Social networks monitoring of water resources

Towards self-regulation of hydrological systems

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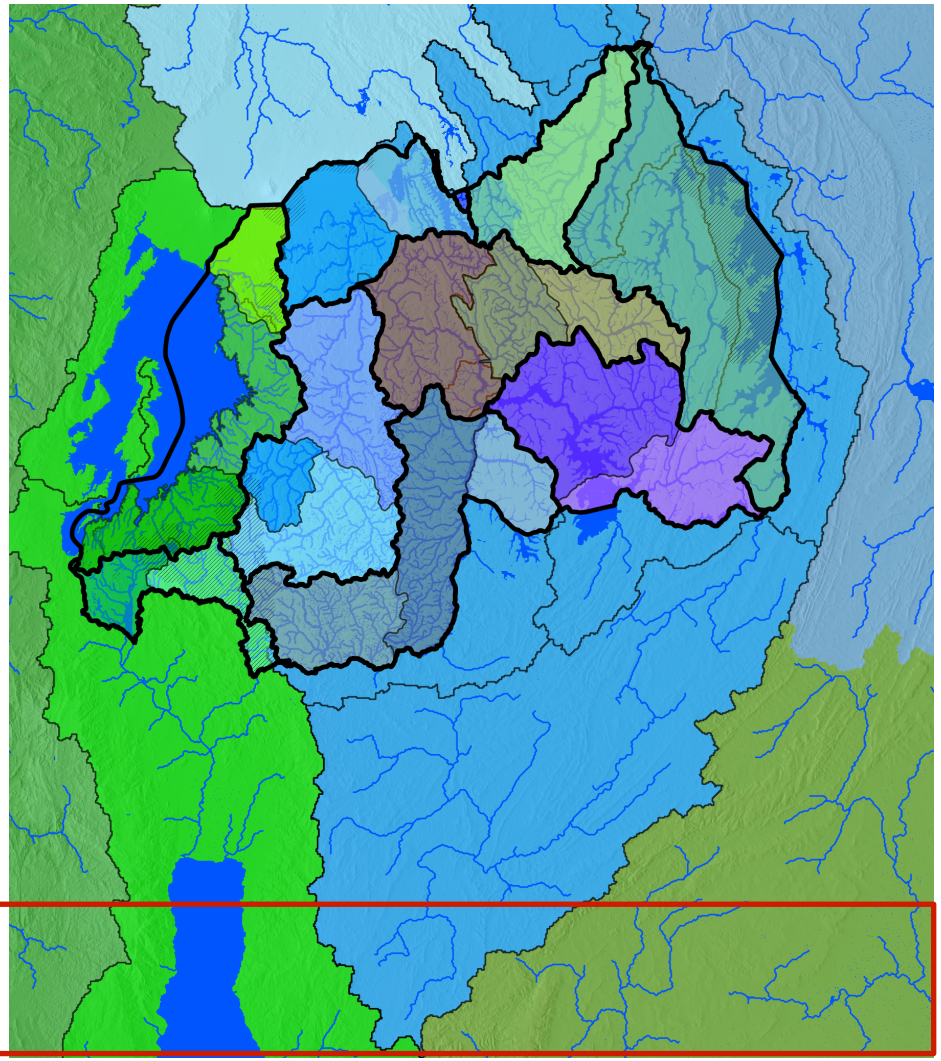
Introduction

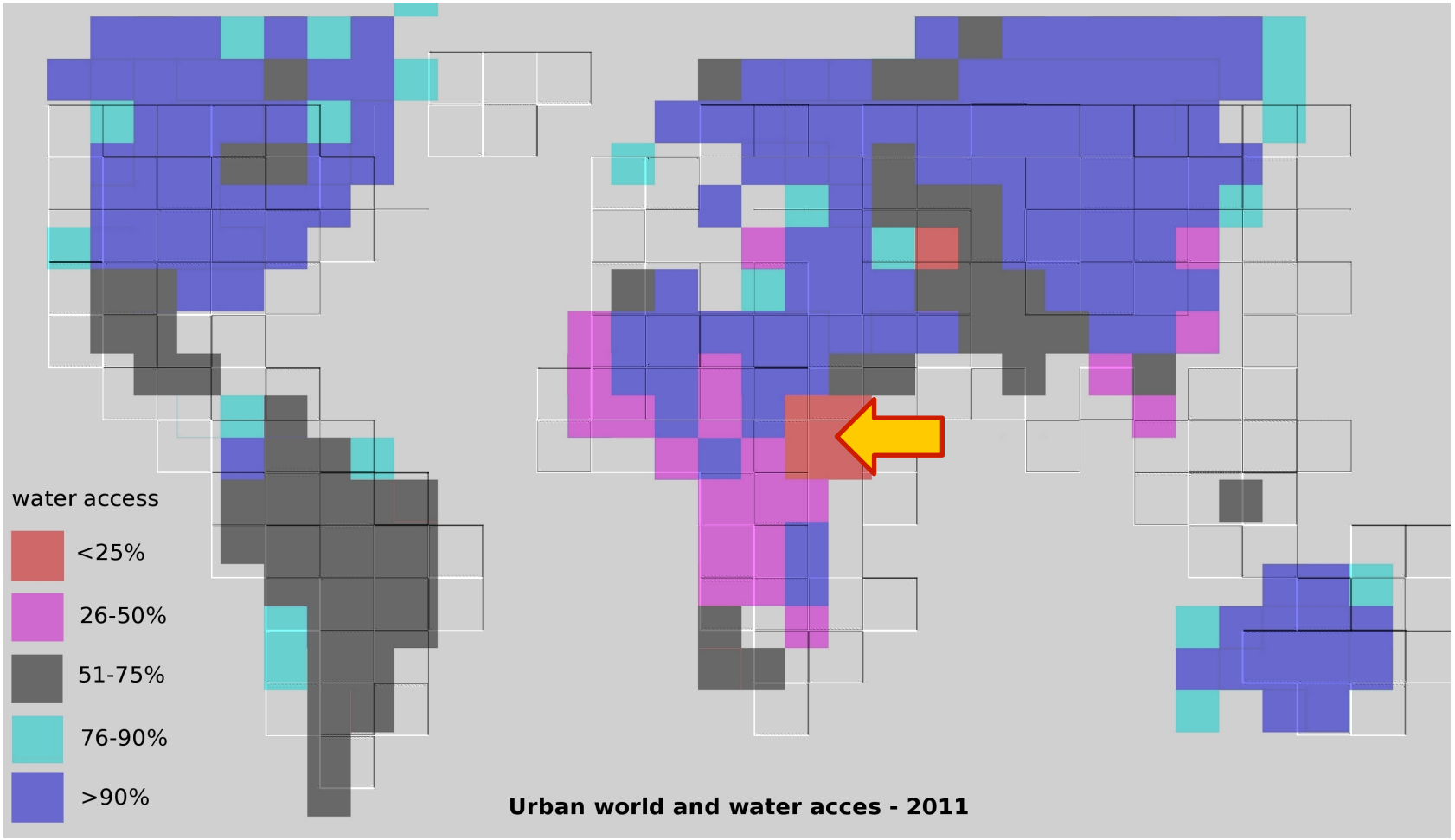
National Water Resources Masterplan for Rwanda 2012-2035 (NWRM)

- Irrigation and hydro-power on the rise
- *Assessment of resources surface and groundwater*
- *Assessment of rural and urban demand*
  Demand and Resources Balance
- **Strategic decisions and options**

- **Management structures**



Access to water supplies
Central-East Africa is a key area



***Source**: United Nations, Department of Social and Economic Affairs (2011)*

Urbanization in Africa

Still dominance of rural population and demand

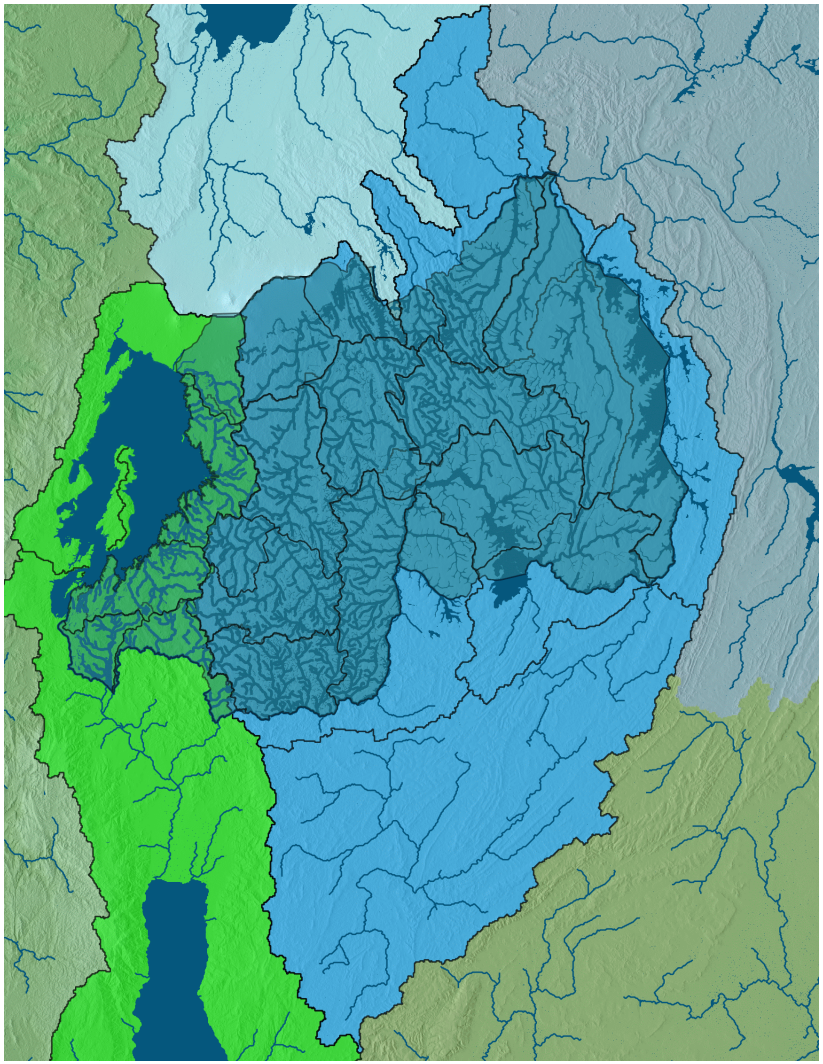
Percentage urban by major area, selected periods, 1950-2050

	Percentage urban					Rate of urbanization (percentage)			
Major area	1950	1975	2009	2025	2050	1950-1975	1975-2009	2009-2025	2025-2050
Africa	14.4	25.7	39.6	47.2	61.6	2.32	1.26	1.10	1.07
Asia	16.3	24.0	41.7	49.9	64.7	1.55	1.62	1.13	1.03
Europe	51.3	65.3	72.5	76.9	84.3	0.96	0.31	0.36	0.37
Latin America and the Caribbean	41.4	60.7	79.3	83.8	88.8	1.54	0.78	0.34	0.23
Northern America	63.9	73.8	81.9	85.7	90.1	0.58	0.30	0.28	0.20
Oceania	62.0	71.5	70.2	70.8	74.8	0.57	-0.05	0.05	0.22

Source: *United Nations, Department of Economic and Social Affairs, Population Division: World Population Prospects DEMOBASE extract. 2009.*

- Africa and Asia post 1975 urbanization (all others pre)
- Rural-urban population from 4:6 in 2010 to 6:4 in 2050…*maybe*
- Balanced approach to rural-urban resources management

System Analysis
Multi-scale basin and aquifer approach



2 International basins
- *National and Transborder Management*

9 major IWRM basins
- *IWRM Basin comittees*

25 meso-basins
- *Problem-oriented (hills)*

100 micro-basins
- *User-oriented, wells*

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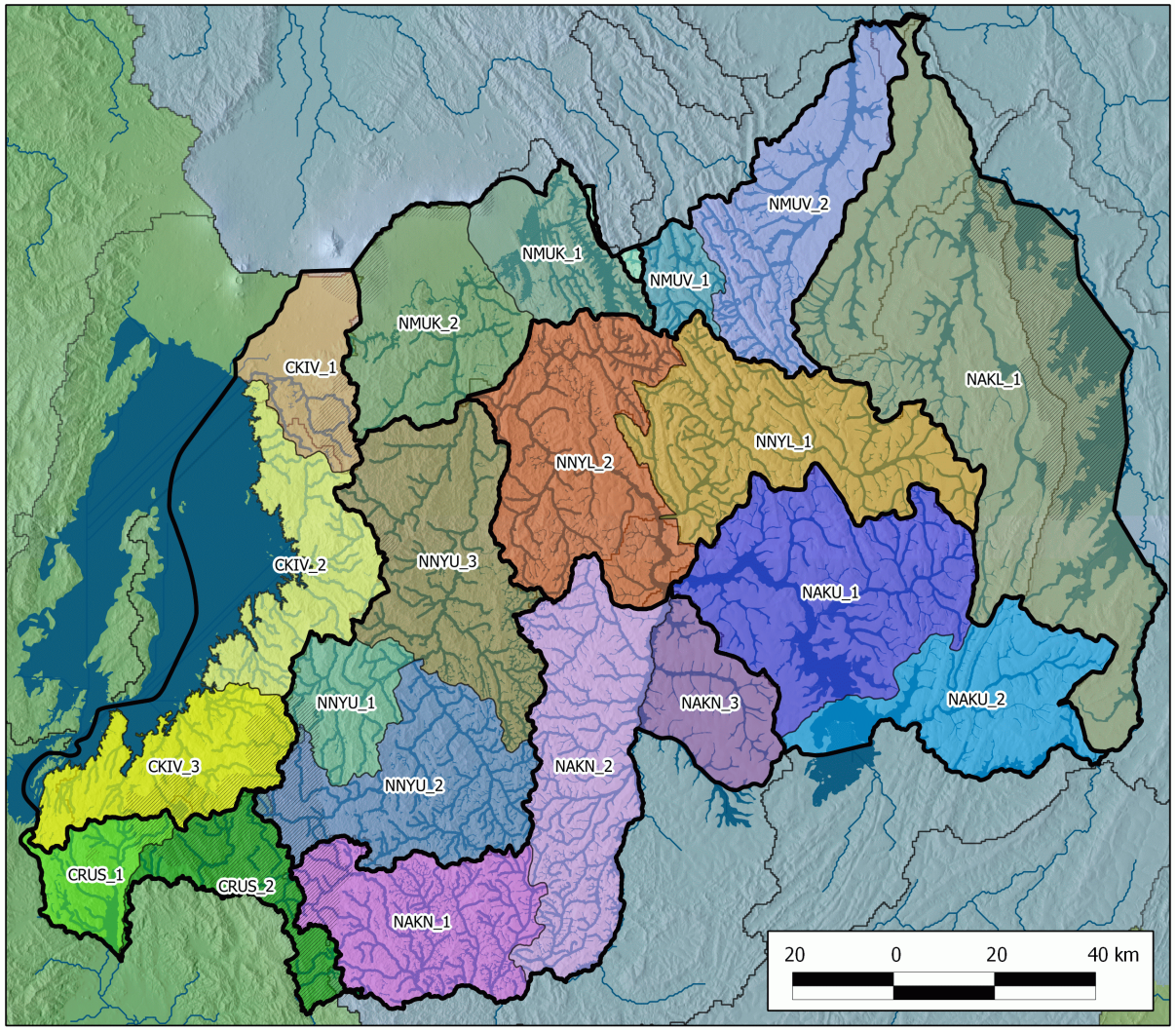
Multi-scale basin and aquifer approach



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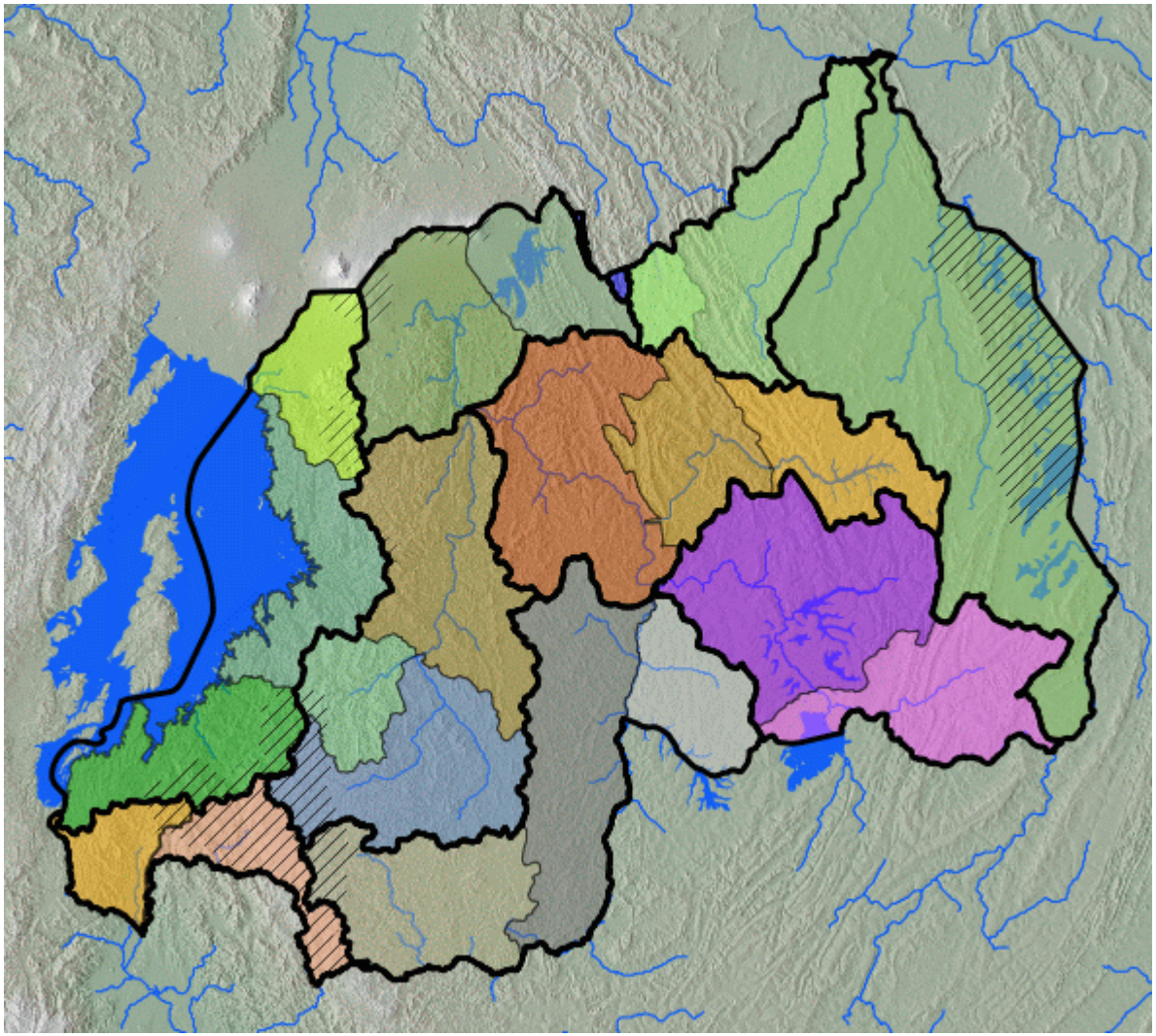

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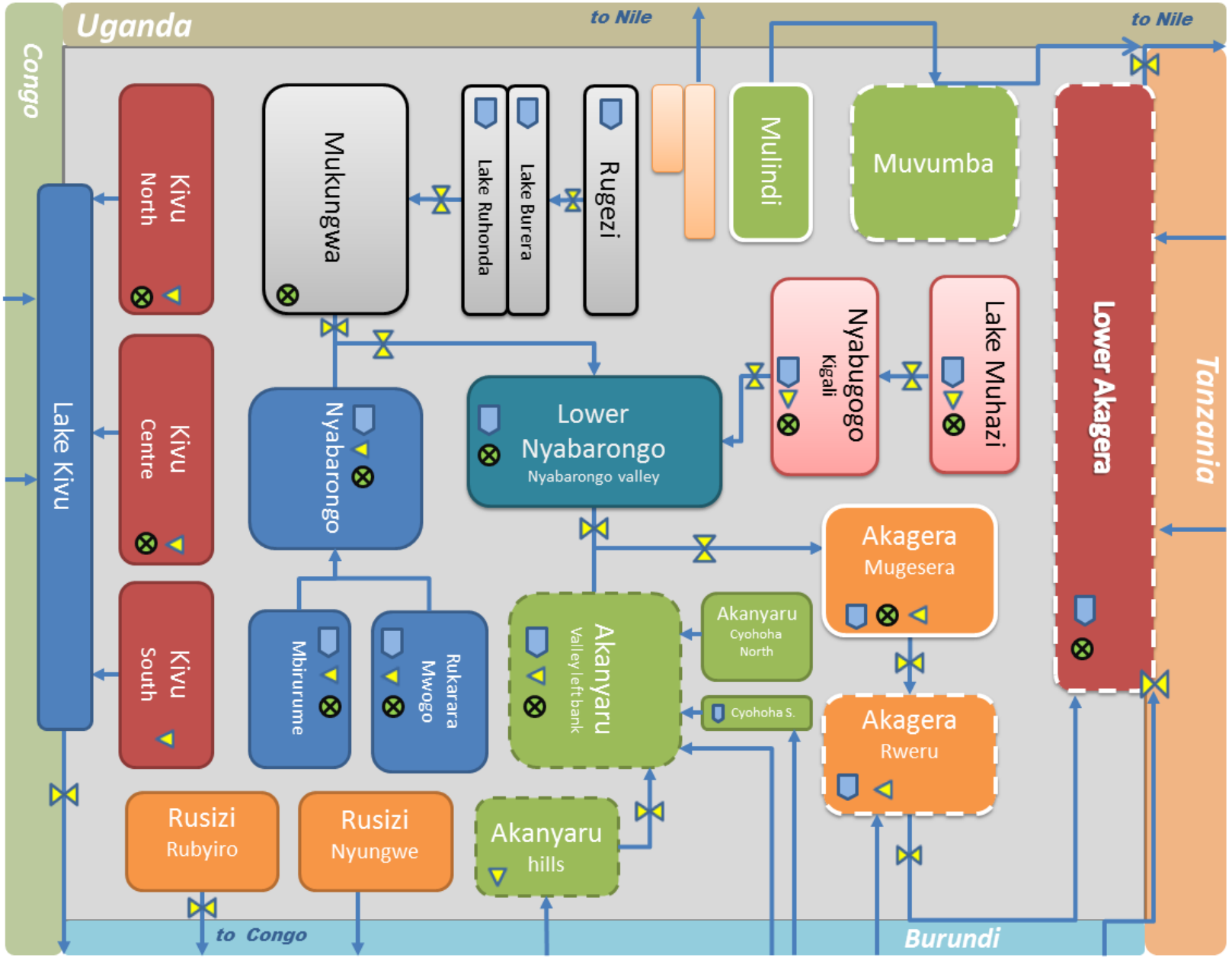
Uganda
to Nile
to Nile
Congo
Tanzania
Burundi
to Congo
Lake Kivu
Kivu North
Kivu Centre
Kivu South
Mukungwa
Lake Ruhonda
Lake Burera
Rugezi
Mulindi
Muvumba
Lower Akagera
Nyabugogo
Kigali
Lake Muhazi
Nyabarongo
Lower Nyabarongo
Nyabarongo valley
Mbirurume
Rukarara
Mwogo
Akanyaru
Valley left bank
Akanyaru
Cyohoha North
Cyohoha S.
Akagera
Mugesera
Akagera
Rweru
Rusizi
Rubyiro
Rusizi
Nyungwe
Akanyaru
hills
water level of lake / wetland
river gauge in basin
groundwater level (piezometer)
runoff gauging station at (sub)basin boundary
basin or sub-basin
basin receiving transboundary inflow
flow

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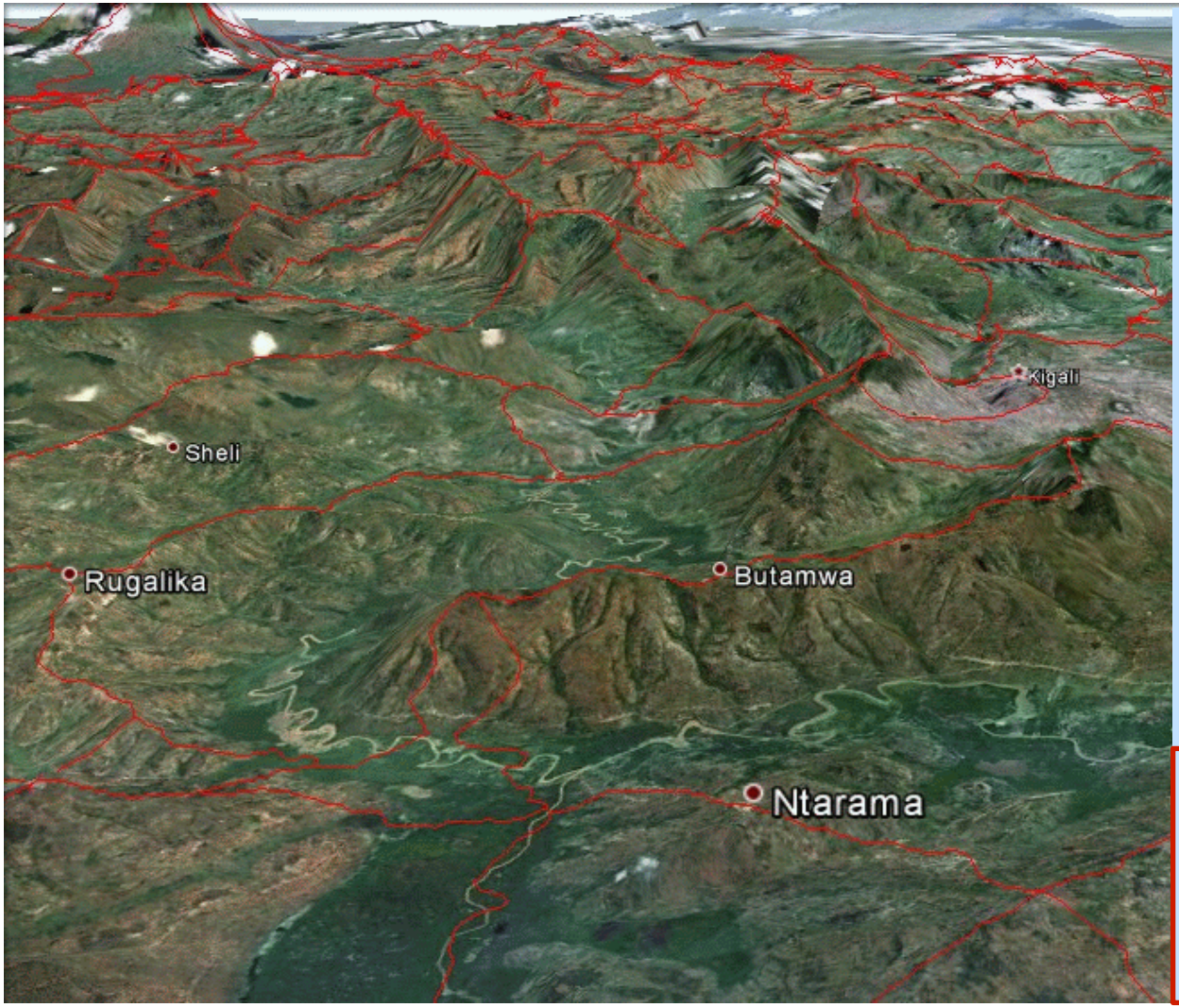

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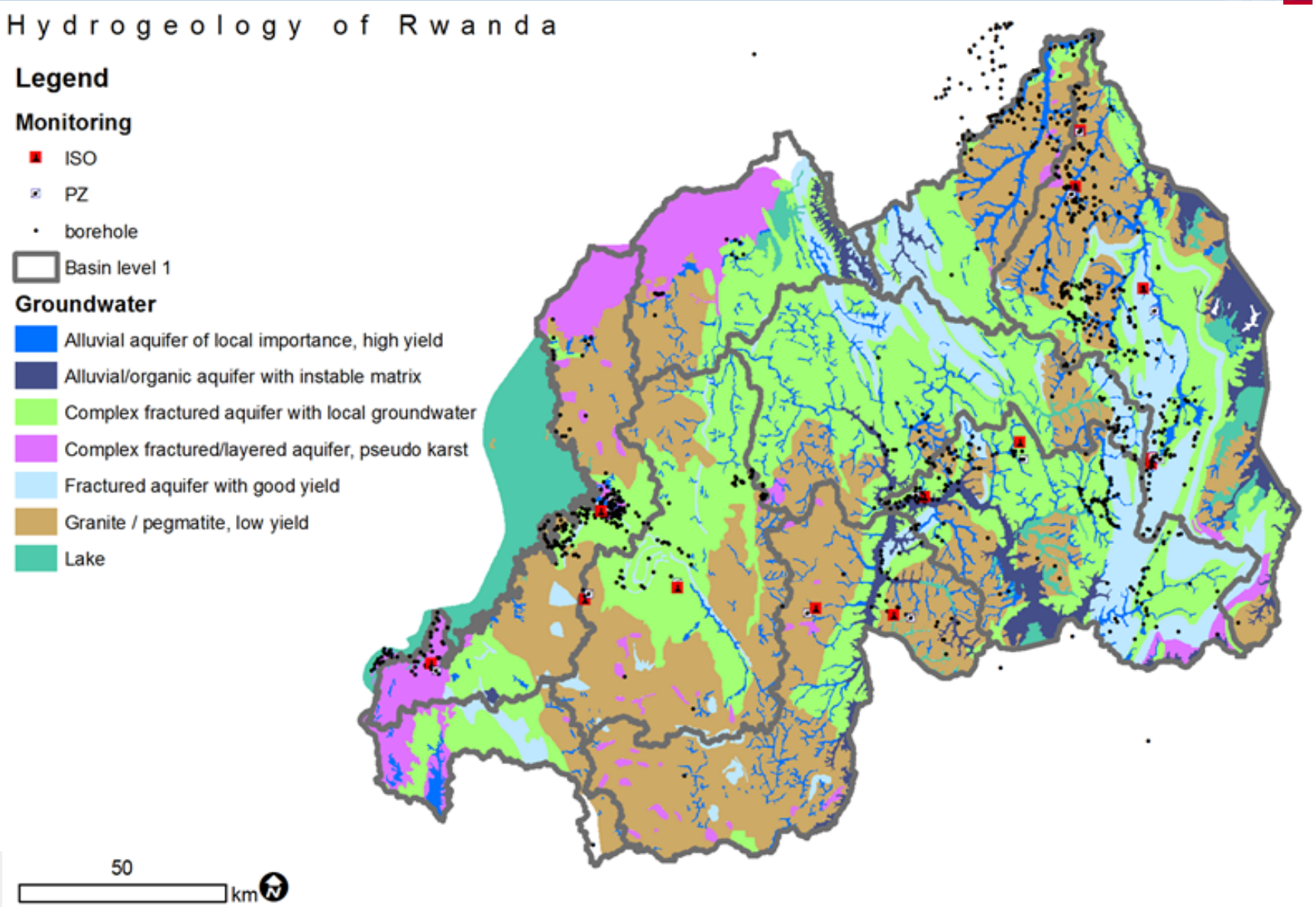
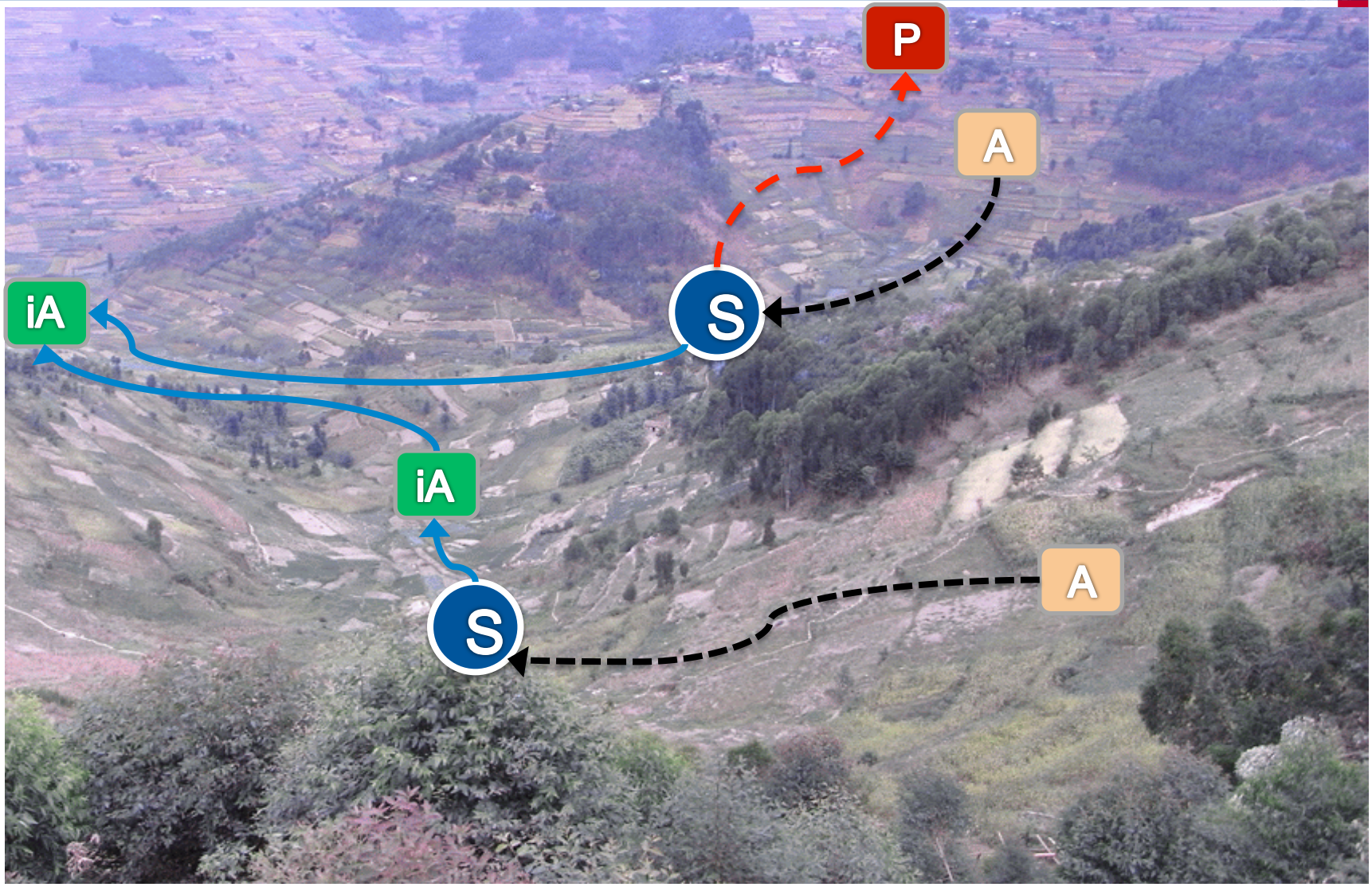
The hidden hydrological engine

Groundwater drives 85-90 % of river flow (baseflow separation)



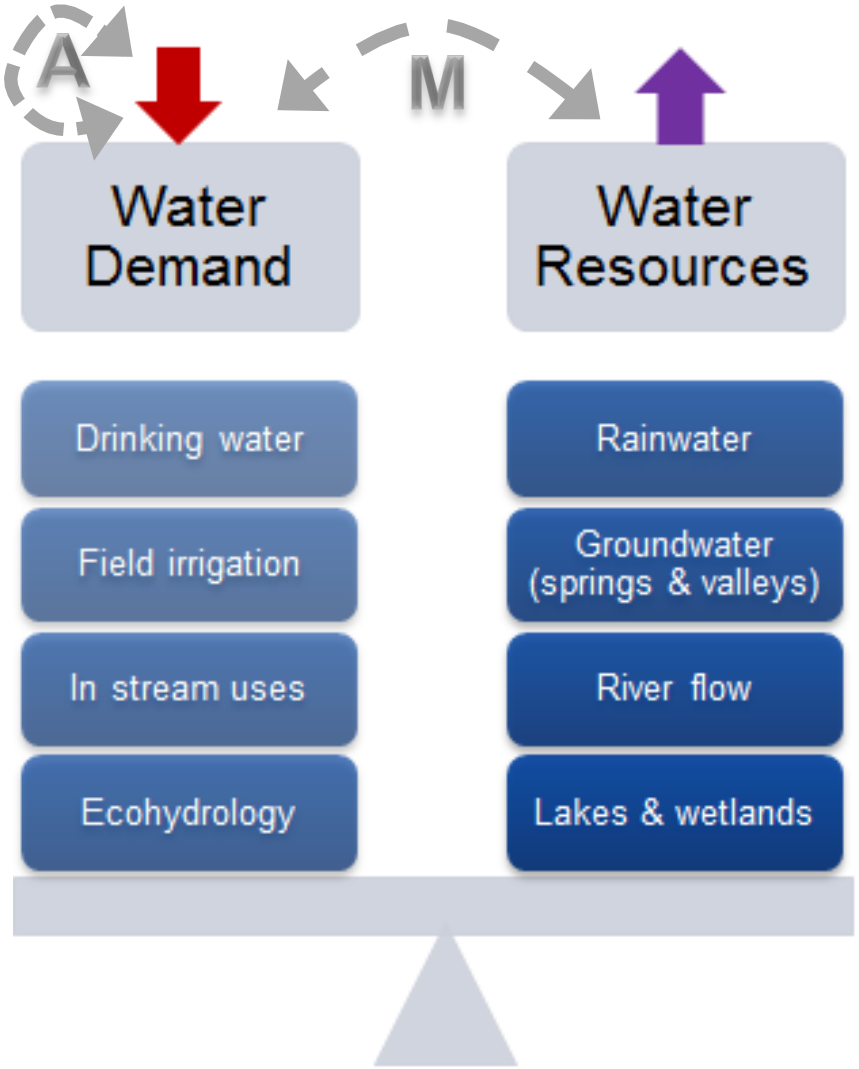
Social monitoring at local scale

Enabling the rural population to self-regulate demand



Social monitoring at local scale

Local scale consumer flexibility by local monitoring



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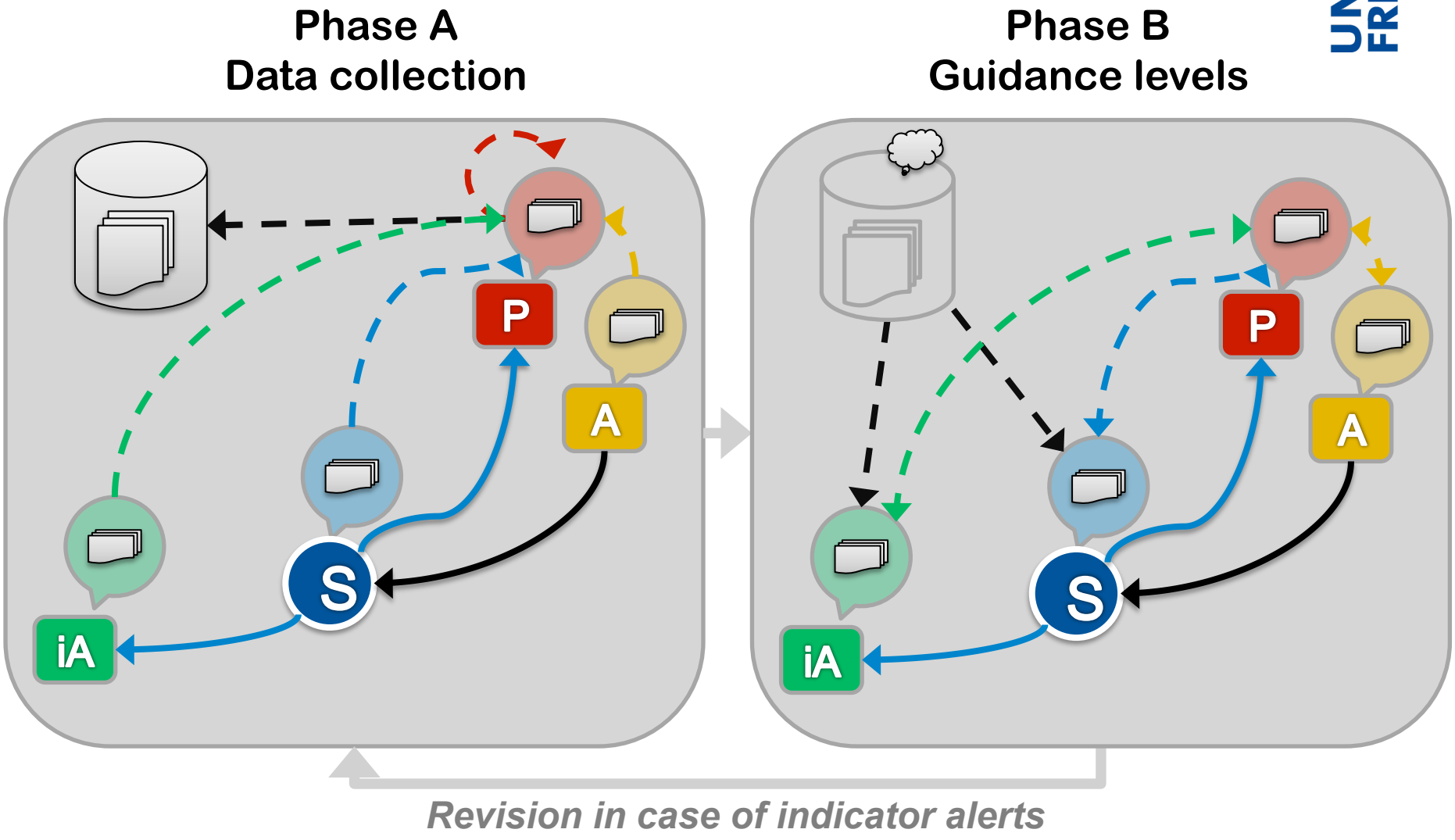

Social monitoring at local scale
Distributed monitoring , reporting and awareness

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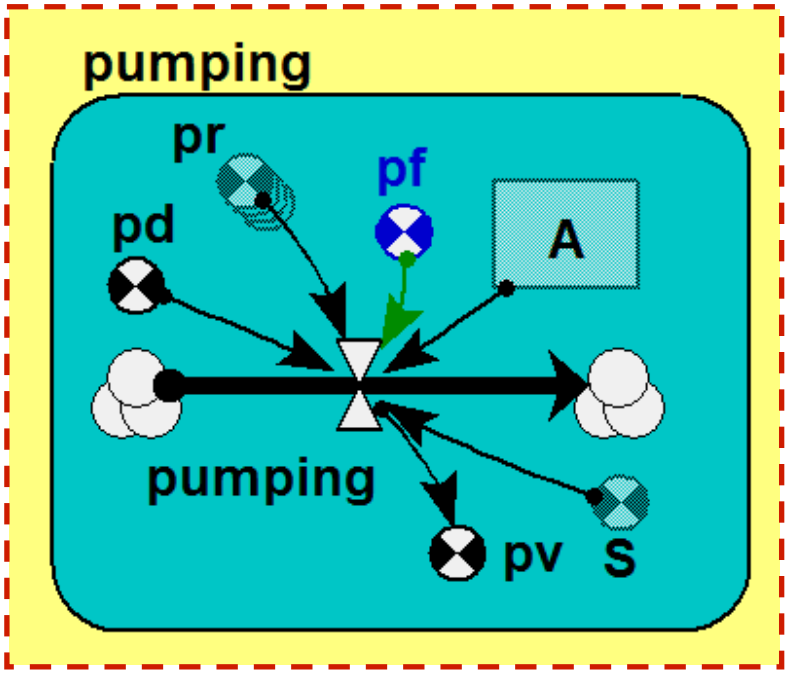
Equipping wells and valley irrigation systems with *community sensors and loggers*

- *100 devices*
- *Water level, temperature, conductivity, turbidity and social data*
- *Data transmission* ***not automatic***
- *Community observer needed*
- *Daily to weekly reading with mobile phone and SMS (HMS)*
- *Objective: Definition and display of guidance levels and* ***red lines***
- ***Social control of compliance***

Results from surveys

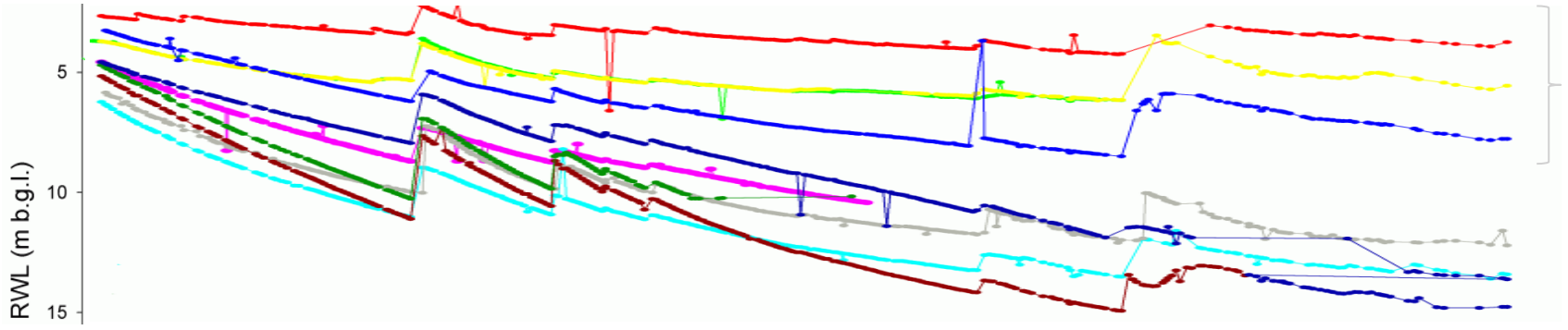
Demand flexibility by guidance levels increases resilience



Pumping flexibility (pf) is introduced:

- *Pumping rate (pr)*
- *Pump depth (pd)*
- *Actual pumping volume (pv)*
- *Potential storage (S)*
- *Actual storage (A)*

$$pa = pr \cdot \left(\frac{(A - pd \cdot S)}{(S - pd \cdot S)} \right)^{pf}$$



P_{f1} > p_{f2}

Summary & conclusions

Society and hydrology – water resources Rwanda

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Local users adapt to ‚*known*‘ scarcity

Guidance data for locals needed

Guidance data can be used for self-regulation

Monitoring needs to become multi-scale and nested