of them are also strategically located near major rivers with potential for irrigation development (Figure 3.1).

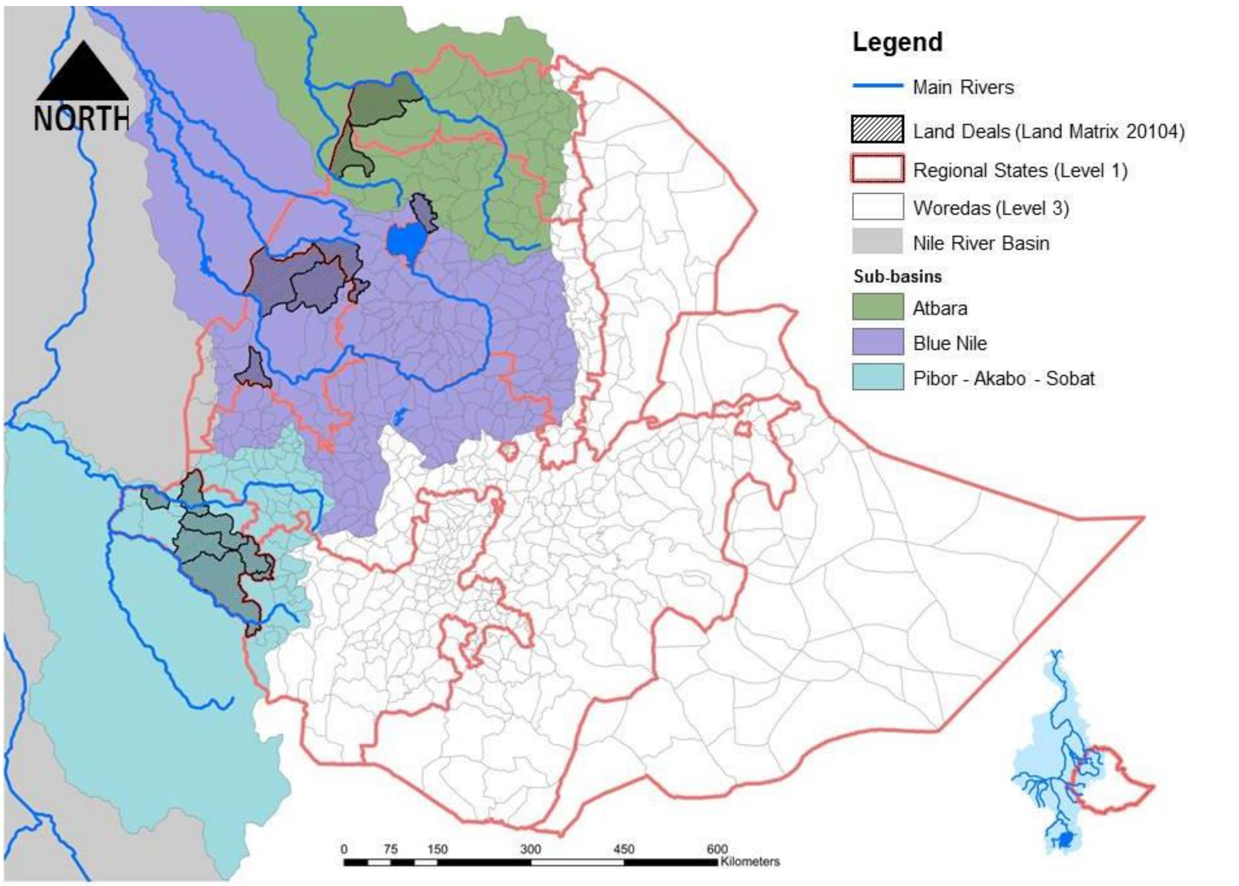

Figure 3.1 Concluded large-scale land agreements in the Ethiopian Nile River basin by woreda.

With regard to the origin of the investors, foreign direct investment (FDI) is the most important both in terms of amount of land acquired (299,200 ha) and number of deals (15). However, domestic investors play a major role as well, with 117,183 hectares acquired by Ethiopian investors alone and 273,500 hectares leased to foreign-domestic partnerships.

From the total 689,883 hectares transferred to private investors in the Ethiopian Nile River basin, only 28% are exclusively intended to grow food crops. The rest are dedicated to grow biofuels (43%), flex crops (26%) and non-food agricultural commodities such as cotton (3%). This trend, again, is in agreement with the market-oriented agricultural development strategies designed by the Ethiopian Government, which have their focus in large-scale agricultural production primarily for exports and raw materials for industries in the belief that a focus on export led production will ensure the accelerated development of the agricultural sector (MoFED, 2010). It is also in line with the government's Biofuel Development Plan under which a total of 16.6 million hectares of land suitable for biofuel plantation were identified during the period 2010/11 – 2012/13 (MoFED, 2014). However, the promotion of private sector participation in biofuel production and large-scale farming for export seems to be at odds with the goal to ensure food security through agricultural development, which is also amongst the objectives pursued by the Ethiopian Government in its "Growth and Transformation Plan 2010/11 – 2014/15" (MoFED, 2010).

This chapter provided a brief summary and discussion of the most relevant features in relation to the large-scale land investments considered in the present study. The methodology used to assess the water requirements associated to these land deals is presented in the following chapter.

Chapter 4: Methods – Assessing Water Requirements of Large-Scale Land Deals

The evaluation of the volume of water that would be required to bring into production the 689,883 hectares of land leased to investors in the Ethiopian Nile River basin – according to Land Matrix (2014) – and the impact of this increase in water consumption on water resources availability is one of the core questions addressed in this research. The present chapter introduces the methodology used and assumptions made in trying to provide an answer to that question.

4.1 Methodological Approach

The approach taken to estimate the impact on water resources of large-scale land investments is based on the principle of mass continuity or water balance (WB) according to which the sum of inputs should equal the sum of outputs plus changes in storage. Equation 1 presents a basic water balance expression, where precipitation (P) equals the sum of evapotranspiration (ET), groundwater recharge (R), direct runoff and interflow (RO) plus changes in soil moisture storage (ΔS):

$$P = ET + R + RO + \Delta S \quad \text{[8]} \qquad \textbf{(Equation 1)}$$

In the case at hand, changes in ET will be used as an indicator of water resources depletion due to large-scale farming development. Therefore, and based on Equation 1, given a certain amount of rainfall, any increase in ET should necessarily represent a decrease in water availability ($R+RO+\Delta S$).

[8] Water balance equation used by FAO (2011).

Changes in ET are associated to changes in land use. Concerning large-scale land investments in the Ethiopian Nile River basin, changes in land use will most likely occur when areas currently covered by natural vegetation will be converted into crop land[9]. Overall, the predominant natural land cover in the considered woredas where large-scale land deals have been identified is grassland, representing more than 67% of the total area (Latham et al., 2014). In this sense, the general assumption made is that these private investments on land will be developed in areas currently covered by grass[10].

Changes in ET are calculated using the agronomic model CROPWAT version 8.0 developed by the Land and Water Division of the Food and Agriculture Organization (FAO) of the United Nations (Allen et al., 1998). The current evapotranspiration of grassland is estimated at plot or land deal level as well as the future evapotranspiration of crops once the land investments will be developed. Results are then aggregated at a sub-basin level to assess the impact of changes in ET on water resources availability. One of the main limitations of this approach is that it does not allow to quantify specific changes in R, RO and ΔS by only estimating changes in ET (Equation 1). To partially address this drawback, the crop irrigation water requirements (IWR) computed using CROPWAT for each of the land deals considered have been compared with runoff and river flow data assuming that water for irrigation would be withdrawn from surface water sources.

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[9] The agricultural development strategy of the Ethiopian Government promotes "*private large scale commercial farms in areas that are not occupied or utilized by people*" (MoFED, 2010).

[10] Grassland is the predominant natural land cover in all the woredas considered except for the Godere, Gonder Zuria and Mengesh woredas where the dominant natural land cover is shrubs (Latham et al. 2014). However, for simplicity it is been assumed that in all cases private large-scale land investments will be developed in currently grass covered land.

This simple approach has been adopted due to the lack of enough detailed spatial distributed information that allowed for the use of more complex hydrologic and hydraulic routing models; as well as the lack of hydrometric data to calibrate and validate the models. However, and despite the limitations of the methodology adopted, it is considered appropriate given the scope of this research and the accuracy and resolution of the data available.

4.2 The CROPWAT Model

CROPWAT 8.0 has been selected to estimate the evapotranspiration associated with different land cover scenarios, for being and open source model that uses a methodology well established and widely accepted by the scientific community. The model uses the FAO Penman-Monteith method to compute reference evapotranspiration (ET_0) from meteorological data (i.e. radiation, air temperature, air humidity and wind speed). Reference evapotranspiration is the evapotranspiration from a reference surface that closely resembles an extensive surface of green, well-watered grass of uniform height, actively growing in a moderately dry soil surface and completely shading the ground (Allen et al., 1998).

Once ET_0 is computed for a specific location, then crop evapotranspiration (ET_c) or crop water requirement[11] (CWR) under standard conditions can be calculated by multiplying ET_0 by a crop coefficient K_c ($ET_c = K_c \cdot ET_0$). This coefficient integrates the effects on evapotranspiration of those characteristics that distinguish the cropped surface from the reference surface. K_c has been empirically estimated for different crops grown in different climatic locations and for the crop different growing stages (i.e. initial, crop development, mid-season and late-season). Nevertheless, ET_c – under standard conditions – does not take into account the effect on crop

[11] The terms crop evapotranspiration (ET_c) and crop water requirement (CWR) are used interchangeably throughout this document.

evapotranspiration of crop management practices (e.g. the use of mulches to reduces evaporation, intercropping), nor does it consider environmental conditions (e.g. water stress, low soil fertility, salt toxicity, soil waterlogging, pests, diseases, etc.). In this sense, ET_c is an estimate of the crop evapotranspiration under ideal or optimal conditions; in other words, it accounts for the amount of water that is needed to achieve full crop production under the given climatic conditions (Allen et al., 1998).

CROPWAT also computes crop irrigation water requirements (IWR) as the difference between ET_c and effective rainfall. From an agronomic perspective, effective rainfall is the fraction of rainfall that can effectively be used for crop production (i.e. that is not lost through runoff and/or deep percolation). Thus, when effective rainfall (Eff. Rain) alone is not enough to meet ET_c, additional irrigation water will be required in order to achieve full crop production. Unlike changes in ET, crop irrigation water requirements can be directly related to the depletion of freshwater resources (surface and groundwater) as irrigation water will most likely be withdrawn from these sources.

CROPWAT computations are performed at a land plot level and they require a varied range of data. Data used to estimate ET_0, ET_c and IWR include: meteorological data including rainfall (FAO, 2006); land deal size, location and type of crop intended to be grown (Land Matrix Global Observatory, 2014; MoANR, 2015; OI, 2015a); crop characteristics (K_c) and crop calendar (Allen et al., 1998; FAO, 2009,2015a 2015b; FAO/IIASA, 2010; Steduto et al., 2012; Garg et al., 2014); land cover (Latham et al., 2014) and soil type (FAO/IIASA/ISRIC/ISS-CAS/JRC, 2009).

4.3 Sources of Uncertainty

In the estimation of ET_0, ET_c and IWR there are different sources of uncertainty and error both associated with the data and with the methodology used.

The inherent lack of transparency in private large-scale land investment negotiations and agreements in Ethiopia is one of the main elements of uncertainty and inaccuracy. The lack of effective communication and coordination between different government levels (i.e. federal, regional and local) and departments with responsibilities for land allocation exacerbates this problem (OI, 2011a). The Land Matrix Global Observatory acknowledges this difficulty and recognizes the character inherently unreliable of its database. Nevertheless, and despite the information compiled in the Land Matrix database may not be completely accurate, it provides information on the general trends regarding private investment on land in Ethiopia (e.g. amount of land requested and size of investments, areas of the country most targeted by private investors, main crops to be grown in large-scale farming, etc.).

Information on the location of the land deal provided in the Land Matrix database is not always as detailed as would be desirable for the purpose of this study. Locations are sometimes reported at a zone, regional state or even country level whereas CROPWAT computations are performed at land plot level and thus require a more precise localization of the investment. The fact that land deals locations are not always reported at woreda or kebele level sometimes makes it difficult to discern if they lay within the Ethiopian Nile River basin boundaries or not. Additional research has been conducted to try to locate at woreda or district level all the land investments potentially situated within the Nile River basin. However, not always has been possible to find additional information that allowed for a more precise location of the land deal. In this sense, some large-scale land investments within the Ethiopian Nile River basin may have been discarded, as only those whose location was identified at district level and 100% of the area of the district laid within the Nile River basin have been considered. Land deals smaller than 200 hectares have not been considered either as the Land Matrix database only includes those large-scale land investments that cover an area of 200 hectares or more.

The meteorological data used in the estimation of ET_0 is another element of uncertainty, as the network of stations compiled in the CLIMWAT 2.0 database for Ethiopia is not very dense in the area of study. The Thiessen polygon method has been applied to define the agro-climatic variables that should be used to estimate ET_0 for each individual large-scale land investment. This process could introduce error in the calculations, as the agro-climatic variables may vary between the location of the station and the actual location of the land deal.

Lastly, crop characteristics (e.g. K_c, length of the growing period and stages) and crop management practices (e.g. planting date, cropping pattern) are the third major source of uncertainty due to the lack of detailed and site-specific information on this regard.

Most sources of uncertainty speak to the fact that different scales of analysis and different data resolution have been used in the realization of this study. CROPWAT operates at a land plot level and so it needs land plot level data resolution, whereas most of the datasets used and available are global datasets with a coarser resolution. Nevertheless, the scale of analysis is regional and so CROPWAT results are aggregated at a sub-basin and watershed level. In this sense, the level of uncertainty associated with both data and methodology is considered acceptable for a regional study which aim is to provide an order of magnitude of the impact large-scale land investments would have on the Ethiopian Nile water resources.

4.4 Scenarios Considered

In order to delimit the impact of error and uncertainty on the final results and analysis, rather than computing a single and deterministic value for ET_c and IWR, a field of possible solutions for the mentioned variables has been estimated. With this purpose, two different scenarios have been considered to try to define a "most likely" range of results that provides reasonable confidence that the "true" values for ET_c and IWR will be somewhere in between. SCENARIO 1 (S1) represents the lower envelope and SCENARIO 2 (S2) the upper envelope of this range. S1 and S2 have been calculated for each large-scale land investment in both the pre-development and post-development situations.

In the characterization of scenarios, different assumptions have been made. The first assumption makes reference to the definition of the pre-development and post-development situations. Pre-development refers to an indeterminate point in the recent past in which none of the land deals had been developed. Post-development refers to a hypothetical future situation in which all the land deals will be in full production. The post-development scenario may not be achieved at any future time, as the proportion of land allocated to private investors that has been actually development is very low (Rahmato, 2011; Anseeuw et al., 2012; Keeley et al., 2014; Yassin, 2014). From the total 473,000 ha of land transferred to investors during the time span from 2010/11 to 2012/13 only 11% was developed at the end of the same period (MoFED, 2014). The causes of this "underdevelopment" of private land investments can be diverse: total or partial project failures due to lack of capacity and/or experience of investors in the agricultural sector; high costs associated with the implementation of the project due to lack of infrastructure and/or a difficult environment (not only natural, but political and socio-economic environments as well); security issues; managerial issues as the large size of some land allocations may complicate their full development; lack of capacity of the Ethiopian Government to effectively monitor and evaluate the successful development of all the land transferred to private investors (Rahmato, 2011; Anseeuw et al., 2012; Keeley et al., 2014; Yassin, 2014). Notwithstanding the foregoing, and although the post-development situation considered in this study might not be a realistic scenario given the present circumstances of land deal implementation, it sheds light on whether the current "land rush" promoted by the Ethiopian Government makes sense or not from a water governance perspective.

4.4.1 Pre-development situation

For the pre-development situation, the estimated ET_c corresponds to the evapotranspiration from a natural land cover of grass without additional irrigation. Thus, ET_c and grass growth will be limited by the availability of water (i.e. rainfall and/or soil moisture). In this sense, it is assumed that the growing season of grass will start when the effective rainfall exceeds the plant irrigation requirements (Eff. Rain > ET_c)[12] and will end when there is not enough available water for grass to grow (Eff. Rain < ET_c). For the off-season, scenarios S1 and S2 have been applied.

S1 represents the circumstances that minimize the consumptive use of water (ET_c). In this sense, the premise is that during the off-season ET_c will be similar to that of bare soil ($K_c = 0.15$)[13], assuming that without the necessary amount of water grass will dry and die.

S2 refers to the circumstances that maximize ET_c. The assumption here is that despite water stress, grass will remain alive and carrying out functions of evapotranspiration. In this case, ET_c during the off-season will be only limited by the amount of water available ($ETc \leq$ Eff. Rain).

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[12] Assumption used by Bossio et al. (2012) in their computations of ET_c for grassland.
[13] Allen et al. 1998

These same scenarios will be applied for the off-season (i.e. time period between the harvesting of one crop and the planting of the next one) of the post-development situation.

4.4.2 Post-development situation

One of the sources of uncertainty regarding water consumption (ET_c) in the post-development situation, as discussed in the section above, is the lack of information about cropping patterns. The Land Matrix database provides information about the crops that are planned to be planted in each land deal, as well as their intention (e.g. food crops, biofuel, non-food agricultural commodities), but assumptions have to be made in relation to the number of crops per year that will be grown and their cropping pattern (e.g. intercropping, crop rotation, fallow periods). The combinations in this sense are multiple. To simplify methodology and to delimit probable results, again scenarios S1 and S2 that respectively minimize and maximize water consumption have been applied.

General assumptions that apply to both scenarios are that no intercropping will occur (i.e. crop monoculture covering the entire size of the land deal) and that crop rotation will take place on an annual basis (i.e. the same crop will be grown during one year before planting a different one).

Besides the aforementioned general assumptions, in S1 the premise is that one single crop will be grown per year during the rainy season (i.e. mainly rainfed crop production although additional irrigation water could be required). For those land investments in which more than one crop has been reported in the Land Matrix database, the selected crop for S1 will be the one with the lowest irrigation water requirements (IWR).

In S2, double cropping is considered (i.e. two crops grown per year). This means that the crop with the highest irrigation water requirements (IWR) for each specific land deal will be grown twice in the same year (i.e. one crop during the rainy season and the second one during the dry season). Given the fact that large-scale land investments are for profit, a double cropping scenario seems more likely than a single cropping one as it maximizes production and consequently benefits. The Ethiopian Government also promotes and encourages the adoption of double cropping systems of production by private investors. Furthermore, it pursues to intensify the use of the country's water resources by expanding irrigation schemes (MoFED, 2010). In this sense, S2 would appear to be a more likely scenario than S1.

Unlike the pre-development situation, in which ET_c is the minimized/maximized variable; in the post-development scenario the optimized variable is the irrigation water requirement (IWR). Usually, the crop with the highest IWR has also the highest ET_c. However, this is not always the case. It will depend on the planting date of the crop and the length of its growing season. Nevertheless, we have decided to minimize/maximize IWR as it can be directly related to water resources availability as mentioned before. Moreover, the difference between $ET_{C\text{-}MAX}$ and the ET_c that maximizes IWR has found to be negligible for the computed cases.

Thus, S1 and S2 by estimating the minimum and maximum amount of water that would be needed to develop each of the land deals considered define a "most likely" range of results regarding water consumption and water use. In this sense, the maximum increase in ET_c will occur between the pre-development S1 and the post-development S2 ($\Delta ET_{C\text{-}MAX} = ET_{C-S2}^{Post} - ET_{C-S1}^{Pre}$); whereas the minimum increase in ET_c will take place between pre-development S2 and post-development S1 ($\Delta ET_{C\text{-}MIN} = ET_{C-S1}^{Post} - ET_{C-S2}^{Pre}$).

Chapter 5: Results and Analysis – Water Consumption Associated With Large-Scale Land Investments and Its Impact on Water Resources Availability

The estimates of crop water use in large-scale land investments in the Ethiopian Nile River basin calculated using CROPWAT are presented and analyzed in the present section. The sub-basin has been considered to be the most suitable scale for the intended analysis, so results obtained at land plot level have been aggregated by sub-basin.

First, estimated changes in evapotranspiration due to large-scale farming development are presented and its overall impact on water resources availability analyzed. Next, results on irrigation water requirements (IWR) and irrigation water withdrawals (IWW) are discussed and compared with data on surface water availability (i.e. river flow and runoff). This analysis is performed using both annual and monthly averaged data. The need for water storage infrastructure to meet the irrigation requirements of large-scale land investments is later discussed as well as the availability of groundwater resources to meet these same requirements. Then, the implications of large-scale land investments in the Ethiopian Nile River basin on the country's water footprint and virtual water flows are examined. Finally, the feasibility and sustainability of the targets set by the Ethiopian Government in its GTP with regard to private large-scale farming development are analyzed.

5.1 Changes in Evapotranspiration and the Water Balance Approach

As mentioned in the previous section, the development of large-scale farming in otherwise natural land will represent a change in evapotranspiration. Moreover, it could imply the need for additional irrigation in the case that effective rainfall would not be enough to meet the crop water requirements (CWR).

Results from CROPWAT show that the overall increase in ET_c in the Ethiopian Nile River Basin due to large-scale land investments will range between 10% and 113%. However, the disaggregated results show that this increase could be even higher in the case of the Atbara and Pibor – Akabo – Sobat sub-basins where ET_c is expected to increase as much as 191% and 189% respectively (Table 5.1).

Sub-basin	**Pre-development CWR (mm/year)**		**Post-development CWR (mm/year)**		**Change (%)**		**IWR (mm/year)**	
	Grassland		**S1**	**S2**			**S1**	**S2**
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Atbara	396	523	433	1,151	-17	191	4	571
Blue Nile	511	595	637	777	7	52	170	274
Pibor - Akabo - Sobat	511	657	746	1,479	13	189	183	899
Ethiopian NRB	**510**	**622**	**683**	**1,085**	**10**	**113**	**175**	**548**

Table 5.1 Crop water requirement (CWR) and irrigation water requirement (IWR) estimates by sub-basin for the pre-development and post-development scenarios.

Increases in ET will necessarily affect water resources availability, as demonstrated by Equation 1 in the Methods section. The average annual rainfall for the Ethiopian Nile River basin has been estimated in 1,184 mm/year (FAO, 2011). The results of applying the water balance equation (Equation 1) in the area where large-scale land lease contracts have been signed between private investors and the Ethiopian Government suggest that the average annual water availability – the sum of groundwater recharge, runoff, interflow and changes in soil moisture storage – will decline between 11% and 85% once the agreements will be fully developed (Table 5.2).

	Pre-development WB (mm)		**Post-development WB (mm)**		**Change (%)**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**
P	1,184	1,184	1,184	1,184	0%	0%
ET_c	510	622	683	1,085	10%	113%
R+RO+ΔS	674	562	501	99	-11%	-85%

Table 5.2 Water balance for the selected large-scale land investments. Pre-development and Post-development scenarios.

5.2 Irrigation Water Requirement and Irrigation Water Withdrawal

In addition to changes in ET_c, results from CROPWAT show that additional irrigation water will be required for normal crop production in the land transferred to private investors. The amount of irrigation water that will be needed not to limit plant growth and crop yield at the Ethiopian Nile River basin level will range between 175 mm and 548 mm per year (Table 5.1).

As already mentioned, irrigation water requirements (IWR) can be directly related to the depletion of freshwater resources (surface and groundwater) as irrigation water will most likely be withdrawn from these sources. Irrigation water withdrawals (IWW) normally far exceed irrigation water requirements because of water lost in its distribution and field application. However, the total amount of water that is lost in the distribution systems is not actually consumed (i.e. removed from the hydrological cycle through evaporation). In this sense, the non-consumed fraction of that water can be recovered and re-used further downstream, it can return to rivers and lakes through runoff and/or it can contribute to groundwater recharge through deep percolation.

The factor that relates irrigation water requirements and irrigation water withdrawals is the water requirement ratio (WRR = IWR/IWW). Frenken and Gillet (2012) estimated the water requirement ratio for 165 countries and 2 territories. Their estimate for Ethiopia is 28%, meaning that in order to meet a crop irrigation requirement of 28 cubic meters, 100 cubic meters of water will have to be withdrawn.

Estimates from CROPWAT show that between 1.205 and 3.777 cubic kilometers per year will be consumed as additional irrigation water in large-scale land investments in the Ethiopian Nile River basin. Accordingly, between 4.304 and 13.490 cubic kilometers will have to be withdrawn annually from rivers, lakes and/or aquifers to meet that demand (Table 5.3).

Sub-basin	Area of land leased (Ha)	IWR (km^3/year)		WRR (%)	IWW (km^3/year)	
		S1 Min	S2 Max		S1 Min	S2 Max
Atbara	4,500	2.0E-04	0.026	28	7.2E-04	0.092
Blue Nile	385,383	0.655	1.055	28	2.339	3.770
Pibor - Akabo - Sobat	300,000	0.550	2.696	28	1.964	9.629
Ethiopian NRB	**689,883**	**1.205**	**3.777**	**28**	**4.304**	**13.490**

Table 5.3 Irrigation water requirement (km^3/year) and irrigation water withdrawal (km^3/year) by sub-basin for the selected large-scale land agreements considering a WRR equal to 28%

The average annual agricultural water withdrawal[14] in Ethiopia for the period 1998-2002 has been estimated in 5.204 cubic kilometers (FAO, 2015c). It has to be noted that this figure refers to the entire country. In this sense, and according to our estimates, the development of large-scale land investments in the Ethiopian Nile River basin alone will multiply the national agricultural water withdrawal up to 2.5 times.

5.3 Impact of Large-Scale Investment Development on Water Resources Availability in the Ethiopian Nile River Basin

Nowadays, irrigation water in Ethiopia is most commonly abstracted from rivers and lakes. Even though groundwater is the most common source for domestic water use, especially in rural communities, direct groundwater abstraction for irrigation purposes is currently marginal in the country (MacAlister et al., 2012).The assumption made in this study is that this will continue to be the case in the future. Consequently, surface water will be the main source of irrigation water in the development of large-scale farming in the Ethiopian Nile River basin. This assumption will allow us to directly quantify the abstraction and consumption of surface water resources – river flow and runoff – associated with large-scale land investments.

Therefore, the amount of surface water that will have to be withdrawn to develop the almost 700,000 hectares of land leased to private investors – between 4.304 and 13.490 cubic kilometers per year – is equivalent to 5.9% to 18.5% of the total runoff generated within the Ethiopian Nile River basin; representing between 5.0% and 15.8% of the mean annual flow of the main Nile at Aswan (Figure 5.1).

[14] It includes water withdrawn for irrigation, livestock and aquaculture purposes.

However, as mentioned before, water withdrawal is not necessarily equivalent to water consumption. In the case of Ethiopia, only 28% of the total volume of irrigation water abstracted will be actually consumed by the plant for evapotranspiration and cell construction. This consumptive water use (IWR) will represent a reduction between 1.7% and 5.2% of the Ethiopian national runoff[15], and a reduction between 1.4% and 4.4% of the mean annual flow of the main Nile at Aswan (Table 5.4).

[15] Runoff generated in the Nile River basin area that lies within the Ethiopian national boundaries.

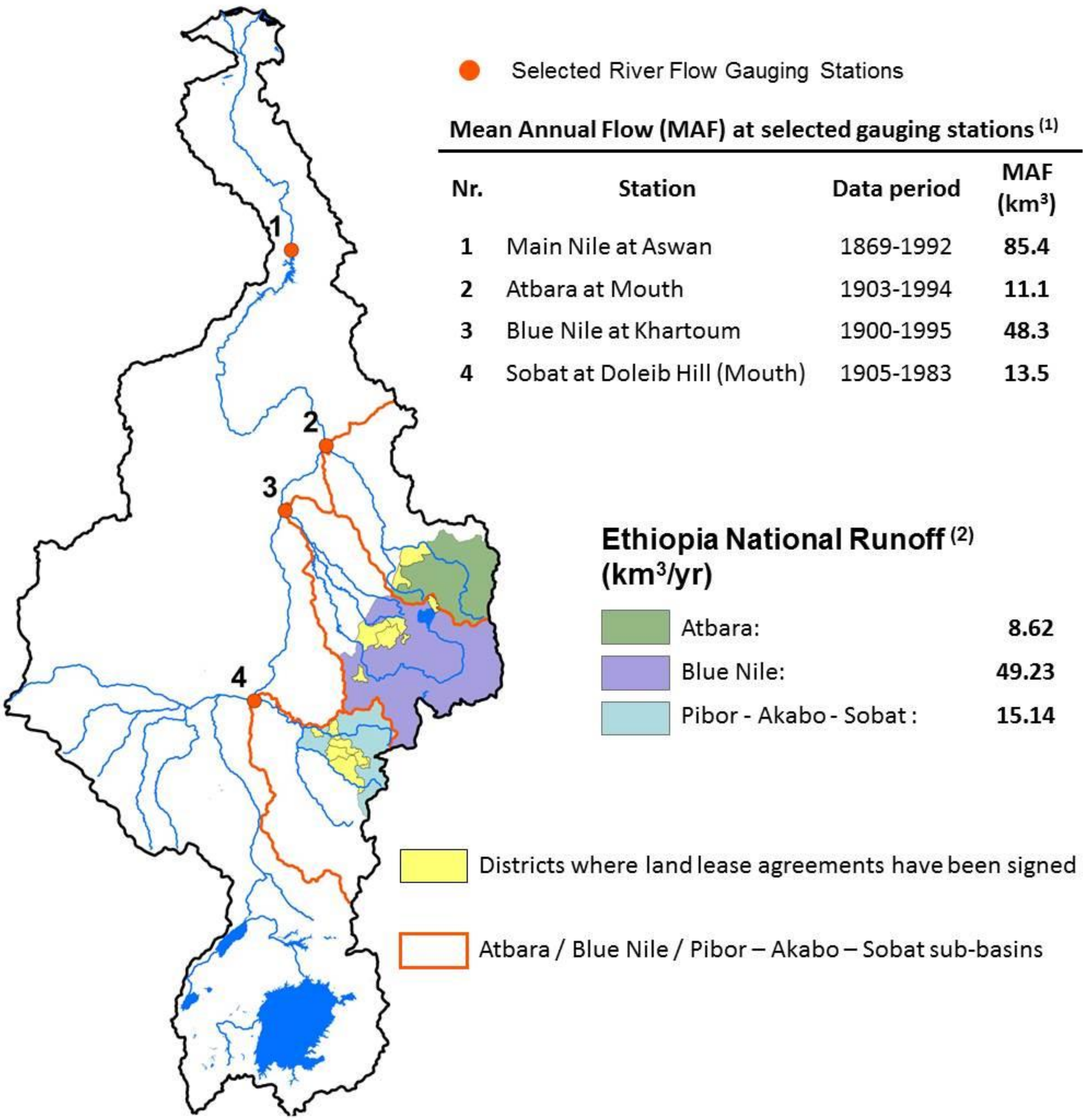


Figure 5.1 Mean annual river flow (km^3/year) at selected gauging stations in the Nile River basin and mean annual runoff (km^3/year) values for the Ethiopian Nile River sub-basins.

(1) Sutcliffe and Parks (1999)

(2) FAO (2011)

Sub-basin	Runoff				River Flow at Selected Gauging Stations			
	% withdrawn for large-scale farming		% consumed by crops		% withdrawn for large-scale farming		% consumed by crops	
	S1	S2	S1	S2	S1	S2	S1	S2
	Min	Max	Min	Max	Min	Max	Min	Max
Atbarah	0.01	1.1	0.002	0.3	0.01$^{(2)}$	0.8$^{(2)}$	0.002$^{(2)}$	0.2$^{(2)}$
Blue Nile	4.8	7.7	1.3	2.1	4.8$^{(3)}$	7.8$^{(3)}$	1.4$^{(3)}$	2.2$^{(3)}$
Pibor - Akabo - Sobat	13.0	63.6	3.6	17.8	14.5$^{(4)}$	71.2$^{(4)}$	4.1$^{(4)}$	19.9$^{(4)}$
TOTAL	**5.9**	**18.5**	**1.7**	**5.2**	**5.0**$^{(1)}$	**15.8**$^{(1)}$	**1.4**$^{(1)}$	**4.4**$^{(1)}$

Table 5.4 Estimated water consumption and withdrawal (%) in relation to the available surface water resources (Ethiopian national runoff and river flow at selected gauging stations) due to large-scale land investment in the Ethiopian Nile River basin (**WRR = 28%**)

(1) Main Nile at Aswan
(2) Atbara at Mouth
(3) Blue Nile at Khartoum
(4) Sobat at Doleib Hill

At a sub-basin level, the Pibor – Akabo – Sobat will experience the highest pressure on its surface water resources. Its runoff will be reduced between 3.6% and 17.8% whereas the mean annual river flow at its mouth may decrease up to 19.9%. These percentages significantly increase when referring to the amount of water that will have to be withdrawn for irrigation purposes: up to 63.6% of the Pibor – Akabo - Sobat runoff and 71.2% of the annual river flow of the Sobat at mouth (Table 5.4).

It can be argued that to reduce pressure on water resources the water requirement ratio or "water use efficiency"[16] of Ethiopia should be improved and that private sector involvement in irrigated agriculture may foster this improvement (which is not necessarily true). The water

[16] For a critical discussion of the "water efficiency" and "water productivity" concepts refer to Boelens and Vos (2012).

requirement ratio for Ethiopia is close to the median for the whole Nile River basin (29.5%), being Egypt the most "water efficient" country (76%) and Uganda the second more "efficient" one (52%). Egypt is also one of the most "water efficient" countries in the world, surpassed only by Turkey (85%) and Bangladesh (78%) (Frenken and Gillet, 2012). In this sense, it is very unlikely that Ethiopia will improve its water requirement ratio to the level of Egypt. But even in that very unlikely scenario, irrigation withdrawals for large-scale farming development will represent from 1.9% up to 5.8% of the mean annual river flow of the main Nile at Aswan (Table B.1 – Appendix B)

5.4 Seasonal Variability

Numbers and figures presented and discussed so far refer to annual averages. However, surface water resources do not remain constant throughout the year, nor do crop and irrigation requirements. In this sense, the analysis of the seasonal variation of water demand and water supply provides more accurate and valuable insights on the pressure that large-scale farming development might exert on water resources.

Gassert et al. (2013) have calculated a set of indicators to assess water-related risks globally. Seasonal variability is one of these indicators and it is defined as "*the coefficient of variation between the mean total blue water*[17] *for each of the 12 months of the year*". Applying Gassert et al. (2013) definition of seasonal variability and its scoring scale at a sub-basin level, we obtain that the Atbara has an "extremely high" river flow seasonal variability followed by the Blue Nile (high) and the Pibor – Akabo – Sobat (Low to medium) sub-basins. This great

[17] Fresh surface and groundwater, in other words, the water in freshwater lakes, rivers and aquifers. (http://waterfootprint.org/en/water-footprint/glossary/#BW)

variation in water supply within a year can increase the pressure on water resources in the absence of adequate water storage infrastructure.

Monthly irrigation water withdrawals associated with large-scale land investments have been compared with values of mean monthly runoff generated in the Ethiopian Nile sub-basins (Table B.2 – Appendix B). This comparison reveals an annual water deficit for S2 of 82, 156 and 3,780 million cubic meters for the Atbara, Blue Nile and Pibor – Akabo – Sobat sub-basins respectively. This means that the aforementioned volumes of water will have to be stored during the wet season – or abstracted from alternative sources (e.g. groundwater) – in order to be able to meet the demand during the dry season. For S1 – 1 crop per year grown during the rainy season – no water storage is required, as monthly runoff is enough to meet the required irrigation water withdrawals. However, even in this scenario, the pressure on surface water resources could become unsustainable during some months of the year (e.g. irrigation water withdrawals in the Pibor – Akabo – Sobat sub-basin for the month of April represent 88% of the runoff generated in the Ethiopian area of the sub-basin during the same month).

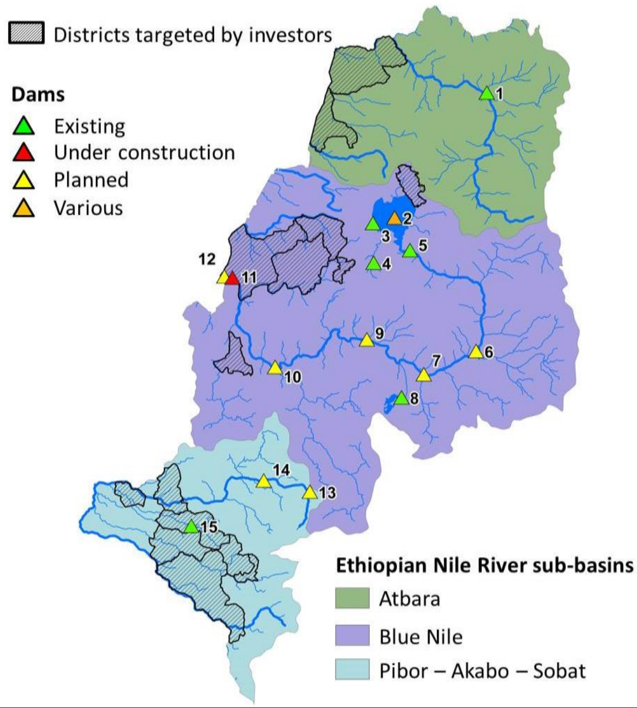
In evaluating water availability for irrigation and water storage needs, environmental flow requirements have not been considered due to the lack of a comprehensive environmental flow assessment in the Ethiopian Nile River sub-basins. However, the importance of a flow regime that provides adequate patterns of flow quantity, quality and timing for achieving or sustaining a predefined condition of ecosystem functioning cannot be neglected in this type of analysis, especially in a country like Ethiopia where the livelihood security of a large part of the population depends on environmental goods and services (Reitberg and McCartney, 2011). Reitberg and McCartney (2011) estimated the environmental flow requirements of the Ethiopian Blue Nile in 21% to 28% of its mean annual flow. Nevertheless, the authors consider these results to be low-confidence estimates pointing out the need for more detailed studies in this regard. In any case, the need for environmental flows will reduce the water availability for withdrawal increasing the need for water storage.

Evaporative losses from water impounding structures have either not been accounted for when assessing water storage needs at the sub-basin level. In this sense, the actual water storage capacity needed to meet irrigation and environmental flow requirements taking into account evaporative losses, will most likely be higher than the estimates presented in this section.

5.5 Water Storage Capacity in the Ethiopian Nile River Basin

The Ethiopian Government, in its water policy and water strategy, recognizes the importance of "*developing water resources as an integral part of national socio-economic development*" (MoWR, 2002). In this sense, two of the national priorities reflected in the Water Sector Development Program 2002-2016 are to "*extend irrigation for agricultural development to the maximum possible*" and to "*expand generation capacity to meet hydroelectric power needs*" (MoWR, 2002). Both strategies will require the construction of water impounding structures.

Figure 5.2 compiles a non-exhaustive list of existing and planned dams in the Ethiopian Nile River basin. Although irrigation is not the main purpose of most of these dams, all of them will carry out a flow regulation function that will attenuate flow seasonal variability benefiting the development of irrigated agriculture.



	Dam	Sub-basin	River	Status	Reservoir capacity[18] (MCM)	Purpose
1.	Tekeze	Atbara	Setit	Existing	9,230	Hydropower
2.	Dams to be constructed on the major inflows to Lake Tana (i.e. Megech, Ribb, Gumara and Gilgel Abay)	Blue Nile	Lake Tana	Various status	1,028	Irrigation
3.	Tana-Beles	Blue Nile	Beles	Existing	run of river[19]	Hydropower Irrigation
4.	Koga	Blue Nile	Koga River	Existing	77	Irrigation
5.	Tis Abay	Blue Nile	Blue Nile	Existing	3,500	Hydropower
6.	Karadobi	Blue Nile	Blue Nile	Planned	40,220	Hydropower
7.	Chemoga and Yeda	Blue Nile	Blue Nile	Planned	NA	Hydropower
8.	Finchaa	Blue Nile	Finchaa river	Existing	650	Hydropower Irrigation
9.	Mabil	Blue Nile	Blue Nile	Planned	17,200	Hydropower
10.	Mendaia	Blue Nile	Blue Nile	Planned	15,900	Hydropower
11.	Grand Ethiopian Renaissance Dam (GERD)	Blue Nile	Blue Nile	Under construction	63,000	Hydropower Irrigation
12.	Border	Blue Nile	Blue Nile	Planned	11,100	Hydropower Irrigation
13.	Geba (1 and 2)	Pibor-Akabo-Sobat	Baro	Planned	NA	Hydropower
14.	Baro Multi-purpose	Pibor-Akabo-Sobat	Baro	Planned	NA	Hydropower Flood control Irrigation
15.	Alwero	Pibor-Akabo-Sobat	Alwero River	Existing	74.6	Irrigation

Figure 5.2 Existing and planned dams in the Ethiopian Nile River Basin[20]

[18] Reservoir capacity refers to the total storage volume of the reservoir as it was designed in the project. However, the usable volume of water will always be lower (e.g. due to sedimentation).
[19] Average annual transfer of 2,424 MCM of water from the Lake Tana to the Beles catchment for hydropower production and irrigation.

At a sub-basin level, most of the existing and planned dams are located within the Blue Nile sub-basin, including the Grand Ethiopian Renaissance Dam (GERD) currently under construction and matter of dispute between Egypt, Sudan and Ethiopia (Milas, 2013; Kimenyi and Mbaku, 2015). The works for the GERD are expected to be finished by July 2017. Once completed, it will increase the sub-basin water storage capacity in 63 cubic kilometers. The Pibor – Akabo – Sobat sub-basin, on the other hand, has the lowest existing and planned water storage capacity, far below the 3,780 million cubic meters that will be needed to fully develop the agricultural land transferred to private investors in the sub-basin.

5.6 Groundwater Resources

The use of groundwater resources during low flow periods might constitute an alternative strategy to the construction of water storage infrastructure to buffer surface water seasonality. As it has been mentioned before, groundwater utilization for irrigated agriculture is currently marginal in Ethiopia, although pumping for commercial agriculture is likely to increase in the future (MacAlister et al., 2012). In recent years, the Ethiopian Government has recognized the importance of groundwater in "*promoting economic growth and removing the vulnerability that comes with climate variation*" and it is stimulating its development for different uses, including irrigation (MoWR/GW-MATE, 2011). In this sense, one of the priorities of Ethiopia's "Strategic Framework for Managed Groundwater Development" (MoWR/GW-MATE, 2011) is to promote conjunctive use of groundwater and surface water in surface irrigation systems to overcome seasonal variability and weather unpredictability.

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[20] Information compiled from different sources: OECD 2001; International Rivers 2010; FAO 2011, 2014; McCartney et al. 2012; Salini Impreglio 2016 and Sinohydro 2016.

The hydrogeological structure of Ethiopia is very complex. Two thirds of the country is covered by volcanic rocks forming variable but highly productive aquifers. The rest is covered by sedimentary and metamorphic aquifers. Groundwater recharge varies considerably in space and time, ranging from less than 50 mm per year in arid plains up to 400 mm per year in the highland areas of north-western Ethiopia (MacAlister et al., 2012; NBI, 2012; Kebede, 2013). By sub-basin, the annual groundwater recharge has been estimated in 9,431 million cubic meters for the Atbara; 2,500 million cubic meters for the Blue Nile and 128.4 million cubic meters for the Pibor – Akabo – Sobat (Kebede, 2013). However, only the 10% of the total annual recharge is assumed to be exploitable (WAPCOS, 1990).

In the case of the large-scale land investments considered in this study, the development of supplementary groundwater irrigation to mitigate surface water seasonality will represent the abstraction of between 9% and 62% of the annual exploitable groundwater resources in the Atbara and Blue Nile sub-basins respectively. With regard to the Pibor – Akabo – Sobat, its annual exploitable groundwater resources represent only the 3.4% of the total annual deficit of 3,780 million cubic meters that the development of large-scale farming will generate. As with its water storage infrastructure capacity, the groundwater potential of the Pibor – Akabo – Sobat is far below of its future needs when land transferred to private investors will be fully productive.

5.7 Virtual Water Flows and the Water Footprint of Large-Scale Land Investments

The approach taken so far to assess the impact on water resources of large-scale land acquisitions in the Ethiopian Nile river basin has focused on water consumption (evaporative water use) and water withdrawals, being the sub-basin the scale or unit of analysis. In this regard, the virtual water and water footprint concepts may be of help in extending the analysis outside the watershed boundaries. These two concepts have their focus on water used – rather than water withdrawn – in the production and consumption of goods.

The virtual water content of a product refers to the volume of water that it is "embodied" in that product, or in other words, to the volume of water that has been consumed and/or polluted all through the production chain of that product. Therefore, when a good is imported/exported a certain volume of virtual water flows from one country to another crossing the boundaries of the watershed from where the water is sourced. The concept was first introduced by Allan (1998) as a possible solution to the problems of water scarcity in the Middle East/North Africa (MENA) region.

The water footprint concept, introduced by Hoekstra and Hung (2002), is an indicator of freshwater use that looks at both direct and indirect water use of a consumer or producer (or a well-defined group of consumers or producers like it could be a national state). In this sense, the water footprint of national consumption is defined as the total volume of freshwater that is used to produce the goods and services consumed by the inhabitants of the nation (including virtual water "embedded" in imported goods); whereas the water footprint of national production is defined as the freshwater volume consumed or polluted within the territory of the nation as a result of activities within the different sectors of the economy (Mekonnen and Hoekstra, 2011).

Mekonnen and Hoekstra (2011) have estimated the national water footprint of production and consumption for all countries distinguishing three different colors: the green, blue and grey water footprints. The green water footprint refers to the volume of rainwater consumed; the blue water footprint refers to the volume of surface and groundwater consumed and finally the grey water footprint is an indicator of the degree of freshwater pollution as a result of the production of a good or service.

The green and blue water footprints of crop production associated with large-scale land acquisitions in the Ethiopian Nile River basin can be directly derived from the results of CROPWAT. In the case of a product, its virtual water content is the same as its water footprint (Hoekstra et al., 2011). Consequently, the virtual water content of the produce to be grown in the land transferred to investors will be exactly the same as the water footprint of those land deals.

The results from Mekonnen and Hoekstra (2011) show that the water footprint of national crop production in Ethiopia is mainly green. This means that nowadays most of the agricultural production in the country is rainfed, being Ethiopia the largest consumer of rain water for agricultural production in the Nile River Basin. At the other end of the spectrum, Egypt and Sudan have the two highest blue water footprints of crop production, being the two largest surface and groundwater consumers within the basin.

The consumption of water associated with the development of large-scale land investments in the Ethiopian Nile River basin will represent an increase between 6% and 7% of the current country's green water footprint of crop production and between 103% and 322% increase of its blue water footprint of crop production (Table B.3 – Appendix B).

As mentioned above, the virtual water content of the crops to be grown in the land deals considered will be the same as their water footprint. However, what makes the virtual water concept interesting is that allows the tracing of global virtual water flows associated with international trade. In this sense, the analysis of the virtual water content of agricultural production in the land transferred to private investors by type of investment (i.e. foreign, domestic, joint-investment with Ethiopian share) can provide some insight into the flows of water that would leave the basin "embedded" in exported agricultural goods.

In this regard, the Ethiopian Government in its Growth and Transformation Plan (GTP) 2010/11-2014/15, makes clear that "*while supporting private investment in large scale farms, its (government's) focus is to ensure that the products from these farms are primarily for export or raw materials for domestic industries*" (MoFED, 2010). The Land Matrix data base does not provide information about the final destination of the products to be grown in the reported land deals. In the absence of data on that specific matter, the assumption made is that the crops to be grown in foreign large-scale land investments will likely be exported. Currently Ethiopia is a net exporter of virtual water, meaning that the virtual water content of exported goods exceeds the virtual water content of those imported (Mekonnen and Hoekstra, 2011). Considering that foreign investors will export their produce, between 1,496 and 1,624 additional million cubic meters of green virtual water would leave the country (and the Nile river basin) every year in the form of exported agricultural products (Table B.4 – Appendix B). This would represent an increase of 68% to 73% of the current green virtual water exports of Ethiopia. With respect to blue virtual water flows, the development of foreign private land investments in the Ethiopian Nile river basin would add 177 to 2,573 additional million cubic meters to the 114.3 that are currently exported every year (Mekonnen and Hoekstra, 2011). In this case, the current blue virtual water exports of Ethiopia could increase up to 22 fold. These numbers, as mentioned above, refer exclusively to foreign direct investment in land in the Ethiopian Nile River basin. However, the exports of virtual water can increase significantly if other investors (i.e. domestic and/or joint investors) were to export their agricultural production too, as the Ethiopian Government promotes.

The fact that such an important amount of water can leave the country – and the basin – in the form of virtual water may be a source of concern regarding water and environmental justice issues, as it will be discussed later in this document.

5.8 Ethiopia's "Water-Centered Development"

The numbers presented so far refer to land lease contracts that according to the Land Matrix Global Observatory (2014) have been signed between the Ethiopian Government and private investors and that are located within the Nile River basin exclusively. In this respect, they only constitute a small portion of the total amount of farmland that the Ethiopian Government plans to develop as part of the country's Growth and Transformation Plan (GTP) 2010/11-2014/15.

One of the strategic pillars of the GTP for sustaining rapid and equitable economic growth is to maintain agriculture as major source of Ethiopia's economic growth. This strategy includes a shift of production to high value crops, intensified commercialization and support for development of large-scale commercial agriculture encouraging private sector investment. Along with all these measures, the GTP states the intention of the government to intensify the use of the country's water and natural resources (MoFED, 2010).

In relation to private sector investment in agriculture, which is the focus of this study, the target of the GTP is to "*transfer nearly 3.3 million hectares of land to commercial farming investors in transparent and accountable manner*" (MoFED, 2010). The plan period ended in 2015 and no information has been founded about the degree of fulfilment of the set goals and objectives. However, in the period 2010/11-2012/13 3.31 million hectares of land were identified and transferred to the federal land bank to be leased to private investors. During the same period, 473,000 hectares of land were transferred to investors but only 11% of these were developed (MoFED, 2014).

Aggregated results from CROPWAT show that the development of large-scale farming in the Ethiopian Nile river basin would require between 683 and 1,085[21] mm per year on average for crop evapotranspiration. Extrapolating these results to the 3.31 million hectares of land that the Ethiopian Government plans to transfer to private investors gives a future water consumption that ranges between 22.6 and 35.9 cubic kilometers per year. This would represent the consumption of 19% to 29% of Ethiopia's total renewable water resources (TRWR[22]) by private investors alone.

Another strategic direction included in the GTP is the development of the renewable energy sector, including the expansion of biofuel plantations. During the period 2010/11-2012/13 a total of 16.6 million hectares of land readily available for investment in biofuel development – like jatropha and caster plantations – were identified (MoFED, 2014). In the Ethiopian Nile River basin, according to the Land Matrix Global Observatory (2014), a total of 372,200 hectares of land have been transferred to private investors for jatropha cultivation with an estimated annual average crop water requirement of 736[23] mm. Assuming the same crop water needs, the development of 16.6 million hectares of jatropha would represent the consumption of 100% of Ethiopia's total renewable water resources, which is clearly out of all proportion.

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[21] The weighted averages of annual crop water requirements estimated in this study are comparable to the ones obtained by Bossio et al. (2012).

[22] TRWR are the sum of internal renewable water resources (IRWR) and external renewable water resources (ERWR). It corresponds to the maximum theoretical yearly amount of water available for a country at a given moment. IRWR are long-term average annual flow of rivers and recharge of aquifers generated from endogenous precipitation whereas ERWR are the part of the country's long-term average annual renewable water resources that are not generated in the country (e.g. inflow from upstream countries). For Ethiopia, TRWR have been estimated in 122 cubic kilometers per year (FAO 2015c).

[23] Jatropha is a deciduous tree. In this case, it does not make sense to distinguish between S1 (1 crop/year) and S2 (2 crops/year) as the tree has an annual cycle.

Chapter 6: Discussion – Water Grabbing and Conflict in the Ethiopian NRB

As highlighted in the literature, and confirmed by the quantitative results presented in the previous section, large-scale land investments and access to reliable water resources are necessarily interconnected (OI, 2011b; Anseeuw et al., 2012; Cotula, 2012; GRAIN, 2012; Franco et al., 2013a 2013b, 2014). An important amount of water is needed to bring land leased to private investors into production; which makes the investment profitless if access to water is not granted along with access to the land. Land lease contracts signed between private investors and the Ethiopian Government are ambiguous in this regard, as they grant the lessee the right to "*build infrastructure such as dams, water boreholes, power houses, irrigation systems, (…) at the discretion of the lessee upon consultation and submission of permit request with concerned offices subject to the type and size of the investment project whenever it deems so appropriate*" (OI, 2015a). This ambiguity leaves the door open for private investors to access and use Ethiopia's water resources with little or no control from the Ethiopian authorities and sometimes to the detriment of local users, as reported in various case studies (OI, 2011a, 2014, 2015b; Bues and Theesfeld, 2012). Thus, the water implications of large-scale land investment do not relate only to water quantity and water quality issues, but to water access and water rights: who gets the water, when and for what purpose? In this sense, the approach taken so far to quantify water use and consumption – based in the hydrologic cycle (water balance) – is not the most appropriate to interrogate the social and political dimensions of water flows associated with land investments in the Ethiopian Nile River basin. The "hydrosocial cycle" will be used instead as a framework to explore the "*dialectical relation between water and society*" through which they "*make and remake each other over space and time*" (Linton and Budds, 2014). In this framework, as posed by Linton and Budds (2014), the materiality of water (H_2O) and its flows actively shape societies (social power/structure) which in turn act upon this same materiality altering water qualities and quantities through the use of technology and/or infrastructure (H_2O ↔ Technology/Infrastructure ↔ Social power/structure ↔ H_2O). This cycle works in both directions and it responds to a specific idea, meaning, construction or knowledge of water ("water") that is fluid and changing in time and space as it is the materiality of water (Linton and Budds, 2014). Along the same lines, we will investigate how the dominant and hegemonic narratives about water configure the current social structure and power relations, both regionally and in the areas affected by large-scale land investments, as well as the ways in which these narratives are contested. In the case at hand, as mentioned before, water and land are inherently intertwined. Consequently, some of the issues explored in this section will be relevant not only to water but to land as well.

Different actors may articulate different ideas and discourses about water, that in their turn embody different interests, power relations and social structures. These different "water views" may coexist and interrelate with each other at different scales.

6.1 The State: Water for Development and Economic Growth

The Ethiopian state has produced its own notion of "water" that mobilizes both at national and regional level. "Water" (and land) is seen as an abundant and unexploited natural resource that if "properly managed" will bring substantial economic growth and poverty reduction to the country. This idea is reflected in several government documents that assert the "water-centered" character of the Ethiopian development strategy:

> *"Ethiopia is endowed with one of the largest surface freshwater resources in sub-Saharan Africa. However, only 2 per cent of the potential is annually utilized, 86 per cent of that going to irrigated agriculture.*
>
> *(…) Ethiopia's huge hydroelectric generation potential has barely been exploited.*

> *(…) This is reflected in the overarching "vision" and policy orientation of the national water policy whose objective is: to enhance and promote all national efforts towards the efficient, equitable, and optimum utilization of the available water resources of Ethiopia for significant socio-economic development on a sustainable basis.*
>
> *It is in this context that both the water policy and water strategy underscore the importance of: developing water resources as an integral part of national socio-economic development (…)"* (MoWR, 2002).
>
> *"(…) the GTP will intensify the use of the country's water and natural resources.*
>
> *(…)It is also estimated that, nationally, a potential of 5.1 million ha of land can be developed through various irrigation methods"* (MoFED, 2010).

The same idea implicitly underlies the promotion of private investment in large-scale agricultural production of cash crops for export, as these are typically crops that require large amounts of water:

> *"While supporting private investment in large scale farms, government's focus is to ensure that the products from these farms are primarily for export or raw materials for domestic industries. For these reasons, emphasis will be put on cotton, date palm, tea, rubber tree and similar types of crops. Double cropping systems of production will be encouraged"* (MoFED, 2010).

At the international level, Ethiopia's claims on its right to an "equitable" and "reasonable" share of the Nile waters have been historically grounded in this same construction of "water" as a driving force for economic development (Tvedt, 2009; Milas, 2013). The understanding that only the extensive development of Ethiopia's untapped irrigation and hydropower resources will lift the country out of poverty can be found in state discourses from the Emperor Haile Selassie's era to the present day:

> *"(...) it is Ethiopia's sacred duty to develop the great watershed which she possesses in the interest of her own rapidly expanding population and economy"* (Emperor Haile Selassie I in the 1950s quoted in Tvedt, 2009)
>
> *"From every perspective, this project*[24] *will play a major and decisive role in realizing the five-year Growth and Transformation Plan and the consequent advance towards the eradication of poverty."* (Meles Zenawi, former Prime Minister of Ethiopia, at the ceremony to lay the foundation stone of the Grand Ethiopian Renaissance Dam, Horn Affairs, 2011)
>
> *"The government has a firm stand that the GERD must be constructed. I as individual and as a government official stand firm that the GERD must be built. We want the dam to root out poverty."* (Alemayehu Tegenu, Ethiopian Minister of Water, Irrigation and Energy, Newstime Africa, 2015)

The materiality of the Ethiopian Nile waters greatly varies in time and space. As mentioned in previous sections, the Ethiopian Nile tributaries present highly seasonal flows. In addition to that, the Ethiopian highlands in which most of the Nile waters originate are prone to erratic rainfall and drought (Milas, 2013). This natural fluctuation in water availability hampers the achievement of the state's "water vision", so the flow regime has to be altered in order to guarantee a constant and reliable amount of water for irrigation and/or hydropower generation. This requires hydrologic knowledge of the basin as well as the construction of large

[24] The construction of the Gran Ethiopian Renaissance Dam (GERD)

infrastructures as dams, canals, pumping stations, power stations. These needs are clearly reflected in the government development plans, where among the set targets are the improvement of the hydrologic and climatologic stations network, the elaboration of watershed master plans and feasibility studies, the construction of several irrigation and hydroelectric projects (MoWR, 2002; MoFED, 2010). The lack of financial resources has been the main constraint the Ethiopian state has encountered in advancing its "water-centered" development strategy. However, in recent years it has been able to undertake several important projects, being the most prominent the construction of the Grand Ethiopian Renaissance Dam on the Blue Nile.

The state's water narrative and its endeavor to reduce poverty through water resources development unfolds in the context of a neoliberal[25] state with market-oriented policies that configure specific power relations and social structures at the local level, challenging in turn Egypt's hydro-hegemony at the regional level. Ethiopia's market-oriented development policies are reflected in the promotion of private investment through the introduction of different type of incentives which include the provision of access to land and water resources, the provision of essential infrastructure service, the supply of labor from labor surplus areas, fiscal incentives such as tax holidays and tax exemptions. In this context, special efforts are being made to attract foreign investment, as it is believed foreign companies can bring large-scale financing both to the agricultural and water sectors (MoWR, 2002; MoFED, 2010). On the ground, these policies result in what Harvey (2003) defines as "accumulation by dispossession".

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[25] The term neoliberalism in this document is used and understood in the same terms Harvey (2005) defines it: *"Neoliberalism is in the first instance a theory of political economic practices that proposes that human well-being can best be advanced by liberating individual entrepreneurial freedoms and skills within an institutional framework characterized by strong private property rights, free markets, and free trade. The role of the state is to create and preserve an institutional framework appropriate to such practices. The state has to guarantee, for example, the quality and integrity of money. It must also set up those military, defense, police, and legal structures and functions required to secure private property rights and to guarantee, by force if need be, the proper functioning of markets. Furthermore, if markets do not exist (in areas such as land, water, education, health care, social security, or environmental pollution) then they must be created by state action if necessary"* (Harvey, 2005).

Accumulation by dispossession operates by creating profitable investment opportunities for the expanded reproduction of capital surplus. These investment opportunities consist in the release of valuable assets at very low cost, so overaccumulated capital can make profit from them (Harvey, 2003). In the case of Ethiopia, substantial extensions of land – and with them access to water resources – are made available to investors at a very low cost[26]. In addition to this, and as mentioned before, different incentives are offered to make investment even more attractive and profitable.

As Marx's principle of "primitive accumulation", accumulation by dispossession entails a wide range of processes, of which the most relevant to the present case are: the commodification and privatization of land (and water) with the consequent expulsion of pastoralist and peasant populations, the commodification of the labor force and the elimination of indigenous ways of living (Harvey, 2003).

The land and waters of Ethiopia are common property of the Ethiopian people, and it is the state duty to manage them for the greatest benefit of all nations, nationalities and peoples of Ethiopia (FDRE, 1995; FNGFDRE, 2000). In this sense, and although the lease of large-scale land plots to private investors does not entail a change in the ownership of the land (or the water), it does imply a privatization of access and use. In the same neoliberal logic operates the idea that untapped land and water resources should be made productive through capital investment. Along the same lines, the Ethiopian Government promotes "*private large scale commercial farms in areas that are not occupied or utilized by people*" (MoFED, 2010).

[26] For land plots 700 km away or more from Addis Ababa, rent price is 111 birr/ha (around 5 USD) or 158 birr/ha (around 7 USD) depending if the land has access to irrigation water or not. For land plots closer to the capital city, price will increase regardless of whether the production will be rainfed or irrigated (MoA 2013). However, lower lease prices have been reported in specific case studies (OI 2011a).

However, and as discussed before, most of these areas are in fact occupied and being used for non-capitalist social groups (i.e. pastoralists) with non-capitalist modes of production and consumption (Lavers, 2012). The fact that the use they make of land and water resources is considered "unproductive" under the neoliberal developmental paradigm of the Ethiopian Government, makes its livelihood "unsustainable" and "undesirable". Coherent with this idea is the settlement program for pastoralists that the Ethiopian Government is implementing. In its view, settlement is the only option for pastoralists to bring about the desired socio-economic growth to their communities. As the Ethiopian Government poses it:

> *"Undoubtedly, the Day the last group of the pastoral population is successfully settled will be considered a Milestone in the economic history of Ethiopia"* (MoFED, 2003).

In this sense, it is feared that the settlement program is used to clear land for investors. Different authors (OI, 2011a, 2013, 2014, 2015b; Rahmato, 2011; GRAIN, 2012; Moreda, 2015) have reported cases of forced mass resettlement in areas where large-scale land acquisitions have occurred. Moreover, the settlement program, by "dispossessing" nomadic people from their livelihood, provides a pool of cheap labor that, as land and water, becomes commodified. Different case studies report the "dispossession" caused by the "enclosure" of what is dubiously considered "empty" land and the conversion of hitherto communal usufruct rights into private usufruct rights. Loss of access to the land, to the forest, to the water, forced settlement, lack of compensation, lack of job opportunities for indigenous people, food insecurity, environmental destruction, political repression to those who raise their voice against large-scale farming development have being reported (OI, 2011a, 2013, 2014, 2015b; Rahmato, 2011). The Ethiopian state thus reveals itself as a neoliberal state in the way it uses coercion and force to suppress opposition to neoliberal policies and strategies (Harvey, 2005); showing, on the other hand, the relation between large hydrosocial systems and autocratic political and institutional organizations that has been suggested in the literature (Swyngedouw, 2009). Although most of the "accumulation by dispossession" discussion has revolved around land it perfectly applies to water. The construction of large hydraulic infrastructure as the GERD, the diversion of water from naturally flowing watercourses to irrigation schemes, changes in water rights from local farmers to large investment farms, have also resulted in the "dispossession" of local communities (Bues and Theesfeld, 2012; Veilleux, 2013; OI, 2014).

The implementation of the state’s "water" (and land) vision through the deployment of a specific set of knowledge, technologies and infrastructure does not only define power relations at the local level, but it seems to be reconfiguring the existing power relations at the regional level as well. As mentioned before, the hydro-politics of the Nile River basin have been historically determined by the position of Egypt as the hydro-hegemon, strongly opposing any water resources development by the upstream countries, including Ethiopia. However, in recent years, especially since 2010 with the signature of the Cooperative Framework Agreement (CFA) and 2011 with the commencement of the construction of the Grand Ethiopian Renaissance Dam, the hydro-politic framework of the basin seems to be shifting from hydro-hegemony to a more cooperative benefit-sharing framework. Zeitoun et al. (2014) discuss the importance of the CFA and the GERD as counter-hegemony mechanisms that have contributed to this shift by setting new rules of the game and imposing a new discourse and a new agenda for Nile transboundary water governance. However, in their accounting of resistance mechanisms they do not include the development of large-scale farming in the Ethiopian Nile River basin. The leasing of large-scale land plots to private investors for agricultural production will fall into the category of leverage mechanisms of resistance (i.e. construction of infrastructure, strategic cooperation, mobilization of funds) identified by Zeitoun et al. (2014), as through strategic cooperation with the private sector alternative funds are being mobilized for land and irrigation development. According to the results of CROPWAT presented in the previous section, if Egypt and Sudan were to equally[27] deduct from their shares the water consumed (IWR) in the development of 689,883 hectares of land in Ethiopia, their exploitation potential would decrease between 1.1% to 3.4% in the case of Egypt and between 3.3% to 10.2% in the case of Sudan. In addition, the volume of water that will have to be withdrawn (IWW) will represent between 5.1% to 16.1% of the mean annual flow of the Nile at Aswan, estimated in 84 cubic kilometers in the 1959 Nile Waters Agreement. So, it seems clear from our results that the development of large-scale farming in the Ethiopian Nile River basin can contribute to change the existing status-quo by altering the current “legal” water allocation arrangement. Furthermore, the fact that Ethiopia is unilaterally advancing in the development of its agricultural and water sectors already indicates a certain shift in power relations and a decrease of Egypt’s veto and bargaining power to decide how water should be allocated within the Nile River basin.

6.2 The Investors: Virtual Water Trade

> *"They do not cultivate the land for the people. They grow sorghum, maize, sesame, but all is exported, leaving none for the people."* (Local Government official from the Benishangul-Gumuz Region quoted in OI, 2015b)

One of the roles of the neoliberal state is to create the conditions for the expanded reproduction of capital (Harvey, 2005). In this sense, the "water" discourse of state and capital (private investors) follow the same neoliberal logic that results in the dispossession of local communities.

[27] The 1959 Nile Waters Agreement, in its fifth section titled General Provisions, states that should the two countries consider and accept to share the Nile waters with any other of the riparian states, “*the accepted amount shall be deducted from the shares of the two Republics in equal parts, as calculated at Aswan*” (UNTS 1963)

For private investors, "water" is an investment asset that should be used to their best benefit; an agricultural input that should be applied to optimize crop yields and thus economic profits. Their discourse agrees with that of the state in characterizing water (and land) as an "abundant" and "underused" resource readily available for capital gains (GRAIN, 2012). The fact that the contracts signed between the Ethiopian Government and private investors seem not to include any explicit limitation on water access and water use reinforces this idea (OI, 2015a). In this sense, the Oakland Institute (2011a) reports that many of the investors interviewed by its research team in Ethiopia were unconcerned with water quantity. However, their concern was to guarantee that there was adequate water supply at any time for crop production. For that purpose, private investors mobilize the same set of knowledge, technologies and infrastructure as the state. An example of that is the construction of 30 km of canals and another dam on the Alwero River that is being carried out by the company Saudi Star for its farm in the Gambella[28] region (OI, 2011a). Discourses of water use "efficiency" and "productivity" also form part of the "water" knowledge deployed by investors and the state. The imposition of hegemonic "water" views on local and indigenous communities constitutes another form of dispossession, as they are forced to abandon their traditional agricultural practices for being considered primitive and underdeveloped (Zwarteveen and Boelens, 2014; Vos and Hinojosa, 2016). Thus, similarly to what has been already discussed in the case of the state, the advancement of private investors' "water" agenda configures social inequalities and uneven power relations at the local level that result in the "material" and "cultural" dispossession of indigenous communities. This double

[28] Pibor – Akabo – Sobat sub-basin

process of dispossession exerted by private investors – backed by state power – over local communities has been reported by different testimonies:

> *"(…) the Karuturi*[29] *staff call the locals 'non-people'. (…) After they collect the harvest, instead of letting the villagers collect what remains, they burn it. Their farms are protected by the Ethiopian Defense Forces. The cattle go there, but are not allowed to graze. The cattle would still graze, so they used chemicals on the crops. Over 20 cattle (cows, oxen, goat, sheep) were killed. We know our cattle will die, but we have no alternative. A cattle owner complained, but the regional authorities say Karuturi is within its rights"* (Villager from the Gambella Region quoted in OI, 2015b).
>
> *"After the villagization program, I was moved to XXXXX and was sent for training. The main purpose of our training was to show us what the investors are doing and how they are cultivating our lands. (…) We saw our lands worked by the others"* (Ethiopian refugee in Kenya quoted in OI, 2015b).

These quotes clearly expose how violence is used to impose a particular view and knowledge about land and water resulting in the dispossession of local communities. Nevertheless, private large-scale land investments do not only shape social structures and power relations at the local level; they increasingly define virtual water flows at the global level. Most of the agricultural production in large-scale land investments is meant for export. Thus, the role that multinational companies play in global water governance by setting the terms of virtual water trade should not be overlooked (Sojamo et al., 2012; Vos and Hinojosa, 2016).

[29] On December 28, 2015 Ethiopia's Agricultural Ministry revoked their contract with Karuturi Global Limited on the grounds that by 2012 Karuturi had developed only 1,200 hectares of land from the 100,000 acquired in 2010. (https://www.culturalsurvival.org/news/ethiopia-cancels-concession-karaturi-land-grab)

6.3 Local Communities: Water, Identity and Survival

Confronting the hegemonic and neoliberal notion of "water" preached by private investors and the state, there is the understanding of "water" held by local communities. Water (and land) is for most indigenous and local people the basis for survival and for their common cultural identity (OI, 2011a, 2013; GRAIN, 2012).

> *"So land is not only economical, it is historical, political, spiritual and very emotional. (…) land according to the village is divided into agriculture, (shifting cultivation all over your own territory but not in another without consultation and permission), used for fishing (rivers and ponds), alluvial soil used for permanent agriculture, areas used for hunting (called dwar), and some areas are used for protection (dense forest) during times of conflict. These areas are respected. Some areas have trees to be worshipped in that place"* (Anuak elder from the Gambella region quoted in OI, 2011a)
>
> *"(The Anuak) used to live on riverbanks, but they are now in a place where there is no river. They are taken far away from fish, and they can't fish at all. Land is their identity—it is what they breathe, and they're taken away from that. Even now, some people are so stressed. They sit in camp and do nothing. Their way of living and their existence has been taken from them"* (Obang Metho, Executive Director of Solidarity Movement for a New Ethiopia[30] , quoted in OI, 2013)

Indigenous people, as the Anuak, have adapted their "water" and "land" knowledge to the environment in which they have traditionally lived, so they lack the tools and the expertise to adapt to different environments. Consequently, any modification in their surrounding conditions

[30] Solidarity Movement for a New Ethiopia is "*a diverse, non-political, social justice movement of Ethiopians that seeks to hold the Ethiopian Government to account for myriad human rights violations*" (OI 2013).

can cause enormous distress on indigenous communities. The clearing of forests for large-scale land farming, the "enclosure" of indigenous traditional lands and rivers, the forced settlement of pastoralists and agro-pastoralist, have been reported as serious threats to the livelihoods of local communities in Ethiopia (OI, 2011a, 2013, 2014, 2015b). Not only their material survival is being compromised; but their emotional and spiritual well-being as well. As expressed by an Anuak elder from the Gambella region quoted in OI (2011a):

> *"Everyone in the village knows the territory, and where the traditional demarcation is. The territory is respected as people fear the ancestral spirits. Many Anuak who die elsewhere want to come back and be buried in their own ancestral village. Land is an emotional, historical, spiritual and political issue".*

In spite of the political repression and violence exerted by the Ethiopian state in the pursuit of its water-centered development vision, several instances of resistance among indigenous people have been reported. Moreda (2015) analyzes the different mechanisms of resistance employed by the Gumuz peoples, from the Benishangul-Gumuz[31] region, to challenge land and water appropriation by private investors. The author finds that although most of the strategies used are covert (e.g. sabotage of investment projects, attacking/killings), more open forms of opposition (e.g. threats to not pay taxes, encroachment onto land already acquired by investors, refusal to comply with the government's settlement program) can also be found, especially in remote areas where the state power cannot easily exert its authority.

Attempts by local communities to challenge large-scale land acquisitions may seem unlikely to succeed in protecting their traditional lands and waters and reconfiguring social

[31] Blue Nile sub-basin.

structures and power relations. Nevertheless, Moreda (2015) highlights the importance these actions may have in determining the economic viability of private investment projects and thus the willingness of the state to support them in case they fail to boost the hoped-for economic development.

6.4 Water Justice and the Politics of Scale

The discussion above shows the importance of going beyond quantities when addressing water use and water allocation issues. The hydrosocial cycle constitutes a useful tool to interrogate how different ideas and knowledge about "water" become produced and how they define and configure social and power relations. It reveals how, not only the hydrologic conditions of a specific catchment, but also power and discourses about water determine water flows and access to water.

The hydrosocial cycle framework applied to different notions of "water" has exposed as well the importance of scale and the politics of scale. It shows how discourses about "water" operating at different levels (i.e. local, national, global) result in power configurations that vary depending on the scale of inquiry. Zwarteveen and Boelens (2014) emphasize the importance of scale when addressing issues of water justice, and how the definition of scale can make an injustice appear or disappear. This fact becomes clear in the case of the Ethiopian Government and its water-centered developmental discourse. The Ethiopian claims for a fair and equitable utilization of the Nile River waters that allows for the country's economic development and poverty reduction can be considered a matter of "justice" if regarded at the basin level, where Egypt and Sudan have historically been the only beneficiaries of the Nile waters. Ethiopia's demand addresses not only issues of distribution (i.e. a fair and equitable share of the Nile waters) but also of political recognition and participation (i.e. a cooperative framework in which all riparian countries have a voice in the basin trans-boundary governance). However, fair claims and demands at the basin level translate into dispossession and conflict at the local level, where indigenous and local communities are denied the three elements of water justice: distribution (i.e. access to water), cultural recognition and political participation (Zwarteveen and Boelens, 2014). Based on the foregoing, it seems adequate to conclude that large-scale land acquisitions in the Ethiopian Nile River basin and the appropriation of water resources associated with them can be considered with no doubt instances of land and water grabbing respectively (Franco et al., 2013b, 2014).

Chapter 7: Conclusion

In this research, the water implications of land grabbing in the Ethiopian Nile River basin have been assessed; not only from a resource management perspective, but paying attention as well to how different discourses and notions about "water" operate at different scales configuring social structures and power relations that result in conflict and water injustices.

The trends and magnitude of large-scale land investments in the Ethiopian Nile River basin have been discussed; showing the clear and strong will of the Ethiopian Government to promote and facilitate the acquisition of land by private investors. Therefore, and despite the intrinsic inaccuracy of land deals data, interrogating the implications of large-scale farming development on water resources availability, sheds light on the (un)sustainability of the Ethiopian water-centered development strategy. In this sense, this research shows the importance of not disregarding the water factor when addressing issues of large-scale land acquisitions for agricultural production.

Based on our results, the amount of water that will be required to bring into production the almost 700,000 hectares that have been leased to investors in the Ethiopian Nile River basin will represent a reduction between 1.7% and 5.2% in Ethiopia's runoff contribution to the Nile waters. In addition, between 5.9% and 18.5% of this contribution will have to be withdrawn – although not necessarily consumed – from surface water sources to meet the irrigation requirements of private large-scale farming. The analysis of monthly data by sub-basin makes it clear that water storage infrastructure will be needed due to the high seasonality of the Nile tributaries, especially the Atbara and the Blue Nile. It also shows that the Pibor – Akabo – Sobat system is the most targeted by investors both in terms of land acquired and water for agricultural production required. In this sense, the annual runoff generated within the Ethiopian Pibor –

Akabo – Sobat sub-basin may be reduced between 3.6% and 17.8% due to the development of large-scale land deals. The examination of the GTP targets with regard to private investment in land gives even more cause of concern; demonstrating the unfeasibility and unsustainability of the government policies with regard to agriculture and water resources development. Between 19% and 29% of Ethiopia's total renewable water resources would be used by private investors alone if the 3.3 millions of hectares that the government plans to transfer to investors were to be put into production. At the same time, the government's biofuel development plan reveals completely disproportionate as it would result in the total depletion of the country's renewable water resources. These results suggest a complete lack of consideration of water quantity and water quality issues by the Ethiopian Government when designing and implementing its market-oriented agricultural development policies. This lack of consideration may also reflect a neoliberal belief in technology (Harvey, 2005); relying on technology transfers from private investors to "optimize" the "productivity" of water resources while "minimizing" the impacts of overconsumption and pollution.

On the other hand, the market-oriented agricultural development strategy of the Ethiopian Government represents a clear challenge to the existing hydro-hegemony in the Nile River basin. The development of land transferred to investors in the Ethiopian Nile River basin will result in a reduction of Egypt's Nile waters share between 1.1% and 3.4%. In the case of Sudan, this may represent a reduction in its share up to 10.2%.

In addition to water quantity issues, the hydrosocial cycle is a useful framework to reveal how water discourses materialize on the ground configuring specific social structures and power relations. The water vision of the state, private investors and local communities have been analyzed showing how different "water" knowledges coexist and confront in the same space, striving to disrupt or to maintain specific social structures and power relations. The neoliberal "water" discourse of the state, backed by a specific set of knowledge and technologies, is resulting in the dispossession of local and indigenous communities while challenging and disrupting the existing hydro-political status-quo in the Nile River basin. Similarly, private investors' "water" view also materializes in the dispossession of local peoples, while informing virtual water flows at the global level. In this regard, the fact that a large portion of the produce from large-scale farming is intended to be exported arises questions of environmental justice and food security. At the local level, indigenous communities confront these hegemonic "water" views using different strategies. Thus, it becomes apparent the importance of scale when interrogating water justice issues. While claims by the Ethiopian state to develop its Nile water resources may seem a matter of justice at the basin scale, these same claims result in water injustices and dispossession at the local level.

In conclusion, this research contributes to a better understanding of the water grabbing phenomenon associated to land grabbing by providing an estimate of its magnitude and impact on water resources in the Ethiopian Nile River basin; as well as by exploring how specific "water" discourses and power geometries inform water flows and how these flows may result in the dispossession of the least favored groups.

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Appendices

Appendix A Large-Scale Land Deals Considered

Information obtained from the Land Matrix Global Observatory (2014) database and modified/complemented by the author. Only concluded land investments (i.e. a lease contract has been signed) located within the Ethiopian Nile River basin have been considered.

A.1 Atbara Sub-Basin

Deal_id	Region (admin 1)	Woreda (admin 3)	Investor name	Investor country	Intention	Contract size (Ha)	Crops
3341	Amhara	Mirab Armacho	And-Net International Trading Company	Israel	Food crops	4,000	Cereals (no specification), Oleagionous plant
3363	Tigray	Kafta Humera	Kaleb Service Farmers House , Sun Opta Inc	Ethiopia, Canada	Food crops	500	Sesame

A.2 Blue Nile Sub-Basin

Deal_id	Region (admin 1)	Woreda (admin 3)	Investor name	Investor country	Intention	Contract size (Ha)	Crops
3354	Amhara	Gonder Zuria	Lesa PLC	Israel	Food crops	3,000	Oil Seeds
1193	Amhara	Jawi	Hiber Sugar Share Company	Ethiopia	Biofuels, Food crops, Renewable Energy	6,183	Sugar Cane
1196	Benishangul-Gumuz	Bilidigilu	I.D.C Investment, Unnamed investor 164	Denmark, Ethiopia	Biofuels	15,000	Jatropha
1198	Benishangul-Gumuz	Dangur	Jatropha Biofuels Agro-Industry	Ethiopia	Biofuels	100,000	Jatropha

(Blue Nile sub-basin cont.)

Deal_id	Region (admin 1)	Woreda (admin 3)	Investor name	Investor country	Intention	Contract size (Ha)	Crops
1201	Benishangul-Gumuz	Dangur	Sun Biofuels, National Biodiesel Corporation	U.K., Ethiopia	Biofuels	80,000	Jatropha
3823[(1)]	Benishangul-Gumuz	Dangur	Getafan Mechanized Farming	Ethiopia	Food crops, Non-food agricultural commodities	3,000	Pulses, Cotton, Oil Seeds
3830[(1)]	Benishangul-Gumuz	Dangur	Nega Mamay Mihret	Ethiopia	Non-food agricultural commodities	3,000	Cotton, Sesame, Soya Beans
1241a[(2)]	Benishangul-Gumuz	Dangur/Guba	MIDROC Group, Jemal Ahmed	Saudi Arabia, Ethiopia	Biofuels	100,000	Jatropha
1304[(1)]	Benishangul-Gumuz	Dangur/Guba	Shapoorji Pallonji & Co. Ltd	India	Biofuels, Food crops	50,000	Oil Seeds, Pongamia Pinnata
1242[(1)]	Benishangul-Gumuz	Guba	MIDROC Group (Horizon Plantations PLC), Jemal Ahmed	Saudi Arabia, Ethiopia	Food crops	20,000	Peanut, Oil Seeds
1252	Benishangul-Gumuz	Guba	Ardent Energy Group, Praj Industries Ltd	U.S.A, India	Biofuels	200	Jatropha
3817	Benishangul-Gumuz	Guba	Access Capital	Ethiopia	Food crops	5,000	Sesame, Bean

A.3 Pibor – Akabo – Sobat Sub-Basin

Deal_id	Region (admin 1)	Woreda (admin 3)	Investor name	Investor country	Intention	Contract size (Ha)	Crops
1244(1)	Gambella	Abobo	Saudi Star Agricultural Development Plc	Saudi Arabia	Food crops	10,000	Rice
1250a(3)	Gambella	Abobo	Saudi Star Agricultural Development Plc	Saudi Arabia	Food crops	4,000	Rice
3824	Gambella	Abobo	Green Valley Agro Plc	India	Non-food agricultural commodities	5,000	Cotton
1218(1)	Gambella	Dima	Sannati Group	India	Food crops	10,000	Pulses, Cereals, Rice
1306(1)	Gambella	Dima	Hunan Dafengyuan Agriculture CO., Ltd	China	Food crops	25,000	Sugar Cane
3826(1)	Gambella	Dima	JVL Agro Industries Ltd	India	Non-food agricultural commodities	5,000	Cotton
3835(1)	Gambella	Dima	Saber Group	India	Food crops, Non-food agricultural commodities	25,000	Cotton, Soya Beans
1221(1)	Gambella	Gog	Ruchi Soya Industries	India	Food crops	25,000	Corn (Maize), Pulses, Soya Beans
3425(1)	Gambella	Gog	Toren Agro Industries PLC (Tekron Group)	Turkey	Non-food agricultural commodities	6,000	Cotton, Soya Beans
1202(1)	Gambella	Itang	Bharat Herbals & OIls (BHO)	India	Food crops	27,000	Cereals, Cotton, Oil Seeds, Rice, Jatropha

(Pibor – Akabo – Sobat sub-basin cont.)

Deal_id	Region (admin 1)	Woreda (admin 3)	Investor name	Investor country	Intention	Contract size (Ha)	Crops
1205[(1)]	Gambella	Jikawo / Itang	Karaturi Global Ltd	India	Biofuels, Food crops	100,000	Corn (Maize), Oil Palm, Rice, Sugar Cane
1241c[(2)]	Gambella	Mengesh / Godere	MIDROC Group, Jemal Ahmed	Saudi Arabia, Ethiopia	Food crops	58,000	Oil Palm

NOTES:

(1) Lease contract available. Information from the Land Matrix Global Observatory (2014) database has been modified/updated/completed with the information included in the contracts. Source: OI, 2015a.

(2) The land deal reported in the Land Matrix Global Observatory (2014) database as 1241 has been split into 4 (1241a, 1241b, 1241c and 1241d), from which only 1241a and 1241c have been considered in the present study. Sources: https://business.highbeam.com/3548/article-1G1-181070458/al-amoudi-firm-secure-large-plot-biofuel; http://nazret.com/blog/index.php/2008/07/28/midroc_ethiopia_adds_floriculture_to_men; www.ventures-africa.com/2013/09/mohammed-al-amoudi-ethiopias-richest-man-spots-opportunities-home/

(3) Land deal 1250a replaces the land deal included in the Land Matrix Global Observatory (2014) database as 1250. Source: http://www.farmlandgrab.org/24295.

Appendix B Results Tables

Sub-basin	Runoff				River Flow at Selected Gauging Stations			
	% withdrawn for large-scale farming		% consumed by crops		% withdrawn for large-scale farming		% consumed by crops	
	S1	S2	S1	S2	S1	S2	S1	S2
	Min	Max	Min	Max	Min	Max	Min	Max
Atbarah	0.003	0.4	0.002	0.3	0.002(2)	0.3(2)	0.002(2)	0.2(2)
Blue Nile	1.8	2.8	1.3	2.1	1.8(3)	2.9(3)	1.4(3)	2.2(3)
Pibor - Akabo - Sobat	4.8	23.4	3.6	17.8	5.3(4)	26.2(4)	4.1(4)	19.9(4)
TOTAL	2.2%	6.8%	1.7	5.2	1.9(1)	5.8(1)	1.4(1)	4.4(1)

Table B.1 Estimated water consumption and withdrawal in relation to the available surface water resources (Ethiopian national runoff and river flow at selected gauging stations) due to large-scale land investment in the Ethiopian Nile River basin (**WRR = 76%**)

(5) Main Nile at Aswan
(6) Atbara at Mouth
(7) Blue Nile at Khartoum
(8) Sobat at Doleib Hill

ATBARA

Month	IWR S1 MCM	IWR S2 MCM	WRR (%)	IWW S1 MCM	IWW S2 MCM	Runoff Atbara[(a)] Ethiopia MCM	Water supply deficit (Runoff < IWW) S1 MCM	Water supply deficit (Runoff < IWW) S2 MCM
Jan	0.0	8.6E-02	28	0.0	0.3	13	-	-
Feb	0.0	7.3	28	0.0	26.0	5	-	21
Mar	0.0	9.8	28	0.0	35.1	1	-	34
Apr	0.0	8.0	28	0.0	28.6	2	-	26
May	0.0	8.0E-02	28	0.0	0.3	6	-	-
Jun	1.1E-02	1.1E-02	28	3.9E-02	3.9E-02	69	-	-
July	2.9E-02	0.3	28	0.1	0.9	1,198	-	-
Aug	0.1	0.1	28	0.4	0.4	3,998	-	-
Sep	3.9E-02	3.9E-02	28	0.1	0.1	2,579	-	-
Oct	0.0	0.0	28	0.0	0.0	601	-	-
Nov	0.0	0.0	28	0.0	0.0	113	-	-
Dec	0.0	0.0	28	0.0	0.0	36	-	-
TOTAL								**82**

BLUE NILE

Month	IWR S1 MCM	IWR S2 MCM	WRR (%)	IWW S1 MCM	IWW S2 MCM	Runoff Blue Nile[(a)] Ethiopia MCM	Water supply deficit (Runoff < IWW) S1 MCM	Water supply deficit (Runoff < IWW) S2 MCM
Jan	162.9	226.3	28	581.7	808.1	738	-	70
Feb	11.3	65.2	28	40.3	232.7	457	-	-
Mar	35.5	140.1	28	126.7	500.3	414	-	86
Apr	3.5	61.0	28	12.5	217.7	435	-	-
May	3.8	3.8	28	13.6	13.6	513	-	-
Jun	0.5	0.5	28	1.8	1.8	1,105	-	-
July	0.0	0.0	28	0.0	0.0	5,087	-	-
Aug	0.0	0.0	28	0.0	0.0	15,536	-	-
Sep	0.3	0.3	28	1.0	1.0	13,893	-	-
Oct	5.4	6.5	28	19.4	23.3	7,270	-	-
Nov	217.1	272.8	28	775.3	974.3	2,499	-	-
Dec	214.8	279.1	28	767.2	996.7	1,282	-	-
TOTAL								**156**

PIBOR - AKABO - SOBAT

Month	IWR S1 MCM	IWR S2 MCM	WRR (%)	IWW S1 MCM	IWW S2 MCM	Runoff Pibor – Akabo – Sobat[(a)] Ethiopia MCM	Water supply deficit (Runoff < IWW) S1 MCM	Water supply deficit (Runoff < IWW) S2 MCM
Jan	93.4	446.1	28%	333.6	1,593.3	1,082	-	511
Feb	66.5	426.5	28%	237.6	1,523.3	482	-	1,041
Mar	55.9	405.9	28%	199.7	1,449.5	305	-	1,144
Apr	64.1	224.2	28%	229.1	800.6	260	-	541
May	8.7	21.0	28%	31.0	74.9	462	-	-
Jun	14.4	220.8	28%	51.3	788.7	952	-	-
July	0.0	0.0	28%	0.0	0.0	1,456	-	-
Aug	0.3	5.9	28%	1.1	21.1	1,799	-	-
Sep	4.5	29.0	28%	15.9	103.5	1,992	-	-
Oct	67.9	134.4	28%	242.4	480.1	2,229	-	-
Nov	80.2	91.7	28%	286.5	327.6	2,198	-	-
Dec	93.9	690.3	28%	335.2	2,465.3	1,922	-	543
TOTAL								**3,780**

Table B.2 Monthly irrigation water needs and water deficit in the Ethiopian Nile river basin associated with large-scale land investments.

(a)The monthly runoff has been derived from the annual runoff, assuming that its temporal distribution is the same as the temporal distribution of the monthly river flow records.

Country	Water Footprint of crop production (MCM/yr)(1)			Water Footprint of large-scale land investments in the Ethiopian Nile River basin (MCM/year)			
				S1		S2	
	Green	Blue	Grey	Green	Blue	Green	Blue
Ethiopia	56,485	1,173	327	3,506	1,205	3,707	3,777

Table B.3 Ethiopia - Water Footprint of National Crop Production and of large scale land investments in the Ethiopian Nile River basin

(1) Mekonnen and Hoekstra (2011)

Type of Investment	Water Footprint(1) of large-scale land investments in the Ethiopian Nile River basin (MCM/year)			
	S1		S2	
	Green	Blue	Green	Blue
Foreign	1495.6	176.9	1623.7	2573.3
Domestic	576.5	248.0	605.9	304. 5
Joint-Investment	1434.0	780.2	1477.7	899.4
TOTAL	3506.0	1205.1	3707.3	3777.2

Table B.4 Water Footprint (MCM/year) of large-scale land investments in the Ethiopian Nile River basin by type of investment.

(1) The water footprint of large scale land investments in the Ethiopian Nile River basin equals the virtual water content of the produce grown in those land investments.