Analyzing irrigation

CT4410

December 14, 2011

Clemmens

The performance of large-scale irrigation projects worldwide has been disappointing to the international community. Continued poor performance could limit our ability to provide food and fibre for a growing, more affluent world population. Improvement in the productivity of large irrigation systems is a key component to assuring future adequate food and fibre supplies. This paper discusses the reasons for poor performance of these schemes and proposes a method to improve their performance. A main problem is that operation of these irrigation systems is not tied to productivity. As a result, the dispersive nature of these large open canal distribution systems causes extreme variability in water delivery service to users. The remedy is to break the system down at key intermediate locations within the network and to improve physical and administrative control at those locations.

Molden et al

Effective irrigation service provides the environment for productive and sustainable agriculture vital for incomes and employment, economic growth and lifting people out of, and keeping them out of, poverty. Poorly managed irrigation can have the opposite effect. Irrigation performance assessment is an important management tool to aid in providing sound service. Performance assessment in irrigation and drainage is the systematic observation, documentation and interpretation of activities related to irrigated agriculture with the objective of continuous improvement.

Type of person	Possible first criterion of good system performance
Landless labourer	Increased labour demand, days of working and wages
Farmer	Delivery of an adequate, convenient, predictable and timely water supply
Livestock keeper	Readily accessible water for livestock
Fisherman	Maintaining the quantity and quality of water for aquaculture and capture fisheries
Irrigation manager	Efficient delivery of water from headworks to the tertiary outlet
Agricultural economist	High and stable farm production and incomes
Economist	High internal rate of return
Politician	Who receives benefits
Broader society	High water productivity, and best allocation of water resources

Typical concepts applied

$$\text{Delivery Performance Ratio} = \frac{\text{Actual Flow of Water}}{\text{Intended Flow of Water}}$$

$$Depleted\ Fraction = \frac{ET_a}{P_e + Q_{in}}$$

$$Water\ Productivity\ (ET) = \frac{Yield\ or\ value\ of\ Harvested\ Crop}{ET_{actual}}$$

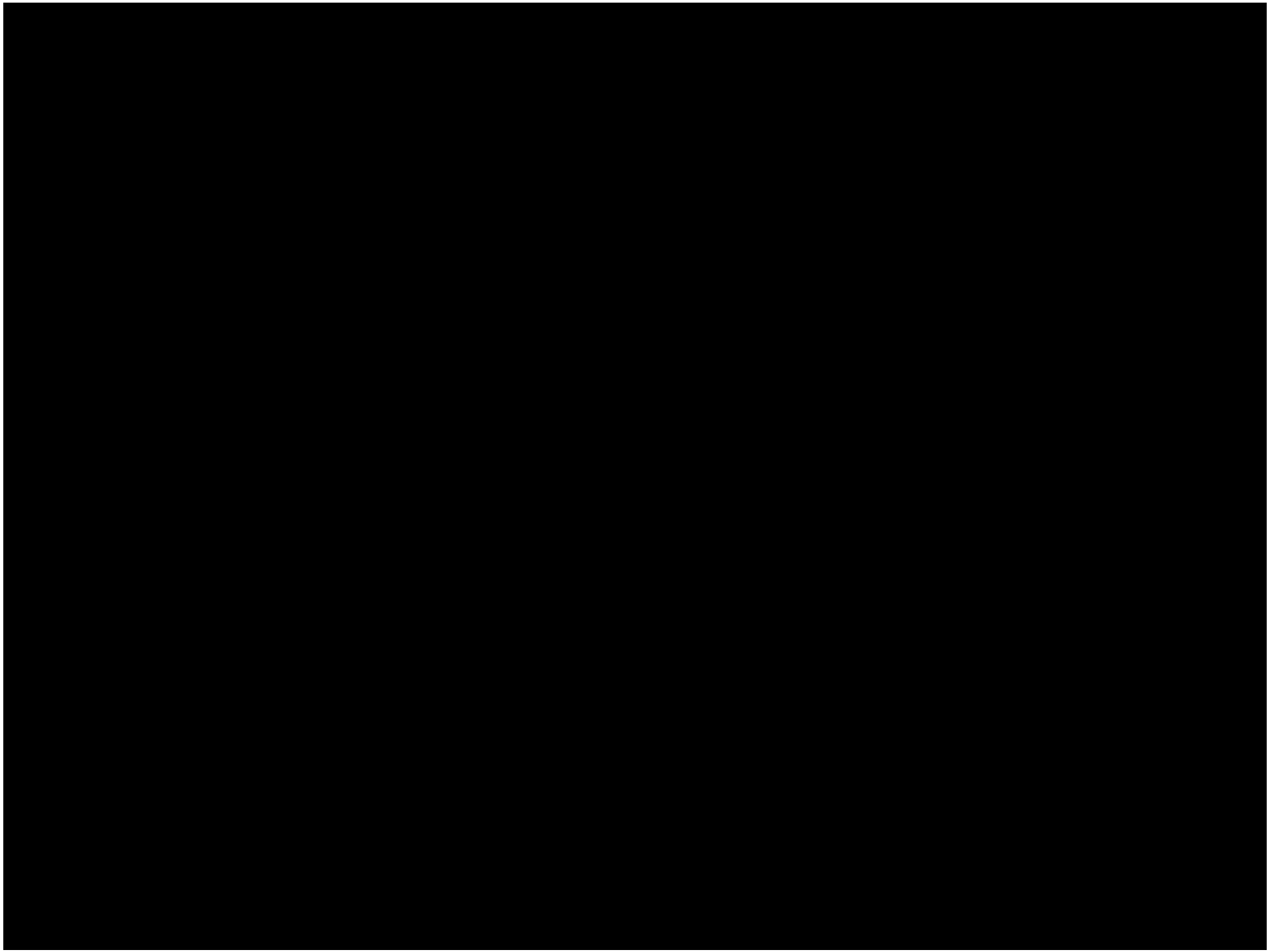
and

$$Water\ Productivity\ (m^3) = \frac{Yield\ or\ value\ of\ Harvested\ Crop}{Volume\ of\ Supplied\ Irrigation\ Water}$$

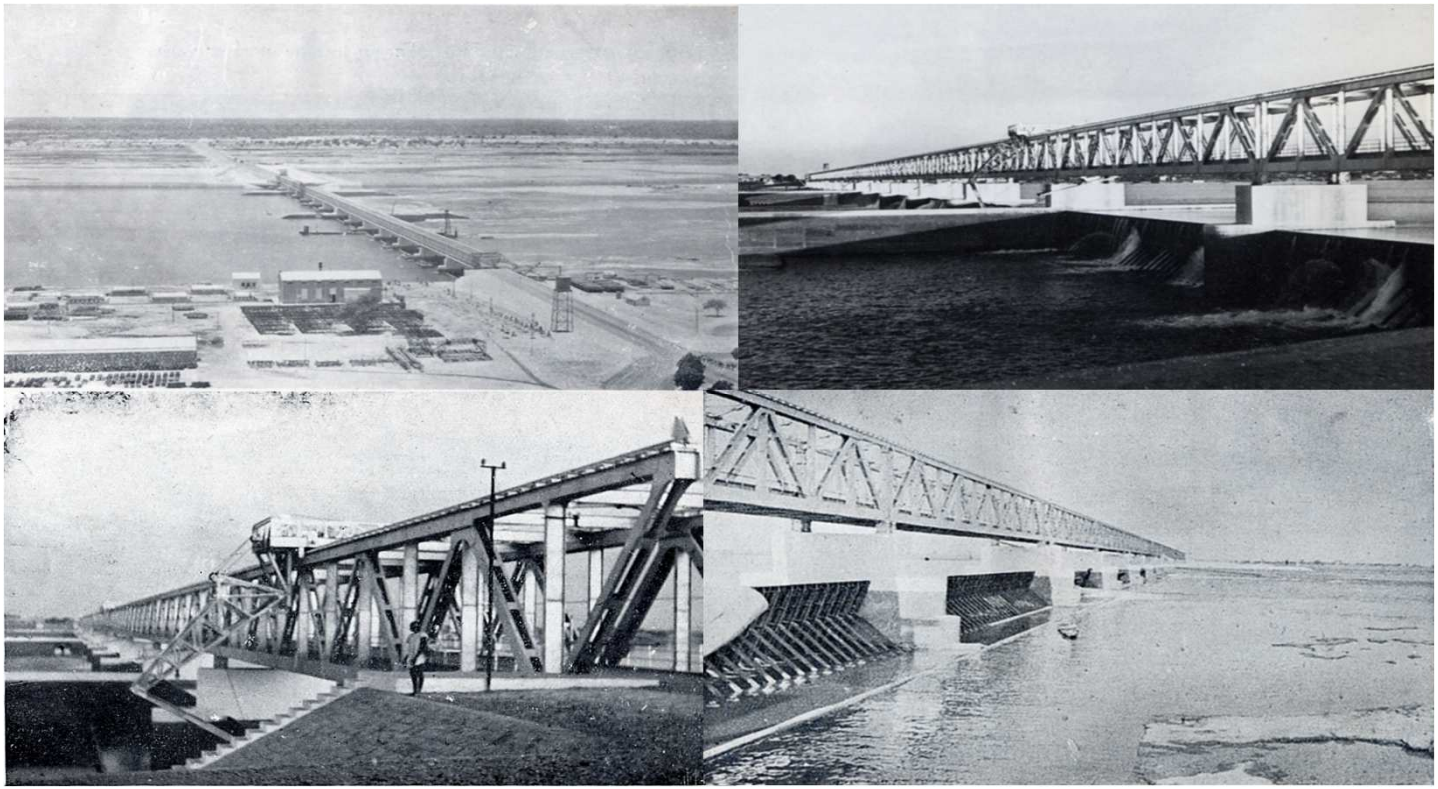
Key descriptors for irrigation and drainage schemes

Descriptor	Possible options	Explanatory notes	Example
Irrigable area	—	Defines whether the scheme is large, medium or small scale	8567 ha
Annual irrigated area	Area supplied from surface water	Shows the intensity of land use and balance between surface or groundwater irrigation	7267 ha
	Area supplied from groundwater		4253 ha surface 3014 ha groundwater
Climate	Arid; semi-arid; humid tropics; Mediterranean	Sets the climatic context. Influences the types of crops that can be grown	Mediterranean
Average annual rainfall (P)	—	Associated with climate, sets the climatic context and need for irrigation and/or drainage	440 mm
Average annual reference crop evapotranspiration (ET_o)	—	Associated with climate, sets the climatic context and need for irrigation	780 mm
Water source	Storage on river; groundwater; run-of-the river; conjunctive use of surface and groundwater	Describes the availability and reliability of irrigation water supply	Over-year storage reservoir in upper reaches. Groundwater aquifers
Method of water abstraction	Pumped; gravity; artesian	Influences the pattern of supply and cost of irrigation water	Gravity fed from rivers, pumped from groundwater
Water delivery infrastructure	Open channel; pipelines; lined; unlined	Influences the potential level of performance	Open channel, lined primary and secondary canals
Type of water distribution	Demand; arranged on-demand; arranged; supply orientated	Influences the potential level of performance	Arranged on-demand

Descriptor	Possible options	Explanatory notes	Example
Predominant on-farm irrigation practice	Surface: furrow, level basin, border, flood, ridge-in-basin Overhead: rain-gun, lateral move, centre pivot; drip/trickle Sub-surface: drip	Influences the potential level of performance	Predominantly furrow, with some sprinkler and (increasingly) drip
Major crops (with percentages of total irrigated area)	—	Sets the agricultural context. Separates out rice and non-rice schemes, monoculture from mixed cropping schemes	Cotton (53%) Grapes (27%) Maize (17%) Other crops (3%)
Average farm size	—	Important for comparison between schemes, whether they are large estates or smallholder schemes	0.5–5 ha (20%) >5–20 ha (40%) >20–50 ha (20%) >50 ha (20%)
Type of management	Government agency; private company; joint government agency/farmer; farmer-managed	Influences the potential level of performance	River system: government Primary and secondary systems: water users' associations



Office du Niger



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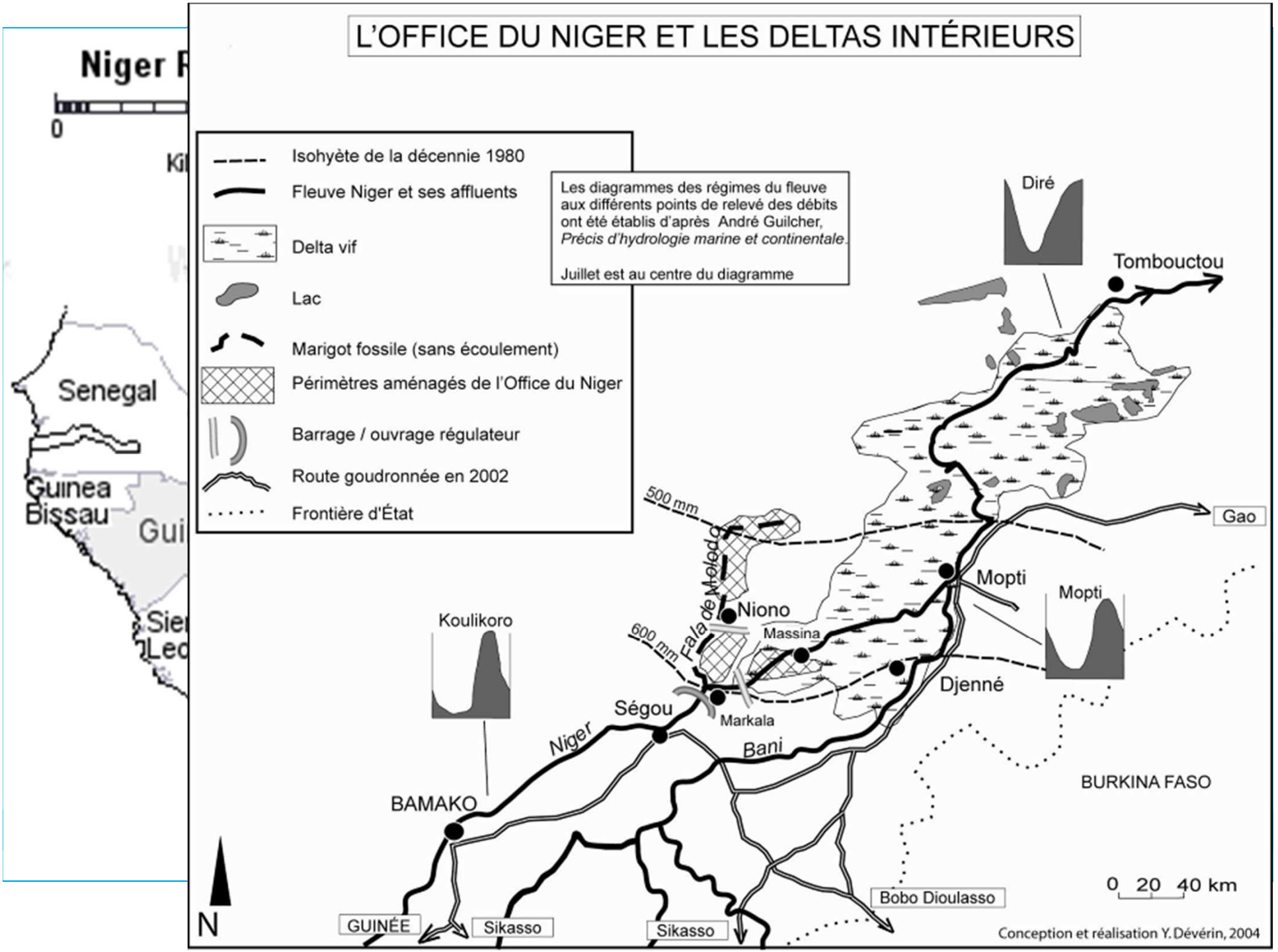
L'OFFICE DU NIGER ET LES DELTAS INTÉRIEURS
Isohyète de la décennie 1980
Fleuve Niger et ses affluents
Delta vif
Lac
Marigot fossile (sans écoulement)
Périmètres aménagés de l'Office du Niger
Barrage / ouvrage régulateur
Route goudronnée en 2002
Frontière d'État
Les diagrammes des régimes du fleuve aux différents points de relevé des débits ont été établis d'après André Guilcher, Précis d'hydrologie marine et continentale.
Juillet est au centre du diagramme
Diré
Tombouctou
Gao
Mopti
Mopti
Niono
Massina
Djenné
Koulikoro
Ségou
Markala
Niger
Bani
BAMAKO
BURKINA FASO
500 mm
600 mm
Fala de Molodo
GUINÉE
Sikasso
Sikasso
Bobo Dioulasso
N
0 20 40 km
Conception et réalisation Y. Dévérin, 2004

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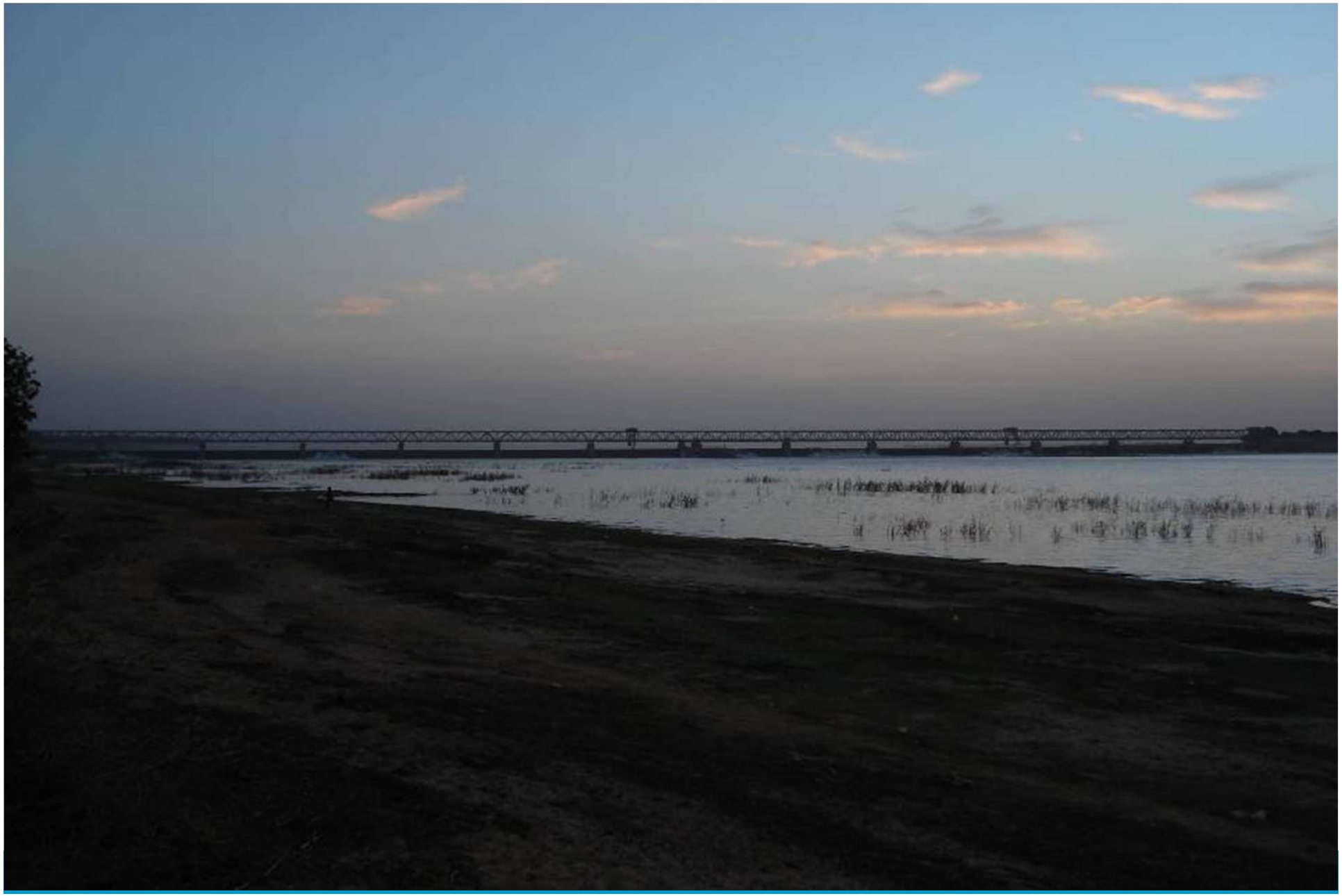

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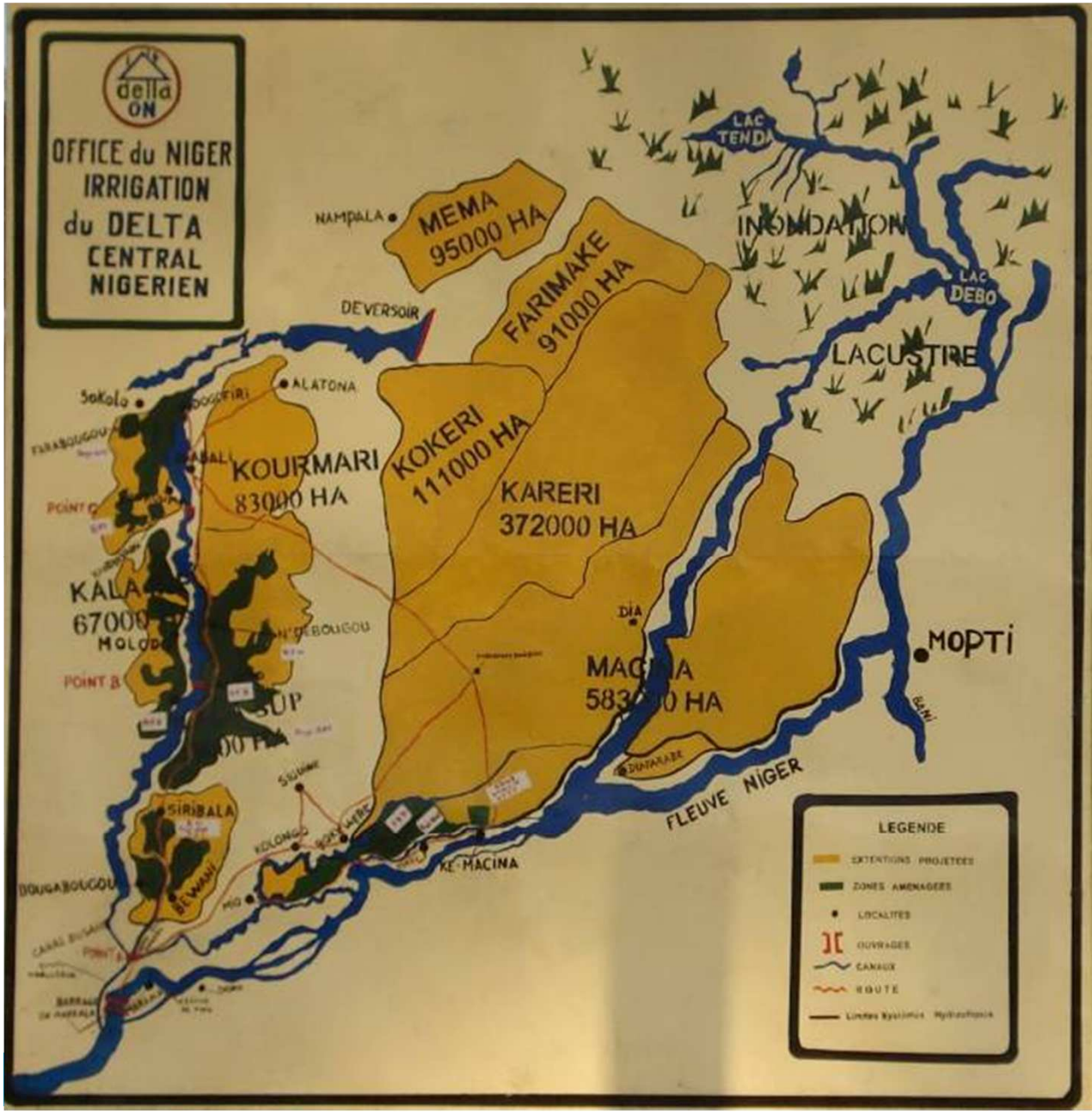

Bref historique de l'Office du Niger

- 1932 Création de l'Office du Niger
- 1934 à 1947 Construction du Barrage de Markala, Long de 816 m Avec 488 Vannes
- 1961 (19 mai) : Nationalisation de l'Office du Niger
- 1962 : Introduction de la canne à sucre ;
- 1970 : Abandon de la culture du coton ;
- 1978 : Table ronde des bailleurs de fonds en vue du redressement de l'Office du Niger ;
- 1994 : Restructuration de l'Office du Niger avec l'appui des partenaires au développement ;

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Let’s take a look

http://www.satellite-sightseer.com/id/9428

Barrage de Markala

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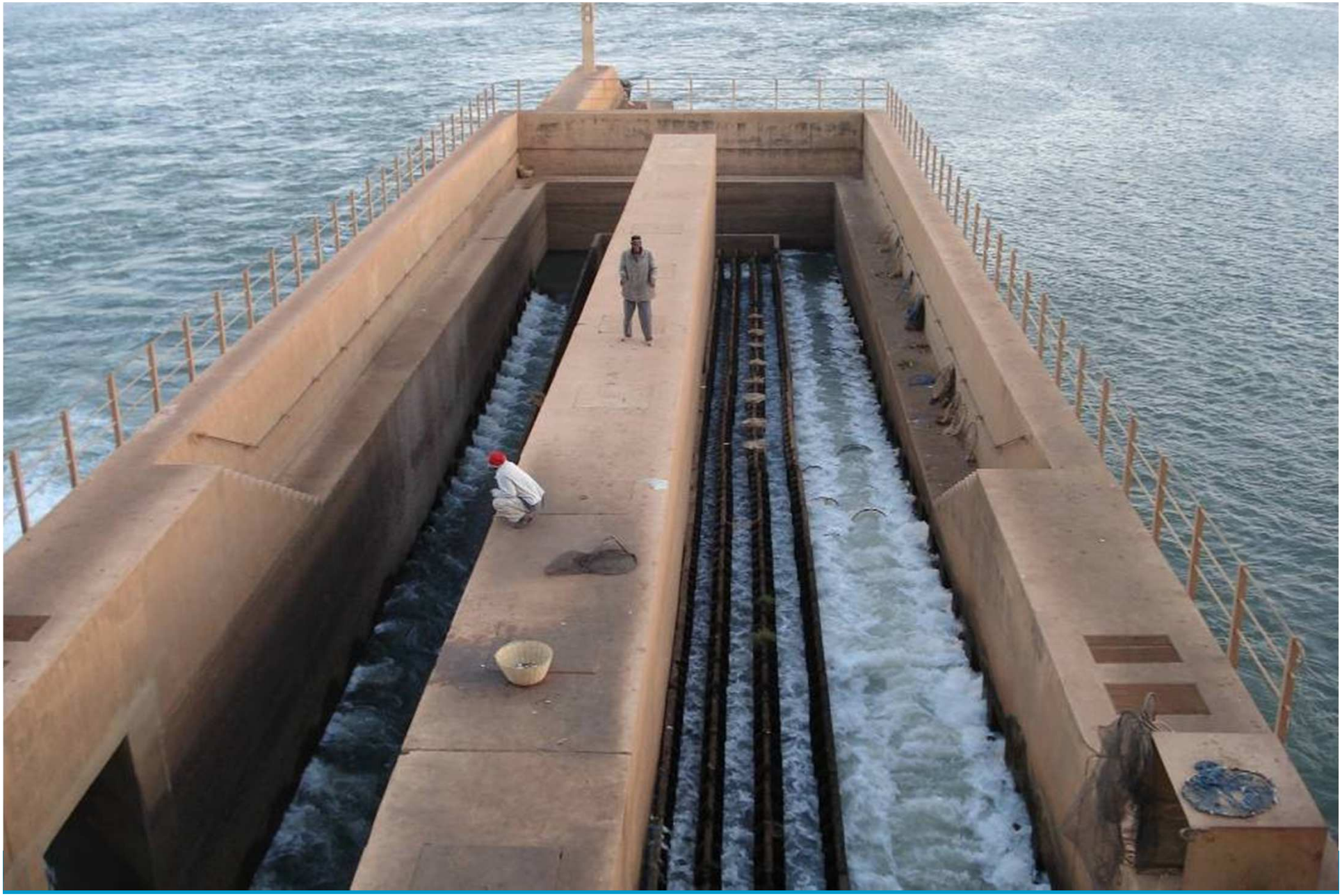

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Primary channel into Office du Niger

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Type of infrastructure
Retail type
Arpon type
Not rehabilitated

Why does it look like this?

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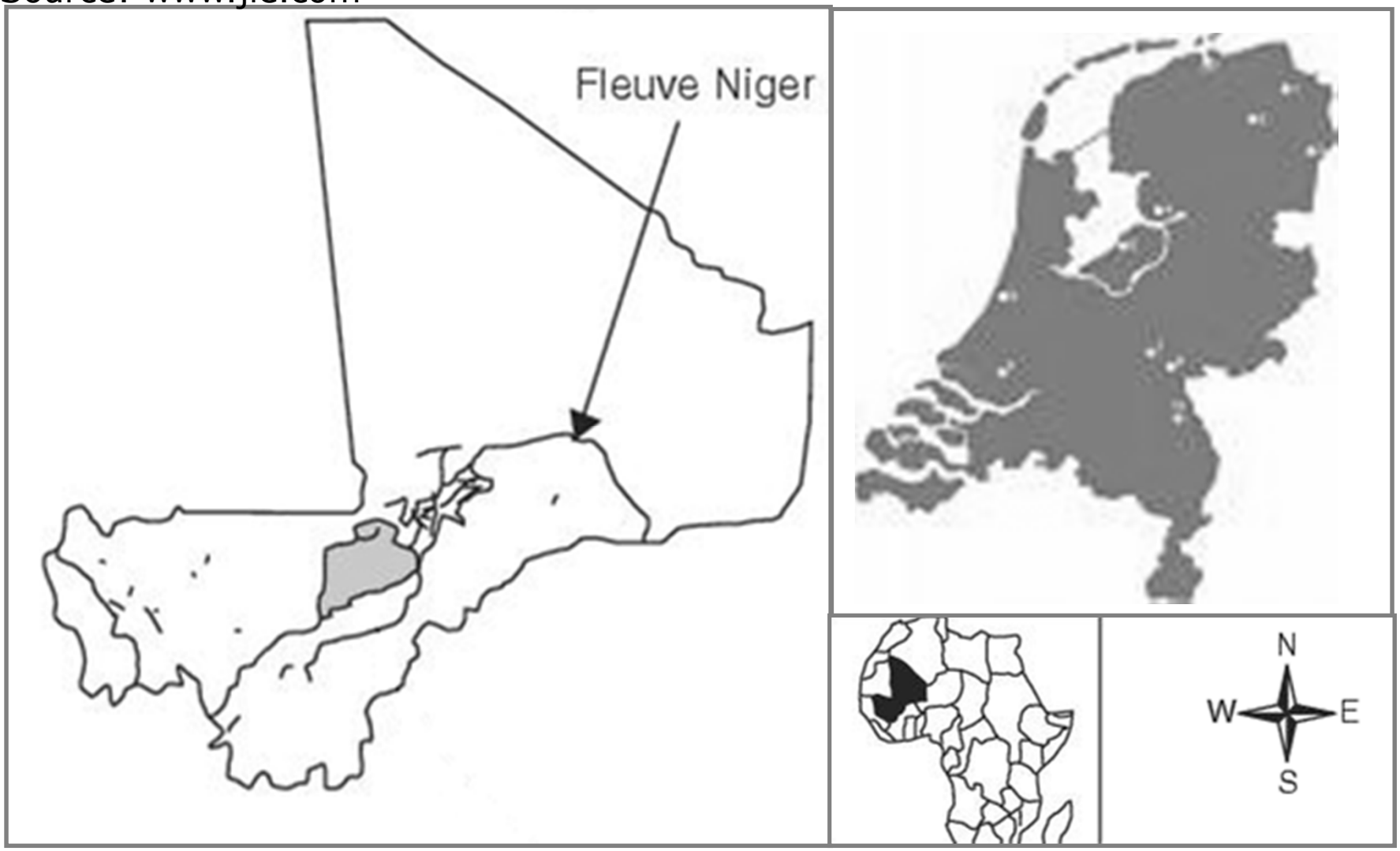
Source: www.jle.com



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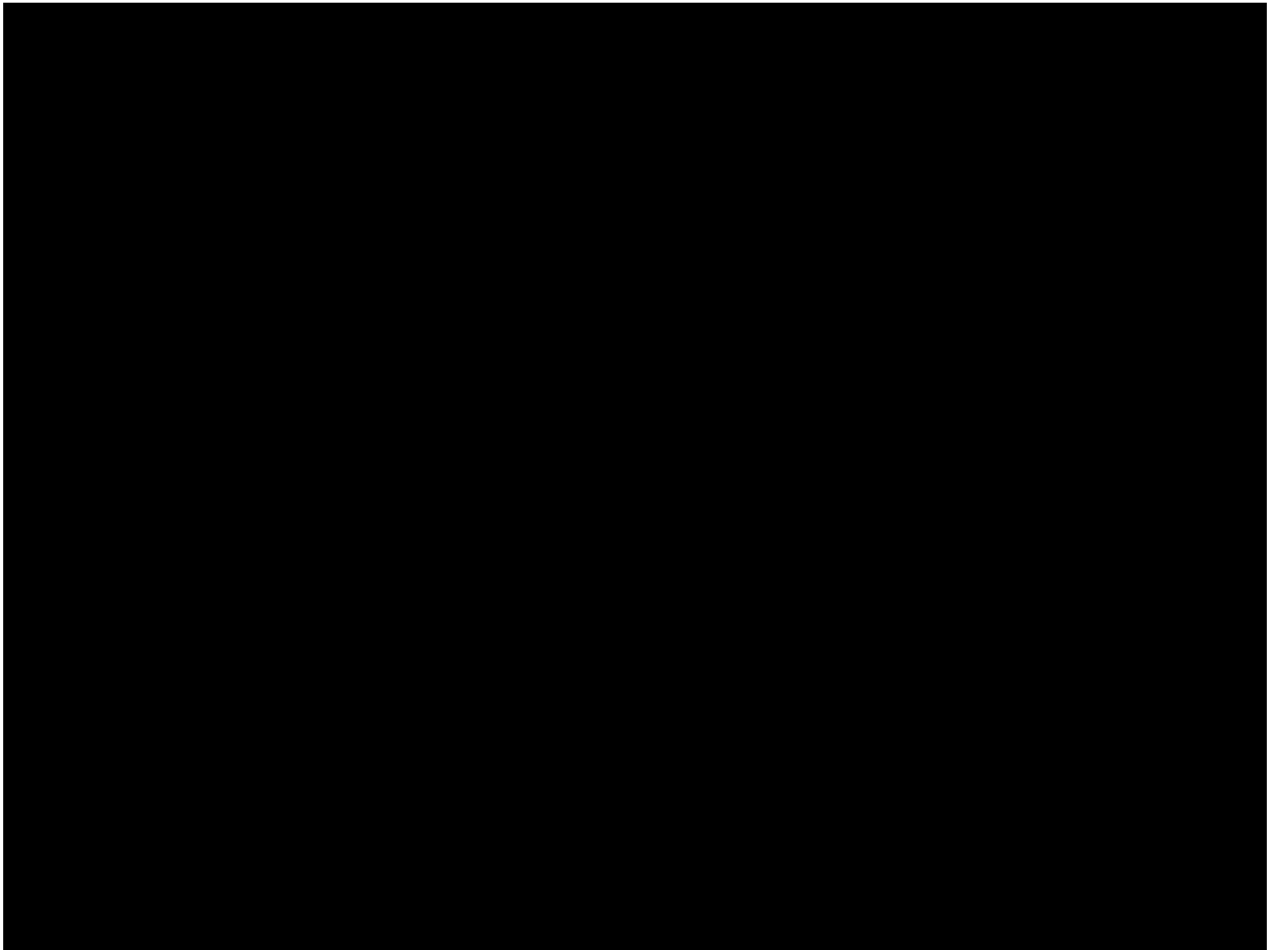
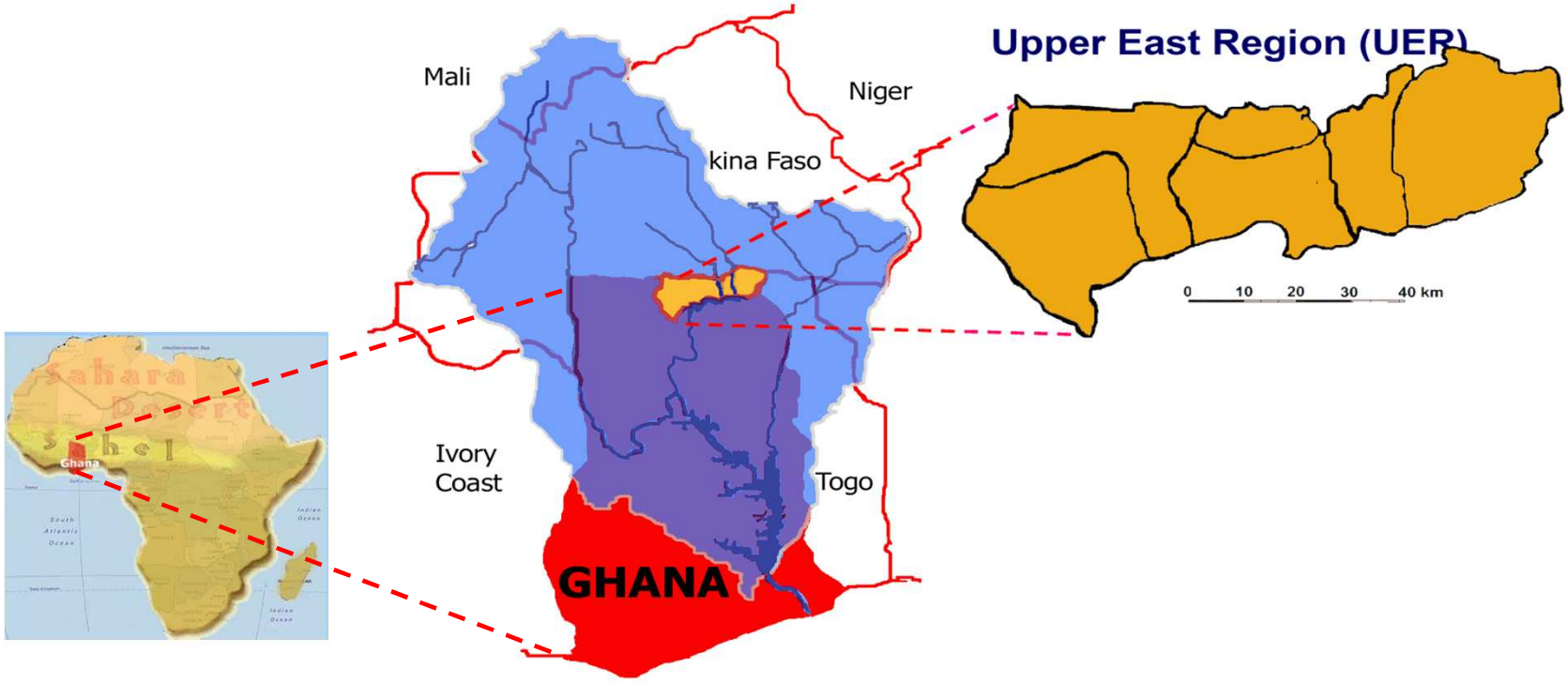
Surface area in numbers

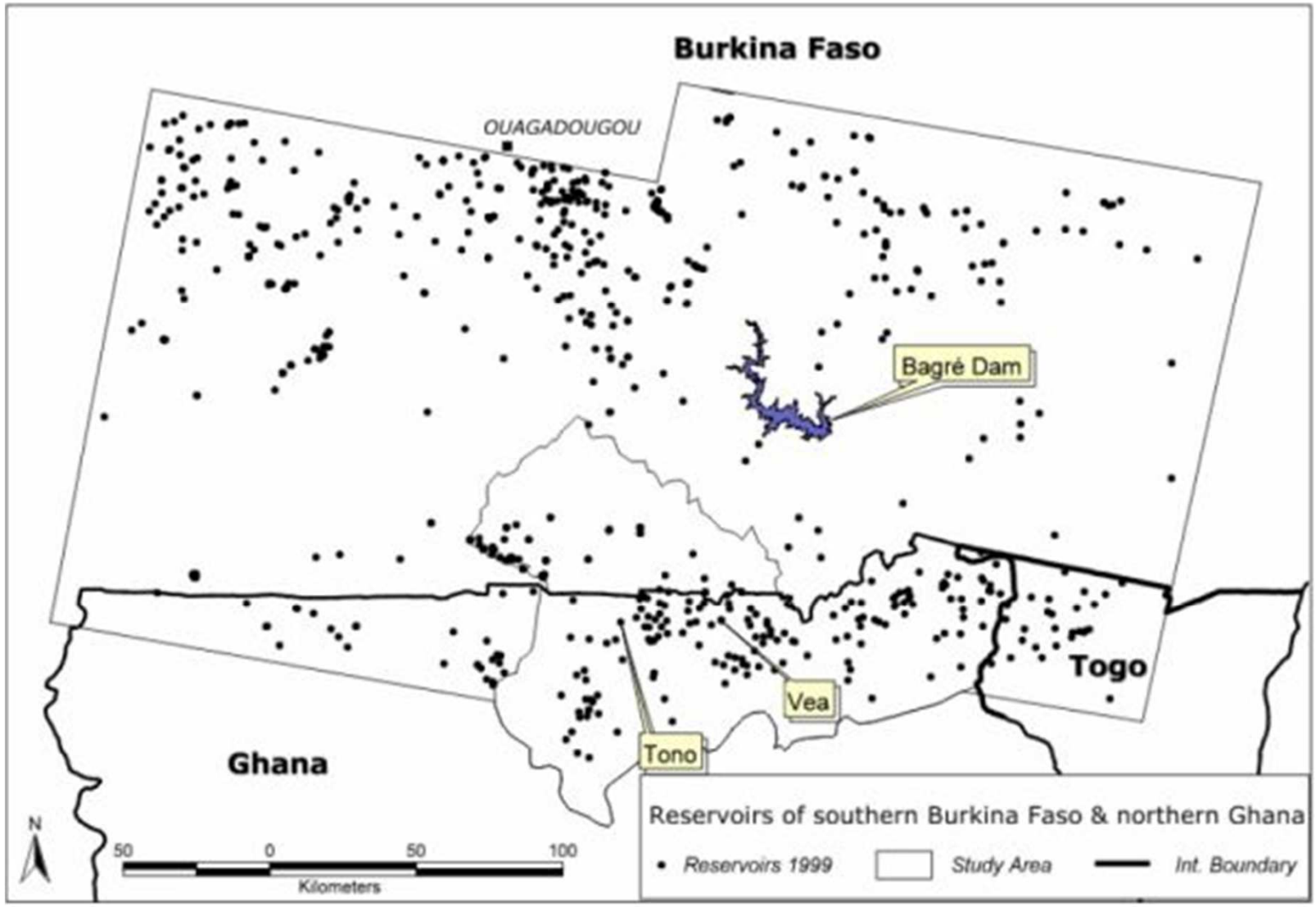
• The Netherlands:	4 200	$\cdot 10^3$ ha
• Total area OduN:	2 000	$\cdot 10^3$ ha
• Potential irrigation:	960	$\cdot 10^3$ ha
• Present irrigation:	93	$\cdot 10^3$ ha



Irrigation in Ghana



Maurits Ertsen
December 14, 2011


Burkina Faso
OUAGADOUGOU
Bagré Dam
Togo
Vea
Tono
Ghana
N
50
0
50
100
Kilometers
Reservoirs of southern Burkina Faso & northern Ghana
Reservoirs 1999
Study Area
Int. Boundary

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reservoir
dam
irrigable fields

Small scale irrigation Domestic use Fishing Livestock watering

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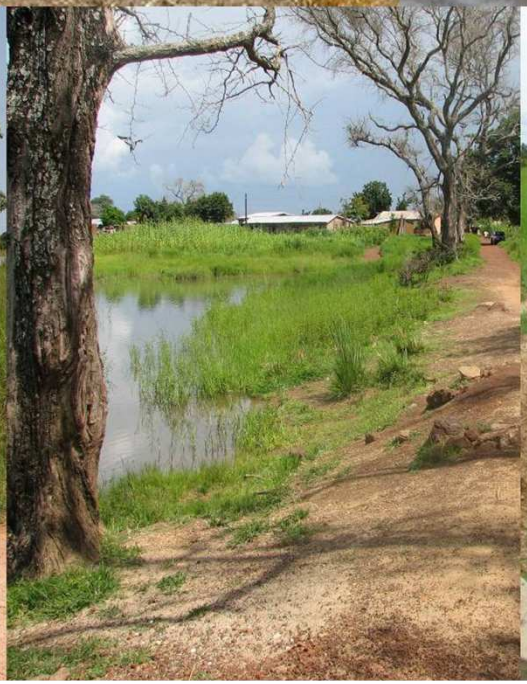

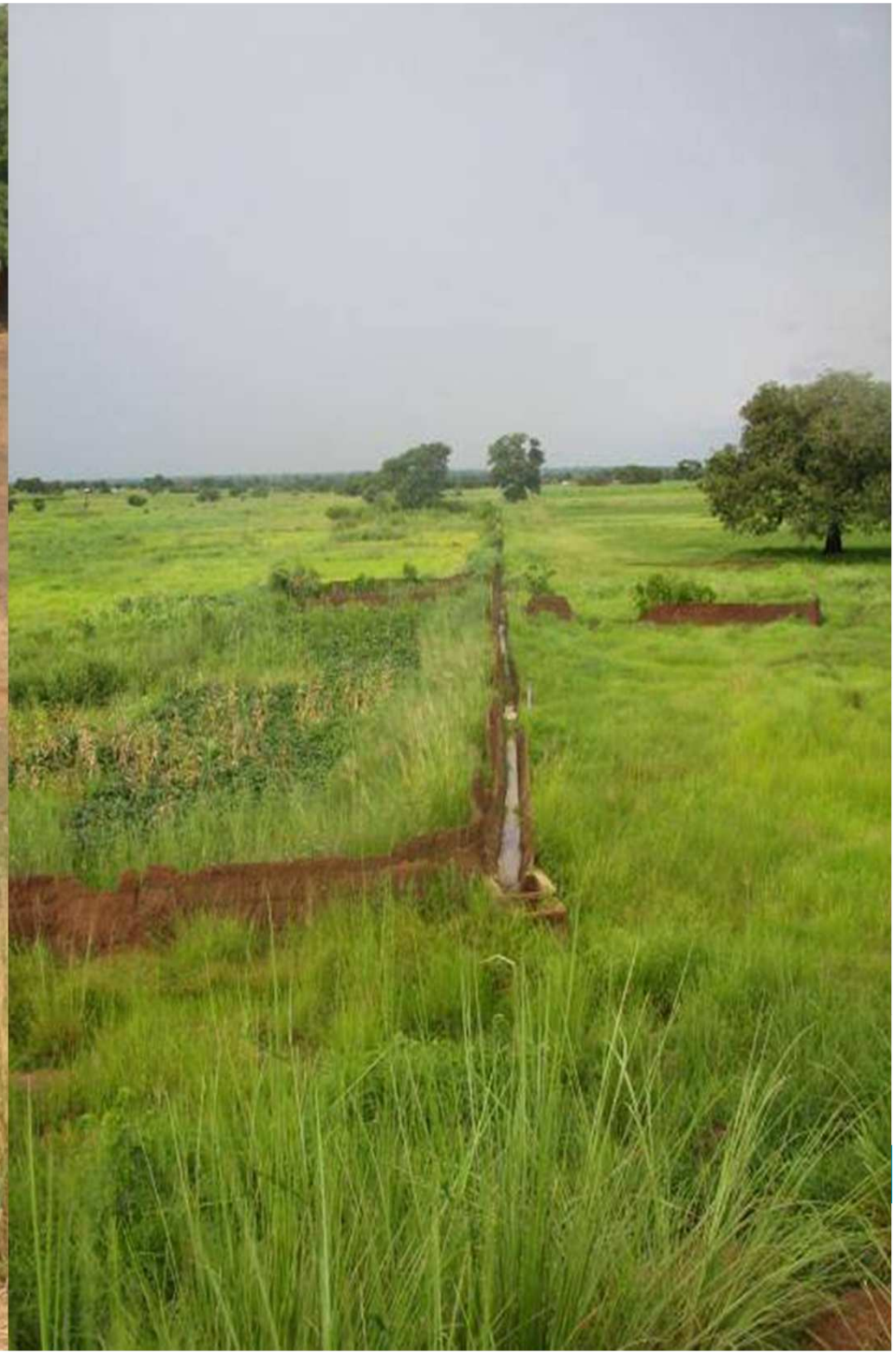

Tanga System Layout

Weega System Layout

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Irrigated Areas

	Area under Cultivation (ha)	Total Water Released for Season (m^3)	Water Released per Area Irrigated (m^3/ha)
Tanga Canal A	0.8629	34121	39542
Tanga Canal B	0.7591	19245	25352
Weega Canal A	2.8824	32373	11231
Weega Canal B	3.1245	35895	11488
Tanga Total	1.6220	53366	32901
Weega Total	6.0069	68268	11365

Measured evaporation

	Rate, mm/day								
Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Tanga	6.0	5.4	6.4	8.3	7.5	7.4	7.6	7.7	7.6
Weega	7.7	5.7	8.0	8.6	8.1	8.0	8.6	7.8	7.7

Calculated Evapotranspiration Rates

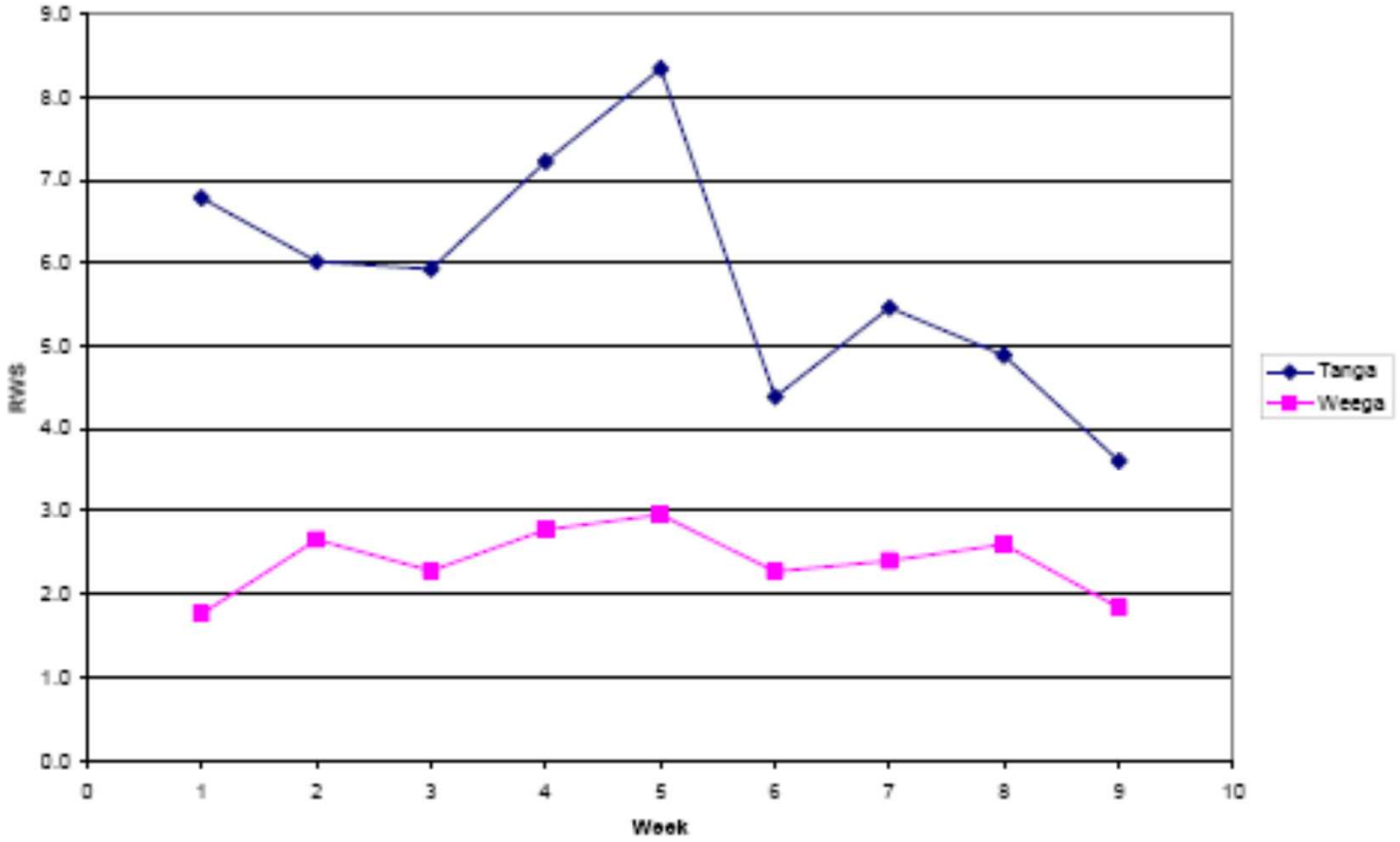
	Rate, mm/day								
Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Tanga	3.9	3.7	4.2	4.8	4.5	5.4	5.1	5.3	5.8
Weega	5.0	3.8	5.2	5.0	4.9	5.9	5.8	5.4	5.9

Total Supply, Demand, and Average RWS for Sample Period

Reservoir	Supply (cm)	Demand (cm)	RWS
Tanga	171.3	30.0	5.7
Weega	79.4	32.9	2.4

Supply and Demand for Nine Weeks (cm)

Week	1	2	3	4	5	6	7	8	9
Demand									
Tanga	2.7	2.6	2.9	3.4	3.2	3.8	3.6	3.7	4.1
Weega	3.5	2.7	3.7	3.5	3.4	4.1	4.1	3.8	4.1
Supply									
Tanga	18.5	15.4	17.4	24.4	26.5	16.5	19.7	18.2	14.7
Weega	6.2	7.1	8.4	9.8	10.1	9.4	9.8	9.8	7.6



RWS for Nine Weeks Starting Jan. 15 and Ending Mar. 18

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