Modelling hydrological services for ecosystem accounting

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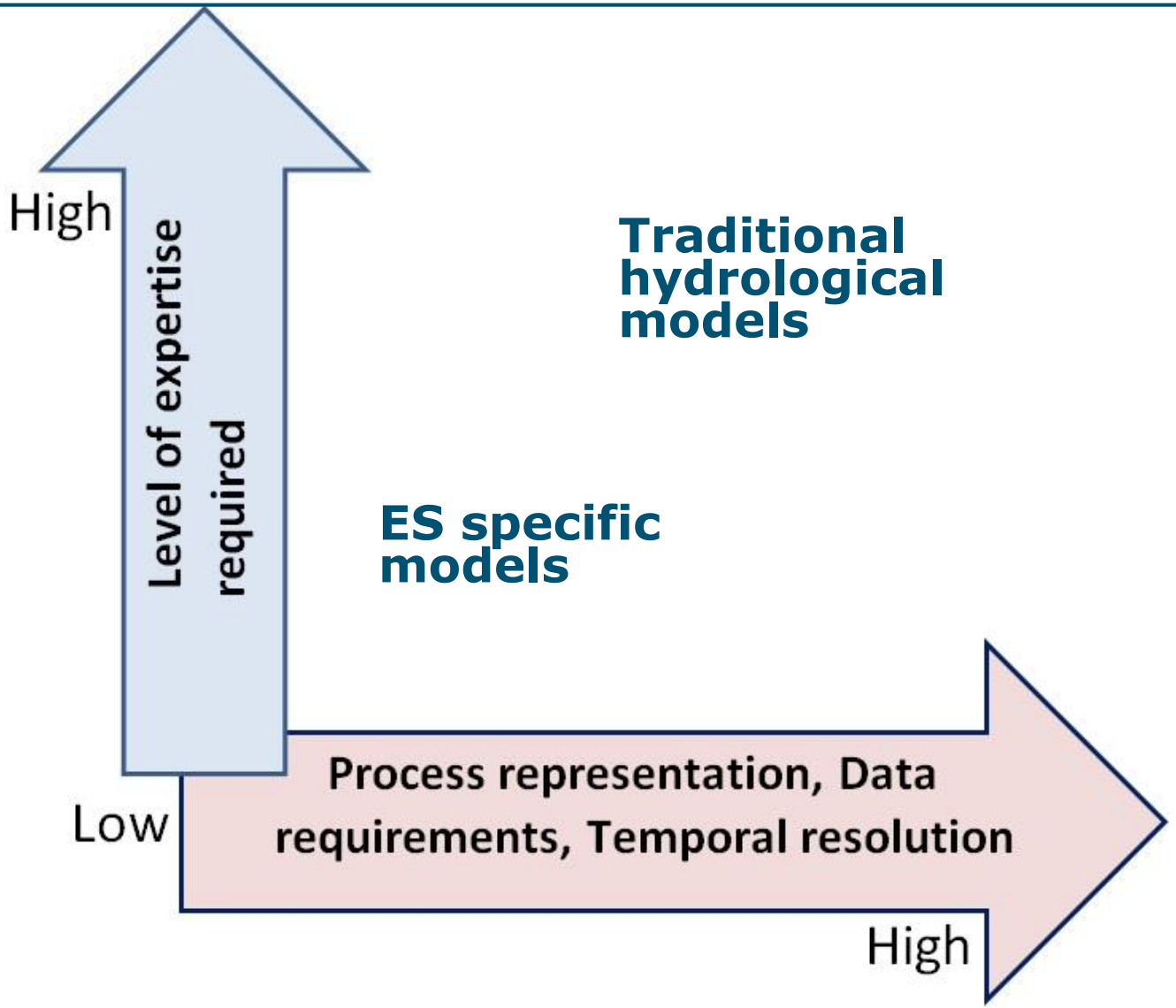
What are hydrological services?

- **Contribution to benefits** produced by **terrestrial ecosystem** effects on freshwater
- Provisioning
    1. Food production
    2. Domestic use
    3. Energy production
- Regulating
    1. Not too much (**flood control**)
    2. Not too little (**drought mitigation**)
    3. Not too dirty (**water quality**)
- Habitat and maintenance

Key challenges in modelling hydrological services

- Modelling **service capacity** and **service flow**
- Modelling **intermediate services**
- Spatial explicitness
- Process representation
- Temporal resolution
- For accounting: need to work at aggregated scales

Overview of models/tools available

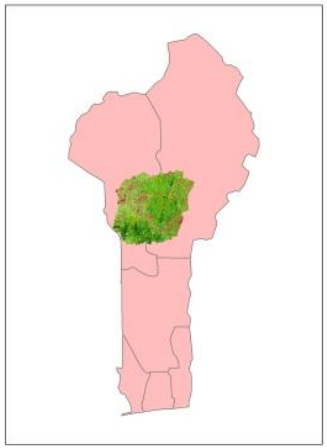


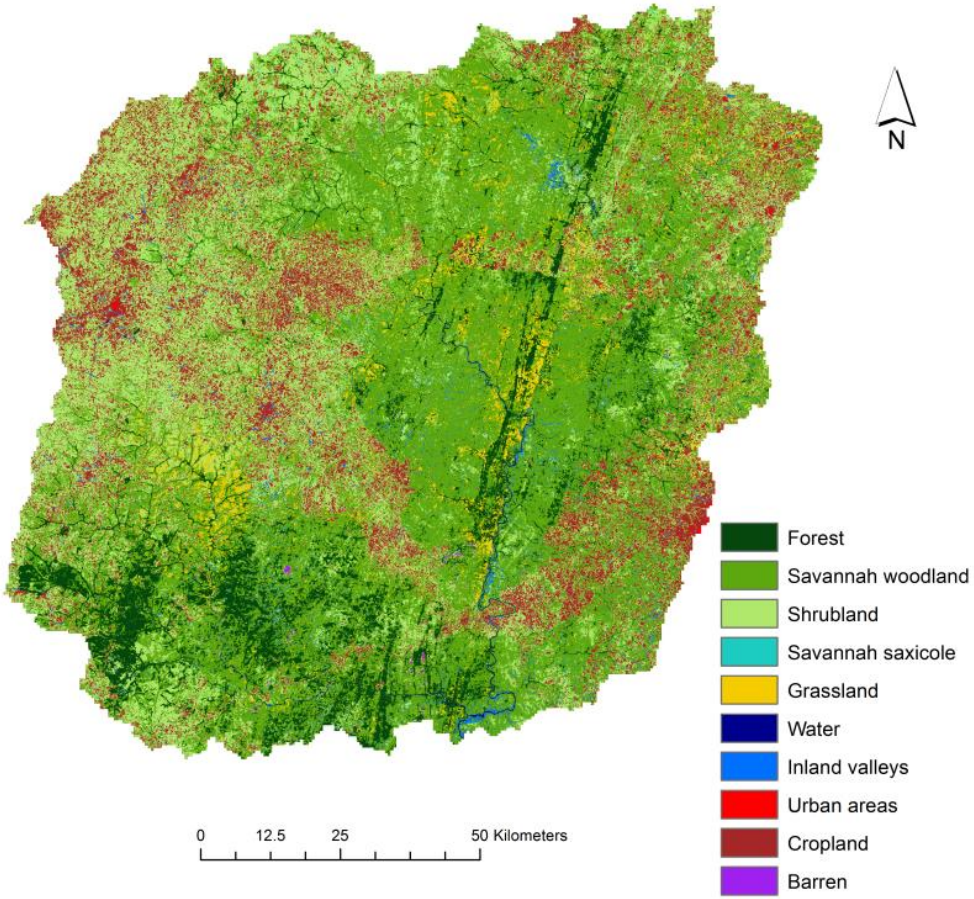
Modelling hydrological services in Benin

1. Water for household consumption
    - Groundwater
    - Surface water
2. Water for rainfed agriculture
3. Water flow regulation by forests & woodlands

Study area

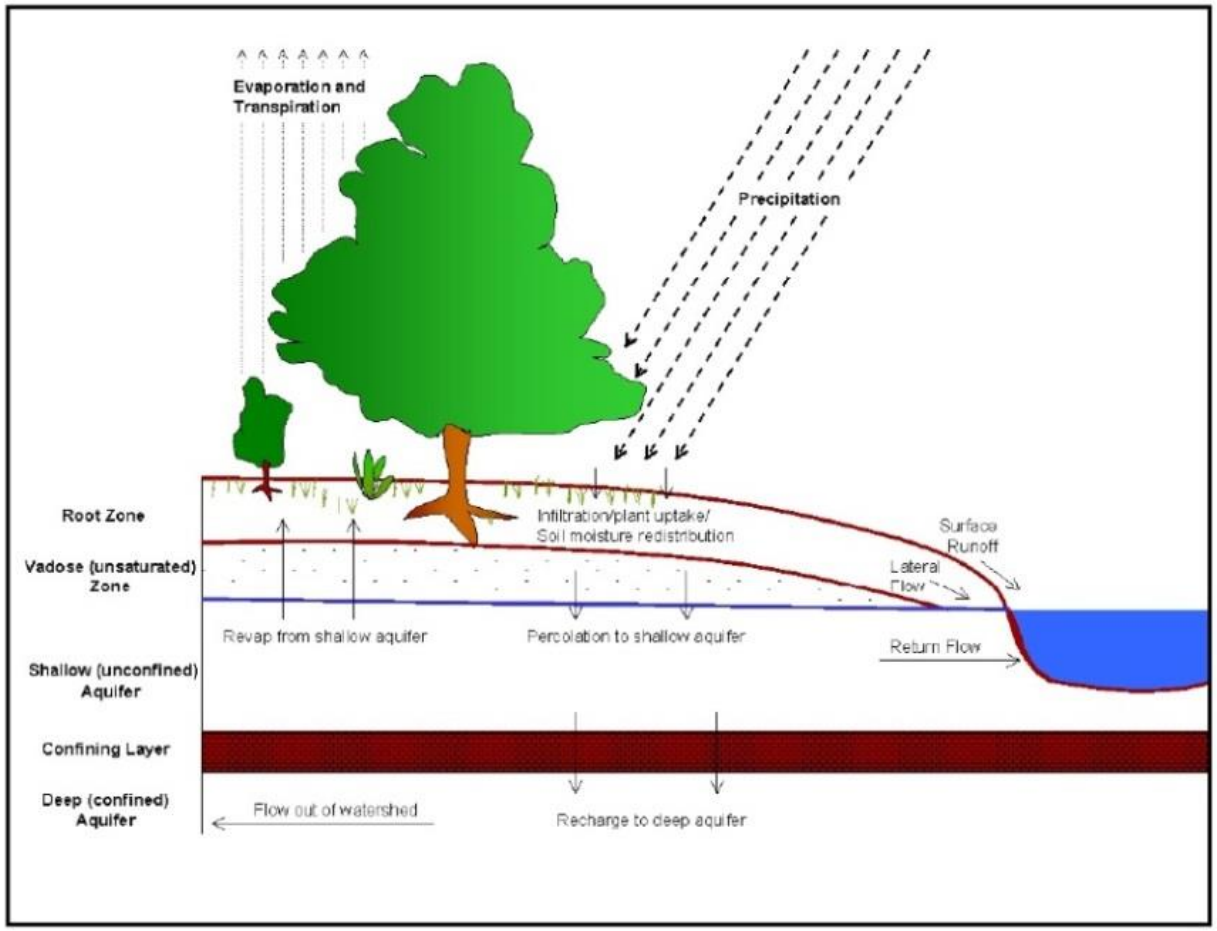
- Upper Oueme watershed: **14,500km²**
- Population: 700,000
- Smallholder **rainfed** agriculture

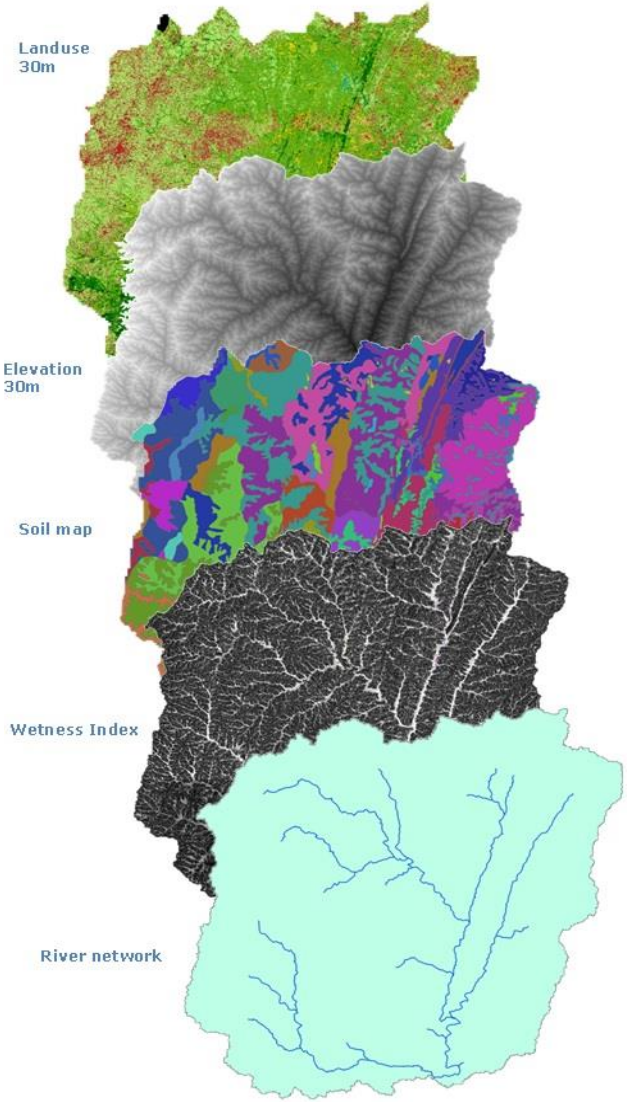




Modelling framework

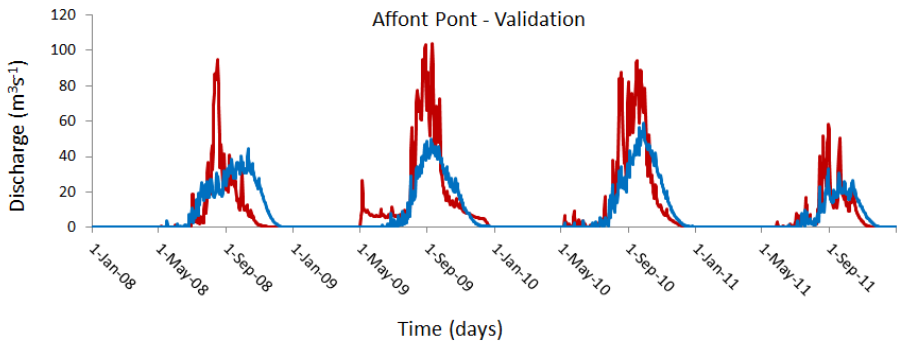
-SWAT model

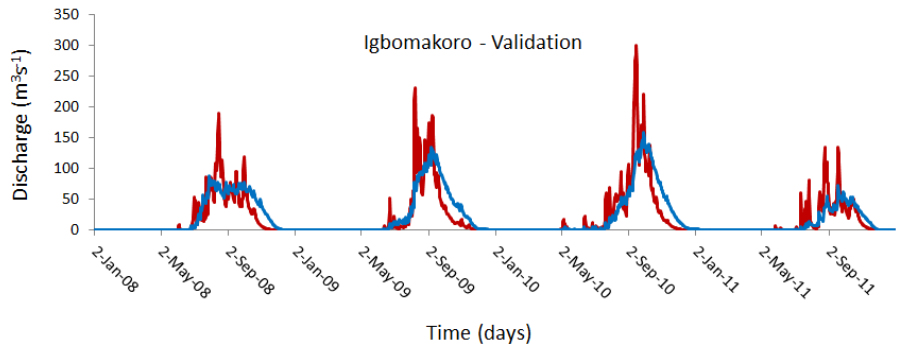


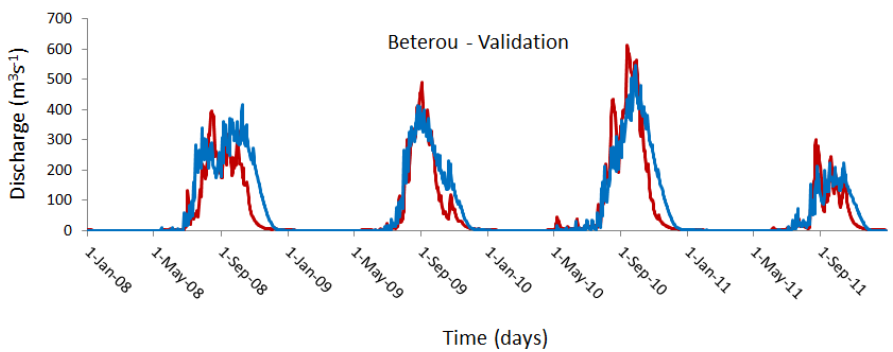


Neitsch, S.L et al. (2009)

Modelling framework



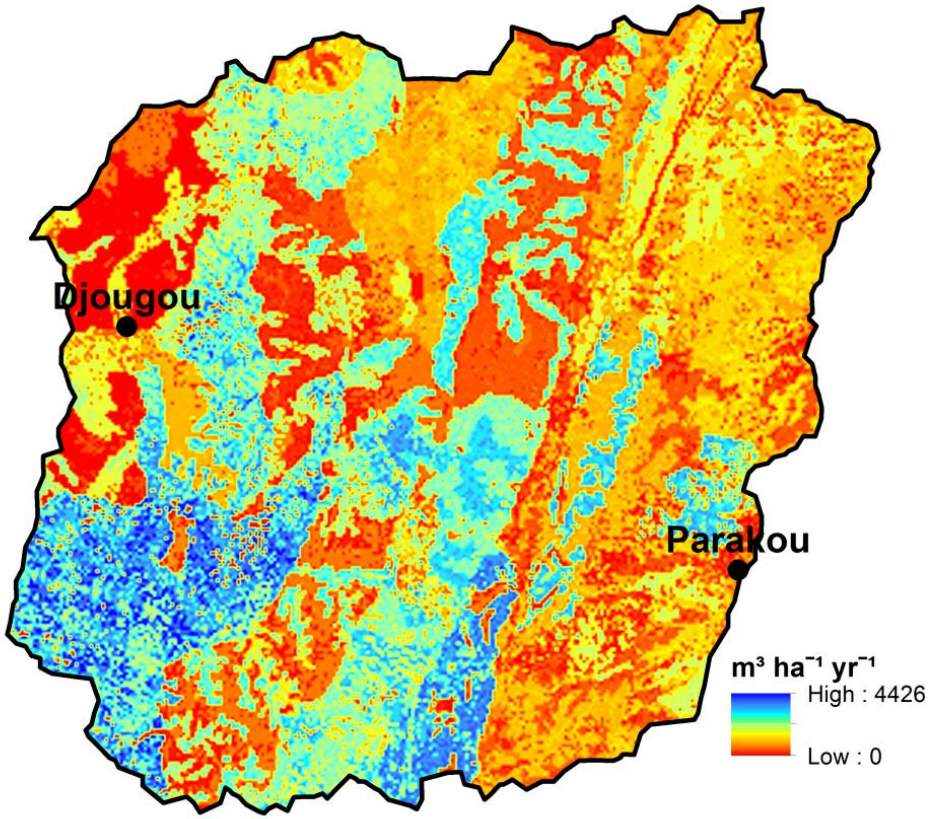




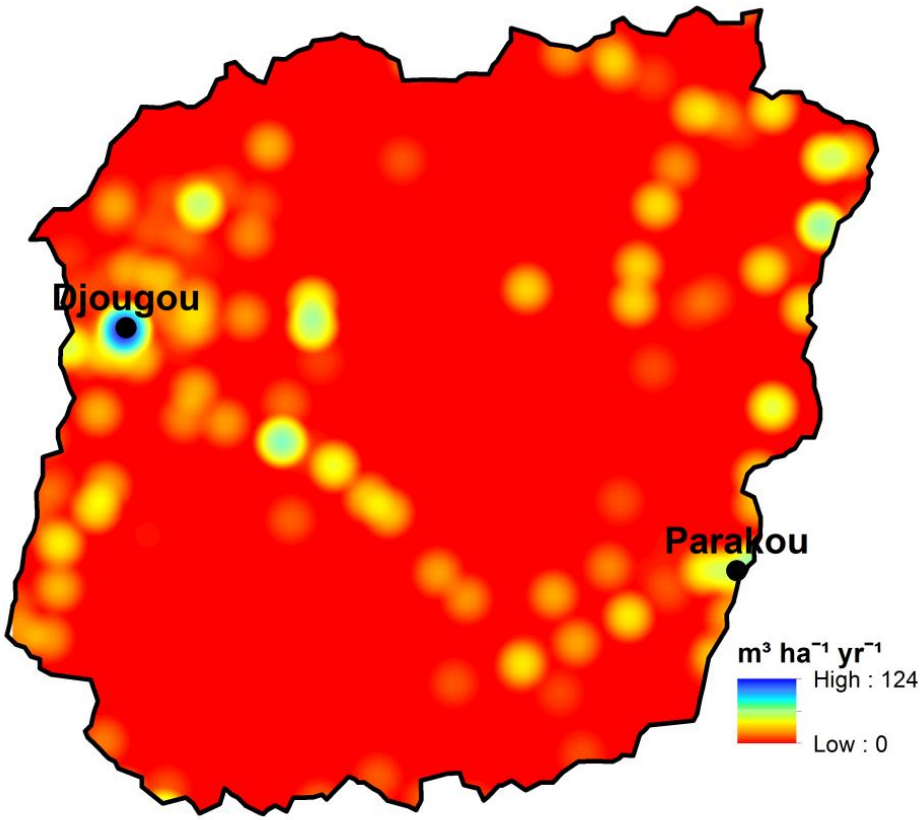
Observed Simulated

Water for households (Groundwater)

Groundwater recharge



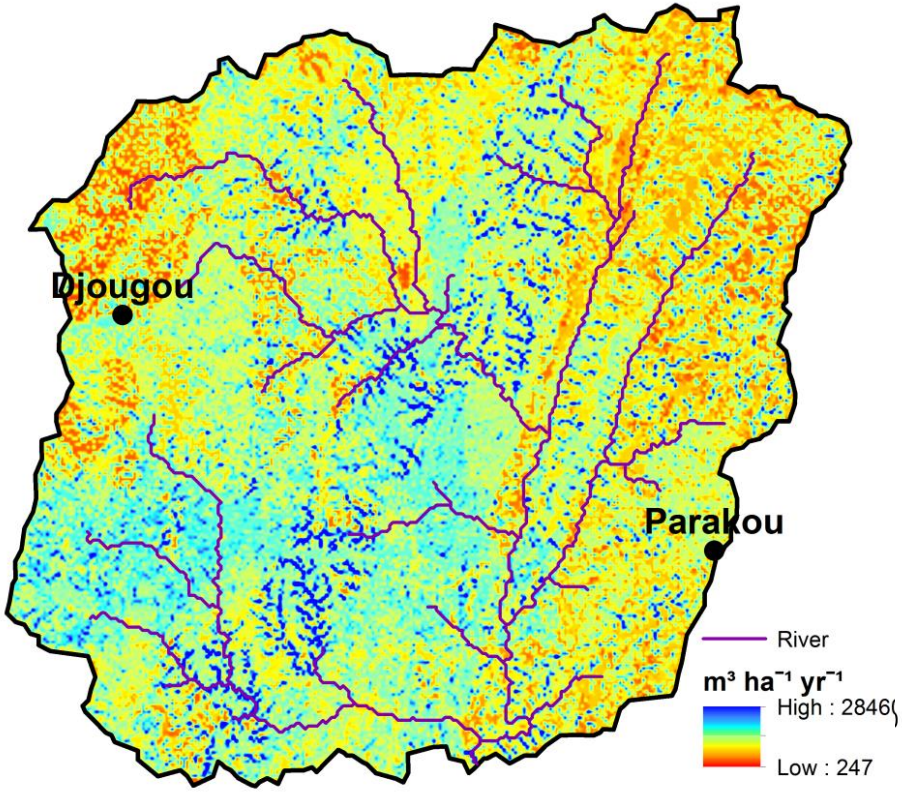
Groundwater use



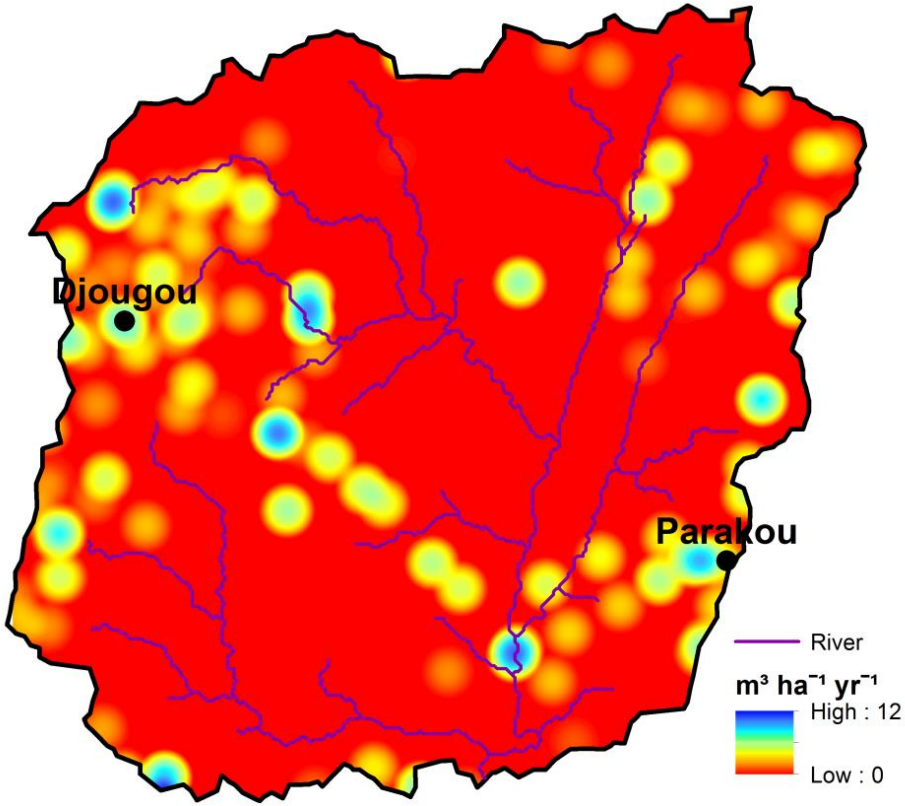
C. Duku et al./Hydrology and Earth System Sciences 19 (2015) 4377-4396

Water for households (Surface water)

Water yield



Surface-water use



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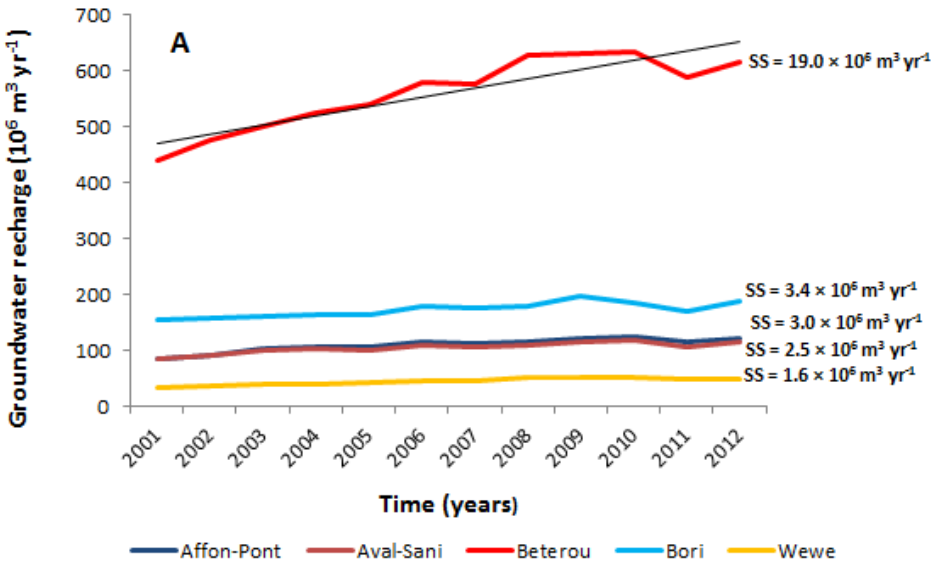
Accounting for hydrological services

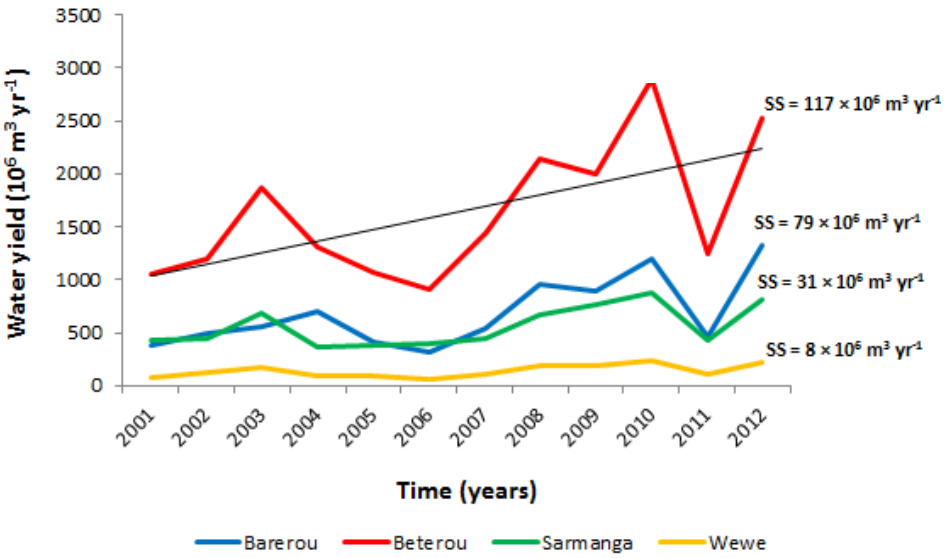
Accounting units	Groundwater		Surface water	
	(10^3 m^3 yr^{-1} recharge)	(10^3 m^3 yr^{-1} extracted)	(10^3 m^3 yr^{-1} water yield)	(10^3 m^3 yr^{-1} extracted)
Affon-Pont	121,000	123	624,000	65
Aguimo	58,000	0	255,000	0
Aval-Sani	114,000	8	458,000	0.2
Barerou	244,000	510	1,328,000	64
Beterou-Ouest	615,000	1,124	2,526,000	219
Bori	185,000	196	1,082,000	30
HVO	206,000	71	638,000	37
Sarmanga	304,000	532	809,000	66
Terou-Igbomakoro	222,000	95	591,000	36
Terou-Wanou	73,000	0	170,000	0
Wewe	48,000	41	213,000	41
Total	**2,190,000**	**2,700**	**8,694,000**	**558.2**

Trends in hydrological services production

Groundwater recharge

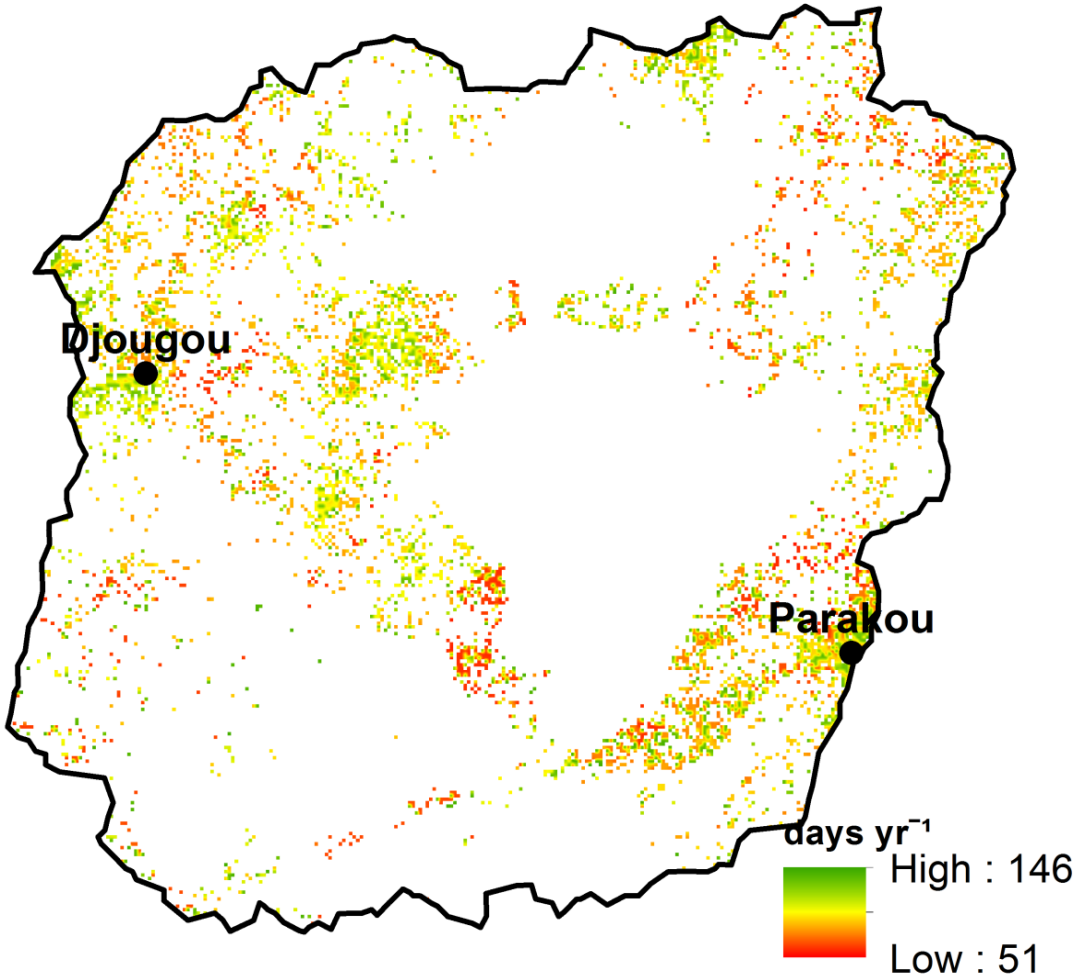


Water yield



Water for rainfed agriculture

- Days WITHOUT crop water stress/Length of growing period
- Crop-independent indicator



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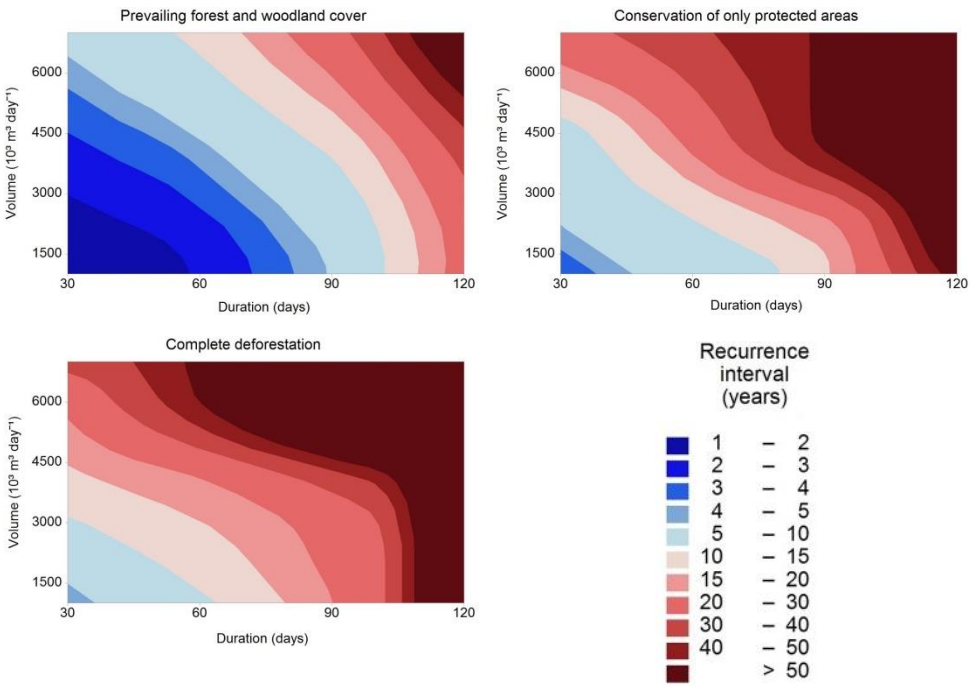
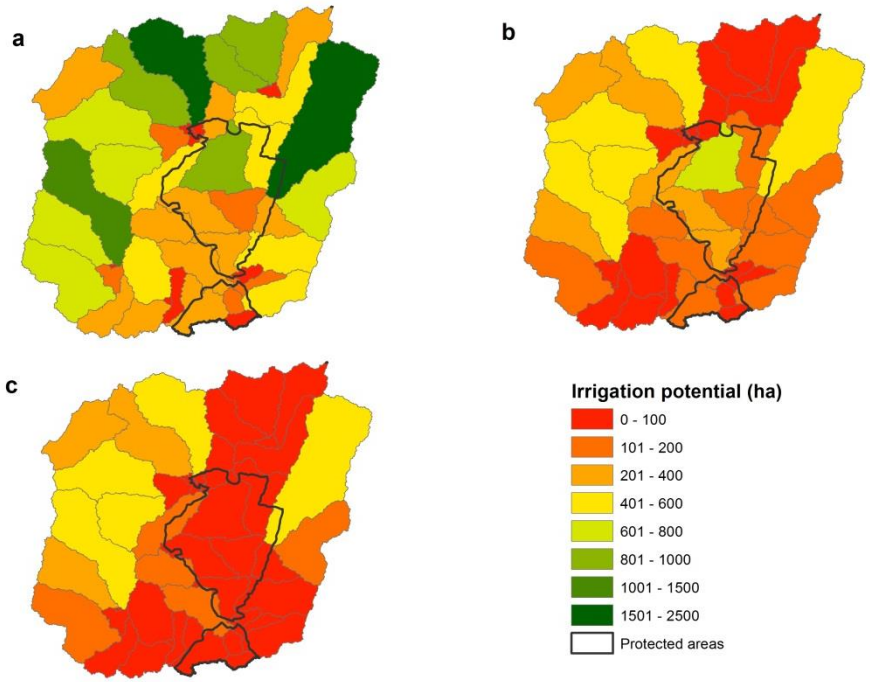
Water flow regulation by forests & woodlands

Water availability



Irrigation potential



C. Duku et al./Agriculture, Ecosystems and Environment 230 (2016) 105-115

Key messages

- Water is a main (the main) limitation to crop production in the sub-humid Sudanian agro-ecological zone
- Water flows and land management are closely connected
- The ecosystem accounting approach facilitates integrated analysis of land and water resources
- There are important trade-offs : reducing forest cover (e.g. for dryland cropping) reduces downstream irrigation potential (as has been quantified in this study)
- Science-based expansion of food production required to meet food requirements of an expanding population under climate change.

THANK YOU

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