PROBLEMS AND CHALLENGES WITH CLIMATE CHANGE AND THE WATER SECTOR IN DEVELOPING COUNTRIES: EXPERIENCES FROM SOUTH AFRICA

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I.W.R.M. IN DEVELOPED vs LESSER DEVELOPED COUNTRIES

HOW DO THE RESPECTIVE NEEDS OF I.W.R.M. DIFFER?

- ***Developed Countries . . . focus on long term quality of life and environment***
  - preservation of aquatic environment
  - re-naturalisation/re-habilitation of catchment/streams
  - water quality
  - demand management
  - climate change impacts
- ***Lesser Developed Countries . . . focus on more immediate issues***
  - creating basic water supplies (vs quality)
  - managing water supply (vs demand management)
  - poverty alleviation (vs enhancing quality of life)
  - harnessing the environment (vs sustaining it)
  - short term needs (vs long term perspectives)
  - climate variability (vs climate change)
  - creating infrastructure (vs improving it)

I.W.R.M. IN DEVELOPED vs LESSER DEVELOPED COUNTRIES

PROBLEMS OF I.W.R.M. IN L.D.C.s

- ***Generalities***
  - decisions often made from a distant capital
  - poor peoples' water needs often overlooked
  - major stakeholder disparities in
    - wealth
    - opportunity
    - skills
    - infuence with government
    - resource endowments
    - capacity for management
  - government project failures abound
  - need is for basic infrastructure for water security
  - environmental issues : lower priority
- ***For successful implementation***
  - build on venacular/indigeneous knowledge
  - involve local community; local 'buy-in'/ownership
  - NGO/CBO/government collaboration
- ***Donor community problems***
  - lack of inter-country co-ordination (e.g. Lesotho rainfall)
  - lack of consideration of national initiatives
  - create financial dependency of host country
  - selling their own technologies
  - lack of capacity building
  - no maintenance/back-up

CHARACTERISTICS INFLUENCING I.W.R.M. IN DEVELOPED vs LESSER DEVELOPED COUNTRIES

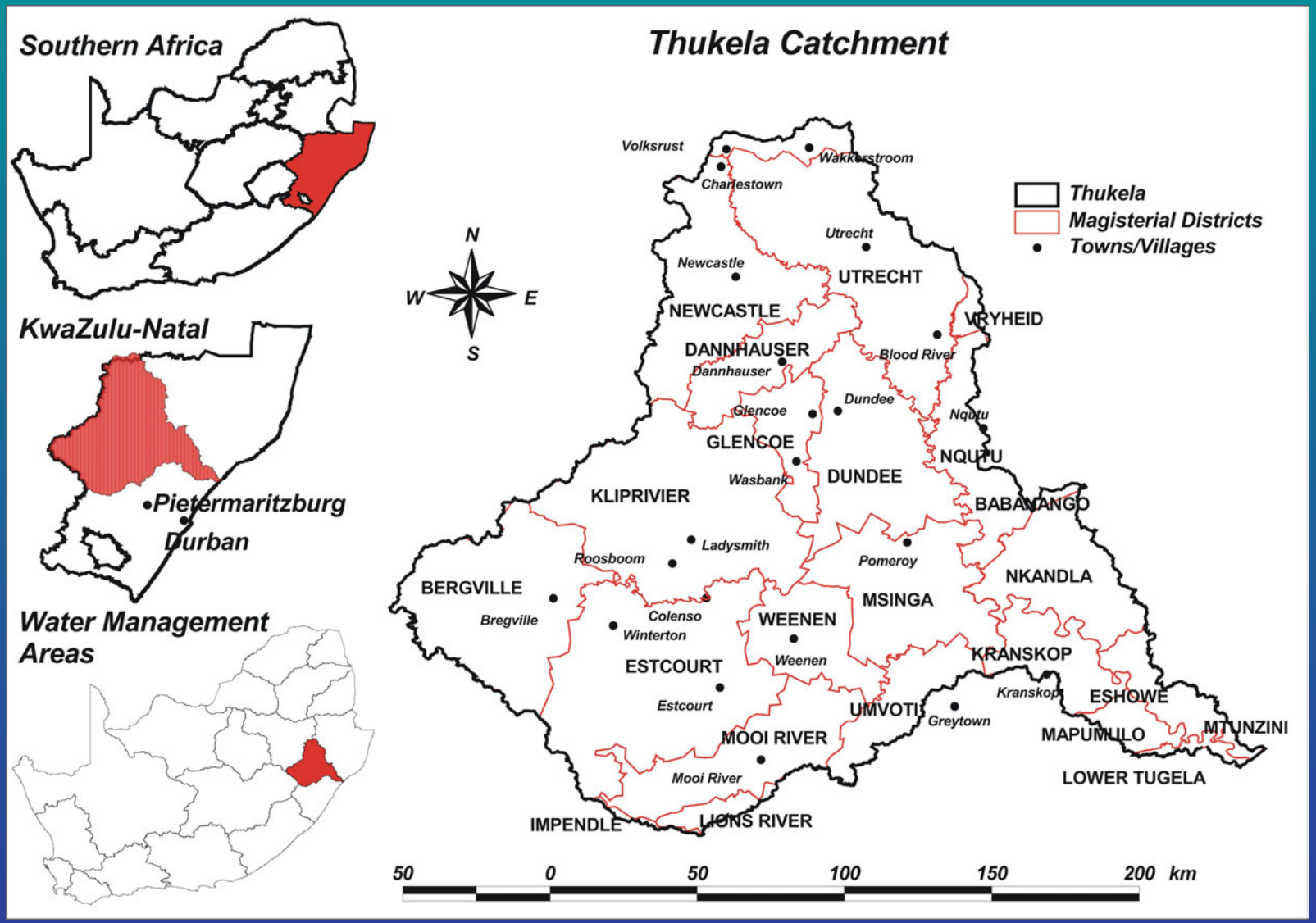
DEVELOPED	vs	LESSER DEVELOPED
	INFRASTRUCTURE	
Highly developed	vs	Fragile
Improving	vs	Retrogressing
Ethos of maintenance	vs	Constructed & neglected
Data: Available, accessible	vs	Data: Poor, inaccessible
Resilient to disasters	vs	Vulnerable to disasters
	CAPACITY	
High skills (sci/admin)	vs	Limited skills (sci/admin)
Expertise to local level	vs	Expertise centralised
Technological adaptability	vs	Often in survival mode

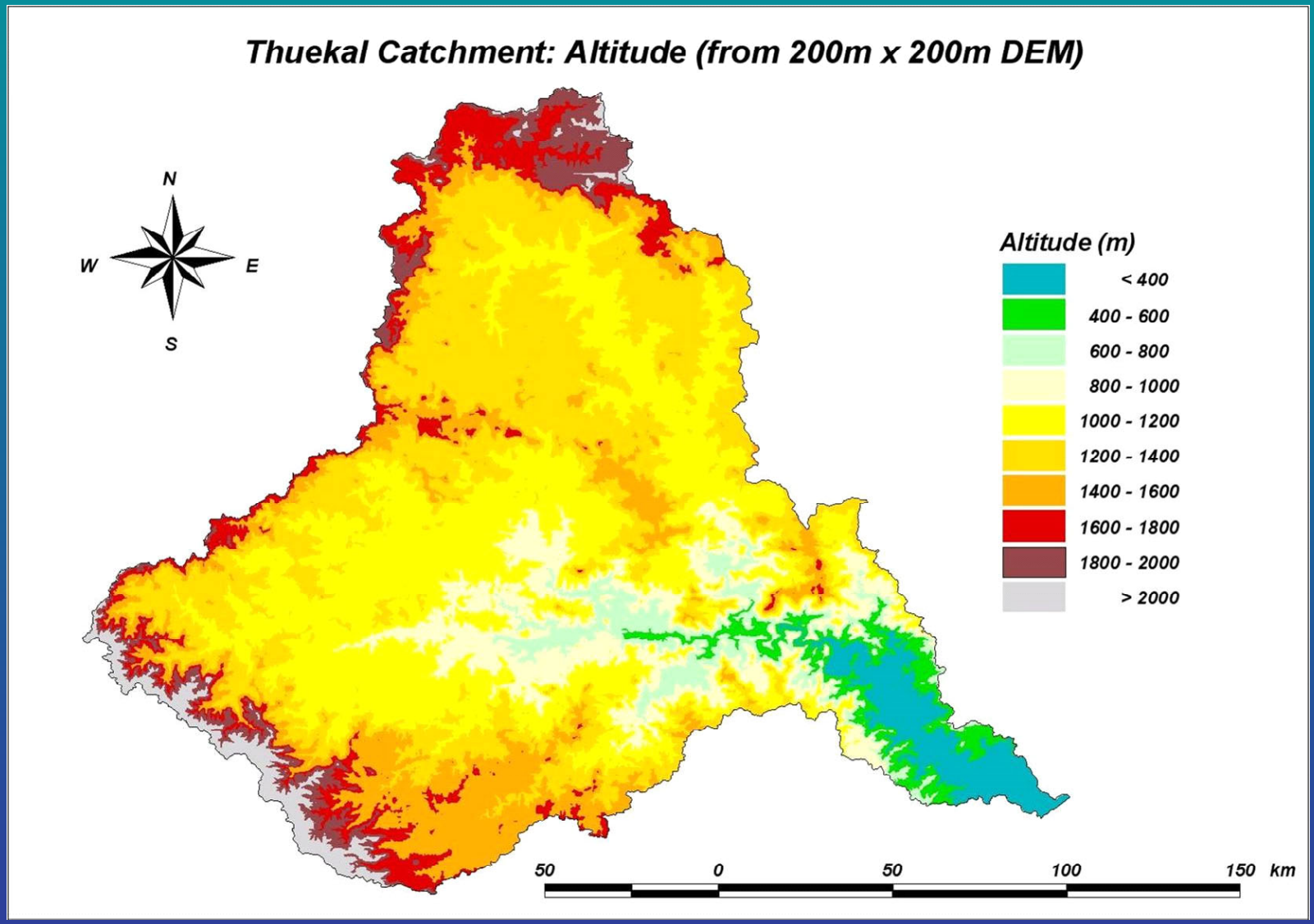
CHARACTERISTICS INFLUENCING I.W.R.M. IN DEVELOPED vs LESSER DEVELOPED COUNTRIES

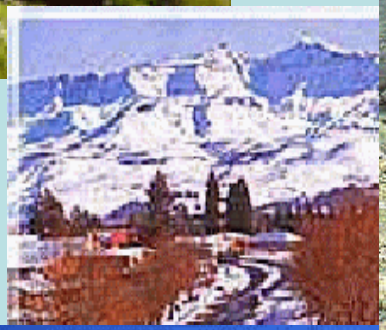
DEVELOPED	vs	LESSER DEVELOPED
ECONOMY		
Mixed, diverse	vs	Land/climate dependent
Independent & sustainable	vs	Aid/NGO dependent
Long term planning	vs	Shorter term planning
Money available for IWRM	vs	Less scope for IWRM
SOCIO-POLITICAL		
Low/no population growth	vs	Pop pressure on land
Public well informed	vs	Public poorly informed
Stakeholders empowered	vs	S/h less empowered
ENVIRONMENTAL AWARENESS/MANAGEMENT		
Re-naturalisation	vs	Rehabilitation
Desire for aesthetics	vs	Desire for survival

CASE STUDY 1:

THUKELA CATCHMENT

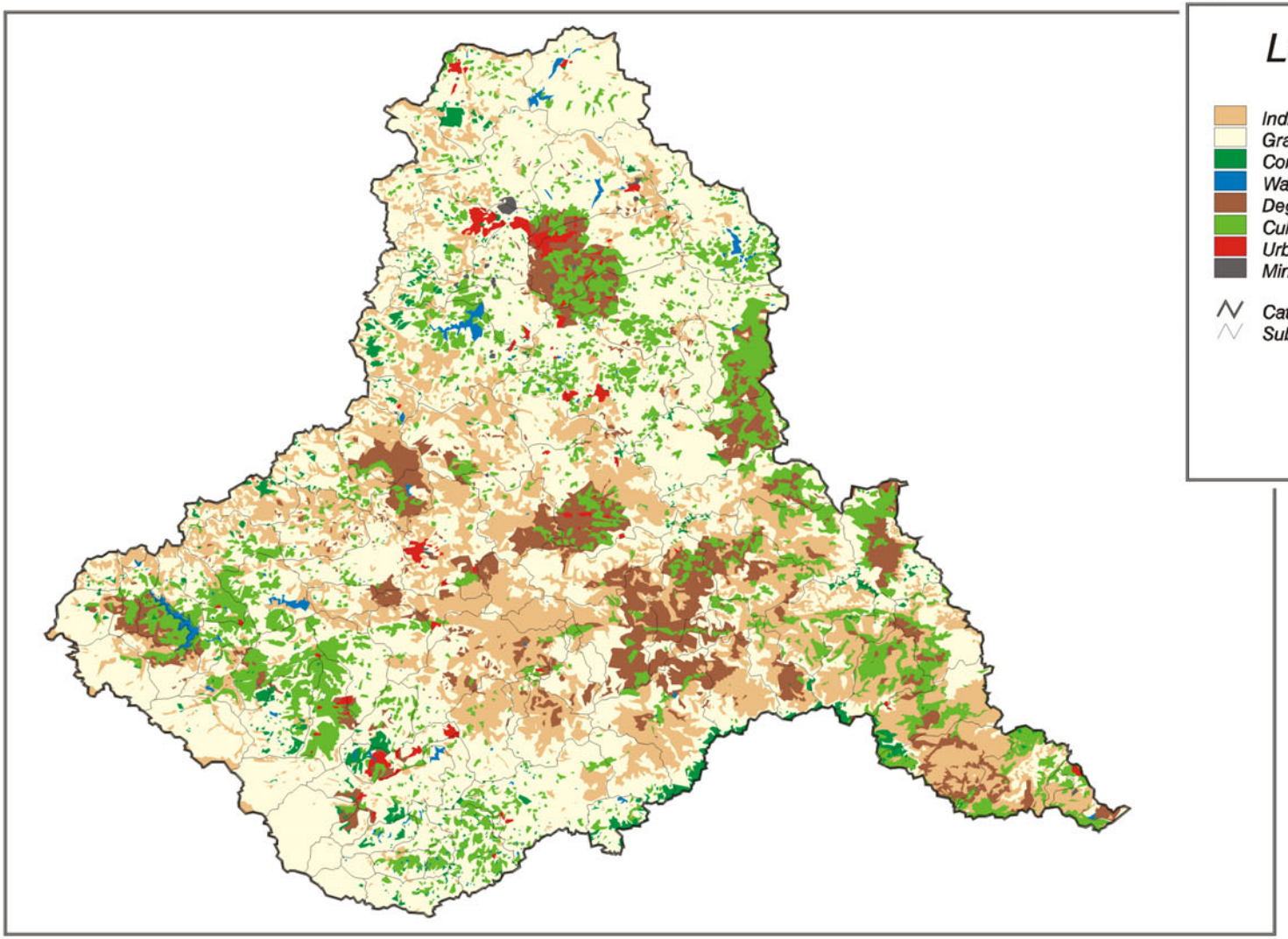

Southern Africa
KwaZulu-Natal
Pietermaritzburg
Durban
Water Management Areas
Thukela Catchment
N
W
E
S
Thukela
Magisterial Districts
Towns/Villages
Volksrust
Wakkerstroom
Charlestown
Utrecht
Newcastle
UTRECHT
NEWCASTLE
VRYHEID
DANNHAUSER
Dannhauser
Blood River
Glencoe
Dundee
Nquthu
GLENCOE
NQUTU
Wasbank
DUNDEE
KLIPRIVIER
BABANANGO
Ladysmith
Roosboom
Pomeroy
NKANDLA
BERGVILLE
MSINGA
Bregville
Colenso
Winterton
WEENEN
Weenen
KRANSKOP
ESTCOURT
Kranskop
ESHOWE
Estcourt
UMVOTI
Greytown
MAPUMULO
MTUNZINI
MOOI RIVER
Mooi River
LOWER TUGELA
IMPENDLE
LIONS RIVER
50 0 50 100 150 200 km


Thuekal Catchment: Altitude (from 200m x 200m DEM)
N
W
E
S
Altitude (m)
< 400
400 - 600
600 - 800
800 - 1000
1000 - 1200
1200 - 1400
1400 - 1600
1600 - 1800
1800 - 2000
> 2000
50
0
50
100
150 km



RES8057

Thukela Catchment : Land Use from Landsat TM (CSIR, 1996)



Land Use

- Indigenous Woodland
- Grassland
- Commercial Forestry
- Waterbodies
- Degraded Landscapes
- Cultivated Land
- Urban / Built-up
- Mines & Quarries

- Catchment boundary
- Subcatchments

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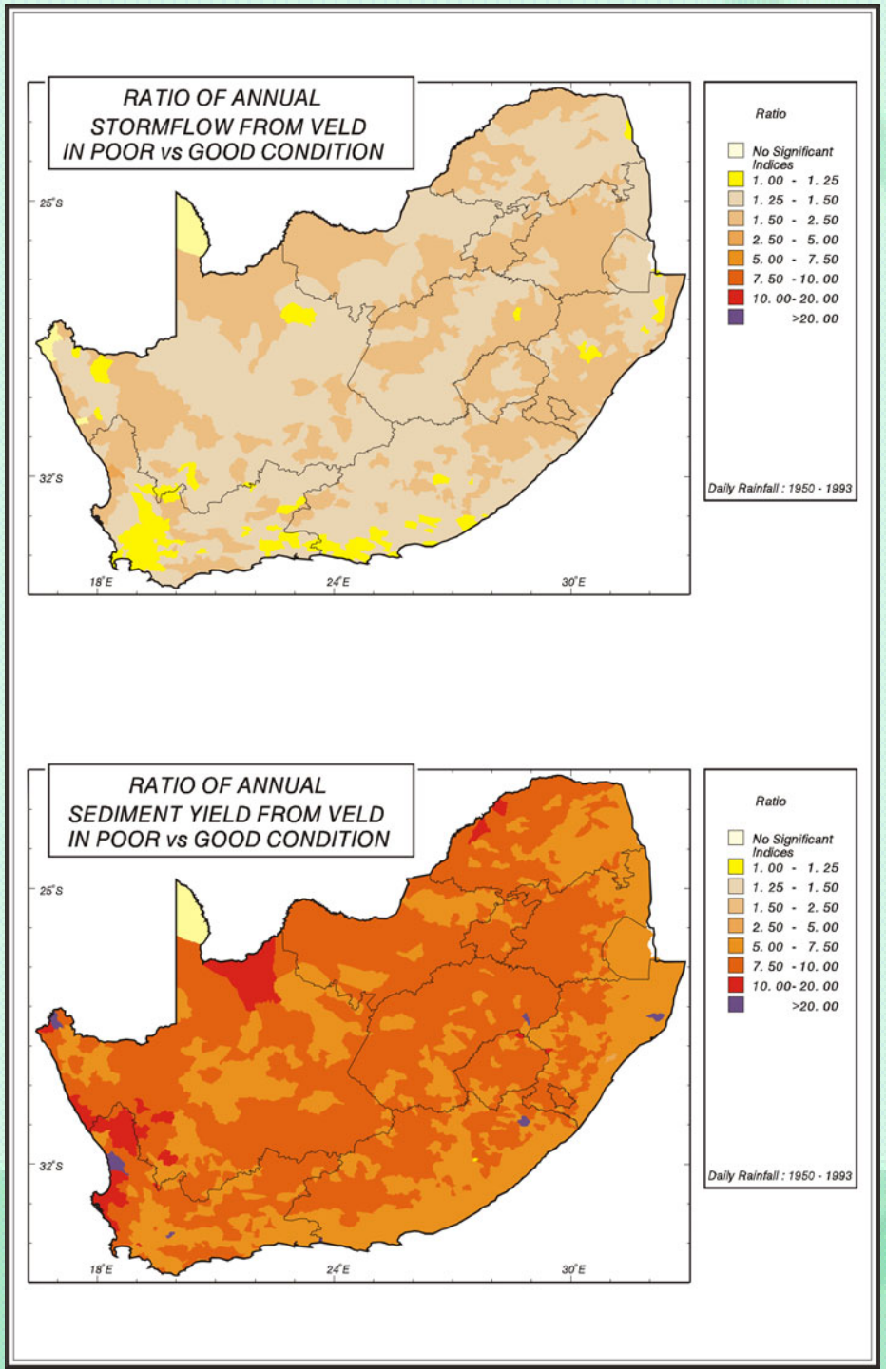
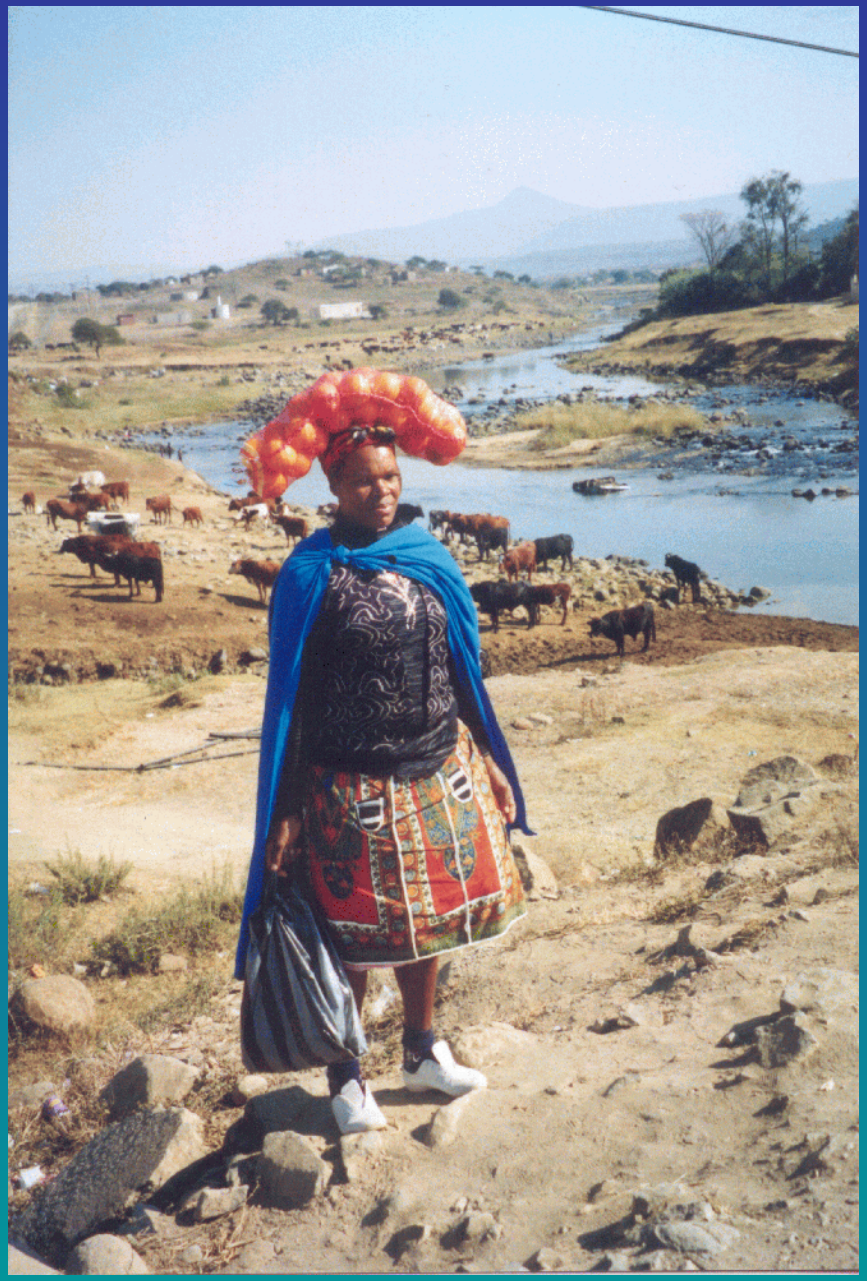
Potshini, Thukela Catchment, KwaZulu-Natal,
South Africa


RATIO OF ANNUAL
STORMFLOW FROM VELD
IN POOR vs GOOD CONDITION
25°S
32°S
18°E
24°E
30°E
Ratio
No Significant Indices
1. 00 - 1. 25
1. 25 - 1. 50
1. 50 - 2. 50
2. 50 - 5. 00
5. 00 - 7. 50
7. 50 - 10. 00
10. 00- 20. 00
>20. 00
Daily Rainfall : 1950 - 1993
RATIO OF ANNUAL
SEDIMENT YIELD FROM VELD
IN POOR vs GOOD CONDITION
25°S
32°S
18°E
24°E
30°E
Ratio
No Significant Indices
1. 00 - 1. 25
1. 25 - 1. 50
1. 50 - 2. 50
2. 50 - 5. 00
5. 00 - 7. 50
7. 50 - 10. 00
10. 00- 20. 00
>20. 00
Daily Rainfall : 1950 - 1993



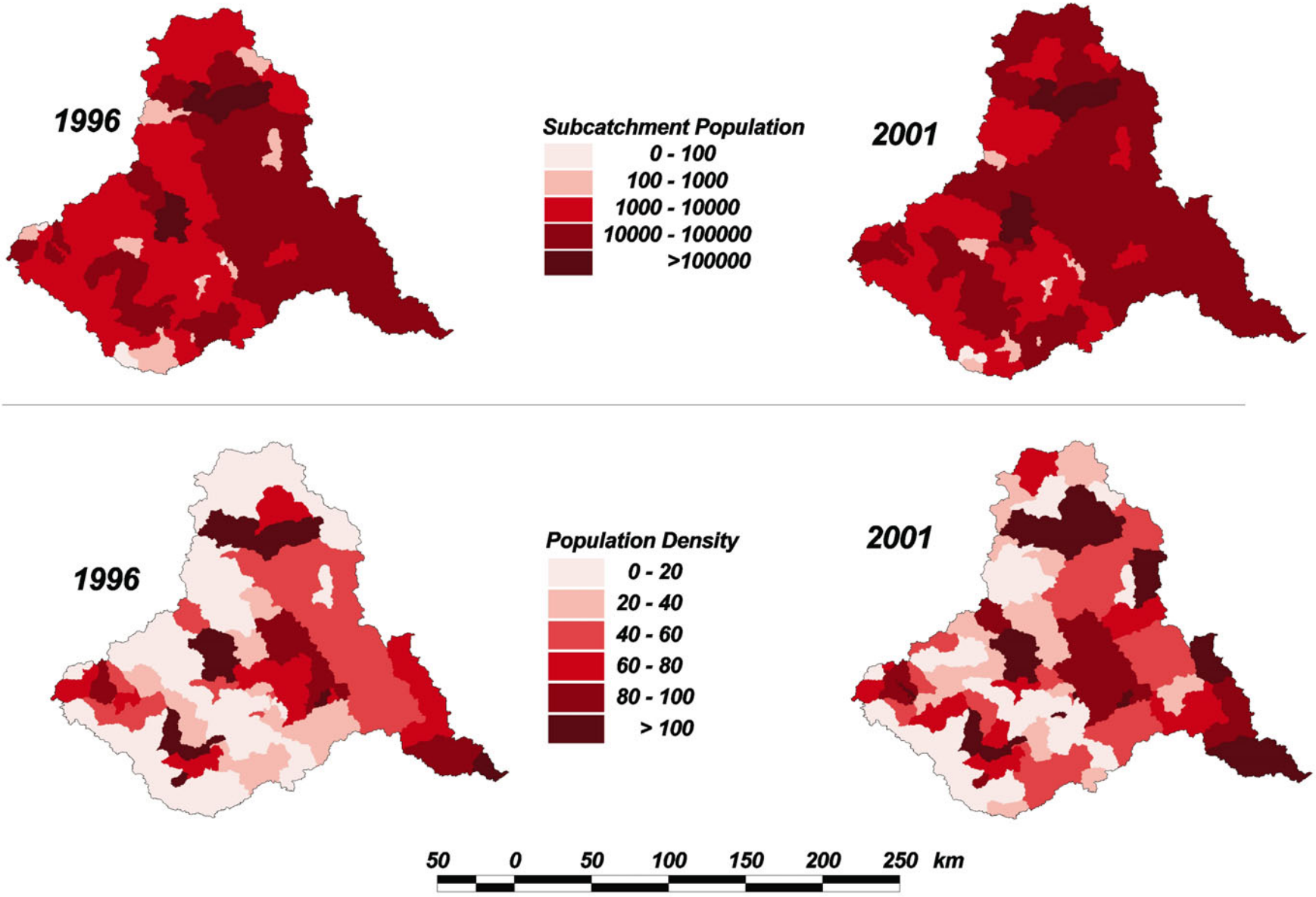
RES2226

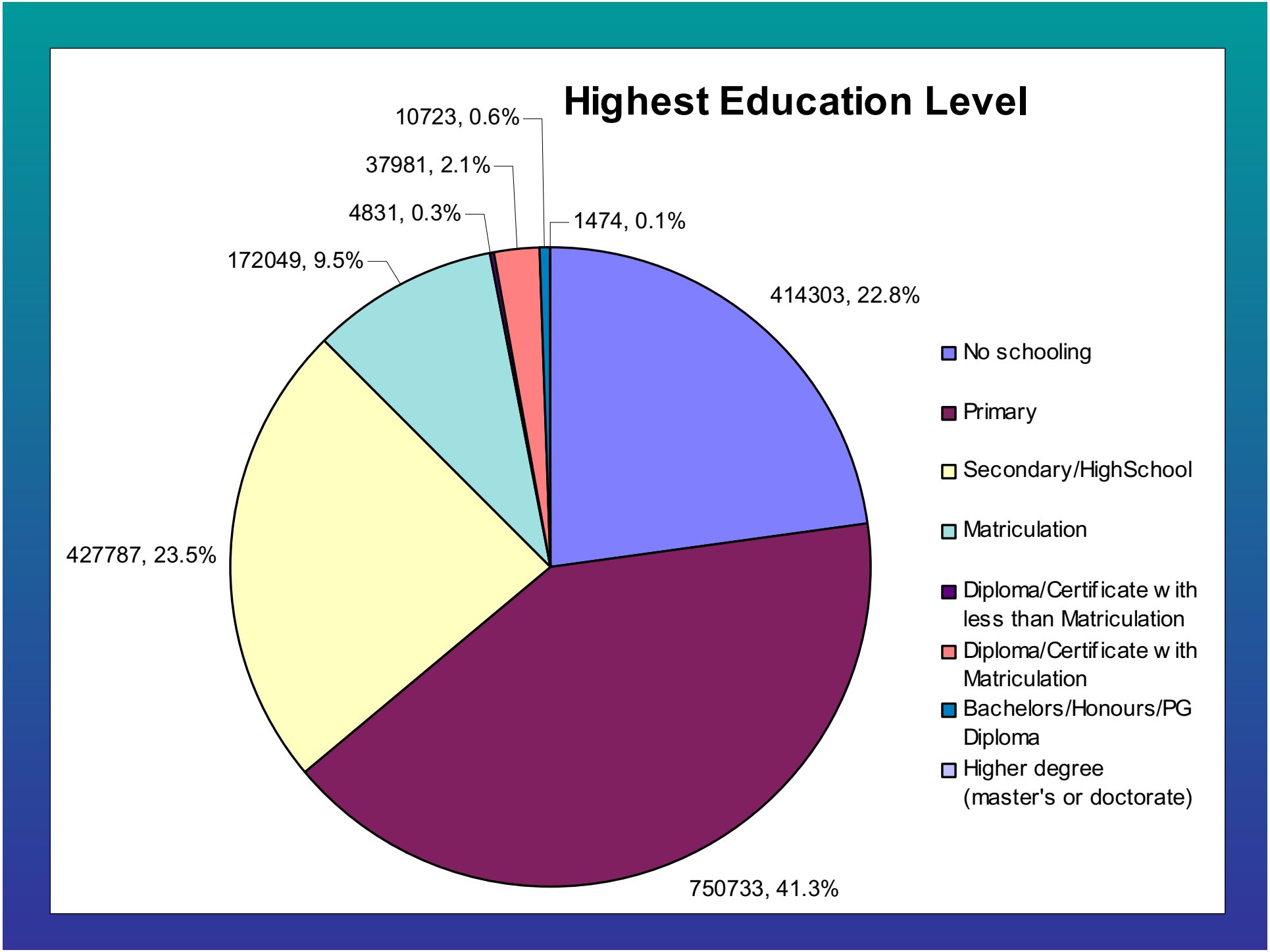

TOYOTA

RES3615

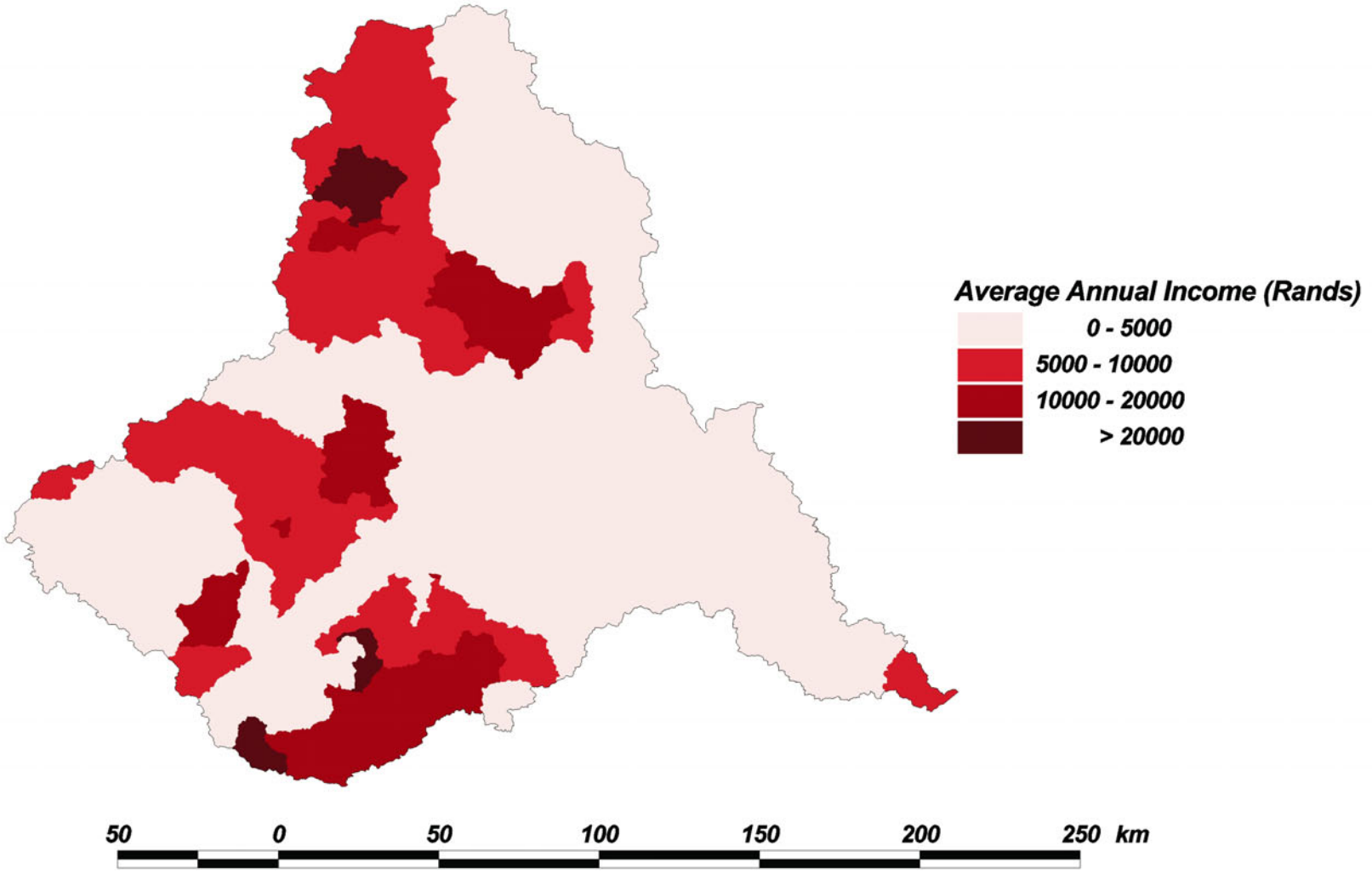

CRISPA
GOLD

Thukela Catchment: Subcatchment Population and Density for 1996 and 2001

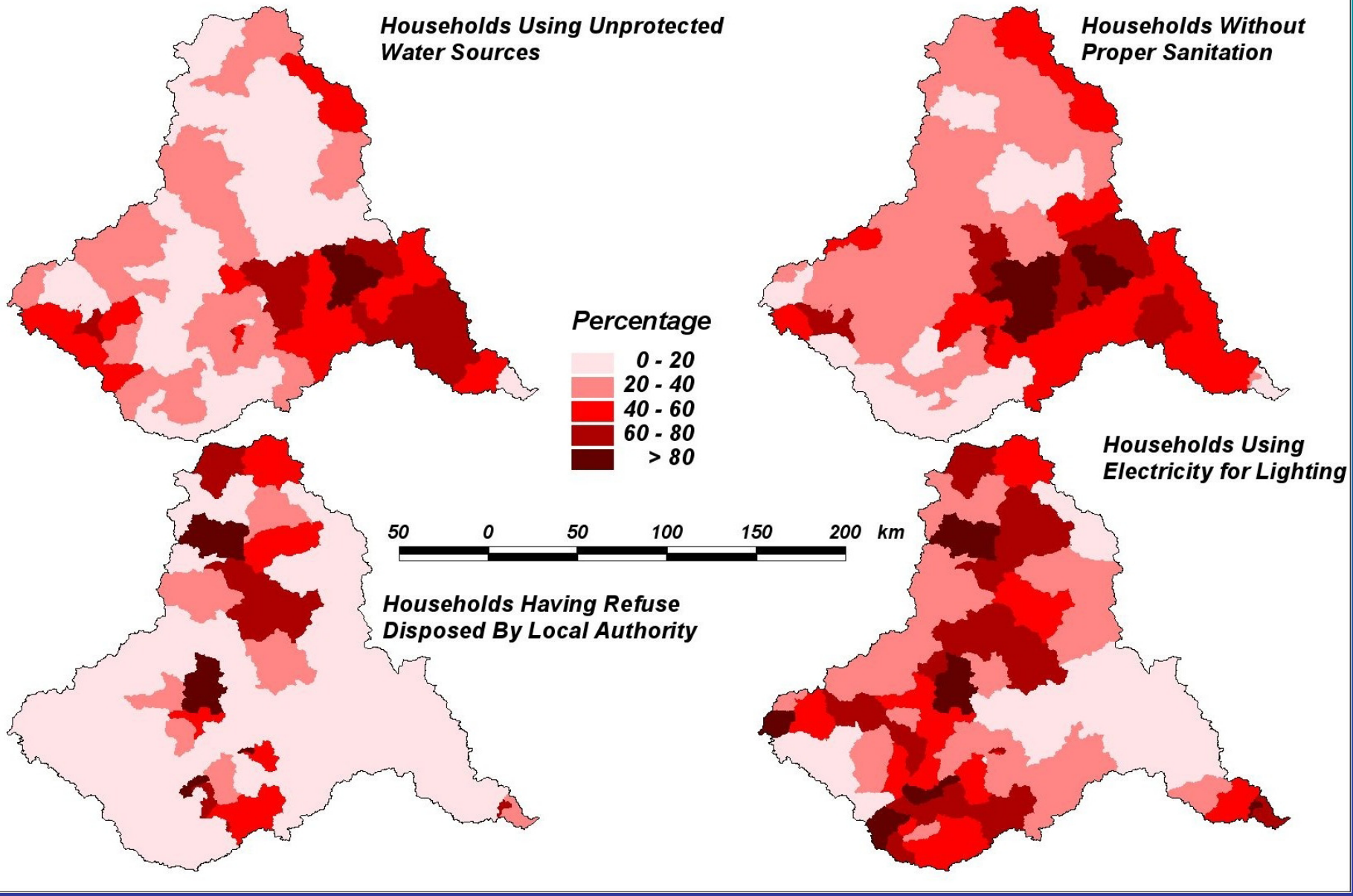



Highest Education Level
10723, 0.6%
37981, 2.1%
4831, 0.3%
1474, 0.1%
172049, 9.5%
414303, 22.8%
427787, 23.5%
750733, 41.3%
No schooling
Primary
Secondary/HighSchool
Matriculation
Diploma/Certificate with less than Matriculation
Diploma/Certificate with Matriculation
Bachelors/Honours/PG Diploma
Higher degree (master's or doctorate)

Thukela Catchment: Spatial Distribution of Average Annual Income (Rands)



Thukela Catchment: Spatial Patterns of Levels of Service Provision



Water Poverty . . .

. . . a reality in the Thukela catchment

RES7533

Assessment of Water Scarcity

- Where are water scarce areas *located*?
- What are the *causes* of the water scarcity?
- Which *times* are associated with water scarcity?
- Which areas require *urgent interventions*?
- What could *suitable interventions* be?
- What are the *impacts* of the interventions?

Assessment of water scarcity requires appropriate tools…!!

Water Scarcity Assessment Tools: Considerations

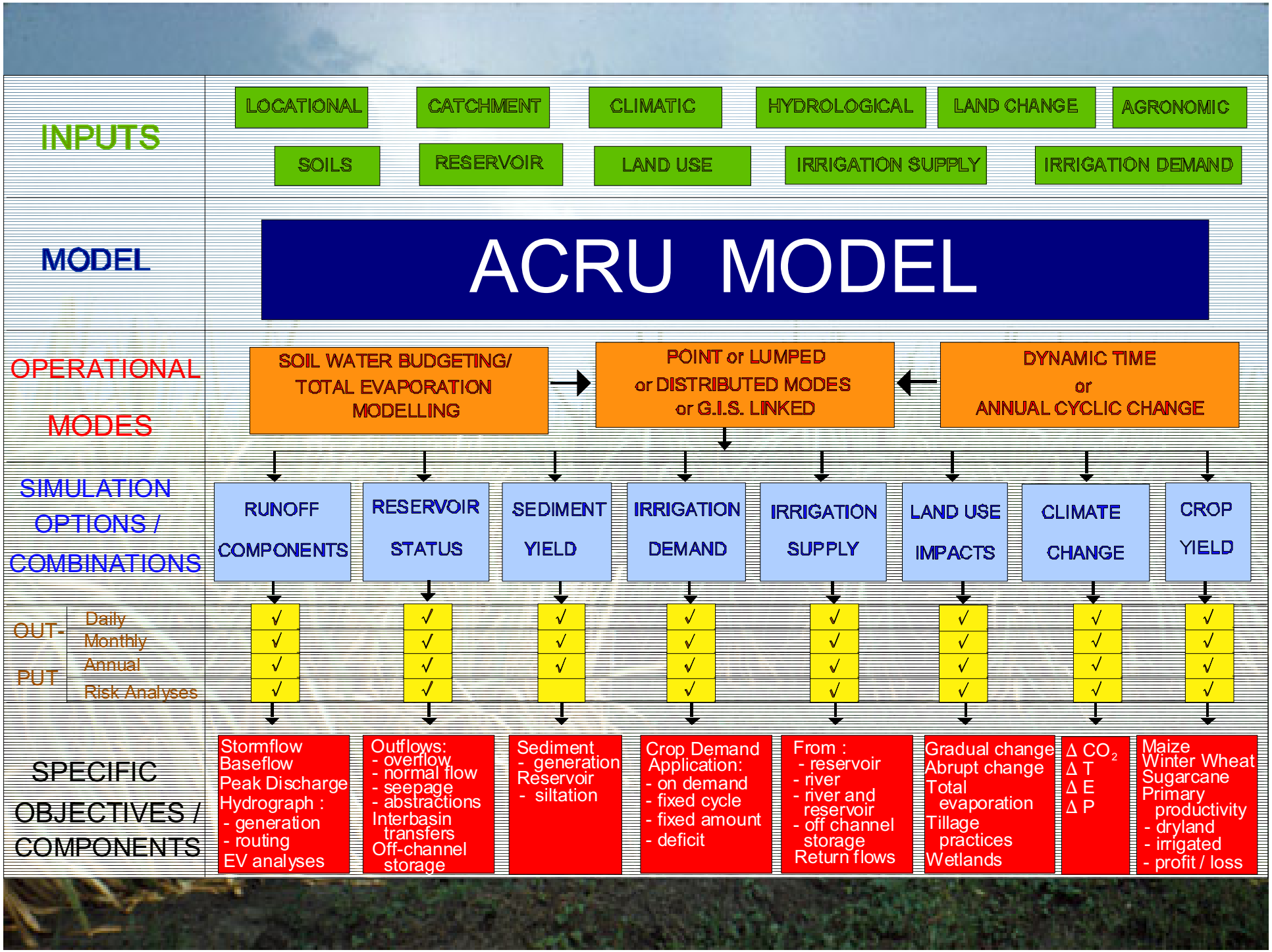
- Water scarcity is both *cause and effect* of poverty
- Water scarcity has *physical and complex social aspects*
- Water scarcity *varies over time and space*
- Water scarcity *cannot be measured directly* using conventional methods, but indirectly using *indicators and indices*
- assessment scales *should match the scale of the issues* to be management

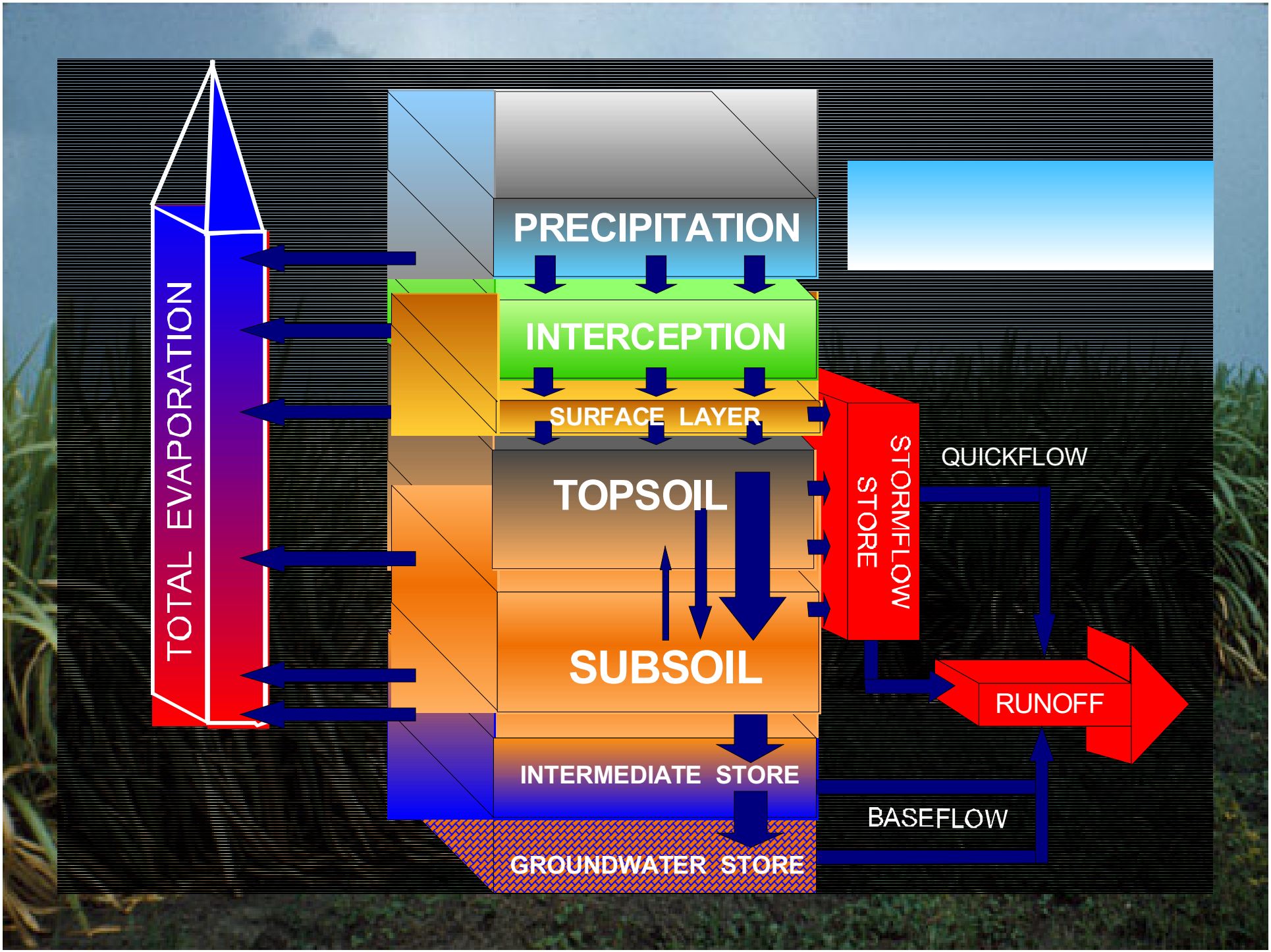
The WPI: Description

- Sophisticated method for investigating water scarcity and its relationship with human welfare
  - Multi-disciplinary
    - culminated from a project involving researchers from academic different disciplines
  - Multi-level
    - Intended to be applicable at different spatial scales to match scales of issues to be managed
  - Framework-based
    - Founded on a rigid conceptual structure
  - Composite
    - Can be presented as a single numerical value

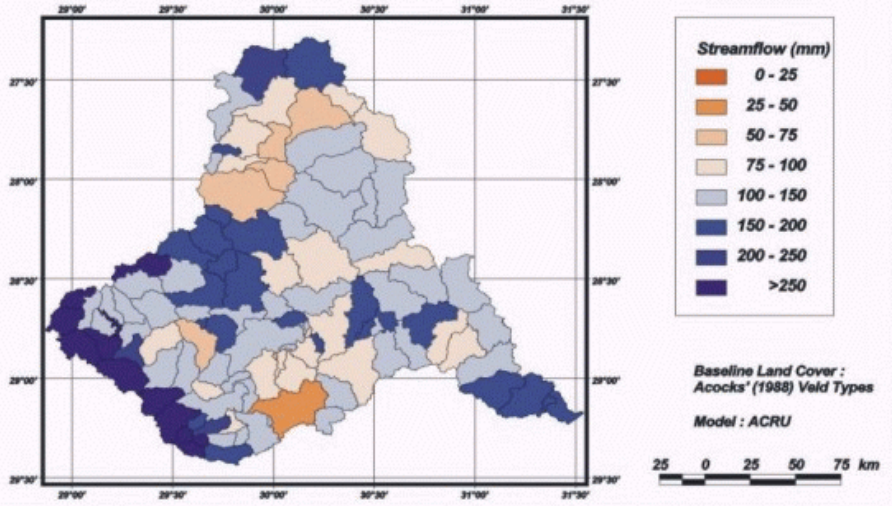
Computing the WPI

Component	Variables
Resources	Annual per capita water availability
Capacity	% households poor (income<X) % with matric or higher education Under 5 mortality per 1000
Use	Domestic water use Industrial water use Agricultural water use
Access	% households using unprotected water sources Average time taken to collect water Land under agriculture as a % total irrigable land
Environment	% degraded land

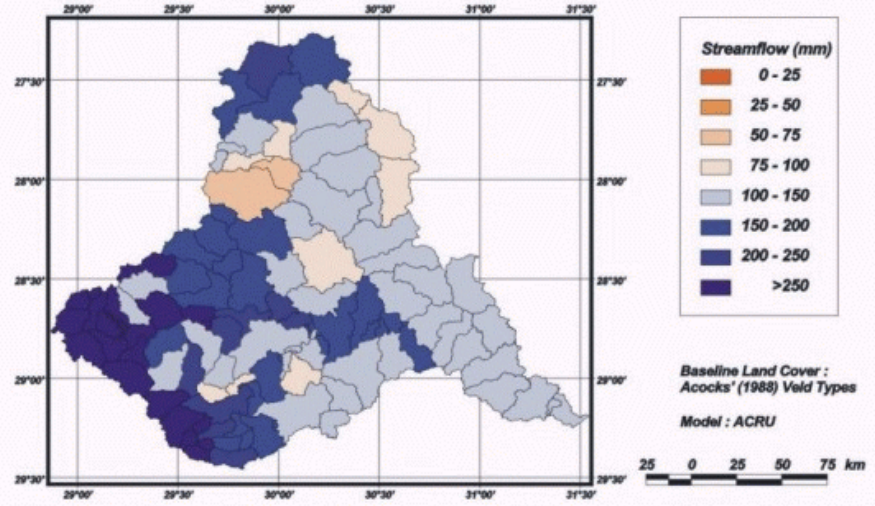

INPUTS
LOCATIONAL
CATCHMENT
CLIMATIC
HYDROLOGICAL
LAND CHANGE
AGRONOMIC
SOILS
RESERVOIR
LAND USE
IRRIGATION SUPPLY
IRRIGATION DEMAND
MODEL
ACRU MODEL
OPERATIONAL MODES
SOIL WATER BUDGETING/ TOTAL EVAPORATION MODELLING
POINT or LUMPED or DISTRIBUTED MODES or G.I.S. LINKED
DYNAMIC TIME or ANNUAL CYCLIC CHANGE
SIMULATION OPTIONS / COMBINATIONS
RUNOFF COMPONENTS
RESERVOIR STATUS
SEDIMENT YIELD
IRRIGATION DEMAND
IRRIGATION SUPPLY
LAND USE IMPACTS
CLIMATE CHANGE
CROP YIELD
OUT-PUT
Daily
Monthly
Annual
Risk Analyses
SPECIFIC OBJECTIVES / COMPONENTS
Stormflow
Baseflow
Peak Discharge
Hydrograph :
- generation
- routing
EV analyses
Outflows:
- overflow
- normal flow
- seepage
- abstractions
Interbasin transfers
Off-channel storage
Sediment
- generation
Reservoir
- siltation
Crop Demand
Application:
- on demand
- fixed cycle
- fixed amount
- deficit
From :
- reservoir
- river
- river and reservoir
- off channel storage
Return flows
Gradual change
Abrupt change
Total evaporation
Tillage practices
Wetlands
Δ CO2
Δ T
Δ E
Δ P
Maize
Winter Wheat
Sugarcane
Primary productivity
- dryland
- irrigated
- profit / loss


PRECIPITATION
INTERCEPTION
SURFACE LAYER
TOPSOIL
SUBSOIL
INTERMEDIATE STORE
GROUNDWATER STORE
TOTAL EVAPORATION
STORMFLOW STORE
QUICKFLOW
RUNOFF
BASEFLOW

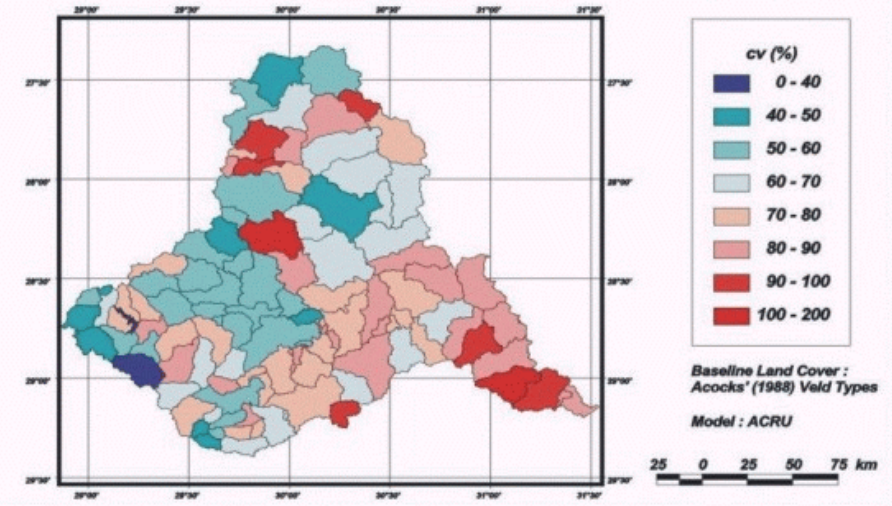
Thukela Catchment : Mean Annual Streamflows (mm) per Subcatchment



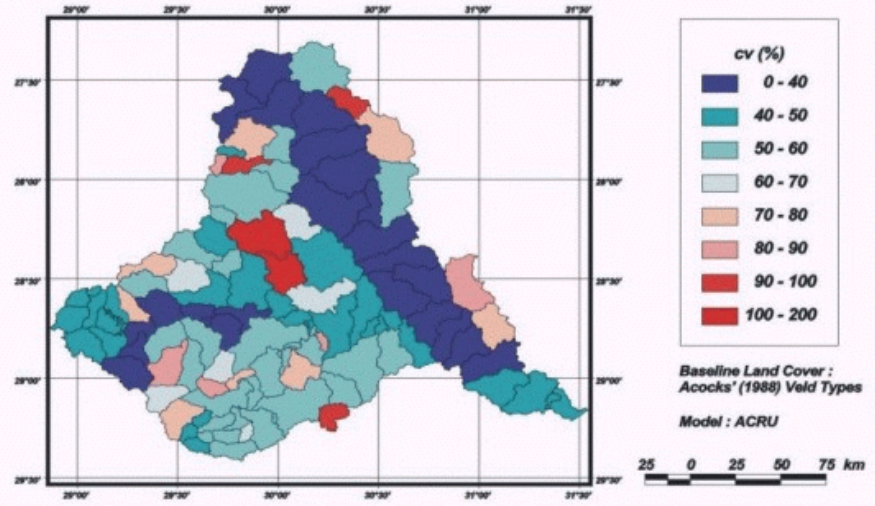
Thukela Catchment : Mean Annual Accumulated Streamflows (mm)



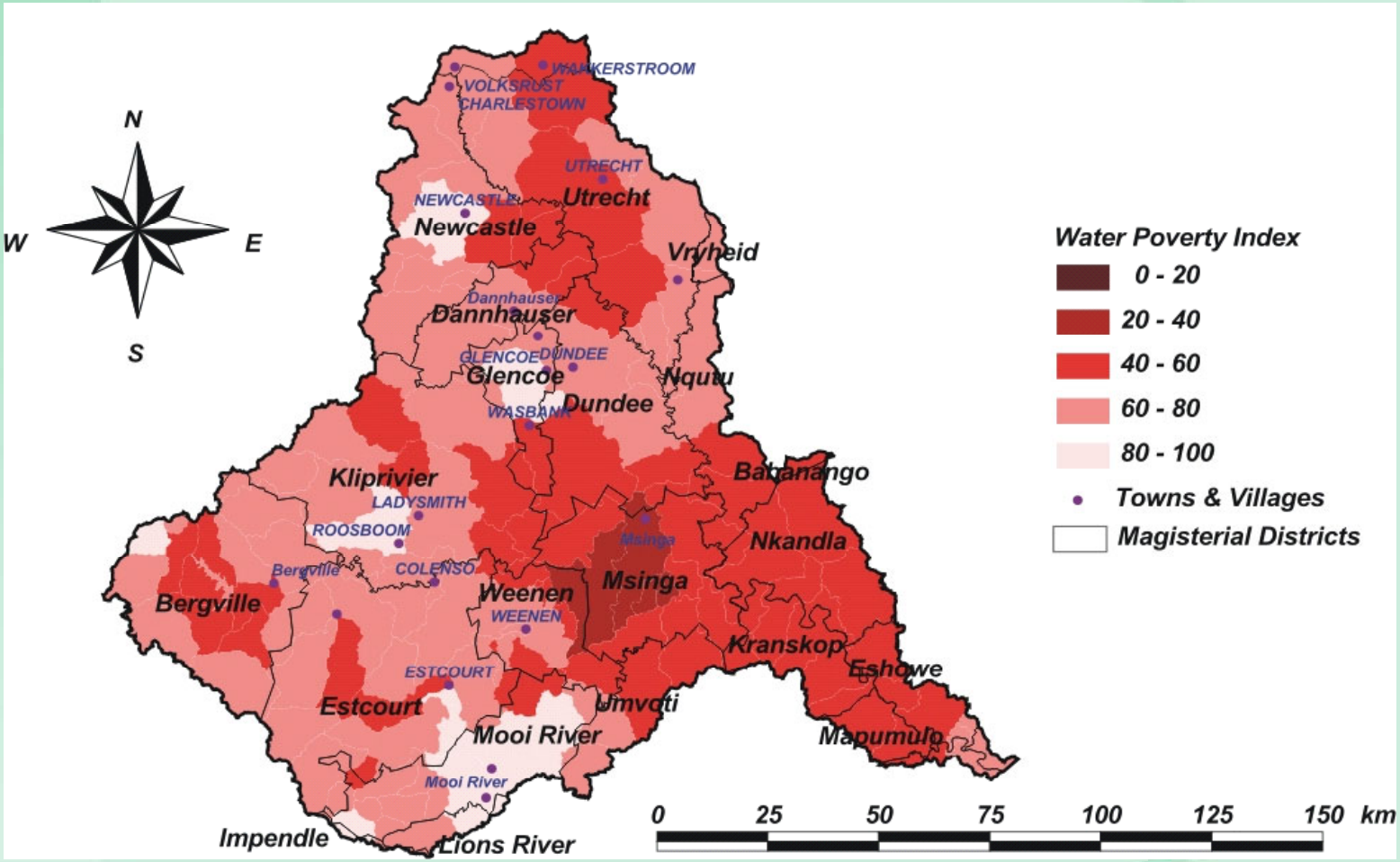
Thukela Catchment : Coefficient of Variation (cv) of Annual Subcatchment Streamflows (mm)



Thukela Catchment : Coefficient of Variation (cv) of Annual Accumulated Streamflows (mm)



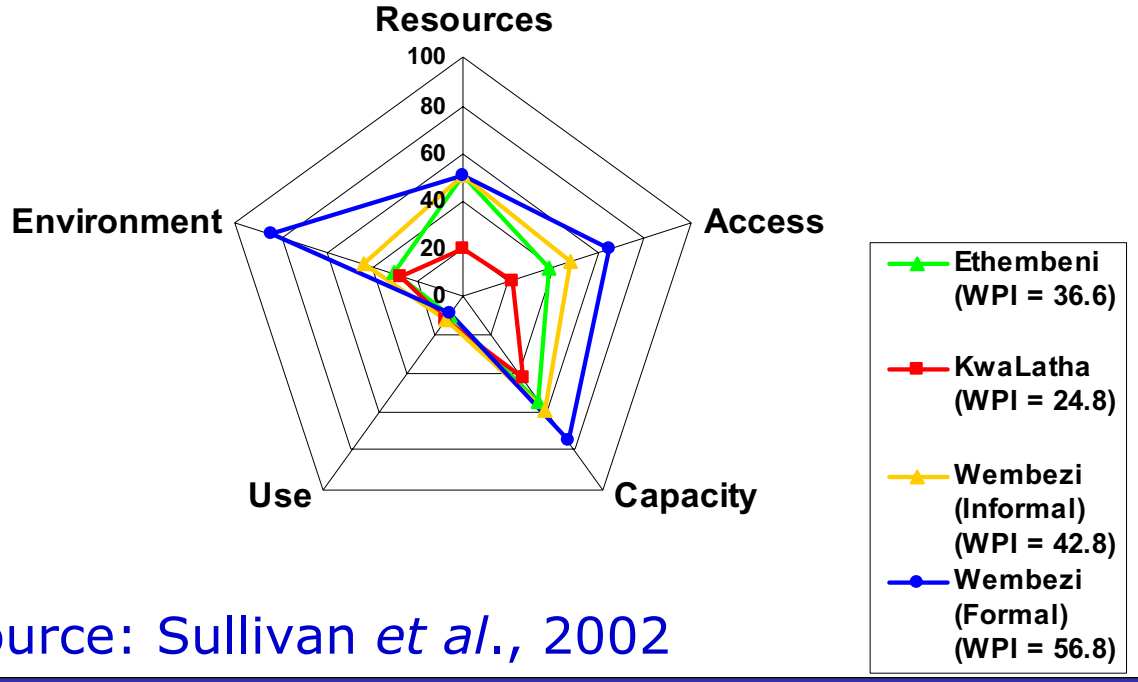
Thukela Catchment: Water Poverty Index



The WPI: Application Examples

Community Level

Using the WPI Tool to Compare Water User Communities within South Africa (WPI_{max} = 100)

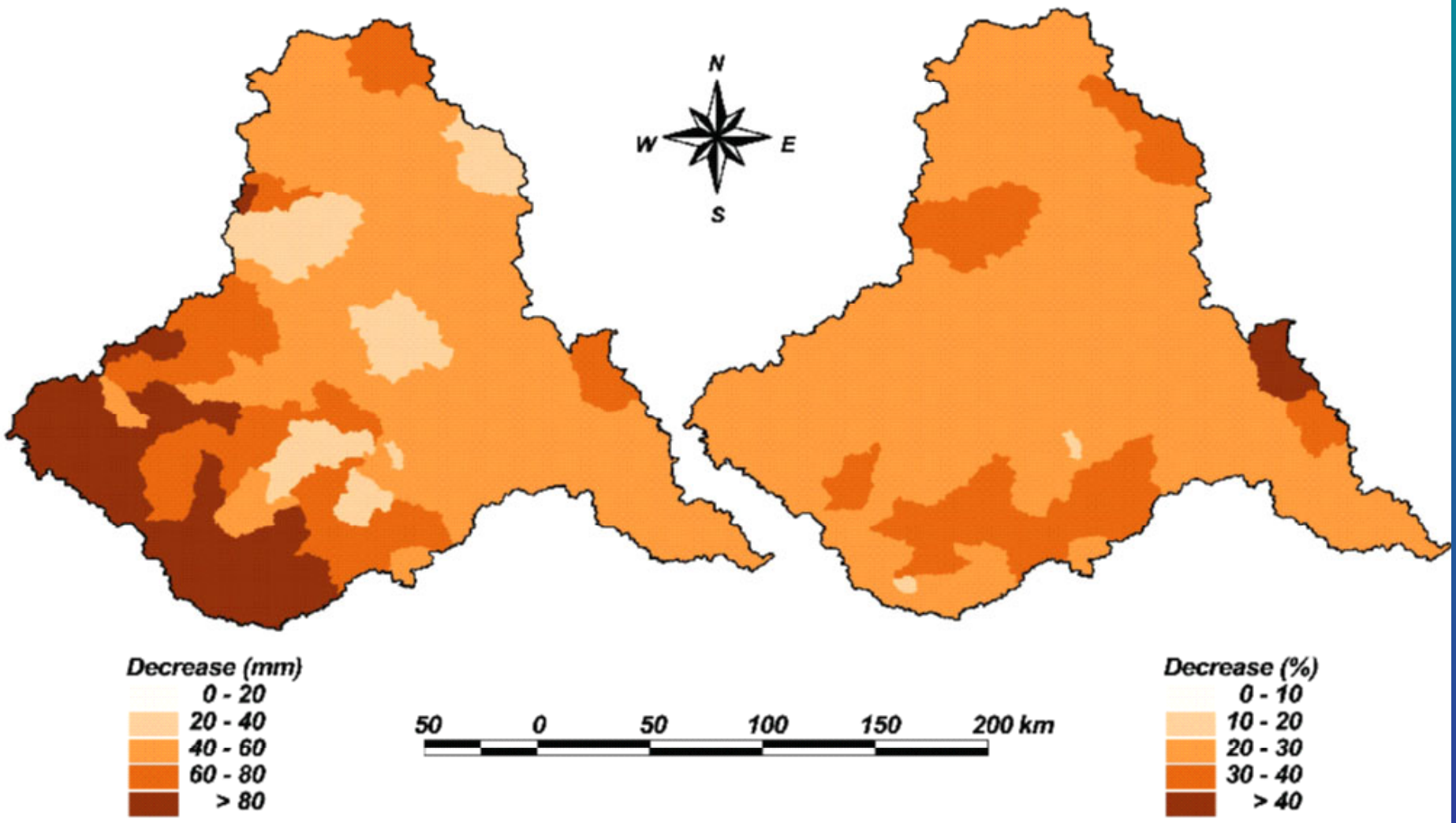


Source: Sullivan *et al*., 2002

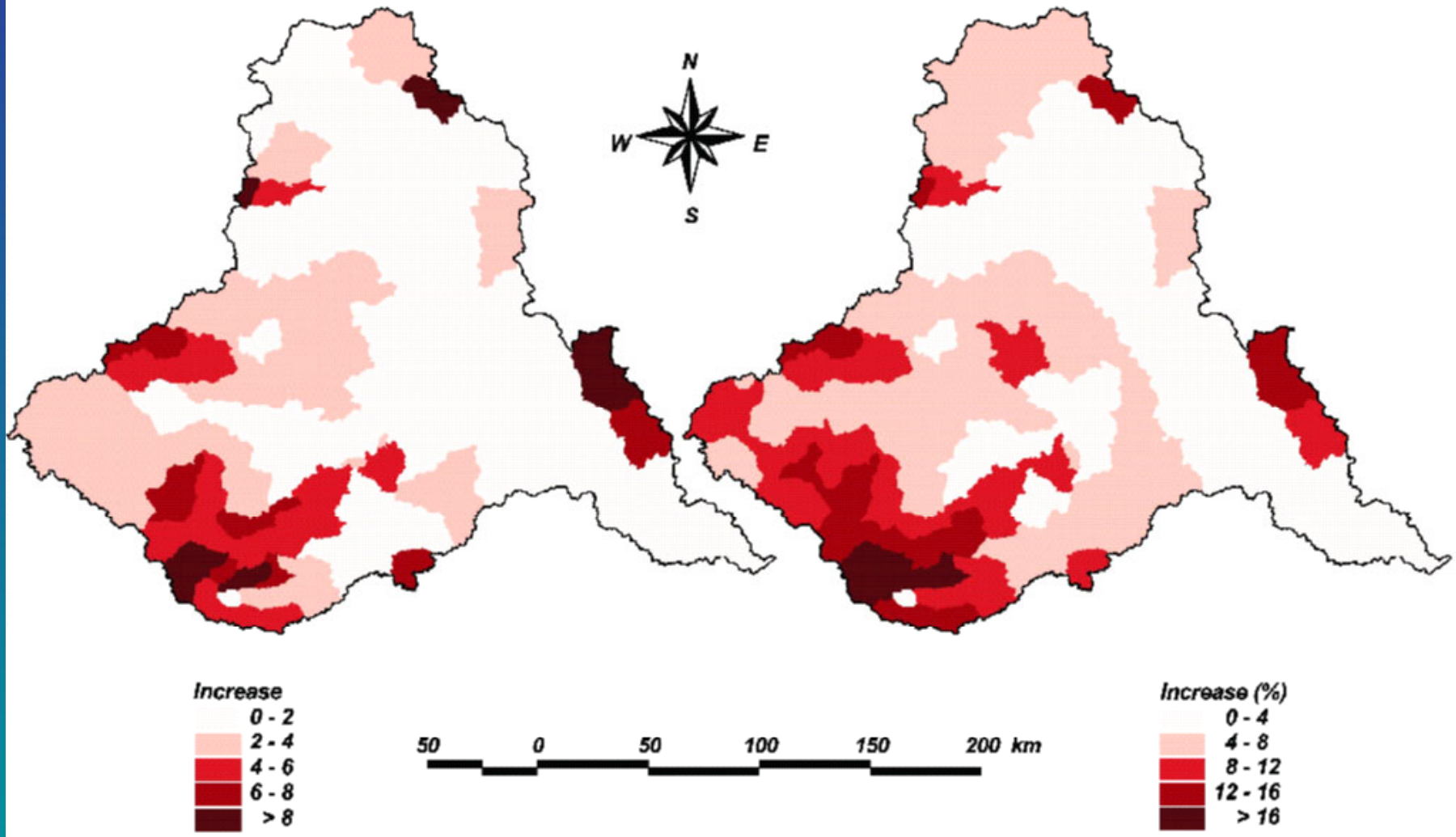
WATER COMMITTEE MEMBER AND ROLAND IN DEEP DISCUSSION WHILE GARY MORGAN TAKES NOTE. DWC EXCURSION, 25 JULY 2002

Water Poverty, Already Acute in Many Meso-Scale Catchments, is Likely to be Intensified by Global Warming

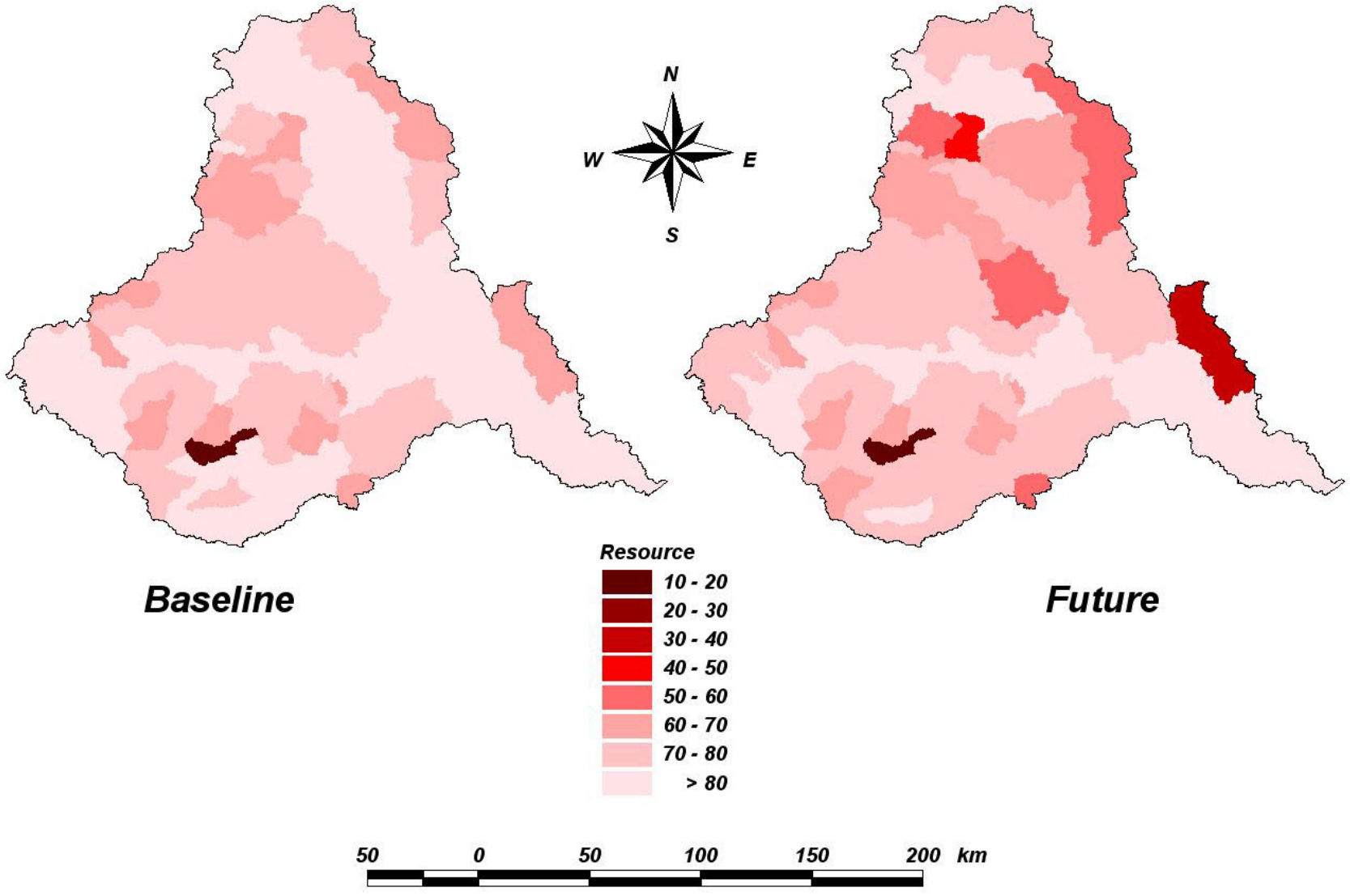
Differences Between Simulated Accumulated Mean Annual Streamflows (mm) under Baseline and Future Climate Scenarios in the Thukela Catchment



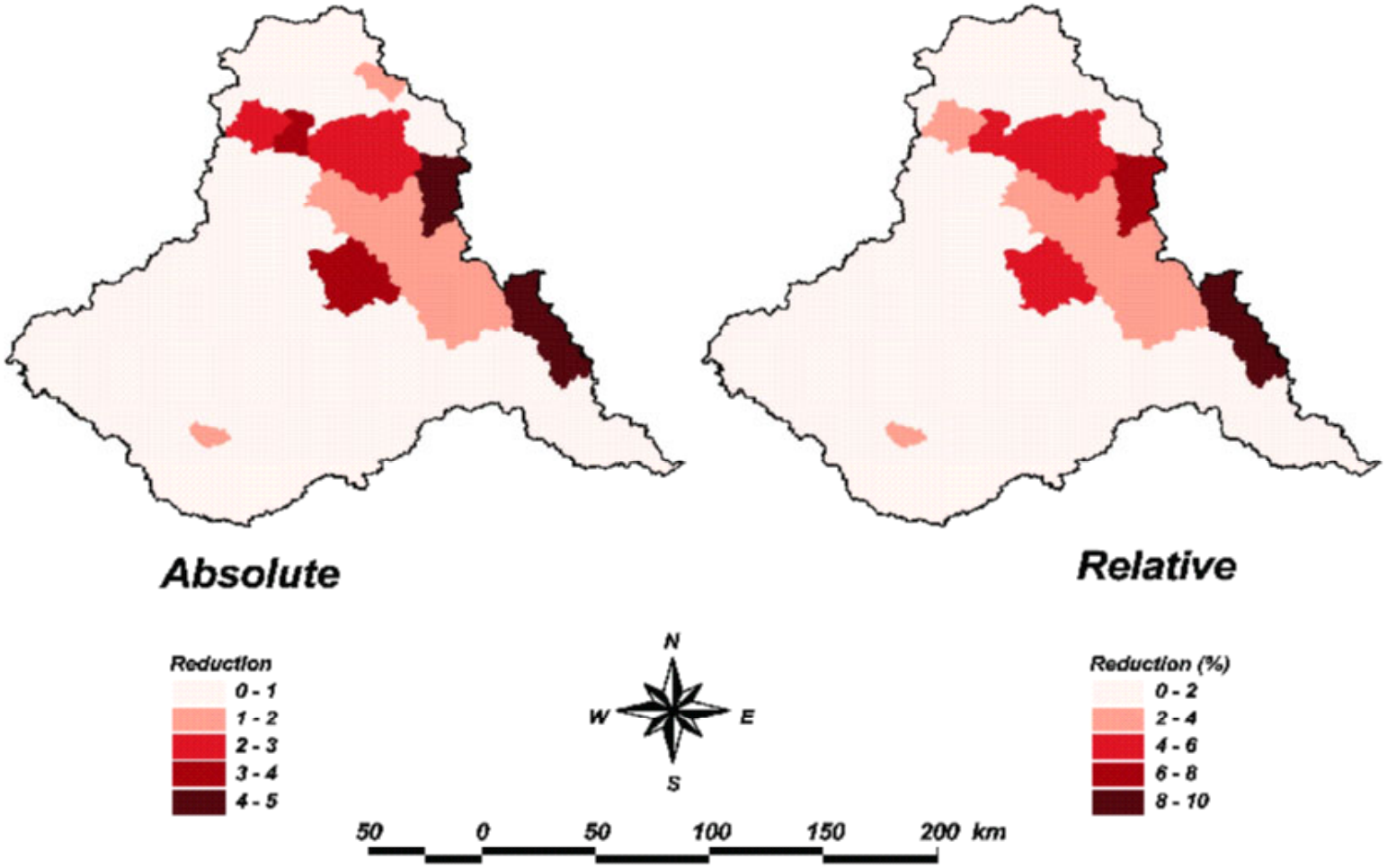
Differences between the Coefficients of Variability (CV) of Accummulated Streamflows Simulated under Baseline and Future Climate Scenarios in the Thukela Catchment



Comparison of the Resource Component of the WPI Between the Baseline and the Future Climate Scenarios



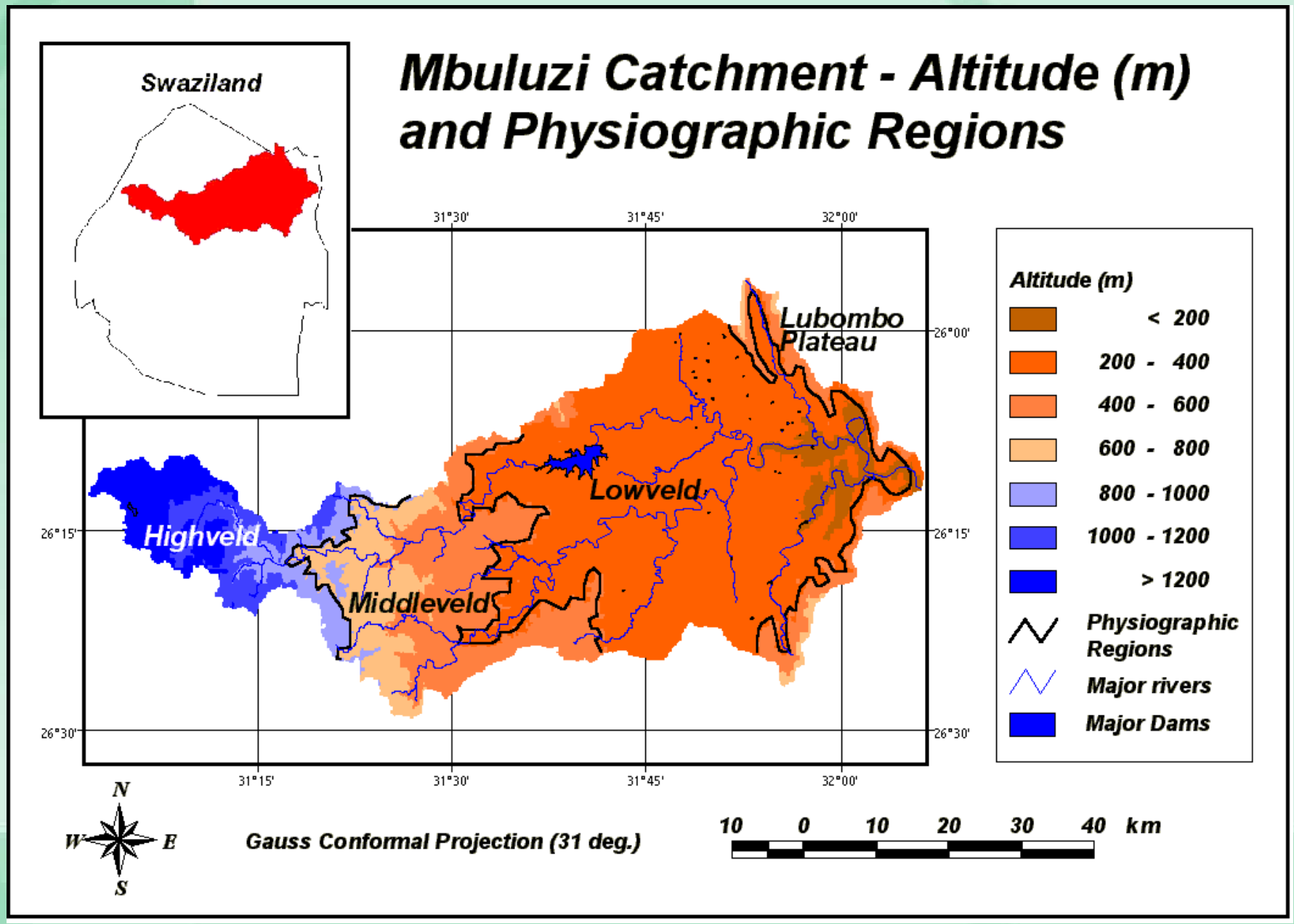
Absolute and Relative Differences of the WPI Between the Baseline and the Future Climate Scenarios

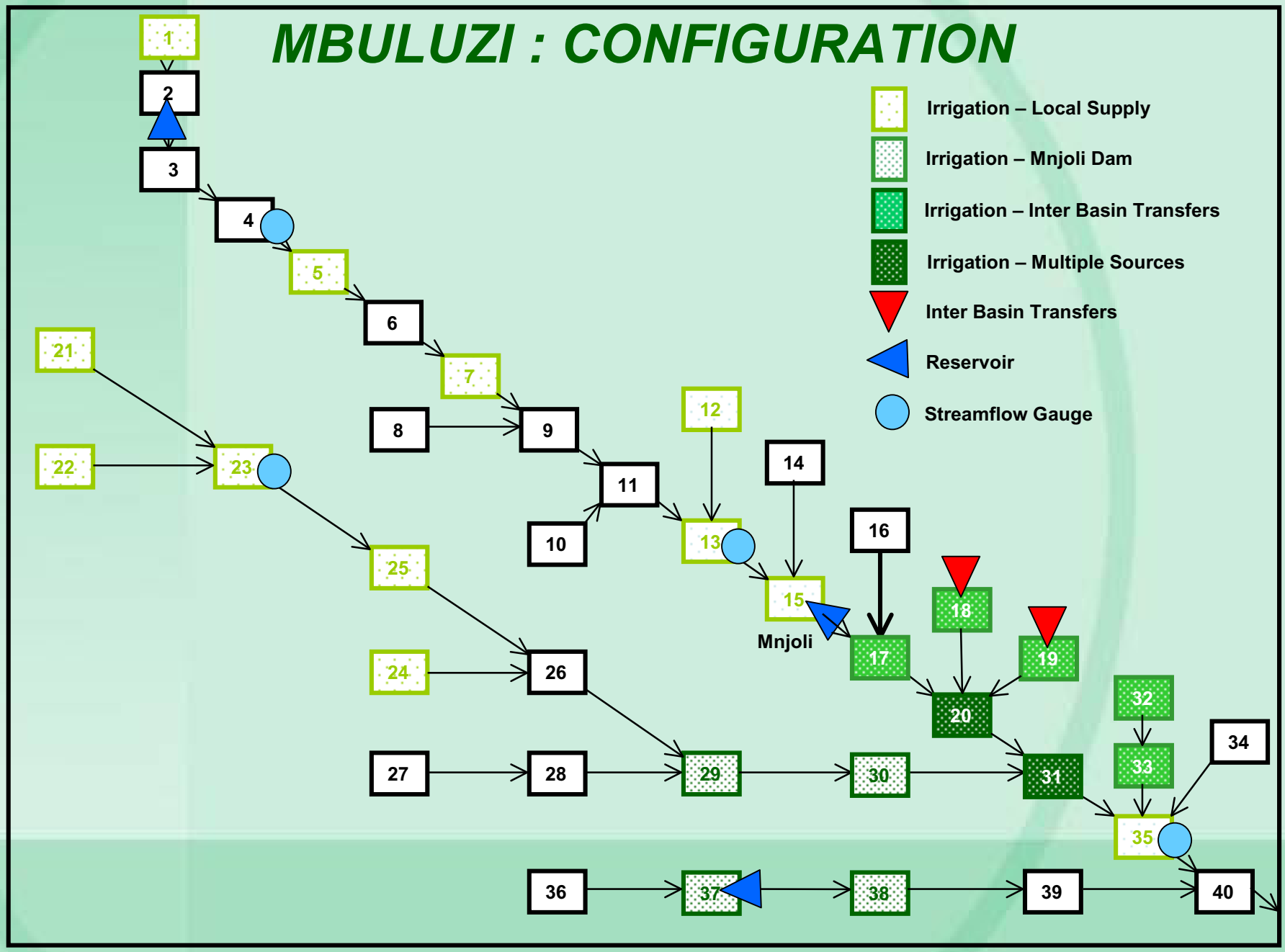


CASE STUDY 2

Climate Change is Likely to Have Severe Impacts on Both Within-Country Water Management and International Flow Obligations in LDCs

(Especially on Already Stressed Catchments, Dominated by High Water Demanding Irrigated Crops)


Mbuluzi Catchment - Altitude (m) and Physiographic Regions
Swaziland
31°30'
31°45'
32°00'
26°00'
26°15'
26°30'
31°15'
Lubombo Plateau
Lowveld
Highveld
Middleveld
Altitude (m)
< 200
200 - 400
400 - 600
600 - 800
800 - 1000
1000 - 1200
> 1200
Physiographic Regions
Major rivers
Major Dams
N
W
E
S
Gauss Conformal Projection (31 deg.)
10 0 10 20 30 40 km


MBULUZI : CONFIGURATION
Irrigation – Local Supply
Irrigation – Mnjoli Dam
Irrigation – Inter Basin Transfers
Irrigation – Multiple Sources
Inter Basin Transfers
Reservoir
Streamflow Gauge
Mnjoli
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
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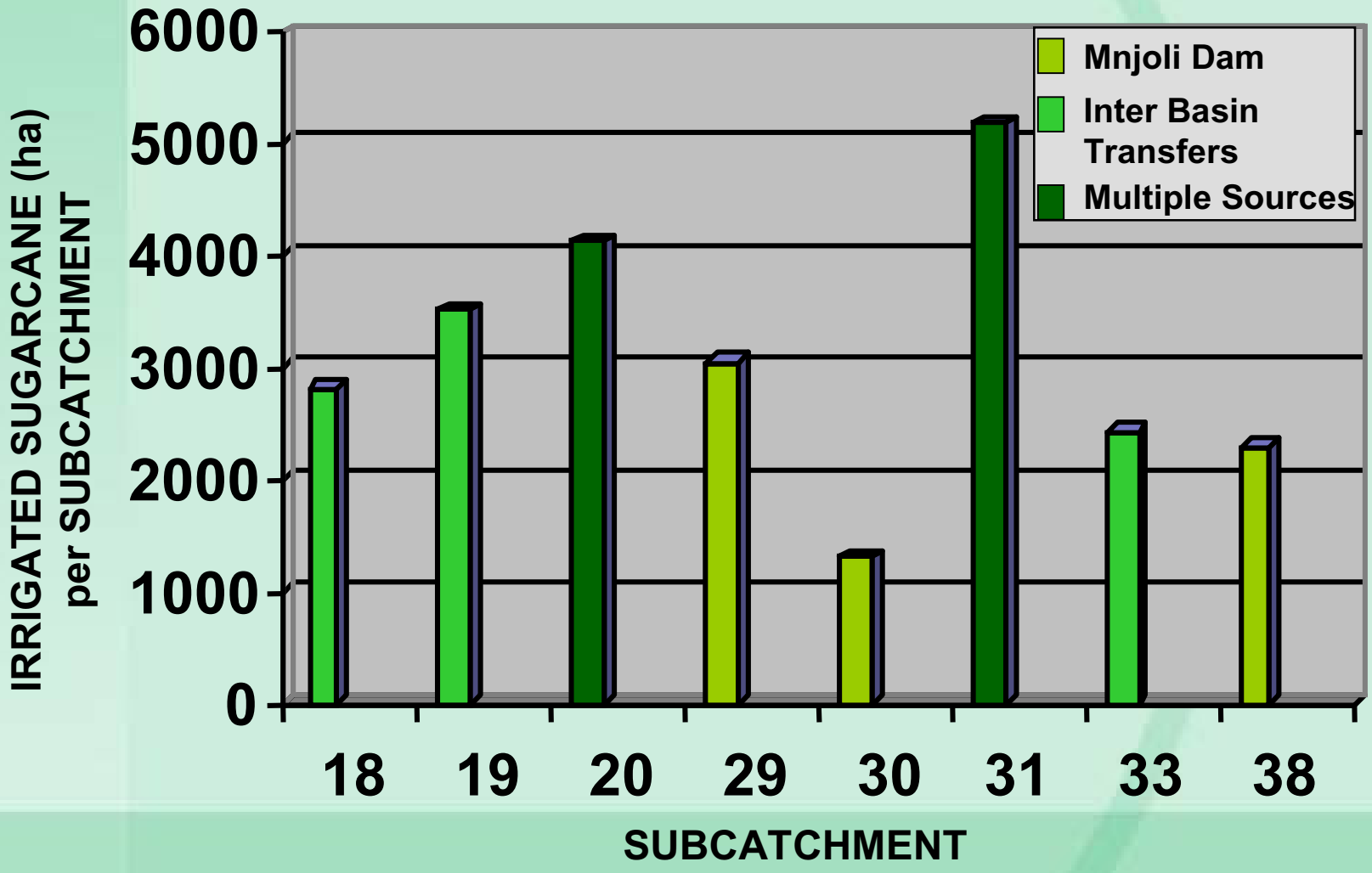
33
34
35
36
37
38
39
40

MBULUZI : LARGE-SCALE IRRIGATION

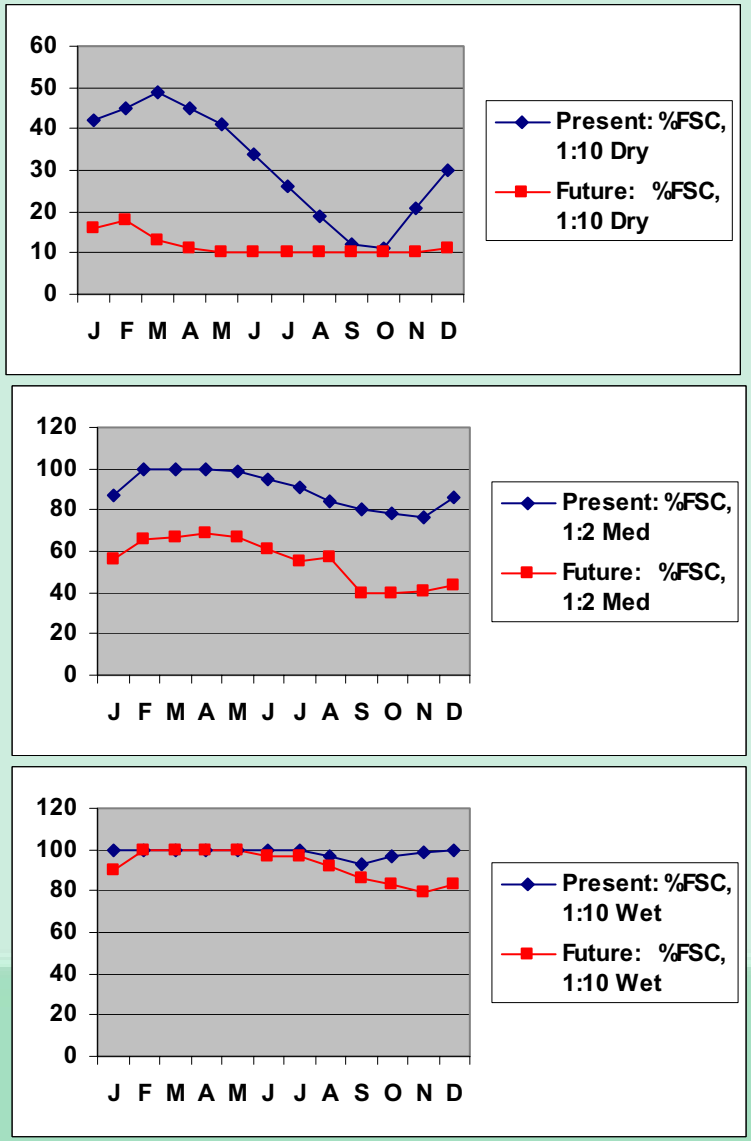


Total: > 24 000 ha

POTENTIAL IMPACTS OF CLIMATE CHANGE, MBULUZI CATCHMENT

(Scenario: T = T + 2°C; P = P – 10%)

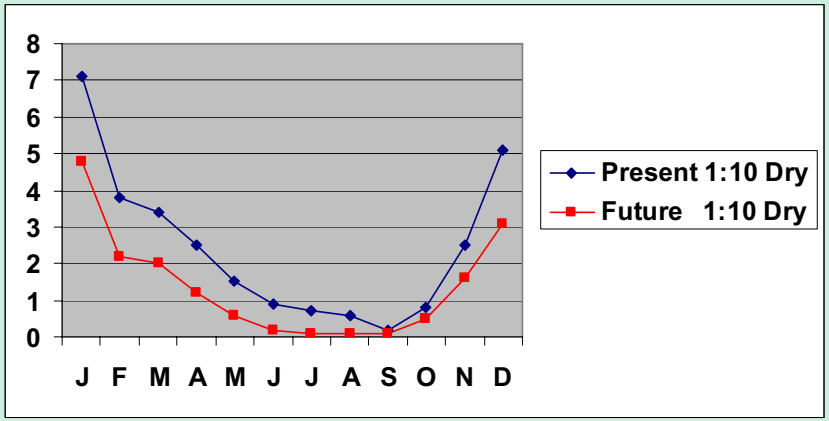
MNJOLI DAM: % OF FULL SUPPLY CAPACITY

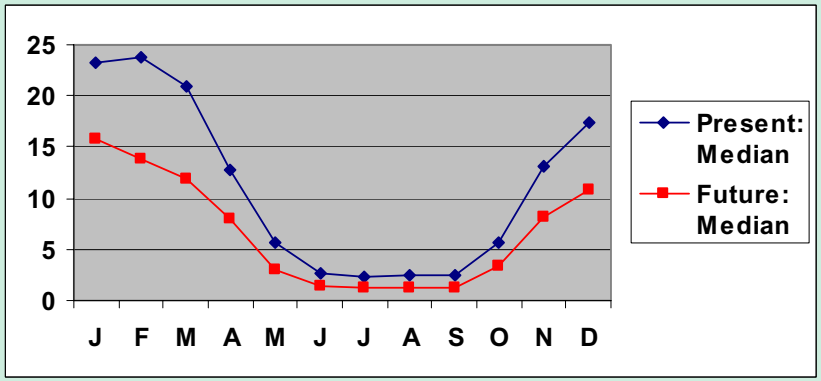


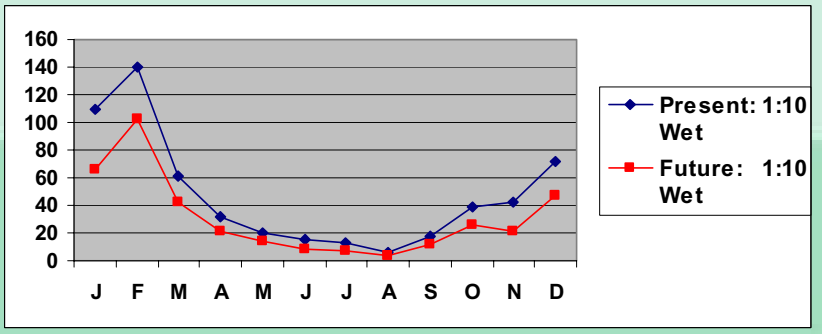
POTENTIAL IMPACTS OF CLIMATE CHANGE, MBULUZI CATCHMENT

(Scenario: T = T + 2°C; P = P – 10%)

MBULUZI OUTFLOWS TO MOZAMBIQUE



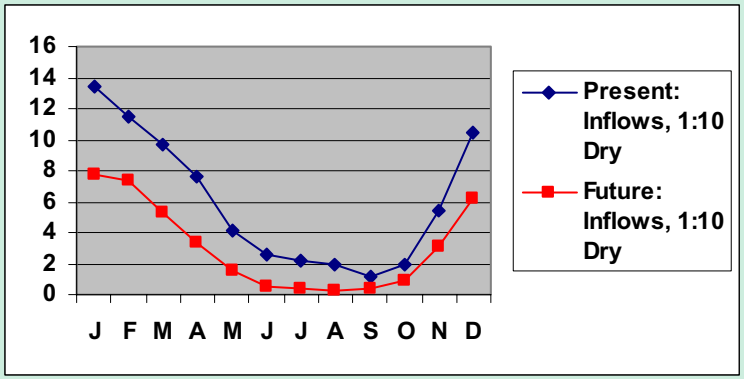


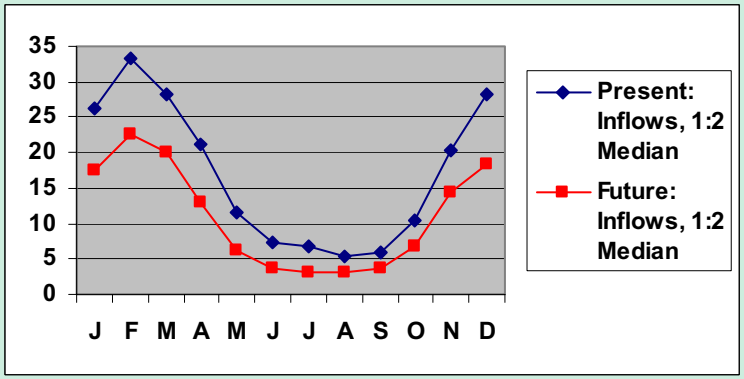


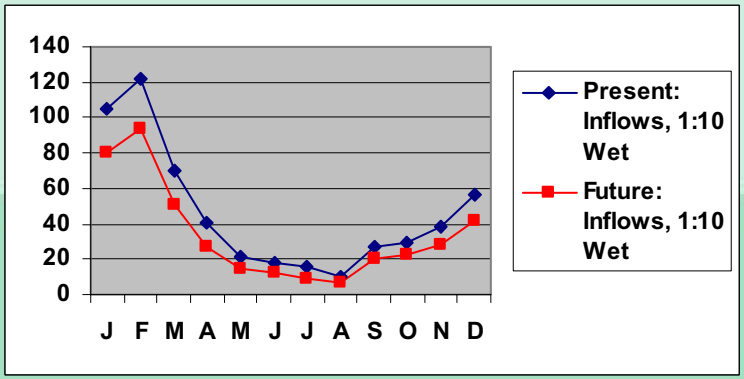
POTENTIAL IMPACTS OF CLIMATE CHANGE, MBULUZI CATCHMENT

(Scenario: T = T + 2°C; P = P – 10%)

INFLOWS (mm) INTO MNJOLI DAM







OTHER CLIMATE CHANGE RELATED WATER PROBLEMS IN LESSER DEVELOPED COUNTRIES: THE ISSUE OF HYDROLOGICAL MODELLING

PROBLEMS ASSOCIATED WITH HYDROLOGICAL MODELLING IN LDCs . . . 1

GOVERNMENT, GOVERNANCE RELATED

- "Legitimacy" of models not yet established
- Still a belief in "measure and analyse"
- "Directional pressure" exerted by international funders
- Hydrological decisions based on politics/influencial people
- Modelling by donor organisations: "They come, do, leave" syndrome
- Governments think "foreigners are better"
- Little technical/conceptual leadership in modelling
- Hydrological "goalposts" change
- Bureaucracy prevails

PROBLEMS ASSOCIATED WITH HYDROLOGICAL MODELLING IN LDCs . . . 2

HUMAN RESOURCES RELATED

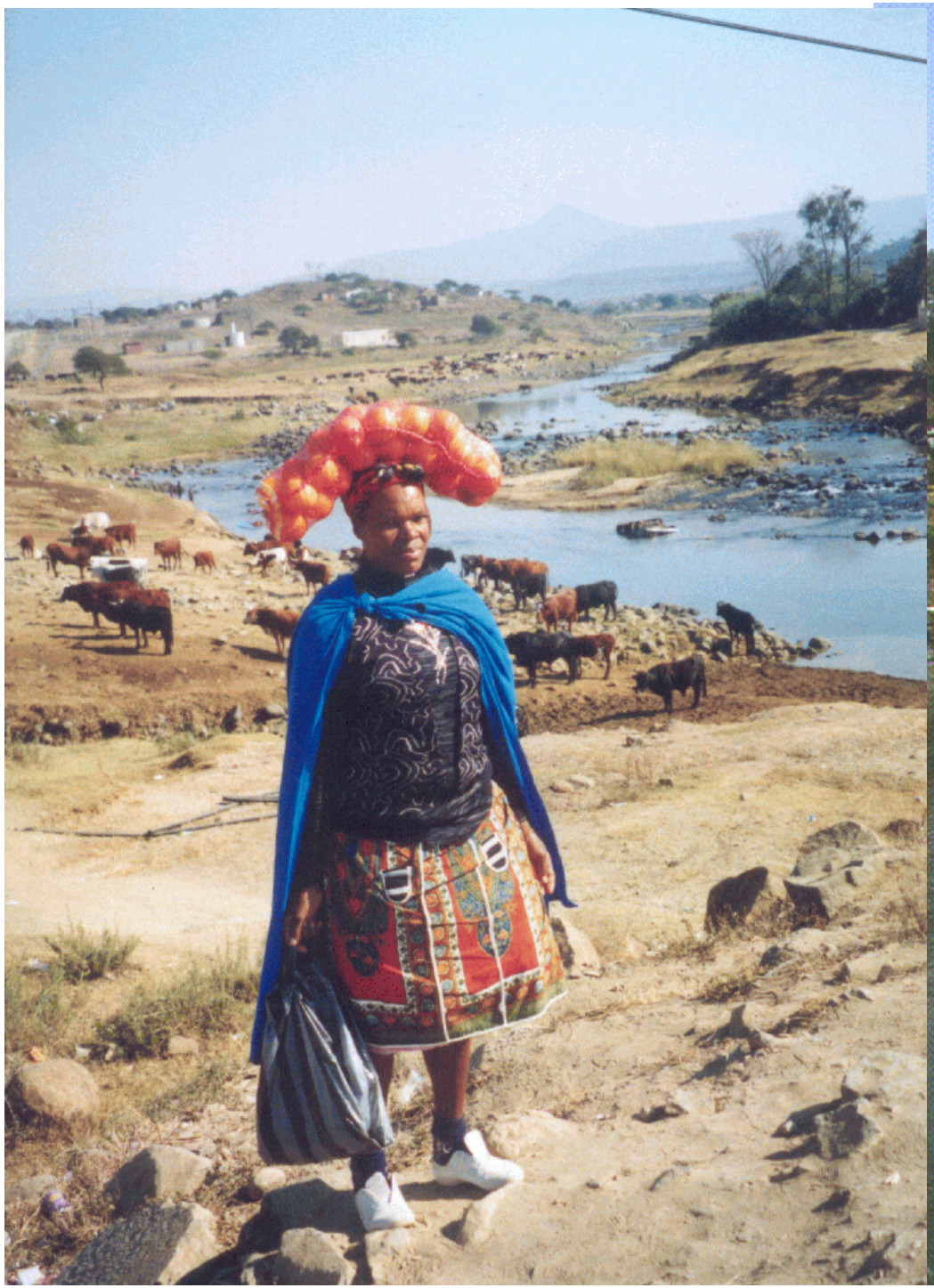
- Few hydrologists have intimate modelling experience
- Local hydrologists in a “comfort zone” re. existing techniques
- Little teamwork - modelling an individual pursuit
- The “rugged personality” syndrome

PROBLEMS ASSOCIATED WITH HYDROLOGICAL MODELLING IN LDCs . . . 3

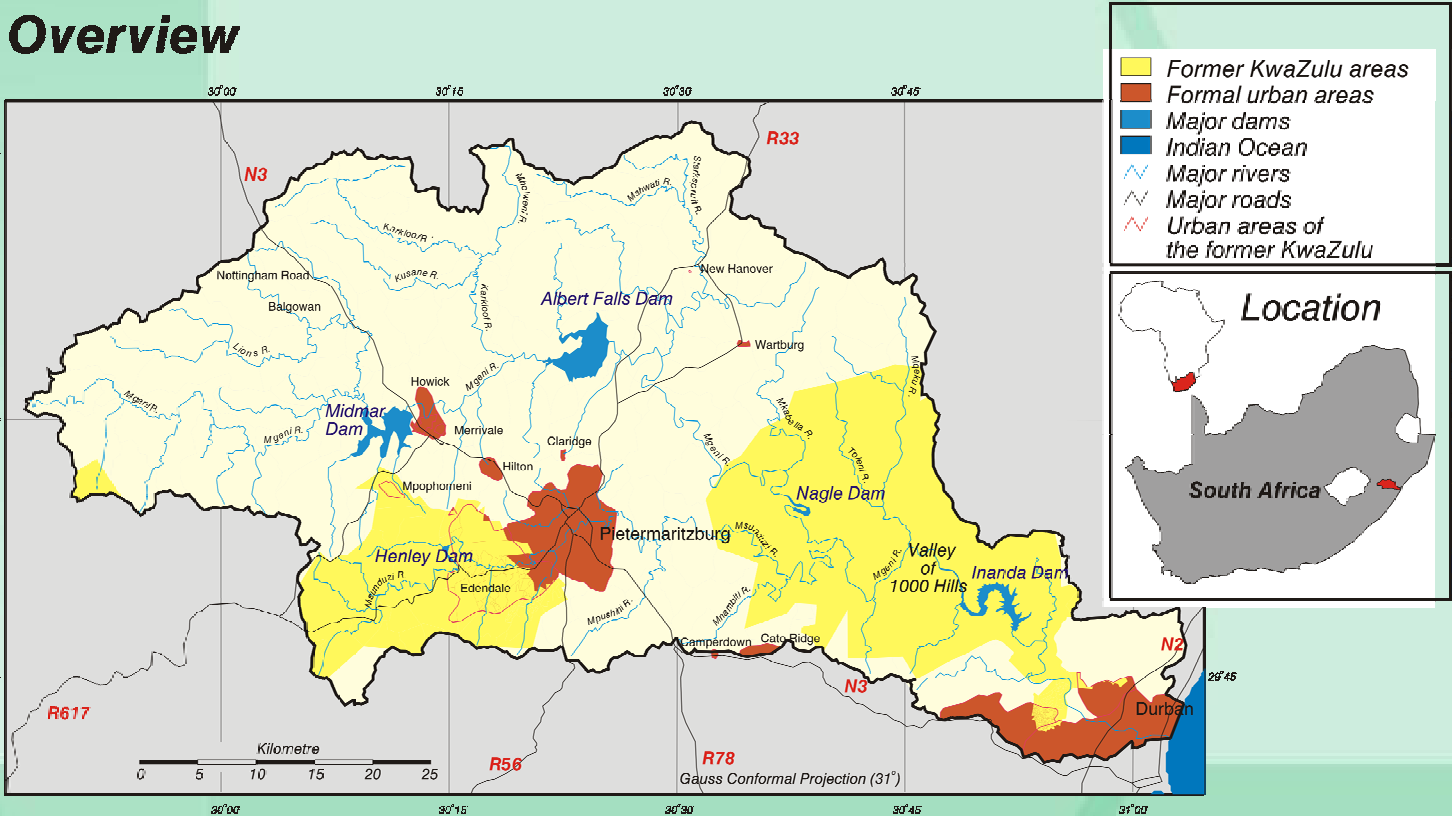
PRACTICAL PROBLEMS

- **Data problems re. input/verification**
  - *length*
  - *access*
  - *donors' own equipment*
  - *housed in different ministries*
- **Models developed in donor countries**
  - *data demanding*
  - *inappropriate process representations*
  - *too complex*
  - *don't answer "on the ground" questions*
- **Power politics - who disseminates model output?**
- **"Institutional inertia", i.e. persistence with "old" models**
- **Lack of facilities**

OTHER CLIMATE CHANGE RELATED WATER PROBLEMS IN LESSER DEVELOPED COUNTRIES: THE ISSUE OF BIOLOGICAL RIVER HEALTH



Overview



Former KwaZulu areas
Formal urban areas
Major dams
Indian Ocean
Major rivers
Major roads
Urban areas of the former KwaZulu
Location
South Africa
Albert Falls Dam
Midmar Dam
Nagle Dam
Henley Dam
Inanda Dam
Pietermaritzburg
Durban
Howick
Merrivale
Hilton
Claridge
Mpophomeni
Edendale
Nottingham Road
Balgowan
New Hanover
Wartburg
Camperdown
Cato Ridge
Valley of 1000 Hills
N3
N2
R33
R617
R56
R78
Kilometre
0 5 10 15 20 25
Gauss Conformal Projection (31°)
30°00
30°15
30°30
30°45
31°00
29°15
29°30
29°45

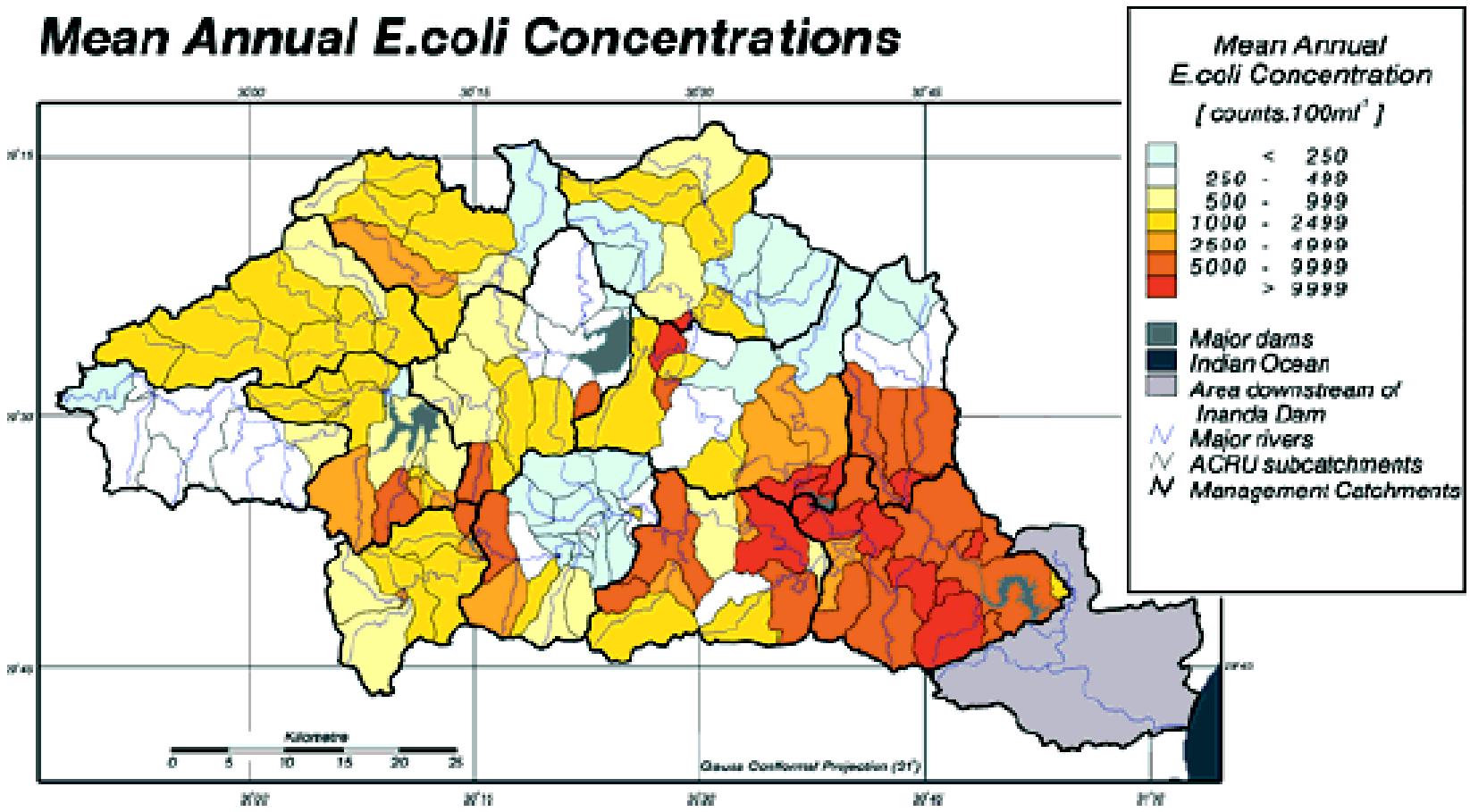


Fig. D.91. Mean annual *E. coli* concentrations from non-point sources per subcatchment in the Mgeni (from Kienzle et al. 1997)

NO NEED TO PANIC!

RES7962

FORCING A SOLUTION?

RES8510

RES8514