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Temporal variability and spatial distribution of suspended matter and organic C pool in the Zambezi River system

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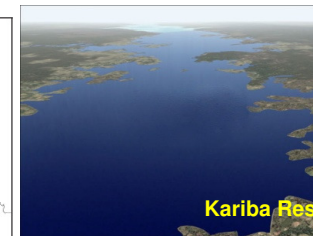
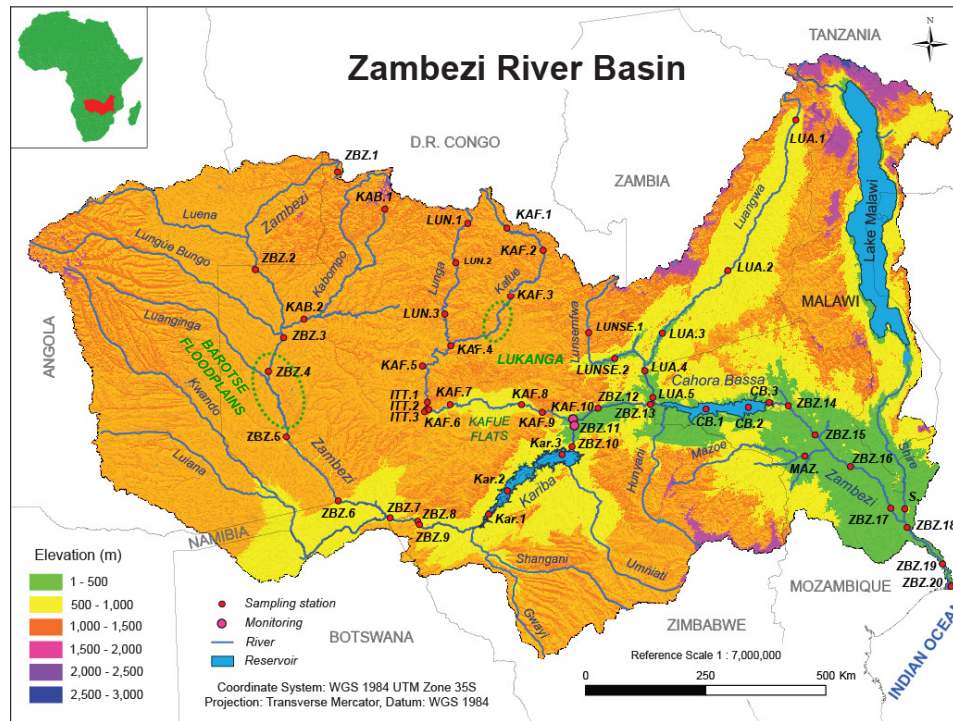
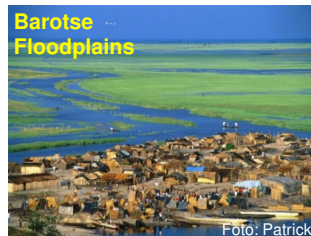
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AFRIVAL Project (African River Basins)
<http://ees.kuleuven.be/project/afrial/>

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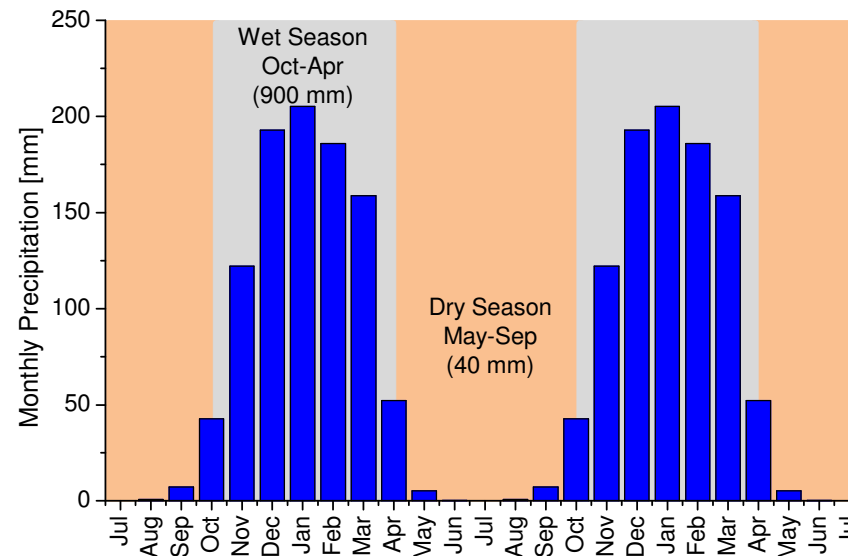
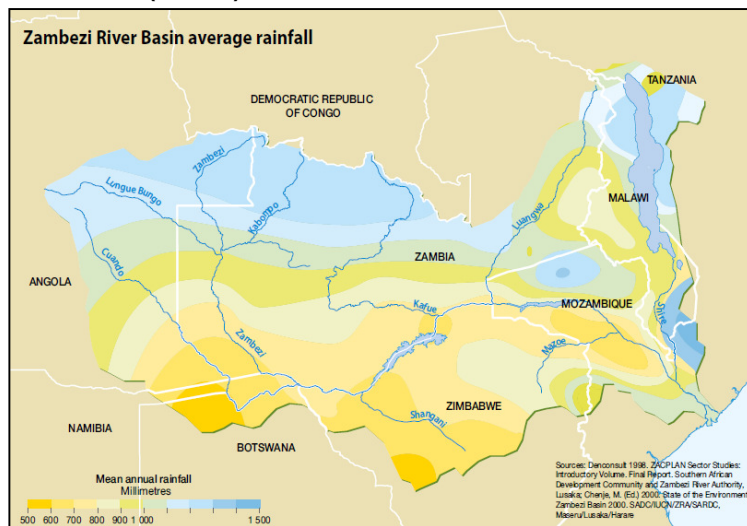
The Zambezi River Basin – general characteristics

- 4th largest in Africa and the largest flowing in to the Indian Ocean (from Africa)
- Total length: > 3000 km; Drainage basin: ~ 1.4 x 10⁶ km² (shared by 8 countries)
- Main tributaries: Kabompo (270 m³/s), Luangina (65 m³/s), Kwando (53 m³/s), Gwayi (85 m³/s), Kafue (370 m³/s), Luangwa (520 m³/s), Shire (115 m³/s)
- 2 main reservoirs: Kariba (5600 km²; 180 km³), and Cahora Bassa (2600 km²; 50 km³)



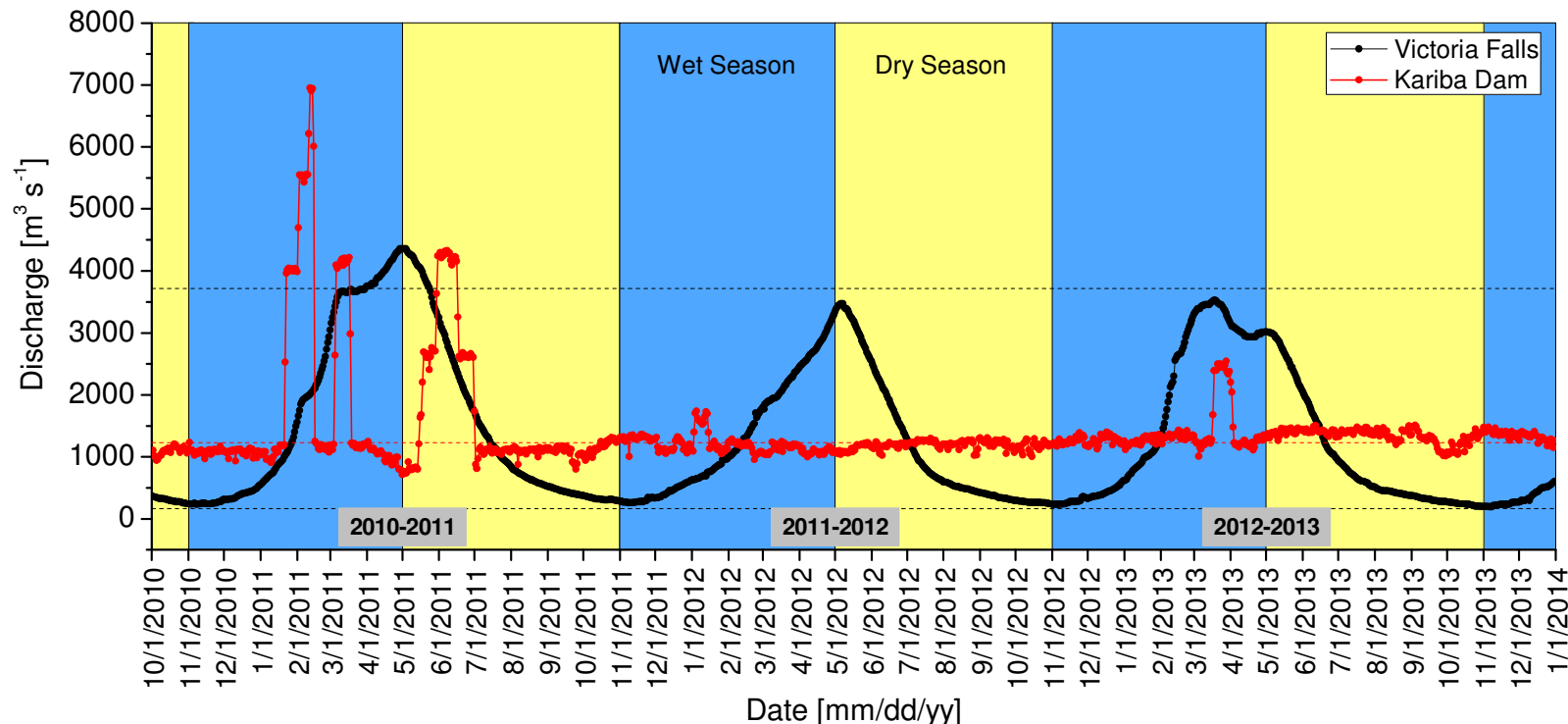
The Zambezi River Basin – climate and rainfall

- Climate is classified as *humid subtropical* or *tropical wet and dry*
- Annual rainfall *varies with latitude*: **1400 mm** in N to **400-500 mm** in S (mean average rainfall for entire basin: **940 mm**)
- Two seasons:
 1. **Wet season** (Oct/Nov – Apr) corresponding to summer, with 95% of annual rainfall
 2. **Dry season** (May – Sep/Oct), corresponding to winter, with 5% of annual rainfall
- Temperature across basin *varies with elevation* and, *and less with latitude*
- Mean monthly t°: **13°C** for higher elevation in S to **23°C** in E (July); and **23°C - 31°C** (Oct)



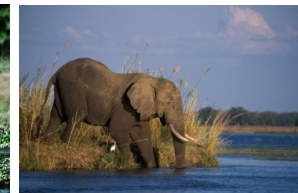
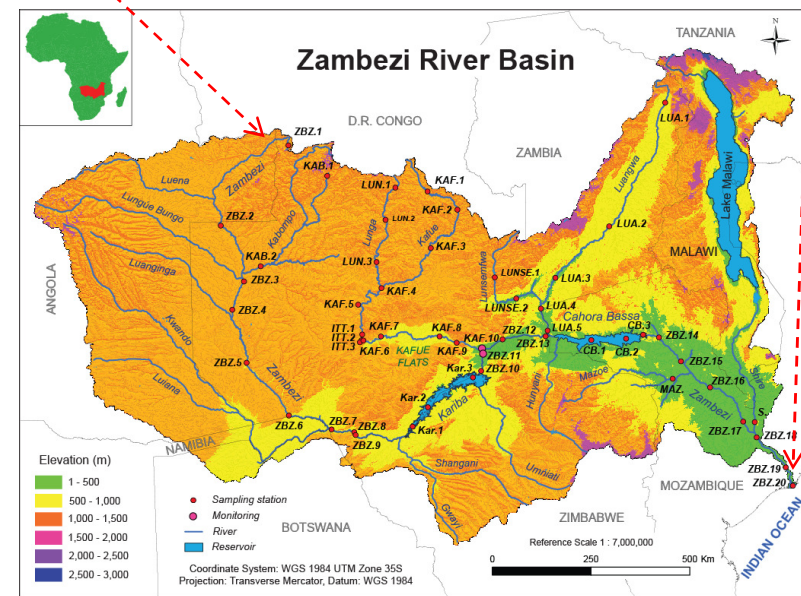
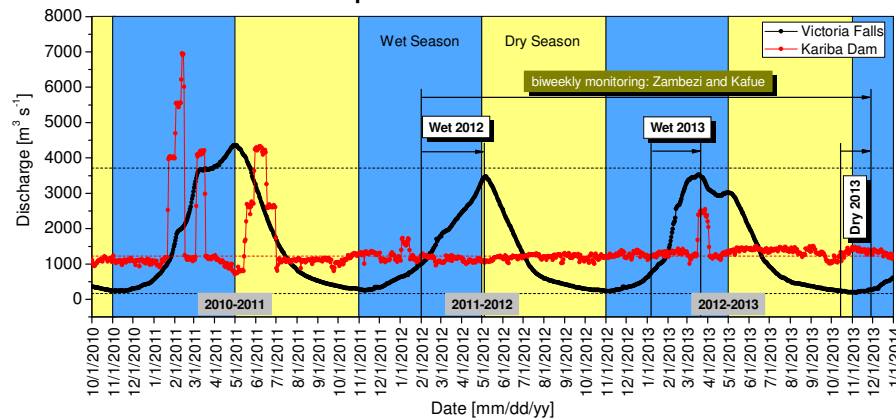
The Zambezi River Basin – hydrological cycle

- Driven by seasonality in rainfall patterns, hydrological cycle of the basin has a bimodal distribution with a **single main peak flood** (max. Q: Apr/May) and min. flow in Oct/Nov
- Due to regional rainfall distribution, northern tributaries contribute much more water than southern ones
- Average annual discharge at Zambezi Delta: **3500-4000 m³ s⁻¹**



Sampling Strategy

- **3 campaigns:** *Wet* (Feb-Apr) 2012, *Wet* (Jan-Apr) 2013, *Dry* (Oct-Dec) 2013
- **56 sites:** 26 along Zambezi (Kariba & CB Res.), and 30 on tributaries (ITT Res.)
- **2 monitoring stations** (Feb 2012 – Dec 2013):
ZBZ.11 ~ 5 km upstream the confluence with Kafue
KAF.10 ~ 6 km upstream the confluence with Zambezi

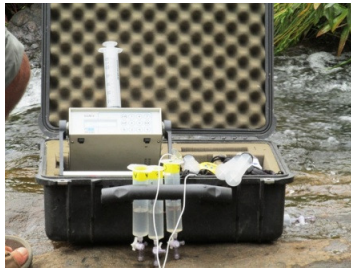


Measured parameters

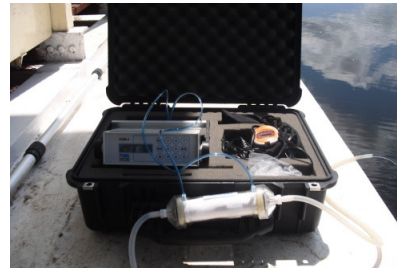
- Physico-chemical: pH, O₂, t°, conductivity, Total Alkalinity
- Total Suspended Matter (**TSM**) and sediment characterization
- Concentration and stable isotope (**δ¹³C and δ¹⁵N**) composition of **POC, PN, DOC, DIC**
- Aquatic metabolism: community respiration, primary production
- GHG (CO₂, CH₄, N₂O) concentrations and fluxes

In-situ CO₂ concentrations

Headspace Technique

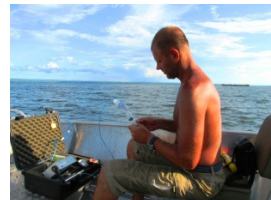
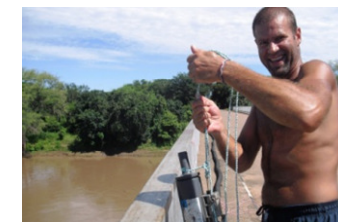
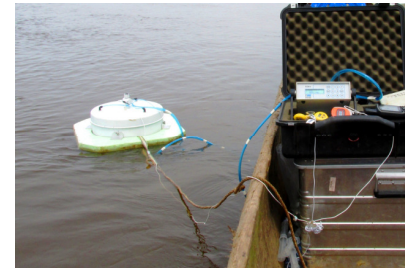


Membrane Equilibrator



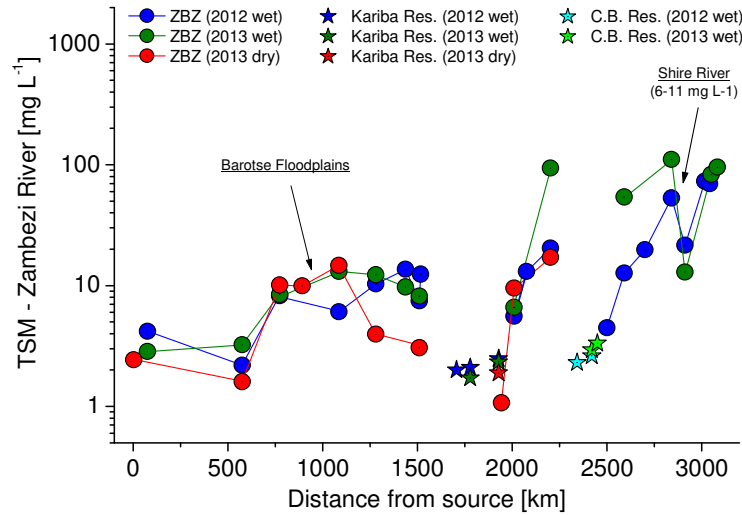
Fluxes

Floating chamber

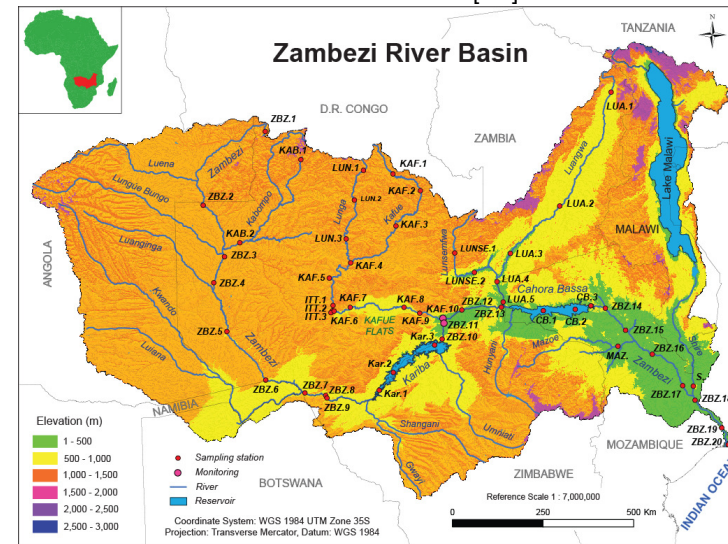
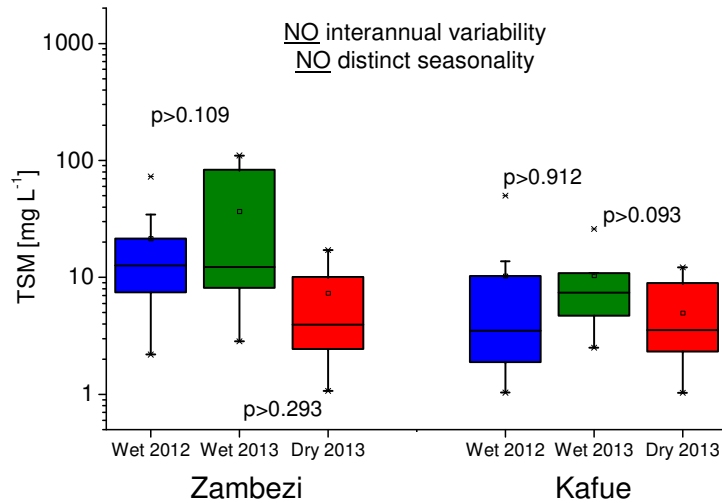
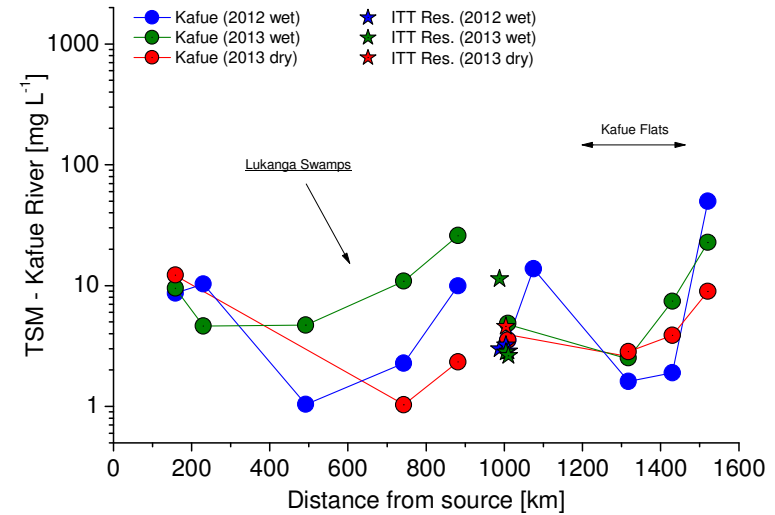


TSM – spatio-temporal dynamics

Zambezi River

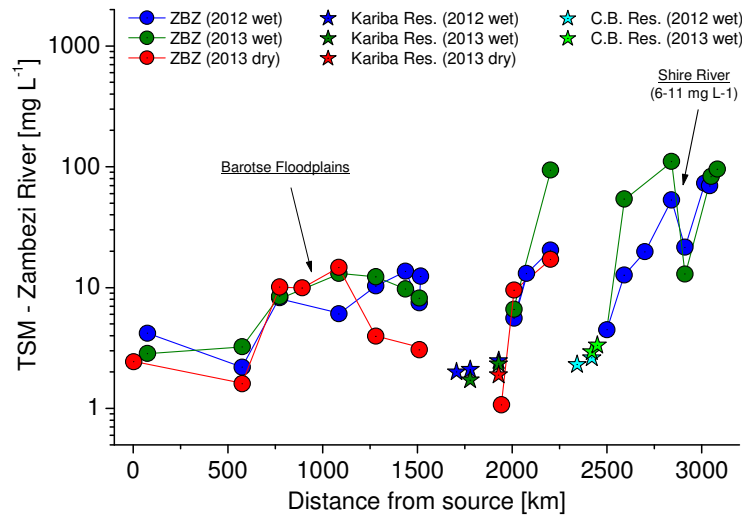


Kafue River

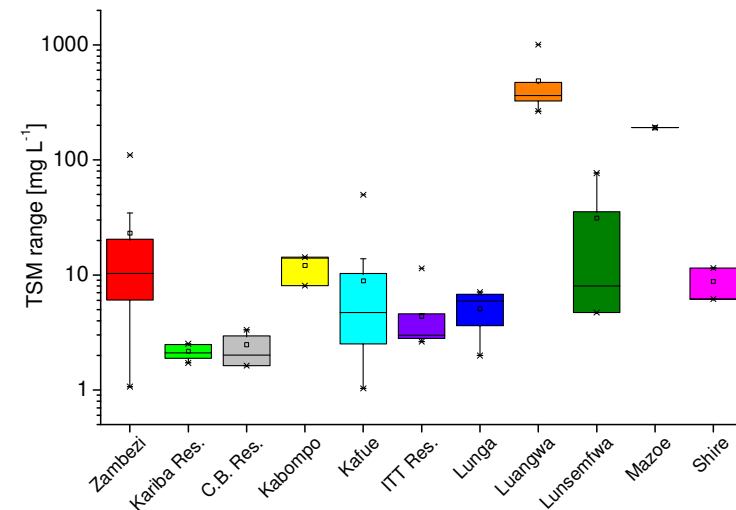
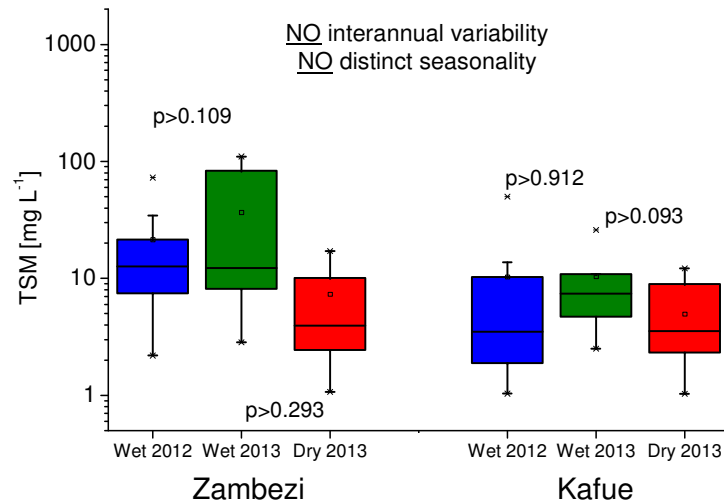
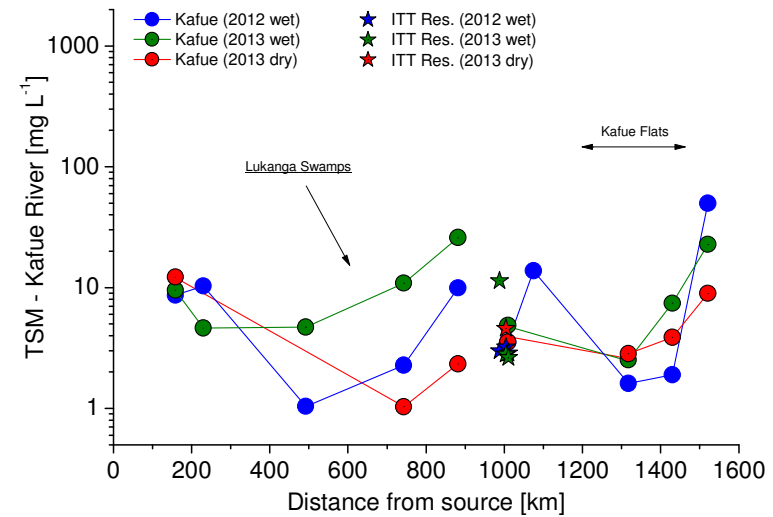


TSM – spatio-temporal dynamics

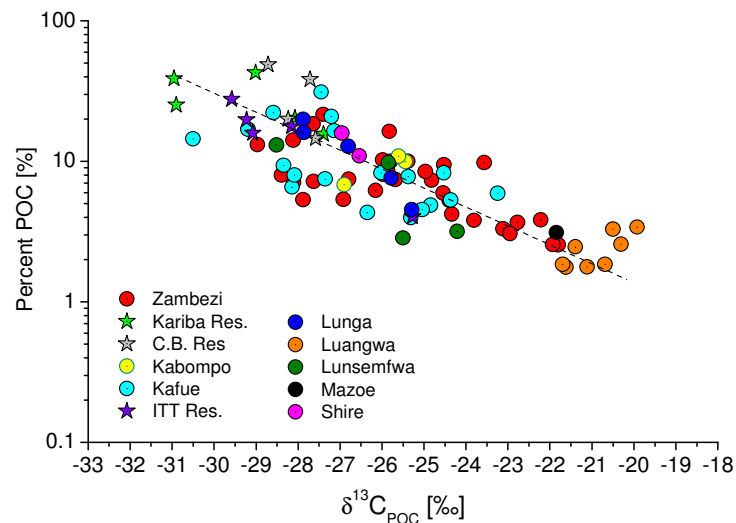
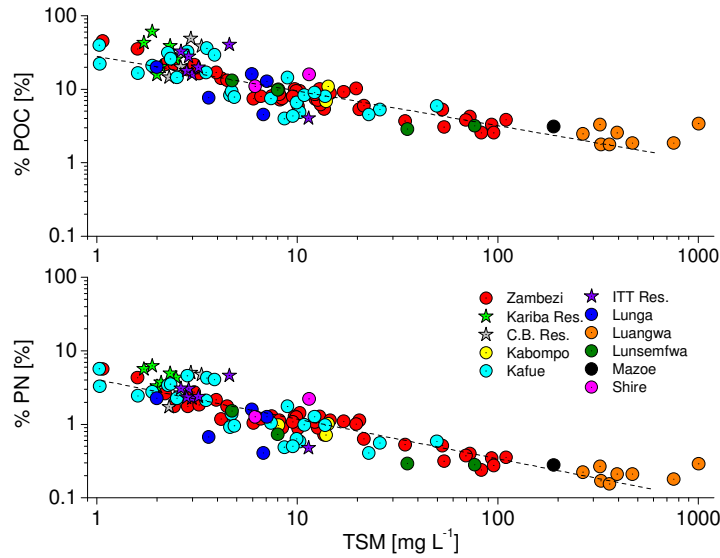
Zambezi River



Kafue River

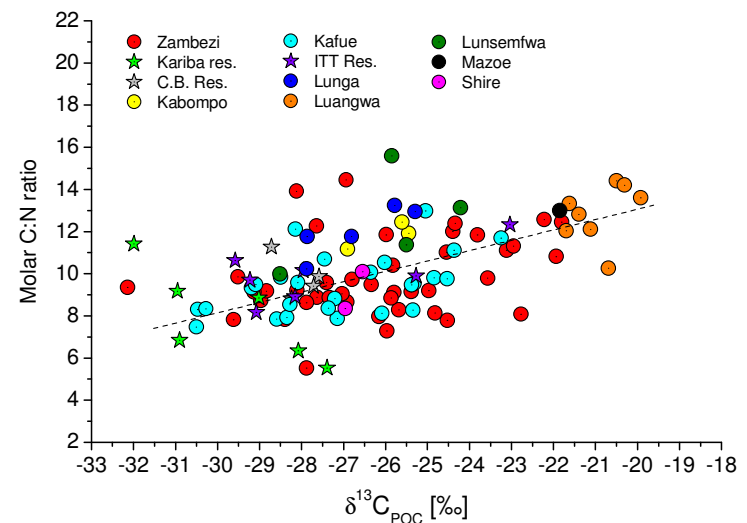


POC, PN, $\delta^{13}\text{C}_{\text{POC}}$, C:N ratio



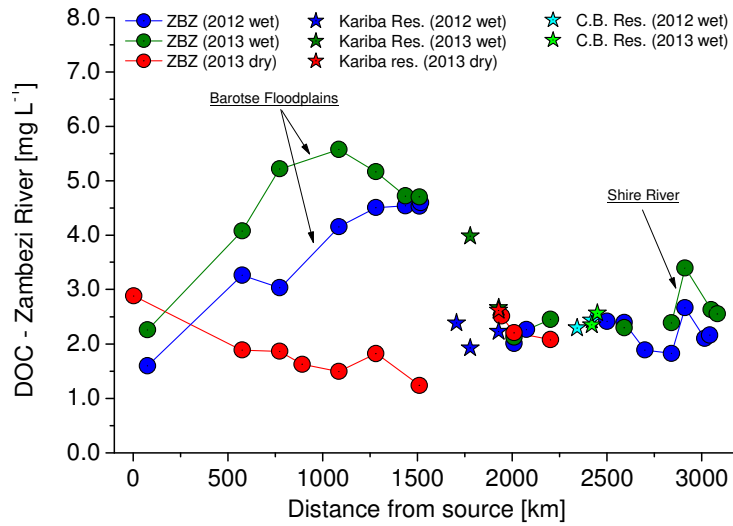
POC - predominantly terrestrial (C3) origin:

Luangwa – more towards C4 soil C;
Reservoirs – fraction from phytoplankton production

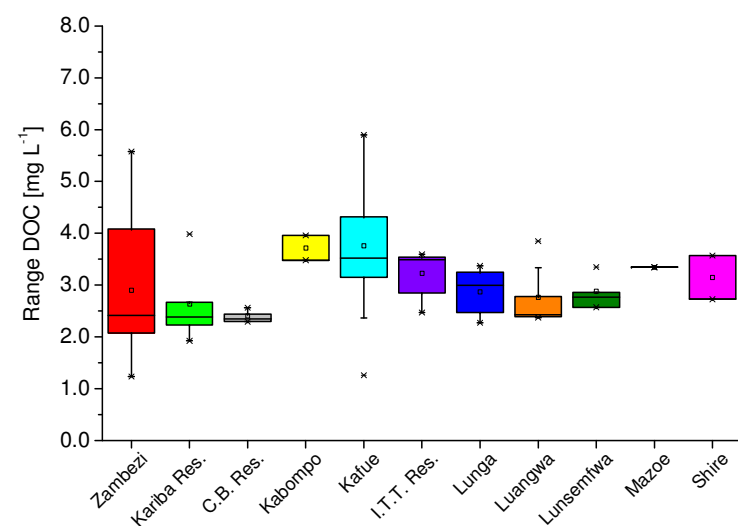
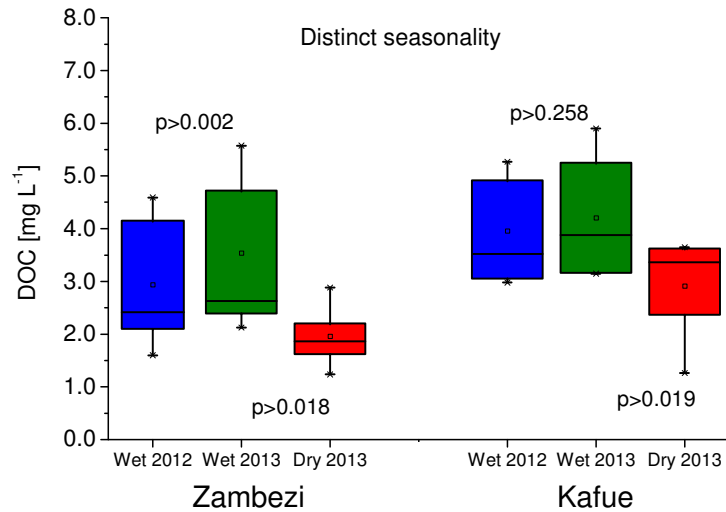
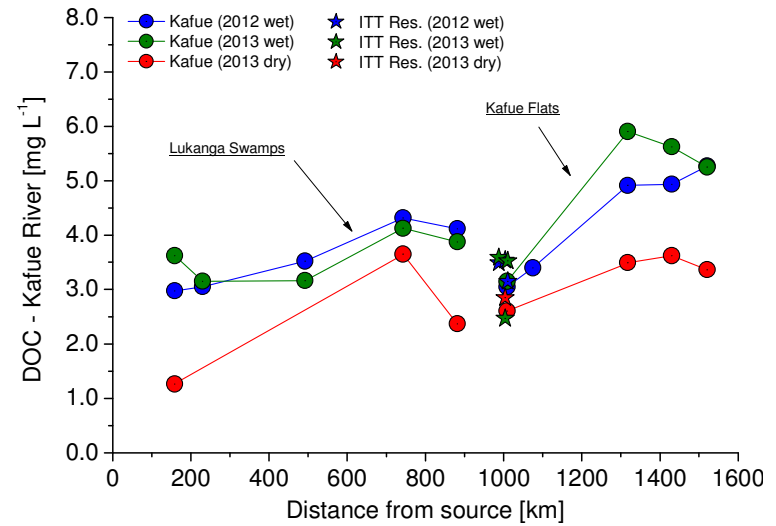


DOC- spatio-temporal dynamics

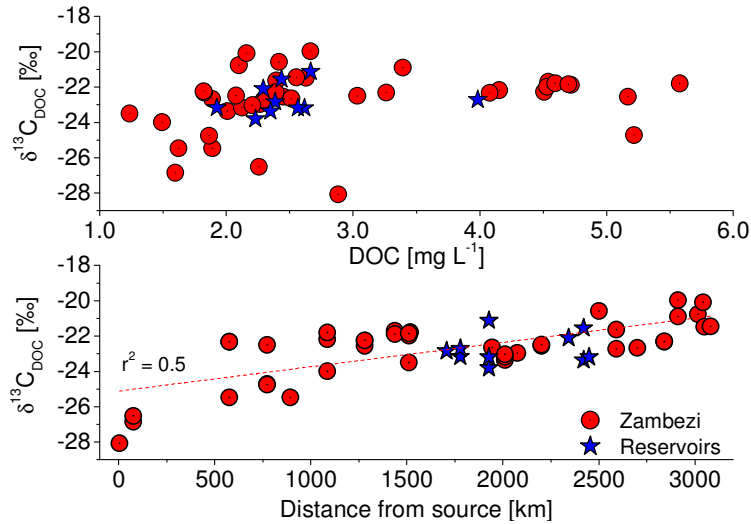
Zambezi River



Kafue River



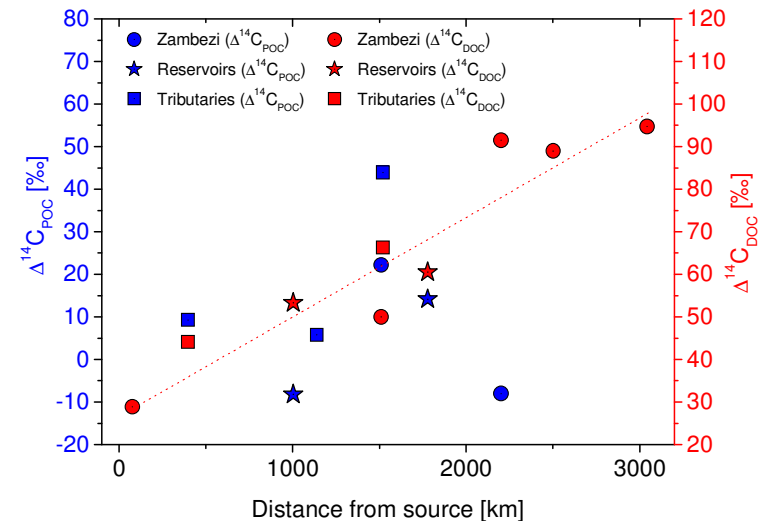
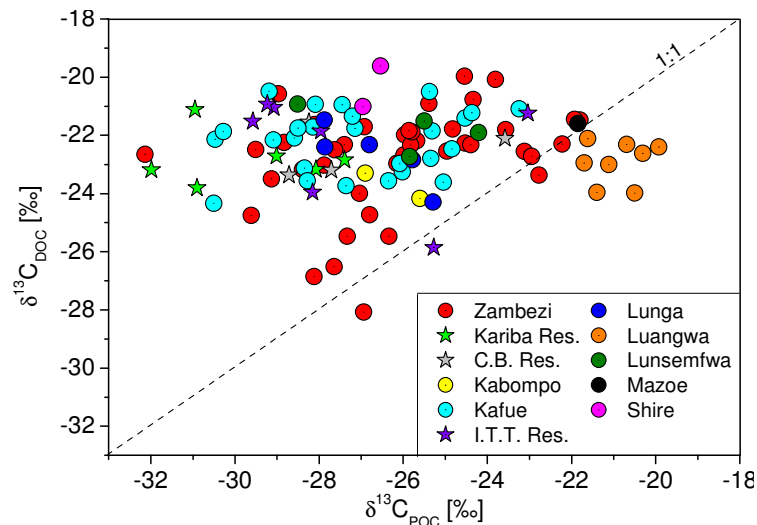
DOC isotopic signature ($\delta^{13}\text{C}_{\text{DOC}}$), and Age ($\Delta^{14}\text{C}_{\text{POC}}$, $\Delta^{14}\text{C}_{\text{DOC}}$)



DOC – mostly C3 origin with minimal in-stream autochthonous production

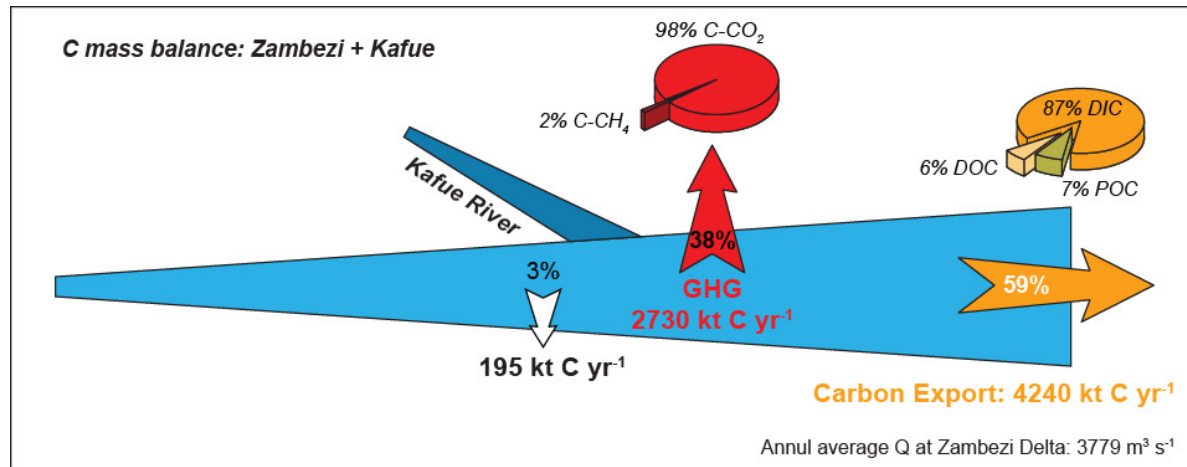
$\delta^{13}\text{C}_{\text{DOC}}$: $\delta^{13}\text{C}_{\text{POC}}$ – decoupling between DOC and POC sources

$\Delta^{14}\text{C}$ – modern nature of riverine organic C pool

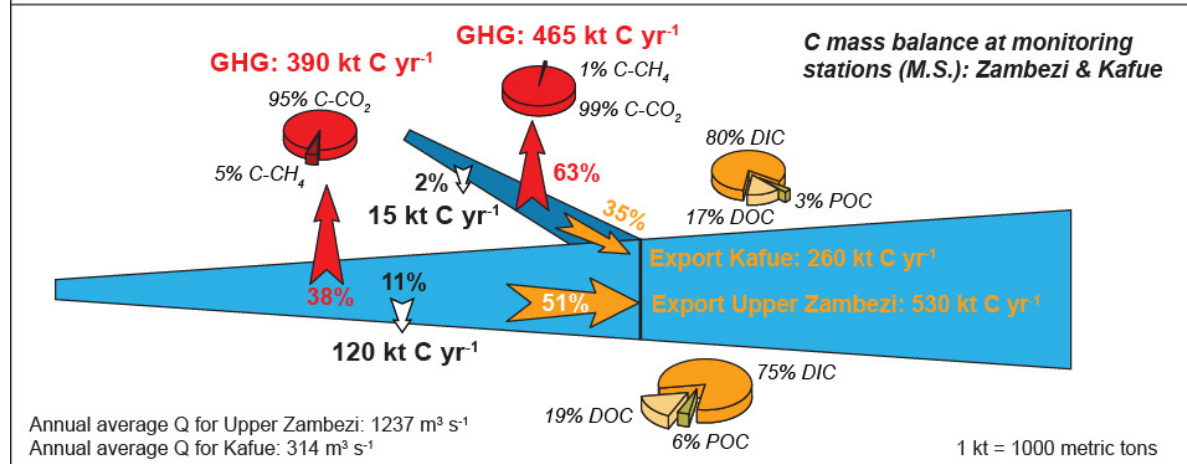


Carbon Mass Balance

Zambezi + Kafue =>



Zambezi & Kafue =>
 at monitoring stations (M.S.)



	Area	Q	TSM	POC	DOC	DIC	CO ₂	CH ₄	C Yield	GHG	C Deposition	C Export
	[km ²]	[m ³ s ⁻¹]	[kt C yr ⁻¹]									
Zambezi at Delta	11445	3779	9558	306	263	3672	2681	46.1	7163	2727	196	4240
Kafue at M.S.	658	314	196	8	45	205	459	4.6	738	464	16	258
Zambezi at M.S.	6403	1237	282	34	99	398	385	20.2	1042	391	120	531



Thank you for your attention!



“Pirates of the Zambezi”