

## **Discussant comments on “Water and Agriculture in a Changing Africa: What might be done?”**

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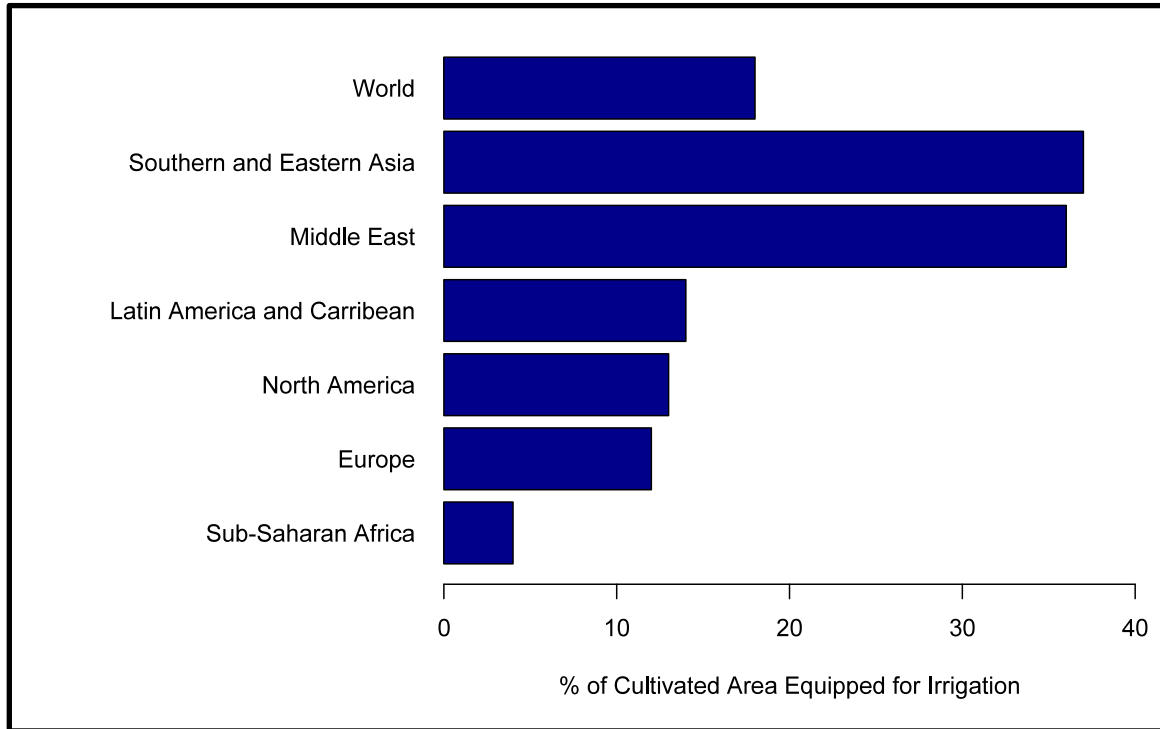
I was honored and humbled to be asked to serve as a discussant for this final leg of the Gates Symposium Series, and in particular to have the opportunity to share the discussion with John Briscoe. The goal of this series is to understand how lessons from other times and places might inform an effective and sustainable effort to eliminate food insecurity in sub-Saharan Africa (SSA) – the one region in the world where widespread lack of access to sufficient food is still deeply entrenched. Moreover, this series has focused on and featured speakers with extensive on-the-ground work. In these regards, with his multidisciplinary work in many different countries in numerous positions, John is the ideal person to address the issue of water- and food- security connections in SSA.

### **When we talk about food insecurity in SSA, who are we talking about?**

I greatly appreciate John’s message that a romantic emphasis on small, local, and organic – the politics of the mirror – is not the right one for SSA. After all, most farms in SSA are small (1-2 ha), sell their harvests locally, and are organic (due to lack of capital). Although there is certainly heterogeneity, most farmers are growing rain-fed starchy staples crops – cereals like maize, sorghum, or millet, or roots and tubers like cassava, yam, and sweet potato. Because these are rain-fed crops, they are vulnerable to weather shocks on a yearly basis. On top of that, since production is confined to the rainy season, there is an additional seasonal component to poverty and malnutrition, on top of the chronic risk. Farmers often lack access to capital for input purchases; as a result, many farms in SSA suffer from low yields and depleted soils. This, combined with a lack of infrastructure and market connectivity, conspires to keep smallholder farmers in poverty. These dynamics have been well illustrated in the earlier talks/papers in this series.

Certainly, many mechanisms for breaking this cycle exist (and many have been discussed in the context of this series!); irrigation is but one. Irrigation can help mitigate weather shocks that contribute annually to low yields and food insecurity; it can also enable year-round production, which can help mitigate seasonal malnutrition and poverty. Finally, irrigation facilitates diversification into higher-value crops like fruits and vegetables. Local demand for such crops tends to be high and elastic in rural SSA, resulting in less dramatic harvest-time price swings and supply gluts. Nevertheless, in spite of these benefits, only 4-5 percent of cropland in SSA is currently irrigated (Figure 1), and most of that is concentrated in a few countries (Madagascar, South Africa, Sudan, and Nigeria) (Frenken 2005). Why? Is irrigation somehow harder to do in SSA? What are the prospects for the future?

**Figure 1. Irrigation around the world**

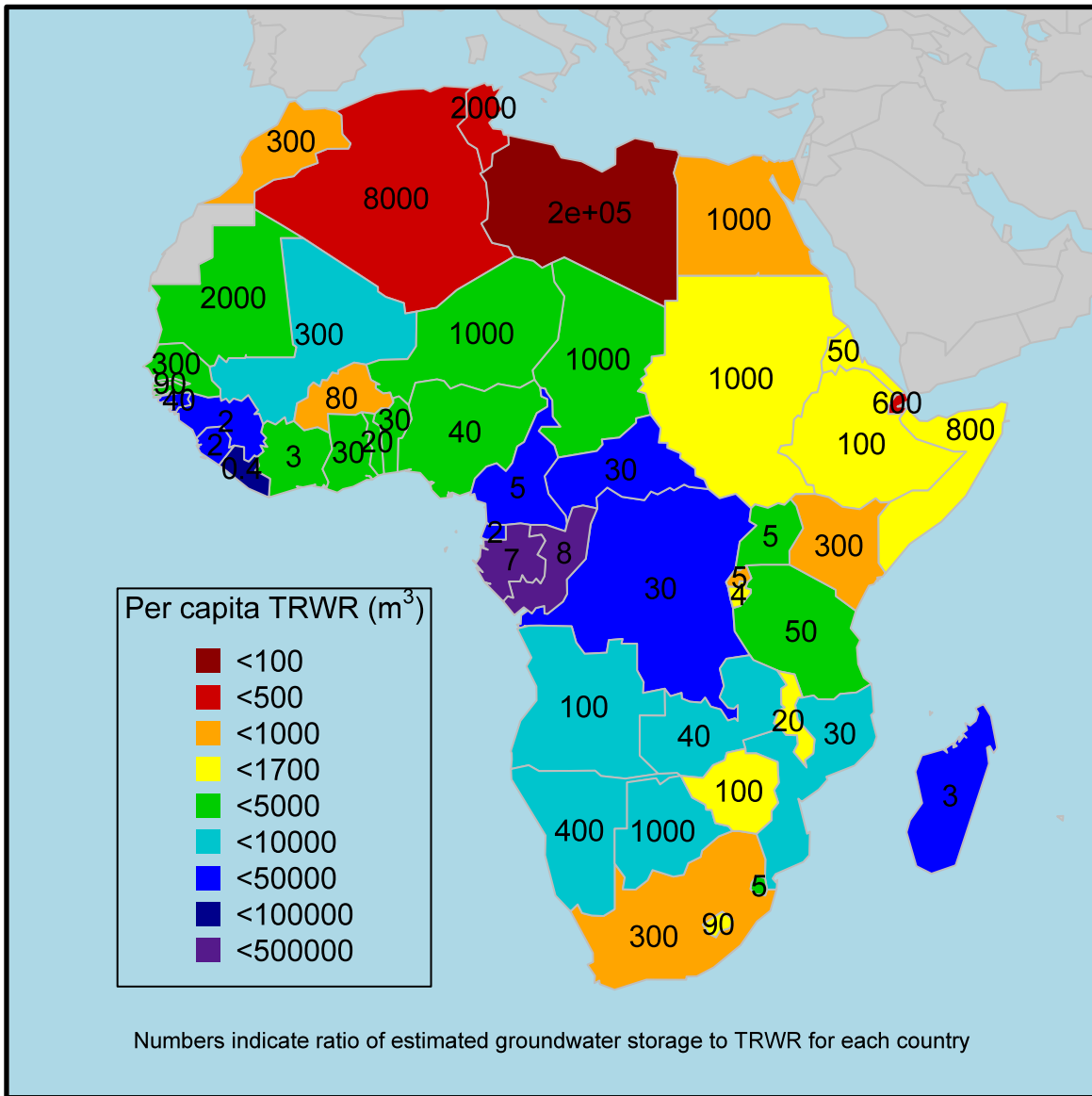


I come at this question from an unabashedly physical sciences perspective. I deeply believe that we need to start with the physical reality and then figure out what technological and institutional arrangements would work best within the physical constraints. As John has so eloquently advised, a wise strategy for any region is to develop benign hydrology first, and then use profits to invest in dealing with malign hydrology. In that framework, the question becomes: what is SSA's benign hydrology? AKA where is the best place to start?

### **There is water**

Looking at large spatial scales, one of the first facts that stands out is that SSA does have a lot of water. As shown in Figure 2, when considering Total Renewable Water Resources (precipitation + recharged groundwater + surface flows from other countries), most of SSA is not considered water-stressed (Frenken 2005). Although there are exceptions, SSA stands in stark contrast to northern Africa. Moreover, even the countries that are TRWR-stressed sit atop groundwater resources that are estimated to be larger by a factor of 10 to 100 (MacDonald et. al. 2012). Of course, accessing these water resources (both surface and groundwater) and using them wisely is not necessarily straightforward.

**Figure 2. Total Renewable Water Resources (TRWR) and estimated groundwater storage in Africa.**



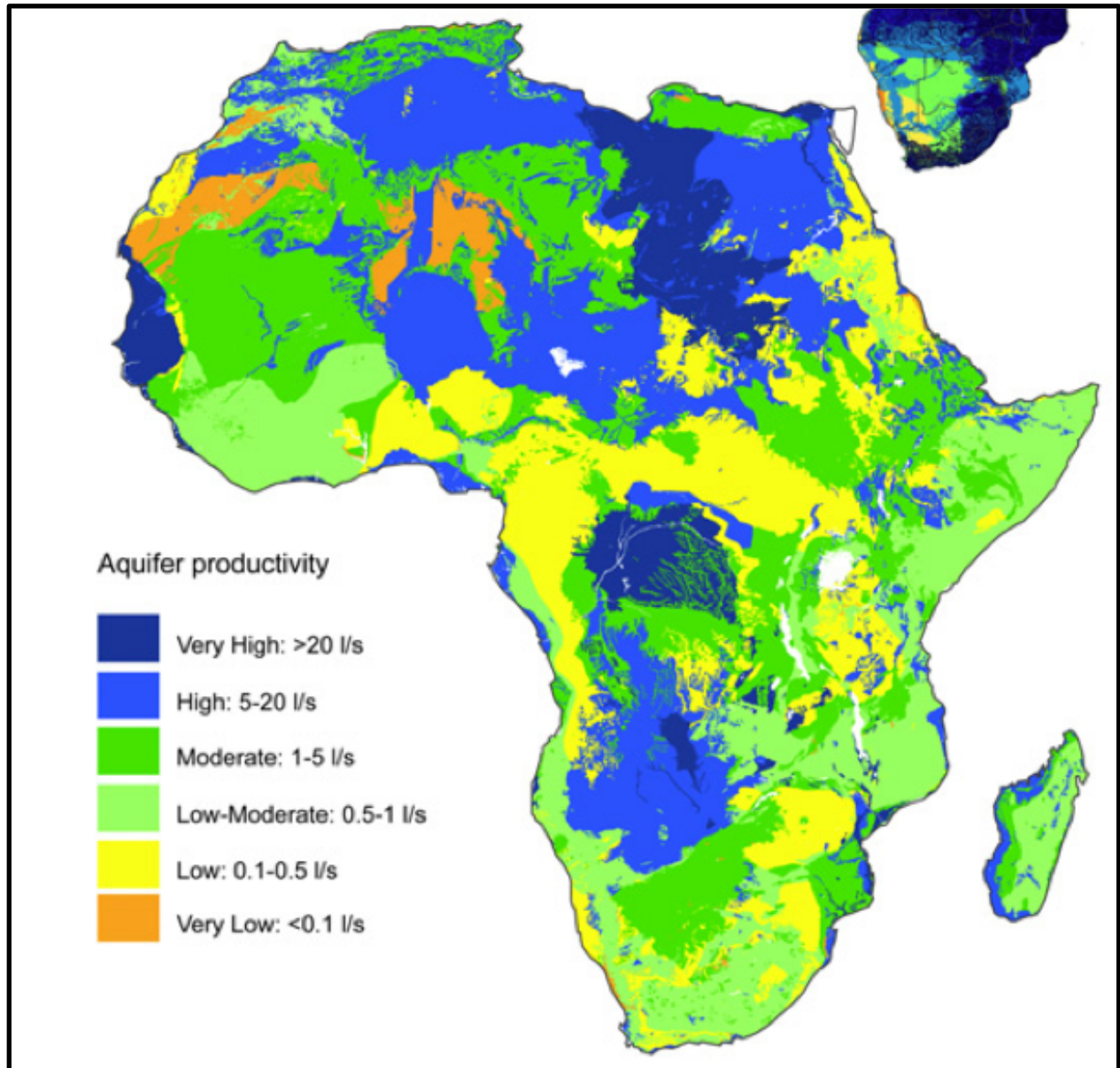
Notes: Countries with TRWR<1700m<sup>3</sup> per person per year are considered water-stressed. Much of Africa, particularly sub-Saharan Africa, lacks economic rather than physical access to water.

Source: Data from Frenken (2005) and MacDonald et. al (2012).

When we zoom in to a smaller spatial scale, we see that much of SSA’s groundwater is likely to yield low- to medium flow- borewells of 0.1-5 liters/s (Figure 3). Such wells are well suited for distributed networks of smaller-scale irrigation systems as opposed to large centralized systems: for reference, 1 liter/s is approximately the amount needed to irrigate half a hectare of vegetables in a hot, dry climate. Fortunately, this reality coincides with the physical reality of farmer

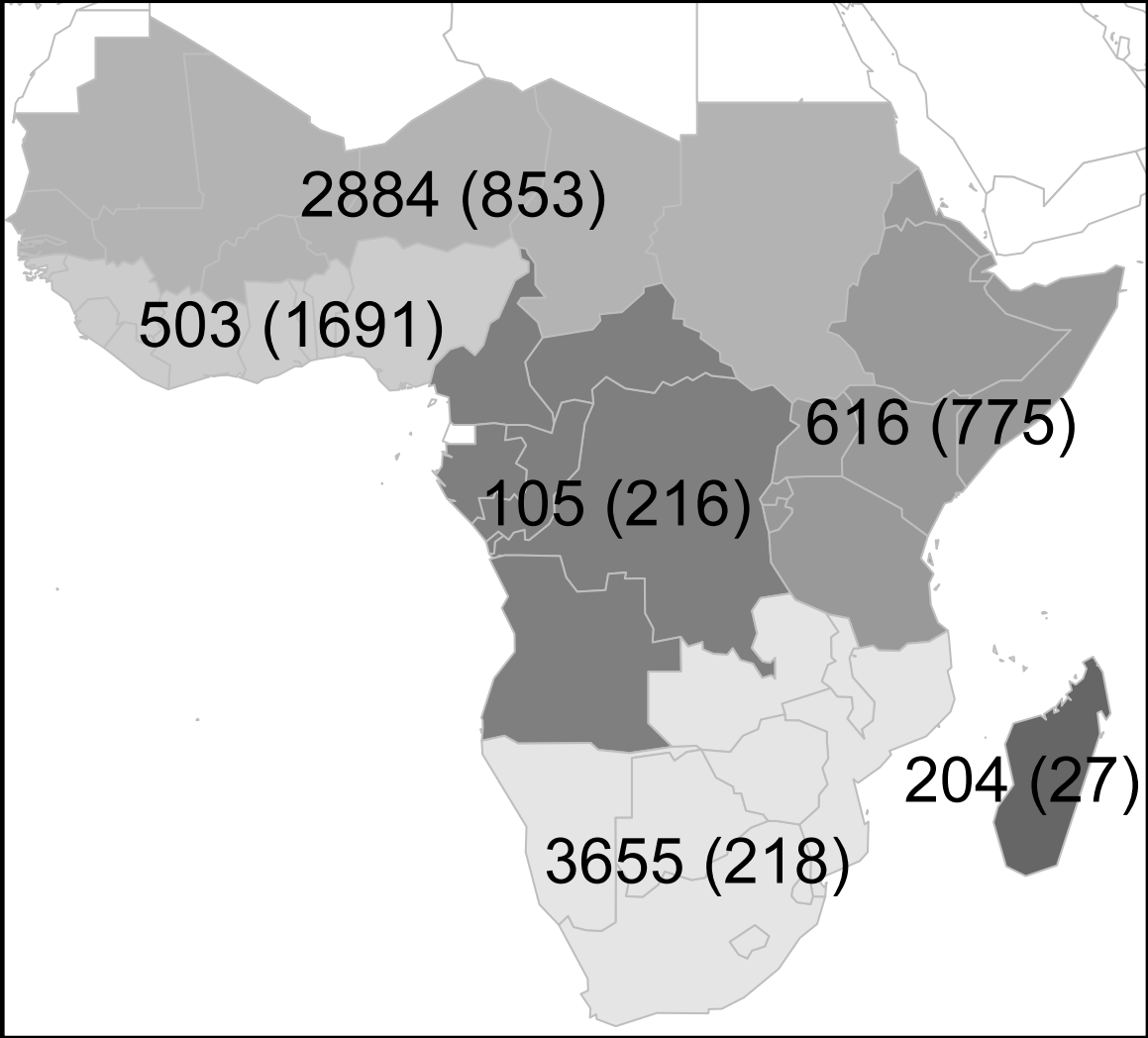
resource endowments in SSA. Most farmers are working less than 1 ha of land (see Thom Jayne's presentation), but due to population increases, per capita landholdings in SSA are decreasing more rapidly than anywhere else in the world at present (FAOSTAT). A recent study examined the feasibility and profitability of large-scale (dam-based) v. small-scale (decentralized pumping from surface sources) and found that in SSA, more area is suitable for distributed irrigation (6.6 Mha v. 1.2Mha), and that those systems would have a much higher estimated rate of return (28 percent average v. 12 percent average) (You et. al. 2011; Figure 4).

**Figure 3. Estimated aquifer productivity in SSA**



Source: MacDonald et. al. (2012).

**Figure 4. Total irrigated area with profitable expansion potential (IRR>12%) for distributed irrigation in parentheses, by region (thousands of hectares)**



The good news is that the type of water available and the food production landscape on the ground are well-matched. Unfortunately, large-scale expansion of distributed irrigation in SSA will likely be tricky due to the policy and institutional requirements necessary to effectively undertake such an expansion in a sustainable manner. As the world has learned from South Asia, a proliferation of private borewell-based irrigation systems in the absence of a proper regulatory and institutional framework can easily lead to unsustainable withdrawals and depletion of precious groundwater resources (e.g., Rodell et. al. 2009). Moreover, projects involving siting and drilling of hundreds or thousands of borewells are the stuff of government and NGO nightmares: they are fraught with uncertainty and local specificity, and therefore difficult to budget and costly to carry out. (At the other end of the spectrum, this series itself has shown how effective strong, centralized institutions can be in terms of harnessing water for food security in the case of China.)

What might be done with this combination of physical and institutional constraints? On the technical side, the physical realities should result in an emphasis on efficient water use and reasonable oversight of groundwater withdrawals. On the institutional side, new arrangements need to be made for managing large-scale, but distributed, systems. As one example, a focus on development of surface water storage networks (individual or community scale catchments) would both help with efficiency and leverage existing institutions, as many communities across SSA already oversee catchments for livestock.

When considering how to best promote and invest in irrigation in SSA, against a backdrop of weak institutions and weak infrastructure, I diverge a bit from John's opinions about the role for NGOs in agricultural development. In SSA, I believe there is a unique and critical role for NGOs to play in helping individuals and communities to overcome informational inefficiencies that are at present hindering irrigation expansion. For starters, the big foundations might best contribute by undertaking detailed water resources mapping at the village level. Currently, geophysical surveys are prohibitively expensive for individual smallholders, and often communities. NGOs can also help at the local level with linking farmers to technologies and information, and at the regional level with developing supply chains that can feed private demand for irrigation equipment and services. Finally, NGOs will be extremely valuable in testing different institutional arrangements for effective water resource management at different spatial scales.

In recent years, investment in agriculture in general in SSA has picked up steam through organizations like the Alliance for a Green Revolution in Africa (AGRA) and the Comprehensive Africa Agricultural Development Program (CAADP). Neither of these institutions has an explicit focus on irrigation at present, although both have indicated a desire for future involvement. The physical reality of distributed water resources and many smallholder farmers suggests a very strong role for private sector investment. In the recent past, small-scale distributed irrigation has been the fastest-growing type of irrigation in SSA (Frenken 2005), and private distributors report that they are doing well (e.g., Kickstart 2011). It is my hope that in the next few years, with some key investments by the public sector, private sector, and international foundations, irrigation in SSA will truly take off, and with it, the livelihoods of millions of smallholders.

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