

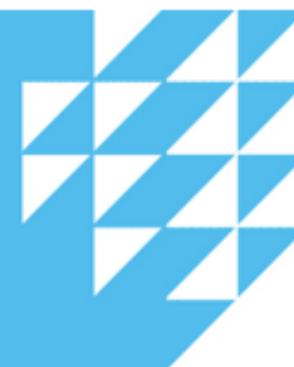


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Overview of Ecosystem Functions in the Okavango Basin

M. Murray-Hudson and S. Domptail



Grateful acknowledgements to Mendelsohn and el Obeid, and Wolski for many of the graphics used....



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Ecosystem Functions



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The characteristic interactions within an ecosystem are called ecosystem functions and in addition to energy, material and information exchanges, involve decomposition and production of biomass.



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Okavango River Basin



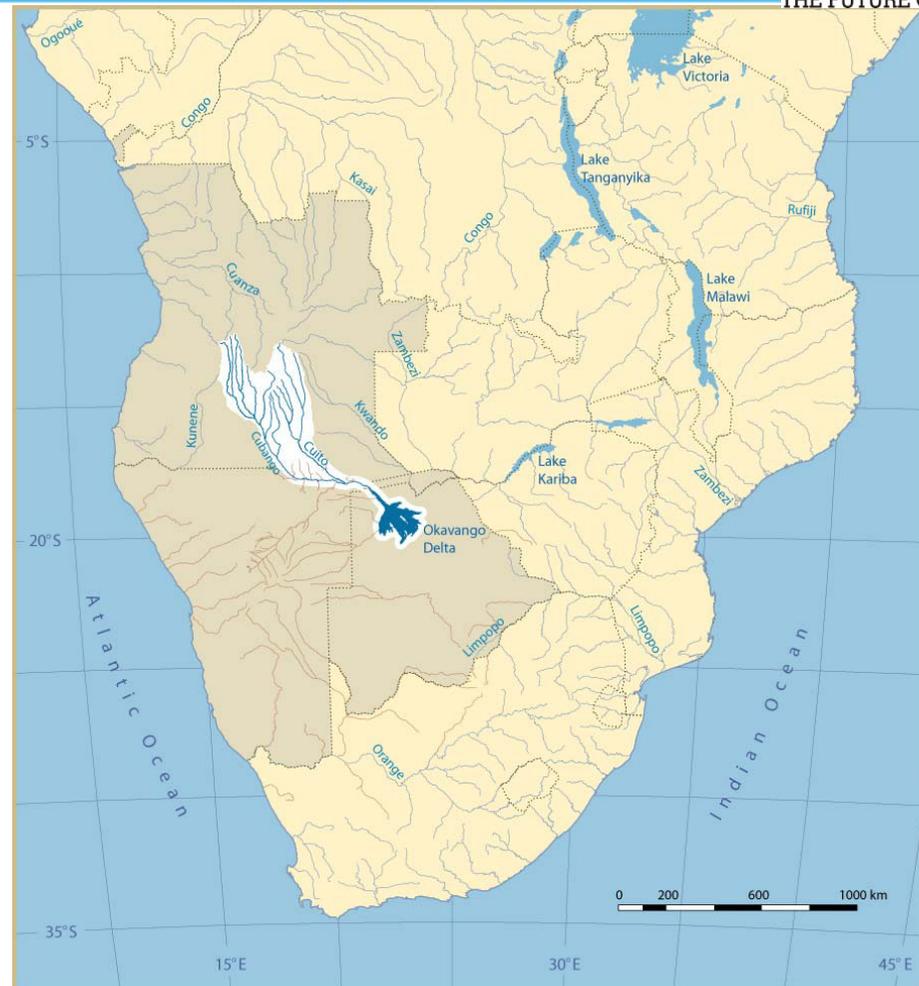
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The Okavango river shared by Angola, Namibia and Botswana

Endorheic system – Kalahari Sedimentary Basin

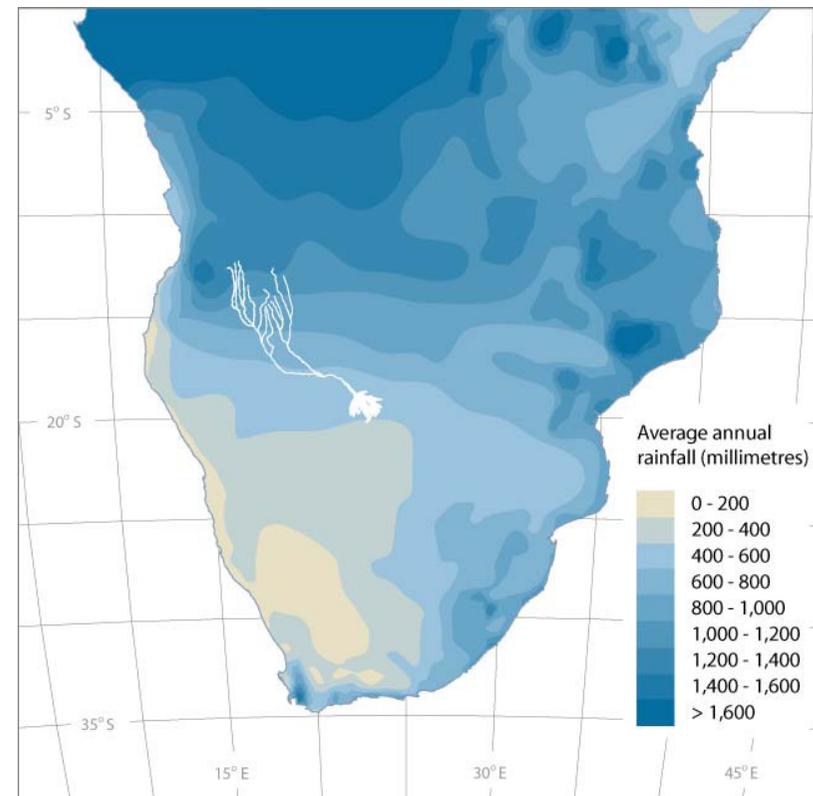
Seasonally pulsed river system

High degree of ecosystem integrity



- Okavango rivers
- Perennial rivers
- Ephemeral and fossil rivers
- International border

- Regional setting
 - Topography
 - Climate
 - Rainfall – Mean Annual Rainfall (MAR)
 - Potential Evapotranspiration (PET)
 - Seasonality
 - Soils
 - Kalahari sands
 - Endogenic clay formation
 - Self-organisation creates heterogeneity – landscape diversity driven by processes.





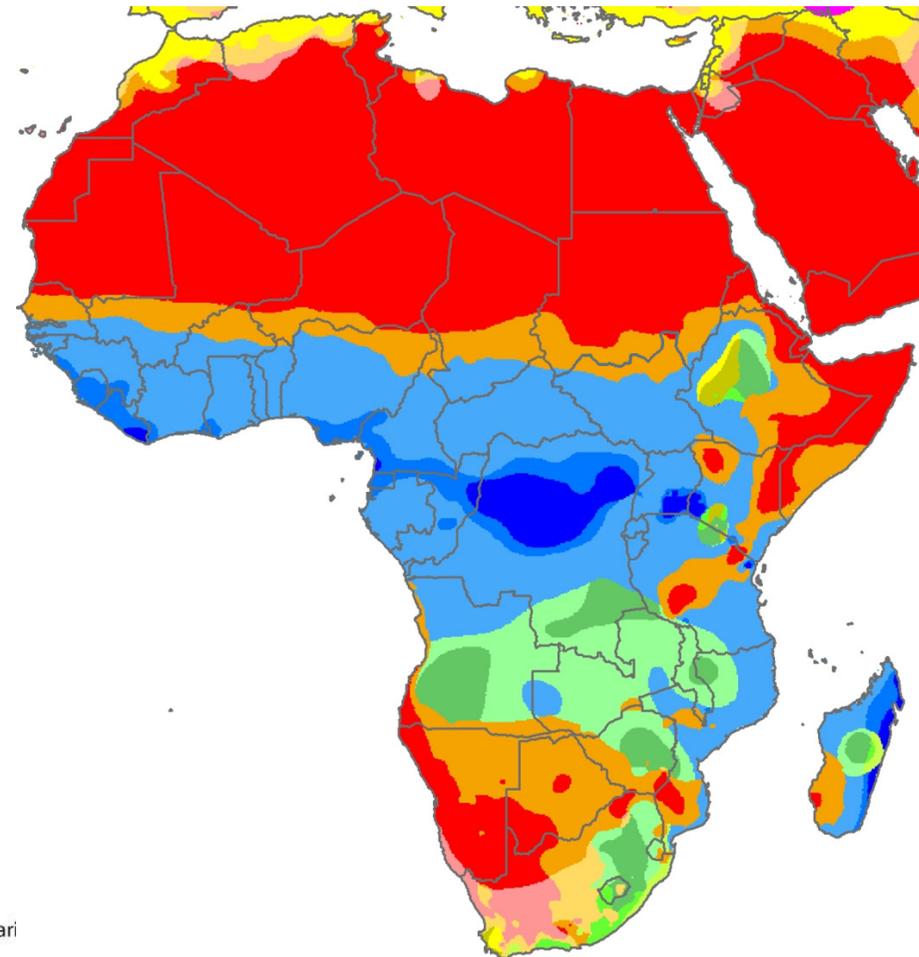
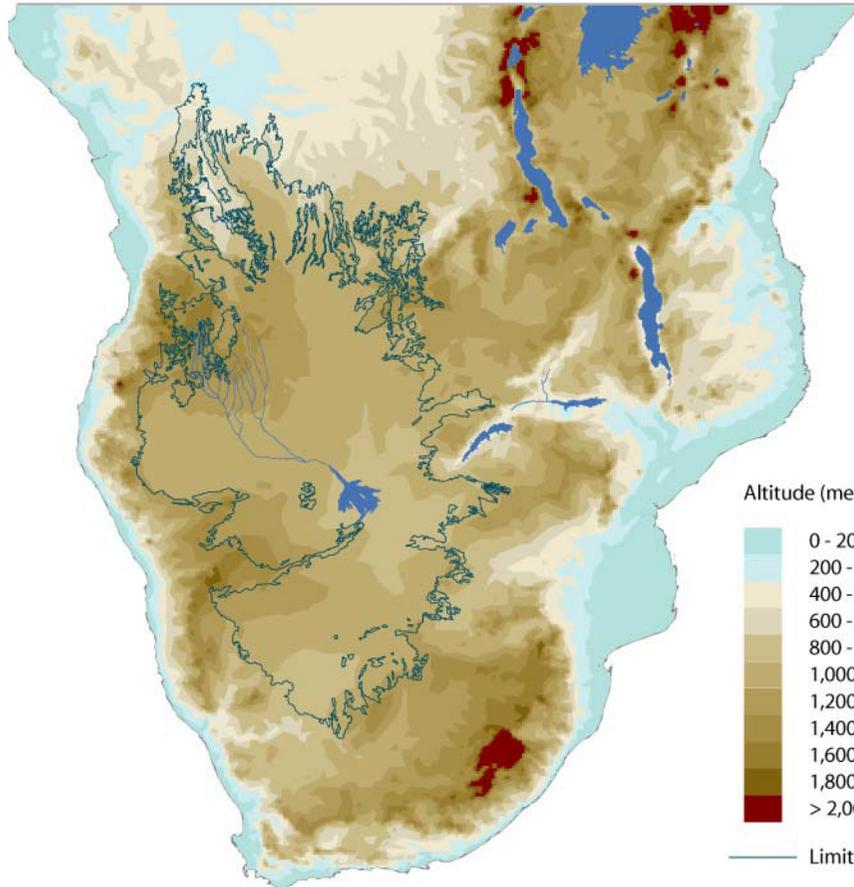
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Topography and Climate



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Equator



Af	BWh	Csa	Cwa	Cfa	Dsa	Dwa	Dfa	ET
Am	BWk	Csb	Cwb	Cfb	Dsb	Dwb	Dfb	EF
Aw	BSh	Cwc	Cfc	Dsc	Dwc	Dfc		
	BSk			Dsd	Dwd	Dfd		



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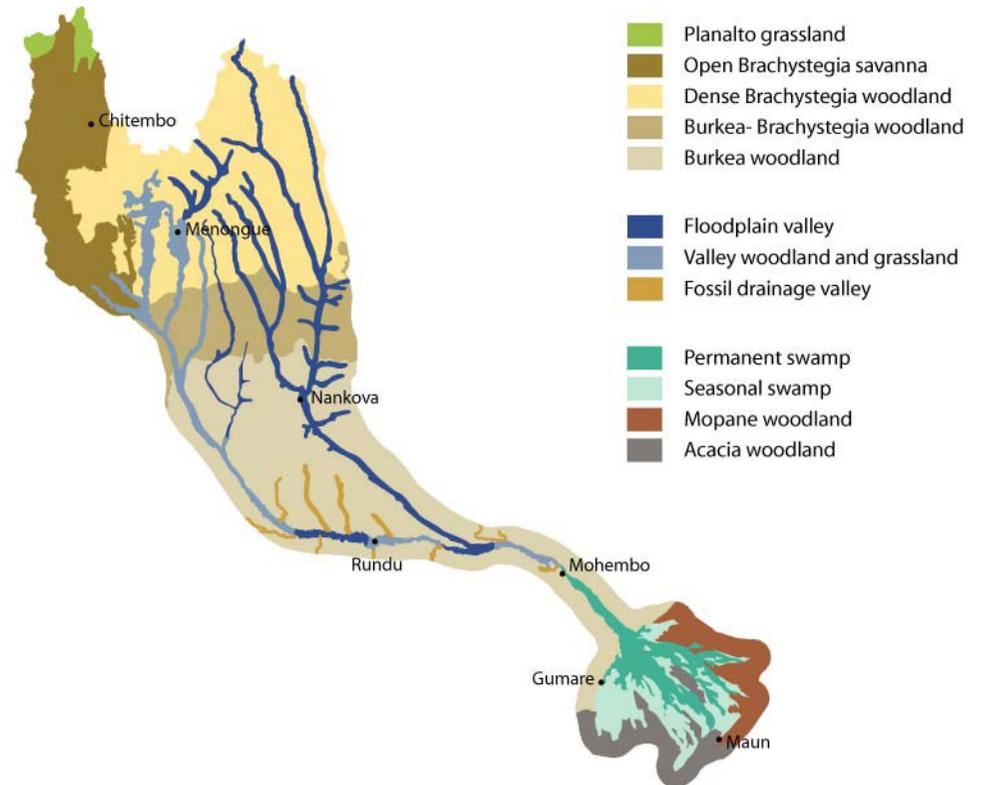
Geology and Vegetation



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- Kalahari Group
65 million years ago to the present
- Karoo Group
300 - 180 million years ago
- Damara Group
700 - 550 million years ago
- Oldest rocks
2,500 - 1,800 million years ago
- Dunes
2 million - 20,000 years ago



- Planalto grassland
- Open Brachystegia savanna
- Dense Brachystegia woodland
- Burkea- Brachystegia woodland
- Burkea woodland
- Floodplain valley
- Valley woodland and grassland
- Fossil drainage valley
- Permanent swamp
- Seasonal swamp
- Mopane woodland
- Acacia woodland



Ecological Determinants (“controls”)



- Mean Annual Rainfall < Annual PET
 - =>The primary determinant of ecological processes in southern Africa is water
- Nutrient availability
 - Low nutrient soils in basin – Kalahari sands
- Herbivory
 - Livestock and wildlife - effects on veg structure
- Agriculture, and all its trappings
 - infrastructure, land clearing, chemical and mechanical inputs (“Human appropriation of Net Primary Production (NPP)”)

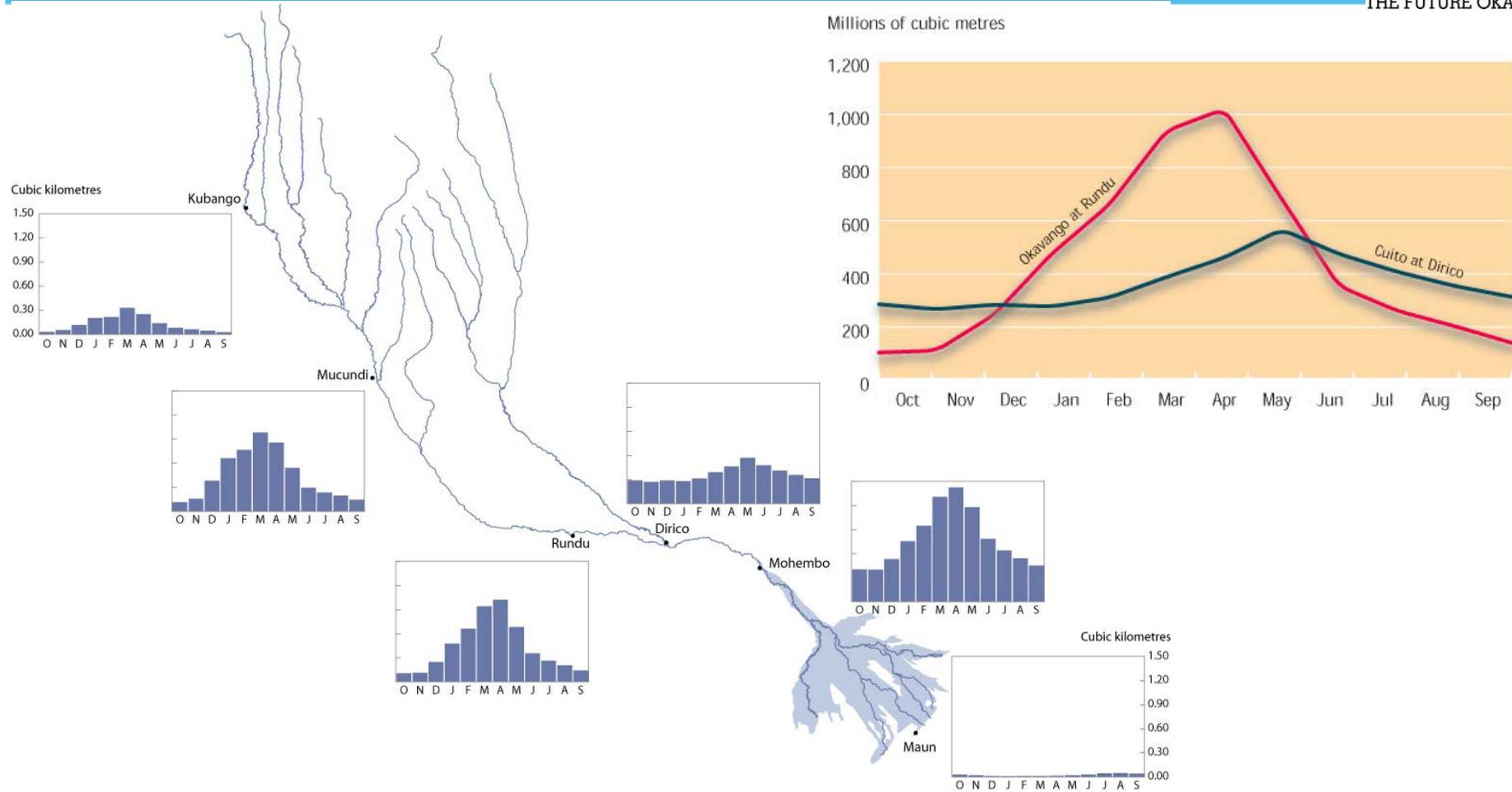


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Pulsing vs Base flow: Cubango vs Cuito



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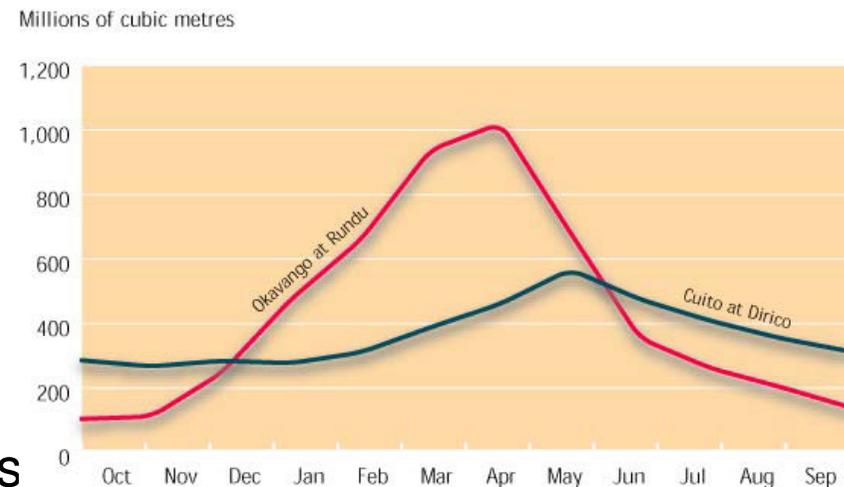


- Pulsing of fluvial system
 - Seasonal rainfall
 - Infiltration, storage and release – upper catchment
 - Erosion and Sediment transport
 - Pulsed flows and overbank flooding – middle and lower reaches
 - Infiltration and evapotranspirative concentration – lower reaches
- Basin-scale movements of people
 - Historically larger-scale than at present – diaspora, wars
 - Presently determined by processes of economic development, land availability and suitability, and national development agendas – mostly intra-national.
- Basin-scale movements of wildlife
 - Historically larger-scale and more diverse than at present
 - Historically driven by climate and disease – rinderpest, tsetse
 - Present mainly elephant
 - Effects presumed mainly on vegetation structure
- Ecological succession

- Water processing
 - Interception, infiltration, storage and release – determined by vegetation cover and soils/geology
 - Filtration, exchange of dissolved and particulate materials, microbial modification
 - Evapotranspiration, atmospheric exchange, concentration of dissolved materials, losses to deep groundwater
- “There are few large rivers in the world that deliver such clear, clean water as the Okavango” – Mendelsohn and el Obeid, 2003.

- Scale matters – especially for management
 - Sustainable Management addresses functions, not services
 - Processes and functions which occur at large scales may not be manageable (e.g., climate)
 - Scale of operation of function should be matched by scale of management

- Sub-basin scale – e.g., Cubango, Cuito or Kavango
 - Different sub-basins have different characteristics
- Cubango
 - Higher runoff, “peakier” floodpulse
- Cuito
 - Flatter topography, more storage, slower release – boosts base flow.



- Production of dissolved nutrients
 - Cubango sub-basin bedrock weathering
 - Leaching of catchment soils
- Sequestration of dissolved salts
 - Endorheic system, $MAR < PET$: dissolved material accumulates
 - “Density fingering” process under Delta islands removes dissolved material to deep groundwater



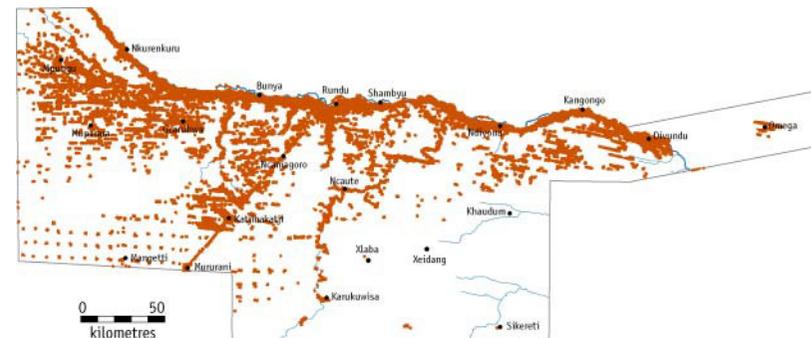
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Local-scale processes



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- Pulsing of fluvial system
 - Seasonal flooding
 - Infiltration, soil moisture
 - Nutrient cycling
 - Pulsed flows and overbank flooding
- Ecological succession
 - Woodland development
 - Effects of intense grazing
 - Effects of flooding
 - Effects of clearing



- Nutrient cycling in floodplains
 - Changes in reduction-oxidation potential change availability of N & P (and others)
- Soil organic matter development
 - Aquatic phases increase assimilation of organic matter in floodplain soils
- Early-stage succession maintenance
 - Clearing of land for agriculture “resets” successional processes; favours establishment of pioneer/weedy species.
- Primary production
 - Cereal growth for human consumption
 - Herbaceous growth in floodplains to drive aquatic system e.g., fish



Relationship between ESS and ESF for the TFO projects - examples



ESS	Ecosystem Function
Agricultural and silvo-pastoral goods (crops)	Primary production
Other resources from the wild (incl. raw material (wood, reeds, bushmeat, fish..))	Primary production; Sustenance of savanna, woodland, floodplain and island vegetation diversity and wildlife (variability and pulsing)
Drinking water	Filtration of particulates and removal of nutrients
Water provision	Storage and release of water
Water balance regulation (incl. flood control)	Floodplain-flow dominated system - slows flow and flattens peak - groundwater storage in both upstream and downstream parts of catchment

Thank you.....

