



Need for Operational Considerations in Water Resources Allocation and Trading Agreements

DBSA - Knowledge Week

by

B. Mwaka & C. Ntuli

Department of Water Affairs & Forestry



water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



Introduction

- Water is a primary resource for sustaining socio-economical developments
- Water resources Systems Operation (SO) is the regulation of the systems in order to redistribute & reconcile water availability with requirements and/or mitigate against risks
- It is dependent on:
 - hydrology
 - water supply agreements
 - Infrastructure status



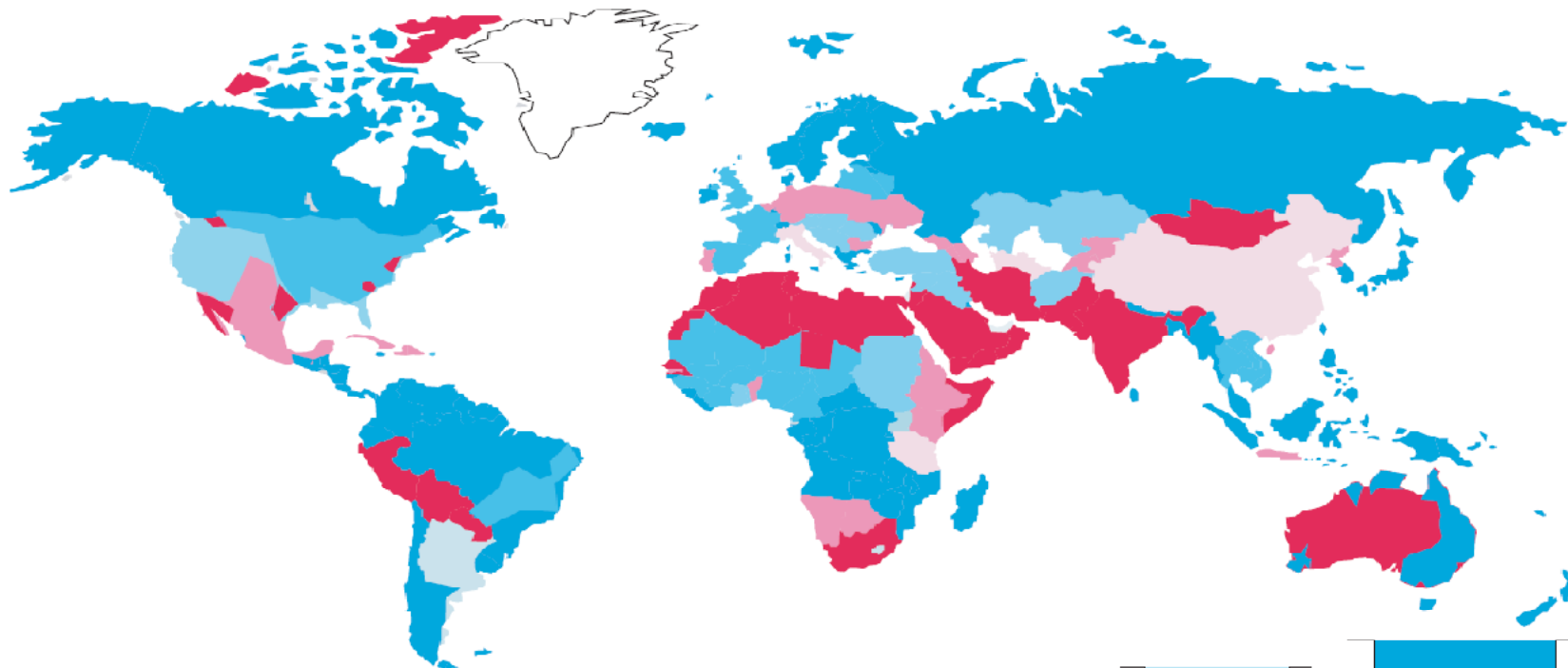
water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA

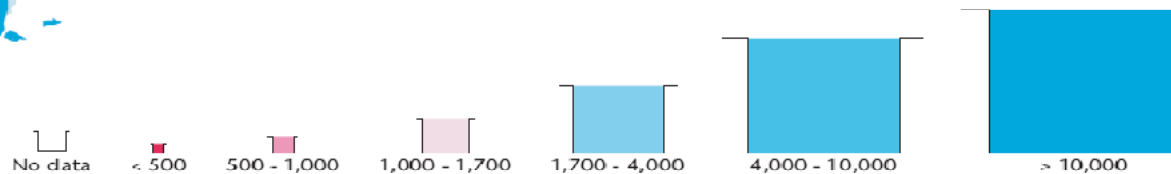


SA is observed to be one of the countries with least water availability/person

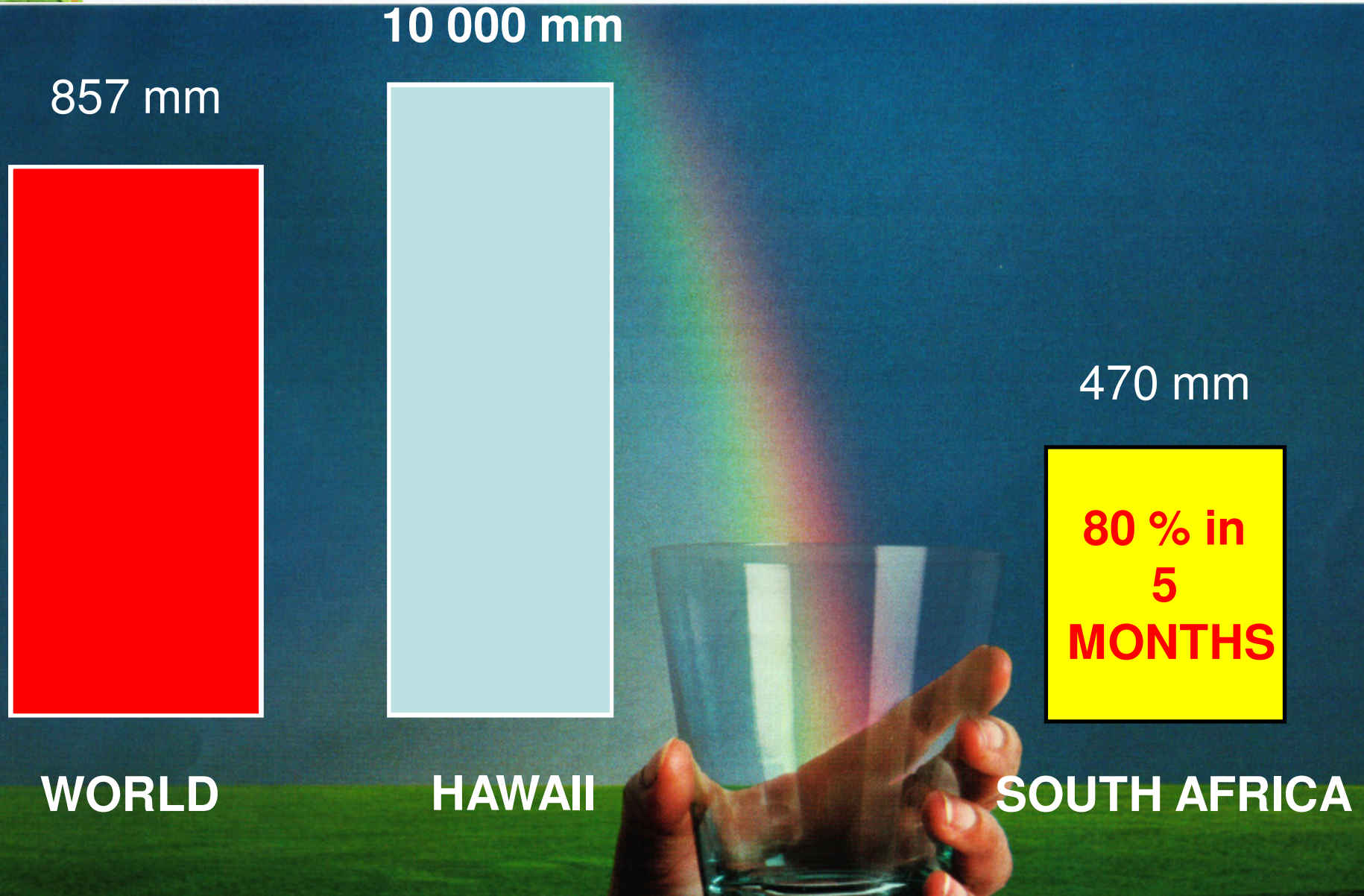
Annual renewable water (m³/person/year)⁵



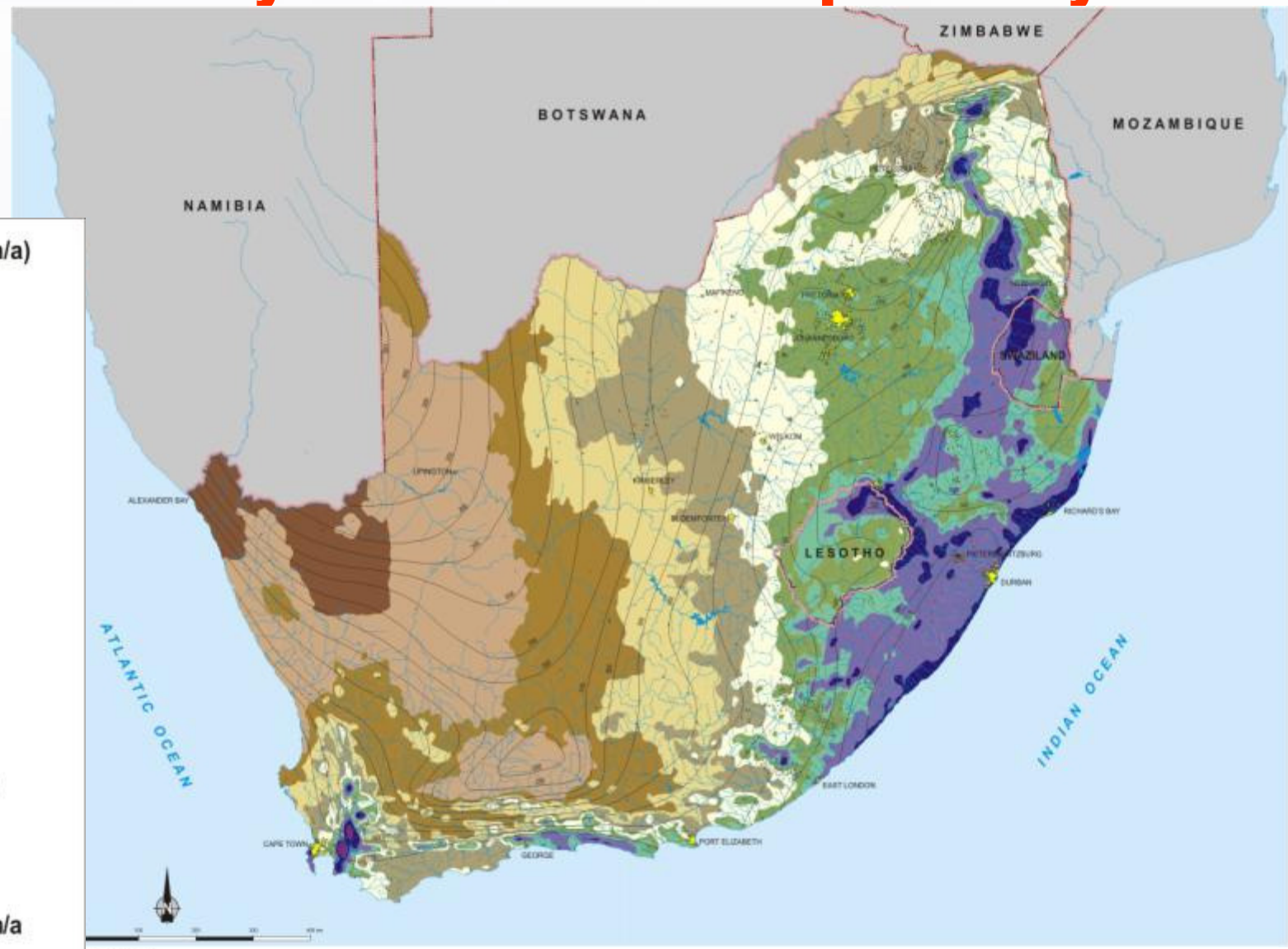
Ref. 5: "Will there be enough water?"
Revenga, C., EarthTrends, October 2000,
www.earthtrends.wri.org



The limited Water is also temporally distributed

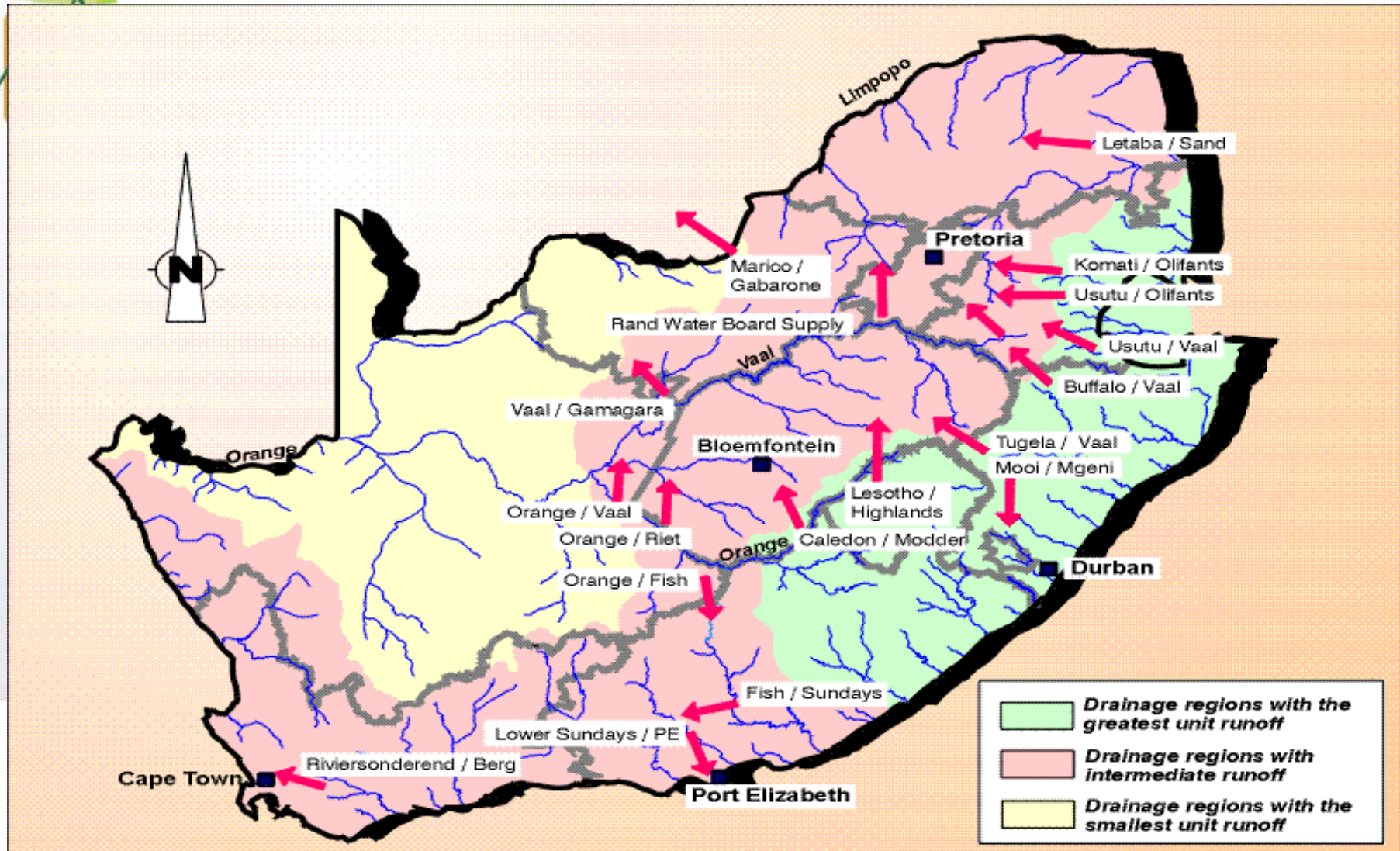


The water availability is also unevenly distribution spacially





Mismatch between water availability & demand necessitated reconciling infrastructure like dams, pipelines, etc.





Systems Operation Mandate

Mandated by National Water Act (NWA) e.g.

- a, *Water Boards, WUAs, etc, may temporarily control, limit or prohibit use of water, but in so doing must provide information on extent of disruption, etc. (Schedule, 3 Sec. 6, NWA)*
- b, *The public need to be informed of risks posed due to anticipated droughts, floods, pollution incidents, etc. (Sec 145, NWA)*



water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



ESKOM/DWAF Orange River System Agreement

- ... Eskom is allowed to use **water at its full load for four hours per day** when it is in an emergency/crisis situation – unless a drought emergency has been gazette for the river system

- $P = \eta \gamma g QH$

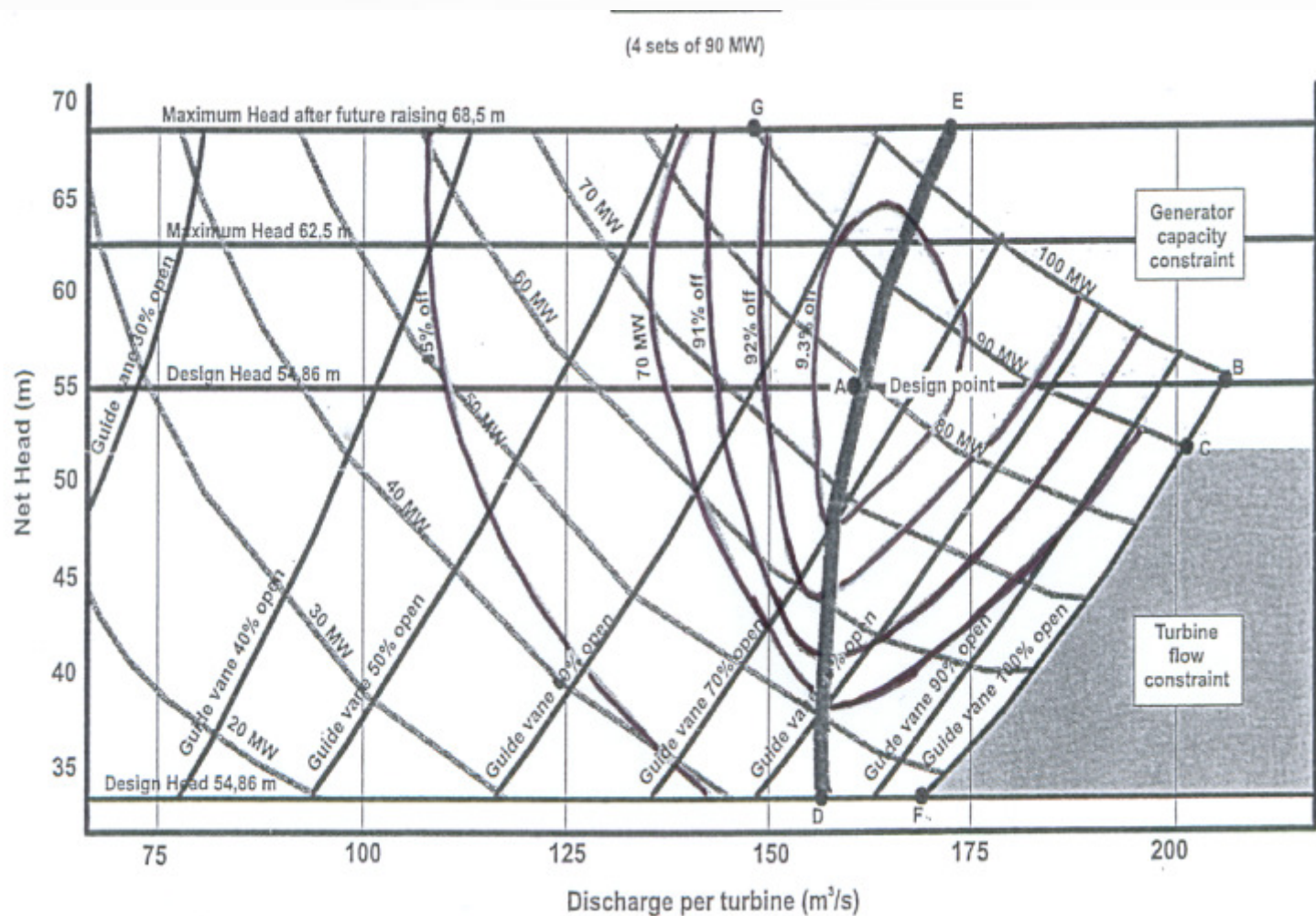


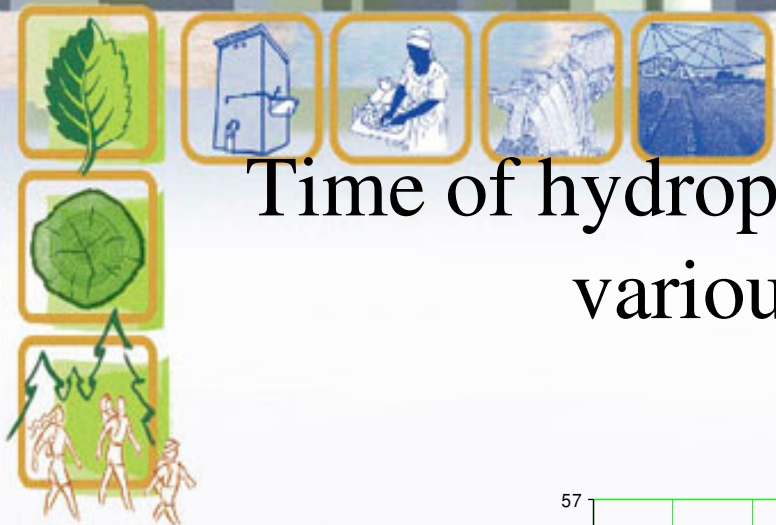
water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



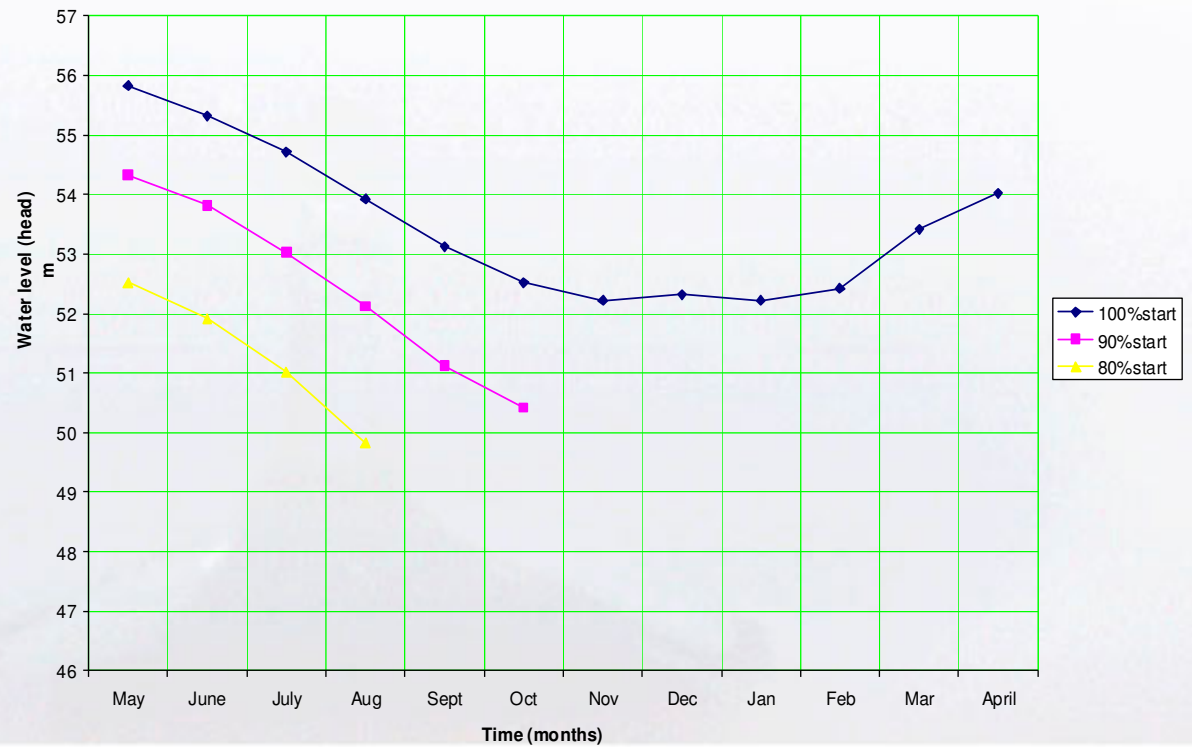
Gariep Turbines Characteristic Curves





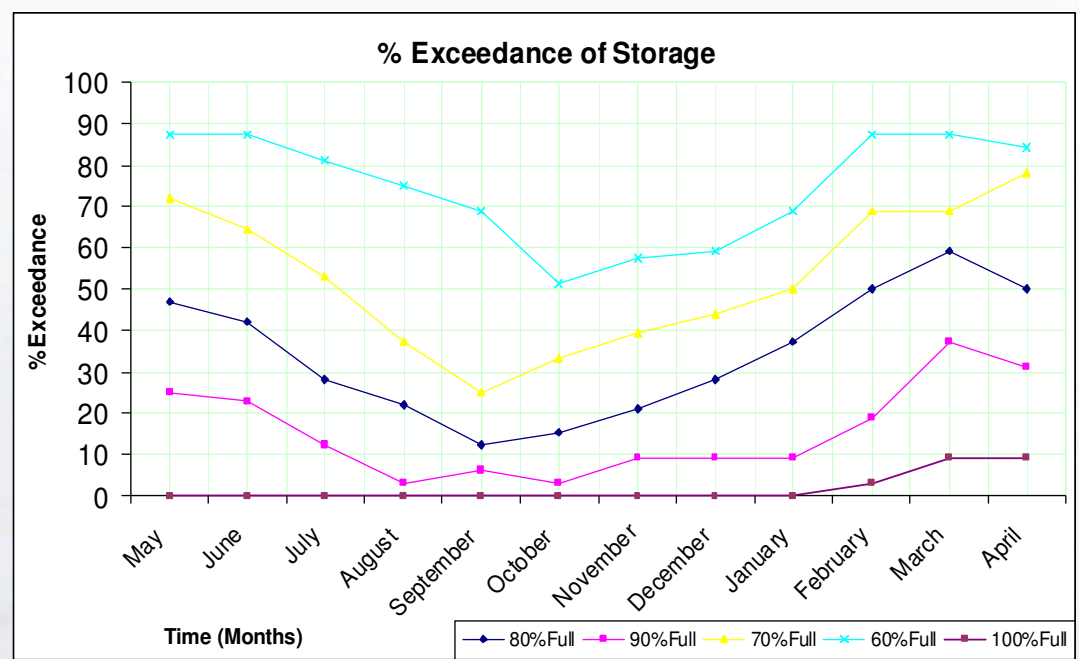
Time of hydropower generation at 90MW for various initial water levels

Emergency Release Drawdown Curve



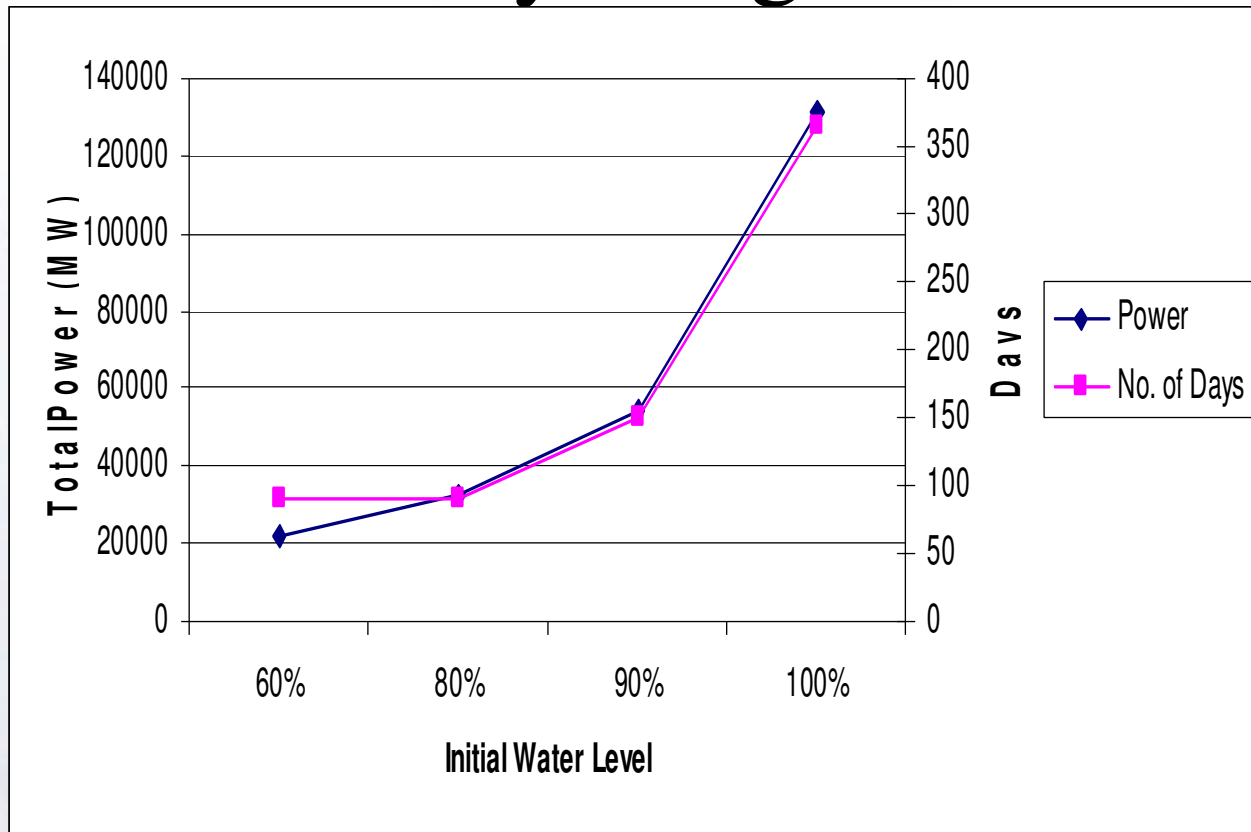


% Exceedance of storage





Initial Water Level against Power & Days of generation



water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



Points to note due to the agreement

- Number of days for power generation are limited, except for initial level at 100%
- The agreement can lead to several months when power cannot be generated.
- Below 40% dam capacity level, power generation is negligible
- Risk of failure to other users increased due to the 4-hour load is demonstrated by the box-plot figure below.

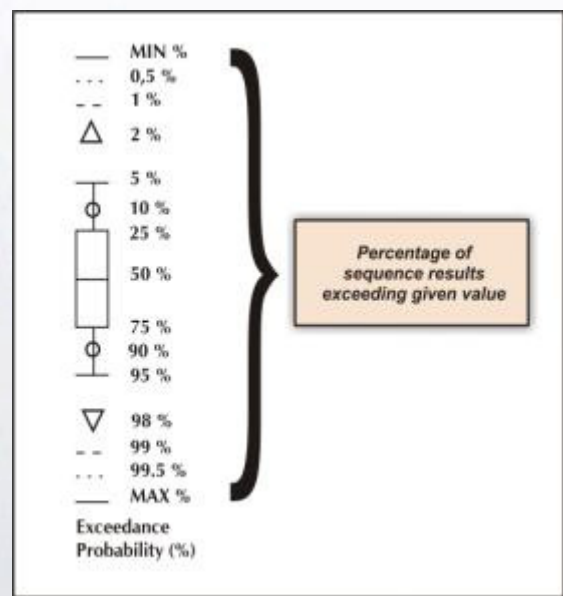


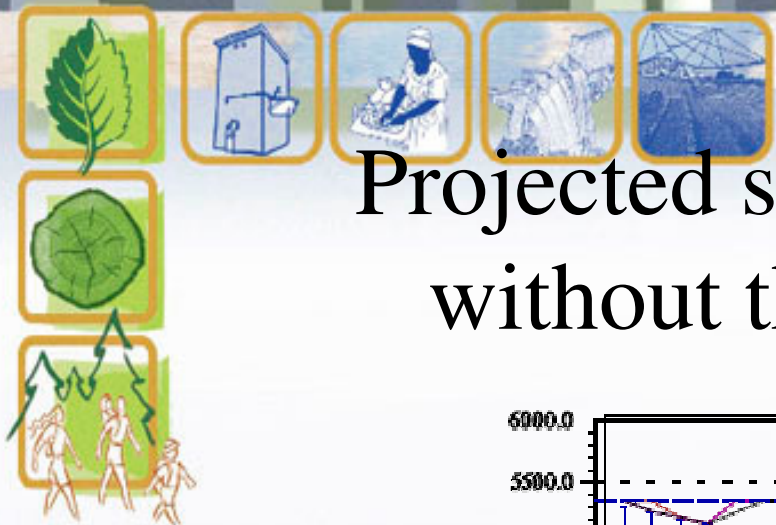
water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



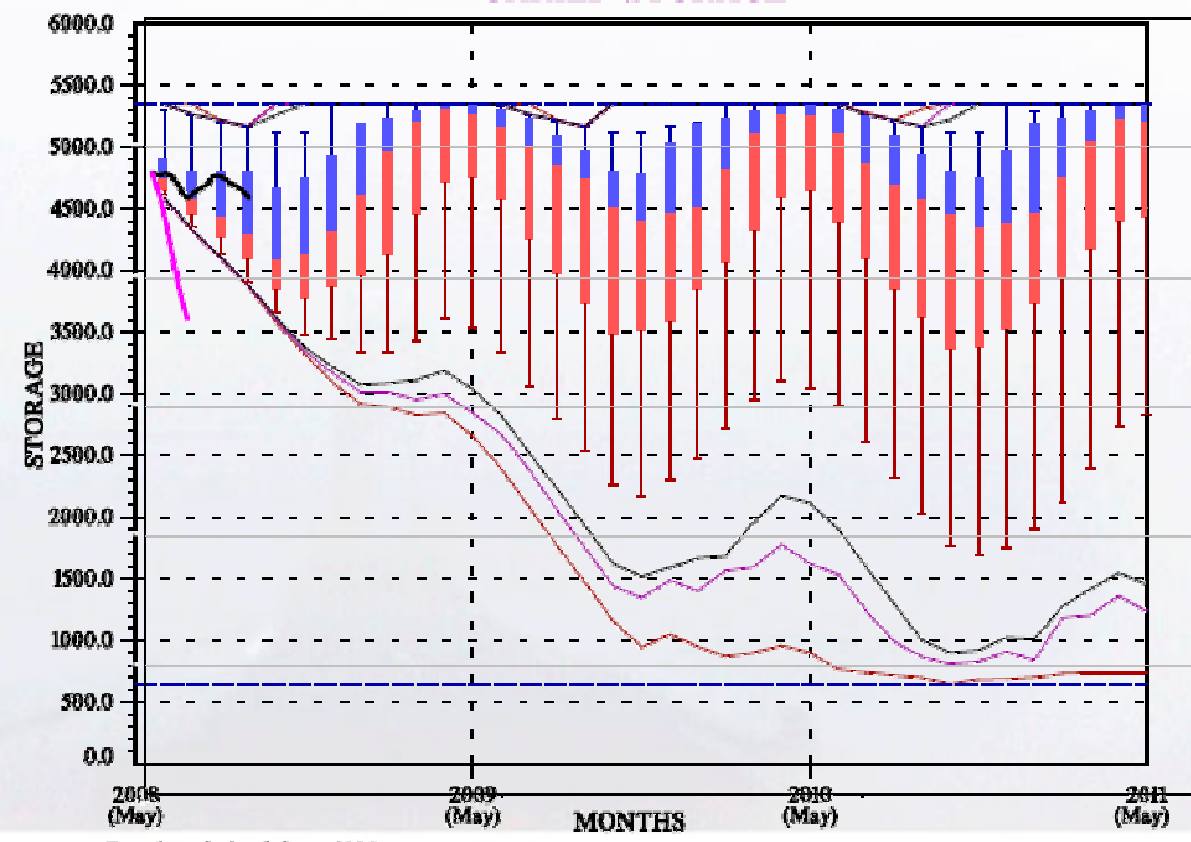
Interpretation of Box Plots





Projected storage trajectory with & without the 4 hr load allocation

GARIEP STORAGE



Boxplots derived from 1000 sequences



Water Banking Allocation Concept

- Another water allocation concept without much regards to operational principles
- The allocation concept allows users to bank their water in government dams and take it whenever required – more or less as money banking is done.
- Its major limitation is failure to consider the risk allocation aspect.



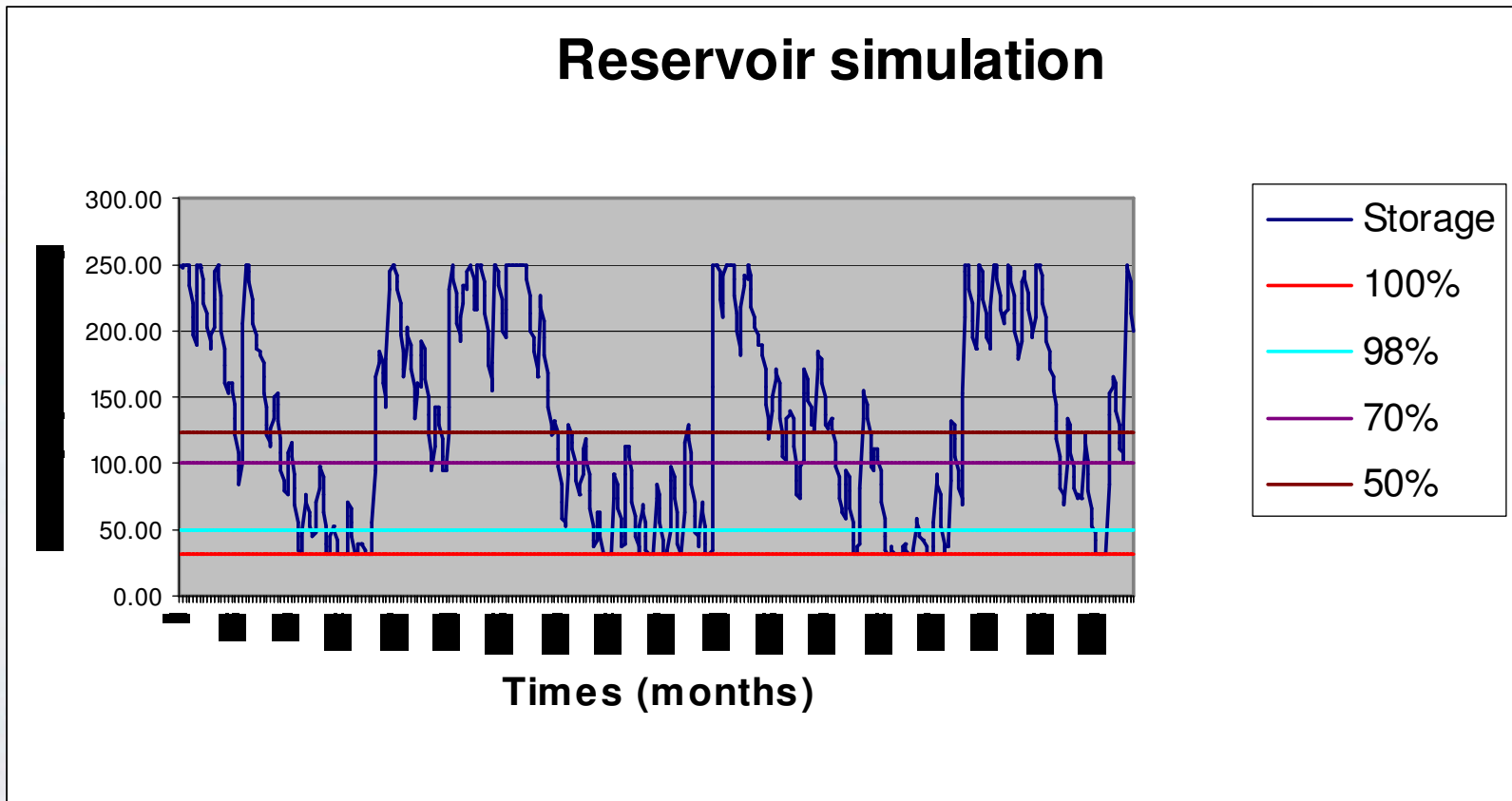
water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



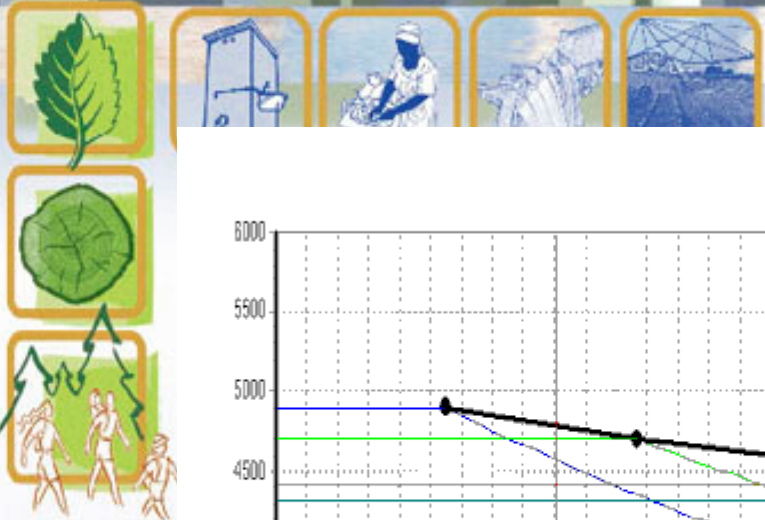
Water is allocated in both volume & risk

Reservoir simulation

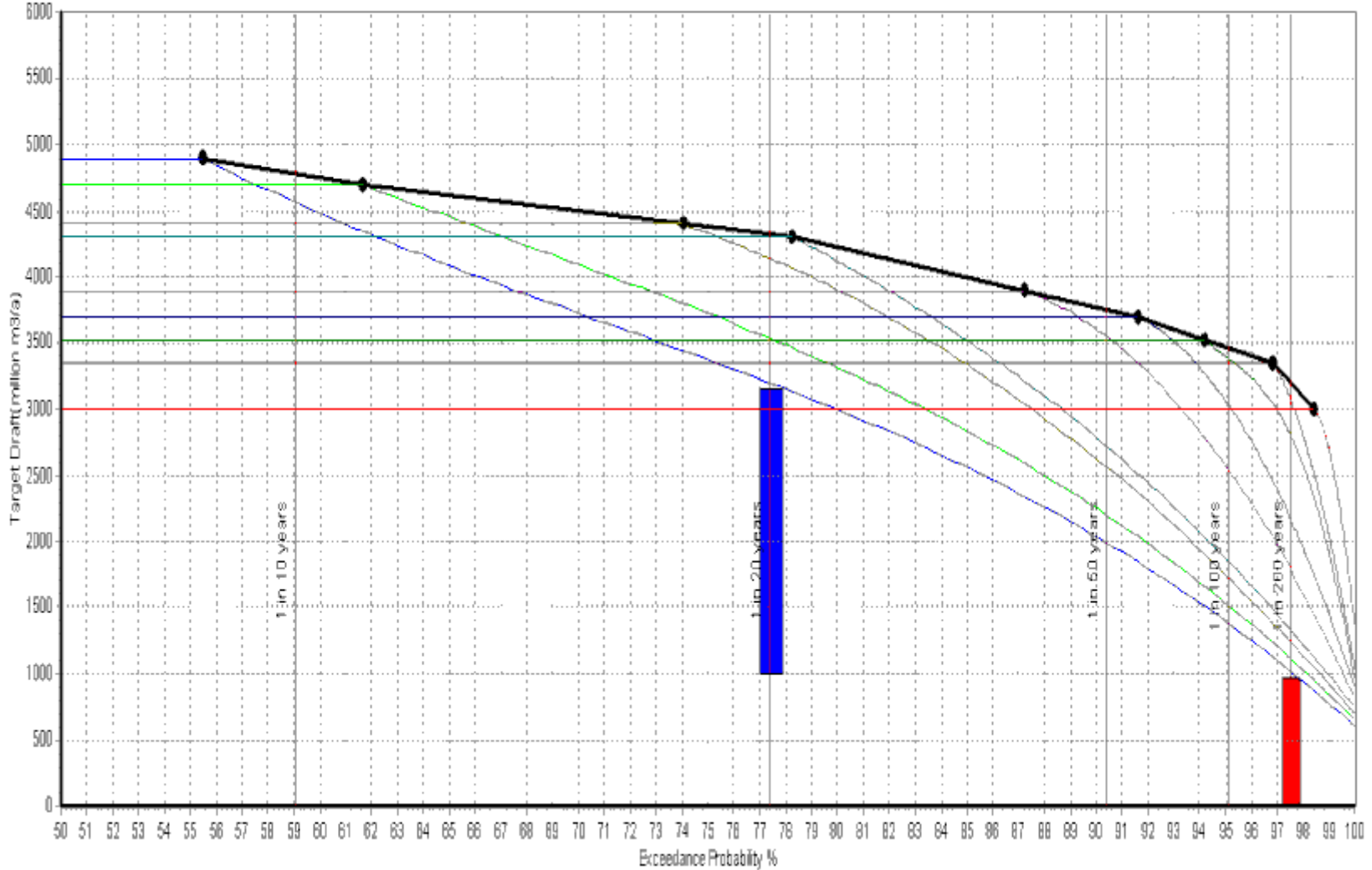


water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



Firm yield derived from (omniSUNOUT)
 501 Stochastic Sequences - Plotting Base = 5 years - Period Length = 5 years

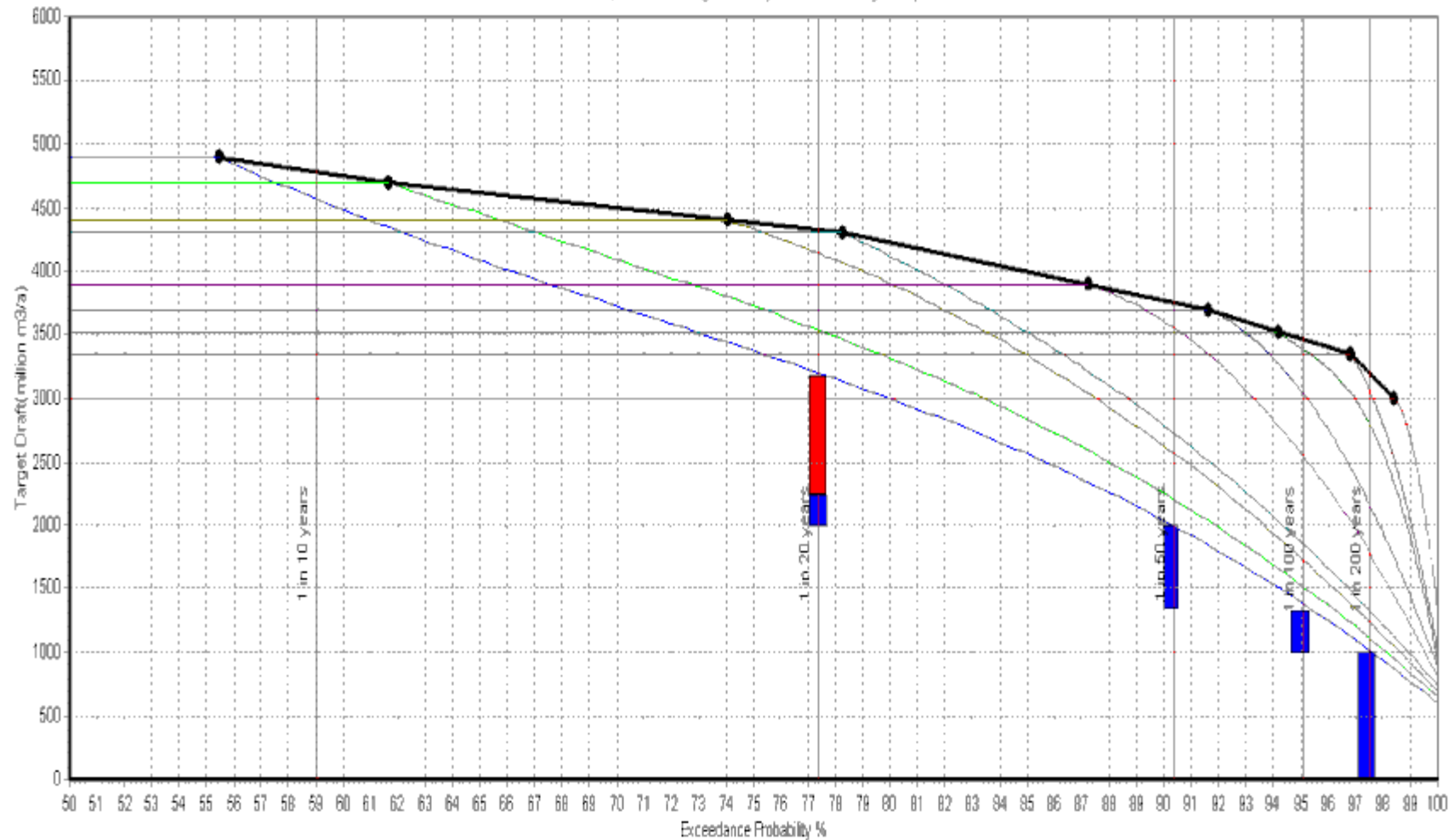


water & forestry

Department:
 Water Affairs and Forestry
 REPUBLIC OF SOUTH AFRICA



Army old derived from (ams1SUMOUT)
 501 Stochastic Sequences - Potting Base = 5 years - Period Length = 5 years



water & forestry

Department:
 Water Affairs and Forestry
 REPUBLIC OF SOUTH AFRICA



Other Limitations of Water Banking Allocation Concept

- Infrastructure hydraulics & capacity
- Water availability distribution
- Water losses (evaporation, quality, etc)
- Capacity differences in our society



water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA



Conclusions

- Hydrological considerations should be the main driver for operating water resources systems, but within business and legal constraints
- Water banking not equivalent to water use efficiency



water & forestry

Department:
Water Affairs and Forestry
REPUBLIC OF SOUTH AFRICA