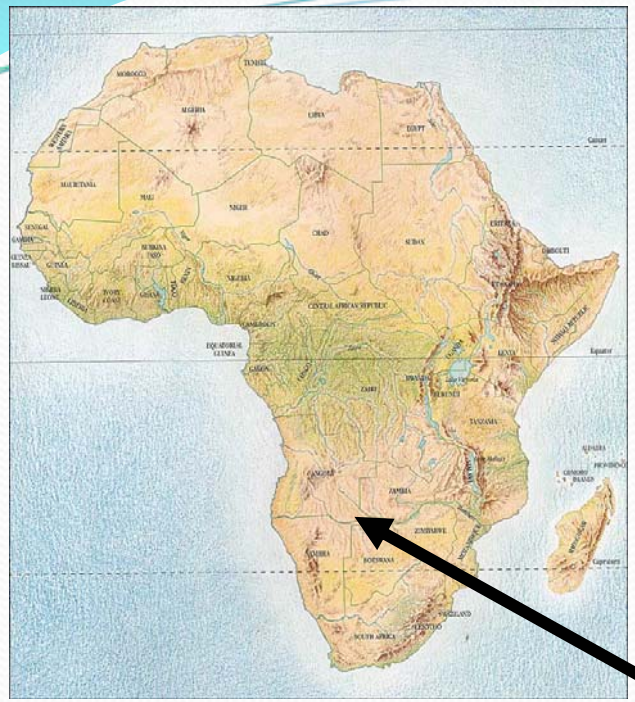
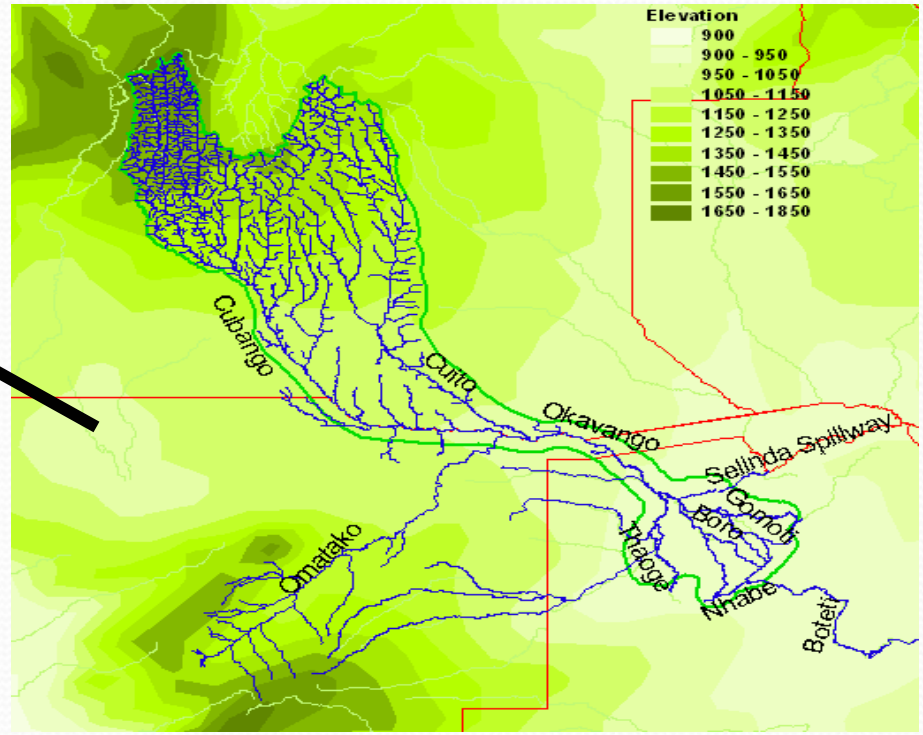
Okavango Basin

Denis Hughes
Institute for Water Research
Rhodes University
South Africa

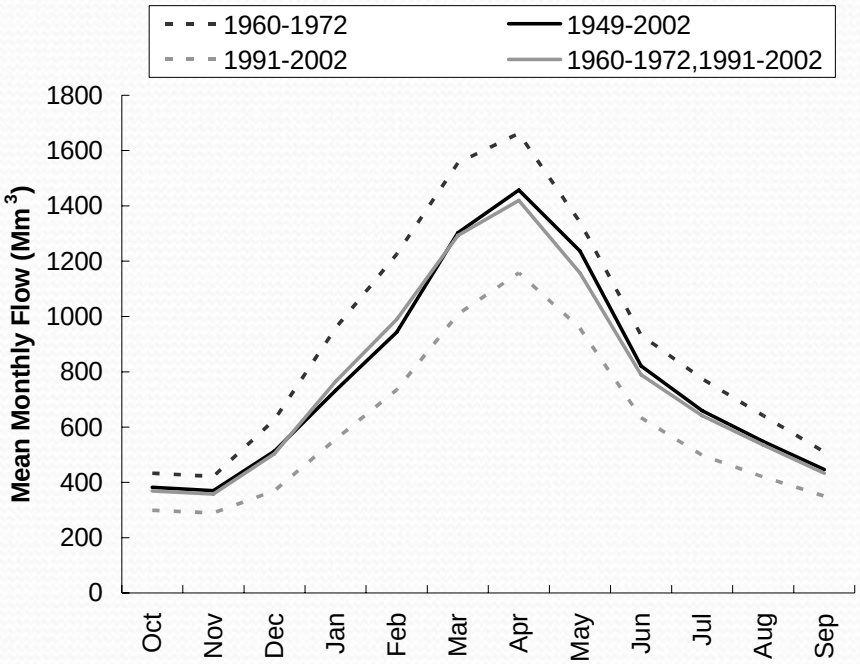
Background

- Basin area covers Angola, Namibia and Botswana
  - 226 000 km^2 (390 000 km^2 including the Delta and the very arid Omatako River in Namibia)
- Most runoff generated in Angola
  - Upper basin areas largely undeveloped.
  - Middle to lower parts of the basin are arid.
- Outlet of the basin is the Okavango Delta in Botswana
  - Ecologically important.
  - Important tourism resource for Botswana.

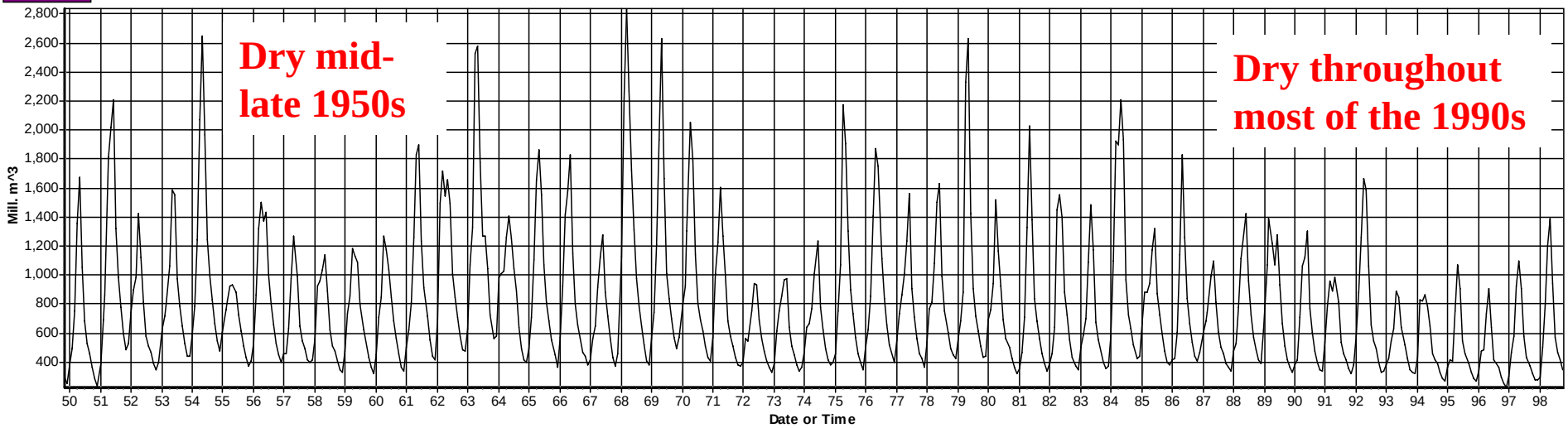


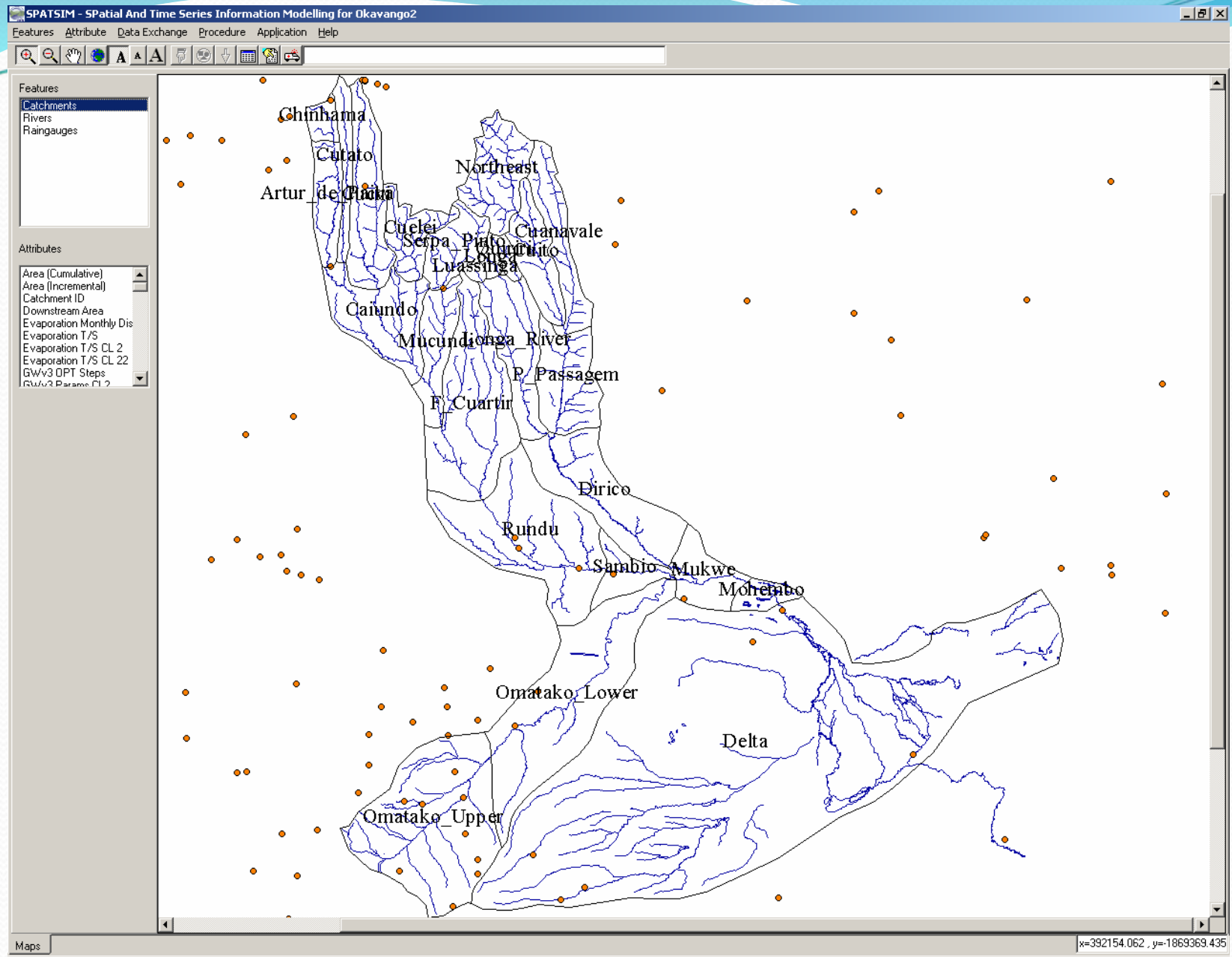

Elevation
900
900 - 950
950 - 1050
1050 - 1150
1150 - 1250
1250 - 1350
1350 - 1450
1450 - 1550
1550 - 1650
1650 - 1850
Cubango
Cuito
Okavango
Selinda Spillway
Boro
Gomoti
Thaoga
Nhabe
Boteti
Omatako

- High degree of multi-decadal variability
  - Important for flood regime in the delta



Observed flows at Mukwe (1950 to 1995)




SPATSIM - SPatial And Time Series Information Modelling for Okavango2
Features Attribute Data Exchange Procedure Application Help
Features
Catchments
Rivers
Raingauges
Attributes
Area (Cumulative)
Area (Incremental)
Catchment ID
Downstream Area
Evaporation Monthly Dis
Evaporation T/S
Evaporation T/S CL 2
Evaporation T/S CL 22
GWv3 OPT Steps
Chinhama
Cutato
Northeast
Artur_de_Paiva
Cuelei
Serpa_Pinto
Cuanavale
Luassinga
Caiundo
Mucundi
Conga_River
P_Passagem
F_Cuartir
Dirico
Rundu
Sambio
Mukwe
Mohembo
Omatako_Lower
Delta
Omatako_Upper
Maps
x=392154.062 , y=-1869369.435

Modelling Process

- Using the monthly time step Pitman model.
- Previously calibrated through two previous projects.
  - WERRD and TWINBAS
  - Some 12 gauged catchments.
  - Most of these in Angola with data only for 1960's and early 1970's.
  - Two downstream gauges (Rundu and Mukwe) with longer data sets extending to present day.
  - Most of the gauged rainfall data in the upper basin also has a restricted record length.

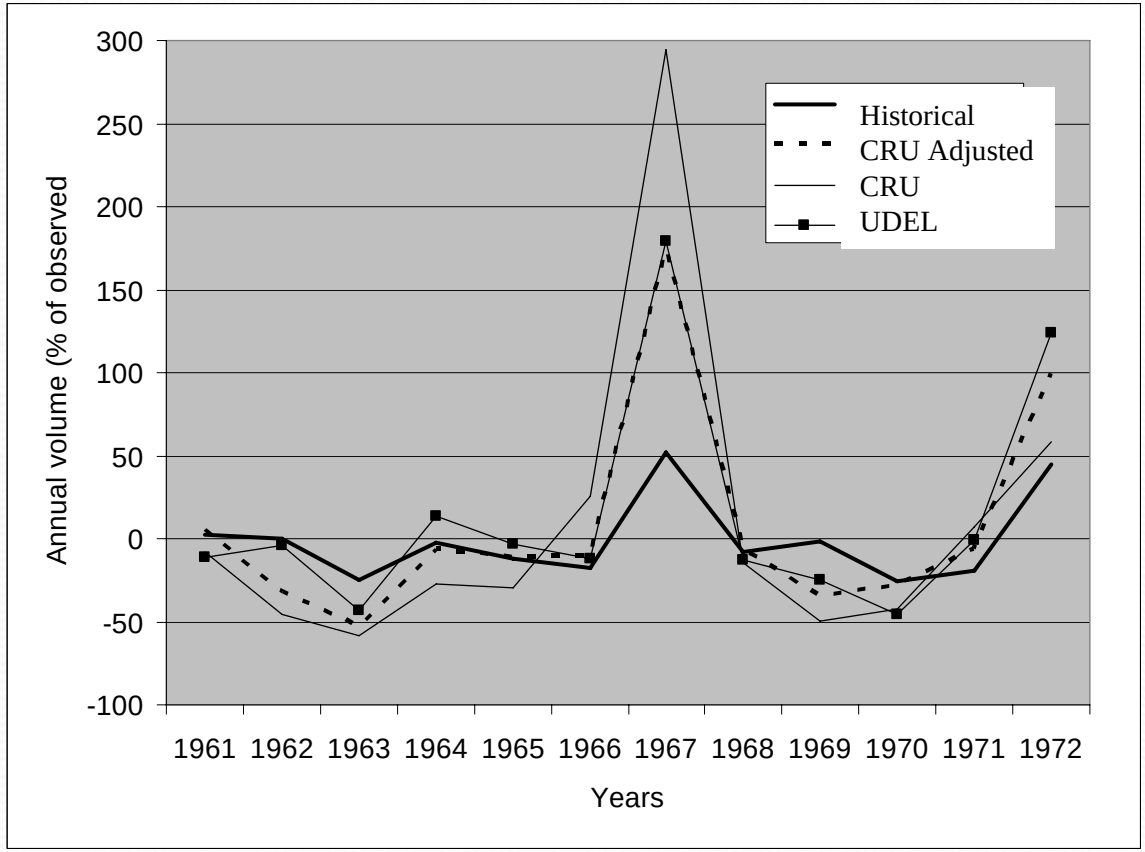
Modelling Process

- The model has been re-calibrated using the historical downscaled GCM data for 1961 to 1990:
  - 1961-1972 for calibration (all available flow stations).
  - 1973-1990 for validation (only at Rundu and Mukwe).
- Some problems with the downscaling resulted in difficulties with the re-calibration process.
- All climate change scenarios run with the same re-calibrated parameter set.
- All climate change scenarios run with potential evaporation data scaled using temperature deviations from the historical (1961-1990) monthly means.

Re-calibration results

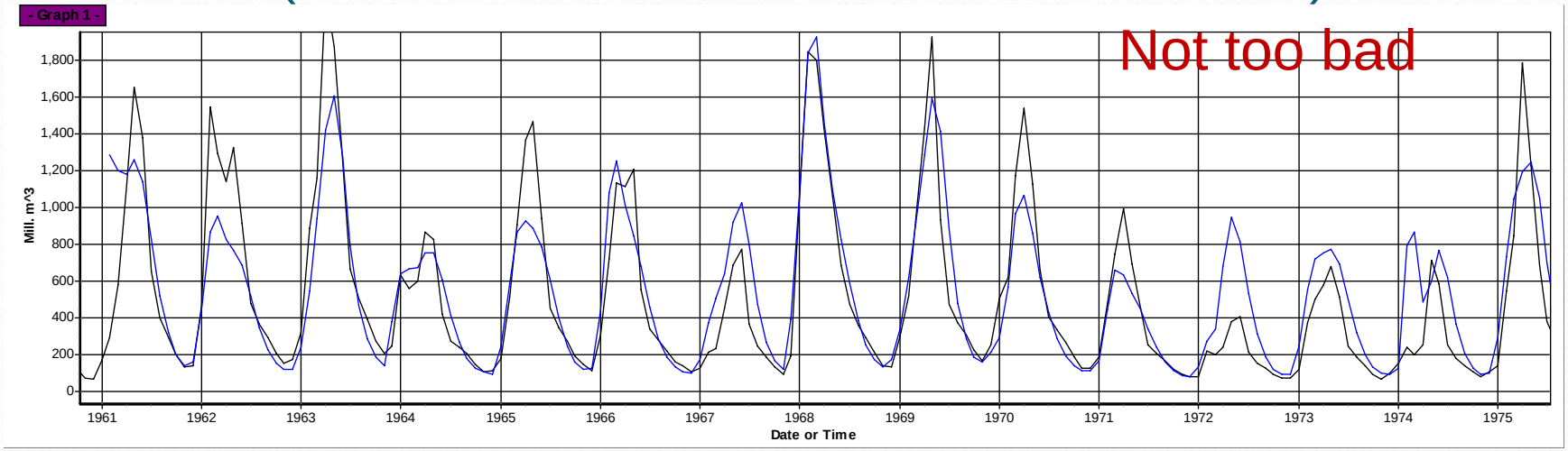
- Deviations of simulated annual flow volumes (%) from observed volumes (Rundu - based on hydrological years – October to September).

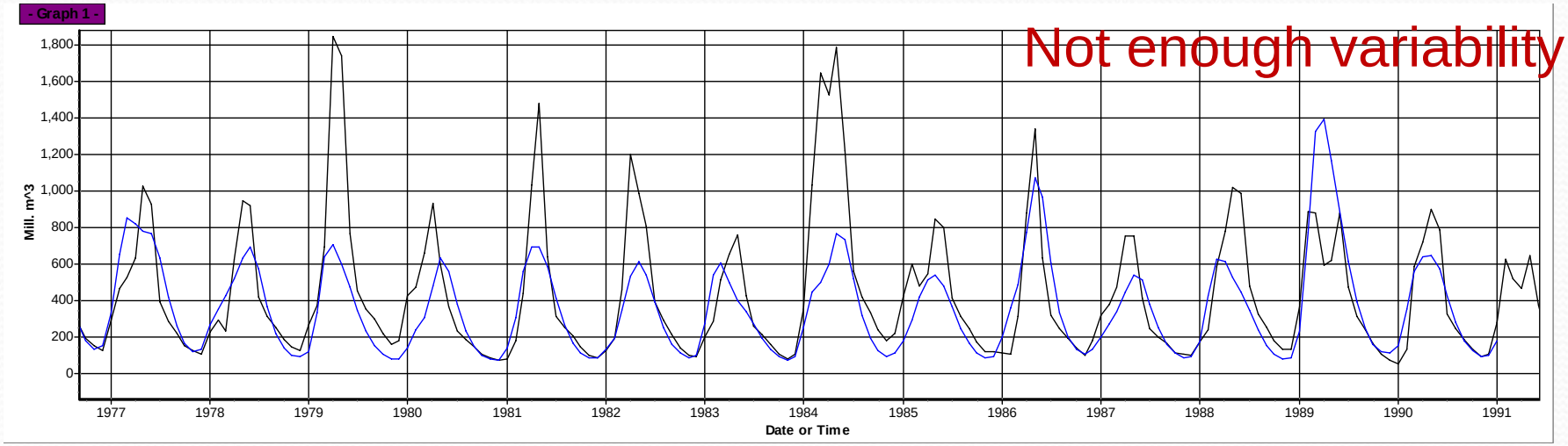
CRU Adjusted = an attempt to correct the CRU data using the frequency characteristics of the historical gauged data



Streamflow time series for Rundu

(black = observed, blue = UDEL simulations)





Re-calibration Results

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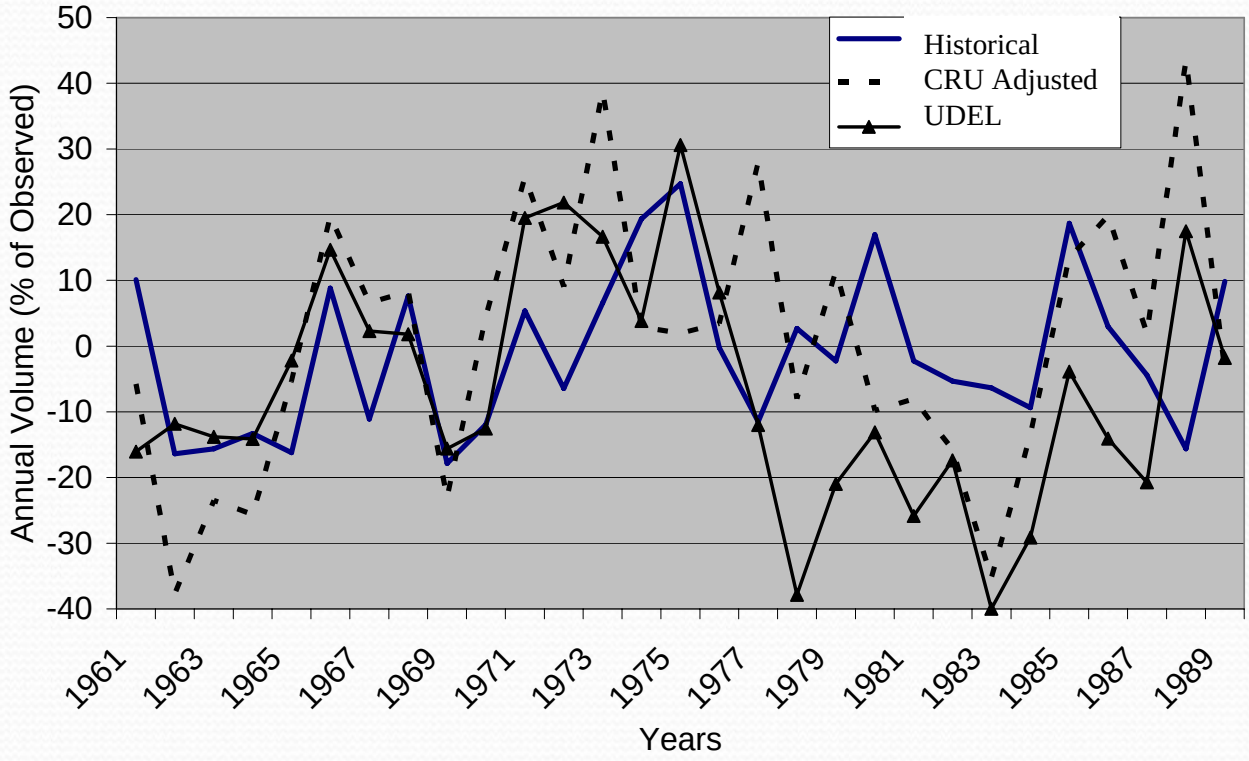
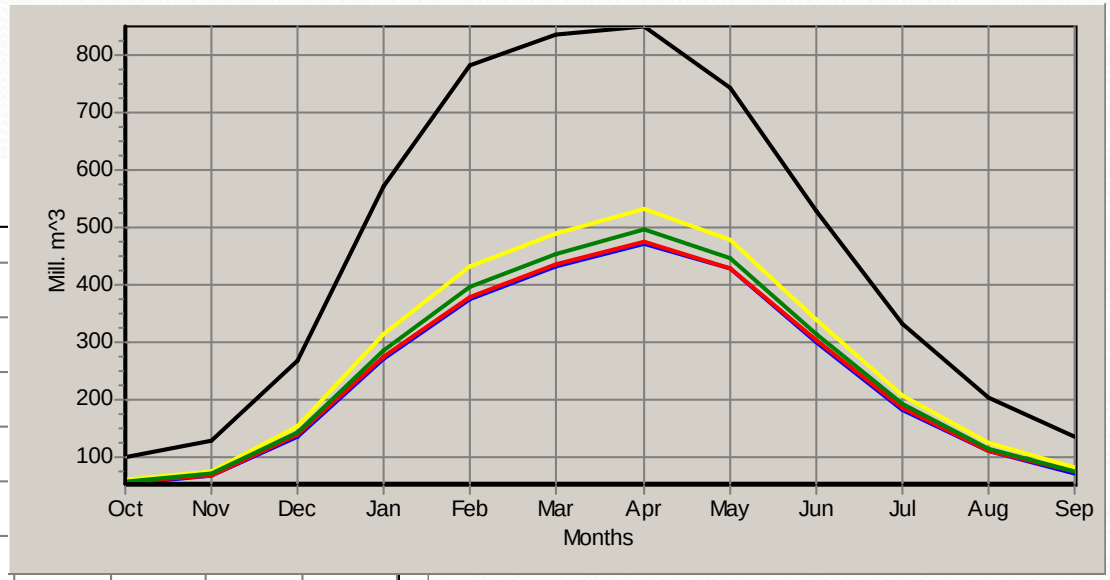
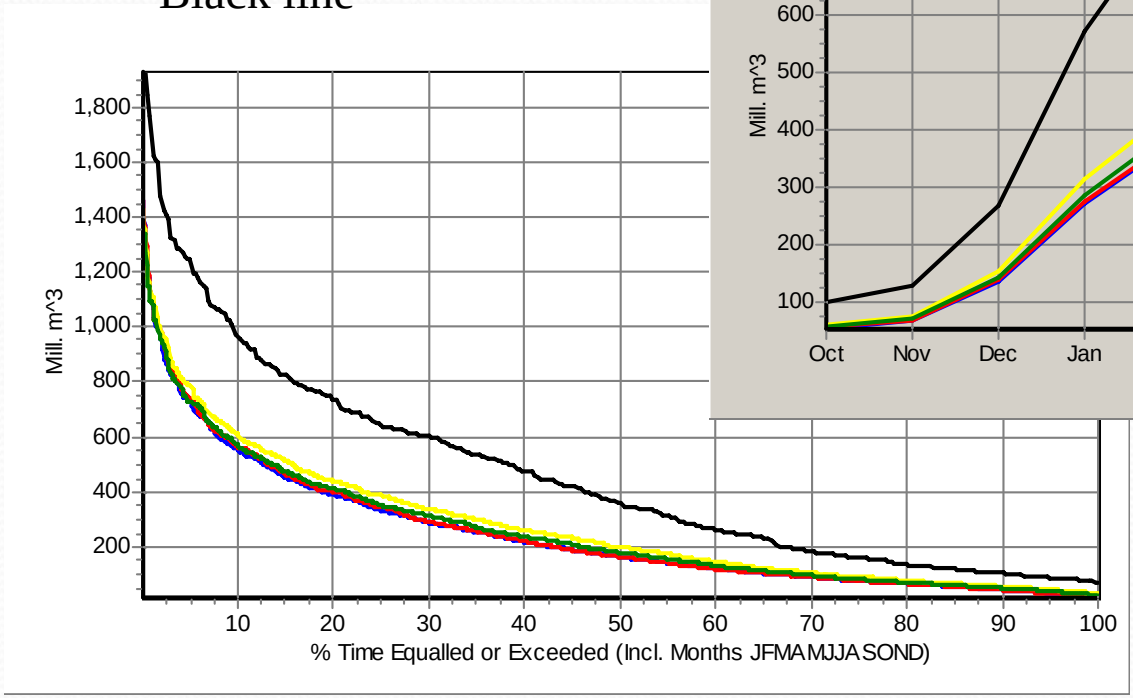


Scenario results (Rundu)

- **HADCM SRES A1B, A2, B1, B3 (2010 to 2099)**
  - Not much difference between the different scenarios with order of lower flows A1B up to B3.

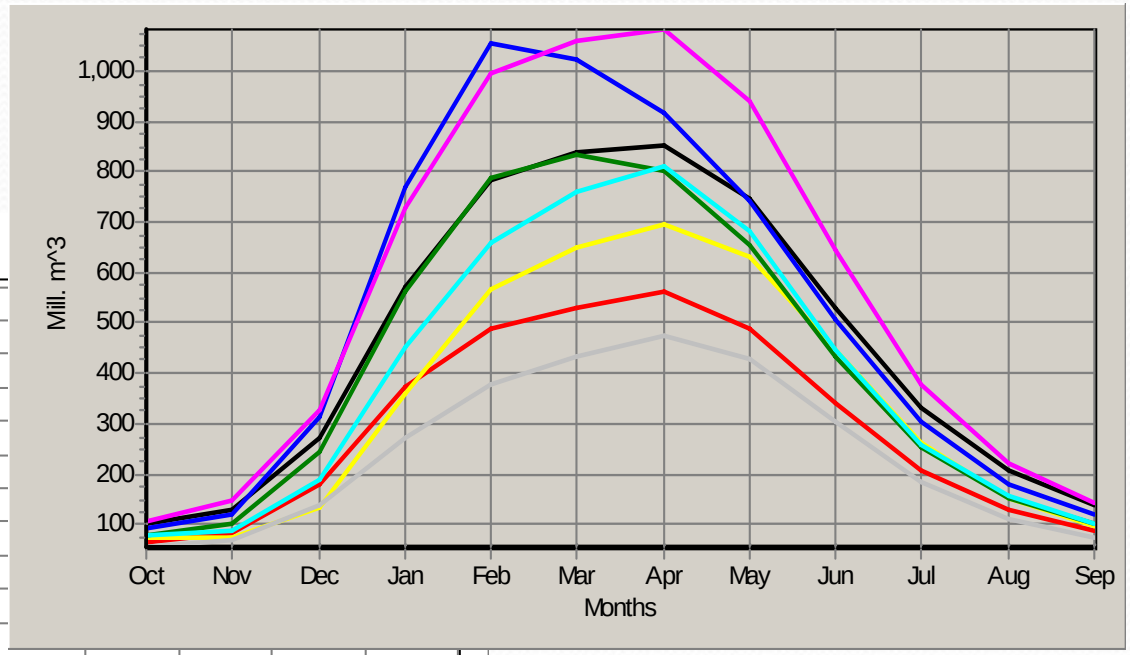
UDEL (1961-1990) = Black line

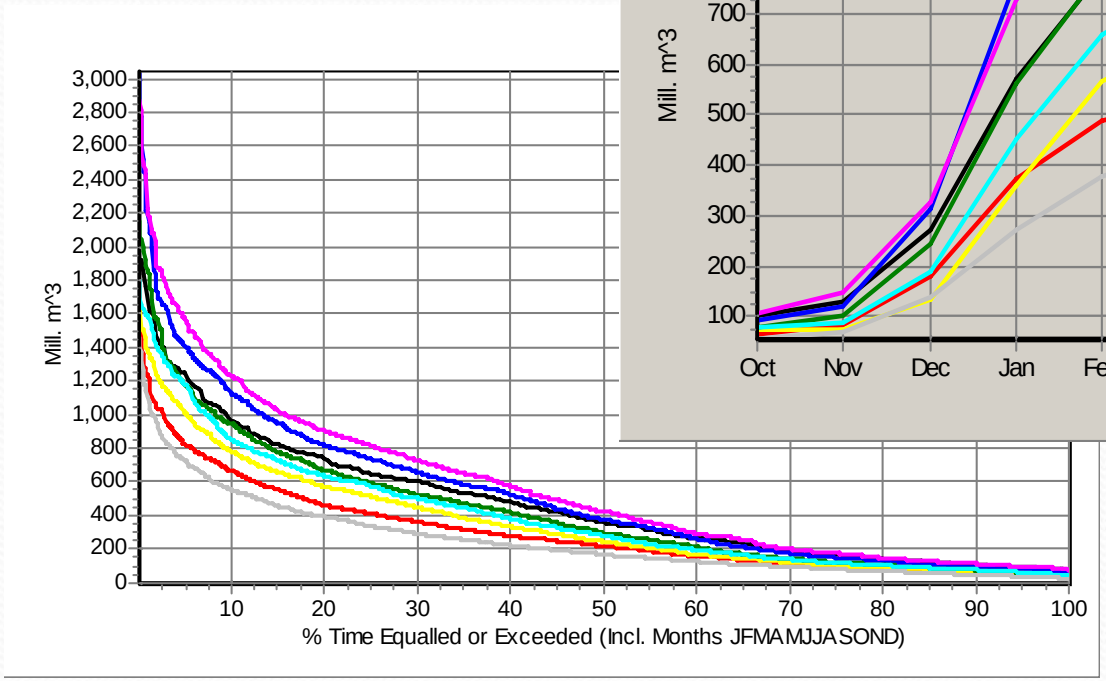




Scenario Results (Rundu)

- **Various models A1B scenario (2010 to 2099)**
- **Order of wetness:**
  - NCAR – pink, CCCMA – blue, **UDEL – historical (black),** MPI – green, HADGEM1 – light blue, IPSL – Yellow, CSIRO – red, HADCM3 - grey



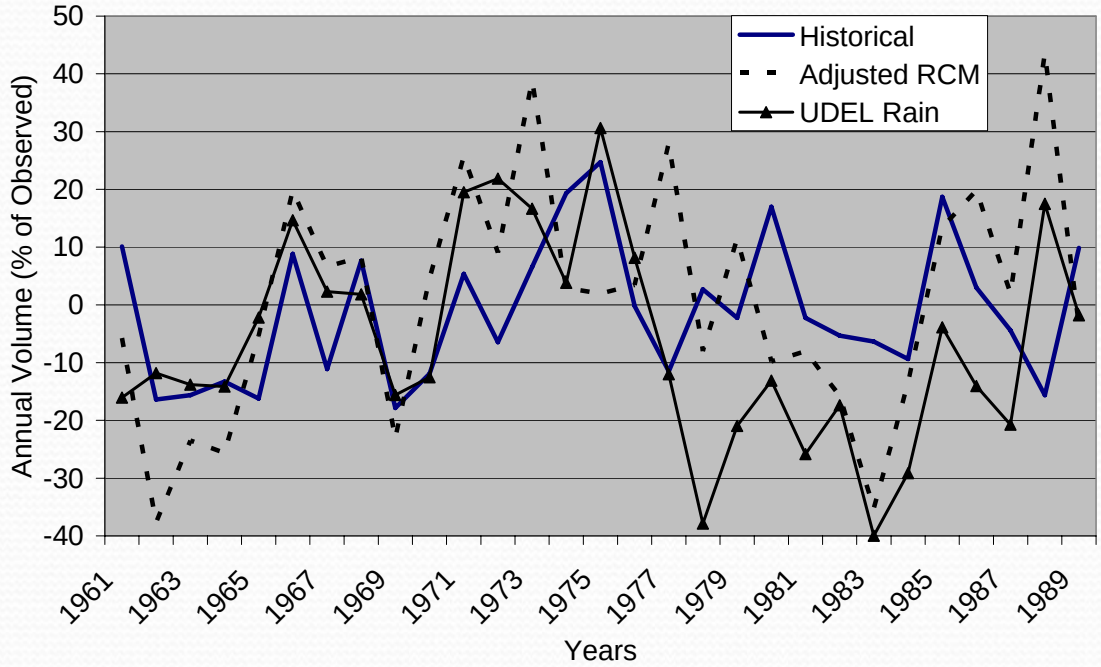


Uncertainty Issues

- Parameter uncertainties
  - Limited flow data for calibration and uncertainties in the accuracy of the historical data for the Angola stations (upper catchment).
  - Questions need to be asked about whether the parameters should be modified for the climate change scenarios to account for changes in vegetation cover or other basin physical.
  - Could run multiple parameter ensembles – but how can we assess which are behavioural (i.e. realistic)?

Uncertainty Issues

- Rainfall uncertainty
  - Relatively poor calibration results using UDEL data compared to historical rainfall data.
  - Importance of rainfall interpolation process and adequate representation of rainfall in an area with quite large spatial variability.



Uncertainty Issues

- Evaporation uncertainty
  - Potential problems with use of a simple linear association between temperature changes and potential evaporation changes.
  - Is this realistic (probably not)?
  - Are there alternative approaches that can be used with greater confidence?
  - Very little observation data available to compare with outputs from different evaporation demand models.
  - However, rainfall (i.e. water availability) is the key determinant of actual evaporation, rather than potential evaporation.

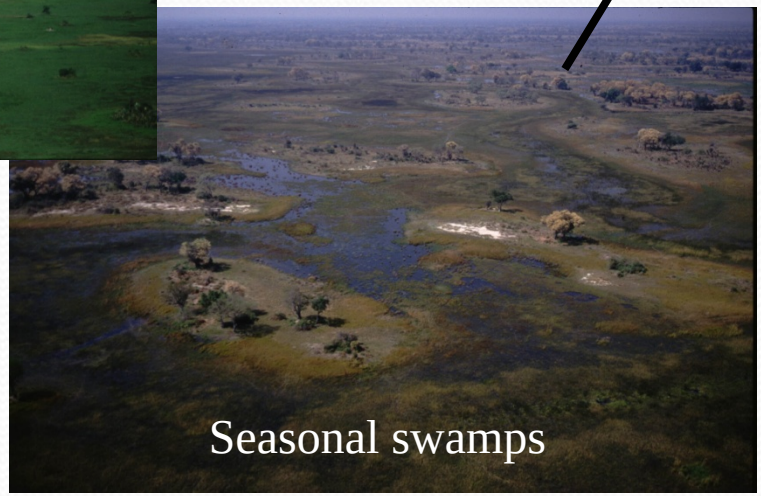
Future Development Issues

- Water resources are currently not very highly developed:
  - Some small scale rural abstractions in Angola, some irrigation and abstractions in Namibia.
- Possibility of hydro-power generation in Angola in the future (some large schemes have been proposed, some using dams and some run-of-river).
- Expansion of irrigation in Angola and Nambia and abstractions for Namibia.
- One of the main concerns is the impact on the ecological functioning of the Okavango Delta:
  - Very dependent upon seasonal flooding patterns.

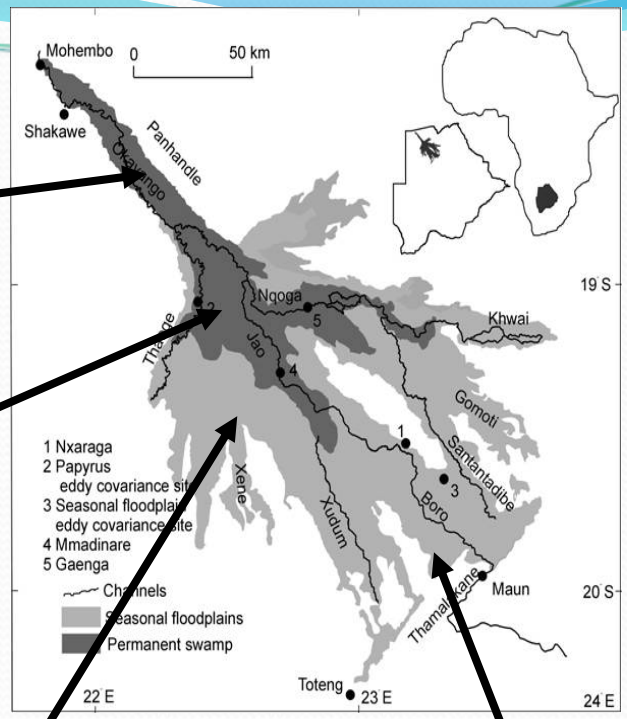
Some Okavango Delta environments

Panhandle

Permanent swamps



Seasonal swamps



Occasionally Flooded

- Previous climate change studies in the Delta showed huge impacts on the flooding regime.
- The results of the QUEST study will show similar impacts.