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Water and Agriculture in Africa: The politics of the belly or the politics of the mirror?

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Abstract

The water and agriculture glass in Africa is half-empty: Africa has failed to develop its massive water resources and failed to achieve agricultural growth. But the glass is half full, too, as Africa is making a start in building its needed infrastructure and in attracting managerial and knowledge assistance which can help start the needed transformation.

In engaging with this great challenge Africa has to make a choice. Will it continue to follow the path advocated by many in the aid community of the rich countries who say "the soft path", "no dams", "the social cart before the economic horse", "small is beautiful" and "no GMOs"? Or will Africans follow the alternative path that brought food security to Asia and income-enhancing agricultural growth to Latin America? The latter focused on science, infrastructure, management and scale. Will, in short, Africans follow "the politics of the mirror" or the "the politics of the belly"?

My qualifications (or lack thereof) on the subject

I was both flattered and a bit disturbed to be asked to contribute a lecture and paper on the challenges of water and agriculture in Africa. This diffidence may seem odd, for the reason I became a water professional is because I spent much of my youth in the semi-arid area of my native South Africa. In the great South African rain shadow, a sense of water insecurity and vulnerability was pervasive. In my application for a bursary to the University of Cape Town my priest endorsed my "calling": "What can be more important", he wrote, "than to have our best young minds grapple with the great challenge of water in our parched land".

After completing my civil engineering degree in (deceptively) lush Cape Town, I worked as an engineer in the South African Department of Water Affairs, on the heroic task of correcting for God's odd sense of humour. Why would He (he was unequivocally He back then!) put our water on the East Coast, and all of our gold and diamonds far away and high up to the west of the Drakensberg? But those were the days of water heroism (or so we thought). We were proud to build the large dams, pipelines and inter-basin transfers that constituted "the water platform for growth". (Seven of South Africa's nine provinces get more than 50 percent of their water from inter-basin transfers). And we did not stop at the border, working already, in the late 1960s, on what was to become the Lesotho Highlands Scheme, whereby water was transferred to an insatiable Johannesburg.

After a detour to study water management at the iconic Harvard Water Program, and a few years in rural Bangladesh trying to disentangle the mysteries and miseries of cholera and water, I returned to Africa in the 1970s, to the newly-independent People's Republic of Mozambique. With an ambition not only of demonstrating that there was an alternative to apartheid South Africa, but that it was possible to play a part in the creation of socialism in Africa. I can't remember my title in the Ministry of Public Works, but I know that in a country which had not a single trained engineer at independence, my job ranged from national planner to fixer of broken pumps.

Those years (in which I learned at least as much as I ever did in the classrooms of Cape Town and Cambridge) were to be my last continuous ones in Africa. Starting in the early 1970s I had engaged with the Indian sub-continent, and in the mid-1980s with Brazil. It is hard to know quite why life takes the turns it does, but except for a nearly-went-back-home experience after Mandela took power, my focus and energy turned away from Africa.

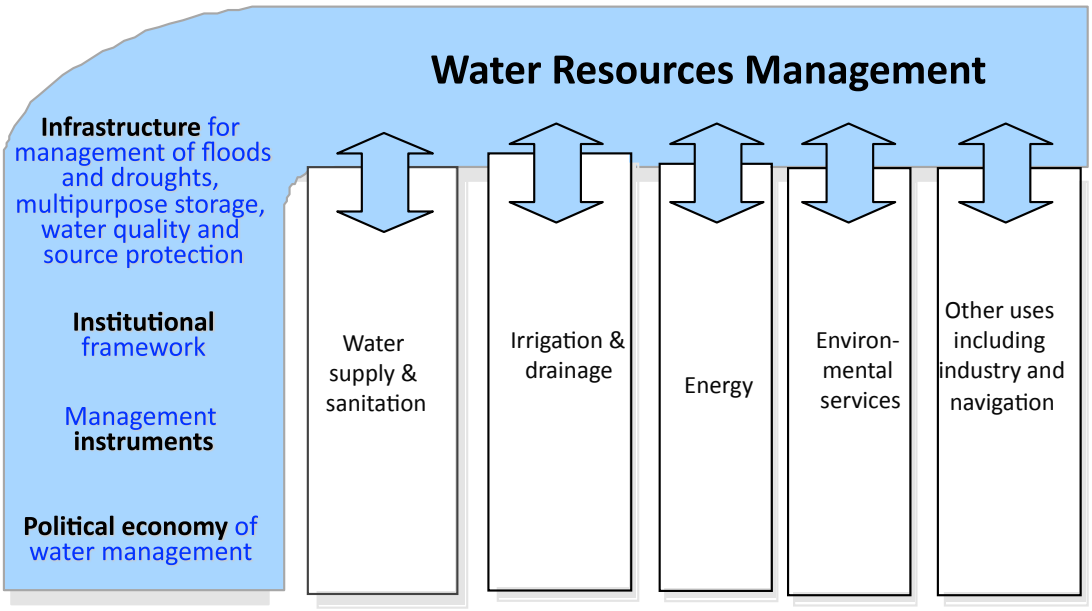
The best explanation for this is that I disliked (and dislike) the aid dependency syndrome in Africa and did not like being on either the receiving or giving side of that relationship. It is an associated truth that working on Africa is frustrating – success is so transient that it often seems illusory. And for a person who thrives in "horizontal relationships" (in which I learn at least as much as I teach), I found engagement with areas of the world that "were going places" to be more rewarding.

In my many post-Mozambique years I did work in Africa – in South Africa, Mozambique, Malawi, Tanzania, Kenya, Sudan, Ethiopia and Nigeria – but it was mostly episodic.

So it is true that what I know in depth of Africa is dated and incomplete, and what I know from recent decades is shallow. So "African expert" I am certainly not!

And what about the "agriculture" side? It is instructive to separate (Figure 1) the resource management and service delivery sides of the water business. My experience "in the comb of Figure 1" has primarily been in the handle (the infrastructure, institutions and instruments for managing the resource) but also quite a bit in the water supply and hydropower teeth of the water comb and only secondarily in the interstices of the agriculture and irrigation tooth.

Figure 1. The water "comb"



Source: World Bank (2004).

So not only am I not an expert on Africa, but I am also not an expert on water-for-agriculture. So discerning readers, move on!

What I can offer is something more elusive, but perhaps of some value. I have seen the water and development business from many sides – as a boy on a farm, as a government official, as a researcher, as a World Bank official, and with the private sector. I have seen the water business from the inside (not least during my decade as the World Bank's Senior Water Advisor), but I have also seen water in the context of the broad challenge of development, particularly at my last World Bank job as the Country Director for Brazil. Observing the handful of water thinker-practitioners I most admire, I think that this sort of uneven walk through the water domain, this experience of seeing the mountain from every angle and in every light, is a perspective shared by the few who have attained "water wisdom"; a perspective that the many who are "water clever" find it difficult to discern and respect. I do not claim to be among the water wise, but that is the goal I set myself in my career. In this paper I try to share some of the signs I have seen in that ongoing journey, and suggest what they might mean for water and agriculture in Africa.

Water development and management

In understanding the challenge of water and well-being, there are a few facts of central importance.

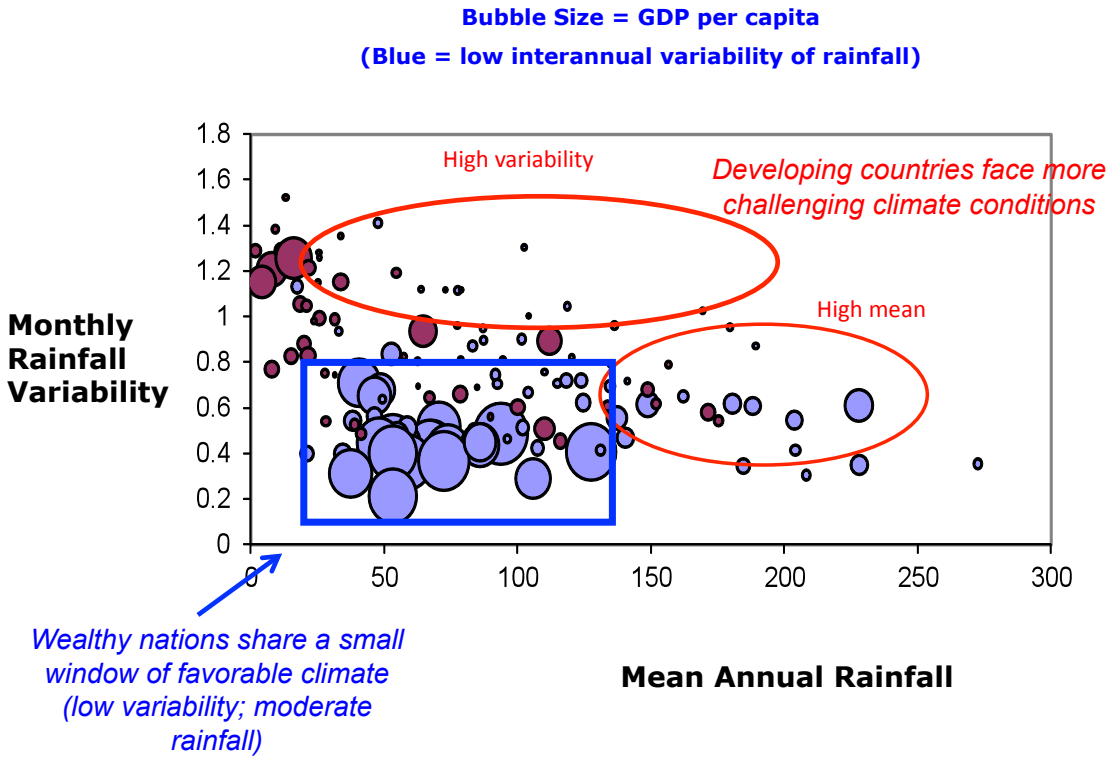
First, while it is true that "water is life", in almost all places on earth, water in most uses is of low value. While the numbers vary widely, the value of water in relatively-high value agriculture is typically of the order of 5 or 10 cents per cubic meter. Because the value/weight ratio is so low, it is seldom a proposition to transport water for agriculture over long distances if it cannot be done by gravity.

Second, partially as a result of the above, water issues are quintessentially local issues, with "local" sometimes being quite large when the river basins are large.

Third, with the "localism" caveat above, agriculture is, in aggregate, by far the dominant drawer of water, and is responsible for more than 70 percent of water abstracted and 95 percent of global water consumption.

Without falling into the trap of water determinism, it is evident that some types of hydrology are conducive to economic development ("benign hydrology"), while other types of hydrology ("malign hydrology") constitute a major barrier to be overcome in the development process. Brown and Lall (2007) have done an insightful analysis of this association. Figure 2 shows the relationship between three measures of hydrologic pattern (average rainfall, monthly variability and annual variability), on the one hand, and GDP per capita, on the other. Figure 2 shows that most now-rich countries are in areas that have relatively benign hydrology – not too little or too much water, not too much monthly or annual variability. And most poor countries face one or more elements of extreme hydrology – too little or (more serious) too much water, and high inter- and intra-annual variability.

Figure 2. Benign and malign hydrology and national wealth



Source: Brown and Lall (2007).

There is a growing perception that water security constitutes one of the great threats facing mankind. From one perspective, the recent US National Intelligence Council report on Alternative Worlds in 2030 (US National Intelligence Council 2012) identifies the water/food/energy nexus as one of the four megatrends (the others are individual empowerment, the diffusion of power and demographic patterns) that will shape the world in 2030. From a different perspective, business leaders polled by the World Economic Forum (World Economic Forum 2013) rate water supply and food as two of the global threats which are both most likely and of the highest potential impact.

Water development and management: In rich and middle-income countries

As the great historian of the Mediterranean, Fernad Braudel, once wrote "one must begin with water" (Braudel 1992). All societies, always, have had to deal with the risk of having too little or too much water.

1. Taking advantage of benign hydrology

As shown in Figure 2, most now-rich countries have emerged in places with benign hydrology and have easily been able to construct a water platform for economic growth. Consider, for example, the case of New England, which has "the goldilocks" endowment – not too much water and not too little (i.e. low risks of droughts and floods), and not too much inter-or intra-annual

variability. The result was that it was easy to construct "a water platform for growth" – the mills of New England had an easily-accessible supply of clean water, adequate flows to dilute wastes, easily-mobilizable hydropower to drive the mills, and an accessible water-based transport system to ship supplies in and goods out. As the city grew and local water supplies were inadequate, the city could extend its tentacles to nearby water sources to bring in the additional needed supplies.

Some of the "water platform" constructed in the northeast United States had not just local but regional, national and global consequences. The construction of the Erie Canal, as related in Bernstein's brilliant history (Bernstein 2005), linked mid-western food producers to European consumers, leading to regional development in the mid-West and food security in Europe, and ensuring that New York City became the dominant port of the northeastern United States.

2. Using wealth to address malign hydrology

Taking advantage of this benign hydrology, economic development in the United States started in the northeast. But the risk-development street is a two way street. Low risk led to development, and the resulting accumulation of capital and capability then meant that the United States could invest massive amounts of capital and know-how in confronting the malign hydrology of the western United States. Dams such as Hoover and Grand Coulee and the associated canals and pipelines confronted this benign hydrology, and constituted a water platform for growth in the western United States. (A nice illustration of this is in Michael Hilzik's (2012) history of why and how Hoover Dam was built and the effect it had on the southwestern US). The result is a massive endowment of water infrastructure in the United States. Reservoirs can store about 3 years of average flow on the Colorado, and there are 6000 cubic meters of storage capacity for every person in the United States.

This same process was evident in different parts of Western Europe. In the humid parts the proportion of runoff available through natural regulation is over 40 percent. Constructing a water platform for growth in these "early developers" (including the UK, France and Germany) did not require huge investments in water infrastructure – to this day just 100 cubic meters of storage per capita and a capability of storing just 10 days of average river flow. On the other hand, the Iberian Peninsula, with malign hydrology, developed much later, and had to invest massively (1500 cubic meters per capita and 200 days of average flow).

Infrastructure is necessary but not sufficient: enhancing water security is a challenge that requires walking on two legs – developing the necessary infrastructure and developing effective institutions. It is instructive to consider two cases from the developed world that show how the intelligent construction of an infrastructure/institutions platform can contribute to reducing the risks of both droughts and floods.

3. Infrastructure and institutions to reduce the impact of droughts

An iconic case of dealing with the risks from droughts is that of the Murray Darling Basin in Australia during the great, recent "Millennial Drought" from 2000 to 2008 (see many reports of the National Water Commission (http://nwc.gov.au); Langford and Briscoe 2011). Australia is the continent in which the difference between average precipitation and average evaporation is the smallest. The result is great hydrological variability, with Australia known as the land of droughts and floods. The first modern response to this variability was, quite reasonably, to build

storage. For the country as a whole there are about 4700 cubic meters of storage per capita. On the River Murray storage capacity is equivalent to about 600 days of average flow. It was apparent to Australian water managers that this infrastructure platform was a necessary but not sufficient underpinning for water security, and that it needed to be complemented by an appropriate set of institutions and instruments. The instrument revolution came about as part of a broad package – the National Competition Policy (NCP) of 1984 – of fundamental reforms in the way in which the Australian economy was run. Recognizing that water was a basic factor of production, the NCP benchmarks included a requirement that water rights were separated from land rights and that water became a commodity that could be traded – amongst users, between different types of users, within states and across states. Non-compliance by the states would mean strong sanctions in the form of non-payment of federal fiscal transfers. Principles and visions are essential elements of reform processes, but they are insufficient: the great achievement was the articulation of a sequenced, prioritized, patient program of implementation.

When the Millennial Drought hit between 2000 and 2008, both the infrastructure and institutions were in place. The fundamental dynamic was that as supply dropped, trading prices rose (from about 10 cents per cubic meter to 80 cents per cubic meter), and users for whom the value of water is relatively low and who had annual crops (such as rice farmers) became willing sellers, and users for whom the value of water is high (cities and those who farmed perennial crops, such as grapes and other fruits) were willing buyers. Because of the large investments made in infrastructure, water could (subject to the laws of continuity and gravity) be moved around the basin and usage patterns could adapt voluntarily and considerably. The remarkable net result was that there was very little impact of gross value added in agriculture despite a reduction in water availability that reached over 60 percent.

Bottom line – this example shows that the construction of a platform of water infrastructure and water institutions can dramatically reduce the adverse impacts of droughts.

4. Infrastructure and institutions to reduce the impact of floods

An iconic case of flood risk reduction is that of the lower Mississippi Valley, where the water collected across almost half of the continental United States funnels down to the Gulf of Mexico. The natural reaction to floods is to build a wall to keep the floods out. Levees were thus constructed first to protect New Orleans and other towns and cities but subsequently to protect large agricultural areas adjacent to the river. The consequent narrowing of the river course had both positive and negative effects on flood risk. The positive effect was that a narrower river flowed faster, carried sediments with it and thus meant more rapid evacuation of high flows. The negative effects included the loss of the wetlands and backwaters that had once filled during floods and provided natural attenuation (as well as considerable environmental benefits), and the occupation of the floodplain in the belief that the land was protected by the levees.

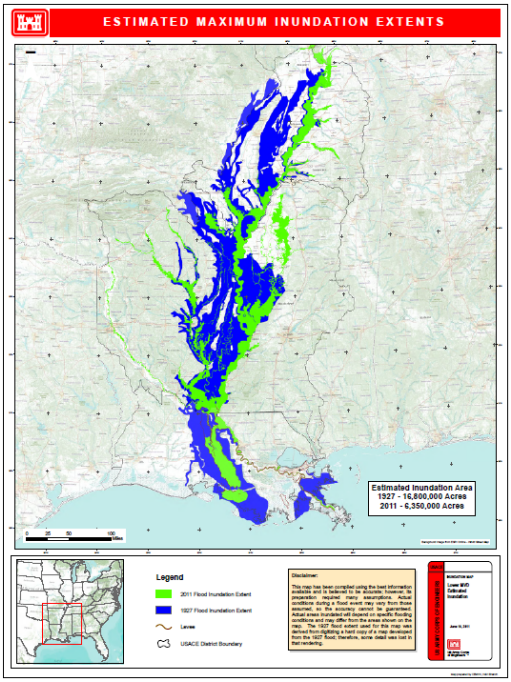
The devastating flood of 1927, documented brilliantly by John Barry in Rising Tide (1998), settled the hydraulic argument once and for all, showing that large floods could not be confined within the levees. Following the flood, the Mississippi River Commission (founded in 1879) and the US Army Corps of Engineers developed a risk reduction strategy based on the philosophy of "making room for the river". This strategy included: deep engagement with all communities (including through their levee boards); the identification of high-value areas (such as New Orleans and the massive navigation and industrial infrastructure in Louisiana) which had to get

the highest level of protection; the designation of floodways (alternative outlets to the sea) and backwaters based on an assessment of areas which both could serve these purposes and where social and economic recovery from flooding would be easiest; compensation (either through monetary compensation or through protection from smaller and more regular floods) to those living in the floodways and backwaters for the option of directing major floods their way.

Critical to the approach was federal funding of the Mississippi Rivers and Tributaries Project, a program that would give the Corps the power to allocate resources according to an overall plan based on priorities in the lower basin.

The great test of the philosophy and investments came in 2011, when the flood was larger than the historic 1927 flood. The outcome was extraordinary (Camillo 2012). As shown in Figure 3, the area flooded was 460 percent less than the area flooded in 1927; the management plan agreed to by all parties was followed; water flooded only low-impact areas, where there were long-standing prior agreements; the process was orderly and mostly consensual; and the damages averted were enormous.

Figure 3. Flood risk reduction on the Mississippi



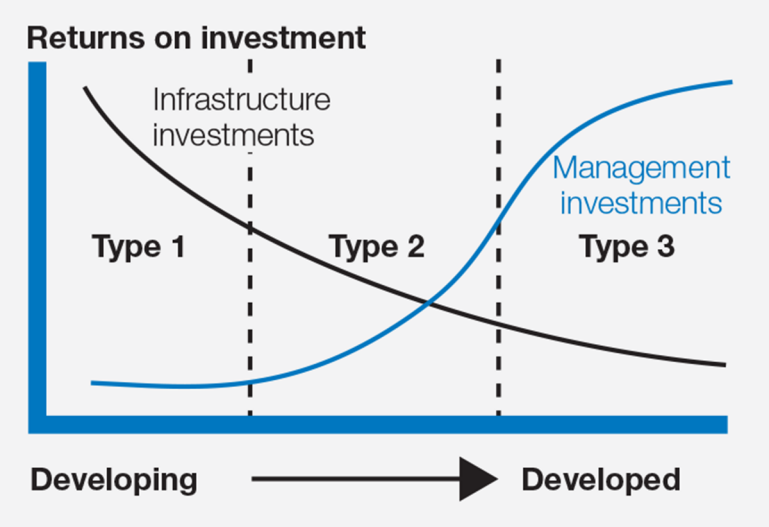
Source: Camillo 2012.

Just as in the case of drought in Australia, the lesson from the Mississippi is that an integrated package of infrastructure and institutions was able to greatly mitigate the effects of extreme hydrological events.

5. What the middle-income countries have done

Those countries which have grown rapidly in recent decades (now called the "middle-income countries" or MICs) have assessed the ways in which rich countries constructed a platform for water security and essentially concluded that they wanted to follow this same, well-trodden path. This does not mean that they have not learned from the mistakes of the first movers, but rather that they regard the general path followed by the rich countries to be an appropriate one. The MICs have specifically (through their own experience, through their voice on multinational institutions like the World Bank (Mallaby 2006), and through their own growing cooperation programs with low-income countries) rejected the influential school in the rich countries that underplays or even disdains the role of infrastructure. A sophisticated expression of this idea is shown in Figure 4, presented by the Chinese Government as an input into the World Bank's 2004 Water Resources Strategy. The essence of the figure is that infrastructure and management are both important, but that without infrastructure there can be no management.

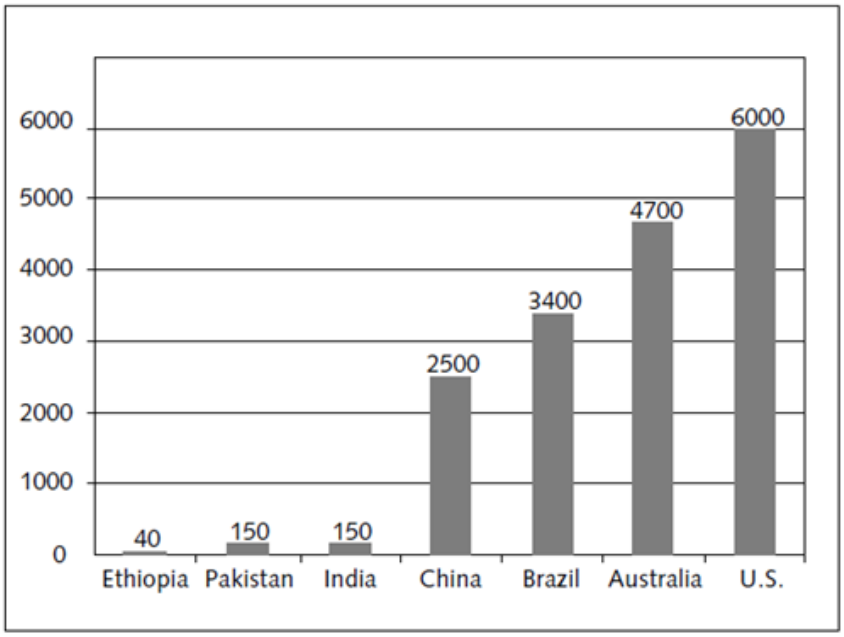
Figure 4. Rates of return on investments in water resources



Source: World Bank (2004).

Figure 5 shows that MICs like Brazil and China have invested, as the now-rich countries did, very heavily in developing the infrastructure required for economic growth and water security.

Figure 5. Water storage in the rich and poor worlds (cubic meters per capita)

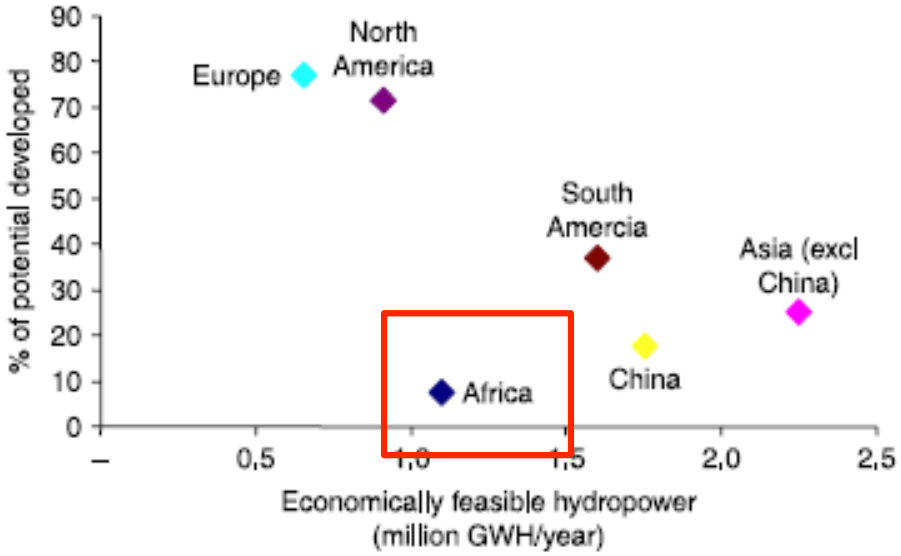


Source: World Bank data.

Water development and management in Africa

Many African countries are represented in the "malign hydrology" quadrants in Figure 2. In sharp contrast with developed countries with difficult hydrology, there has been very little investment in the building of water infrastructure in most African countries. Figure 6 depicts this great gulf for hydropower – whereas rich countries have developed about 80 percent of their economically-viable hydropower potential, the comparable figure for Africa is less than 5 percent.

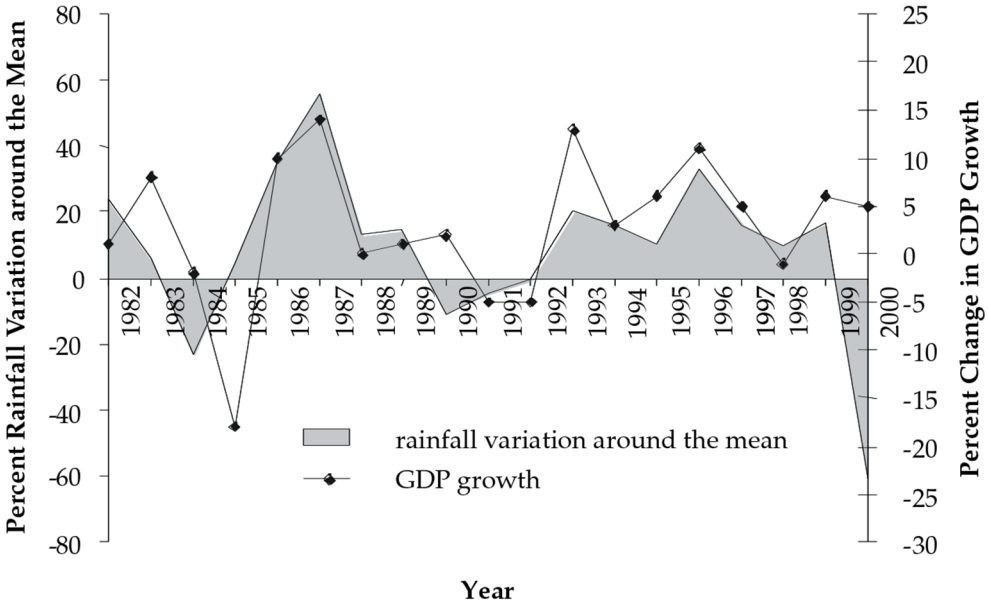
Figure 6. Hydropower in different regions



Source: World Bank data.

Consider the case of Ethiopia, which has large potential both for hydropower and for irrigated agriculture. As shown in Figure 5, the water storage per capita in Ethiopia is just 40 cubic meters per capita, less than 1 percent of the comparable figure for the U.S. and Australia. The main consequence for the people of Ethiopia – as illustrated in Figure 7 – is that there is no buffer between rainfall, on the one hand, and agriculture and GDP on the other. And in a country with 45,000 MW of hydropower potential, less than 10 percent of the population has access to electricity.

Figure 7. Rainfall variation around the mean and GDP growth in Ethiopia



Source: World Bank (2006).

The World Bank was conceived primarily as an instrument for bridging a major gap whereby infrastructure projects which require long-term, low-interest financing, could be undertaken in developing countries which did not have developed domestic capital markets, and which were considered too risky to have access to long-term international private sector lenders. In its early years the World Bank was basically an infrastructure Bank. To cite just one example, in its first ten years in Brazil, the World Bank financed 10 major hydro-electric plants.

While most of these projects were successful and uncontroversial, there were serious social and environmental issues that arose in some cases, including some large dam projects. As described by Albert Hirschman, "As long as nature is in charge of mishaps like floods they are acts of God; when man undertakes to remedy one of nature's ills, this remedy is expected to cure all ills" (Adelman 2013). In the 1970s, the global NGO movement grew and came to play a prominent role (both directly and through its influence on rich country governments' representatives on the Board of the World Bank). Over subsequent decades an array of "safeguards" were put in place that made it extremely costly and time-consuming for the World Bank to finance such projects. Detailed attention was focused on "the sins of commission", but little on the associated "sins of omission". The result was that lending for such projects by the World Bank in particular had virtually dried up by the end of the 1990s, when lending for social objectives had become dominant and infrastructure lending accounted for just 5 percent of overall World Bank lending. Bilateral lending also declined dramatically. The situation with the regional development banks was similar if not quite as acute. For developing countries with financial resources (including China, India and Brazil) this was not a huge issue as they could and did self-finance such

projects. But for almost all African countries it meant an inability to finance the infrastructure necessary to build their water platform of growth and security.

In the early 2000s this situation started to change. The fundamental reason for the change was the shift in global economic geography. Rapidly growing countries like China, India and Brazil had long disagreed with this policy direction and had gone their own way with their own resources. Now, as they started to assume a greater role on the global stage, they started to question the policy prescriptions coming out of the rich world through organizations like the World Bank (Mallaby 2006).

In the water world there were two stages on which this changed political economy was played out. First was the Report of the World Commission on Dams that was designed to build a consensus on ways to stop bad dams and support good ones. The process (Briscoe 2010) was hijacked by the anti-dam NGOs with the report producing guidelines which had never been implemented and which were so extreme that adoption would have meant that no other dam would be built in the future. The report was categorically rejected by all developing countries and not endorsed by the World Bank. Second was the development of a new Water Strategy for the World Bank (World Bank 2004) in which a central recommendation was for the Bank to re-engage with "high risk/high reward hydraulic infrastructure". Concerted opposition from the international NGO community was balanced by strong support from the developing country members of the World Bank. Particularly important in the process was the strong support on the Board of the World Bank from China, India, Brazil and the African countries.

Translation of intent into practice has been a more difficult challenge, since the array of costly and time-consuming internal regulations ("safeguards") and instruments for delaying projects (including the World Bank's independent Inspection Panel) remained in place. The good news is that infrastructure lending has again become a major area of World Bank lending (although little of this would be categorized as "high-risk/high-return"). An interesting wrinkle is that the World Bank now has a major commitment to climate change, both mitigation and adaptation. The new President sees large hydropower, especially in Africa, as the logical response to developing climate-friendly energy (Schneider 2013). Whether he has the commitment and persistence to change the internal rules, which make any World Bank investment in large water infrastructure so time consuming and costly, is a question yet to be answered.

In the meantime, as international finance institutions (IFIs) struggle with this governance issue, the middle-income countries have moved not only to center-stage of the global economy, but have become increasingly important sources of finance and assistance to African countries. Brazil is now engaged with several large water projects in Africa, but the big actor is China, which finances an estimated 300 large dam projects outside of China, many of these in Africa.

There are several perspectives on this development. On the one hand, there is broad appreciation from Africans and their governments that someone is willing to invest and help build much needed infrastructure. On the other hand, the western countries and IFIs who have withdrawn gnash their teeth about standards and motives. To this observer it seems that this wave of investment is overall of great value to Africans. But there are some critical areas in which China, in particular, could improve its practices. The two major areas are social and employment.

On the social, to the surprise of many, World Bank reviews (2000) show that China is, far and away, the developing country that has dealt with the very difficult resettlement issues best. In part this is because this is relatively easy to do in a rapidly urbanizing economy; in part it is because of a strong commitment by Chinese dam builders to deal with the welfare of the resettled. (The iconic case here, of course, is Three Gorges and the 1.5 million resettled people). While western NGOs spread stories of the disaster this is for local people, the reality is that most affected resettled people relish the opportunity to move out of agriculture and into industrial jobs, and that the most disaffected group are farmers who were unlucky enough not to be resettled (Hessler 2002).

So in China large water projects are treated as integrated construction and social projects. But when Chinese companies go abroad, they deal with similar projects as simple construction projects, using the "no interference in domestic political affairs" principle as a reason for not dealing with the thorny resettlement issues. At several high-level events with Chinese development officials I have raised this concern. In all cases it has been acknowledged as very serious. And since China is "the great implementer", if and when China decides to change its practice it is likely that this will be done.

The other challenge – the use of imported Chinese labor – is likely to be more difficult. The fact is that China is a low-cost builder is in large part because Chinese workers accept a low wage/high productivity/long hours deal. This model does not translate easily into most African countries where workers are not willing to engage in the same contract.

Agriculture

Others in this series of assessments have far more knowledge than I on agriculture. What I am able to contribute is primarily about the political economy of agriculture and water as I have seen on the ground in some countries where I have lived and worked. In particular I will explore the implications of on-the-ground experience with the green revolution in Bangladesh in the 1970s, and with large-scale commercial agriculture in Brazil in recent years.

Agriculture in other places

In the mid-1970s I lived in Bangladesh in a village on an island at the confluence of the combined Ganges/Brahmaputra with the Meghna River. The village either was underwater (for three months of the year) or was dry. Most fields grew just a single crop of low-yielding floating amon rice. Life in the village was nasty, brutish and short, with life expectancy of women 46 years. As a young socialist-environmentalist (Briscoe 1979) I opposed a plan for an Asian Development Bank-funded project that would put an embankment around the island, arguing that this would destroy the ecology and only make the rich richer. Twenty-two years later I returned to the village for two weeks, to find a different world (Briscoe 2001). Life expectancy of a woman was now 68 years, with life transformed primarily because the flood control and irrigation project meant that there were now three high-yielding crops a year. More broadly, investment in infrastructure, agricultural research and water management had transformed Bangladesh, unforgettably described by Henry Kissinger as "a basketcase which could never feed itself". The green revolution (which was as much a blue, or water revolution as it was a crop

revolution) transformed the face of modern Asia, ushering in an unimaginable era of food security.

In the mid-2000s I lived for three years in Brasilia, where I served as the World Bank Country Director for Brazil. In the process I got a close, first-hand look at Brazilian agriculture. As The Economist (2010a) has headlined it: "Brazil's Agricultural Miracle: How to Feed the World – The emerging conventional wisdom about world farming is gloomy. There is an alternative." First, some basic facts. Brazil ranks in the top five exporters of a wide range of agricultural products – orange juice, sugar, soybeans, chicken, coffee, beef, pork, maize and cotton. Over the past 10 years the production of grains has doubled; over the past thirty years the value of agricultural production has grown by 250 percent. Increased inputs of land, labour and capital account for just 10 percent of this growth – total factor productivity, the economist's term for smarter use of inputs, accounts for an astonishing 90 percent of this growth (Delfim Neto 2008). Central to this extraordinary performance was a political decision taken in the 1970s and stuck to by every government since: Brazil would invest massively and consistently in cutting-edge agricultural science and research. The main vehicle for this investment was the Brazilian Company for Research in Agriculture and Livestock (EMBRAPA), acknowledged to be without peer in the world of agricultural research in the tropics. Among the signature achievements of EMBRAPA (The Economist 2010b) are the following:

- **The soil**: EMBRAPA poured industrial quantities of lime onto the soils of the cerrado (previously considered uncultivable) to reduce levels of acidity.
- **Pasture**: EMBRAPA went to Africa and brought back a grass called *brachiaria*. Patient crossbreeding created a variety, called *braquiarinha* in Brazil, which produced 20-25 tonnes of grass feed per hectare, many times what the native *cerrado* grass produces and three times the yield in Africa.
- **Farm practices**: EMBRAPA pioneered and encouraged new operational farm techniques. Brazilian farmers pioneered "no-till" agriculture. In 1990, Brazilian farmers used no-till farming for 2.6 percent of their grains; today it is over 50 percent.
- **Soybeans**: EMBRAPA turned soyabeans into a tropical crop. It has also been importing genetically modified soya seeds and is now the world's second-largest user of GM after the United States

What are some of the implications of these experiences that might be relevant for Africa?

First is the central issue of scale, in which there is a sharp contrast between Bangladesh and Brazil. Peter Hazell and colleagues (Hazell et al. 2007) have noted that Green Revolution technology (cf. Bangladesh), centered on seeds, was largely scale neutral – small farmers could participate, especially as new rounds of crop breeding made the modern varieties less variable in yield and thus less risky. By contrast, Hazell et al. (2007) note that today's dynamic agriculture (as in Brazil) focuses on integrated production and marketing systems, and that new technologies are deployed more effectively at large scale, as they involve higher capital inputs, mechanization and require high levels of education.

Second is the issue of political economy. There is a sharp division between (at the extremes) two visions of modern agriculture. The first is characterized by the ideas that small is beautiful, that

organic is good and that GMOs and chemicals are bad. The second is that science and management expertise are the central tools if the trend of falling productivity is to be reversed and if there is to be sufficient food for a growing world.

This clash of vision plays out in different arenas, as I have experienced first-hand.

Illustration one was a fascinating political process inside Brazil just after Lula was elected as President in 2002. Lula was a city boy, who had grown up in the autoworkers unions in São Paulo. When he was elected President his campaign manager (and subsequent very successful Finance Minister) invited Lula to attend the big annual agricultural fair in the town of Ribeirão Preto. At this fair Lula was introduced to Roberto Rodrigues, a professor of agricultural sciences who was also a large sugar cane farmer and had a distinguished history with the national and international agricultural cooperative movement. Lula expounded to Rodrigues what were largely the views of the Movimento Sem Terra (MST), an important part of Lula's Workers Party, and a radical agrarian reform movement linked into the world anti-capitalist, anti-GMO movement. Rodrigues explained to Lula why pursuit of such a strategy would fly in the face of the great competitive advantage that Brazil had so carefully built, and would wipe out a very important sector that could bring wide-ranging benefits to Brazil and the world. Rodrigues expected Lula to defend the MST position, instead of which Lula asked "why has no one explained this to me before…. and I want you as my Minister of Agriculture". As Lula explained in another context, echoing a popular carnival song, "intellectuals love poverty, the poor just want to be rich". Under Lula's successful government the large-scale agricultural sector in Brazil continued to go from strength to strength.

A similar clash of visions emerged in the course of the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) in 2008. I learned of this report when I was summoned by the Minister of Agriculture in Brazil to ask how the World Bank (which provided the Secretariat for the IAASTD) could have produced a report which flew in the face of what Brazil considered to be the obvious facts about agricultural productivity and food supply. The IASSTP, hi-jacked by environmental NGOs, eulogized the ideas of small and organic is beautiful, scale and chemicals and GMOs are bad, and condemned "the Brazil model" which had played a hugely positive role in dampening the effects of the 2008 global food crisis.

Most of Brazilian agriculture is rain fed, depending on benign rainfall patters in the center-west, and south and southeast. The arid northeast is the one area where irrigation is vital. In the northeast there were, for decades, two different strands of irrigated agriculture. One strand was to provide public irrigation facilities to small farmers. For the most part the expensive infrastructure was used to grow subsistence crops, with little impact on the regional economy. The second strand was for entrepreneurial farmers to irrigate high-value fruit and vegetable crops, for national and international markets. Many of these enterprises thrived. And slowly, in some places, the entrepreneurial farmers started to sub-contract poor farmers in. The deal was that the entrepreneurial farmers would take care of credit, crop choice, technology and marketing, while the poor farmers would provide labor in exchange for a share of revenues.

In recent years, Brazil has started to experiment with a new public private partnership irrigation model (Bell et al. 2009) that aims to build on the capabilities of agribusiness, but also ensures that poor farmers are included. The core idea is what is technically known as a "reverse concession". The government specifies a particular area to be put under irrigation and requires

that about 30 percent of the area be farmed by small farmers. The government issues a request for proposals for private enterprises to develop the area. The bids are judged on two criteria. The first criterion is based on the financial input required by the government for building the necessary infrastructure (with a limit specified and a weight of about one-third in the evaluation proposal). The second criterion assesses the quality of the model for incorporating small farmers into the production model, and has a weight of about two-thirds in the assessment process. It is still too early to know whether this model will work as planned, but it provides another example of Brazilian efforts to build an agricultural model that is based on entrepreneurship and economies of scope and scale while also paying attention to social justice.

In summary, as described well by The Economist (2010a): "Brazil has followed the opposite prescription from that of the advocacy community. For most NGOs small and organic is beautiful; they frown on chemical fertilizers and loathe GMOs and they think it is more important for food to be sold on local than on international markets. Brazil's strategy is the opposite. Brazil's farms are many times the size even of American ones. Farmers buy inputs and sell crops on a scale that makes sense only if there are world markets for them. They depend critically on new technology. Brazil's progress has been underpinned by the state agricultural-research company and pushed forward by GM crops. In short, Brazil represents a clear alternative to the growing belief that, in farming, small and organic are beautiful."

Agriculture in Africa

For decades the growth in total factor productivity (Figure 8) in African agriculture has been dismal – less than a third of that in Asia and Latin America both with green revolution technologies and with new technologies.

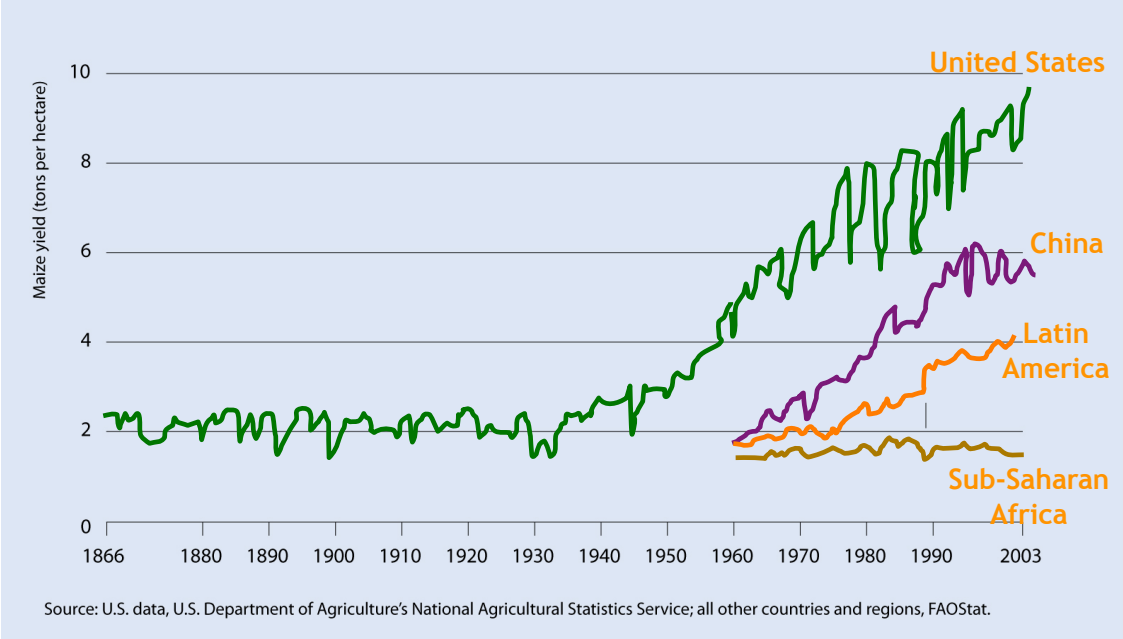
Figure 8. Total factor productivity growth in agriculture

REGION	1970-90	1991-06
Sub-Saharan Africa	**0.31**	**0.86**
Latin America	1.02	2.44
Asia	1.51	2.62
North America	1.49	1.91
Europe	1.26	1.52

Source: Fisher et al. 2010.

The consequence, as illustrated for maize in Figure 9, is that Africa has fallen further and further behind other continents.

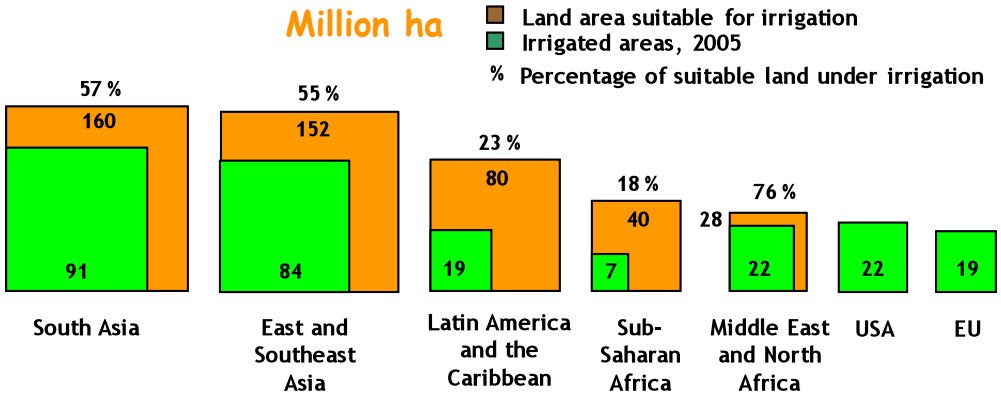
Figure 9. The growth in maize yield



Source: Steduto (2013).

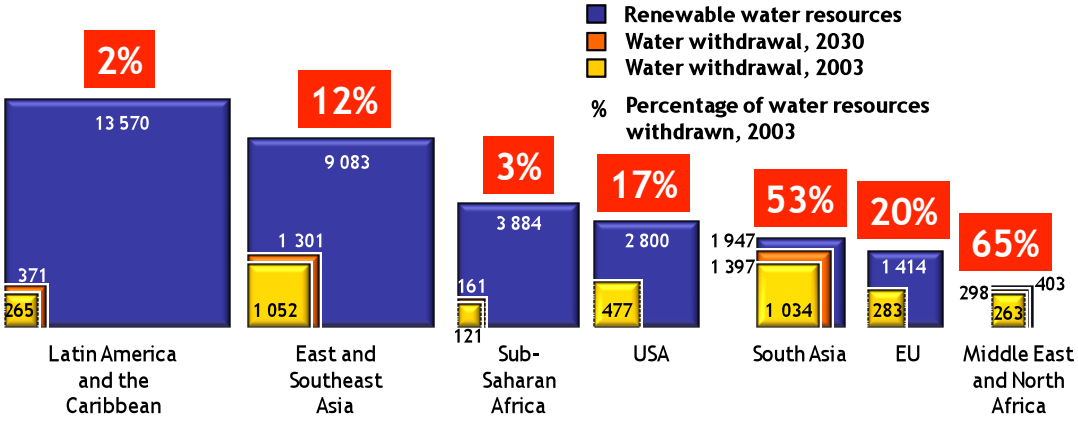
The cup is also, however, half full. The potential increases in yields in Africa are very large. Second, there is lots of land potentially available for cultivation in Africa. The FAO (2009) estimates that 80 percent of the world's cultivable land reserves are in Africa. The quality of this land is not worse than, for example, Brazil's cerrado. And Africa has immense untapped water resources and associated irrigation potential (Figures 10 and 11).

Figure 10. Irrigated land and potential expansion



Source: Steduto (2013).

Figure 11. Water development potential (Km^3)



Source: Steduto (2013).

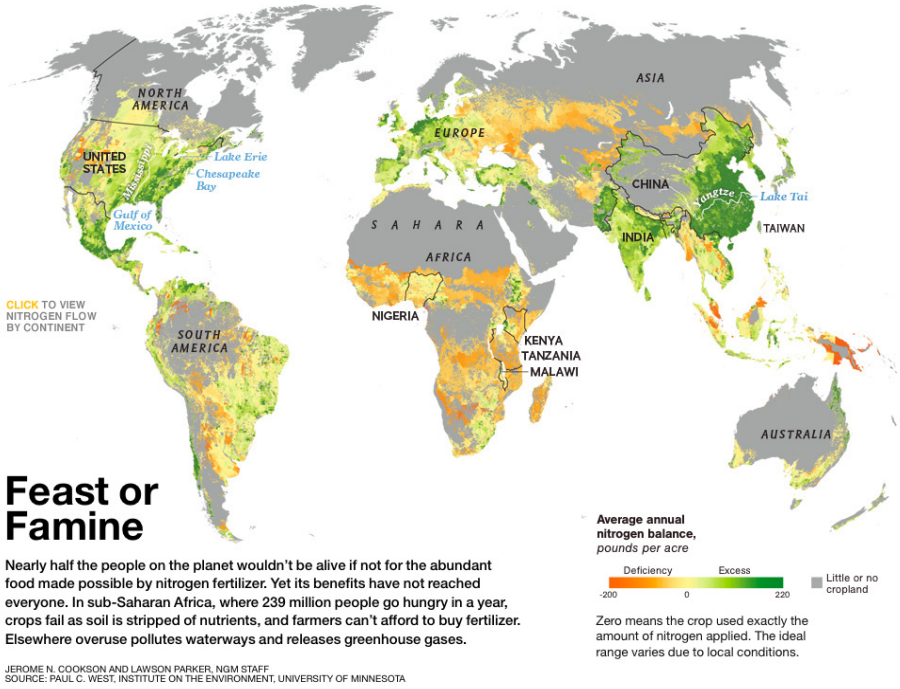
Some thoughts on a way forward for Africa

So what does the experience of other countries suggest might be some ways in which African agriculture can realize some of its enormous potential?

Looking at proximate causes, the simple answer is that Africa needs "more".

First consider fertilizer. While overfertilization is a major issue in large parts of the world, there is no question that Africa is at the other end of the extreme, with application rates a tiny fraction of those in other parts of the world (Figure 12).

Figure 12. Fertilizer around the world

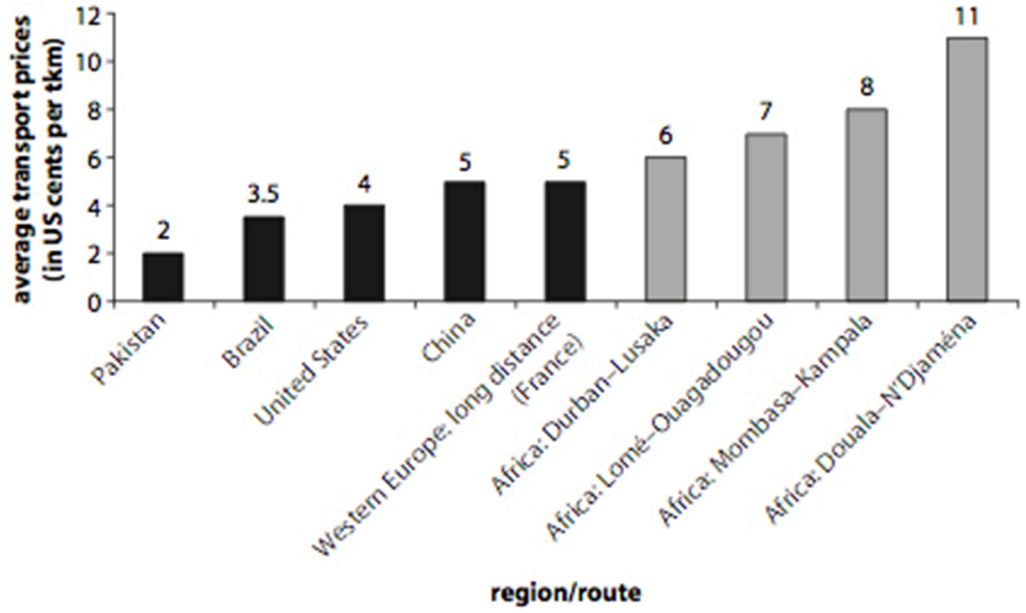


Source: National Geographic (2013).

Second, modern agriculture depends on inputs of energy, and again Africa is literally "the dark continent" lagging far behind all other parts of the world. Water-based energy could make a major contribution – Africa has huge hydropower potential, only 5 percent of which has been tapped (Figure 6).

Third, the same deficit is true for transportation infrastructure, which means that the costs of getting inputs to farmers and goods to markets are unusually high in Africa (Figure 13).

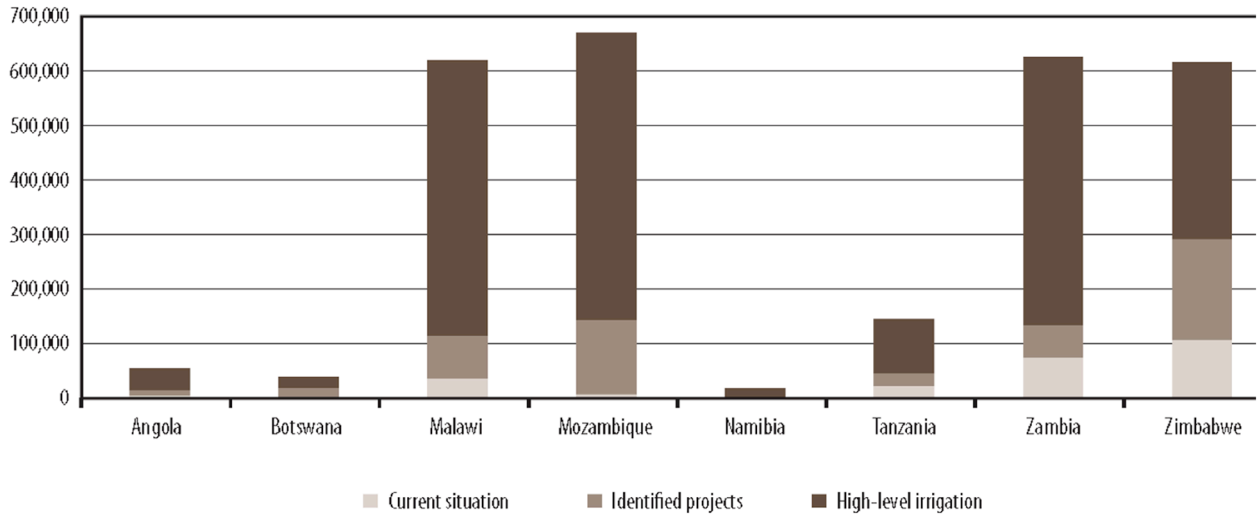
Figure 13. Average transport prices: A global comparison



Source: Teravaninthorn and Raballand (2008).

Fourth, Africa needs more irrigation, because irrigated lands are the most highly productive. Irrigated lands account for only 12 percent of all cultivated lands in the world but account for 42 percent of grain production. Sub-Saharan Africa has large untapped water resources for agriculture. As described by Abric et al. (2011), only around 4 to 5 percent of cultivated land is irrigated, two thirds of which is accounted for by Madagascar, South Africa, and Sudan. The potential exists to bring an additional 20 mha or more of land under irrigation. Irrigation in Africa uses less than 3 percent of total renewable resources compared to 36 percent in South Asia and 51 percent in the Middle East and North Africa. Figure 14 presents the illustrative case of a World Bank analysis (2010) showing the glaring gap between actual and potential irrigation in the Zambezi Basin.

Figure 14. Irrigation potential in the Zambezi Valley (annual irrigated area, in hectares)



Source: World Bank (2010).

Fifth, Africa needs more knowledge, on what to do and how to do it. And here aid is playing a negative role. Whereas Brazil, as described earlier, invested heavily in training agricultural scientists in U.S. universities, the NGO-dominated development scene in Africa has resulted in a massive mis-direction of skills. A Ghanaian leader in a large multi-national corporation put this well: "When I was a boy the aspiration of every smart child was to be an engineer; today Ghana's best and brightest want to become anthropologists, because the donor-driven job market is dominated by NGOs social sectors and that is the sort of skill they want."

Sixth, Africa needs to define its own future in agriculture, and rely less on the fickle advice of donors and NGOs who have played such a dominant role in most African countries in recent decades. The Asian/African contrast is revealing. In recent decades African countries have followed the donors' lead in reducing investments in agriculture. Asian countries have typically four times more of their overall budgets in agriculture (Lipton 2012) and five times the amount per cultivated hectare on agricultural research. Brazilian agricultural leaders have been asked (The Economist 2010b) whether "the miracle of the cerrado can be exported to Africa, where the good intentions of outsiders have so often shriveled and died" and answered "we went to the U.S. and brought back the whole package of cutting-edge agriculture in the 1970s…but that didn't work and it took us 30 years to create our own…Africa is changing, perhaps it won't take them as long".

Seventh, and related, Africa needs greater capacity to do things. As Larry Summers has described, the great gap that is emerging in the developing world is between countries that can implement and those who can't. Here the African track record is salutary. Manufacturing has not advanced (Devarajan and Fengler 2013), having the same small share of GDP today as in the 1970s. As agriculture becomes more industrial, the factors that hinder manufacturing (including limited managerial capacity and poor and expensive infrastructure) have to be addressed as binding constraints on agriculture, too.

The central challenges that emerge are the following:

- Africa has immense agricultural potential
- But Africa shows no signs of being about to endogenously develop the institutions and investments to take advantage of this potential
- So what can be done differently to catalyze the development of the necessary institutional capacity and investment, and
- What role can foreign public and private investment play in this process?

Central to this challenge is the controversial issue of foreign direct investment (FDI) in land.

First some facts. FDI in agriculture and land has increased considerably in a number of African countries over the last decade. A natural focus of such investment has been in areas where there is underutilized capacity. For example, consider Mali's Office du Niger (Abric et al. 2011), a large irrigation project started in 1932 but in which only a small proportion of the potential area has been developed. The Office du Niger has embarked on two major foreign partnerships – a Sino-Malian joint venture is developing 20,000 ha that had not previously been irrigated, and the Malian government awarded a 50-year lease for 100,000 ha of unirrigated farmland to Maibya, a subsidiary of Libya's sovereign wealth fund.

Second, some perceptions.

Perception 1 is that of NGOs and think-tanks in the U.S. and Europe who focus on the environment, justice and human rights. Op-eds bemoaning the "commoditization of global agriculture has aggravated the destabilizing effects of these large-scale land grabs" are published in the New York Times (Kugelman 2013). And OXFAM (2008) declares that "Oxfam research shows that big land deals in poor countries are leaving people homeless and hungry, and that families are being unfairly evicted from their land and left with no way to grow food or earn a living".

Perception 2 is the quite different perception of most African governments. As described by Cotula et al. (2009) "a recurring theme is, from the perspective of African governments, the relatively low importance and value of financial transfers compared to the expected broader economic benefits such as employment generation and infrastructure development. International land deals may constitute a development opportunity in recipient countries – by bringing capital and know-how, creating employment and developing infrastructure." African leaders also realize that there is often a large gap between rhetoric and reality. As reported in the Financial Times (Maton 2012), "Zambia's vice-president and a farmer himself, aired concerns that the majority of promises made by foreign investors do not materialize…his point not being that foreign investors are unscrupulous, but that farming is a complex business while raising capital is about painting the rosiest picture possible." This reality is mirrored in the experience of the World Bank's International Finance Corporation. A major independent evaluation of the IFC and agribusiness in Africa (World Bank IEG 2011) concludes that "difficult business environments, a shortage of indigenous entrepreneurs, the small size of the potential investments, lack of access to markets, and the discouraging experience of working directly with small-scale sponsors have constrained IFC engagement and performance in Sub-Saharan Africa" and "these factors have pushed it toward a focus on foreign sponsors and export-oriented or niche local or regional businesses, such as palm oil and rubber."

How should these quite different perceptions be assessed?

First, it is important to examine the recent record. Many of the NGOs who "speak in the name of the rural poor" played and play a major role in opposing investment in agriculture in the developing world. In the words of the World Bank's World Development Report on Agriculture, "opposition from environmental groups that saw agriculture as a contributor to natural resource destruction and environmental pollution" was an important factor in driving a major reduction in World Bank lending for agriculture (from 18 percent in 1980 to 4 percent in 2008, when the food crisis hit). Yet these same groups seem undeterred in continuing to advocate (as in the case of the IASSTD report described earlier) against science-driven, modern agriculture of the Brazilian type, and for a "small is beautiful", anti-GMO, organic vision of agriculture, inter alia for African countries.

Second, specific cases can help illuminate the reality. In another contribution to this series, Paul Collier describes a case of a serious, concentrated effort to bring investment and management to a several thousand hectare project in the Congo. The small group of people who lived in the area prior to the project were compensated fairly and offered employment. Once the investors had created the infrastructure and invested in improving the land, however, many other people appeared, claiming that they, too, had been displaced and should be compensated. As Collier says, there was a land grab – but it was land grabbed by local opportunists grabbed from the businesses who had invested money and management expertise.

Reflecting on these choices, I look back at my own experiences, especially in Bangladesh and Mozambique in the 1970s. I opposed agricultural modernization and infrastructure in Bangladesh, and was sure I was "on the right side of history" in being part of a group of politically-active "cooperantes" in Mozambique who reveled in this poor country following the socialist path and standing up against South Africa later in that decade. In the first case, my influence was, happily, limited. In the second, I was part of a larger and more influential group, which helped Mozambique down a path of collectivization and confrontation, with disastrous consequences for millions of people. In both cases I was not seeing a poor country in its own terms, not seeing that the priority for people was to have enough to eat and escape poverty, not seeing that the appropriate politics was "the politics of the belly" (Scroggins 2004). Rather I was part of a (self-righteous) group of people with full bellies who saw the developing world as the arena in which their own fantasies of a better world would be fulfilled. With, of course, passports in our pockets for the time when things got nasty. This was development as fantasy, or "the politics of the mirror" (Scroggins 2004).

So what path will African leaders choose to follow. Will they continue to react to the messages from the west: "don't build dams", "reduce spending on agriculture", "concentrate on the MGDs and put the social cart before the economic horse", "stay way from GMOs", "discourage large scale, science driven agriculture", "discourage FDI in agriculture"? Will Africa continue to succumb to the ideal and challenges of the Africa imagined by the west, and pursue "politics of the mirror" or will if focus on its real problems and engage with "the politics of the belly"?

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John Barry's seminal book describes the history of development and management of America's great river, including the contesting of ideas for managing floods. The culmination of this debate was when "nature spoke" in the massive flood of 1927. Barry describes the impacts of the flood on the economy and political history of the United States.

Bhatia, R., R. Cestti, M. Scatasta and RPS Malik (eds). 2008. *The indirect economic impact of dams*. New Delhi: Academic Foundation and The World Bank.

This collection of essays examines the indirect impact of major dam projects in Brazil, India and Egypt and shows that the indirect impact of these investments was as large as the direct impacts, and that they transformed regional and national economies. The essays also show that these were robust investments, benefitting societies even when the assumptions made at appraisal of sectoral developments (for example in irrigation and energy) were inaccurate.

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This is a historian's analysis of 400 years of water management in Prussia. The analysis documents the dialectic of responses to water challenges, and emphasizes that all responses are "provisional". The book shows how success in meeting specific water challenges at specific times leads to a new generation of challenges and responses. The book also documents the reality that past successes tend to be discounted by succeeding generations, who take the new reality for granted.

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This paper dissects a series of successful water reforms, and draws some general lessons for political and technical leaders who aspire to undertake water reforms.

Brown, Casey and Upmanu Lall. 2007. Water and economic development: The role of variability and a framework for resilience. *Natural Resources Forum* 30: 306–317.

This paper examines the relationship between key hydrological variables – mean rainfall, monthly and annual variability – and wealth. The analysis shows that most currently-rich countries have developed under relatively benign hydrological conditions, whereas most poor countries face malign hydrology.

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After the flood of 1927 the Mississippi River Commission adopted a strategy of "making room for the river". The test for this strategy came in 2011, when there was a flood a little larger than the 1927 flood. Camillo's book describes the extraordinary success of a century of investment in infrastructure and institutions.

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This article examines the policies that have led Brazil to become an agricultural superpower, and contrasts these with the standard recipes that have been emphasized by the aid community.

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This article presents an innovative framework for assessing the narrow and broad benefits of major water infrastructure projects.

World Bank. 2003. *Water resources sector strategy: Strategic directions for World Bank engagement.* Washington DC: World Bank.

This strategy was the subject of extensive and intensive discussions by the 180 countries who govern the World Bank. The document framed the wide difference in endowments and aspirations of rich and poor countries, and led to the re-engagement of the World Bank with "high-risk/high-reward" water infrastructure. The strategy also presented a framework for the economic and political analysis of water projects.