Nile Basin Asymmetries: A Closed Fresh Water Resource, Soil Water Potential, the Political Economy and Nile Transboundary Hydropolitics

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Abstract The Nile Basin is characterised by a number of *asymmetries*. First, the water endowments and use are asymmetrical. The eight upstream riparians provide all the *surface water* in the basin but they make negligible use of these surface waters. Downstream Egypt and the Sudan are arid but benefit from a notional total use of the *flowing surface waters*. A second asymmetry is that the upstream riparians are also well endowed with *soil water*. Soil water cannot be shared except in traded commodities and these non-shareable *soil waters* are probably twice the volume of the technically shareable surface waters. The third asymmetry is in adaptive capacity.

Egypt has adapted to its serious water deficits since the early 1970s by achieving water security by diversifying and strengthening its economy. Its diversified economy has enabled it to import food and embedded *virtual water*. The upstream riparians have achieved much lower levels of adaptive capacity. The fourth and most important asymmetry is a consequence of Egypt's adaptive capacity. There is a marked asymmetry in *power relations* in the Nile Basin. Egypt is the basin hegemon. A hegemon is a first amongst assumed equals. Its interests have been asserted in basin *hydropolitics* and are expressed in de facto allocations and in the existing Nile Water Agreements – 1929 and 1959 – between Egypt and the Sudan. Its interests continue to be influential across the basin in the initiatives that emerged in the 1990s as an organisation established in 1999 – *The Nile Basin Initiative*.

1 Introduction

The first purpose of the chapter is to highlight the driving forces that have shaped the current approaches to managing the water resources of the Nile Basin. The major driving force is demography. Population is rising rapidly in all the riparian economies. Each additional individual requires about 1,000 m^3 of water per year for food, livelihood and domestic water needs. Ninety per cent is for food. As a consequence of the rising

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populations all the economies have had to mobilise more water to meet the needs of the additional consumers. These additional demands have closed the *freshwater* Nile resources. The flowing freshwater of the Nile basin is used mainly in Egypt and the Sudan. Egypt has already reached the stage that the quality of its water environment is being impaired by the levels of water abstraction for irrigation and other economic and social uses. A second driving force arises from the additional consumption associated with the advancement of an economy and associated uses of water by society. As the incomes of riparian populations rise, their new consumption behaviour requires more water. This driving force is as yet weak in the Nile Basin as the GDP per head of the populations of the Nile Basin countries are not rising significantly – with the exception of those of Egypt and the Sudan. This driving force is not currently significant but it will be when the economies begin to develop more rapidly. A third, and related, driving force is the diversification of economies. This force has the very important potential to ameliorate the problems of water scarcity caused by population increase. A more advanced and diverse economy is strong and has options that weak economies do not. A diverse economy can generate revenue surpluses that enable the economy to import water intensive commodities such as staple foods. Egypt has already demonstrated that it is possible to cope with the challenges of a serious water deficit. Egypt has achieved food security by having the capacity to remedy its water scarcity in the global trading system by 'importing' virtual water. It will be shown that those Nile Basin riparians already experiencing water deficits revealed by their no longer being food self-sufficient can only achieve water and food security by engaging in international commodity trade. Internal trade amongst the riparians will be shown to be limited. It will also be shown that Egypt not only benefits from the freshwater in the Nile River, which is fed by rainfall in Ethiopia and in the East African Lakes Basin. It is also the major 'importer' in the basin of virtual water from the soil water surplus East Africa in its substantial imports of tea and coffee.

The chapter provides estimates of the water resources that contribute to water and food security of the Nile riparians. The *freshwater* in the Nile River and its tributaries – about 100 billion cubic metres annually (Zeitoun & Allan, 2007) – is important but is not the major water resource of the basin as a whole. The basin's water resources also include the – usually ignored – *groundwater* in aquifers to which the respective riparians have access. Even more important – and *always* ignored until FAO began to make estimates of soil water use in the Nile Basin in 2005 – is the *soil water* in the rainfed soil profiles of the basin (FAO, 2008). Rainfed soil water produces crops and livestock products. The volume of soil water in the territories of the Nile riparians, an area much larger than the Nile Basin itself, has been estimated to be about 229 billion cubic metres (evaporation from crops only) annually (Zeitoun & Allan, 2007). The review of the Nile Basin's water resource endowment will provide a perspective on the underlying fundamentals that should inform water policy makers and water users on water management options to achieve ecological and environmental sustainable outcomes.

Nile freshwater resources do not by any means provide water security for the Nile riparians. The chapter will provide an overview of the *water security* of the basin's riparians by examining their *food trade* statistics.

The Nile surface waters are closed. That is, further use of them with current technologies, will seriously degrade the flowing water resources and also impact negatively ecological diversity more generally. Water security is an issue of growing significance. The nature of the conflictual relations over these shared water resources will be analysed. The agreements and institutions that have been established to buttress *prior use* approaches – that is *water integrity* – which serve the interests of downstream riparians will be discussed. The upstream riparians prefer the principle of *water sovereignty* – which especially serves the interests of upstream riparians that enjoy high levels of rainfall. There will also be a discussion of the attempts to introduce the notion of *equitable utilization* a principle of international customary water law. The idea of shared *socio-economic benefits* that could be gained from alternative approaches to managing scarce transboundary waters will also be reviewed.

It will be concluded that the Nile Basin is characterised by a number of *asymmetries*. First, water endowments are asymmetrical. The eight upstream riparians provide all the *surface water* in the basin but they have not used these surface waters. Downstream Egypt and the Sudan are extremely arid or semi-arid but benefit from a notional total use of the *flowing surface waters*. A second asymmetry is that the upstream riparians are also well endowed with *soil water*. Soil water cannot be shared and these non-shareable *soil waters* are probably twice the volume of the shared surface waters. The third asymmetry is in adaptive capacity. Egypt has adapted to its serious water deficits since the early 1970s by achieving water security by diversifying and strengthening its economy. Its diversified economy has enabled it to import food and embedded *virtual water*. The upstream riparians have achieved much lower levels of adaptive capacity. The fourth and most important asymmetry is a consequence of Egypt's adaptive capacity. There is a very marked asymmetry in *power relations* in the Nile Basin. Egypt is the basin hegemon. Its interests have been asserted in basin *hydropolitics* and are expressed in the existing Nile Water Agreements – 1929 and 1959 – between Egypt and the Sudan. Its interests continue to be very influential across the basin in the initiatives that emerged in the 1990s as an institution established in 1999 – *The Nile Basin Initiative*.

2 Asymmetric Hydrology

The orientation of the Nile river flow is from two relatively high rainfall regions in the south to a rainless desert region in the north. Egypt and the Sudan benefit from the summer rains that fall in the highlands of Ethiopia and in the relatively well-watered region in the Lakes Basin in East Africa. The East African basin includes most of Uganda, Rwanda and Burundi but only very small parts of Kenya, Tanzania, and the Democratic Republic of the Congo (DRC). Figure 1 shows the small proportion that the headwaters region of the Nile Basin occupies of the East African and Horn of Africa riparians.

Fig. 1 The Nile Basin and the areas covered by the territories of the riparians (London Water Research Group, 2007; map reproduced with permission of the FAO) (*see Color Plates)*

Table 1 provides the areas of the riparians and the proportions of their territory that lie within the Nile Basin. Table 2a shows quantities and proportions of the flowing Nile *freshwater*. Estimates are also shown in Table 2b of the *groundwater* resources of the ten riparians – mainly unutilised, and also estimates of the soil water being used currently based on the evapo-transpiration from the crops being raised. There are no estimates of the potential volumes of utilisable soil water in the basin countries.

Table 1 Base data on Nile Basin states in relation to the Nile Basin

	State Area (km^2)	State Area in Nile Basin (km^2)	Per cent of Area of Basin	Per cent of State Area inside Nile Basin
Egypt	1,001,450	326,751	10.5	32.6
Sudan	2,505,810	1,978,506	63.6	79.0
Ethiopia	1,100,010	365,117	11.7	33.2
Eritrea	121,890	24,921	0.8	20.4
Eastern Nile		2,695,295		
Uganda	235,880	231,366	7.4	98.1
Kenya	580,370	46,229	1.5	8.0
Tanzania	945,090	84,200	2.7	8.9
Burundi	27,834	13,260	0.4	47.6
Rwanda	26,340	19,876	0.6	75.5
DR Congo	2,344,860	22,143	0.7	0.9
Southern Nile		417,074		
Basin as a whole		3,112,369	100	

Source: based on Phillips et al. (2006: 67) (based on FAO AQUASTAT data).

Table 2a Freshwater flows of the Nile and its tributaries and precipitation in the ten riparians

	Average annual precipitation (mm)	Inflow ($Mm^3\ y^{-1}$)	Outflow ($Mm^3\ y^{-1}$)
DR Congo	1,245	0	1,500
Burundi	1,110	0	1,500
Rwanda	1,105	1,500	7,000
Tanzania	1,015	7,000	10,700
Kenya	1,260	0	8,400
Uganda	1,140	28,700	37,000
Eritrea	520	0	2,200
Ethiopia	1,125	0	80,100
Sudan	500	117,100	55,500
Egypt	15	55,500[a]	Less than 10 to sea

[a]Allocation to Egypt after deduction of evaporation from Lake Nasser, according to 1959 Sudan-Egypt Nile Basin Treaty. Evaporation from Lake Nasser is currently high because the level of the lake is high after almost two decades of above average rainfall in Ethiopia. Evaporation fell to between five and six cubic kilometres in the drought years of the mid-1980s (Stoner, 1995).
Source: Stoner, D., 1995. Future irrigation planning in Egypt, In Howell, P. P. & J. A. Allan, *The Nile: sharing a scarce resource*, Cambridge: Cambridge University Press, pp 281–298.

The asymmetric hydrology can be deduced from Tables 1 and 2a, b. They show that apart from some relatively minor surface flows derived from rainfall in southern Sudan almost all the Nile flows come from Ethiopia – about 85%. The rest comes from the East African Highlands. The East African water is subject to major evaporative losses in Lake Victoria and to high levels of evapo-transpiration in the wetlands of southern Sudan. These losses reduce the flow on the White Nile at Khartoum to 50% of the flow from Lake Victoria. The freshwater flows from Ethiopia that come down the Blue Nile and the Atbara flow fast into the Sudan and

Table 2b Freshwater flows of the Nile by riparian and showing the average annual precipitation, soil water consumption and groundwater production

	Average annual precipitation (mm)	Nile River Freshwater Flows*		Soil Water Consumption** (Mm3 y-1)	Groundwater Production*** (Mm3 y-1)
		Inflow (Mm3 y-1)	Outflow (Mm3 y-1)		
DR Congo	1,245	0	1,500	31,909	421,000
Burundi	1,110	0	1,500	6,132	2,100
Rwanda	1,105	1,500	7,000	11,000	3,600
Tanzania	1,015	7,000	10,700	31,583	30,000
Kenya	1,260	0	8,400	20,386	3,000
Uganda	1,140	28,700	37,000	45,504	29,000
Eritrea	520	0	2,200	843	
Ethiopia	1,125	0	80,100	31,075	40,000
Sudan	500	117,100	55,500	50,313	7,000
Egypt	15	55,500[a]	<10,000 (to sea)	0	1,3000
Total in System		approx, 100,000		approx, 229,000	

* Evaporation from natural & constructed storage not accounted.
** 2002 soil water data based on Nile Basin Dataset (FAO, 2006a – see also Appendix B). The figures do not include soil water used by natural vegetation.
*** Aquastat *production* figures. Groundwater *availability* data are not available. No production data available for Eritrea. Allocation to Egypt after deduction of evaporation from Lake Nasser, according to 1959 Sudan-Egypt Nile Basin Treaty. Precipitation and freshwater data from FAO (1997: Table 20). Evaporation from Lake Nasser is currently high because the level of the lake is high after almost two decades of above average rainfall in Ethiopia. Evaporation fell to between five and six cubic kilometres in the drought years of the mid-1980s (Stoner 1995).
Source: Stoner, D., 1995, Future irrigation planning in Egypt, In Howell, P. P. & J. A. Allan, *The Nile: sharing a scarce resource*, Cambridge: Cambridge University Press, pp 281–298.

Egypt. Flood waters reach Egypt within a few weeks of their entering the system in the highlands of Ethiopia and are much less subject to evaporation. Waters stored in Lake Nasser/Nubia are subject to evaporative losses at a rate of 3 m depth per year. Aswan has the highest evaporative rate on Earth. When the Lake was low in 1986 the losses were over five billion cubic metres per year. The Lake has been at a high level for almost two decades and the losses are currently about 13 cubic billion cubic metres per year, the level recorded in the late 1970s (Stoner, 1995).

The first hydrological asymmetry is the difference between the fresh water endowment of the southern basin compared with that of the north. The second asymmetry, is in soil water endowments – see Table 2b. This asymmetry comes about for the same reason as the freshwater asymmetry – the rainfall distribution in the basin. The southern basin is even more rich in soil water than it is in freshwater. Soil water is the infiltrated rainfall that remains in the soil profile long enough to sustain vegetation and crops. Table 2b shows estimates of soil water use in the ten riparians; there are no estimates of actual soil water resources that could potentially be utilised. The soil water used in the southern riparians is estimated to total

229 billion cubic metres (FAO, 2006a). This volume is more than twice the 100 billion cubic metres of fresh Nile water flows.

The significance of the southern soil waters had not been given any prominence until the mid-1990s when the author first raised the idea publicly at a Nile 2002 meeting in Addis Ababa (Allan, 2001). The scale of the soil water resources of the southern basin is very significant both economically and politically especially as Ethiopia and the riparians of the East African Highlands export almost all their Nile freshwater. Freshwater can be, and has been, captured. Soil water on the other hand cannot be shared unless it is incorporated in traded commodities. Soil water is not politically significant unless attention is drawn to it. It can become very political if it is suggested that it be taken into account in comparing the water endowments of competing riparians. As a silent water resource it underpins significantly the water security of the southern basin riparians. Flowing surface freshwater is already highly politicised as it is palpably shareable and quickly becomes the focus of conflict as the demands for water of competing riparians rise.

The prominence of the climate change science makes it necessary to check what climate scientists are saying about the future of the Nile Basin. The future climate scenarios are favourable for Nile basin riparians. Both surface freshwater and soil water resources will be higher although they may be more drought and flood impacted. In this case both the north and the south will benefit as the north will receive the higher river flows if the existing international allocations of waters continue. Since the low flows of the 1980s levels of seasonal monsoon precipitation in the south of region have been above the long-term average. The majority of climate change scientists suggest that future Nile flows will continue at current high levels rather than at the low levels of the early 1980s levels (Milly et al., 2005; Conway et al., 2007). The existence of extensive spillage from Lake Nasser-Nubia since the early 1990s (see maps at google.com) has created large flooded areas to the north west of Aswan confirming the higher flows. The southern riparians will benefit from the higher levels of soil water in the twenty-first century. Amongst the many uncertainties regarding climate change impact is the levels of future evaporation and evapo-transpiration.

3 Asymmetric Political Economies

The Nile riparians are also asymmetric vis-à-vis their development indicators. The extent to which an economy is developed is extremely important with respect to its capacity to deal with water scarcity. Table 3 shows that the downstream riparians, Egypt and the Sudan, have achieved much higher levels of GDP per head. This indicator, albeit crude, is helpful as a way of estimating the adaptive capacity of an economy. Egypt's higher GDP per head is consistent with its capacity to meet it seriously worsening water resource insecurity. Egypt's more diverse and relatively stronger economy has enabled it to achieve security – not by self-sufficiency in land and water – but through its capacity to trade its way to security by importing water intensive food commodities.

Table 3 Past and projected populations of Nile Basin States, 1960–205 in millions and GDP per head 2006 in US$ per head

	1960	1975	1990	2005	2020	2035	2050	Est Growth Rate[a] p.a.	GDP/ Head 2006 Indicator of adaptive capacity
Egypt	27.8	39.3	55.8	74.9	96.9	114.7	127.4	1.2%	1484
Sudan	11.4	16.7	24.9	35.0	44.5	53.3	60.1	1.2%	934
Ethiopia	24.1	35.2	52.0	74.2	104.8	138.3	171.0	2.0%	164
Eritrea	/	?	?	4.5	6.6	8.6	10.5	2.0%	249
Uganda	6.8	10.8	17.4	27.6	46.6	73.6	103.2	3.0%	842
Kenya	8.3	13.6	23.6	32.8	38.5	42.2	44.0	0.9%	650
Tanzania	10.2	16.2	26.1	38.4	49.8	60.2	69.1	1.4%	319
Rwanda	2.9	4.4	6.8	8.6	11.6	14.4	17.0	1.8%	242
Burundi	2.9	3.7	5.6	7.3	11.1	15.1	19.5	2.0%	114
DRCongo	15.4	23.9	37.4	56.1	84.4	118.6	151.6	2.2%	136
All Nile States	111.0	165.7	249.4	359.4	494.7	639.0	773.7	1.75%	

Based on FAOSTAT, FAO Statistics Division ("long-term series (quinqu.) tot./rural/urban" from FAOSTAT Classic view).
[a]Estimated growth rate derived from population figures. GDP data form UNDP and World Bank.

All the riparians face serious water resources challenges as a consequence of their rising populations. The current growth rate of Uganda is particularly significant when projected to mid-century. The population growth in north-east Africa as a whole is high by global standards. Egypt has begun on its demographic transition which will lead to a leveling off of the rising trend by mid-century. But a doubling of Egyptian population is still possible. The levels at which the populations of Ethiopia, of Uganda and of Kenya are growing place extreme burdens on the limited adaptive capacity of these economies as well as on their limited soil and freshwater water resources. That Egypt is at a more advanced stage in the demographic transition than the economies in the south of the basin is a major asymmetric feature of the political economy of the Nile Basin.

Egypt has demonstrated that it is possible to cope with the closure of its Nile water resource. Egypt has always been more dependent on Nile freshwaters than any of the other riparians. By the millennium, however, it had sufficiently diversified its economy to be able to access half its national food requirements via global trade in food commodities. Such trade freed the political leadership from the economic and political stress of mobilising non-existent water within its own economy. Egypt's achievements in the political economy are much less prominent in political discourse than the conventional emphasis which concerns the devotion of political energy and investment to developing the very unpromising and already over-utilised freshwater resources.

Adaptiveness as expressed by the capacity to diversify the economy is clearly *asymmetrically arranged* in the Nile Basin. Egypt is relatively adaptive. The other economies are much less so. Most are classified as fragile states. One of the reasons for the lack of adaptiveness in the southern political economies is that the southern riparians have endured and are currently experiencing high levels of internal and/or international conflict. Such conflict is also *asymmetric* across the basin with high levels in the south. Egypt is significantly less troubled by internal conflicts, especially by armed conflict. Although even Egypt is seriously divided internally, however, over the issue of how and at what pace it should modernise its society and economy. In the south in 2008 there were numerous examples of violent conflict; in the Sudan, in Uganda, in Kenya and in the DRC. There was an international violent intervention in Somalia in 2007, which was ongoing in 2008. If the 1990s are included all the Nile riparians except Egypt and Tanzania, have endured high levels of internal violent conflict. Only 9% of Tanzania's area lies in the Nile Basin.

4 Water, Food and Trade and Water Security and Sustainability Asymmetries

A further *asymmetry* is expressed in the levels of trade in food commodities both between riparians within the basin and especially with respect to trade between the Nile riparians and economies outside. The Nile Basin riparians can achieve water security either by increasing their crop and livestock productivity or by 'importing' virtual water. Virtual water is the water required to produce a crop or a livestock product. It requires about 1,000 tonnes (cubic meters of water) to produce a tonne of wheat. It requires about 16 times that volume of water to produce a tonne of beef. If an economy can avoid the economic and political stress of mobilising impossibly scarce local water to meet food needs the outcome can be favourable for a food importing economy such as Egypt. Or at least it was until 2006 when global food prices began to rise rapidly. Global food prices have been kept low by EU and US subsidies for most of the second half of the twentieth century. Egypt encountered its food deficit in the early 1970s at a point in economic history when wheat was on the world market at half its production cost. The end of Egypt's Nile waters based water security has been very effectively hidden by the wonderfully economically invisible and politically silent import of water intensive food commodities. The political leadership of Egypt was greatly assisted by the invisibility and silence of the solution of the politically embarrassing strategic problem of the absence of water and food self-sufficiency. No political elite or national leader wants to draw attention to an external solution over which they have no control that reveals extreme national insecurity.

There are two other political-economy related *asymmetries* between the north and the south of the Nile Basin. The first concerns the use of water resources in agriculture and livestock production. The second relates to the extent to which Egypt has become dependent for its water security on the global trading system to a much greater extent than any of the other riparians (see Tables 6.1–6.3).

There are three elements to the asymmetries in water resource use for crop and livestock production. First there is scarcely any irrigation in the south. Egypt's agriculture is 98% irrigated (Tables 4 and 5).

Secondly, crop and livestock productivity and are high in Egypt and low in the southern riparians. Thirdly, livestock production is a major element of the national economies of the southern riparians, of Ethiopia, of Kenya and of Tanzania and also of the southern Sudan. Livestock production is a relatively minor activity in Egypt as reflected in the respective contributions to national GDP.

High yields and high returns to agricultural water are associated with irrigated cropping in the north. Low yields per hectare everywhere obtain in the rain-fed tracts of the south where there are substantial volumes of under-utilised soil water. A major difference between the north and south is that the irrigation option has *not* been tried to a significant extent in the south. The southern riparians have been, and continue to be prevented, from using Nile waters by a combination of factors. First, the economies of the southern riparians are weak which prevents them mobilizing investment in water infrastructure. Secondly, their political weakness has to date prevented them from challenging the Egyptian hegemony on Nile freshwater allocation. At the same time they have not been given support to build dams and diversion structures by the international community. International agencies and international financial institutions (IFIs) and bilateral agencies have not wanted to intervene beyond the level of fostering cooperation over shared management of Nile freshwater resources through such initiatives as the Nile Basin Initiative.

A second element of the crop and livestock production asymmetry is that the southern riparians have the majority of the waters in the Nile Basin even when they export almost 100% of the Nile surface flows. To date these economies have not been able to take advantage of this potentially favourable *asymmetry*. Yields of staple grains from rainfed farming languish at under one tonne per hectare (Dorosh, 2008). That is at the levels of the past half millennium. The African tropical rainfed regions have not benefited from the green revolution experiences enjoyed by Asia in the second half of the twentieth century. The jury is out on what yields are possible for these rain-fed regions in tropical Africa. Food and Agriculture Organisation (FAO) scientists argue that the poor soils of tropical Africa and their drought prone rainfall regimes determine a low rain-fed yield scenario (Burke & Steduto, 2007). Others have argued that it is not only environmental factors that determine pre-modern levels of rain-fed yields. It has been shown that distance from urban markets has a marked impact on rained crop yields in upland East Africa suggesting that a more than doubling of productivity will be possible (Tiffen & Mortimore, 1994; Dorosh

Table 4 Rainfed and irrigated agriculture of all Nile Basin states

	Total	Rainfed	Irrigated
Area of Land Farmed (1,000 ha)	52,449	46,020 (87%)	6,429 (13%)
Crop Production (MT per annum)	172,107	96,811 (56%)	75,301 (44%)

The data include all of the agriculture in the DR Congo, 99% of which is understood to take place outside of the Nile Basin.

Table 5 Rainfed and irrigated cultivated land in Nile Basin states

	Rainfed Land		Irrigated Land		Total			
	Area (1000 ha)	Production (1000 MT)	Area (1000 ha)	Production (1000 MT)	Area (1000 ha)	Production (1000 MT)	Share of Irrigated Land	Share of Irrigated Production
Eastern Nile								
Egypt	0	0	4,432	57,714	4,432	57,714	100%	100%
Sudan	10,945	4,648	1,502	9,320	12,447	13,969	12%	67%
Ethiopia	9,796	14,422	187	2,243	9,984	16,662	2%	13%
Eritrea	529	445	20	83	548	526	4%	16%
Southern Nile								
Uganda	5,989	20,046	10	188	5,999	20,234	0%	1%
Kenya	3,552	8,629	68	3,511	3,621	12,139	2%	29%
Tanzania	6,455	15,082	108	1,776	6,562	16,858	2%	11%
Rwanda	1,271	4,494	4	21	1,275	4,515	0%	0%
Burundi	1,032	3,569	90	425	1,122	3,994	8%	11%
DR Congo	6,451	25,476	8	20	6,459	25,496	0%	0%
Nile Basin	46,020	96,811	6,429	75,301	52,449	172,107	12%	44%

NB. Values shown are state-wide, and not limited to crops produced within the basin itself.
Source: Modified from FAO Food Balance Sheets by FAO Land and Water Unit.

et al., 2008). The road connectivity factor is closely related to a large number of other input, infrastructure and management factors that when in place can increase the productivity of remote crop and livestock producers (Dorosh et al., 2008). The Egyptian farming systems could not be more different. The irrigated delta and alluvial river lowlands of Egypt are so densely settled that almost all farms are within five kilometers of an urban centre and connected by good roads and market services.

The oil price spike since 2005 has directly affected the costs of all sorts of production and transportation. It has also encouraged the production of biofuels, which compete for land and water. Egypt has useful oil and gas resources, which help its foreign exchange affairs. It exports natural gas. The Sudan is enjoying rising oil revenues and is able to attract the assistance of global players such as China to develop both its oil as well as its water infrastructure (Mohieldeen, 2008). Since 2000 the Sudan has been developing a dam on the main Nile just south of the Egyptian border. The Merowe (or Meroe) reservoir will generate hydropower and provide water for irrigation and other uses. The evaporation from the reservoir and the diversion of water for irrigation will bring the Sudan's utilisation to, or beyond, the 18.5 billion cubic metres per year – 25% of annual flow – which is the share agreed with Egypt in the1959 Nile Water Agreement between Egypt and the Sudan. Egypt has not opposed the construction of the dam because it wants the Sudan to be in the same position as Egypt itself with all the 1959 waters in use so that they are more difficult to negotiate (Mohieldeen, 2008). In brief, the southern Nile riparians face the additional asymmetry of being less well endowed with non-water natural resources. Only in soil water are they better endowed than the two downstream riparians.

4.1 Adapting to Water Scarcity

The extent to which the Nile basin economies have resorted to the international market for food to solve their water scarcity problem is also asymmetric. On this issue of global and Nile Basin market solutions it is extremely asymmetric. Egypt is a major importer of water intensive crop and livestock commodities from outside the Basin. (Table 5.3) It exports a relatively small proportion of its crop and livestock production to the rest of the world and an insignificant proportion to the other Nile Basin riparians. Some of the upstream East African Nile Basin economies - notably Kenya and Uganda – export significant volumes of rain-fed soil water intensive commodities such as tea and coffee to rest of the world and to Egypt (Fig. 2). The Sudan in normal circumstances is a major exporter of livestock products (Table 6.2) both within the Basin to Egypt and to markets beyond the basin especially to the Gulf economies.

Table 6.3 shows the virtual water 'imports' and 'exports' for crop and livestock products for the individual Nile Basin economies both within the basin and with the rest of the world. A number of things are evident. The proportion of the *in-basin* crop and livestock trade compared with the trade *with rest of the world* is trivial. Figure 3 also illustrates this difference. Egypt depends on the global system for

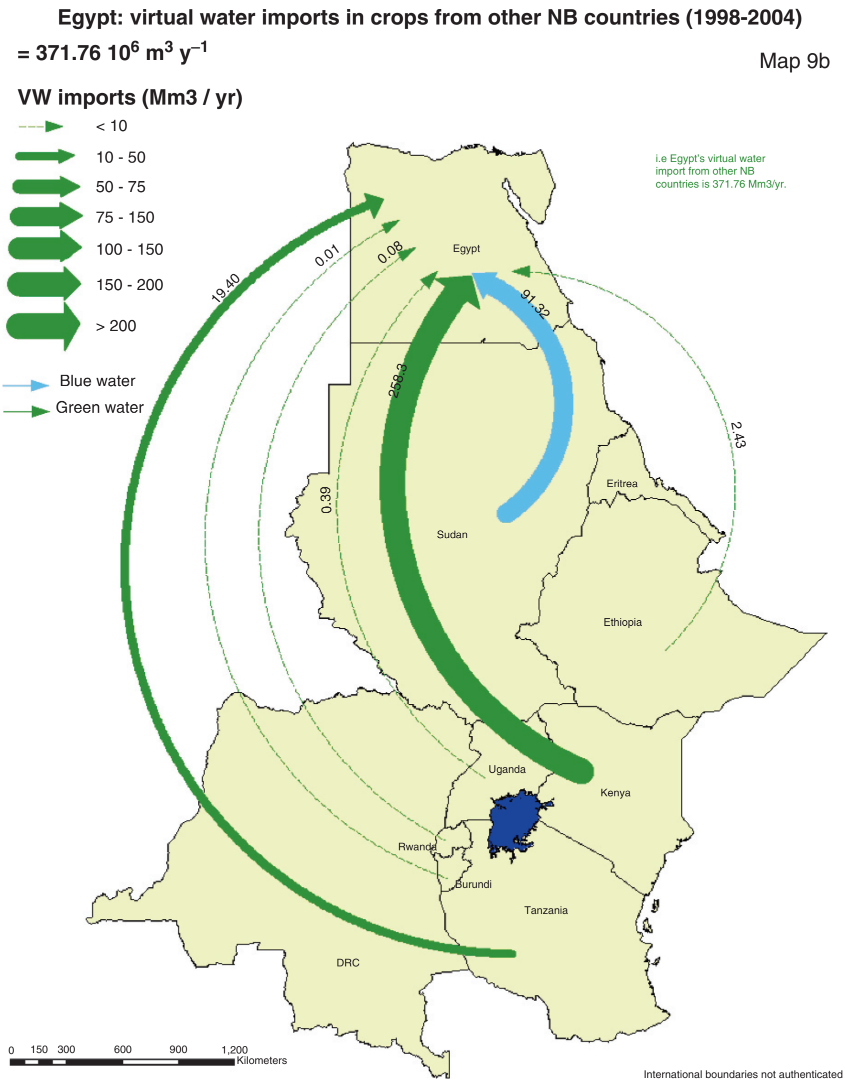

Fig. 2 Egypt's virtual water (vw) imports in crops from other Nile Basin countries (1998–2004) (source: London Water Research Group, 2007) (*see Color Plates*)

its food and water security to an extreme extent. The Nile Basin can provide neither the freshwater nor the soil water that Egypt requires now. It certainly cannot provide these waters for Egypt's future even higher requirements. Egypt's water security depends on its capacities to diversify and strengthen its economy.

Figure 3 also confirms a number of the other asymmetries identified in this analysis. Despite almost all the Nile freshwater flows being used in Egypt and the Sudan the main 'exports' of virtual water are generated in the southern riparians. Even

Table 6.1 Virtual water related CROP 'imports' and 'exports' within the Nile Basin between riparians and 'trade' with the rest of the world. Mm^3 of virtual water per year

	In Basin		With rest of world	
	'Imports'	'Exports'	'Imports'	'Exports'
Egypt	372.0	51.0	30195.0	1034.0
The Sudan	184.0	122.0	3565.0	652.0
Ethiopia	1.0	10.0	1061.0	1053.0
Eritrea	0.0	0.0	8.0	0.7
Uganda	41.0	169.0	682.0	2501.0
Kenya	197.0	403.0	1817.0	2909.0
Tanzania	31.0	132.0	1818.0	1888.0
Rwanda	48.0	1.0	56.0	400.0
Burundi	30.0	2.0	28.0	318.0
DRC	0.0	15.0	0.0	1.0
Total	905.0	905.0	30230.0	11321.0

Table 6.2 Virtual water related LIVESTOCK 'imports' and 'exports' within the Nile Basin between riparians and virtual water 'trade' with the rest of the world. Mm^3 of virtual water per year

	In Basin		With rest of world	
	'Imports'	'Exports'	'Imports'	'Exports'
Egypt	18.0	0.9	2041.0	28.0
The Sudan	0.2	18.0	93.0	2503.0
Ethiopia	0.0	0.0	0.2	29.0
Eritrea	0.0	0.0	0.0	34.0
Uganda	1.5	0.3	5.0	2.6
Kenya	0.2	4.0	0.9	5.6
Tanzania	3.3	0.3	10.0	0.3
Rwanda	0.1	0.0	0.3	0.2
Burundi	0.1	0.0	0.6	0.04
DRC	0.0	0.0	0.0	0.2
Total	24.0	24.0	2122.0	2062.0

Table 6.3 Virtual water related CROP & LIVESTOCK 'imports' & 'exports' within the Nile Basin between riparians & 'trade' with the rest of the world. Mm^3 of virtual water per year

	In Basin		With rest of world	
	'Imports'	'Exports'	'Imports'	'Exports'
Egypt	390.0	51.9	32236.0	1062.0
The Sudan	184.2	138.0	3668.0	3155.0
Ethiopia	1.0	10.0	1061.2	1082.0
Eritrea	0.0	0.0	8.0	34.7
Uganda	42.5	169.3	687.0	2503.6
Kenya	197.2	407.0	1817.9	2914.6
Tanzania	34.3	132.3	1828.0	1888.3
Rwanda	48.1	1.0	56.3	400.2
Burundi	30.1	2.0	28.6	318.0
DRC	0.0	15.0	0.0	1.2
Total	949.0	949.0	32352.0	13383.0

Source: All tables from Zeitoun and Allan (2007) based on FAO data for the Nile Basin.

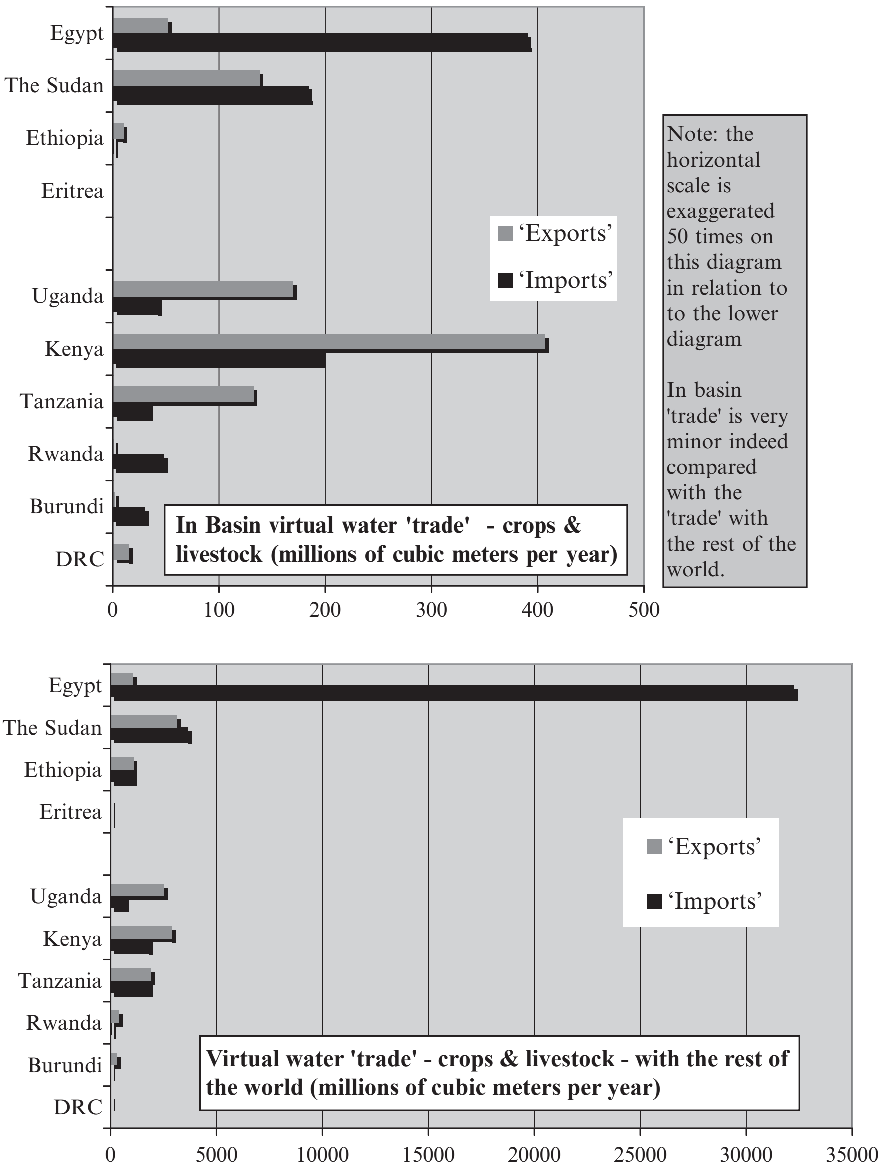

Fig. 3 Virtual water trade within the Nile Basin and between the Nile Basin and the rest of the world (1998–2004) (source: London Water Research Group, 2007)

the significant virtual water 'exports' of the Sudan derive from rain-fed soil water, mainly as livestock products from Darfur and Kordofan. Potential water surpluses – that is soil water surpluses – are in the south and not in the North. Adaptive capacity, however, is currently much stronger in Egypt than in the rest of the basin. Egypt has also diversified its irrigation sector by industrialising production of high value vegetables and fruits in its West Delta Project. During and since the 1990s this Egyptian private sector initiative has utilized groundwater to produce high value crops for export to Europe and the Middle East. As predicted the groundwater has been over-pumped and the venture needs Nile freshwater which has to be pumped up from the delta 'The proposed project will assist the Ministry of Water Resources and Irrigation (MWRI) to implement reforms for financial sustainability of irrigation infrastructure and for greater efficiency in the use of water resources and their conservation. The proposed project aims to achieve this by introducing full-cost recovery policies premised on a volumetric water usage charge with the expansion of surface water irrigation infrastructure to West Delta Area (project area); and to substantially involve key farmer stakeholders and the private sector in important aspects of system design and finance, construction and management through an appropriate sharing of the related risks with Government' (World Bank, 2006). The West Delta project with its hydrological, environmental and investment dilemmas faced by the Egyptian Government and its international backers highlights the predicament of Egypt. The West Delta Project makes sense in terms of export income, job creation and the high returns to water from industrialised farming. But it makes little sense from the point of view of the impacts on the already impaired delta water environment and relations over water with upstream partners who are being denied the option to develop their Nile freshwater resources.

Egypt has become dependent for its water security on the global trading system to a much greater extent than any of the other riparians. As Egypt's population grows its future water requirements will increasingly be met through its capacity to import food and the virtual water associated with such trade. Egypt's agricultural production could increase but not significantly.

5 Asymmetric Power Relations and Their Impact on Basin Water Agreements

The hydropolitics of the Nile are also extremely asymmetric. These asymmetric power relations have not mattered until the late twentieth century. Until then the demands on the water resources by the riparians were not beyond the capacities of the Nile Basin water resources – freshwater, groundwater and soil water. These water resources were sufficient to meet the needs of the populations of the mid-twentieth century. The population of the Basin has trebled since that time and continues to expand.

As a result the freshwater resources of the Basin are effectively closed. There is no freshwater to re-allocate. The downstream riparians – Egypt and the Sudan – have laid claim to 100% of the flows from both Ethiopia and from the East Africa highlands. They expressed their assumed entitlement to the total flow in the arrangements of the 1959 Nile Waters Agreement, which allocated 75% to the flow to Egypt and 25% to the Sudan. The assumption was in principle the same as that of the British-sponsored 1929 Nile Waters Agreement. In 1929 96% of flow was allocated to Egypt and 4% to the Sudan. The flow that could be managed with the limited infrastructures in place in 1929 was, however, less than half the flow that could be controlled and managed after 1959 with the High Dam at Aswan. The dam was operational from 1970. The 1959 agreement allocated 55.5 billion cubic metres per year to Egypt and 18.5 to the Sudan. It was estimated that ten billion cubic metres of water would be evaporated and leaked annually from Lake Nasser/Nubia out of the total long term assumed flow of 84 billion cubic meters per year. When the British were exerting colonial influence across almost all of the Basin – except Ethiopia – in the late nineteenth century and until the mid-twentieth century they were just as protective of the freshwater flows of the Nile to downstream Egypt and the Sudan. During this period British influence and imperial capacity established the practice that Egyptian engineers could monitor the flows of the Nile upstream in the Sudan and at Lake Victoria in Uganda.

Transboundary water flows are easily politicized. The natural flows of freshwater, unlike most groundwater and all soil water, can be re-allocated. Politics can be defined as the process that brings about the allocation of resources. Who gets, what when and how (Lasswell, 1956). The users who first need to use the natural flows capture the resource and assume henceforth that they have prior-rights to the utilisation of the water. Groundwaters can be transboundary but they are rarely politicized and never to date as much as freshwater flows have been in the Nile case. In other basins such as the Jordan Basin groundwater resources are highly politicized. For example, on the West Bank (Zeitoun, 2008) and to some extent in the case of the Disi aquifer between Jordan and Saudi Arabia (Greco, 2003).

Soil water resources cannot be politicized. They cannot be pumped or moved. Unfortunately, they are as a consequence ignored by everyone. By engineers who manage water, by economists who value water, and perhaps most importantly by water policy-makers and those at the most senior levels of national government who relate to their opposite numbers over transboundary waters. It has been shown in this chapter that the soil water resources of the Nile Basin riparians vastly exceed the freshwater resources. The freshwater resources are closed. The soil water resources have been significantly utilised but the productivity is so low that it will be possible to increase the returns to soil water in the southern basin riparians (Tiffen & Mortimore, 1994; Keijne et al., 2004; Molden, 2007; Dorosh et al., 2008). This information is not yet in currency in transboundary Nile waters international relations.

6 Hydropolitics, International Water and International Water Law

> 'Upstream states use water to gain power. Downstream states use power to gain water' (Warner, 2008).

Egypt's power has been sufficient to establish for half a century its downstream preference for the principle of 'prior use' rights (Waterbury, 1979, 2002). No upstream has used significant volumes of Nile freshwaters that would impair Egypt's definition of its water resource security. The 1959 Nile Waters Agreement between Egypt and the Sudan allocated 75% of the *total Nile flow* to Egypt and 25% to the Sudan. The other riparians have followed the letter of the 1959 agreement without accepting its principles. This outcome is only partly because of Egyptian hegemony – that is the capacity of one partner to exert its power over partners that are nominally equal. It is also because the upstream riparians lack the resources to invest in and the capacities to develop their Nile waters. Here is yet another *asymmetry*. The northern riparians have the capacity to invest. The southern economies do not. This asymmetry is exacerbated by another. Egypt enjoys pivotal relations with the World Bank and other international agencies (IFIs). The southern economies do not. The southern riparians have strong *potential* relations with pivotal international financial institutions but their current levels of engagement in no way match those of Egypt. The long process of establishing the Nile Basin Initiative (NBI) since 1992, when cooperative basin-wide engagement started, is evidence that the fundamental impediment to significant water and benefit sharing over Nile waters is Egypt's sensitivity concerning water security (Cascao, 2008a, b).

The high levels of food imports by Egypt and the way that Egypt has participated in the establishment of the Nile Basin Initiative (NBI) and especially in the NBI Framework Agreement negotiations during 2007 suggests that Nile Basin water management options are limited. The riparians are still adopting classic upstream v. downstream positions. Transboundary waters are not regulated by international water law. Customary international water law exists. Customary international water law provides some norms of international bahaviour that tend to favour those who have already captured freshwater flows early in the history of water resource development in a basin.

The ancient civilizations of the Middle East first used the waters of such rivers as the Nile five thousand years ago in their lower reaches where simple technologies could provide partial control of floods and flows. This pattern has continued until the last decades of the twentieth century with the outcome that Egypt and the Sudan feel that they have acquired rights to the water by having developed economies dependent on the Nile freshwater flows.

There are three sets of principles that a riparian can reach for in taking a position on shared transboundary waters. First, that of *sovereignty*. Secondly, that of *integrity*. Thirdly that of *equitable utilization* (McCaffrey, 2002). The first two principles contradict each other. The third is a fair and reasonable approach but defining the idea so that it can be operationalised has proved to be impossible. *Sovereignty* is a simple concept. It appeals to upstream states which are often located in highlands which attract much of the precipitation that feeds the basin hydrology. The Nile is an extreme case as there is no recharge in Egypt, nor in the northern half of the Sudan; that is for over one third of the length of the system. Upstream Ethiopia exports almost all its Nile waters and contributes 85% of the flow at Khartoum. The East African riparians contribute the rest. Half of the East African water that leaves Uganda down the White Nile evaporates as it traverses the Sudd wetlands. Upstream riparians naturally adopt the *sovereignty* principle as it argues that all the water that falls on national territory can legitimately be utilised by an upstream riparian. In practice it is only upstream riparians with power and administrative, technical and financial capacities that can, at will, utilise such water resources. The United States, China and Turkey are examples of riparians that have been able to apply the principle of sovereignty.

The principle of *integrity* appeals to downstream riparians. It argues that prior utilization brings with it the entitlement to claim and use such flows in the future. This principle can be imposed by powerful downstream riparians such as Egypt and midstream riparians such as South Africa, India and Israel. In the Nile Basin Egypt has captured the surface flows of the Nile Basin and is reluctant to relinquish them. The evidence is the way that Egypt has participated in the establishment of the Nile Basin Initiative and especially in its unwillingness to agree the NBI Framework Agreement negotiated, but not agreed or ratified, during 2007. Egypt and the Sudan would not agree the article, which as far as they were concerned compromised their water security. They interpret their water security to be 100% of the freshwater resources of the Nile system.

The contradiction of sovereignty and integrity has been addressed by the UN International Law Commission. In the deliberations of the Commission since the early 1970s it was recognised that sovereignty and integrity were incompatible. Building on a long established principle of *equitable use* introduced into the 1896–1906 US-Mexico negotiations over the Rio Grande (McCaffrey, 2002) and the notion of equitable utilisation developed by the International Law Association (ILA, 1966) the principle of *equitable utilisation* has become the central organizing idea for future transboundary waters agreements. Unfortunately, equitable utilisation is very difficult indeed to operationalise and as a consequence the dominant riparian can easily ignore it and refuse to take it into account when engaged in negotiations. Hegemon riparians such as Egypt, Israel and India as downstream or mid-stream riparians have not recognised the 1997 UN Convention. Nor have the dominant upstream riparians – China and Turkey. 'Upstream states use water to gain power. Downstream states use power to gain water' (Warner, 2005). This insightful aphorism confirms another: 'Water flows uphill to money and power' (Reisner, 1984).

Power asymmetry is the most important of all the asymmetries identified in this analysis. Egypt does not have a monopoly of *hard power*. It does not need hard power which is in any event the least effective face of power (Lukes, 1974; Zeitoun, 2008). Egypt does have substantial *soft power*. One type of soft power is *bargaining power* – that is it can assert its interests to great effect. For example it has not agreed the key Article 39 of the draft 2007 NBI Framework Agreement as it would impair its continued assertion that it is entitled to 75% of the Nile flow. This delay is just a small increment in a process of delays in addressing the issue of re-allocation of Nile water. This tactic has been in place for decades and has been a low profile element in the Egyptian negotiating strategy since the inception of the Nile Basin 2002 process in 1992 and also during the process of establishing the Nile Basin Initiative since 1997. Such power is most effective in what is known as *ideational power*. Those who possess this type of power can set the agenda that determines what is accepted and even believed by other parties. Those with ideational power achieve their ends partly by knowing more than other participants and partly by having close relations with third parties – such as the International Financial Institutions (IFIs) that can finance the infrastructures in upstream states. In all these capacities Egypt is powerful and the other riparians are not. So powerful is Egypt that the strong commitment of the World Bank to reduce poverty in the upstream riparians by assisting them to install water infrastructures of all types has been successfully resisted.

7 Concluding Comments

Those managing Nile waters face extremely challenging water environments. The main purpose of the chapter has been to show that many asymmetries make ecological and economical sound and equitable utilization of the basin's waters – surface freshwater, groundwaters and soil waters – very difficult indeed. Surface waters are effectively closed to further major development without a new framework agreement enabling upstream surface water utilisation and the implied re-allocation that must accompany such new initiatives.

The asymmetries are environmental, economic, developmental and political. They concern water itself but mainly socio-economic capacity and power. And the most important of these is power. It has been shown that there are extreme asymmetries in water resource endowments, in the adaptive capacities to deal with differing endowments and in the capacity to establish the terms of engagement over water resources in the basin. The southern riparians enjoy relatively favourable rainfall regimes and as a consequence they have substantial surface freshwater resources. More importantly they have substantial soil water resources, which enable rain-fed crop production. The soil water is important for the southern riparians as they export almost all their Nile surface waters. It has been shown that the asymmetries in levels of socio-economic development, in demographic trends, in adaptive capacity and the ability to set the terms of engagement are inter-related and pivotal. The ways that Nile freshwater flows are allocated are explained by these asymmetries as are the relative levels of development of the individual riparians.

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