History, Capacity Development, Research Outputs: Discipline of Agricultural Engineering School of Engineering, University of KwaZulu-Natal

Jeff Smithers, Peter Lyne, Roland Schulze, Tilahun Workneh, Aidan Senzanje, Alaika Kassim and Ashiel Jumman

29 October 2025

Edgewood Campus | Howard College Campus | Nelson R Mandela School of Medicine | Pietermaritzburg Campus | Westville Campus

Outline

- History timeline
- Capacity development
- Power, traction and alternative fuels research
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- Postharvest technology and food engineering

Outline

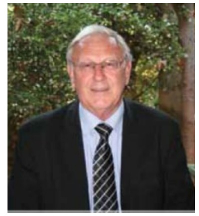
- **History timeline**
- **Capacity development**
- Power, traction and alternative fuels research
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- Postharvest technology and food engineering

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

History Timeline

Faculty of Agriculture established
Mr. Geiger – services course

Prof Mering- Lecturer
First graduate (Mr C Stephens)



Prof Schulze acting HoD (up to 1992)

Prof Smithers HoD (up to 2012)

Prof Smithers PC (up to 2018)

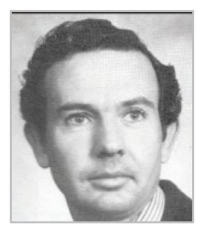
Dr Kassim acting PC

1948 | 1950 | 1956 | 1976 | 1991 | 1993 | 2002 | 2012 | 2018 | 2019 | 2025

Prof Vorster HoD (up to 1973)
5-year Ag Eng degree programme

Prof Meiring HoD (up to 1990)

Prof Peter Lyne - HoD (up to 2002)

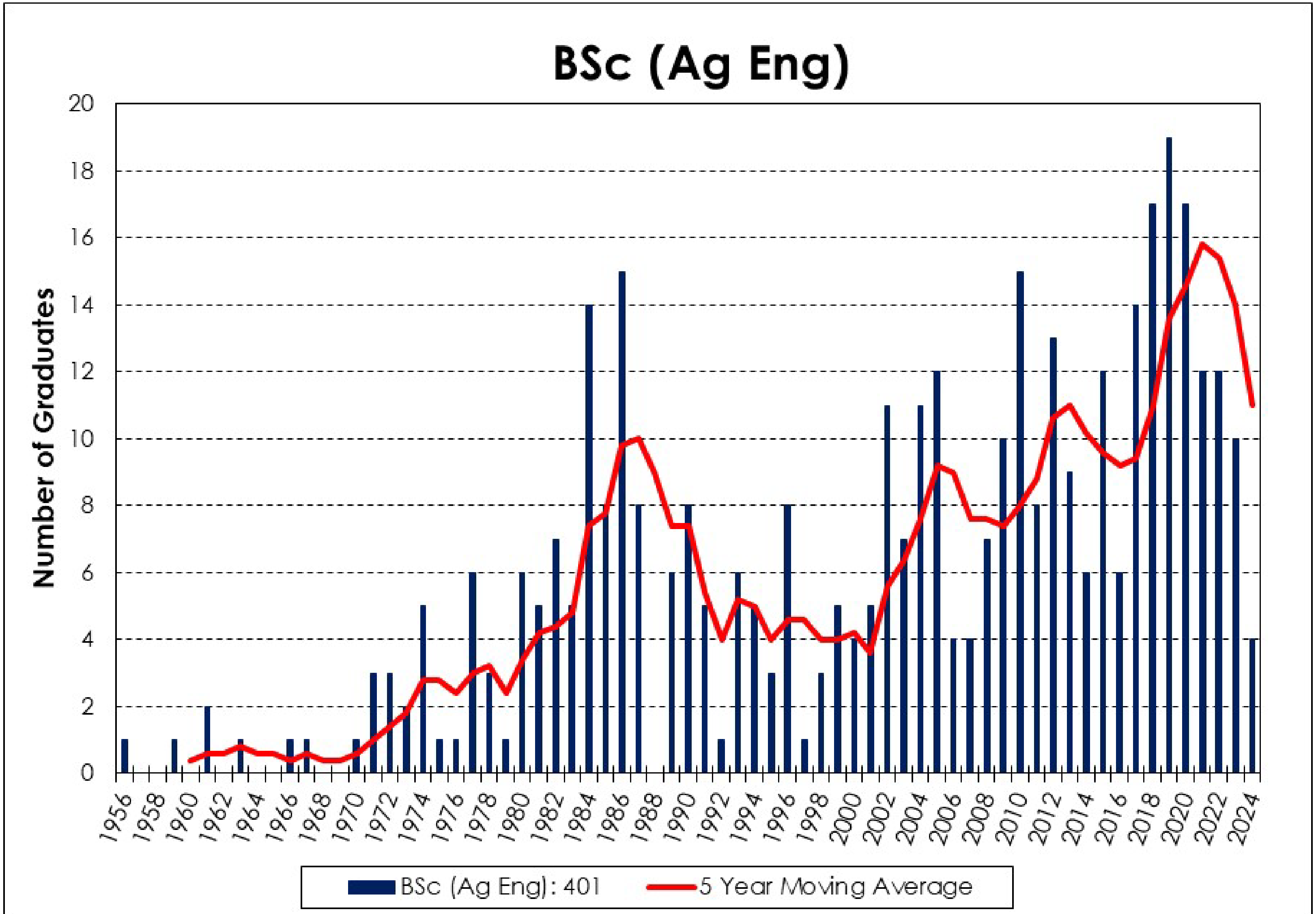


Dr Senzanje PC (up to 2015)

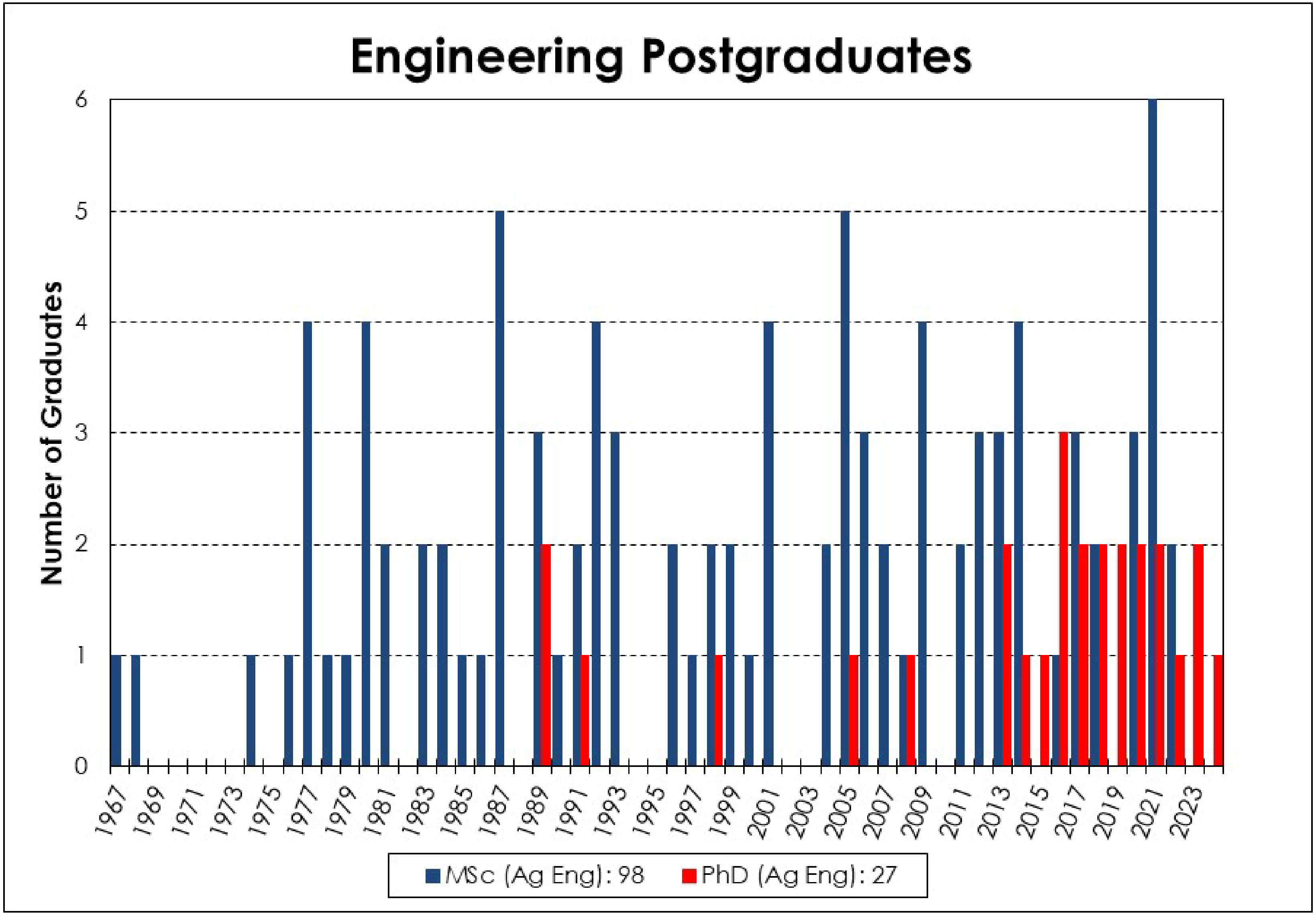
Prof. Workneh PC

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

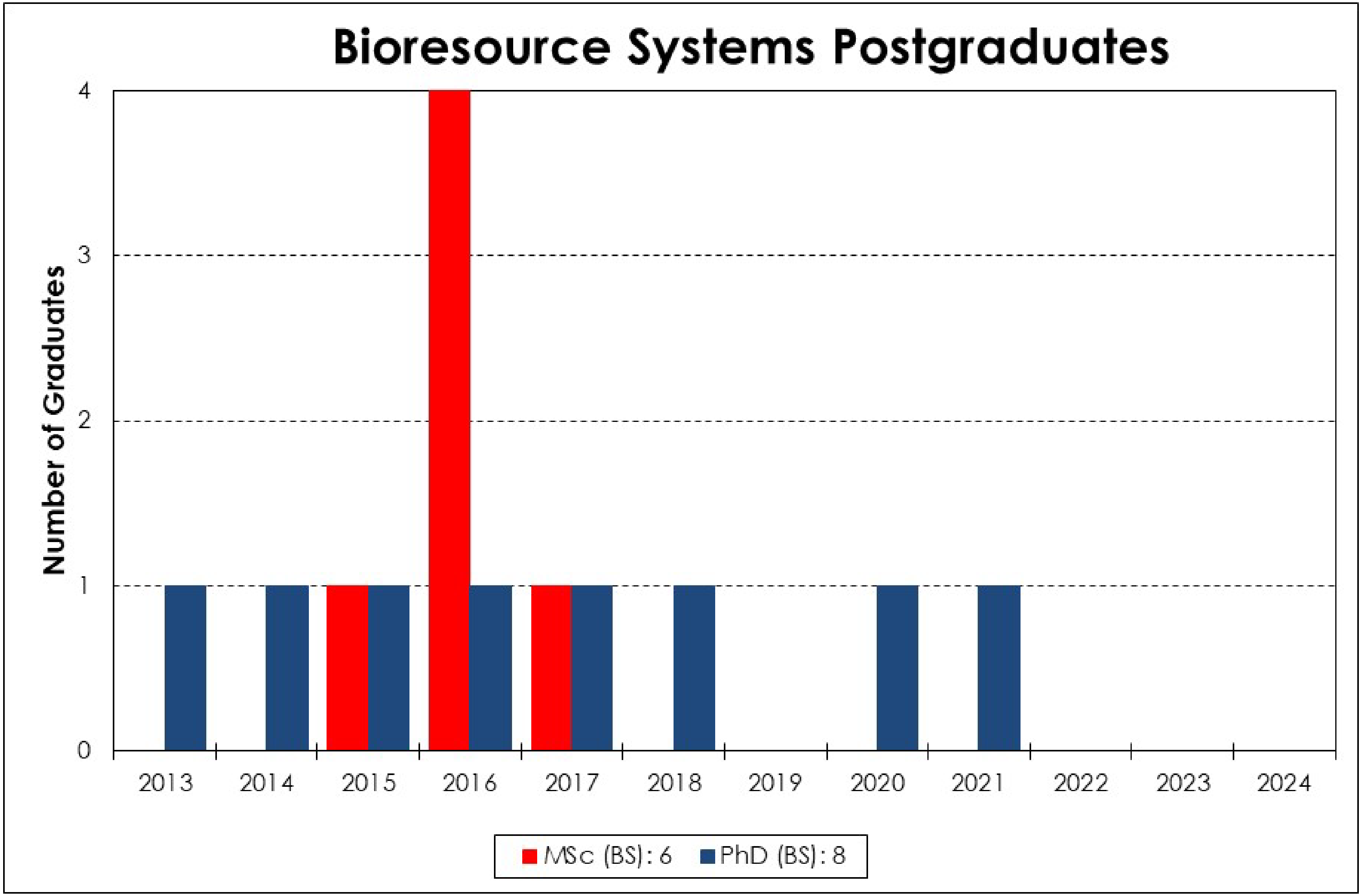
Capacity Development



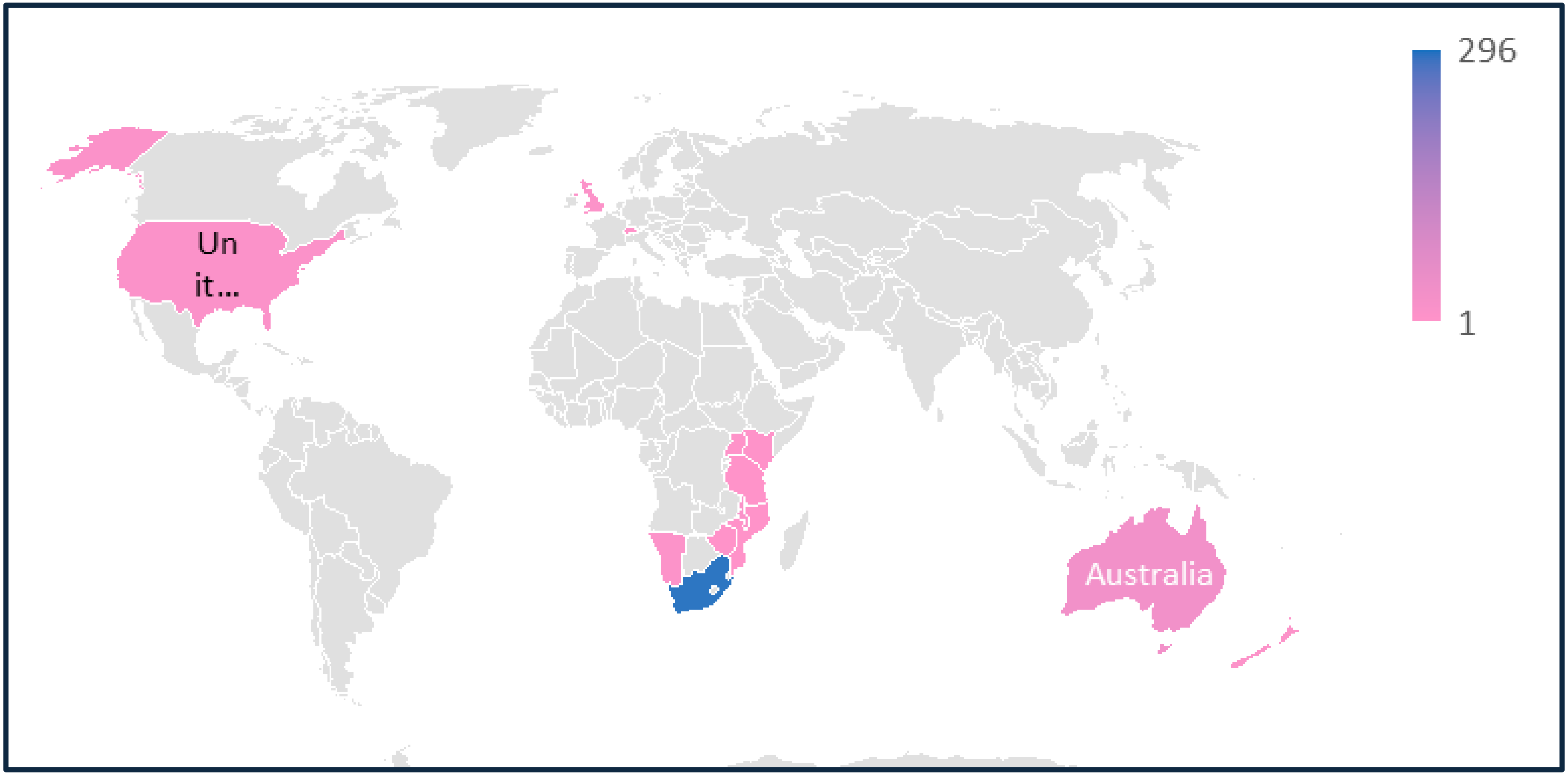
Capacity Development



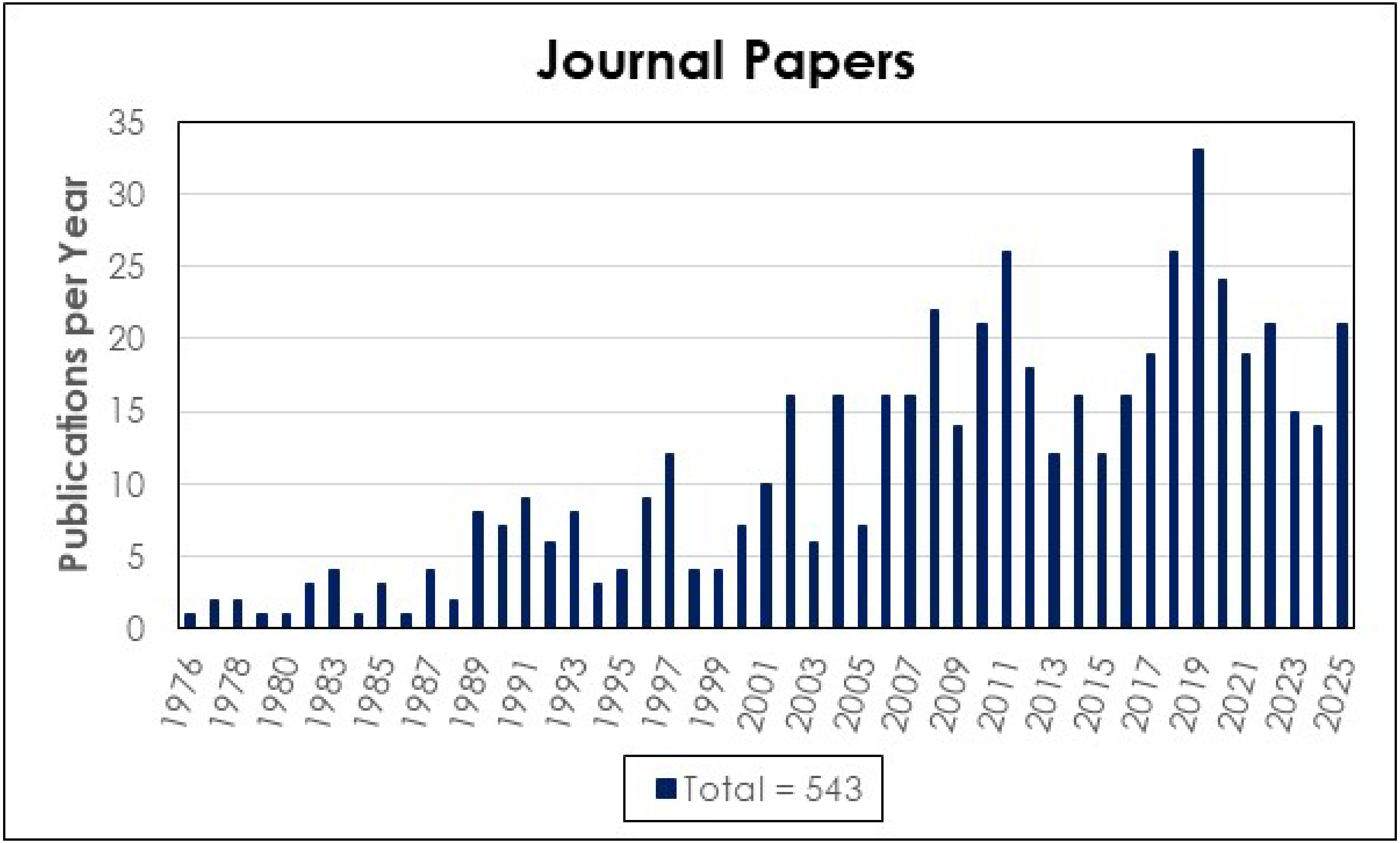
Capacity Development



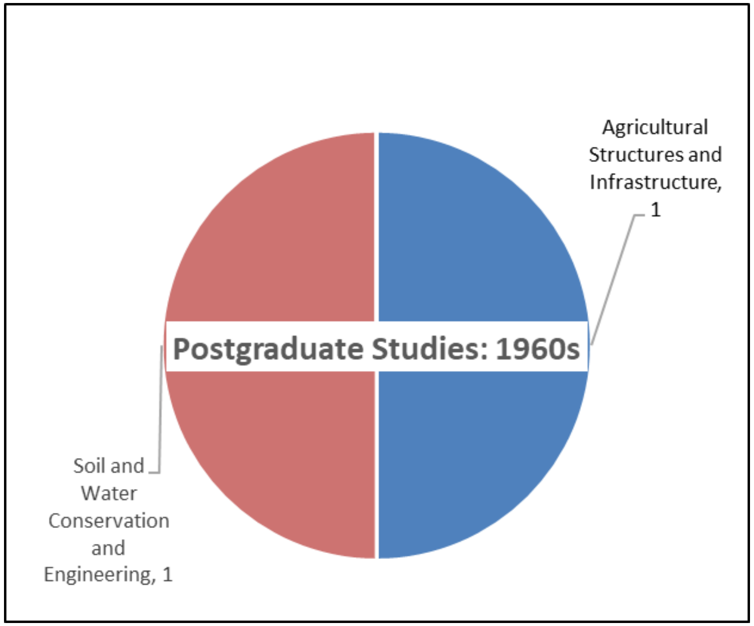
Where are the Graduates?

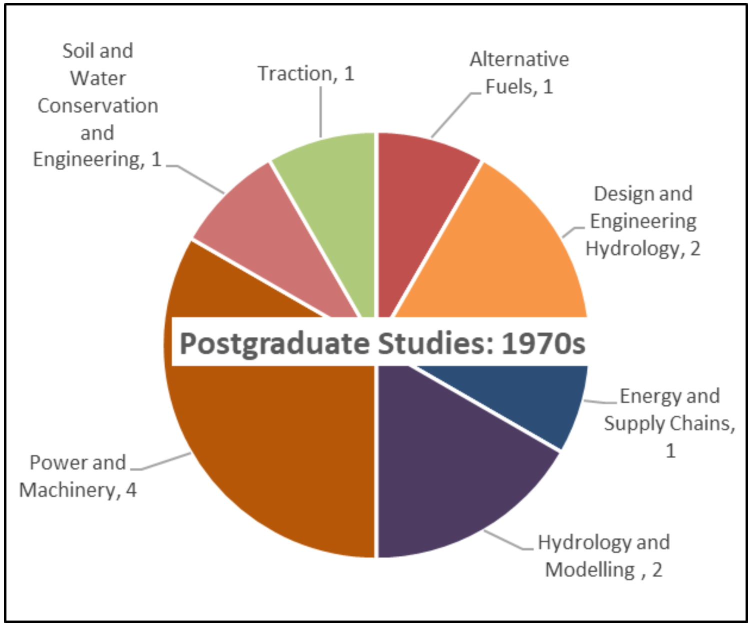


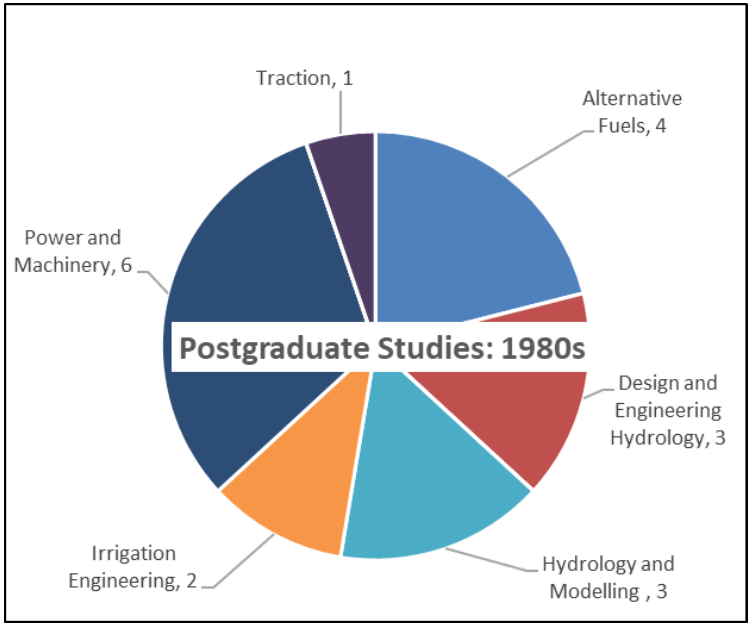
Research Publications

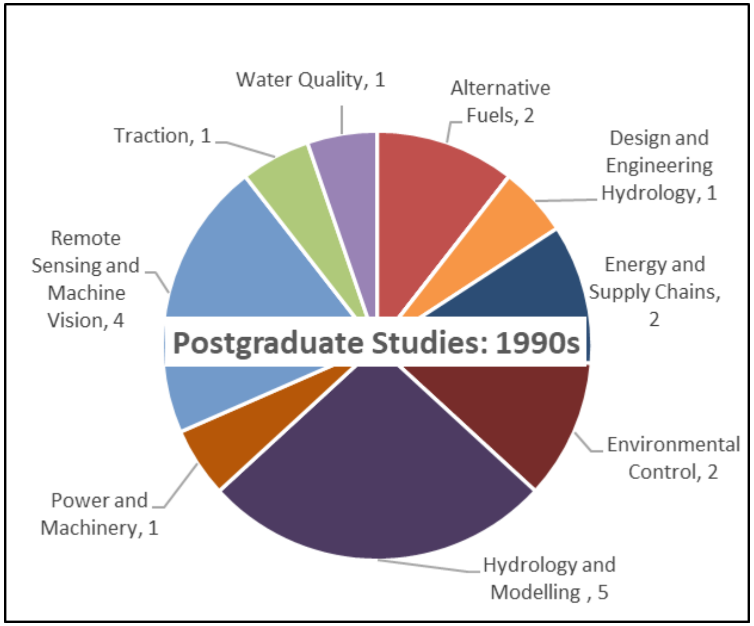


Evolving Research Fields



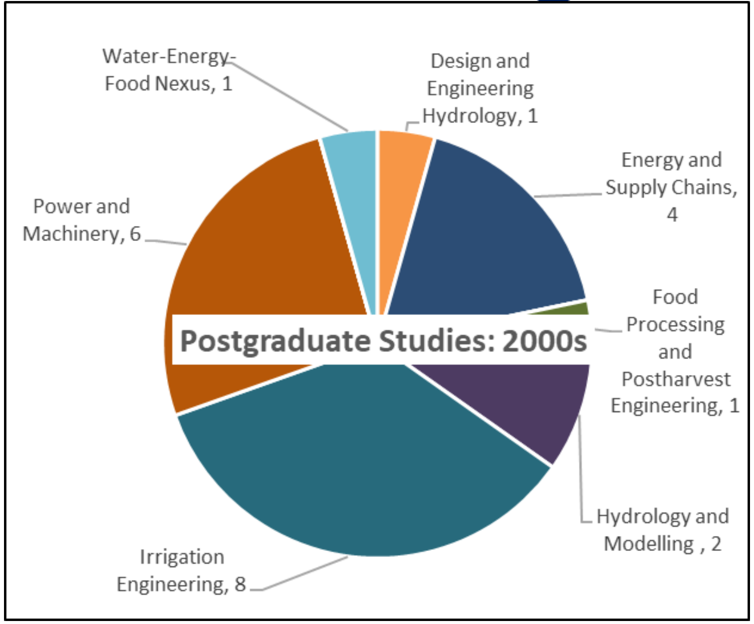


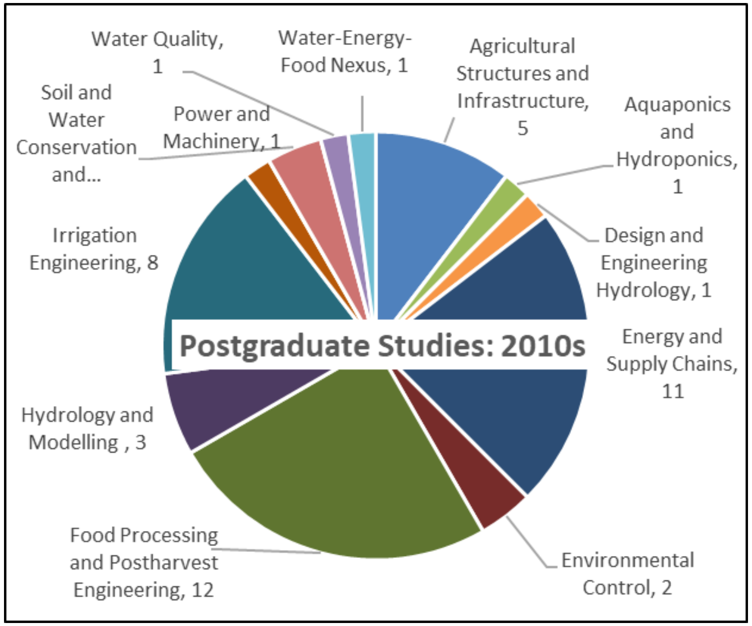


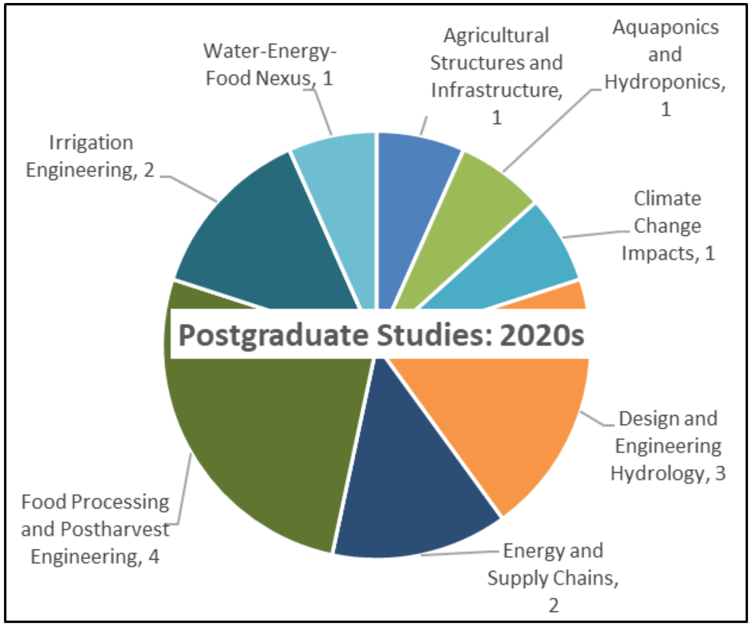


UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Evolving Research Fields







UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Outline

- History timeline
- Capacity development
- **Power, traction and alternative fuels research**
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- Postharvest technology and food engineering

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Ag Eng 75th

Mechanisation Programme

Contents

- “Fuel Crisis”
- Sasol Diesel
- Costs of Ag Production
- Soil Compaction
- Post-harvest deterioration

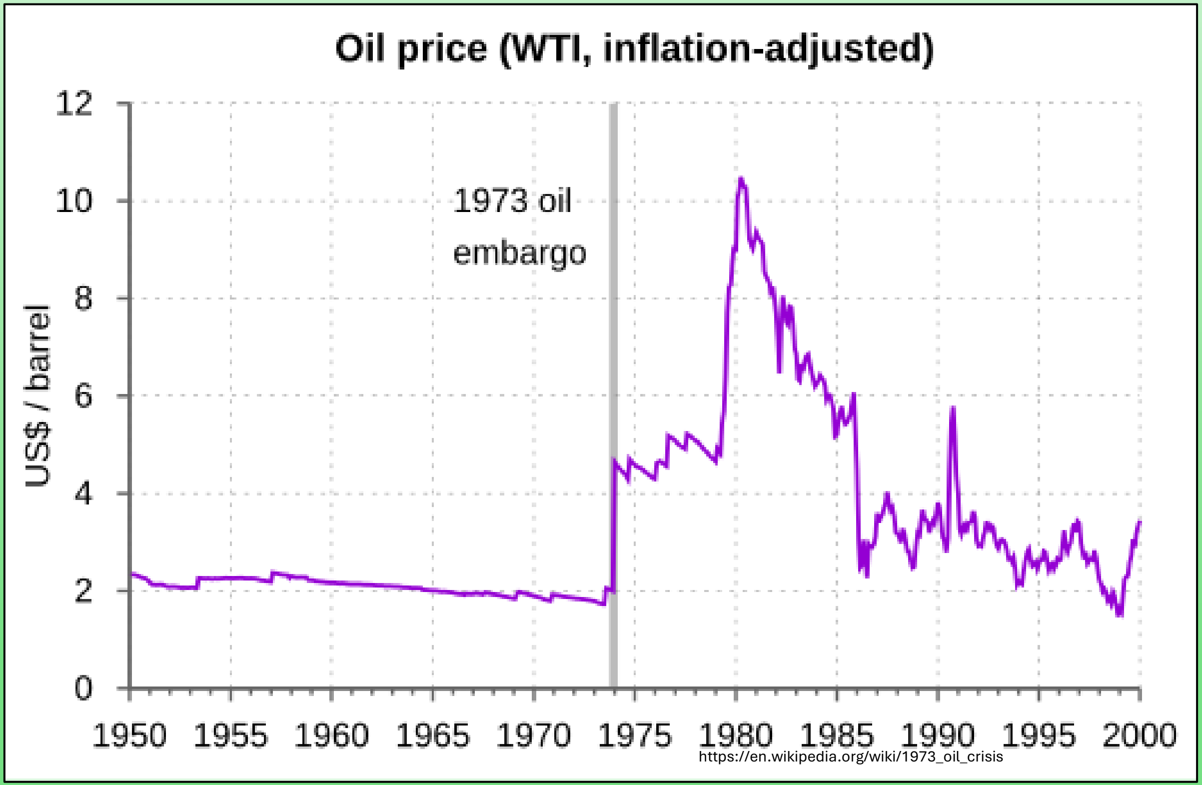
1970's Fuel crisis

Liquid Fuel

Daily fuel rationing from 6 pm. to 6 am

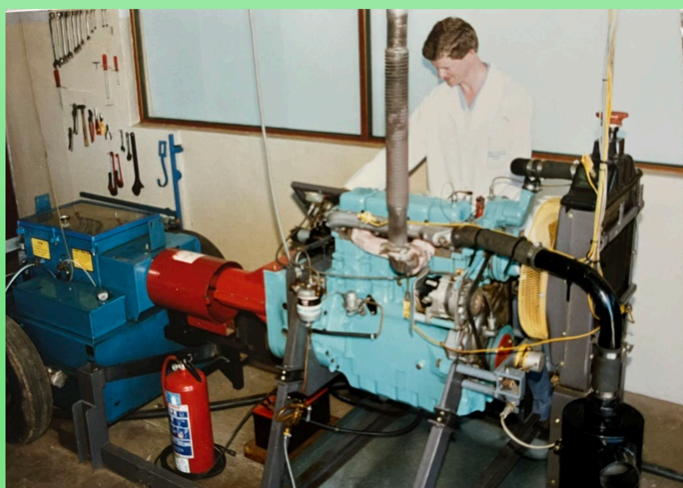
Weekend restrictions

Reduction in the speed limit to 80 km/h



Alternative Fuels Research

- UKZN focus on Ethanol for Diesel
- Ag Eng Collaboration with
  - MB (Germany)
  - Perkins (UK)



Tractors running on Ethanol

Combustion expertise

- Fuel Burning Process
- Engine Durability

Sasol Diesel

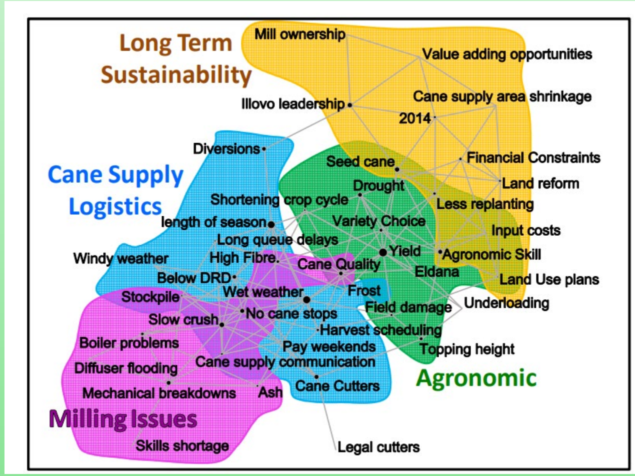
Durability test rigs

Altitude simulator

Agricultural Production Costs

- Machine efficiency
- Supply Chains
- Vehicle Scheduling

Optimising Supply Chains in Sugarcane



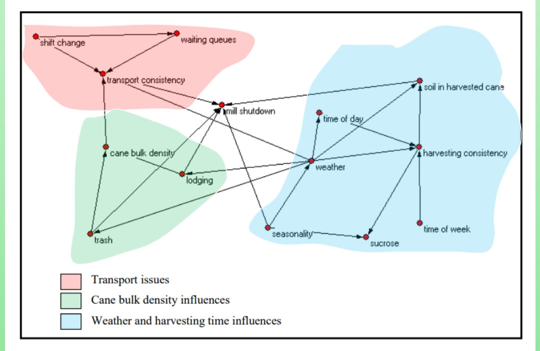


Figure 2.4 A cause-and-effect network of the factors that impact on cane flow consistency

Vehicle Scheduling

Vehicle queues reduced to almost zero

Vehicles from 70 to 25

Reliability of cane supply, no-cane stops from 600 h to 150 h

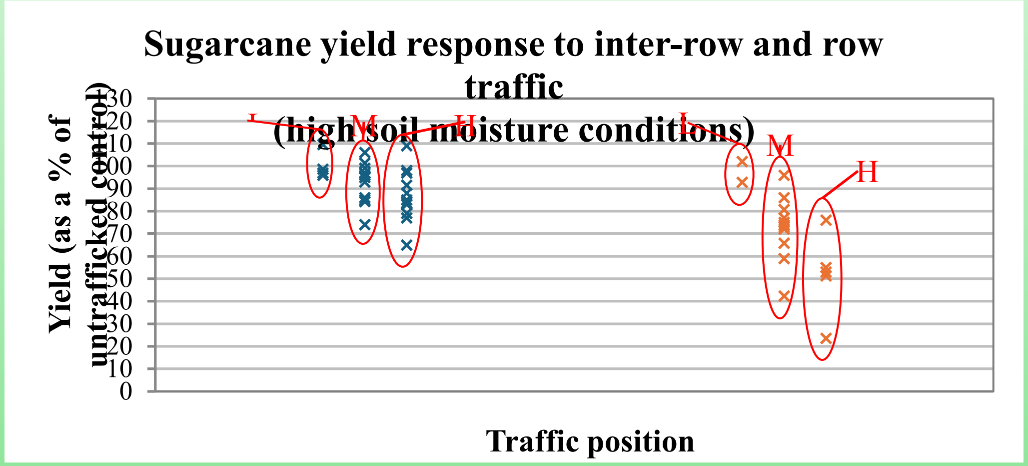
National Gold Logistics Award

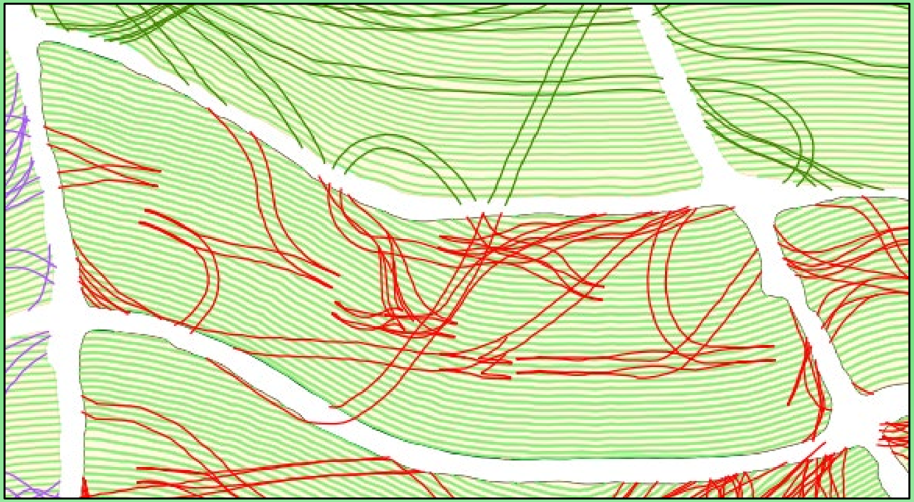
Compliance in transport systems

- Road Traffic Management System. (RTMS)
- 396 Depots
- > 17000 Vehicles

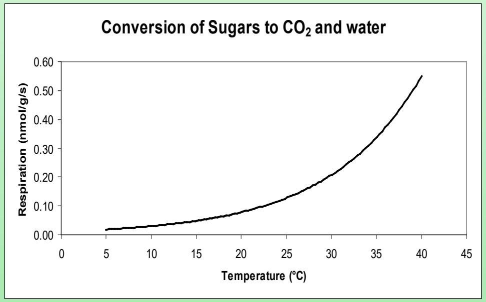
- Performance Based Standards (PBS)
- 2000 Vehicles
- 600 M km
- 20% improvement in metrics

Traffic Induced Compaction and Yield decline





Harvest to crush delay



Revenue = RV Price * RV% * Tons at weighbridge

?

Ag Eng 75th

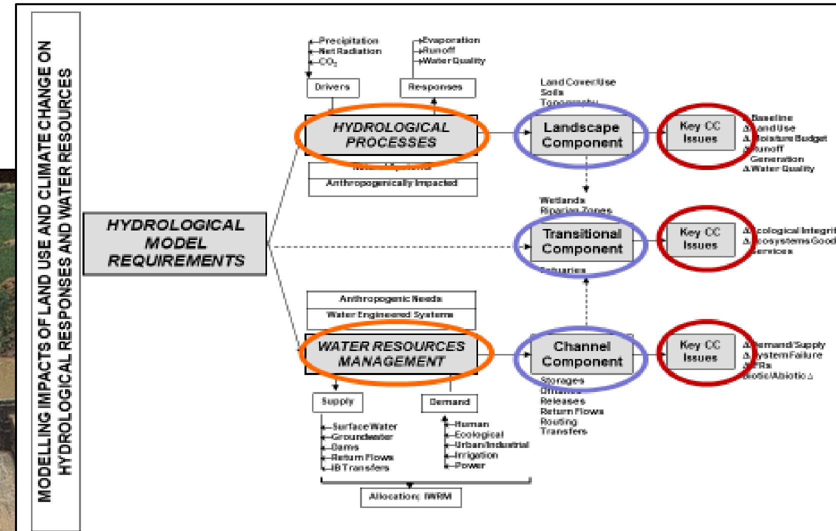
Thank you

Outline

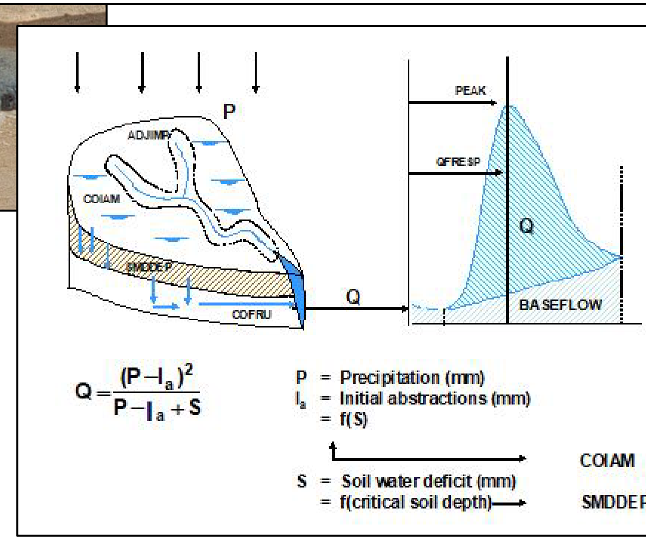
- History timeline
- Capacity development
- Power, traction and alternative fuels research
- **Hydrological research**
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- Postharvest technology and food engineering

Hydrological Research…1975-2025: A Personal Journey

Phase 1: From Measuring to the Beginning of Modelling to the Birth of Hydrology as a Discipline



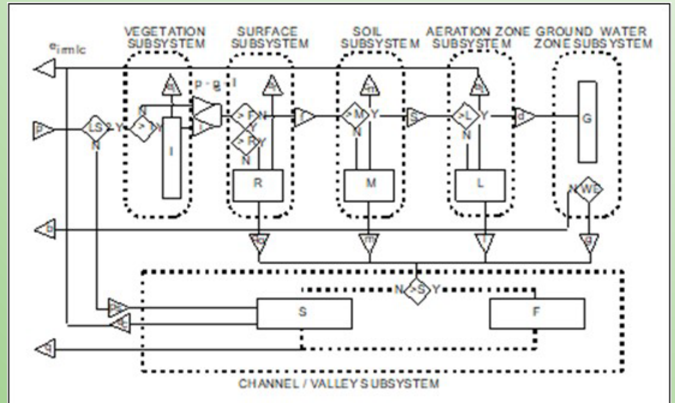
Research Catchments at Cedara, De Hoek/Ntabamhlope, Zululand

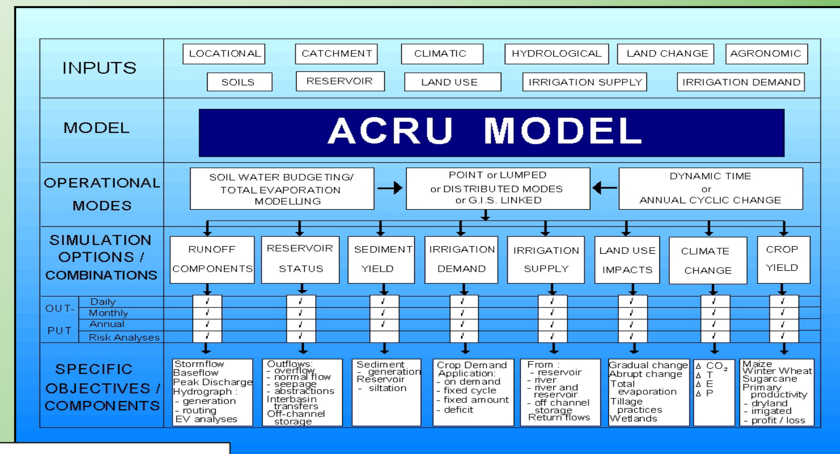


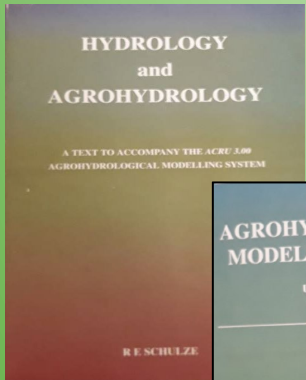
After 2 Years, the Principal Calls Me In 1982… re. Hydrology as a Discipline

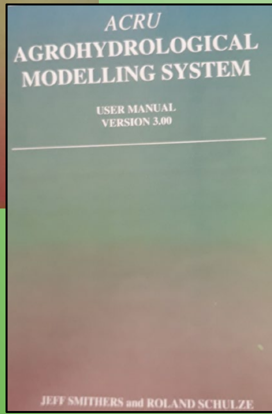
Hydrological Research…1975-2025: A Personal Journey

Phase 2: Development of the *ACRU* Agro-Hydrological Modelling System





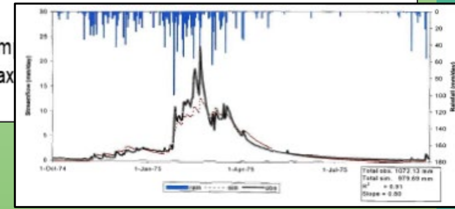


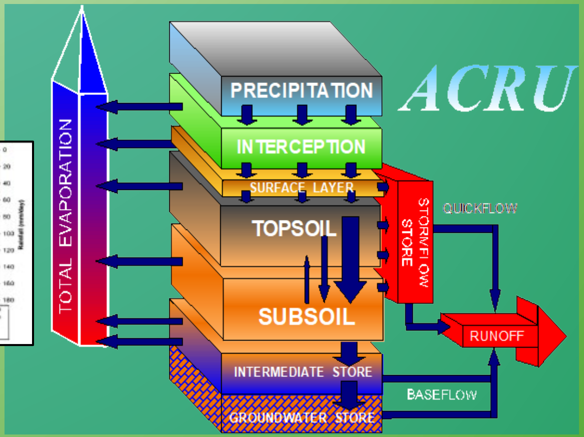


$$q_p = 0.2083 Q_s A / 1.83\, L$$

where

q_p	=	peak discharge ($m^3.s^{-1}$),
Q_s	=	stormflow depth (mm) from an individual catchment,
A	=	catchment area (km^2),
L	=	catchment lag (response) time (h)
	=	$\dfrac{A^{0.35} MAP^{1.1}}{41.67 y^{0.3}\, i30^{0.87}}$ and
1.83	=	a multiplier which was com… associated with annual max… catchments,





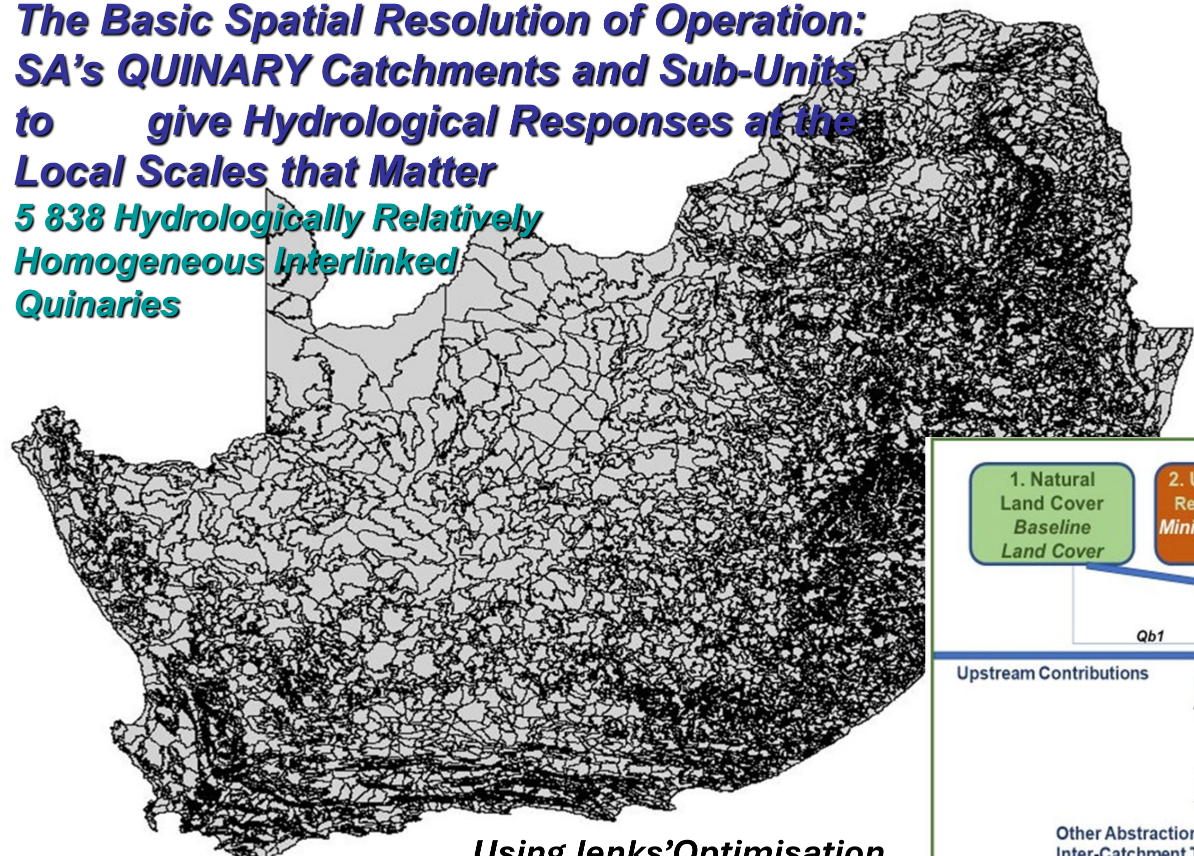
… Including the 'Alien' Scientist Being the AgEng HoD for 2 Years

Hydrological Research…1975-2025: A Personal Journey

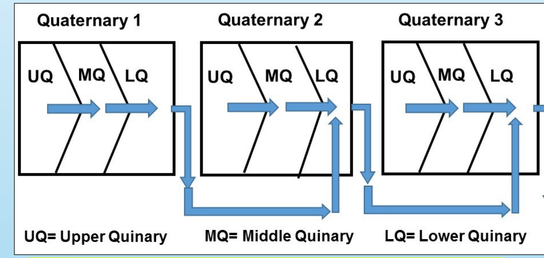
Phase 3: Development of the National Level Databases and Modelling

The Basic Spatial Resolution of Operation: SA's QUINARY Catchments and Sub-Units to give Hydrological Responses at the Local Scales that Matter

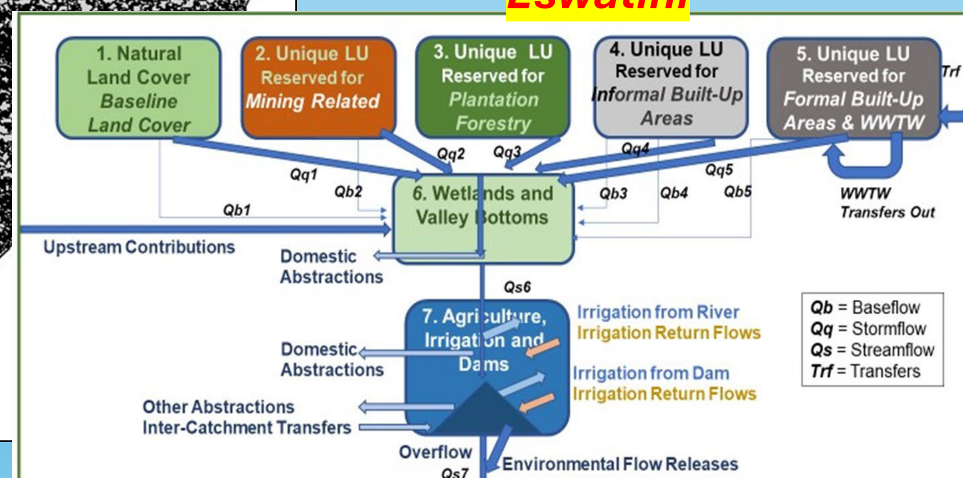
5 838 Hydrologically Relatively Homogeneous Interlinked Quinaries



Using Jenks'Optimisation

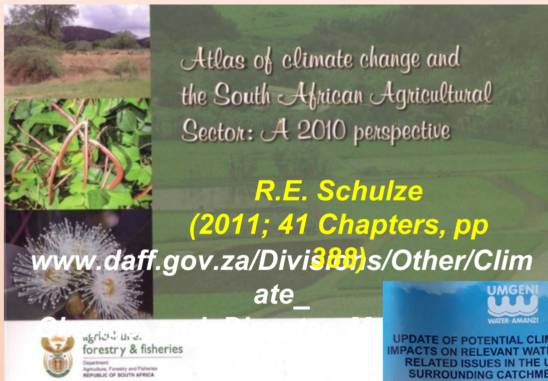


We now Model 40866 Spatial Units across RSA, Lesotho & Eswatini

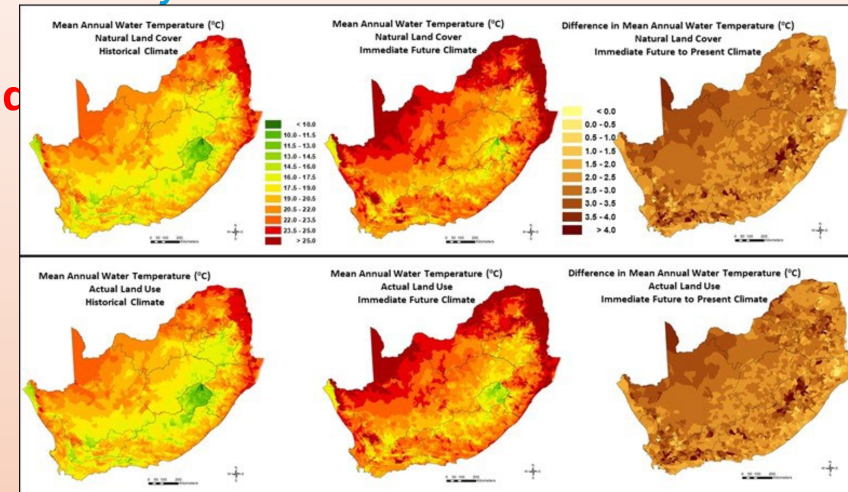


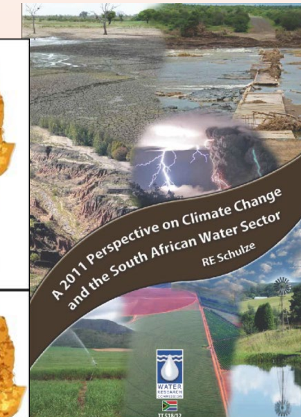
Hydrological Research…1975-2025: A Personal Journey

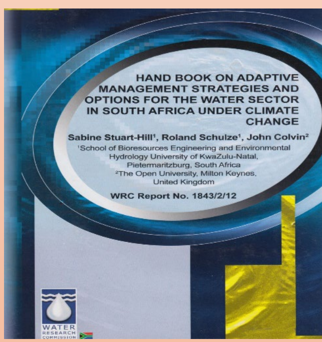
Phase 4: 1990s…Climate Change Rears its Head

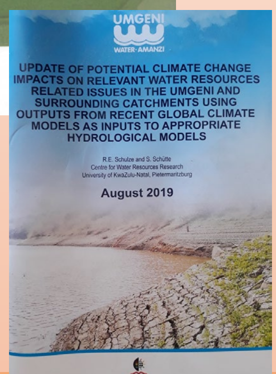


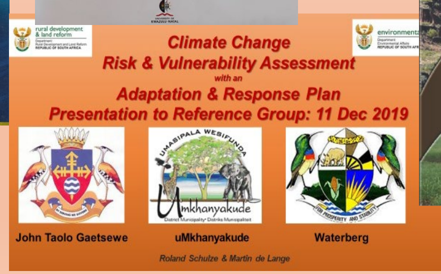
R.E. Schulze
(2011; 41 Chapters, pp 388)
*www.daff.gov.za/Divisions/Other/Climate_*

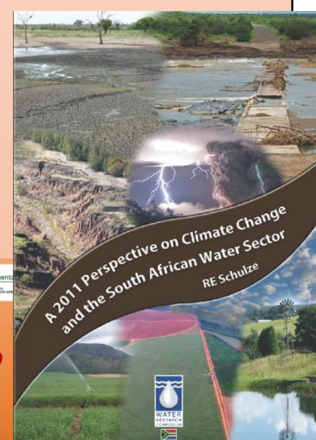


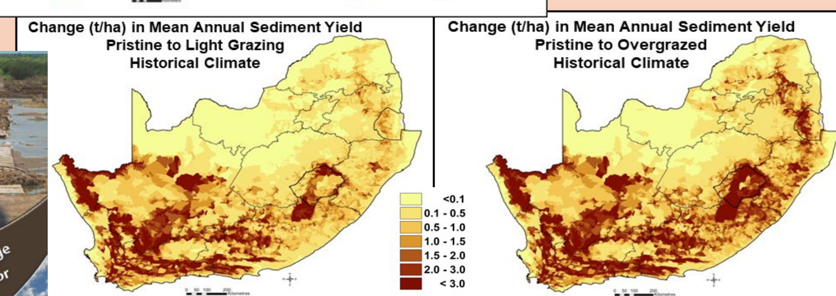












Involvement in Local, National & International Committees

Author/Co-Author to 137 Publications on Climate Change

Hydrological Research…1975-2025: A Personal Journey

Phase 5: Post-Retirement… Addressing Issues of the Real World

a. Detailed Regional/Local Studies, e.g.

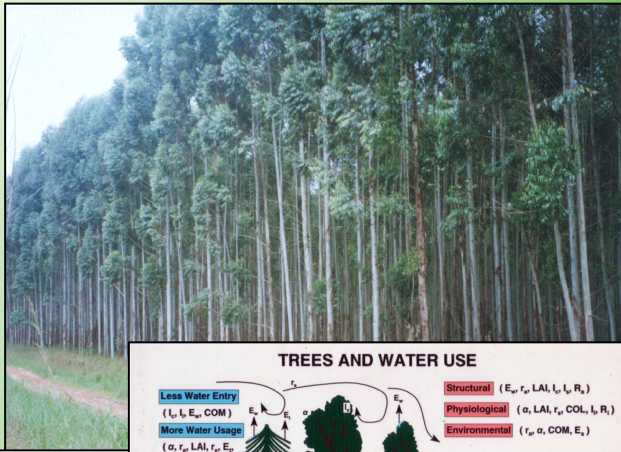
Waterberg — Komati System
City of Tshwane — QwaQwa
uMngeni-uThukela System
Berg System

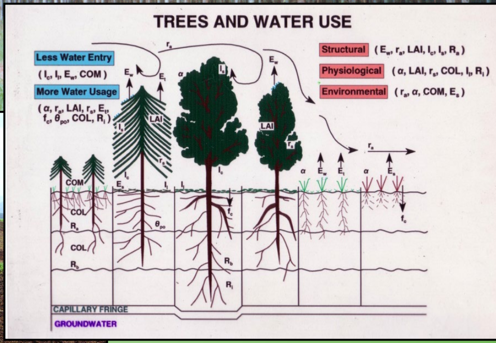
b. Impact Studies… Afforestation, Overgrazing, Veld Burning, Tillage Practices, WWTW, Alien Invasives, Urban Systems

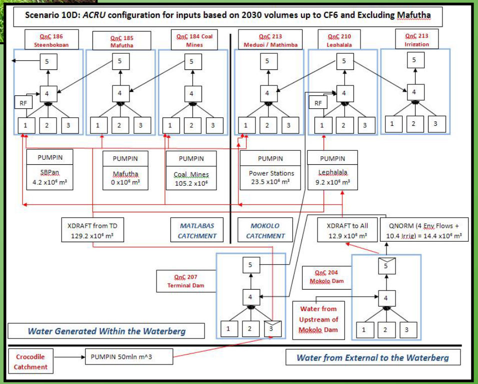
c. The April 2022 Durban Floods

d. The Era of Internationalisation

Member of the IPCC, e.g. Austria, Australia
Annual International Post-Grad Lecturing, e.g. IHE, SMHI
International Accreditations, e.g. Kenya, Columbia







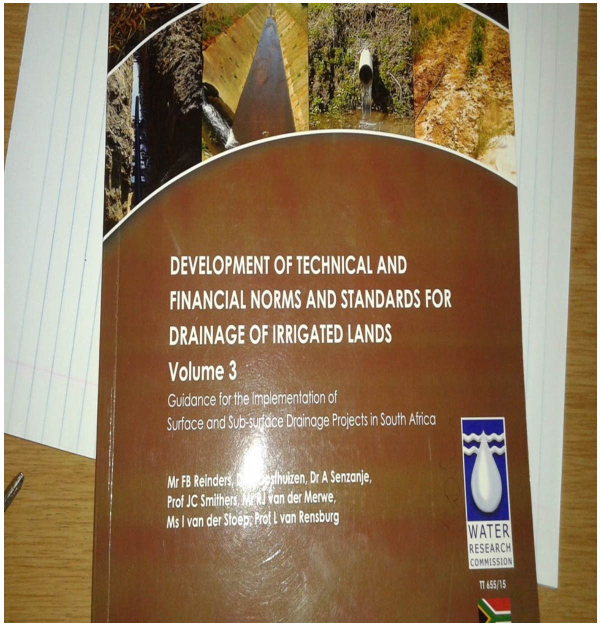
Including Learning New Skills en route

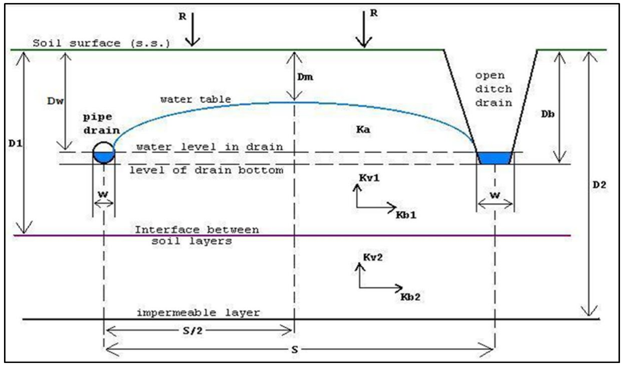
Outline

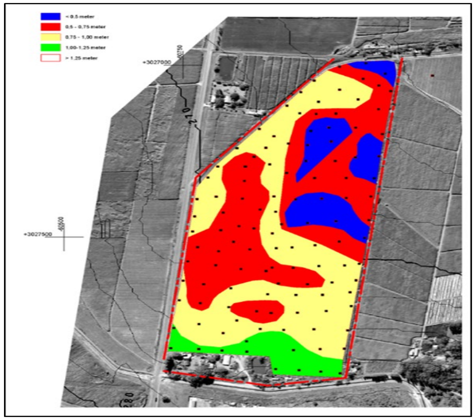
- History timeline
- Capacity development
- Power, traction and alternative fuels research
- Hydrological research
- **Irrigation and soil and water conservation engineering**
- **Design and engineering hydrology**
- Postharvest technology and food engineering

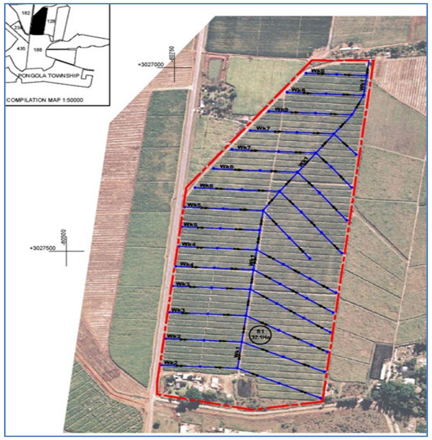
Irrigation and Soil and Water Conservation Engineering

- Development of Technical and Financial Norms and Standards for Drainage of Irrigated Lands



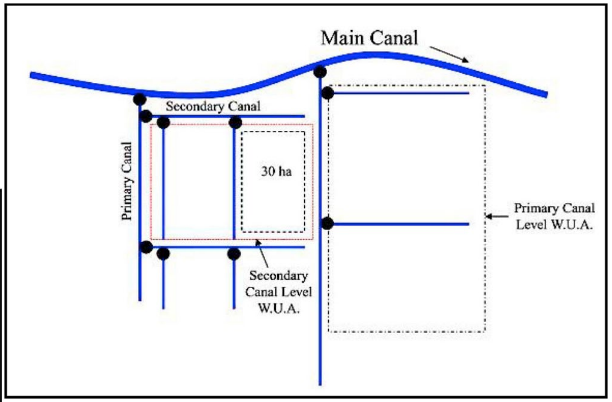


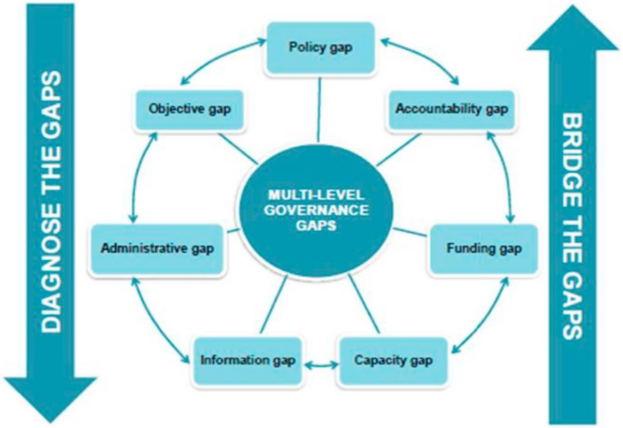




Irrigation and Soil and Water Conservation Engineering

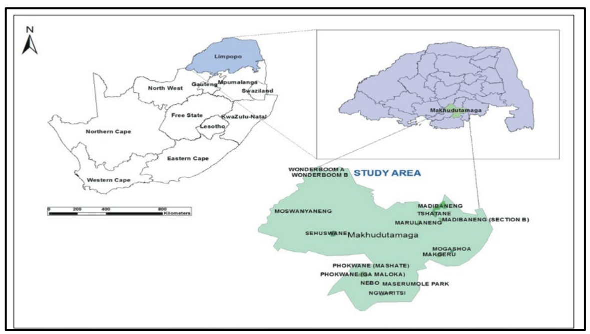
- Irrigation infrastructure performance in smallholder irrigation in South Africa

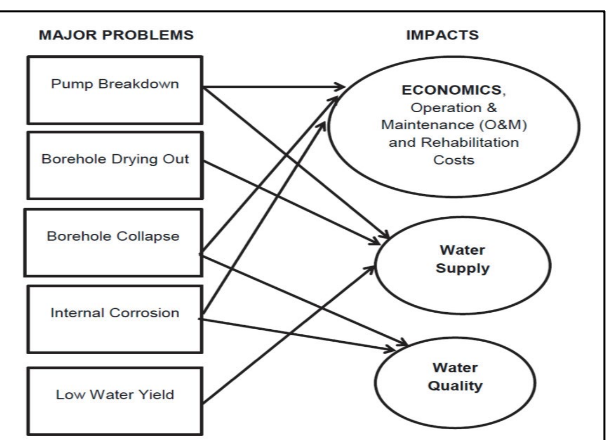


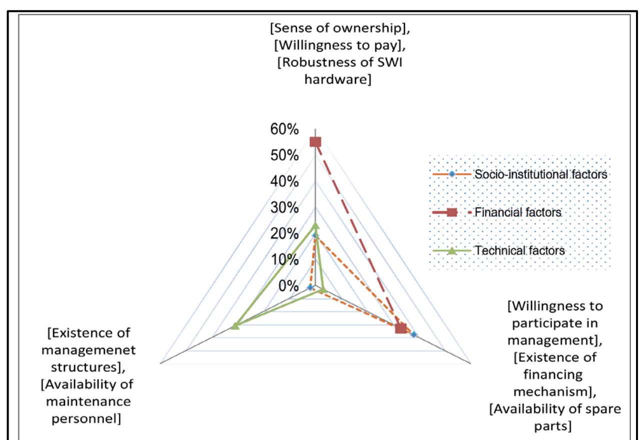


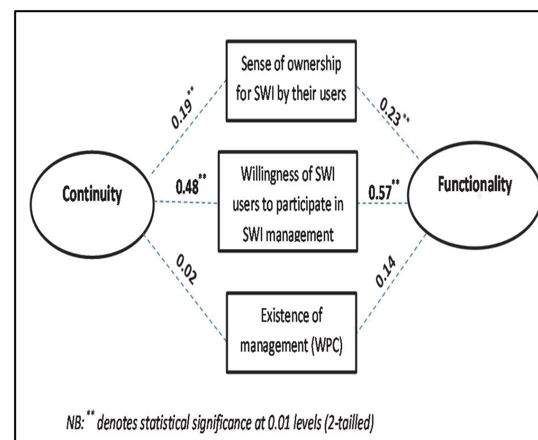
Irrigation and Soil and Water Conservation Engineering

- Rural water supplies infrastructure management in South Africa and the sub-region
- Short furrow irrigation system



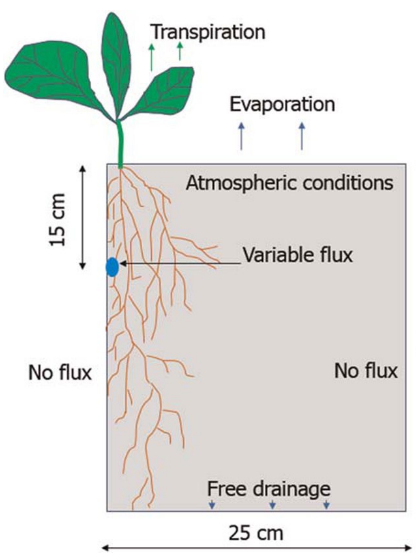


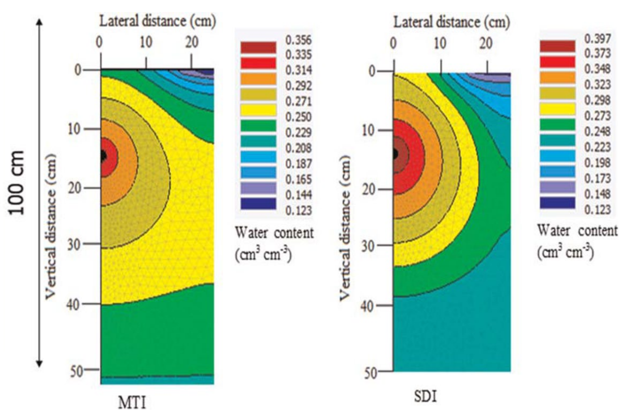


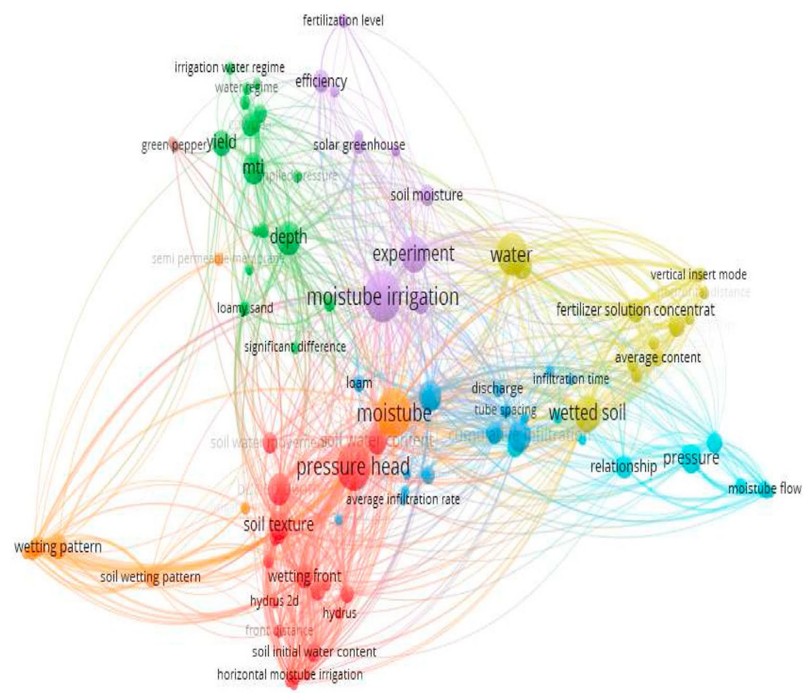


Irrigation and Soil and Water Conservation Engineering

- Moistube irrigation technology research – characterization, soil water dynamics, and crop response to Moistube irrigation

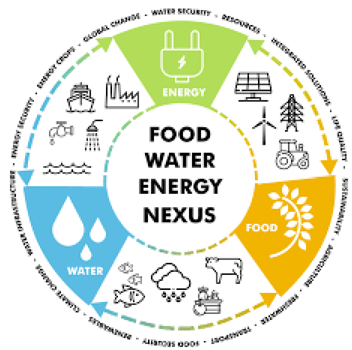


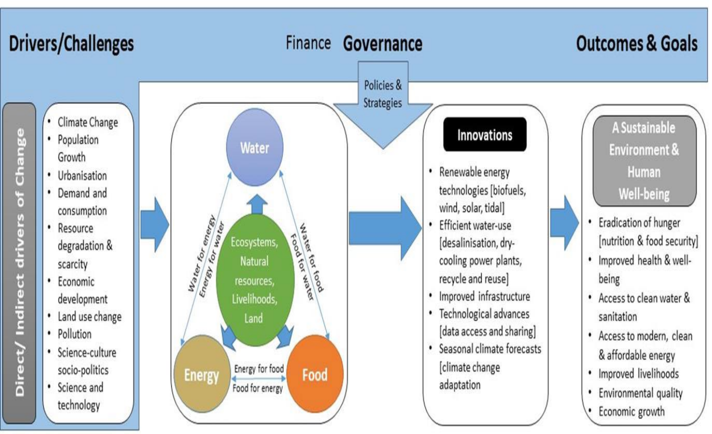


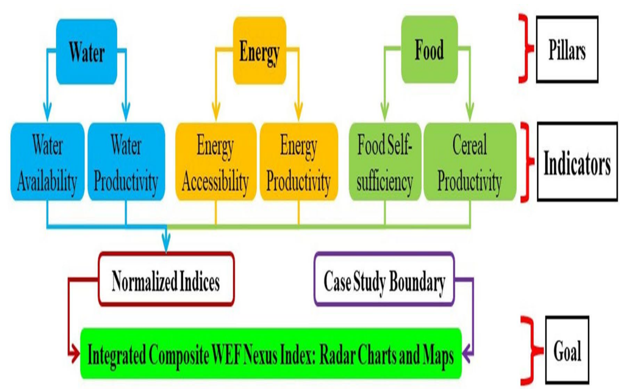


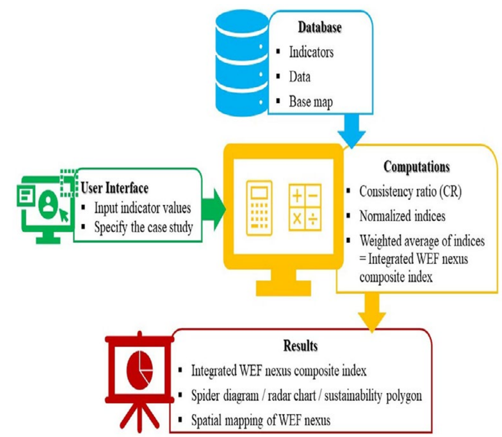
Irrigation and Soil and Water Conservation Engineering

- Water-energy-food (WEF) nexus characterization, applications and development of the iWEF model





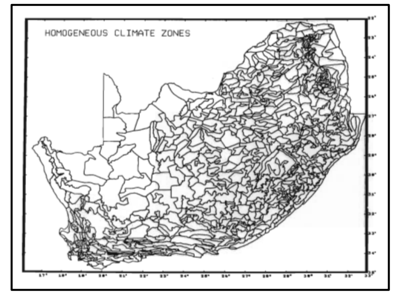


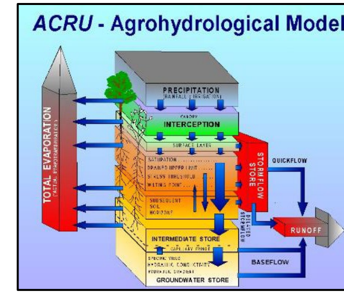


UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

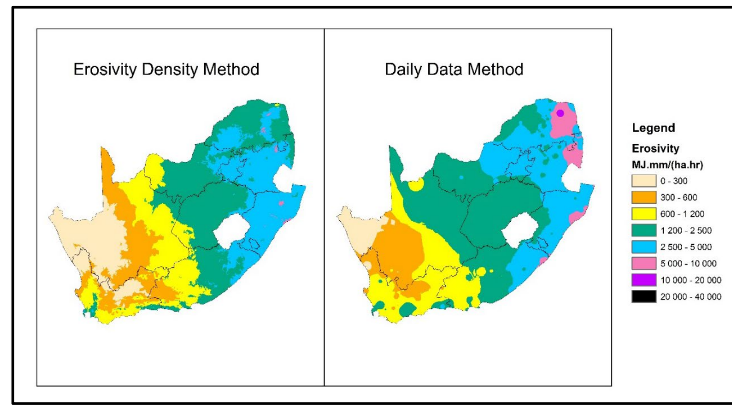
Irrigation and Soil and Water Conservation Engineering

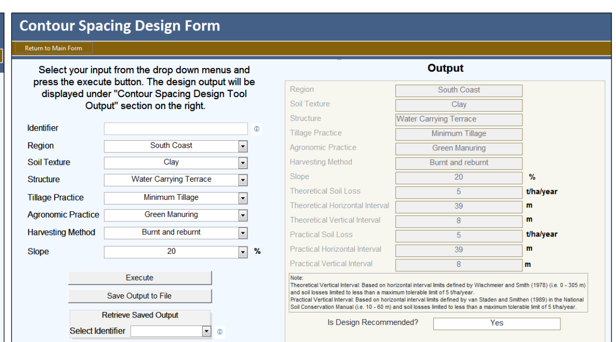
- Crop water requirements
- Irrigation scheduling tools

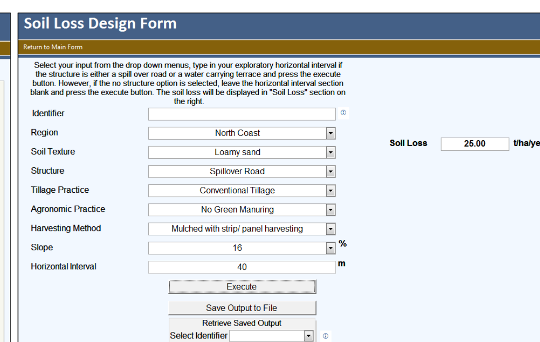




- Soil and Water Conservation Engineering
  - Rainfall erosivity
  - CoSDT development & software

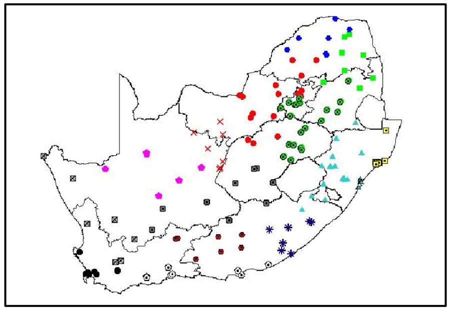


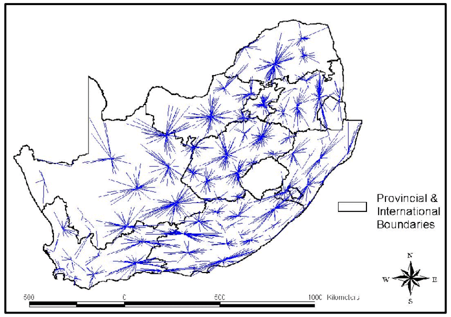


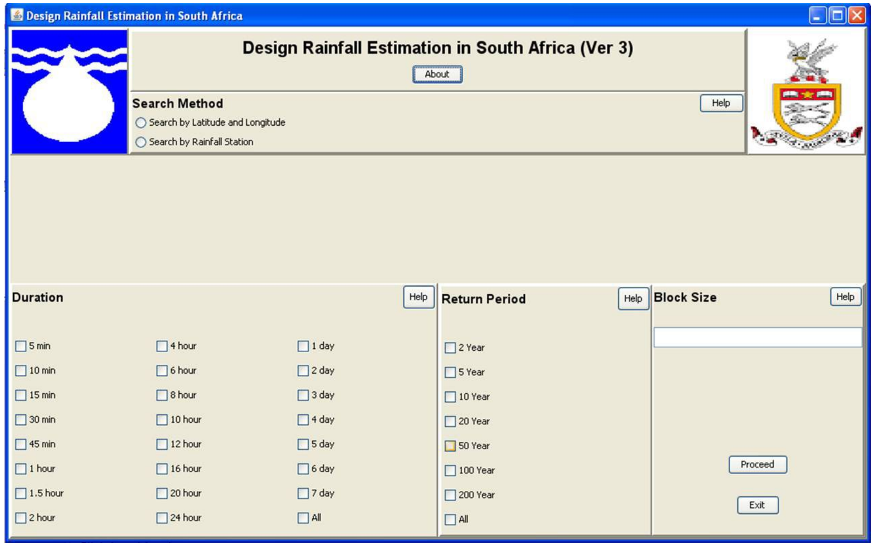


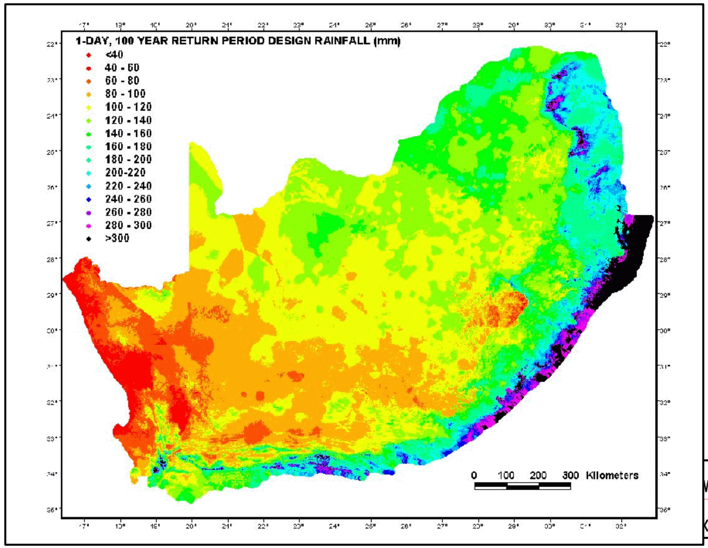
Design Rainfall Estimation

- DRE-SA software
  - Regionalised approach
  - 5 min – 7 days
  - 2 – 200 year RP
  - Software: 1’x1’ resolution
  - Recommended by SANRAL DM
  - Widely used



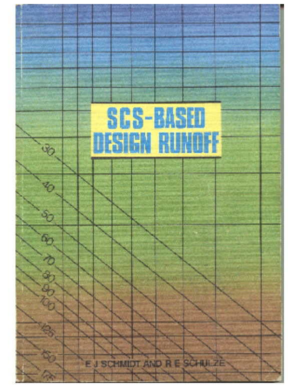


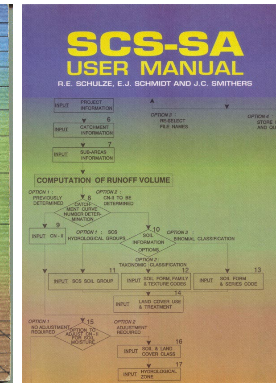


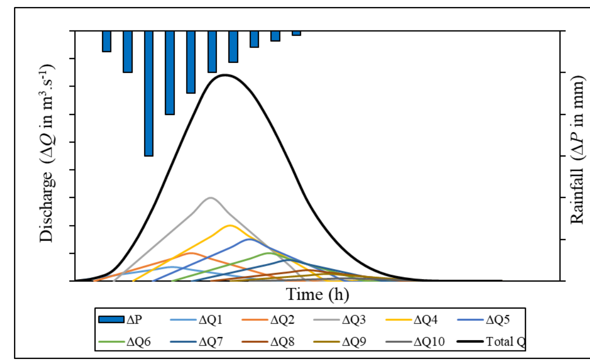


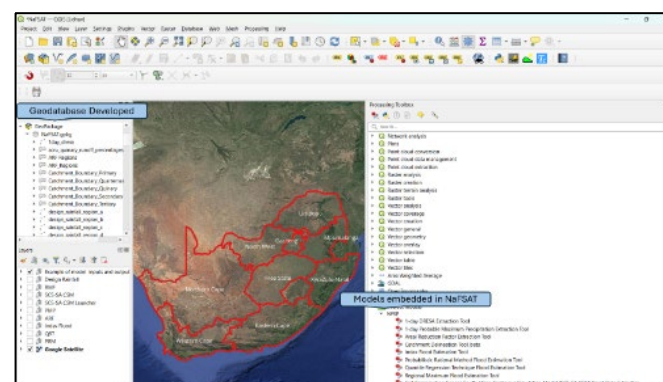
Design Flood Estimation

- SCS-SA
  - Modified and adapted for local conditions
    - S-S lag estimation equation
    - Expanded HSGs
    - Regionalised accounting for AMC
    - Design hyetographs
  - Production of user manuals
  - SCS-SA software (> 700 sold)
  - Many courses
  - Recommended for use in SA
  - Further development – CSM
- NFSP
  - New developments
  - NaFSAT





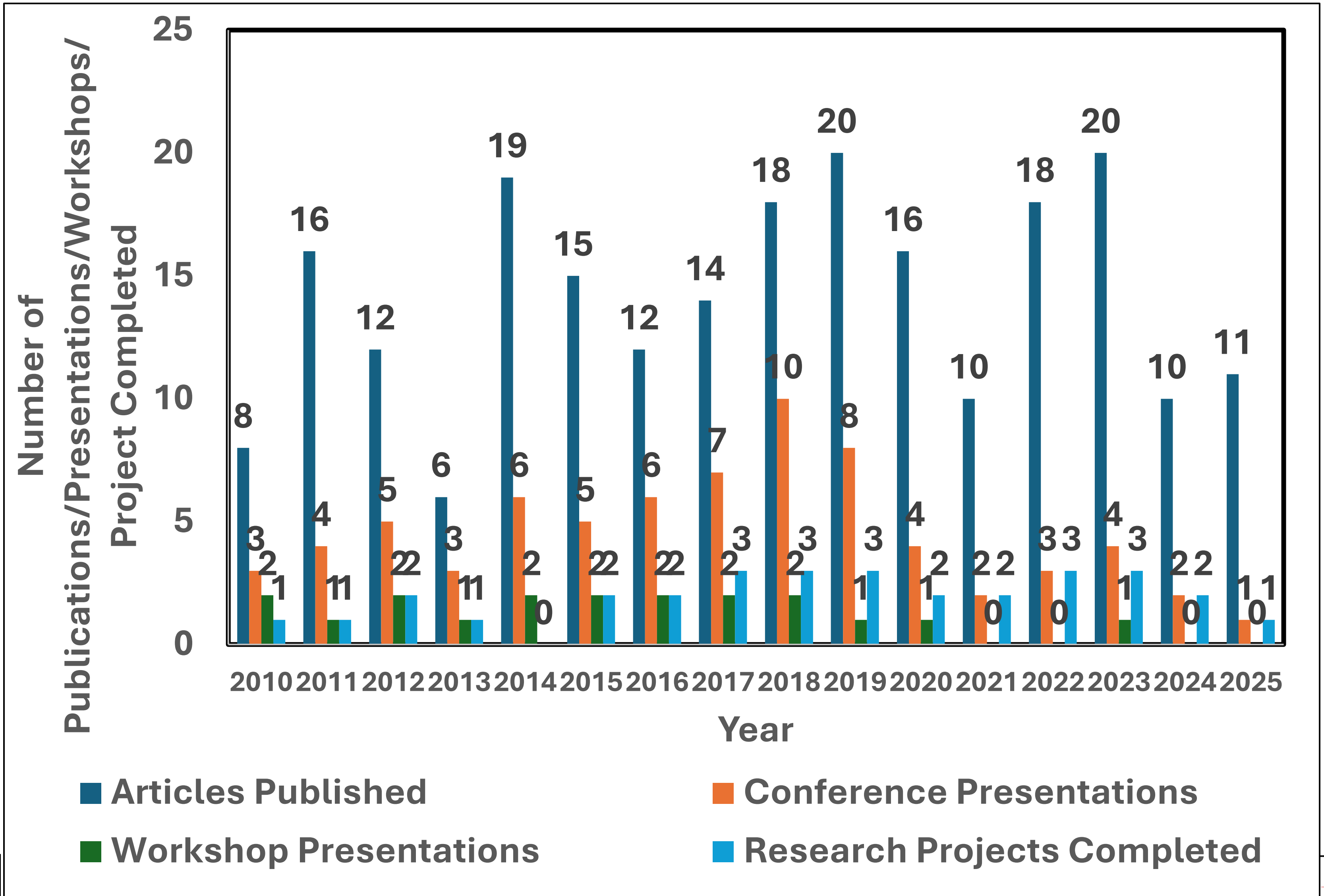




Outline

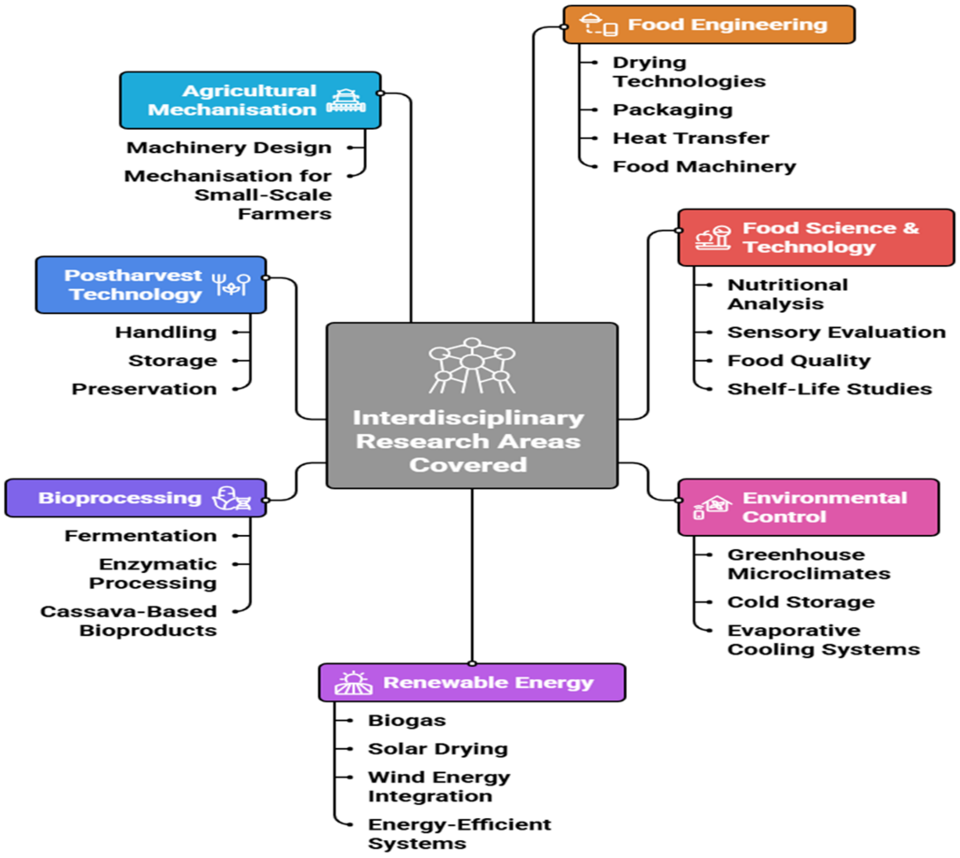
- History timeline
- Capacity development
- Power, traction and alternative fuels research
- Hydrological research
- Irrigation and soil and water conservation engineering
- Design and engineering hydrology
- **Postharvest technology and food engineering**

Applied Agricultural and Food Systems Engineering

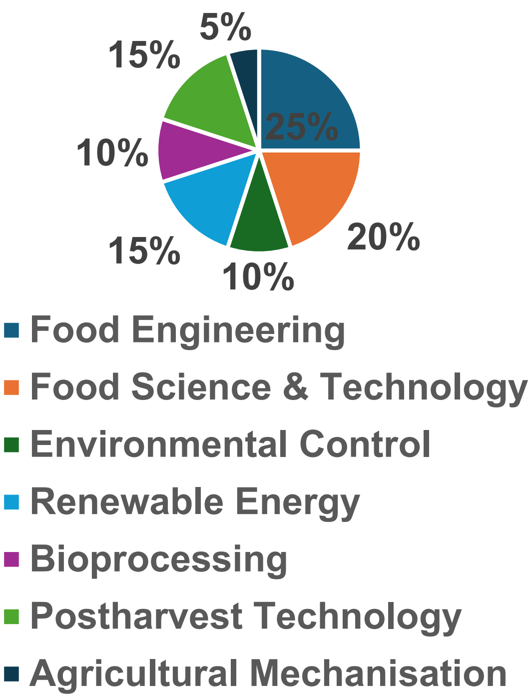


UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Major and Specific Areas Covered

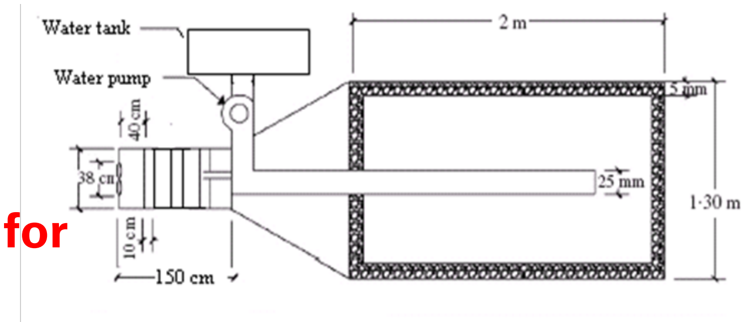


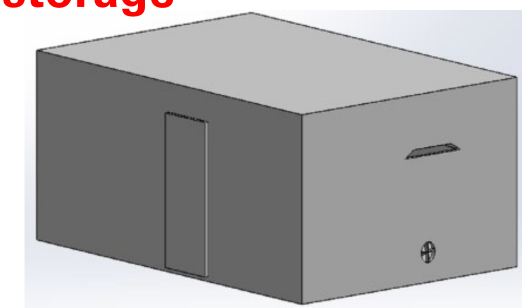
Applied agricultural and food systems engineering Percentage of Total Publications

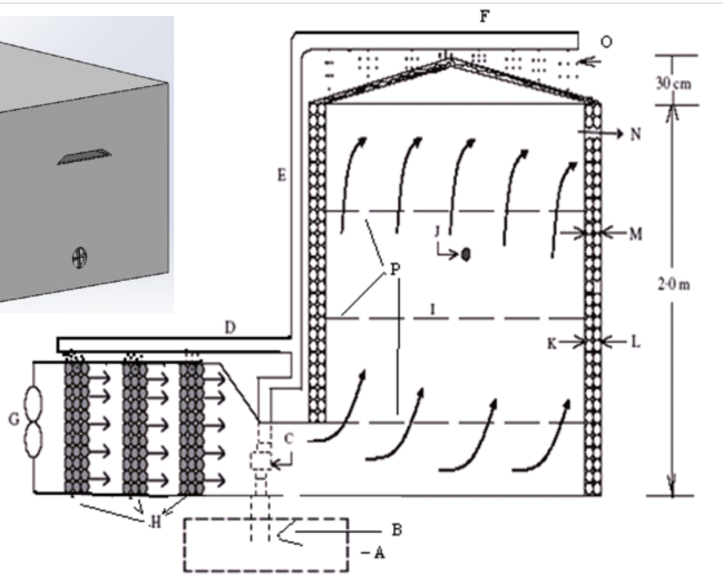


Impact

Evaporative cooling technologies for fresh produce storage







Smoothing tomatoes' bumpy ride to market

Thank you for your attention!