Overview of water resources assessment in South Africa: current status and future challenges

Dr W V Pitman

31-August-2011

Another project sponsored by www.wrc.org.za

South Africa's water resources

A quick comparison:

- Average MAP of 465 mm compared with world average of 810 mm
- MAR of about 50 billion cubic metres, which is:
  - About 10% of Zambezi River or
  - About 1% of Congo River

Previous assessments of water resources in South Africa

(By publication date and authors)

- 1952 (D C Midgley)
- 1969 (D C Midgley & W V Pitman)
- 1981 (D C Midgley, W V Pitman & B J Middleton)
- 1994 (D C Midgley, W V Pitman & B J Middleton)
- 2008 (B J Middleton & A K Bailey)

The 1952 assessment

Computer hardware

- None

Computer software

- None – relied heavily on graphical techniques

Challenges

- Processing large volume of data without benefit of a computer

Innovations

- Concept of similar hydrological zones

The 1969 assessment

Computer hardware

- Main frame (single user), punch cards

Computer software

- Rainfall-runoff regression, deficient flow analysis

Challenges

- Geographical mapping without GIS

Innovations

- Quaternary catchment unit, relating reservoir yield to probability/assurance

The 1981 assessment

Computer hardware

- Main frame (multiple user with remote terminals)

Computer software

- Pitman rainfall-runoff model

Challenges

- To allow for increasing land use

Innovations

- Simulation of standard length time series of natural flow, "naturalization" of flow records

The 1994 assessment

Computer hardware

- Personal computer, DOS operating system

Computer software

- WRSM90 (Pitman model with network of runoff, reservoir, irrigation and channel modules)

Challenges

- To allow for increasing and more complex land use

Innovations

- Application of GIS, modelling complex catchments

The 2008 assessment

Computer hardware

- Personal computer, Windows operating system

Computer software

- WRSM2000 with surface/groundwater models and new and improved land-use methodologies

Challenges

- To include surface/groundwater interaction and water quality

Innovations

- Menu system with all study products available

Current status

Computing power

- Doubles every 2 years, so have about 1 billion times that of 60 years ago

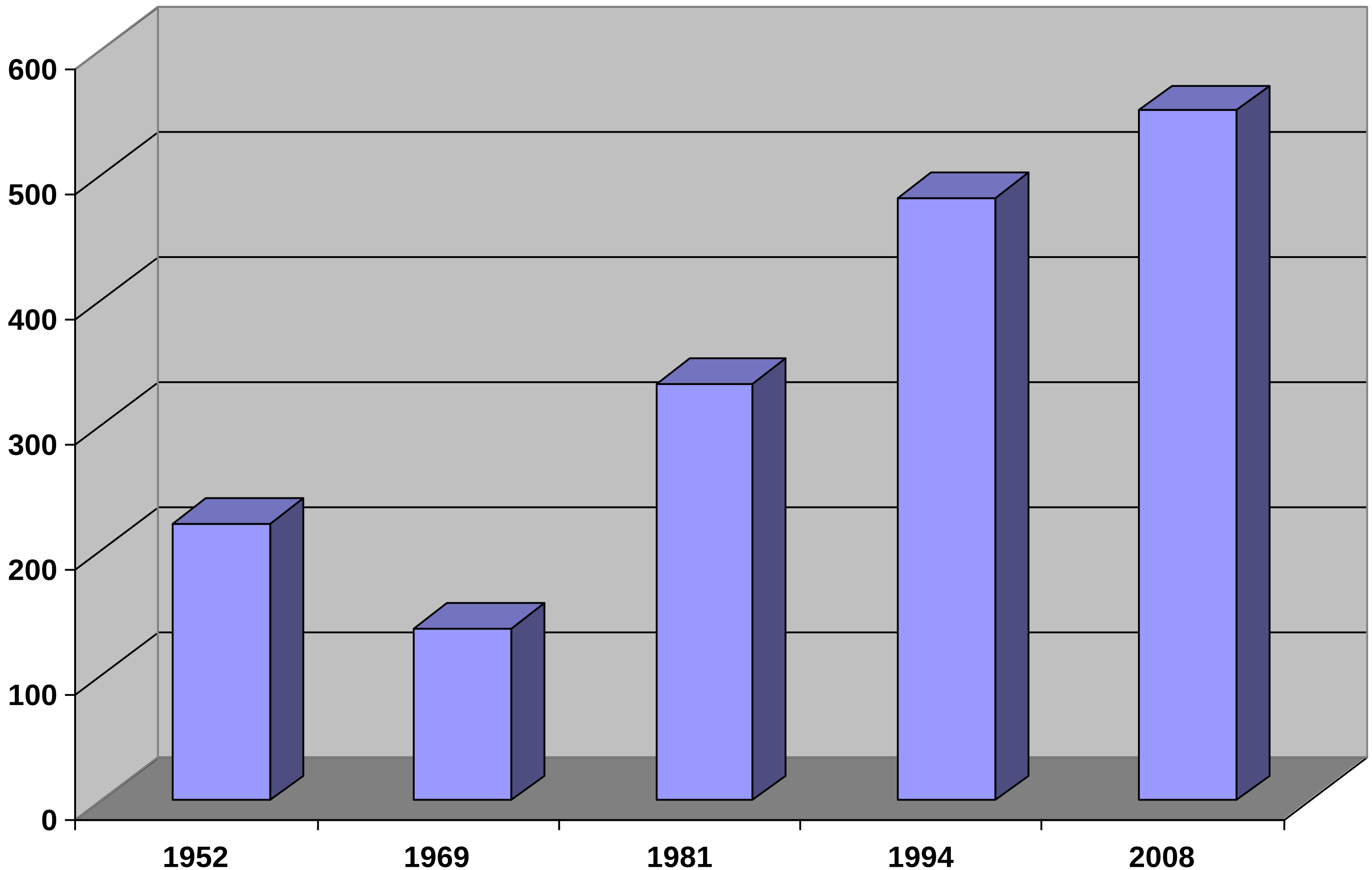
Computing software

- Ongoing development of programs to enable us to handle the ever-increasing complexity of water resources systems

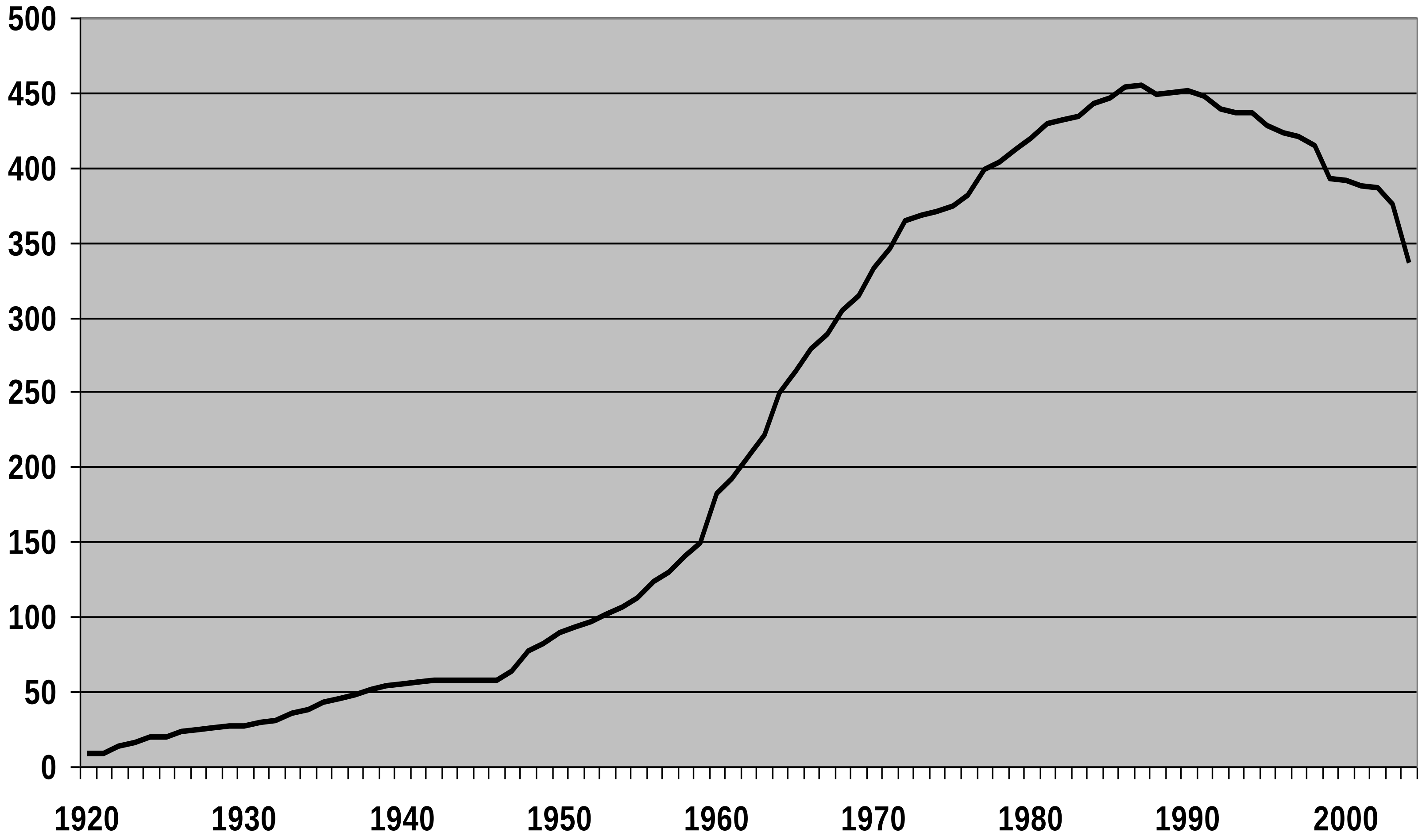
Data problems

- Decline in hydrological monitoring over recent decades, exacerbated by increasing land use

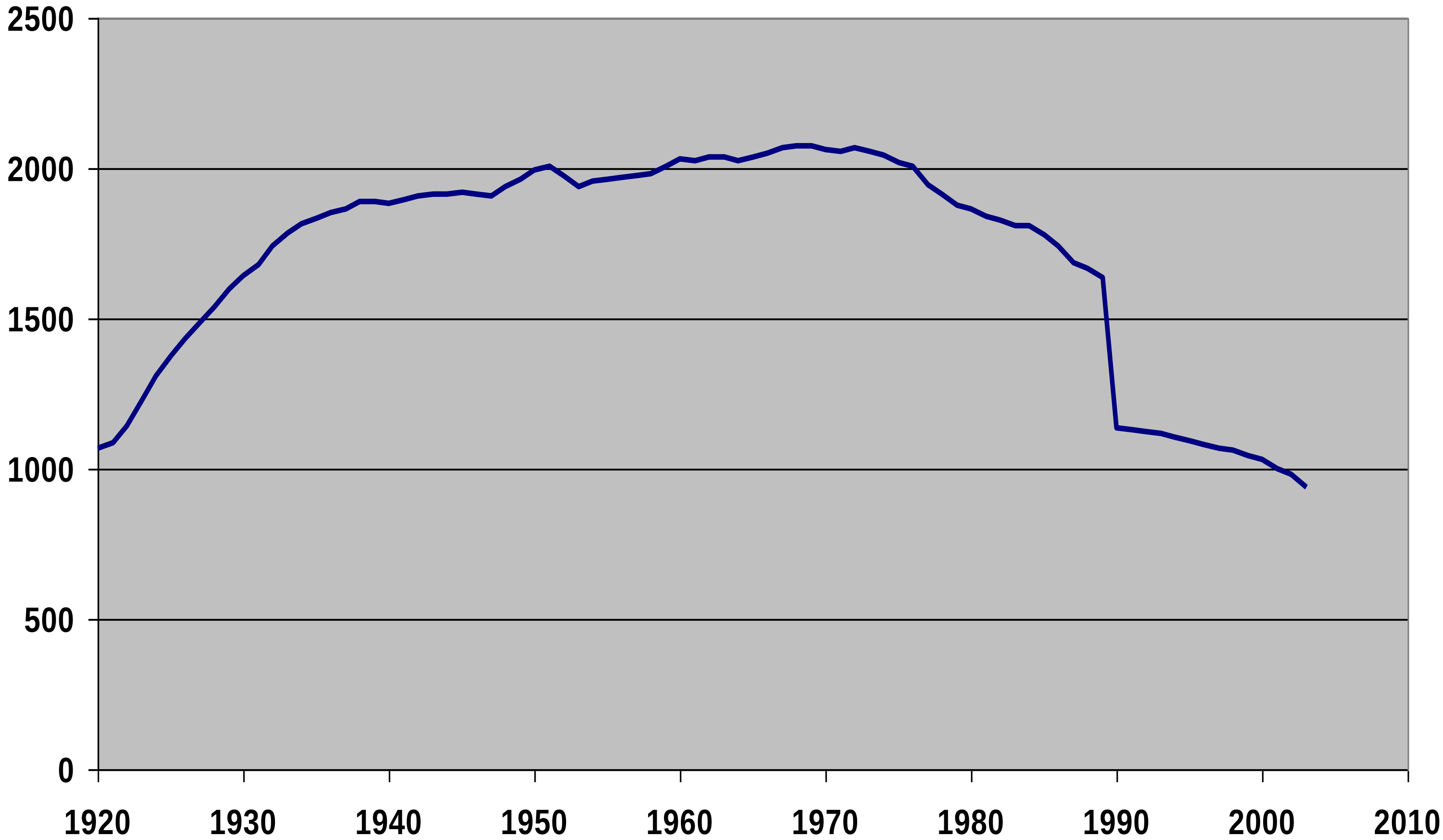
No. of flow records used in each study



No. of flow gauges open in each year



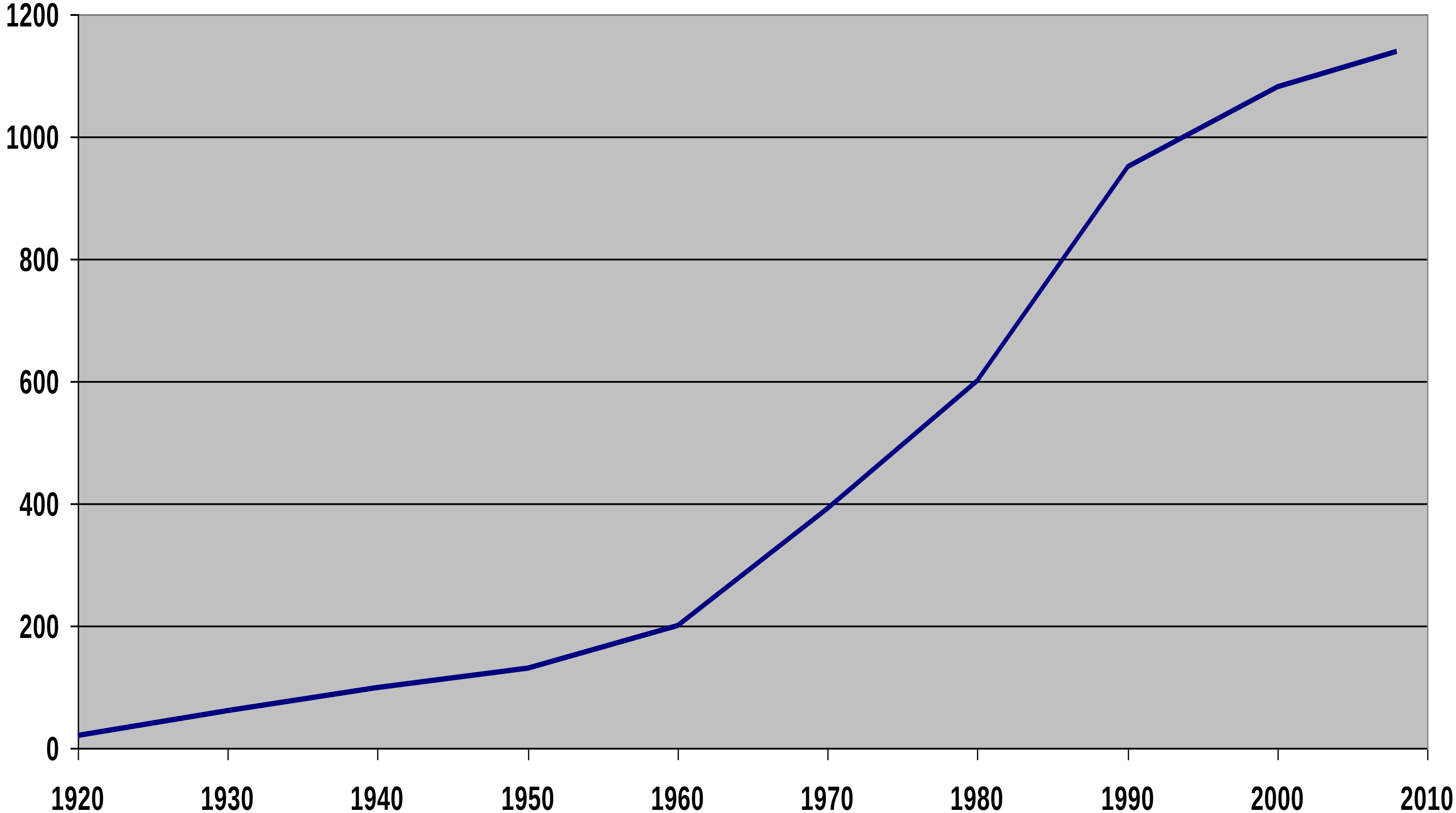
No. of rain gauges open in each year



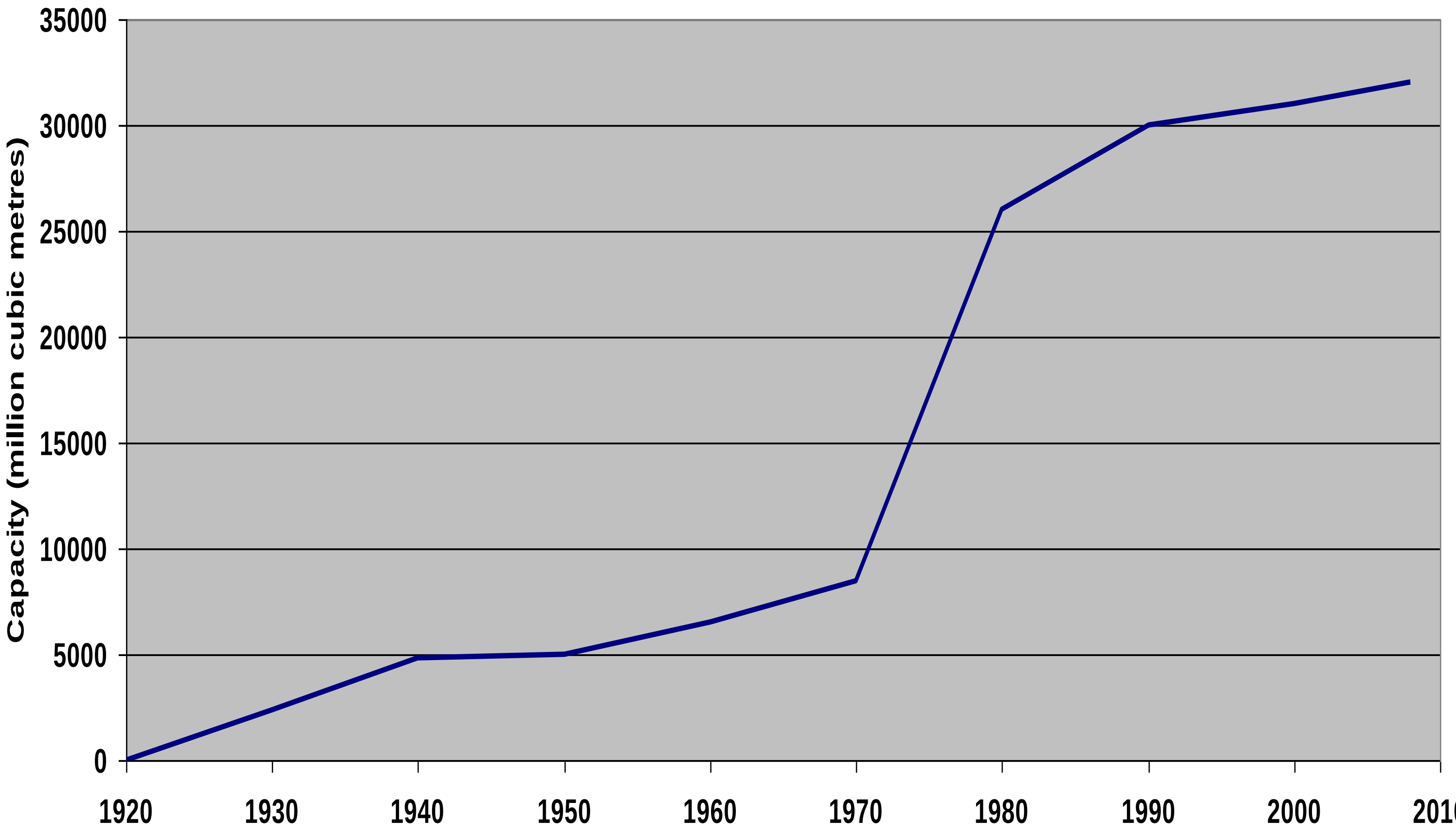
Growth in land cover and water use

- Irrigation (main usage, still accounts for 60% total)
- Industrial, mining, urban and power generation
- Inter-basin transfers
- Afforestation (reduction in runoff)
- Encroachment of alien vegetation (reduction in runoff)
- Urbanization (paving of land surface – increase in surface runoff)
- Construction of dams (abstraction of water and evaporation losses)

Growth in number of large dams



Growth in total dam capacity



Future challenges

- Avoid long gaps between assessments
- Improve hydrological monitoring or, at the very least, bring it back on track
- Reduce duplication of effort with reliable and accessible data bases that are well-managed
- Pay more attention to deteriorating water quality
- Improve modelling of surface/groundwater interaction
- Environmental flow requirements (EWRs)
- Recognize climate cycles and climate change

The proposed 2012 assessment

Computer hardware

- Increasing computer power (doubles every 2 yrs.)

Computer software

- WRSM2000 with daily time step and Visio for network construction, Google Earth

Challenges

- Decreasing and deteriorating hydrological data exacerbated by increasing land use

Innovations

- Web-based system for all study products

Hydrological monitoring

- “What is important is that the monitoring of rainfall and runoff must be continued vigorously and the monitoring network must be improved to ensure that the actual effects of climate change are measured accurately and brought into the analysis of resources as quickly as possible.” (Van Rooyen et al, 2009)
- Recruitment of adequate manpower and funding needed to achieve this (e.g. critical manpower shortage in DWA, (Herold, 2010))

Climate cycles

- "Behold, there will be seven years of plenty throughout the land of Egypt: and there shall arise after them seven years of failure" (Genesis 41:29-30, circa 1800 BC)
- "Neither the lengths of the periods nor the synchronous occurrences are precise in the mathematical sense but their presence is beyond doubt" (Alexander, 2007)
- Historical data should reflect these cycles if they exist

Climate change

- “Climate change is probably the worlds biggest distraction” (Hawthorn, 2011)
- “Climate change can be viewed as an additional uncertainty” (Van Rooyen et al, 2009)
- “There are fundamental flaws in current global climate models used for climate change applications” (Alexander, 2007)
- Hence accurate hydrological data is essential

Historical examples of climate change

Medieval Warm Period

- About 1,000 years ago – Vikings discovered and colonized Greenland, which was warm enough to grow crops (hence name).

Little Ice Age

- Ended around 1850 – River Thames froze in winter, allowing Londoners to ice skate.

Summary and conclusions

- Growing complexity in water resources has been matched by growth in computing power and development of appropriate tools
- Hydrological monitoring has fallen behind and needs to be improved, aided by recruitment of suitable people and allocation of funds
- More attention must now be paid to water quality and surface/groundwater interaction
- Don't get too distracted by climate change