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Water Implications of Foreign Direct Investment in Ethiopia's Agricultural Sector

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ABSTRACT: Ethiopia is often highlighted as a country in which a lot of foreign land acquisition is occurring. The extent to which these investments also constitute significant acquisitions of water is the subject of this paper. It is apparent that water availability is a strong driver of the recent surge of investments in agricultural land globally, and in general the investments occur in countries with significant 'untapped' water resources. Ethiopia is no exception. We propose that the perception of unused and abundant water resources, as captured in dominant narratives, that drives and justifies both foreign and domestic investments, fails to reflect the more complex reality on the ground. Based on new collections of lease information and crop modelling, we estimate the potential additional water use associated with foreign investments at various scales. As a consequence of data limitations our analyses provide only crude estimates of consumptive water use and indicate a wide range of possible water consumption depending on exactly how foreign direct investment (FDI) development scenarios unfold. However, they do suggest that if all planned FDI schemes are implemented and expanded in the near future, additional water consumption is likely to be comparable with existing water use in non-FDI irrigation schemes, and a non-trivial proportion of the country's water resources will be effectively utilised by foreign entities. Hence, additional water use as well as local water scarcity ought to be strong considerations in regulating or pricing land leases. If new investments are to increase local food and water security without compromising local and downstream water availability they should be designed to improve often very low agricultural water productivity, and to safeguard access of local populations to water.

KEYWORDS: Lease agreements, foreign direct investment, crop water requirements, Ethiopia

INTRODUCTION

Ethiopia is often highlighted as a country in which a lot of foreign land acquisition is occurring (e.g. Butler, 2010; Time Magazine, 2011; The Guardian, 2011a). Estimates of the extent of the land assigned for foreign direct investment (FDI) range from 600,000 ha (Cotula et al., 2009), 1.2 million ha (World Bank, 2010a), 2.9 million ha (Access Capital, 2010) and 3.6 million ha (Mousseau and Sosnoff, 2011). In Ethiopia there are hundreds of different agreements with foreign governments and private sector companies from India, China, Saudi Arabia, Korea, Qatar, Libya, Israel and the European Union. Earlier investments, between 2000 and 2005, were primarily in the flori/horticultural sector with the EU, India and Israel investing more than 60% of their total foreign direct investment (FDI) in Ethiopia in this sector (Bues, 2011). Subsequently, from about 2006 to 2008, investments in floriculture continued to grow, and investment for production of rice, cotton and biofuels also increased dramatically. The recent surge in FDI is in part driven by the 2008 food crisis, due to export restrictions on key food crops that followed. At least 25 countries imposed export bans or restrictions in 2008, including India, Russia, Argentina and Vietnam. Brown (2011) asserts:

> [f]earing they might not be able to buy needed grain from the market, some of the more affluent countries, led by Saudi Arabia, South Korea, and China, took the unusual step in 2008 of buying or leasing land in other countries on which to grow grain for themselves. Among the principal destinations were Ethiopia and Sudan.

In addition, the 2008 food crisis both increased the value of food and land, and pushed investors to look for new sources of investment (Mann and Smaller, 2010), resulting in the entry of new investment funds in the US (BlackRock and Goldman Sachs), UK (Knight Frank) and Germany (Deutsche Bank), targeting agricultural investment. Investment in agricultural land is increasingly viewed as a safe investment in times of financial crisis (FC, 2011). Moreover, a growing number of countries including China, India and Arab countries are faced with domestic resource constraints, in particular land and water (SOLAW, 2011), and hence look for opportunities to meet their rapidly growing demands internationally. And finally, new energy and climate policies of various countries have increased the demand for biofuels, making them a key driver of new land acquisitions (Anseeuw et al., 2012). Drivers on the side of the investors and international markets are met by increasingly favourable investment conditions in the target countries, many of which promote market liberalisation, commercialisation of agriculture and rural labour and commodification of land and water resources (Mann and Smaller, 2010). Agricultural investments are part of a wider trend of very rapidly increasing foreign investment in Ethiopia, constituting approximately one-third of all foreign investment (Weissleder, 2009), which has increased exponentially from a total of US$45 million in 2000 to over US$3200 million in 2008 (Mousseau and Sosnoff, 2011).

Increasingly, it is being recognised that land acquisition often equates to de facto water acquisition (Skinner and Cotula, 2011) and FDI is driven as much or even more by the need for water to produce food than by the need for land (Mann and Smaller, 2010; Woodhouse and Ganho, 2011). For example, Saudi Arabia, a major investor in Ethiopia, for many years encouraged wheat production at home, but is now phasing out its own wheat production due to depletion of the (mostly fossil) freshwater reserves in the country. In 2008, Saudi Arabia established a new agricultural fund for which a prime concern is preserving domestic water resources by investing in agricultural production overseas (Mann and Smaller, 2010).

In much of sub-Saharan Africa a dominant narrative is one of underutilised land and water resources that require investment to 'unlock' their potential and drive the engine of development (World Bank, 2008; 2010b). This narrative is exemplified in Ethiopia by its prime minister who stated, "[w]e have three million hectares of unutilised land. This land is not used by anybody. This land should be developed" (IANS, 2011). While it is debatable if this land is indeed unutilised, there is certainly significant potential to increase land productivity. The same narrative exists for water, where IWMI has introduced the concept of 'economic water scarcity' (Molden et al., 2007). 'Economic water scarcity' is therein defined as when "human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands". Most sub-Saharan African countries, including Ethiopia, are identified to be suffering from economic water scarcity, based on the criteria that less than 25% of water from rivers is withdrawn for human purposes, but malnutrition exists indicating that more water could be used for production of food. Indeed, Ethiopia does have enormous untapped water resources (World Bank, 2006; Awulachew et al., 2010). Only about 5% of total blue water is withdrawn so that most of it leaves the country as flow in the Nile and other rivers, thereby benefitting downstream riparians.

In Ethiopia, about 95% of agricultural production is currently rain-fed and only an estimated 640,000 ha are currently irrigated – from a potential of 5.3 million ha (Awulachew at al., 2010). Key entry points to alleviate poverty and drive economic development are large and small water infrastructural development for irrigation, as well as soil and water conservation measures to buffer against rainfall variability and to increase water and land productivity (Awulachew et al., 2010). Investment in agricultural research and development has been identified as key to improving land and water productivity (e.g. Sulser et al., 2010). About 15% of the Government of Ethiopia's expenditure is committed to the agricultural sector (Awulachew et al., 2010) with enormous successes in terms of production growth. Several recent policy frameworks such as the Growth and Transformation Plan for the Period of 2010 to 2014 (MoFED, 2010) encourage large-scale intensification and commercialisation of agriculture through additional investment by foreign investors. International investors in Ethiopia may be further encouraged through direct support in terms of customs duty or income tax exemptions (Lavers, 2011).

It would seem that the FDI taking place in Ethiopia is exactly the kind of investment being called for internationally and nationally for water resources development to spur economic development. However, there is general unease reflected in much of the press (e.g. The Guardian, 2011b; 2011c; La Via Campesina, 2011; Dakar Appeal, 2011; Global Investment Watch, 2009; Afronline The Voice of Africa, 2011) and by many NGOs, civil society and human rights groups (e.g. the Ecumenical Water Network [EWN] and Ecumenical Advocacy Alliance [EAA], the Oakland Institute and the Solidarity Movement for a New Ethiopia), which equate FDI with 'land and water grabbing' and warn of a form of neo-colonialism. There is concern about the impacts of FDI on local people, their displacement from land, loss of access to resources, and lack of adequate compensation (Oakland Institute, 2011; EWN and EAA, 2011). There is also concern about the export of food grown in Ethiopia, resulting in a flow in the opposite direction of emergency food relief, which is essential for a large proportion of the poor and undernourished population: between 5 and 7 million Ethiopians require food aid. But also at the heart of the controversy over FDI is the de facto shift of – often informal – land and water rights of customary users to foreign users, often with completely unregulated access to water (Skinner and Cotula, 2011). Socio-economic and environmental impacts of agricultural intensification, and additional irrigation and hydropower development also include changes in local (e.g. groundwater) and downstream water availability, for example losses of access to drinking water for livestock (Avery, 2010; Elias and Abdi, 2010; Abbink, 2011). Pollution, damming, abstractions and hydrological alterations impact aquatic and freshwater ecosystems and their services for humans (Brisbane Declaration, 2007). These impacts are of course not limited to FDI but also occur with any similar domestic investment and agricultural intensification.

In this paper we focus on FDI in Ethiopia and its implications in terms of water appropriation. To do so we 1) document existing agreements in selected districts, regions and at national level to paint a clearer picture of the FDI situation in Ethiopia, including how access to water is regulated; 2) estimate the potential water resource impacts of land use change associated with FDI for well-documented cases, using a crop model; and 3) extrapolate from these cases and compare resulting total water resource impacts with the water situation nationally and for the Blue Nile basin, as well as for two contrasting local case studies.

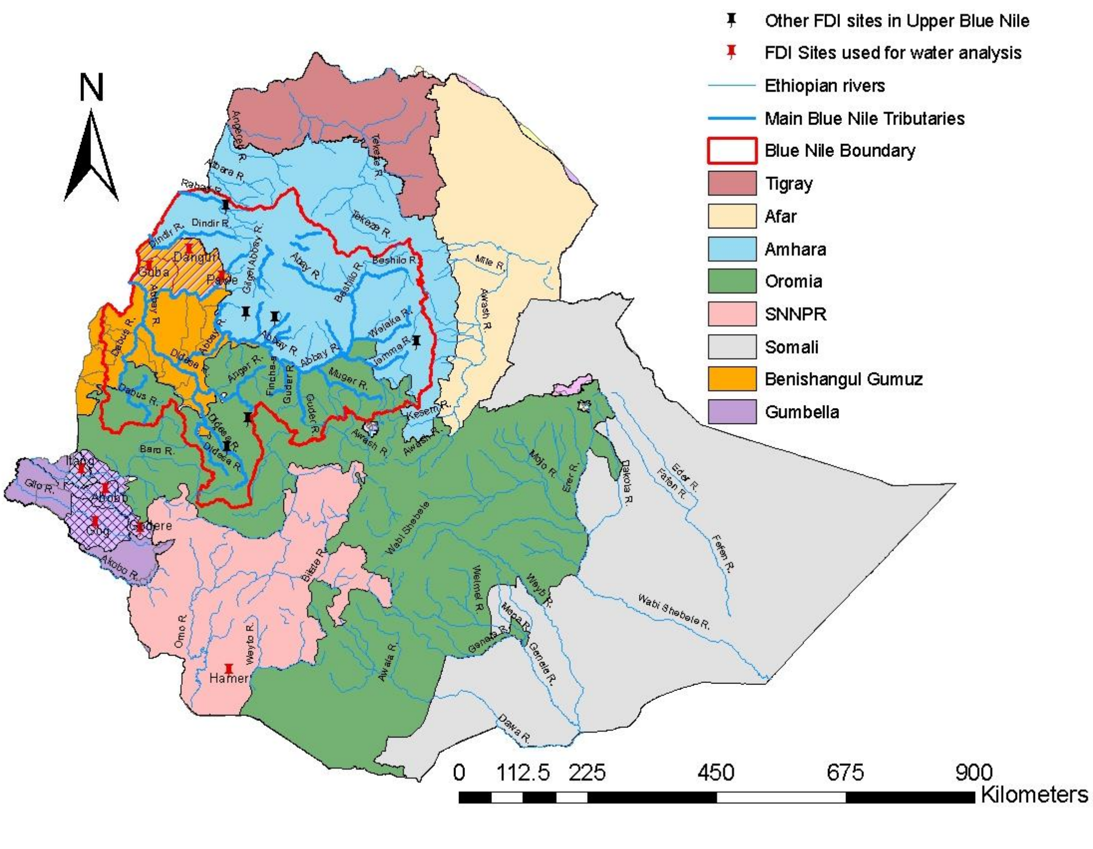
Uncertainty exists at all levels of this analysis, from inaccuracies in the lease information to lack of information on specific locations and land use changes that have resulted, or will result. Thus we have developed scenarios for modelling changes in water use that suggest lower and upper boundaries of possible water use changes associated with FDI. Comparing these scenarios for water use change to known water availability and plans for irrigation development at national, basin and sub-basin scales, we test the hypothesis that water use implications of FDI will be unimportant in a water-abundant country such as Ethiopia.

We propose that the perception of unused and abundant water resources, as captured in dominant narratives (World Bank, 2006, 2008, 2010b; Molden et al., 2007; Awulachew et al., 2010; IANS, 2011), that drives and justifies both foreign and domestic investments fails to reflect the more complex reality on the ground.

FDI LEASES IN ETHIOPIA – NATIONAL AND REGIONAL

Our analysis started with a review of known licences granted to foreign (including diaspora, i.e. Ethiopians living outside Ethiopia) investors at national and regional level, in order to provide an upper limit of potential land use change driven by FDI. We gathered information from national and regional agreements, focusing on those regions with the most FDI activity, Oromia, Amhara, SNNP, Gambella, and Beneshangul Gumuz – see figure 1. It is important to keep in mind, however, that so far only a small fraction of the licenses granted to foreign investors have been implemented. Thus much of the following data and discussion refers to potential land use changes and their potential water effects.

Figure 1. Map of Ethiopia with administrative and hydrological boundaries and FDIs used in the water use analysis as well as other known FDI sites.



Note: Hatched areas indicate those districts in which FDIs used in the water analysis are located.

FDI at the national level

The Agricultural Investment Support Directorate under the Ethiopian Ministry of Agriculture assesses the biophysical and socio-economic situation and suitability of so-called 'unutilised lands' at the national level for commercial agriculture (Access Capital, 2010). Disclosure of land leases at the national level by the Federal Government encompasses 24 individual contracts made between 2009 and 2011. Regional governments had autonomy to manage their land before 2009, thus the federal registry reflects leases that arose after the change in rules in 2009. These leases amount to a total of 350,099 ha land, of which 285,012 ha are with foreigners (mostly large land areas) while 65,087 ha are with Ethiopians, including the diaspora (mostly small land areas) – see table 1. Out of the 285,012 ha land leased to foreigners, 250,012 ha are leased to eight Indian firms.

Table 1. National level: Land lease agreements between local, diaspora and foreign investors and the Ethiopian Investment Authority.

Investor/Company	Source	Region	Investment type	Land area (ha)
Keystone	Diaspora	B/Gumuz	Horticultural crops	431
Tsegaye Demoze	Diaspora	SNNPR	Cotton, sesame, soybean	1000
Reta	Diaspora	SNNPR	Cotton, grains	2137
Rahwa	Ethiopia	SNNPR	Cotton, grains	3000
Kehedam Trading	Diaspora	B/Gumuz	Oil crop	3000
ASKY	Ethiopia	B/Gumuz	Cotton	3000
Verdanta	Indian	Gambella	Tea	3012
Lucci Agricultural	Ethiopian	SNNPR	Cotton	4003
Daniel Agricultural	Diaspora	SNNPR	Cotton, grains	5000
Mela Agricultural	Ethiopia	SNNPR	Cotton	5000
Access Capital	Ethiopian	B/Gumuz	Sesame and beans	5000
Dr. Tamie Hadgu	Diaspora	SNNPR	Cotton, seeds	5000
Bruhoye	Ethiopia	B/Gumuz	Cotton, soybean	5000
Tracon Trading	Ethiopia	B/Gumuz	Cotton	5000
White Field	Indian	SNNPR	Cotton	10000
Sannati	Indian	Gambella	Rice	10000
Saudi Star	Saudi	Gambella	Rice	10000
Adama	Ethiopia	SNNPR	Cotton	18516
Ruchi	Indian	Gambella	Soybean	25000
CLC (Spentex)	Indian	B/Gumuz and Amhara	Cotton	25000
Huana Dafengyuan	China	Gambella	Sugar cane	25000
BHO	Indian	Gambella	Edible oil crops	27000
Shmporji	Indian	B/Gumuz	Pongamia (biofuel)	50000
Karuturi agro-products	Indian	Gambella	Palm cereals, rice and sugar cane	100000

Source: Agricultural Investment Support Directorate under MoA, 2011.

According to these data, Ethiopian and diaspora investors generally acquire land for growing cotton, grains, and horticultural and oil crops, while foreign investors also plan to grow rice, vegetables, flowers, sugar cane and other biofuels. To date none of the agreements at national level have been for growing feed for livestock. However, representatives of the US based Cargill (the world's largest agribusiness) have reportedly been in Ethiopia, scouting for locations for future feed grain production (MacDonald and Simon, 2011). FDI in biofuel has increased rapidly since 2006, and now represents up to 50% of FDI at the national level. Cotton is projected to be grown on up to 25% of the leased land, while food crops including edible oils cover the remaining area.

FDI at the regional level

Until the new FDI directive in 2009, and still in cases in which land area is less than 5000 ha, the regional governments have the authority to lease land without involvement of the federal government, and thus many more lease agreements are made at the regional than at the national level. Weissleder (2009) lists Oromia (especially for flori/horticulture production), Amhara, and SNNPR (Southern Nations, Nationalities, and Peoples Region) as the main FDI regions. Since 2009, the Gambella and Beneshangul Gumuz regions have also become the target of large-scale investment. In order to develop a better understanding of leases at the regional level, we interviewed authorities (at the Amhara Regional Trade and Investment Office in Bahir Dar, and the Oromia Regional Investment Office in Addis Ababa), and collected documentation in Amhara and Oromia and to some extent also from Beneshangul Gumuz, while information from Gambella and SNNP came only from the national registry. While the data collected reflect the major trends in FDI, we would like to caution that they are subject to multiple sources of error. For example, important FDI in agricultural land also takes place under the umbrella of other agreements, such as leases to national companies that sublease to foreign investors. The leases described below for the Amhara and Oromia regions represent the leases that have been granted since 2008/2009. A few agreements also date back to as early as 1997/1998.

The Amhara region comprises about 170,752 km^2 or about 15.5% of Ethiopia's total area (Adenew and Abdi, 2005; BoWR, 2005), including significant parts of the Ethiopian highlands and Lake Tana, such that 46% of the Amhara region discharges into the Blue Nile. Rugged mountains, valleys and gorges characterise the landscape with elevations ranging from 700 to 4600 metres above sea level (masl). The land use of the region is classified as 28% arable land, 30% pastureland, 2.1% forested land, 12.6% bushland, 7.2% settlement, 3.8% water bodies and 16.2% marginal land (BoA, 1999). The agro-climatic zones include cold (above 2300 masl), humid and semi-humid (2300-1500 masl) and arid and semi-arid (below 1500 masl) (Adenew and Abdi, 2005). The mean annual rainfall recorded in the region is in the range of 770 mm to 1660 mm (Bewket and Conway, 2007).

According to the regional investment office, 174,400 ha of land in Amhara have been leased for different types of agricultural activities, including unspecified crop production, oil seeds, agro-industry, vegetables and fruits, forestry, special seeds, livestock and animal feed production, horticulture, and cotton production.

Of the 960 land leases in the Amhara region, only three are to foreign investors (covering 25% of the total area leased), while the remainder is to diaspora or domestic investors as shown in table 2. Ninety nine percent of the investment projects (all domestic or diaspora) have a size of less than 1000 ha, and 63% of the investment projects have a size less than, or equal to, 100 ha. A Saudi and an Indian investor hold the three biggest investment projects.

Oromia comprises about 363,000 km^2 (ONRS, 2011), or almost 33% of the total area of the country (ONRS, 2011), with extensive ranges of mountains, plateaus, hills, plains, gorges and valleys (MoA, 2011) with elevations ranging from 420 to 4370 masl, while 31% of the Oromia region discharges into the Blue Nile. Oromia also drains into the Awash, Gibe, and Didessa rivers. The region has three broad agro-ecological zones; 7.7% is cold, 42% of the land is humid and semi-humid and 51% of the land is arid and semi-arid. The average annual rainfall of the region varies between 200 mm and 2600 mm (MoA, 2011). The total land size of the region is 363,000 km^2. The region has large cultivable and irrigable land, huge water resources and rich mineral resources (MoA, 2011). Agricultural land area in Oromia is estimated to be 29.5%, grassland, forest, woodland, and bushland account for 69.5%, water bodies and wetlands, and settlements are less than 1% (Terefa et al., 2002).

Table 2. Investment type and size coverage in the Amhara region.

Investment type	Land leased		Percentage share	
	No. of projects	Area (ha)	Projects	Area
Domestic/Diaspora	957	132,000	99.7	76
Foreign	3	42,000	<1	24

Source: Amhara Regional State Environmental Protection Land Use and Administration Authority (EPLAUA), 2011.

Oromia produces most of the exports for the country such as coffee and horticulture and other forest products. The Oromia region investment office reports about 1000 foreign and 2750 domestic leases, the single largest domestic lease being for bio-diesel production (Green Energy Plc. in West Harerge). Unlike Amhara regional or national leases, where FDI tended to be the largest size leases, 94% of the FDI in Oromia are of less than 1000 ha. This reflects the dominance of FDI in horticultural farms near Addis Ababa for production of flowers, herbs and strawberries, etc. However, also in Oromia the few large (1000-5000 ha) and very large (>5000 ha) leases represent the vast majority of the leased area, i.e. 96%, with FDI accounting for 91%, i.e. 1.4 million ha, of the land leases as shown in table 3.

Table 3. Investment type and size coverage in the Oromia region.*

Investment type	Land leased		Percentage share	
	No. of projects	Area (ha)	Projects	Area
Domestic/Diaspora	724 (2750)	150,000	73	9
Foreign	891 (1001)	1,400,000	27	91

* Table includes data from 891 FDI leases (out of a total of 1001) and 724 domestic leases (out of a total of 2750) for which information on land size was recorded.

Source: ONRS, 2011.

The Gambella region, covering about 32,033 km^2 (GRS, 2001) or about 3% of Ethiopia's total area and comprising relatively swampy lowlands, is dominated by pastoralists, with an altitude range of 410 to 2300 masl. The Gambella region drains into the Baro-Akobo rivers and eventually into the White Nile. The average rainfall ranges from 463 mm to 2500 mm (MoA, 2011). The greater part of the Gambella region is covered by woodland and grassland which account for 36.4% and 30.3%, respectively, of the region. Cultivated land, forest, shrubland, swamp and other land use types cover 3.4, 16.7, 4.6, 7.7 and 0.9%, respectively, of the region (GRS, 2001). Gambella is considered to have very high agricultural potential. According to the federal government 200,000 ha of land have been leased to foreign investors – 165,000 to Indian investors – see table 1. Rowden (2011) has summarised the details of these contracts as shown in table 4. MoA (2011) and Pearce (2011) report 400,000 ha of land (large parts of which are located in the Gambella National Park) have been leased or declared to be leased to foreign investors. The major land cover types of the allocated investment areas are open woodland, with scattered villages, swampy grassland and shrubland.

The Beneshangul Gumuz region comprises about 50,336 km^2 (BGS, 2003) or about 4.6% of Ethiopia's total area while 23% of the Beneshangul Gumuz region discharges into the Blue Nile. Small parts of the region also drain directly into Sudan and join the Blue Nile below the Roseries dam. The agro-ecology of Benshangul Gumuz comprises 75% of wet lowland, 24% of midaltitude land and 1% of high-altitude land. The average annual rainfall is between about 860 mm and 1275 mm (MoA, 2011). The region is suitable for the production of both high-value and cereal crops. The irrigable part of the region near the Beles watershed and the Dabus river is suitable for fruits and sugar cane (MoA, 2011). According to the federal government, close to 100,000 ha of land have been leased with 78,000 ha to foreign and diaspora investors (see table 1).

Table 4. Features of disclosed contracts with Indian agricultural companies in Ethiopia, all located in the Gambela region.

Company	Crops	Land area (ha)	Term (years)
BHO Bio Products Plc.	Cereal, pulses, edible oils	27,000	25
Karuturi Ago Products Plc.	Palm, cereals, pulses	100,000*	50
Ruchi Agri Plc.	Soya beans	25,000	25
Sannati Agro Farm Enterprise Pvt. Ltd.	Rice, pulses, cereals	10,000	25
Verdanta Harvests Plc.	Tea, spices	3,012	50

Source: Rowden, 2011. * with option for 200,000 ha more.

The SNNPR (Southern Nations, Nationalities, and Peoples Region) comprises about 107,403 km^2 (SNNPR, 2001) or about 9.7% of Ethiopia's total area. The land cover in SNNPR is classified into 34.7% cultivated land, 23.3% shrubland, 16.4% grassland, 13.3% woodland, 8.3% forest, 1.5% water bodies and the remaining 2.5% other land use types (SNNPR, 2001). It drains into the Omo, Weyto and Bilate rivers. The agro-ecological zone in SNNPR is classified into 49.8% arid and semi-arid, 36.8% semi-humid and 6.5% humid zones, and the mean annual rainfall ranges from 400 to 2400 mm (Waktola, 1999). Nine of the 24 investments reported by the federal government – see table 1 – are from SNNPR, five of them (amounting to 23,000 ha) being with foreign or diaspora investors.

Uncertainties with the data

We obtained information on leases through interviews with, and documents provided by, different institutions at the federal and regional level, but we did not do any ground-truthing of individual investment projects. National FDI data were kindly provided by the Agriculture Investment Support Directorate under the Ministry of Agriculture. Additional regional FDI data were obtained from the Amhara and Oromia Regional Investment Offices. While the national data could be verified project-by-project directly from the contract documents, information from the regional investment offices was limited to their respective databases, which did not include all contract documents.

As such, we provide an upper limit of potential FDI impacts on water resources by including all lease contracts that we could confirm from official sources, rather than only projects that are already operational. For example, projects in the Oromia regional database have been classified into 'operational', 'under construction', 'pre-implementation', 'not implemented', 'not reported', and 'abandoned' and some of them have no status ('not mentioned'). Investments that are listed as 'abandoned' and 'not implemented' were not considered in our analysis. We did however include projects from the categories 'not reported' and 'not mentioned'. Thus, there may be some overestimation in our numbers. There may also be underestimation in the case of Beneshangul Gumuz and Gambella as our data do not include leases from these regions prior to 2009 or from the establishment of the Agricultural Investment Support Directorate within the Ministry of Agriculture.

The model-based water analysis (see below) was performed on national FDI data from the Agricultural Investment Support Directorate, which is reliable, but comes without information on the status of implementation. The general understanding from the contract documents is that the lessee shall develop half of the leased land within the first year from the date of signing the contract or from the date of receipt of all the clearances, and the entire plot of leased land shall be developed within a period of not more than 2 years starting from the date of signing, though they may not all proceed that rapidly.

FDI LEASES AND WATER RIGHTS IN ETHIOPIA

Characteristics of lease agreements

Foreign investors can only lease land – typically for 25-50 years – but cannot buy the land (see e.g. land rental agreements available from the Ethiopian Ministry of Agriculture and Rural Development). Foreign investors are generally exempt from taxes on imports of capital goods and from taxes on repatriated profits. The very low land rents (often guaranteed for long periods) are justified by the Ethiopian government by the need for incentives to make up for the lack of infrastructure and non-availability of skilled labour.

Land lease rates depend on location relative to the capital city and other outlets for export products (such as Djibouti or Port Sudan). For each kilometre closer to Addis Ababa, the lease rate increases by about US$0.25 per hectare per year (Access Capital, 2010), allowing lease rates of up to US$150 per hectare per year close to Addis Ababa. The investments made by Karuturi Agro-products plc. and Saudi Star were granted at exceptionally low prices, i.e. US$1.15 per hectare per year for Saudi Star.

Proximity to water sources and availability of irrigation also increase the lease rate (Rahmatora, 2011). From the national-level data that we analyzed, it seems that most leases are for irrigable land, and it can be inferred that lease rents are generally higher for projects where irrigation is likely, or some irrigation infrastructure already exists, than for rain-fed projects. For land located about 700 km away from Addis Ababa, the investor has to pay about US$6.30 per hectare per year for rain-fed agricultural land, and about US$9.10 for irrigable land (Access Capital, 2010). So there is recognition in the lease rates that FDI is drawing upon local water resources, although proximity to Addis Ababa and other export outlets is given higher value in leases than irrigation potential. Generally, land lease rents range from about US$1 to US$40 per ha per year, and the most common rate in leases by national agencies is about US$9 per ha per year. These are among the cheapest rates in the world, e.g. compared to US$350-800 per ha per year on average across Africa (Access Capital, 2010).

Foreign investors are required to take good care of, and conserve, the leased land and other natural resources affected (see e.g. Social and Environmental Code of Practice, Ethiopian Ministry of Agriculture). The standard FDI lease agreement has the following clauses related to water: "[t]he lessee has the right to build infrastructure such as dams, water boreholes irrigation system at the discretion of the lessee upon consultation and submission of permit request with concerned authorities, subject to the type and size of the investment property whenever it deems so appropriate".

The Ethiopian Water Resources Management Proclamation, 2005 (available from the Ethiopian Investment Agency) states that all water resources of the country are the common property of the Ethiopian people and the state. Domestic [municipal] use shall have priority over and above any other water uses. A permit is required to construct waterworks and to abstract water. Permits will be issued only if the proposed water use does not infringe, in any manner, on any person’s legitimate interests upon the water.

So in principle regulation and legislation are in place to ensure sustainable use of water and avoid 'water grabbing', i.e. negative effects of FDI for other water users and their formal or informal and customary water rights, including environmental water requirements. But the implementation of these laws is very weak (Mousseau and Sosnoff, 2011), and the lease agreements permit the development and use of surface and subsurface water without any precondition. Hence, land rights are implicitly also water rights.

CHANGE IN WATER REQUIREMENTS UNDER FDI

To quantify the FDI effects on water resources, we began our analysis with already licensed land lease agreements with foreign investors at the national level as obtained from the Ethiopian Agricultural Portal of the Federal Investment Authority presented in table 1. A subset of these agreements located in seven different districts of the Gambella, Beneshangul Gumuz and SNNPR regions, was used to calculate potential water use changes associated with land use change under these agreements (for location see figure 1). We estimated current or pre-lease annual consumptive water use (i.e. evapotranspiration) and post-lease implementation water use using the FAO CROPWAT model (v.4.3) (FAO, 1998). Data requirements for the model included the location, crop type to be grown and the total area of land leased obtained from the lease agreements as shown in table 5; current or pre-lease land use/land cover in the study districts derived from overlaying the land use/land cover map with the district map in GIS environment; coverage of the different soil types in the district determined by overlaying the administrative map with the soil map (FAO, 1997), and average monthly weather data including ET_0 and rainfall estimated using the FAO NewLocClim (Grieser et al., 2006) for the centre of each district. A number of assumptions about both current and future land use had to be made to approximate the change in land use that would result from FDI.

Table 5. Origin of the investor, the total area of land leased and the planned crop type for the foreign investments used in the water use change analysis.

Region	District	Origin of investor	Area (ha)	Planned crop
Gambela	Abobo	Saudi	10,000	Rice
Gambela	Goge	Indian	25,000	Soybean
Gambela	Itang	Indian	27,000	Edible oil crops, cereals and pulses (sesame, sorghum, soybean)
B/Gumaz	Dangur	Ethiopian	5000	Cotton/Soybean
B/Gumuz	Guba	Diaspora	3000	Oil crops (e.g. Sesame/castor bean)
B/Gumuz	Pawe	Indian	25,000	Cotton
Southern Nations (SNNP)	Hamer (and Jawi)	Diaspora	2137	Cotton and grain (maize)

Source: Agricultural Investment Support Directorate under the Ministry of Agriculture and Rural Development, 2011.

Current or pre-lease land use was determined based on existing land use maps. With the exception of Hamer, grassland is the major pre-lease/current land use/land cover type in the study districts (as shown in table 6), often used for grazing and communally held. Our assumption was that these 'undeveloped' grasslands are the most likely areas to be converted to commercial farms in all the districts. Consequently, the current annual water use was estimated using the Crop Water Requirement (CWR) estimated for the growing season of the grass (under extensive grazing), and the evapotranspiration loss during the off-seasons. For grass, the growing season was about 3.5 months in all the districts. The dates at which the effective rainfall was equivalent to ETo, which corresponds to the time when the soil moisture would be enough to trigger growth of grass was considered as the beginning of the growing season. Crop coefficient (Kc) values for extensive grazing (0.30, 0.75 and 0.75 from FAO) were considered for the initial, middle and end of the growing stages of the grass. The evapotranspiration during the off-season was estimated taking a Kc value for bare land (Kc = 0.15) since the land may remain only partly covered by dead and dry grass that is often burned off during the dry season.

Table 6. Relative coverage (%) of existing land use types in the selected districts.

Districts	Grass-land	Culti-vation	Shrub-land	Wood-land	Forest	Swamps	Alpine vegetation
Abobo	39	0	0	38	0	9.1	14.3
Goge	87.1	0	0	6.4	0	3.1	3.4
Itang	77.2	0	0	11.7	0	11.1	0
Dangur	84.0	8.1	7.7	0		0	0
Guba	90.2	0	6.7	3.1	0	0	0
Pawe	45.2	10.5	36	0	0	0	0
Hamer*	4.1	0	40.8	3.9	0	0	0

Source: MoA, 2004. *51% of the district is 'barren land'.

To estimate land use change and associated additional water use due to the investment, we used information provided by the lease agreements about the types of crops to be grown (table 5). There was usually no, or only indirect, information on the management practices to be used, such as number of crops per year or whether irrigation would be practised. Therefore, two scenarios were used to estimate the CWR of the new projects:

- Scenario I: growing of one rain-fed crop per year during the rainy season
- Scenario II: growing one rain-fed crop during the rainy season followed by one irrigated crop during the off-season

The consumptive water use for Scenario I was the sum of CWR during the growing season estimated using the corresponding Kc values of the suggested crop and the evapotranspiration loss during the off-seasons. Similarly, the consumptive water use of Scenario II was the sum of the CWR of the rain-fed crop plus CWR of irrigated crops and the off-season evapotranspiration loss. Some of the projects indicate that more than one crop would be grown, but it is not clear if they are grown sequentially or in parallel. Therefore, it was assumed that long-duration crops would be rotated with short-duration ones.

Results presented in table 7 show that significant increases in evapotranspiration are predicted in all seven cases. Even with a shift only from rain-fed grasses to a single rain-fed crop, increase in water use is likely to be between 6% and almost 90% depending on the climate and cropping choice. If irrigation is developed and two crops per year grown, the increase in water use on site is predicted to be between 85 and 275%.

Estimate of maximum and minimum additional consumptive water use by all reported FDI licences in Ethiopia

This analysis is based on the calculations of crop water use and possible irrigation requirements at the seven sites conducted using CROPWAT presented above. In this analysis the calculated maximum and minimum changes in evapotranspiration (for the 7 sites) were extrapolated to estimate the range in total possible water use in FDI schemes throughout Ethiopia. The analyses were done for both Scenario-I (i.e. only one rain-fed crop grown during the rainy season) and Scenario-II (i.e. one rain-fed crop during the rainy season followed by one irrigated crop during the off-season). Because the total area of FDI in Ethiopia is not known exactly, the calculations were repeated for different total FDI areas, ranging from the lowest estimate of 390,000 ha to the highest estimate of 3.6 million ha. This is a very crude estimation of water consumption that does not make allowance for differences in climate, differences in the crops grown or differences in water management practices in different FDI schemes across the country. Nevertheless, it provides a first back-of-the-envelope estimate of the possible upper and lower bound of additional water consumption from the currently licensed FDI schemes in Ethiopia.

Table 7. Estimated CWR (mm) of the current/pre-lease and planned land use types under FDI.

	Current CWR (mm)			Future water requirement (mm)								
	Rain-fed grass land			Scenario I			Scenario II				Change (%)	
District	Growing season	Off-season	Total	Growing season (R)	Off-season	Total	Irrigated (I)	R+I	Off-season	Total	Scenario I	Scenario II
Abobo	316	185	501	791	144	935	1033	1824	53	1877	87	275
Goge	240	151	391	420	128	548	446	866	66	932	40	138
Itang	294	179	473	386	184	570	476	862	96	958	21	103
Dangur	252	148	400	539	111	650	549	1088	25	1113	63	178
Guba	361	246	607	392	250	642	506	898	227	1125	6	85
Pawe	233	153	386	540	112	652	495	1035	52	1087	69	182
Hamer	294	141	435	424	116	540	638	1062	24	1086	24	150

Source: Estimates based on scenarios and CROPWAT analysis described above.

The results are presented in table 8. As would be expected both the total potential area of FDI and whether or not irrigation is applied make a significant difference to the amount of additional water consumed. The additional water consumed is water 'lost' from the system as a consequence of evapotranspiration over and above that evapotranspired under current land use. Based on our best estimate of the area of currently licensed FDI schemes (i.e. 1.76 million ha) the range in water consumption is from 0.6 billion cubic metres (Bm^3) (i.e. all rain-fed and only a marginal change in evapotranspiration – based on the minimum additional water use found in Scenario I cases presented in table 7) to 24.2 Bm^3 (i.e. all irrigated and significant change in evapotranspiration – based on the maximum additional water use found in Scenario II cases presented in table 7). To put these estimates in context and assuming that changes in evapotranspiration will translate directly into changes in river flows (not necessarily true) these figures represent 0.5 and 19% of Ethiopia's total national mean annual flow (125 Bm^3). The minimum additional water consumption for the currently licensed FDI irrigated scenario (II) at 8.5 Bm^3 is greater than estimates of current total annual irrigation water use of 5.2 Bm^3 (FAO Aquastat, 2011), while the maximum is almost five times the current use. If irrigation intensity is even higher than in our scenario II, i.e. more than one irrigated crop per year, water use would be even higher. In reality, the total additional consumption of water by all FDI schemes when operational will probably lie somewhere between the estimated figures. However, what is certain is that if planned FDI schemes are implemented and expand greatly in the near future, consumption is likely to be comparable with existing irrigation water use in non-FDI schemes and a non-trivial proportion of the country's water resources will be effectively utilised by non-national entities.

Table 8. Estimated maximum and minimum additional water consumption for different scenarios and different areas of FDI schemes across Ethiopia, based on largest and smallest changes found in seven sites, and greatest to least estimates of FDI land areas.

	3.6 million ha		1.76 million ha		0.39 million ha	
	Scenario-I	Scenario-II	Scenario-I	Scenario-II	Scenario-I	Scenario-II
Maximum (Bm^3)	15.6	49.5	7.6	24.2	1.7	5.4
Minimum (Bm^3)	1.3	17.5	0.6	8.5	0.1	1.9

Estimate of maximum and minimum additional water consumption by confirmed FDI schemes in the upper Blue Nile Basin

There are 12 large-scale foreign investments in the Upper Blue Nile basin that could be confirmed from the regional or the federal investment authorities. The investments are taking place in six out of 17 Blue Nile sub-basins – see figure 1 – and they vary in their size and project description. The overall land acquisition associated with confirmed licences amounts up to 138,961 ha which represents about 0.7% of the total area of the Upper Blue Nile basin (Awulachew et al., 2007). Many investors plan to grow cereals (wheat, maize and sorghum), cotton, sesame or soybean. One investor wants to develop a 50,000 ha project of *Pongamia pinnata*, a legume tree that can be used as feedstock for biodiesel. Repeating the analysis described above for these 12 cases, as presented in table 9, shows the possible additional water use in FDI schemes throughout the Upper Blue Nile basin, ranging from a low of 0.05 billion cubic metres per year (Bm^3/yr) in the minimal rain-fed scenario to 1.9 Bm^3/yr in the maximum irrigated scenario. In the Blue Nile, it is estimated that formal irrigation currently covers less than 20,000 ha with withdrawals of only about 0.26 Bm^3/yr (McCartney et al., in press). This is an underestimate of irrigation withdrawals, because small-scale informal irrigation occurs in many places but is not mapped and withdrawals are unknown. Nevertheless, the total withdrawals for irrigation are widely accepted to be negligible in comparison with the mean annual flow of the Blue Nile at the border with Sudan (i.e. 46 Bm^3/yr).

Government-planned formal irrigation development, as defined by the basin master plan (some of which may be replaced by FDI or may include FDI) is for 461,000 ha (out of a total potential of 815,881 ha) in the medium to the long-term future. It is estimated that this would require on average 3.8 Bm^3/yr of water withdrawals (McCartney et al., in press). If irrigation is developed on all land with confirmed FDI licences (138,961 ha) a sevenfold increase in formal irrigated area would result, with correspondingly higher irrigation withdrawals. This is approximately 30% of the government-planned formal irrigation, and 4% of mean annual flow of the Blue Nile.

Table 9. Estimated maximum and minimum additional annual water consumption for the area of FDI schemes in the Upper Blue Nile basin.

	Area of confirmed FDI licences ~140,000 ha	
	Scenario-I	Scenario-II
Maximum (Bm^3/yr)	0.60	1.91
Minimum (Bm^3/yr)	0.05	0.67

Estimate of maximum and minimum change in run-off in the Dinder sub-basin of the Blue Nile basin, from FDI schemes

Estimated changes in evapotranspiration for schemes located in the Dinder sub-basin were used to evaluate the possible implications for flow for both Scenario-I and Scenario-II. As with the countrywide analyses the assumption made was that an increase in evapotranspiration will translate directly into a reduction in river flows. The results, as presented in table 10, indicate that if both schemes are rain-fed only (i.e. Scenario-I) the total reduction in mean annual flow from the catchment will be approximately 0.5%. However, if both schemes are irrigated (i.e. Scenario-II), the reduction in mean annual run-off is likely to be closer to 2%. Although these numbers may appear small, they are misleading because these calculations have made no allowance for temporal variations in flow. The run-off reduction due to rain-fed agriculture will be primarily in the rainy season when flows are high. However, if irrigation is used, water abstractions will occur during the dry season, when flows are significantly lower. If irrigation water was withdrawn between January and May, when flows are lowest, the reduction in flow would be 9.6% of the total mean flow in these months, with possibly severe consequences for downstream water users and aquatic ecosystems.

Table 10. Estimated change in mean annual run-off from the Dinder sub-basin* as a consequence of known FDI schemes located in the basin.

District	Area leased (ha)	Current evapotranspiration		Additional water consumption Mm^3		% Reduction in flow	
		mm	Mm^3	Scenario-I	Scenario-II	Scenario-I	Scenario-II
Dangur	5000	400	20	32.5	55.7	0.48	1.36
Guba	3000	607	18.2	19.3	33.8	0.04	0.59
Total						0.52	1.95

*Note that the Dinder river is a tributary that joins the Blue Nile river in Sudan. Consequently, in Ethiopia it is classified as a sub-basin of the Blue Nile, even though it actually lies outside the portion of the Blue Nile (Abbay) basin in Ethiopia.

Beyond quantities – Local level impact on water use and services from FDI

The controversy over water use in FDI is not only about quantities of water, but rather about potential harm to traditional users, and how this may occur through foreign investment. Here we summarise two case studies that explore the complex nature of the interaction between foreign and local users of water that goes beyond quantities.

Case 1. Intensive irrigation development by Saudi Star in the Gambela region for rice production increases agricultural water extraction from the Alwero river

Saudi Star has leased 10,000 ha in Gambela for rice production for export (table 1). This is an example of intensive high capital irrigation development that will divert water from a river that currently supports multiple livelihood functions, as well as valuable ecosystems.

This land was used for maize production using shifting cultivation techniques and some was forest land providing different forms of ecosystem services, such as food, fuel wood and medicine for the local community (Mousseau and Sosnoff, 2011). The leased area is near the Alwero river, a tributary in the Baro-Akobo basin system which ultimately flows into the White Nile in Sudan.

With part of the land concession (1800 ha) Saudi Star will use water from a dam on the Alwero river, which can store 74 million cubic metres of water. The dam can provide irrigation water for more than 10,000 ha of land (Rahmatora, 1999; Awulachew et al., 2007), but this area was not originally intended for the planned cotton plantation. Mousseau and Sosnoff (2011) reported that Saudi Star plans to build a 30 km cement canal to transfer water from the Alwero dam to the fields, and to build an additional dam on the Alwero to abstract even more water from the river. Saudi Star plans to use specialised techniques that increase the consumption efficiency of rice (Mousseau and Sosnoff, 2011). The additional water use from the Saudi Star land lease may amount to 0.14 Bm^3/yr according to our calculations of ET change in scenario 2 multiplied by 10,000 ha. That is only a small fraction of the total annual discharge of the Alwero river but could have significant local livelihood and ecosystem effects.

The Alwero river has traditionally been used by local communities for fishing, transportation, water supply, and for agricultural practices. Irrigation water abstractions may reduce the river flow at critical times which, in turn, may affect the activities of the local community as well as the river's aquatic ecosystems. It is also thought that Saudi Star has cleared some parts of the Gambella National Park (Mousseau and Sosnoff, 2011), though this is not certain because this protected area does not have a well-defined boundary. If so, it may be that wetlands with abundant fish populations and bird life are presently being altered due to the rice production by Saudi Star.

Case 2. Intensification of water use and groundwater exploitation through entry of foreign investors into an existing small-scale irrigation scheme resulting in degradation of informal water rights to the local population in Oromia

In this case, documented by Bues (2011) and developed by Bues and Theesfeld (this issue), water-sharing in a small-scale irrigation scheme between local farmers and foreign investors resulted in conflict over water and significant change in institutional water rights and informal water rights to the benefit of foreign investors who had better bargaining power and the support of government.

The irrigation scheme is situated in the central highlands of Ethiopia. The average annual rainfall is 815 mm, and the temperature ranges from 10.5 to 25.4 ^{o}C (Girma and Awulachew, 2007). The scheme was built in the 1980s, the original objective being to establish state-owned horticultural farms with a corresponding 1600 ha of irrigation. Only 500 ha were realised, and a state-owned farm was installed to produce vegetables and fruits. This farm was only operational for a few years, after which the land was partly given to smallholders, the rest remaining unused. Around 2005, the government allocated approximately 140 ha to floricultural and horticultural investors, both from the area of the former state farm and also from local farmers, who were granted compensation.

Since the arrival of the investment farms in the area, canal water has been shared among both. The water flows into the primary canal leading southwards to local farmers and nine floricultural and horticultural farms that are located adjacent to the canal. Out of these, six are operational, while three are not fully operational due to financial difficulties. Five out of the nine farms are entirely owned by foreign investors from the Netherlands (two), Israel (one), the Palestinian Territories (one), and China (one). Two of the farms are organised as joint ventures between Ethiopian and foreign investors (Russian/Ethiopian and Israeli/Ethiopian), and two farms are completely Ethiopian. The average farm size is 20 ha. The nine farms were allocated land from the former state farm and from local farmers.

The flori/horticultural farms irrigate their greenhouses and open fields throughout the year. Water needs for irrigation and operation of farm activities are met by borehole-extracted groundwater and, to a lesser degree by canal water. Operations are significantly capitalised, including drip or spray irrigation, computer-driven water regulation for humidity control in greenhouses, and often water recycling systems. In contrast, local farmers use irrigation water primarily during the dry season for production of onion, tomato, potato and chickpea using flood and furrow irrigation and, unlike the flori/horticultural farms, are entirely dependent on canal water.

The establishment of these new floricultural and horticultural farms in Dhandhamma and Filtinno communities resulted in changes in water withdrawal rights due to rescheduling of canal water withdrawals and new pricing systems for irrigation water as well as through changed land rights. These changes disadvantaged local farmers. The main reason for this outcome was power asymmetries, in particular stronger governmental support for the foreign investors than for the local farmers.

CONCLUSIONS

Sustainable agricultural intensification is urgently required in Ethiopia, given the low productivity of water and land resources and, at the same time, the dire situation of the poor in terms of water and food security. Agricultural development that is equitable and locally appropriate is needed to improve local and national food security now and into the future. For that development and intensification, additional investment in agricultural land and water management is of paramount importance. The Government of Ethiopia has plans for significant expansion of irrigated area to improve production of food and biofuels and increase productivity of land, as part of overall plans to escalate economic development.

FDI is rapidly growing in response to a number of global drivers and incentives from the Government of Ethiopia and could in principle bring benefit (improved technologies, innovation, increased productivity, market access, etc) to local populations. Current leasing arrangements do not give any special attention to the acquisition of water or to local water scarcity, but implicitly encourage development of water resources with agricultural intensification. And while legislation is in place to regulate FDI in order to share benefits with local populations and minimise negative social and environmental impacts, it is not clear that these are sufficiently enforced. The case studies presented here and in a recent paper by Lavers (2011) "raise doubts about the government's ability to manage investment to combine the objectives of increasing production with equitable growth and security for smallholders".

We have quantified potential water use impacts for selected FDIs and used two different scenarios of agricultural intensification (rain-fed and irrigated) to extrapolate to the country and Blue Nile basin the potential additional water use associated with FDI. At the national scale we use 1.7 million ha as best estimate of currently granted FDI licences by national and regional governments (Amhara and Oromia). Based on this estimate we found that at the national scale the additional water use by foreign entities may constitute a non-trivial portion of the nation's water resources if current licences are fully implemented. Minimum additional water consumption for the currently licensed FDI irrigated scenario (II) at 8.5 Bm^3 is greater than current total annual irrigation water use of 5.2 Bm^3 (FAO Aquastat, 2011), while the maximum is almost five times the current use.

In the Blue Nile basin we estimated water use based on 12 confirmed projects, thus these are no longer 'potential'. If irrigation is developed for all 138,961 ha of current FDI, our estimates represent a sevenfold increase in formal irrigated area, and potential irrigation withdrawals. This is approximately 30% of the government-planned formal irrigation, and 4% of the mean annual flow of the Blue Nile. Again, a non-trivial result. In addition we estimated the potential impact of FDI on river flow in a sub-basin of the Blue Nile. We found that two schemes in the Dinder sub-basin, if irrigated, could reduce mean annual river flow by 2%, but the impact would be much greater in the low-flow season when irrigation would divert approximately 10% of the mean dry season flow. .

In evaluating the implications for water availability, the scale of assessment is important. At the basin or sub-basin scale changes in land use within a single scheme will, for the most part, be relatively small compared to the area of the basin (e.g. even a 50,000 ha scheme is small in a 40,000 km^2 basin). Hence, at this scale the impacts of a single scheme on mean annual run-off are not likely to be great. However, as our analysis demonstrates, the cumulative impacts of many investment schemes, particularly at specific times of the year (i.e. during the dry season), will be much greater.

We have further shown that the water-related impacts of a single FDI scheme at the local scale can be severe for customary water users as well as for the environment. These impacts arise from complex interactions between existing systems and new schemes related to land and water rights, and changes in water availability. In general, greater power to capture and exploit resources by foreign investors who have access to large amounts of capital to invest and/or greater political power and support of the government can result in appropriation of water away from traditional users, despite rules and regulations that aim to protect them, as exemplified in the study by Bues (2011). The underlying policy and institutional environment that allows this to occur needs further attention.

In this paper, we have not characterised the specific impact on people's livelihoods and production that might arise from this appropriation of water. However, the potential significance of the water appropriation that we have estimated indicates a strong need to further explore what livelihoods impacts there might be.

Nor have we explored the potential compensatory benefits to local peoples that might arise from these developments. For example, the CEO of Saudi Star, Haile Assegide, said in an interview (18 March 2011) that their investment strategy would include reduced mechanisation – integrating a mix of labour and capital – that will result in more job creation than would an intensive mechanisation strategy. With this strategy, Saudi Star plans to employ 4000 to 5000 seasonal labourers for every 100,000 hectares under production (Mousseau and Sosnoff, 2011), and they pay about US$3 per day for their labourers, which is three to four times higher than the normal rate in the local area (Mousseau and Sosnoff, 2011). Saudi Star has also pledged to engage in infrastructural development in the district, which may result in a variety of benefits to the local population. It is still controversial however, whether job creation will compensate for lost livelihoods. As asserted by Abbink (2011):

> [a]ccording to the recent World Bank study, 2010, the job creation rate of the new schemes so far is extremely limited: for the cases where information was given it was only 0.0005 job per ha (World Bank, 2010). So most likely the schemes will likely not create many jobs, certainly not in replacement of jobs lost by locals because of land alienation or dispossession.

While the effects of FDI on local livelihoods and jobs, and even on domestic water availability, remain to be explored in other studies, the results of our simulations in terms of additional water use, in combination with information about low current crop yields in Ethiopia, suggest that agricultural investments can, and should, be designed with improved rain-fed and irrigated agricultural water productivities in mind (Hoff et al., 2012).

An additional aspect we have not been able to explore in this paper is the time frame related to these developments. While there has been an exponential rise in leases and licences over the past few years, most of the large-scale developments tend to start on much smaller areas, planning to expand over time. Thus there may be 10 years or more before the existing plans are fully implemented.

The preliminary findings and results presented here have highlighted the very high level of uncertainty surrounding FDI. A whole list of factors are uncertain, including the actual leases and leased areas, the implementation status of any licences, the specific location of planned developments, the crops to be grown, and the production and management practices to be employed. Consequently, our estimates of water consumption are also very uncertain. To develop more detailed quantified FDI water use estimates, and to develop an understanding of the time frame within which impacts will occur and their livelihood impacts, much more comprehensive and detailed cataloguing of lease details and their status is needed. This must include more information on planned water management practices, and address such issues as the variability of water supply in space and time when rainfall is highly seasonal.

Our very preliminary findings of this study demonstrate that water use impacts of current FDI at the national, basin, and local scale are potentially non-trivial, so that the narrative of 'economic water scarcity' or abundant untapped water resources needs to be re-evaluated while water appropriation needs to be a strong consideration in FDI.

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