THE NEED FOR APPROPRIATE IRRIGATION WATER MANAGEMENT IN THE ENTIRE NILE BASIN

EFFICIENT WATER USE FOR AGRICULTURAL PRODUCTION (EWUAP)

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Introduction

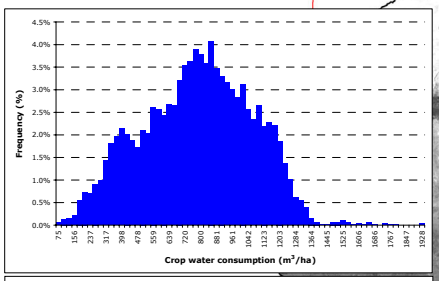
The Nile Basin hosts several million hectare of irrigated cropland. Egypt and Sudan cover 92% of all irrigated land in the Nile Basin. The thirsty crops require water in addition to rainfall. Irrigation water is diverted from rivers and – on to a lesser extent – extracted from groundwater systems. The majority of this water is consumed by crop evapotranspiration and is not longer available for downstream water user groups in the Nile Basin. It is literally vaporized, depleted and not longer physically present in the basin. Not all excessive irrigation water supply is consumed, and most "irrigation losses" are naturally recycled. It is thus essential to investigate the following questions:

(i) What is the current net diversion from the Nile water resources to irrigated land?
(ii) Is it possible to save water diverted and water consumed in the future?
(iii) How much consumptive water can be saved at the same pace of dry matter production?
(iv) How much extra food can be produced with the same amount of water consumed?
(v) How much extra food can be produced with the same amount of water diverted?

The Global Mapping of Irrigated Areas for the Nile Basin (source: FAO Aquastat and University of Frankfurt am Main) has been selected as a first step in identifying areas of interest. The location of the GMIA irrigated areas is rather satisfactory, but it was concluded that a smaller fraction within each zone is really irrigated. This explains the difference between the 5.5 million (FAO) and the 4.3 million ha (current study).

Water consumption in irrigated agriculture

The annual total crop evapotranspiration of all 4.3 million hectare of irrigated land in the Nile Basin has been calculated. The values of actual evapotranspiration are computed by means of the Surface Energy Balance Algorithm for Land (SEBAL) developed by WaterWatch in The Netherlands. The total crop water consumption in irrigated agriculture of the Nile Basin is 33.7 billion m^3. The net irrigated area is 4.3 million hectare, hence the annual average crop water consumption per unit irrigated land is 784 mm. This average crop water consumption of 784 mm (7840 m^3/ha/yr) varies considerably across the basin. The minimum values are 100 mm and the maximum values go as far as 1400 mm/yr, upto peak values of 1900 mm/yr (see frequency distribution).



Frequency distribution of crop water consumption across all 4.3 million ha of irrigated land in the Nile Basin

Some facts of the 2007 irrigation situation

The total crop land area in the Nile Basin is 23.7 million ha, out of which 4.3 million ha is irrigated land (18.1 %). The remaining part – 19.1 million ha – is thus rainfed land. The total crop water consumption in agriculture is 184.6 billion m^3/yr, and the 33.7 billion m^3 occupies 18.2% of the agricultural water consumption in the Nile Basin. The 33.7 billion m^3 is however, also the managable part, which makes this volume very interesting to inspect further.

The discharges in the river Nile vary with the location in the basin. The average inflow in Lake Nasser is historically 55 billion m^3/yr. This can be considered as the annually renewable water resources that originate from the upper Nile catchment. The water consumption in irrigated crops is thus 61% of the annually renewable resources!

This EWUAP study shows that the irrigation efficiency is 59% on average, with a considerable variation. This implies that out of every 100 liter of water diverted from the river and applied to the field, 59 liter will be consumed by incremental ET.

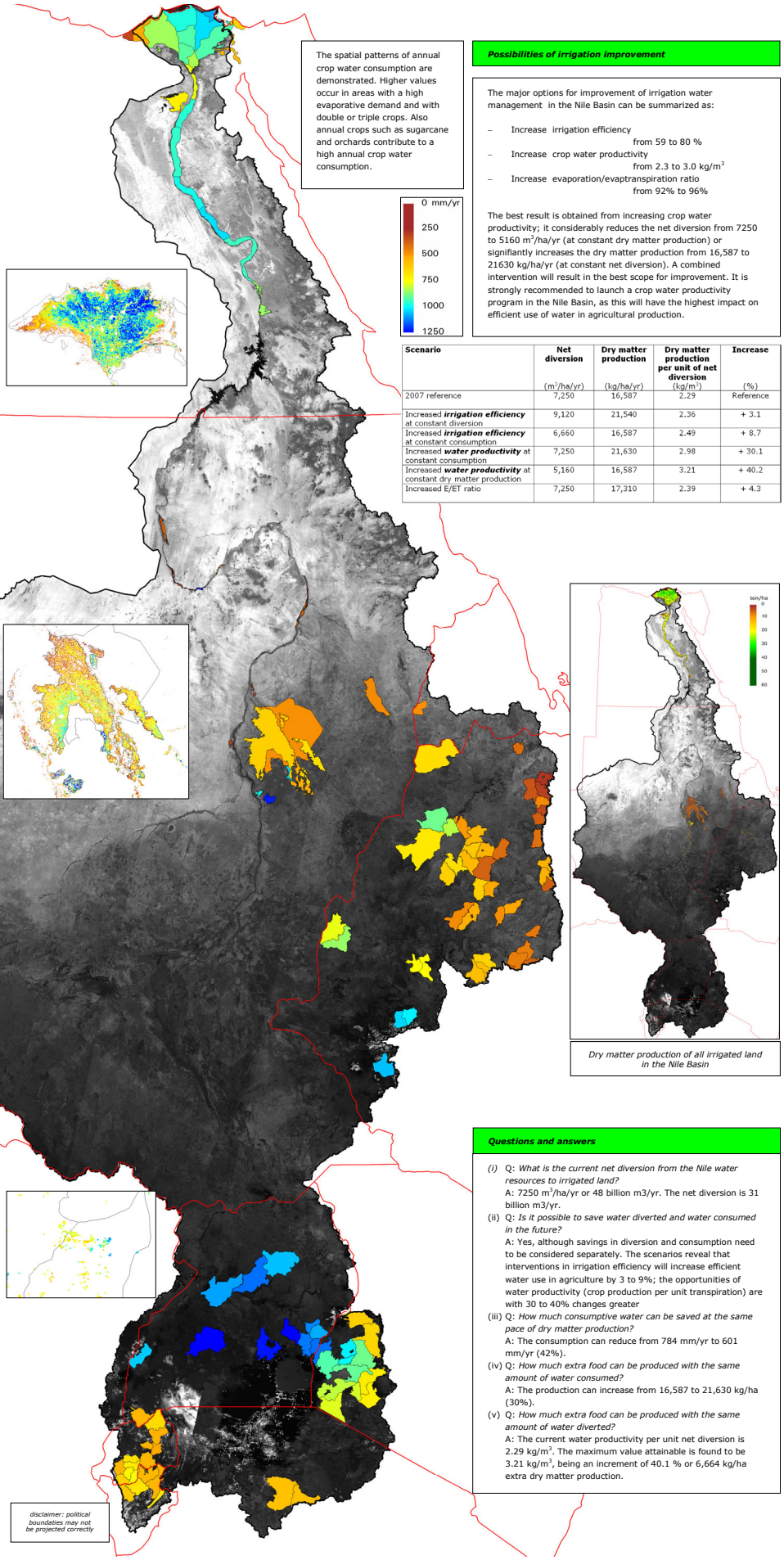
The total withdrawals from the river Nile for irrigation are estimated to be 48 billion m^3/yr using the 59% irrigation efficiency. The latter value adds up to a total amount of 87% of the total flow. Irrigation is thus by far largest consumer of Nile river resources. The majority of this water will return through drainage networks and groundwater seeage into river corridors. The total runoff from rainfall and irrigation is 21 billion m^3/yr, and if we assume that 80% of these "losses" are recoverable (i.e. 16.8 billion m^3/yr), then the net withdrawal becomes 48.0-16.8 = 31.2 billion m^3/yr

The average 2007 water balance of all irrigated land (4.3 million ha) in the Nile Basin

IN		OUT	
	Billion m^3 (mm)		Billion m^3 (mm)
Rainfall	6.7 (157)	Evaporation	2.8 (65)
Irrigation supply	48.0 (1116)	Transpiration	30.9 (719)
		Runoff and drainage	21.0 (489)
TOTAL IN	**54.7**	**TOTAL OUT**	**54.7**

The evaporation from soil is with 65 mm/yr only a small fraction (8%) of the total ET of 784 mm.

The consumption of 33.7 billion m^3 of water (with particular reference to the 30.9 billion m^3/yr transpiration) will lead to dry matter production of crops. The average dry matter production is 16,587 kg/ha/yr. This is equivalent to a water productivity of 2.3 kg/m^3 per unit of water transpired. The spatial variation of dry matter production from irrigated land is shown in the color plate at the right hand side of this poster.



The spatial patterns of annual crop water consumption are demonstrated. Higher values occur in areas with a high evaporative demand and with double or triple crops. Also annual crops such as sugarcane and orchards contribute to a high annual crop water consumption.

Dry matter production of all irrigated land in the Nile Basin

Possibilities of irrigation improvement

The major options for improvement of irrigation water management in the Nile Basin can be summarized as:

- Increase irrigation efficiency from 59 to 80 %
- Increase crop water productivity from 2.3 to 3.0 kg/m^3
- Increase evaporation/evaptranspiration ratio from 92% to 96%

The best result is obtained from increasing crop water productivity; it considerably reduces the net diversion from 7250 to 5160 m^3/ha/yr (at constant dry matter production) or signifiantly increases the dry matter production from 16,587 to 21630 kg/ha/yr (at constant net diversion). A combined intervention will result in the best scope for improvement. It is strongly recommended to launch a crop water productivity program in the Nile Basin, as this will have the highest impact on efficient use of water in agricultural production.

Scenario	Net diversion (m^3/ha/yr)	Dry matter production (kg/ha/yr)	Dry matter production per unit of net diversion (kg/m^3)	Increase (%)
2007 reference	7,250	16,587	2.29	Reference
Increased ***irrigation efficiency*** at constant diversion	9,120	21,540	2.36	+ 3.1
Increased ***irrigation efficiency*** at constant consumption	6,660	16,587	2.49	+ 8.7
Increased ***water productivity*** at constant consumption	7,250	21,630	2.98	+ 30.1
Increased ***water productivity*** at constant dry matter production	5,160	16,587	3.21	+ 40.2
Increased E/ET ratio	7,250	17,310	2.39	+ 4.3

Questions and answers

(i) Q: *What is the current net diversion from the Nile water resources to irrigated land?*
A: 7250 m^3/ha/yr or 48 billion m3/yr. The net diversion is 31 billion m3/yr.

(ii) Q: *Is it possible to save water diverted and water consumed in the future?*
A: Yes, although savings in diversion and consumption need to be considered separately. The scenarios reveal that interventions in irrigation efficiency will increase efficient water use in agriculture by 3 to 9%; the opportunities of water productivity (crop production per unit transpiration) are with 30 to 40% changes greater

(iii) Q: *How much consumptive water can be saved at the same pace of dry matter production?*
A: The consumption can reduce from 784 mm/yr to 601 mm/yr (42%).

(iv) Q: *How much extra food can be produced with the same amount of water consumed?*
A: The production can increase from 16,587 to 21,630 kg/ha (30%).

(v) Q: *How much extra food can be produced with the same amount of water diverted?*
A: The current water productivity per unit net diversion is 2.29 kg/m^3. The maximum value attainable is found to be 3.21 kg/m^3, being an increment of 40.1 % or 6,664 kg/ha extra dry matter production.