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Foreign Agricultural Land Acquisition and the Visibility of Water Resource Impacts in Sub-Saharan Africa

Philip Woodhouse
University of Manchester, UK; phil.woodhouse@manchester.ac.uk

ABSTRACT: The many headlines focusing on 'land grabbing' have distracted attention from the role that access to water plays in underpinning the projected productivity of foreign direct investment in acquisition of agricultural land in developing countries. This paper identifies questions that arise about the explicit and implicit water requirements for irrigation in agricultural projects on land that is subject to such foreign investment deals. It focuses particularly on land acquisition in sub-Saharan Africa (SSA), where, for savanna ecosystems that cover some two thirds of the region, rainfall uncertainty is the principal constraint to increased agricultural productivity. The paper argues that, even where land acquisition deals do not specify irrigation, choice of location and/or crop type indicates this is invariably an implicit requirement of projects. It is arguable that private investment in water infrastructure (e.g. for water storage) could provide wider benefits to neighbouring small-scale producers, thus reducing the risk inherent in much of African agriculture. However, it is also possible that foreign investment may compete with existing water use, and some land deals have included provisions for priority access to water in cases of scarcity. Empirical studies are used to identify the mechanisms through which large-scale land investments influence water availability for smaller-scale land users. The paper concludes that, although effects on water resources may constitute one of the main impacts of land deals, this is likely to be obscured by the lack of transparency over water requirements of agricultural projects and the invisibility of much existing local agricultural water management to government planning agencies.

KEYWORDS: Agriculture, land tenure, land grabbing, irrigation, Africa

INTRODUCTION: 'LAND GRAB' AND WATER REQUIREMENTS

Availability of adequate moisture is a fundamental requirement for agricultural use of land. Designation of exclusive rights to use land provides prior rights to 'green' water (rainfall and plant transpiration) on that land. However, in many contexts it also implies a demand on 'blue' water resources (rivers, lakes and aquifers),[1] since agriculture typically accounts for 70-80% of such water 'abstracted' (pumped, stored or diverted) in less industrialised economies (UNDP, 2006). However, in current debates on the impact of foreign investment in agricultural land, the consideration of water has been peripheral. In part, this may be due to the more or less purposive construction of water as a distinct 'sector', notably since the International Conference on Water and the Environment in Dublin in 1992 (Young et al., 1994), and the subsequent establishment of the World Water Council and the high-profile World Water Forums it has convened every 3 years since. The consolidation of water as a domain of separate professional and academic concern has been further reinforced by the political importance of access to water for drinking and hygiene as a 'basic need' or 'human right'. This usually accounts for relatively small percentages of the total water resource use. However, the existence of a billion or so people

[1] The terminology of 'blue' and 'green' water is often used to distinguish between water that is typically used by 'irrigated' and 'rain-fed' crops, respectively. In practice, the boundary may be hard to draw for all situations, but has been used to identify the difference between rainwater that is intercepted *in situ* by growing crops and water that is delivered to crops by human action from rivers, lakes, or groundwater.

without adequate access to water for drinking and washing has become emblematic of wider development failure and immiseration, and has promoted action to improve drinking water and sanitation provision to primary political importance among the Millennium Development Goals. It is not to detract from the importance of this 'water and sanitation services' agenda to observe that 'the water sector' has come to be primarily associated with it, and the identification of water as integral to land use correspondingly weakened.

As a consequence, headlines about land deals do not automatically lead to a discussion of water requirements. Yet it is clear that water scarcity is a major driver of international flows of investment in agricultural land. This is not because there is any 'global' scarcity of water, but local scarcity of water for agricultural use is emerging in economies that are expanding particularly quickly, such as in India and China (de Fraiture et al., 2008), and where renewable water resources are particularly limited, such as in the Gulf countries (Woertz, 2010). In such contexts, a range of options will include improving efficiency of water use (recycling wastewater, improved irrigation, etc) and investing in expanding supply (inter-basin transfers, desalination, etc), but all will tend to be expensive, at least in the short term. Consequently, simply displacing agricultural water demand to areas with less intensively used (and therefore cheaper) water resources has an economic logic (Mann and Smaller, 2010). This logic is arguably stronger than that for increased agricultural land area, most evidently in cases such as that of Saudi Arabia where policy is to halt existing irrigation using non-renewable 'fossil' water from aquifers that are no longer recharged by rainfall. Instead, Saudi investment in agricultural production is to focus on other countries with renewable water resources, notably in Africa, as exemplified by the seven-year plan to produce 7 million tons of rice annually under irrigation on a total of 700,000 ha to be acquired in Niger, Mali, Senegal, Uganda and Sudan (GRAIN, 2010).

A recurrent emphasis in reports of 'land grab' land deals is that these constitute a major change in international relationships, with international capital investment being deployed in African contexts in which regulatory and legal frameworks are ill-equipped to defend the interests of existing land users or the wider public interest of the country concerned. One such report (World Bank, 2010) states that some foreign investment has in fact targeted countries with weak regulations, although this needs to be seen in the context of the Bank’s own pursuit of financial and trade liberalisation – and strengthening of private property rights in land – to improve the climate for agricultural investment (World Bank, 2009b). There seems little doubt that land deals in Africa have involved new types of foreign investors, and I shall review below why this is so, but it is also important to recognise the proactive role played by African governments. Alden Wily (2011) has highlighted the legal basis through which much existing customary land tenure in Africa remains vulnerable to expropriation by government on behalf of national and foreign investors, with consequent displacement of existing land users. Borras and Franco (2012) have argued that existing analysis of land deals too often is conceptually simplistic and lacking sufficient empirical detail to illuminate processes of local or national enclosure of land resources, and their social and economic consequences. What is clear is that political narratives of 'unexploited resources' frequently underpin a '*terra nullius*' justification for government to displace existing land use and land users’ rights (see Makki and Geisler, 2011, for Ethiopia, and Fairbairn, 2011, for Mozambique). It is also important to recognise that, if the current land deals involve a new wave of foreign investors, for many African governments they are only the latest initiative in a long-running search for capital investment to raise agricultural productivity. For the most part, this search has been guided by ideas of 'modernisation', either through mechanisation and creation of large-scale production units, or through transformation of small-scale 'subsistence' producers into small-scale commercial farmers, following an 'Asian' or 'green revolution' model based on increased input use. In each case, the goal has been to raise the amount of marketed agricultural output either for export or for local food markets. A key question is to what extent different types of existing land and water users within 'rural communities' stand to gain or lose from such developments (Borras and Franco, 2012).

This paper considers the extent to which water requirements of proposed agricultural projects are transparent in land deals involving foreign direct investment (FDI). It focuses particularly on SSA because this is the region in which a majority of land deals are being made (World Bank, 2010), and which has been promoted internationally as having an abundance of underutilised land and water for agricultural development: a 'sleeping giant' ready to be awakened by commercial agriculture (World Bank, 2009a). The paper makes two principal arguments. Firstly, it argues that this perception of abundance, and the investment strategies it fosters among both African governments and foreign investors, fails to recognise the specific ways in which (lack of) water availability constrains land productivity both temporally and spatially in the semiarid and sub-humid African savannas. Secondly, and as a consequence of this failure, land deals tend to overstate the potential of 'rain-fed' farming and understate (or obscure?) the need for agricultural projects to include investment in water management. At the same time, this process also has the effect of rendering invisible the water management strategies of existing small-scale agricultural producers. Thus, the current discussion of land deals risks obscuring, not only the water management needs of the agricultural projects but also their impacts upon existing local water resource users. The paper first reviews the context of water management in African agriculture. It then considers the logic of the current round of foreign investment in agricultural land in Africa from the point of view of African governments and foreign investors. It assesses the extent to which the planned investments have implications for 'blue' water use and then explores the type of mechanisms through which impacts may be felt by other water users, and means through which these may be made more visible.

WATER USE IN AFRICAN AGRICULTURE

For both large- and small-scale models of modernisation, water management has played a role. This was to be expected, since for the two thirds of SSA that lies outside the equatorial humid zone, water is the key constraint to agricultural production. These areas are characterised by 'savanna' vegetation – grassland with a tree density that varies according to prevailing rainfall levels. Annual rainfall may vary from as little as 400 mm in Sahelian zones to 1200 mm in 'Guinea savanna', but in all cases is strongly seasonal, being restricted to 4-5 months in a year. Moisture constraints for agriculture are caused not by the long dry season alone. High inter-year variability of total rainfall, including significant rainfall deficits ('meteorological' drought) once or twice a decade, and high probability (2 out of 3 years) of dry spells at critical crop growth stages during the rainy season mean that a significant risk attaches to all other investments in agriculture if crops are dependent on rainfall alone (Röckstrom, 2003; Röckstrom et al., 2010). African agriculture includes many different 'indigenous soil and water conservation' approaches to increase interception and retention of rain, thus reducing risks associated with low and unreliable rainfall (Reij et al., 1996), as well as traditions of stream diversion for crop irrigation in the East African highlands (Adams, 1992), and construction of terraces on hillsides and cultivation of raised beds in wetlands in Zimbabwe (Soper, 2006). More generally, cultivation is often split so as to occupy a variety of topographical positions and thus spread risk associated with rainfall: floods in lower-lying sites in wet years, drought on higher, better-drained sites in drier years (Richards, 1985).

Consistent with a modernisation perspective, government efforts to deal with water constraints in agriculture have focused on engineering approaches, beginning under colonial administration in the 1920s, with large-scale irrigation schemes at Gezira on the Nile in Sudan, and on the Niger in Mali, both designed to produce cotton for export. Productivity on such schemes proved disappointing, however, and a major stimulus to new irrigation investment came only in the 1970s, partly in response to a rainfall reduction of about 30% in much of the West African savanna that began with a severe drought in 1972/73. However, development of formal irrigation in Africa made relatively little headway, when compared to developments in South Asian countries such as India and Bangladesh. Irrigated agriculture is estimated (UNDP, 2006) to account for less than 5% of African agriculture, compared with nearly 40% in South Asia. Consequently, although agriculture accounts for 85% of all water withdrawals for economic activity in Africa, this represents only 2-3% of African internal renewable water resources, compared to 25-35% in South Asia (FAO, 2009). Part of the explanation is found in reviews undertaken in the 1980s, which showed that state-managed irrigation systems, in which African cultivators were typically tenants of the state, suffered from a number of design problems. These included physical design failures, such as cost-cutting measures that omitted adequate drainage and led to waterlogging and salinisation after the schemes were put into operation, or inappropriate dimensions of reservoirs or pumping stations due to designs based on inadequate river flow records (Moris and Thom, 1985; Hocombe et al., 1986). Other problems resulted from lack of understanding of the economic and social context. These included erroneous assumptions about availability of household labour (Diemer and Vincent, 1992) and inadequate budgets for supporting infrastructure such as roads, resulting in poor market access, or for compensating and resettling populations displaced from sites of reservoirs or new irrigation areas (Adams, 1992).

Growing disillusion with formal irrigation schemes in the 1980s was amplified by a more general retreat from state investment and support for agriculture as governments adopted 'structural adjustment programmes' to reduce public expenditure as a condition for credit from international financial institutions. Contrasting impacts are evident in two Sahelian examples. In the Senegal river valley, the winding down of the state agency (SAED – Société d'Aménagement et d'Exploitation des terres du Delta du fleuve Sénégal) coincided with the completion of two dams (at Manantali and Diama) designed to regularise the flow of the river and control its annual flood and thus provide year-round irrigation on 300,000 ha in the river valley, 224,000 ha of which was for the left, or Senegalese, bank. Senegal's New Agricultural Policy of 1984 sought investment by commercial entrepreneurs to expand the irrigated area, while existing irrigation infrastructure would be managed by farmers' associations. By 2003, the river basin authority (OMVS) recorded 94,000 ha as equipped for irrigation on the Senegalese bank, but only 35,000-40,000 ha were estimated to be in production (OMVS, 2003) – little more than the 31,500 ha existing in 1988. It is unclear from the OMVS reports whether older (state-funded) irrigation has been substituted by new schemes funded by private investment. However, the failure to achieve overall expansion of the irrigated area during 15 years of market-based reform has been attributed to the raised cost of inputs such as fertiliser previously subsidised by the government. Increased production costs resulted in abandonment of many smaller village-run irrigation schemes of the 'Middle Valley', more distant from the coastal cities of Dakar and Saint Louis and hence with higher transport costs (Adams, 2000). There is also evidence that political tension in the Senegal river valley, escalating to international confrontation between Mauritanian and Senegalese governments, was linked to the impact of irrigation development on seasonal (flood regime) land use patterns and the disruption of associated overlapping land rights (Horowitz, 1989). More generally, the experience of the Senegal river valley over the past two decades exemplifies ways in which foreign finance can dominate decisions on competing demands for water use, and the limitations and challenges of relying upon 'formal irrigation' to compensate for the loss of production resulting from disruption of locally adapted exploitation of seasonal hydrology (Koopman, 2007).

In contrast, in the Office du Niger, in Mali, incremental reform of state management has been interpreted as producing more positive outcomes (Aw and Diemer, 2005). As with the SAED, productivity on the Office du Niger was declining by the early 1980s. This trend was reversed by a series of measures, including: raised crop yields due to scheme rehabilitation and technical improvements in water management; devolution of certain activities (notably initial processing of the rice crop) to organisations of the small-scale tenant farmers cultivating the irrigated plots; and reforms that increased the role of farmer representatives on the central management of the scheme. Average productivity of the principal (rice) crop trebled between the mid-1980s and 2002, so that the 60,000 ha in the scheme delivered 50-60% of national rice consumption. Additionally, an increasing area cultivated during the dry season for higher-value crops, such as fruit and vegetables, added a further 46% to the value of the output from the scheme. Higher levels of productivity have enabled higher fees to be charged for water, reducing government expenditure. Conversely, an estimated one third of the small-scale farmers cultivating on the Office du Niger in 2002 struggled to achieve more than subsistence income (Aw and Diemer, 2005), and rising water fees threaten such households with eviction. Moreover, such pressures are liable to be intensified, as the Malian government seeks large-scale private investment to expand the irrigated area, as will be explored further below.

These two cases illustrate both the potential and the pitfalls associated with large-scale irrigation investment in SSA. A combination of inadequate technical design and failure to engage irrigation planning with local political and economic realities has too often generated a catalogue of low productivity. In many cases, lack of maintenance and operational budgets has resulted in low percentages of irrigated areas being harvested. Thus, while in Mali cropping intensity of 171% indicated a substantial proportion producing more than two crops per year, in Senegal only 73% of the 'equipped' irrigation area was actually harvested. Elsewhere, even lower rates of usage of irrigation infrastructure are recorded, such as 43% in Sudan and 11% in Congo (FAO, 2005a). Irrigation investment in Africa stalled for almost two decades from the mid-1980s. A re-engagement with agricultural water management has been signalled by the World Bank (2003, 2006), but some sources estimate that loans for irrigation and drainage in Africa were lower in 2002-05 than they had been in 1978-81 (CAWMA, 2007). Moreover, it needs to be made clear that the problems previously experienced in irrigation under African conditions still pose challenges for irrigation designers (Lankford, 2009).

One consequence of the retreat from formal irrigation has been a growing recognition of, and interest in, 'informal' or indigenous irrigation water management among African farmers. Official data for irrigation in Africa discriminates between a 'formal' irrigation sector, equipped for full or partial water control, and 'informal' or 'non-equipped' cultivation of lowland areas. 'Formal' irrigation is typically state-funded and uses standard engineering structures (dams, canals, pumps) to store and distribute water on the flood plains of major river systems. 'Informal' or 'non-equipped' lowland cultivation typically uses indigenous technology to achieve a measure of water management, for example through stream diversion into irrigation furrows, drainage of wetlands, or planting crops following a receding flood. Taken together, these categories have been estimated (FAO, 2005a) to constitute a total of 15.4 million ha of "areas under water management" in Africa. However, nearly half of this is in North Africa and Madagascar. Estimates for the rest of SSA put formal irrigation in the mid-1980s at 2.64 million ha, with an additional 2.38 million ha of informal water management (Hocombe et al., 1986). In 1994, FAO estimated 5 million ha of formal irrigation, rising to 6 million in 2004, and about 2 million ha of informal water management, which remained unchanged across the decade (FAO, 2005a).

If we ignore the obvious questions about accuracy of estimates of areas subject to informal water control, we may note that the data maintain a sharp distinction between 'irrigated' (blue water) and non-irrigated/'rain-fed' (green water) agriculture. Statistics for 'informal irrigation' refer to 'wet' lowland agriculture and quite explicitly omit any mention of 'dryland' water management, such as rainwater harvesting or other techniques for retaining and conserving rainfall, such as terraces, pits, contour ridges and stone lines, and so on (Reij et al., 1996; Röckstrom et al., 2003). Such techniques are widely used in cultivation of drier savannas, and their exclusion must evidently underestimate the extent of agricultural water management used in Africa.

This is important because various forms of more or less informal water management have underpinned much of the most dynamic elements of African agriculture over the past two decades. In particular, the production of fresh fruit and vegetables for growing urban markets by small-scale producers in peri-urban areas or on major transport corridors has exploited wetland resources to allow year-round production, and in some cases involved significant investment by farmers themselves in infrastructure such as boreholes or weirs for stream diversion into irrigation furrows (Southgate and Hulme, 2000; Bolding et al., 2010). While covering significant areas, informal irrigation may often be contingent on water availability, expanding in years of high rainfall and run-off and contracting in drier years (Lankford, 2004). Despite the significance of a range of techniques of 'informal' water management, both in historic indigenous agricultural production strategies and in contemporary instances of entrepreneurial agricultural growth, the spread in techniques straddling 'irrigated' and 'rain-fed' classifications means they tend to have low visibility for development planners whose professional training demands a sharp distinction between 'irrigated' and 'rain-fed' agriculture (Moris and Thom, 1985).

This dissonance between actually existing agricultural water management and official perceptions means that from the perspective of many African governments, the pursuit of a major increase in agricultural productivity involves a modernisation of farming via formal irrigation that depends on bringing in investment. This perception is reinforced by calls for a rapid expansion of irrigation in Africa (Commission for Africa, 2005). Movik et al. (2005) cite FAO as calling for major increases in cultivated areas under "reliable water control" from 12.6 to 20 million ha. The Comprehensive Africa Agriculture Development Programme established by NEPAD (New Economic Partnership for Africa) takes a somewhat more cautious line in its 'pillar 1' (Sustainable Land and Water Management), but makes clear that no effort must be spared in encouraging investment in irrigation (CAADP, 2009). Yet African governments face challenges to water infrastructural projects for agriculture, from both environmental and financial considerations, that governments in earlier episodes of state-led development did not have. Two decades of neo-liberal policy have restricted public-sector funding of agriculture, not only by African governments themselves but also by many multilateral funding agencies, reflecting also a broader decline in the relative importance of agriculture in development funders’ policies. Lending for agricultural development slipped from 30% of World Bank loans in 1980 to 7% in 2000, a trend only recently reversed by a rise to 12% in 2010 as a result of the rise in food prices in 2007-08 (IPS, 2010).

The above review has highlighted the general significance of water as a constraint to improving farm productivity in the savanna (semiarid and sub-humid) environments that predominate in SSA, and the role water management plays in both indigenous agricultural strategies and state efforts to bring about an increase in productivity through modernisation. Despite the difficulties frequently encountered in agricultural modernisation in Africa, particularly where it has involved large-scale mechanised production systems, there has not emerged any widely recognised alternative model of productive farming, despite evidence of dynamic responses to new markets and technologies (Wiggins, 2000; Woodhouse, 2003). A widely shared perception of 'stagnation' of agricultural productivity in SSA thus creates a climate in which African governments more or less actively solicit foreign investment to develop 'underutilised' agricultural resources. In the Sahelian examples of Senegal and Mali, briefly reviewed above, rainfall is low enough for irrigation to be an obvious prerequisite for commercial agriculture, and past and present agricultural investment has focused on the major river flood plains. However, even in the higher rainfall 'sub-humid' savanna zones, foreign investment tends to cluster around both major rivers and the production of crops with high water requirements. In the following section we review the factors driving new investment.

WATER USE IN PLANNED FDI PROJECTS

If the search for investors in agriculture has been a long-standing concern of African governments, the interest of international investors is relatively recent. It has arisen from an international context characterised by perceptions of rising insecurity of energy and food supply and concomitant volatility in energy and food commodity prices. While these perceptions are linked to narratives of climate change, it is important to recognise that it is the policy responses to climate change concerns, not the biophysical effects of climate change, that have had the most immediate impact. Predicted climate change impacts are often characterised in terms of changing rainfall patterns, typically in terms of increasing frequency of extreme events (greater concentrations of rainfall in fewer and more intense storms), leading to higher run-off and greater risks of both floods and soil-moisture deficits (Arnell et al., 2001). However, the modelling of such predictions at regional or national scales relevant to agricultural policy is at a relatively early stage, and effects on flood patterns in African river basins are as yet unclear (Conway et al., 2009; Goulden et al., 2009). Significant determinants of inter-year rainfall variation have only recently been identified, such as the relationship between rainfall intensity in East Africa and atmospheric circulation patterns resulting from changes in ocean surface temperature differentials in the Indian Ocean (Conway et al., 2007). The most that may be said about climate change impacts on moisture availability in African agriculture is that it is likely to be subject to extreme fluctuation. In many respects, this suggests that the constraint of rainfall uncertainty that confronts the majority of African farmers cultivating savanna areas today will continue to be the main constraint to farming in future, if in more intense form, and water management will continue to be a primary factor in agricultural productivity.

Yet, as noted above, it is policy responses to climate change concerns that create the most immediate impacts on investment in agricultural land. An example of this is the way climate change mitigation concerns have been used to justify subsidies for biofuel production. Biofuels constitute the nexus through which a number of strands of energy policy have become linked with agricultural production, with major implications for land and water use in Africa. The principal driving force is a combination of environmental and security concerns that have diverted agricultural output from food to biofuel production (FAO, 2009). Thus, from 2004, the perception of rising oil prices as indicating diminishing oil stocks and insecurity of future energy supply prompted governments in the USA and EU to fund subsidies – estimated at over US$10 billion in 2006 alone – for the production of biofuel from agricultural crops. In 2007, this diverted some 30% of US maize output, or 12% of world maize output, into ethanol production (FAO, 2009), reducing cereal availability for food supply and thus driving up food prices. Speculative activities further reinforced a short-lived 'spike' in food prices in 2007-08 during which some prices rose by as much as 100 times (Imai et al., 2008; Ghosh, 2010), before dropping back again.

The political climate favouring production of biofuel has been promoted by environmental arguments that they constitute a renewable energy source that can substitute fossil fuel (petroleum), and thus reduce net carbon emissions as part of a strategy to mitigate climate change. Biofuels are therefore the link through which growing concerns with climate change reinforce and accentuate the rise in agricultural commodity prices that may already reflect rising fossil fuel costs, particularly in nitrogen fertiliser. It has been estimated that biofuel production is uneconomic when crude oil prices in the US and EU are below US$50 and US$70, respectively (Dufey, 2006). While the economic recession in late 2008 caused oil prices to fall below this level for 6 months, they generally exceeded it for the period 2006-2011 (US EIA, 2011). This suggests a continuing incentive for governments to promote biofuel production, despite claims that in certain cases (notably ethanol production from maize) biofuel does not necessarily produce a net reduction in carbon emissions (Pimental and Patzek, 2005). Policy decisions favouring biofuel production on grounds of climate change mitigation and energy security are therefore likely to be a long-term factor driving up agricultural commodity prices, and as a consequence, promoting competition for control of land, water and other inputs to agricultural production (Borras et al., 2010). The dimensions of this impact on international agriculture can be gauged from projected increases in land areas dedicated to biofuel production. Estimates of de Fraiture et al. (2008) projected a global total of 42.2 million hectares devoted to biofuels in 2030. White and Dasgupta (2010) cite projections of biofuels accounting for 20% of global arable land by 2050.

Whatever the accuracy of such figures, they reinforce the prospect of rising food commodity prices, and have had the effect of galvanising interest of international finance capital in agricultural production, prompting acquisition of large areas of agricultural land in Africa, Latin America and South-East Asia by a variety of international commercial investors (Cotula et al., 2009; Mann and Smaller, 2010; World Bank, 2010). It is the transactions in Africa, accounting for about 75% of the 45 million ha of deals reported in 2009 (World Bank, 2010), typically involving land acquired as 40-99 year leases agreed between commercial companies and African governments, that have aroused the greatest controversy. Concern centres firstly on the use of land for biofuel in countries subject to food shortages. Secondly, there is a perception that some investors, notably those from high-income food-importing countries in the Middle East, plan to use the land (particularly that acquired through agreements with the Ethiopian government) to produce food destined exclusively for export to the investor’s domestic market. In the case of Saudi Arabia’s 'AgroGlobe 7x7' scheme to produce 7 million tons of rice in Africa, GRAIN (2010) reports that 70% of the output is designated for export to Saudi Arabia. Finally, there is a concern that new projects developed through these transactions will result in the displacement and impoverishment of existing land users (Alden Wily, 2011; Borras and Franco, 2012). Yet the focus on land and the physical displacement of people from it risks obscuring impacts with far wider reach: the impacts of new large-scale agricultural projects on the consumption, diversion and storage of water resources and ramifications for hydrological processes far beyond the land they occupy.

With the exception of some of the large Sahelian projects, relatively little of the commentary on these investment deals has addressed the implications for water use. Mann and Smaller (2010) are among the few who identify water scarcity as one of the long-term drivers of land acquisitions for agriculture:

> [a] critical motivation in the current trend towards large-scale land acquisitions is the water factor. Agriculture trade specialists have long recognised the notion of trade in virtual water to account for the water needed to grow different crops. Today we see investment in water rights in foreign states, through the purchase or lease of land with associated water rights and access, as a critical part of the new process of securing long-term farming investments.

A recent review of land deal contracts by Cotula (2011) also observes that land leases in semiarid countries would be worthless if they did not ensure access to sufficient water for agricultural use. In contrast, a review undertaken by the World Bank (2010) explicitly states that its estimates of farmland 'available' for investment are based on suitability for rain-fed production alone. This is a questionable stance where commercial agriculture in SSA is concerned, as indicated by another recent World Bank (2009a) study on agricultural development potential:

> [i]rrigation may not be as critical in the Guinea Savannah as in other more arid production environments, but the potential contribution of irrigation to African agriculture should not be underestimated. Commercial farmers in southern Africa have long known that even a single preplanting irrigation can make an enormous difference in enabling timely planting and ensuring that crops get off to a vigorous start, which can significantly affect eventual yields and reduce risks.

This underlines the point made in the previous section that water management is needed in much of African agriculture to compensate for irregular and unpredictable rainfall, not necessarily for a lack of total rainfall.

In practice, for those cases where information is available (e.g. Woodhouse and Ganho, 2011), the choice of crops proposed for projects financed by FDI suggests a high likelihood of production that demands 'blue' water (irrigation), not just 'green' water (rainfall). Sugar cane and rice, both of which have a high demand for water and a long growing season, would usually require irrigation in all but the most humid climatic zones of SSA. However, wheat is a cool (i.e. dry) season crop in the tropics and thus also requires irrigation in SSA, except in the very highest altitudes (e.g. Ethiopian Highlands). Available data may not be accurate, retrieved as they often are from press sources. Nonetheless, where reports specify the crops to be grown and their location, they do indicate a preponderance of projects with high water demand that implies a requirement for irrigation that is not part of the publicly available information on the land deal.

This observation is reinforced by the case of *jatropha*, often introduced as a biofuel (biodiesel) crop that, it is claimed, will grow on poor soils and with low water demand. It has been proposed as a means by which small-scale producers can gain access to the growing market for biofuel by growing a crop that does not compete with food crops requiring land with better fertility and moisture availability. However, a number of sources indicate that commercial yields of biofuel from jatropha will require good soils and no moisture constraint. Schut et al. (2010) cite research indicating yields of 2.72 tonnes of jatropha oil per hectare (t oil per ha) under optimal growing conditions, including no limitations of water or nutrients. They observe that the average yield of 2.64 t oil per ha, given as the planned production level in 12 jatropha projects in Mozambique, would therefore be "extremely difficult, if not impossible" to achieve (Schut et al., 2010). This conclusion can only be strengthened by the fact that jatropha projects are promoted as enabling the exploitation of 'marginal land' not used for food crops. Indeed, Nhantumbo and Salomão (2010) report that an existing jatropha project in central Mozambique had switched to forestry due to soil-quality considerations. The same authors also observe that even where biofuel projects plan to grow crops with low water demand, such as sorghum, project design includes irrigation and the construction of dams. A recent review of foreign-funded investments on Mali's Office du Niger irrigation scheme (Oakland Institute, 2011) also notes concessions of irrigated land to jatropha biofuel projects.

The available information on land deals in Africa is incomplete and the above discussion makes no claim to comprehensive coverage. It is consistent, however, with the conclusion that 'blue' water will, frequently, be a requirement of the current wave of land deal projects. However, in most cases this is not acknowledged. Even where irrigation is an explicit requirement, as in the Sahel, it is not uncommon for the quantity of water required by a project to remain unspecified (Cotula, 2011). A general absence of environmental impact assessments for such projects (Cotula, 2011) also reinforces this barrier towards understanding how projects will affect water resources.

INFRASTRUCTURAL INVESTMENT: IMPROVING ACCESS, INCREASING COMPETITION, OR DISPLACEMENT?

The preceding section suggested that FDI is set to increase water demand by agricultural projects. It may be argued that this is indeed necessary to increase agricultural output, as many African governments hope. It needs to be asked to what extent these projects will provide production that is additional to that which is already taking place, and possibly providing infrastructure (dams, canals, drains) which will enhance water management possibilities for existing producers. Conversely, to what extent will water demand by FDI projects simply displace existing water use, resulting in increased agricultural risk and impoverishment? As with other aspects of FDI land deals, press reports provide a source for concern. An account of the agreement by Libya to finance the expansion of irrigation infrastructure to allow irrigation of a further 100,000 ha in Mali's Office du Niger scheme claimed that the project would involve a Libyan-owned local company (Malibya), a Chinese construction company, and the recruitment of Bangladeshi labour to grow rice on the new irrigated areas. More relevant to the focus of this paper, the same report claimed "the project is going to push some local farmers off the land and compete directly with others for water from the Niger river, the most important source of irrigation for the Sahel-Sahara. Already, Malibya is negotiating with the Malian government for priority in water allocation during the off-season, when water levels are low" (GRAIN, 2009). This latter point has also been reported by Cotula (2011). As I noted earlier, the expansion of dry-season irrigation of high-value fruit and vegetables has greatly increased the profitability of farming the land of the Office du Niger, which is used principally for rice production during the wetter part of the year when the river is in flood. Reduction in water availability during the dry season would thus threaten the most valuable output of existing producers on the scheme and undermine the viability of their production.

The scale of the issue is illustrated by a more detailed recent study (Oakland Institute, 2011) of the land concessions to new agricultural investors in Mali. It identifies a total of 544,567 ha allocated to 22 concessions, of which 16 are foreign. This is more than double the FAO (2005b) estimate of 200,000 ha 'easily irrigable' land in the Office du Niger. Much of the new concession area is planned to produce crops in the dry season or with high, year-round water requirements (such as sugar cane). With the current level of water storage and delivery infrastructure, irrigation of the existing 74,000 ha of the Office du Niger during the dry season months (April and March) has been estimated to divert up to 70% of the flow of the Niger at Markala (Zwarts, 2010; see Hertzog et al., this issue). In terms of total annual flow, the Office du Niger uses only 11% of the Niger's water, so major expansion of the irrigated area is possible if increased water storage of floodwater is constructed, to allow higher flows to be maintained during the dry season. The Fomi Dam, approved in 2008 by the Niger Basin Authority for construction upstream in Guinea will provide this additional dry-season flow, as well as hydroelectric power.

However concern has been expressed that a reduced annual flood caused by increased storage at Fomi will have negative social and environmental repercussions, not least for the population downstream that depends on the annual flood of the inner delta of the Niger for fishing, pasture and rice cultivation (Zwarts, 2010). The experience of the impact of the Manantali dam on the flood regime in the Senegal river valley, discussed earlier, provides a bleak warning of the potential problems.

The speed with which reports of FDI investments have proliferated needs to be contrasted with the relatively small proportion of schemes that have actually been implemented. Woertz (2010) cautions against the challenges confronting implementation of existing land deals between Gulf states and African governments. More generally, the World Bank's (2010) inventory of 454 agricultural projects involving foreign land acquisition showed that only 21% were actually in production, many at a much smaller scale than had been planned. This means that there is an inevitable empirical deficit in debates on the impact of such investments. Very few studies have explored the impacts of these projects on existing water use (van der Zaag et al., 2010 are noteworthy exceptions – see below), and, as noted earlier, there is often a lack of adequate Environmental Impact Assessments before decisions are made on investment projects (Cotula, 2011). In this regard, recent studies of water demand and supply in the lower Limpopo river basin usefully illustrate the types of water dynamics that will need to be investigated if the impact of large FDI projects is to be understood. An analysis undertaken by Vilanculos and Macuacua (2010) compared registered and non-registered water use in the Limpopo valley in Mozambique. Under the Water Law of 1991 all water use must be registered and licensed except 'common use' (*usos comuns*) that includes use by rural households for their domestic needs, watering livestock and irrigation of an area of up to one hectare per household as long as this does not involve mechanical devices or siphons. Under the same law 'common use', although not requiring registration, has priority over registered use by individuals or firms for commercial activity. Vilanculos and Macuacua (2010) estimate existing registered and unregistered use of Limpopo water to be comparable, at 95.2 million cubic metres per year (Mm^3/yr) and 88.3 Mm^3/yr, respectively. This was based on an assessment that about 4000 ha of small-scale (unregistered) irrigation are being undertaken in the river flood plain. Using government projections of formal irrigation development, they estimated that while non-registered use may double in future, registered use will increase by a factor of 13 as planned irrigated area reaches about 70,000 ha. They observe that even this greatly increased water use would constitute only half the average annual flow of 3670 Mm^3/yr, taken as the combined flow of Limpopo and its tributary, the Elefantes (the Oliphants river in South Africa).

At this aggregate level, it would appear that there is no conflict between a rapid expansion of commercial irrigation (most likely funded by FDI) and existing small-scale water users. However, as observed earlier, the seasonal variation in flow (average 14.4 Mm^3/yr in September and 1126 Mm^3/yr in February) and the year-to-year variability mean that average total yearly discharge is a poor guide to water availability, particularly since irrigation usage will be most intense when flows are lowest. A more detailed analysis undertaken by van der Zaag et al. (2010) not only takes account of water stored in the reservoir of the Massingir dam, on the Elefantes river, but also uses annual records to estimate the probability or assurance with which a given amount of water will be available. They conclude that, even on the most optimistic assumptions of storage by the Massingir dam (currently being rehabilitated following a major failure of its water outlet structures in 2008), the maximum area that could be irrigated with 80% assurance (i.e. suffering inadequate water supply in only 1 in 5 years) would be 58,000 ha. This is a smaller area than the government is seeking investment for (73,000 ha). The analysis argues that a more likely scenario (with reduced storage capacity at Massingir) would see only 52,000 ha irrigated at this level of assurance. More critically, a 30,000 ha sugarcane-ethanol project which had been allocated land close to the dam would have the effect of pre-empting water use downstream, where assurance of supply would fall to between 59 and 65% (inadequate water expected in approximately 2 in every 5 years). Although the government revoked the original concession for this biofuel project because the investors had failed to comply with the terms of the concession (Borras et al., 2011), it agreed to a new concession for a sugar/ethanol factory and 40,000 ha close to the dam (hence with priority of access to water) with a South African sugar company in 2011 (Bambo, 2011).

The Limpopo case suggests that although small-scale water use is protected under Mozambique's water law, its non-registered status makes it invisible to government planners and thus vulnerable to competition from registered commercial users who will invariably be equipped with more effective means of abstracting water from rivers or aquifers. In many respects, this parallels the situation of non-registered customary land rights (van Koppen et al., 2005) and highlights the importance of rendering existing water use (and users) more visible within statutory legal frameworks. The analogy with land rights suggests, however, that the legal status of customary rights is often inadequate to prevent expropriation and displacement (Alden Wily, 2011).

CONCLUSION

In this paper I have argued that the water dimension of agricultural land acquisition in Africa has yet to be widely acknowledged. Yet in all but the most humid of tropical agroclimatic zones, water is a key constraint and agricultural water management is a prerequisite for commercial production. A requirement for irrigation is clear in some investment projects, such as those in the Sahel (some of which involve the construction of irrigation infrastructure) – even if the contractual terms of access to it are not. However, for a large number of projects in semiarid or sub-humid zones the nature of water constraints has been largely ignored or obscured in both contractual disclosure and press reporting, as well as by failure to undertake environmental impact assessments. I have argued that seasonality, annual variation, and intra-seasonal interruptions characteristic of rainfall in Africa's savannas mean that water management is fundamental to successful agriculture and evident in many indigenous farming systems that deploy techniques ranging from water conservation and harvesting to stream diversion and irrigation. However, the nature of water constraints is intermittent and highly specific to key moments in crop development, and thus not predictable on the basis of indicators of annual total rainfall or run-off that are used in agroclimatic zoning exercises. This raises questions about the most useful indicators to assess both existing use and the impact of new investments. It seems clear that such indicators would need to focus on water supply and demand for crops at periods of water scarcity (i.e. dry season) and/or greatest sensitivity to water shortage (in the case of drought periods during the rainy season). It seems a discussion of land deals in such terms has barely begun.

The empirical evidence of actual impacts of recently agreed FDI projects is inevitably sketchy, and this paper makes no claims to have undertaken a comprehensive review, even for SSA. Rather, it has attempted to identify the types of questions that need to be asked about the use of water by proposed projects if the impacts (positive and negative) of these new agricultural investments are to be understood. In reviewing the types of crops proposed by FDI projects I have concluded that many will necessarily involve development of water use, and associated infrastructure for storage and distribution of water. There are evidently potential benefits to other water users, including small-scale agricultural producers, if such infrastructure can provide new sources of water at times when 'green' and/or 'blue' water may be scarce. Yet there are also risks that new large-scale agricultural projects will have a negative impact on existing small-scale water users. This risk is heightened because the critical nature of water resources is highly specific to time and place, and thus measures such as annual rainfall or average river flow give no guide to likely impacts. In the absence of more sophisticated understanding of how different types of water resources (e.g. river banks, swamplands, river flows) are used at different times of the year by different types of users, there is a risk that large-scale commercial agriculture will cause unforeseen but disproportionate damage to existing small-scale production systems. This is likely even where existing small-scale water use has legal protection, because it may lack visibility, in part due to its small physical extent, (often) intermittent duration and blurring of demarcation between 'green' and 'blue' water management. A final, and perhaps most important, aspect of the water dimension of large-scale land acquisitions is that impacts are likely to be far more extensive than might be anticipated from the area of land occupied. Unlike land which has a distinct spatial boundary, water use depends on flows through the landscape. Thus the main impacts of land deals may be felt via their effects on water resources. Consequently, restriction or interruption of flows of water in an area occupied in one part of the landscape will have potentially widespread downstream impacts.

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