The Control of Invasive Alien Plants, Conservation Measures and Dams – A Manipulation of Research?

Guy Preston

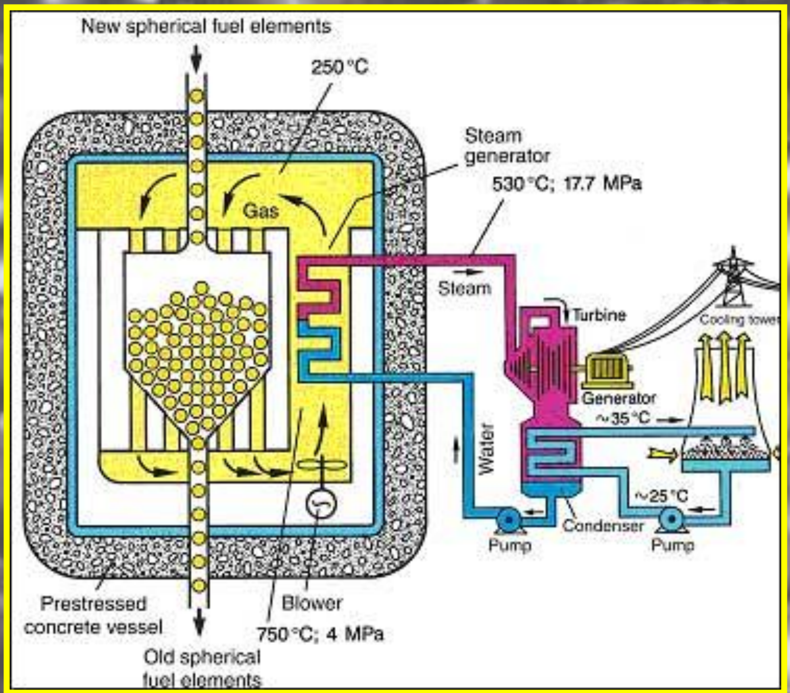
WATER SECURITY IN A WATER-SCARCE COUNTRY.

Wednesday 31st August 2011, 15h30 to 16h00

It is irrational to be "opposed to dams"; but it is essential to question whether dams deserve the "halo" they are given in certain circles (even if usually those with vested-interests).

The resource economics regarding the cost-effectiveness of dams (versus alternatives) has been inadequately done in South Africa, and has misled decision-makers.

Moreover, there has been no systematic study to look at the projected costs of dams, and the actual costs upon completion, and how these compare with the alternatives, in South Africa.



When the Pebble Bed Modular Reactor was proposed, the author wrote to some Ministers saying that the energy being generated by the PBMR would cost more than 100 times the price (without externalities) of saving the same amount of electricity by using compact fluorescent lamps. After spending over R9 billion on the PBMR, it was shelved for being too expensive.

In 1997, the author proposed banning electric hot-water cylinders, and making it mandatory to use solar-compatible cylinders. (The costs are similar, but the latter can function off electricity or solar panels.) Had this been done, and solar panels later been added, about 2,000 MW of energy could have been saved – enough to stave off the energy crisis in 2008. It will now cost over R30 billion to replace just the electric geysers that have been installed since 1997.

Abstract

1. The principal purpose of research (backed up by monitoring and evaluation of the implementation of the research) should be to inform decision-making about the relative merits of different potential interventions regarding water security in a water-scarce country.

2. Various water planning analyses have indicated that the conservation of supply – notably with regard to the control of invasive alien plants, but also in terms of catchment management, wetland conservation, soil management and siltation – and demand-side management are the most cost-effective interventions in specific schemes.

3. An insufficient emphasis on these aspects in research has meant that decision-makers intent on augmentation of supply through new dams, transfer schemes, desalination plants and the like, are able to sideline research, and continue to promote sub-optimal choices in the management of water in the country. What does this say about the role of research?

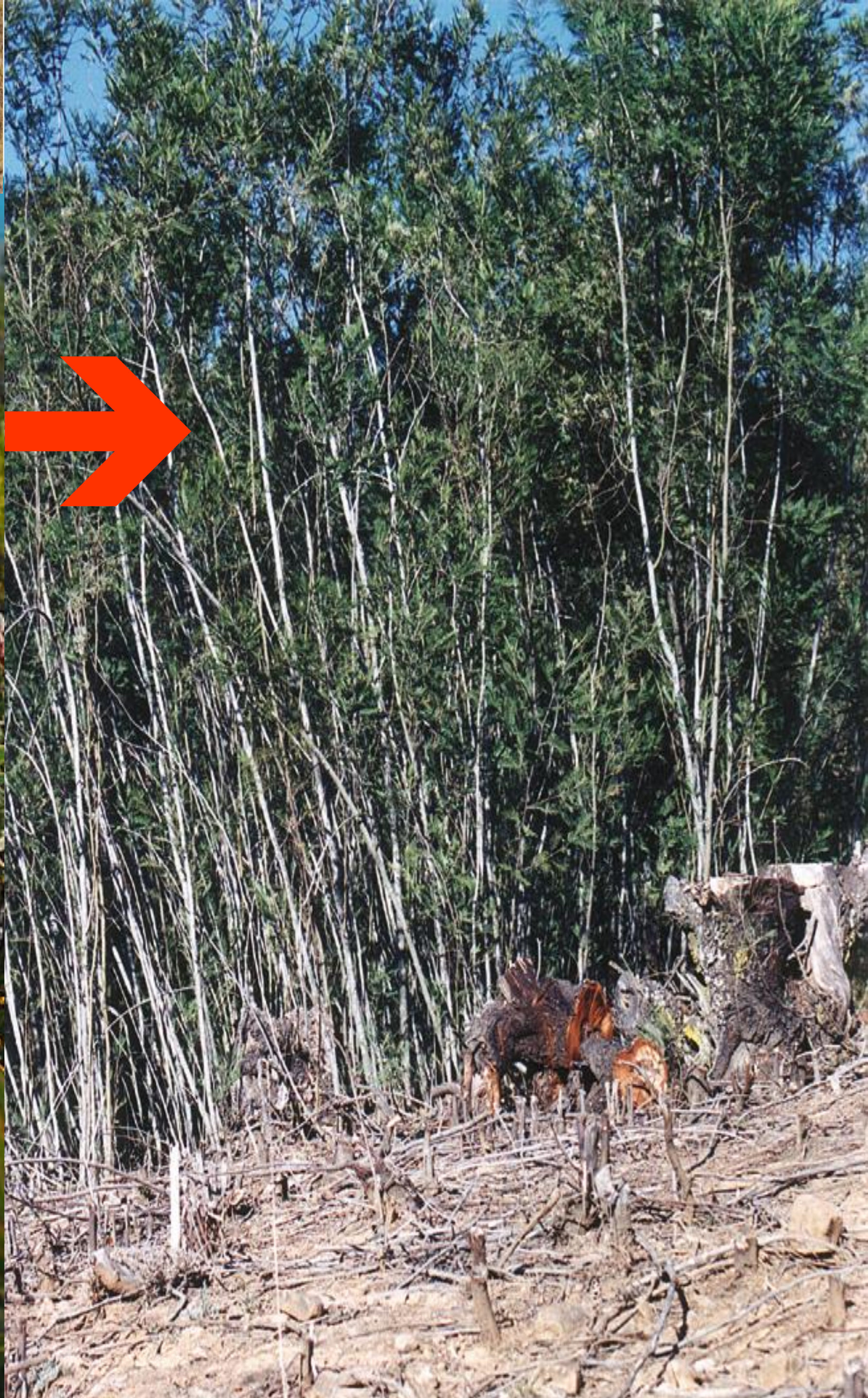
4. Furthermore, the failure of the research to estimate at the full costs and benefits associated with the various options, compounds the problem, and contributes to the risk of poor decision-making regarding planning and development.

5. To add insult to injury, there must be question marks about the research guiding decision-makers on the costs of the preferred supply-side interventions, when there are often massive discrepancies between what the decision-makers are told will be the cost of dams and other augmentation schemes, and their final costs.

Contents

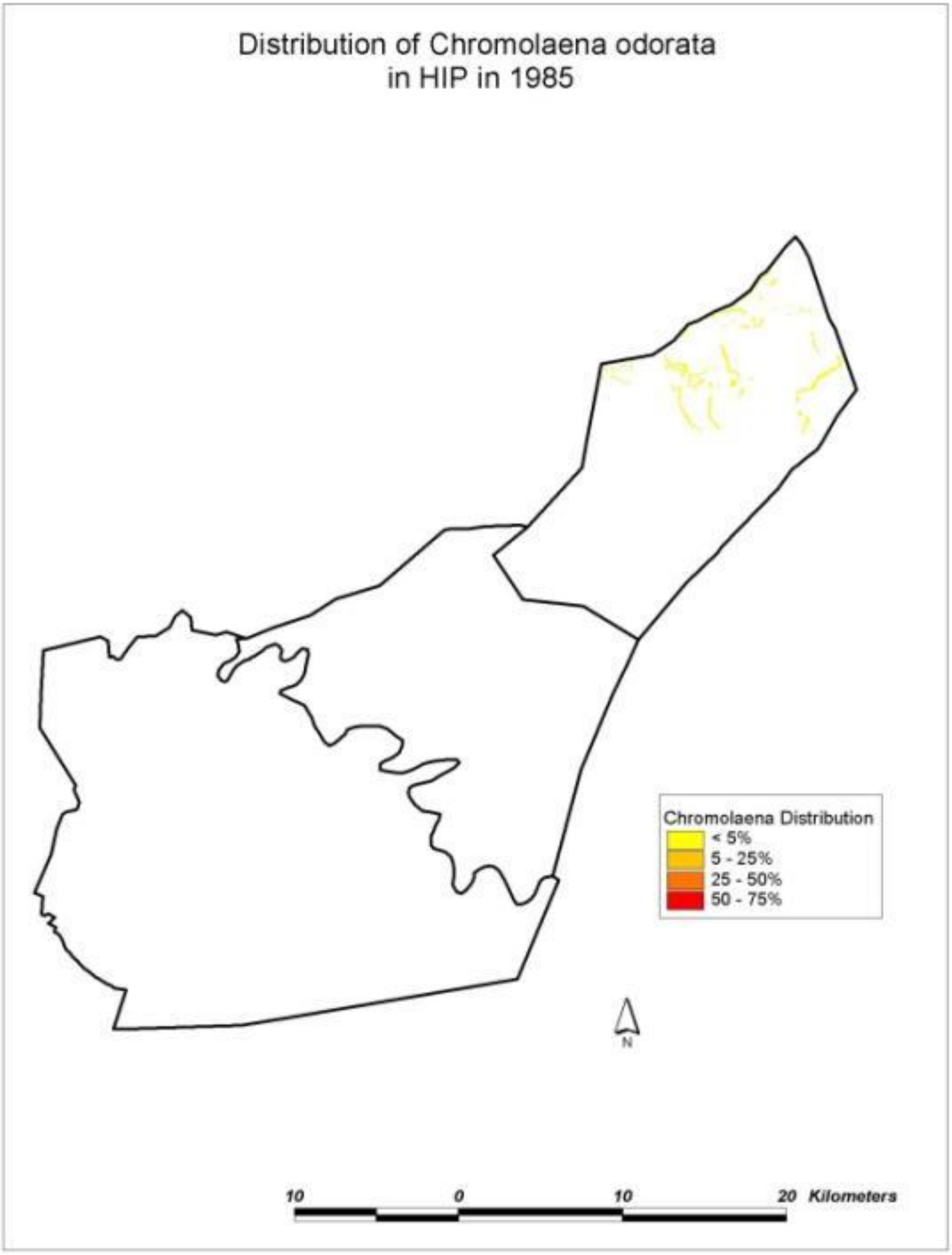
1. Water Security and the control of invasive alien plants

Species produce sufficient offspring to ensure the survival of the species, given the prevailing threats and competition in their natural habitats – in general, that they are replaced by their offspring. When moved to new habitats, they may both escape their predators and be able to out-compete the indigenous species, leading to an invasion where each individual produces massive numbers of offspring that themselves live to reproduce.

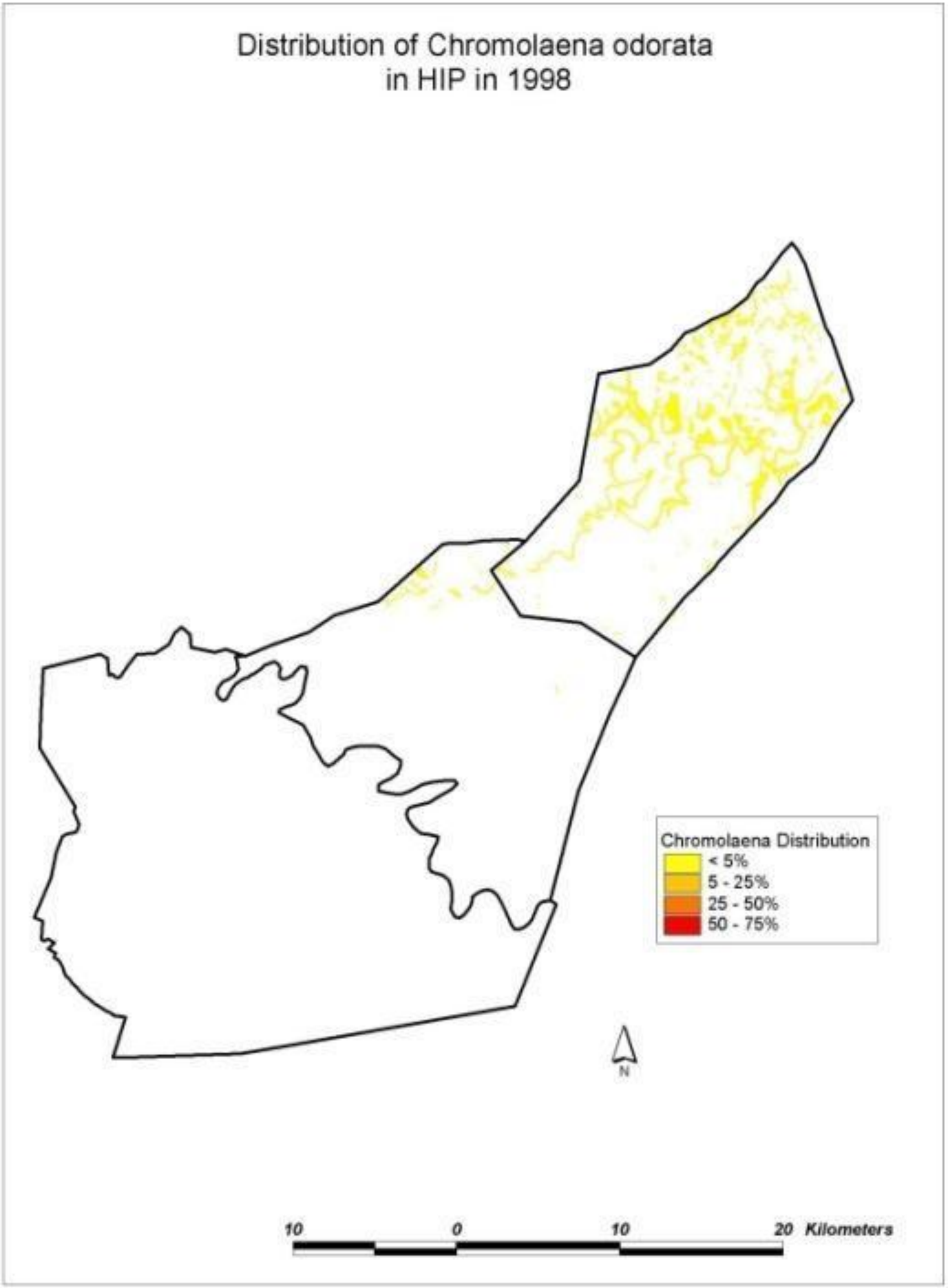



Chromolaena odorata (triffid weed), from Central and South America, is invading the Hluhluwe-Imfolozi Park.
Our wild (and domestic) animals will not eat *Chromolaena*.

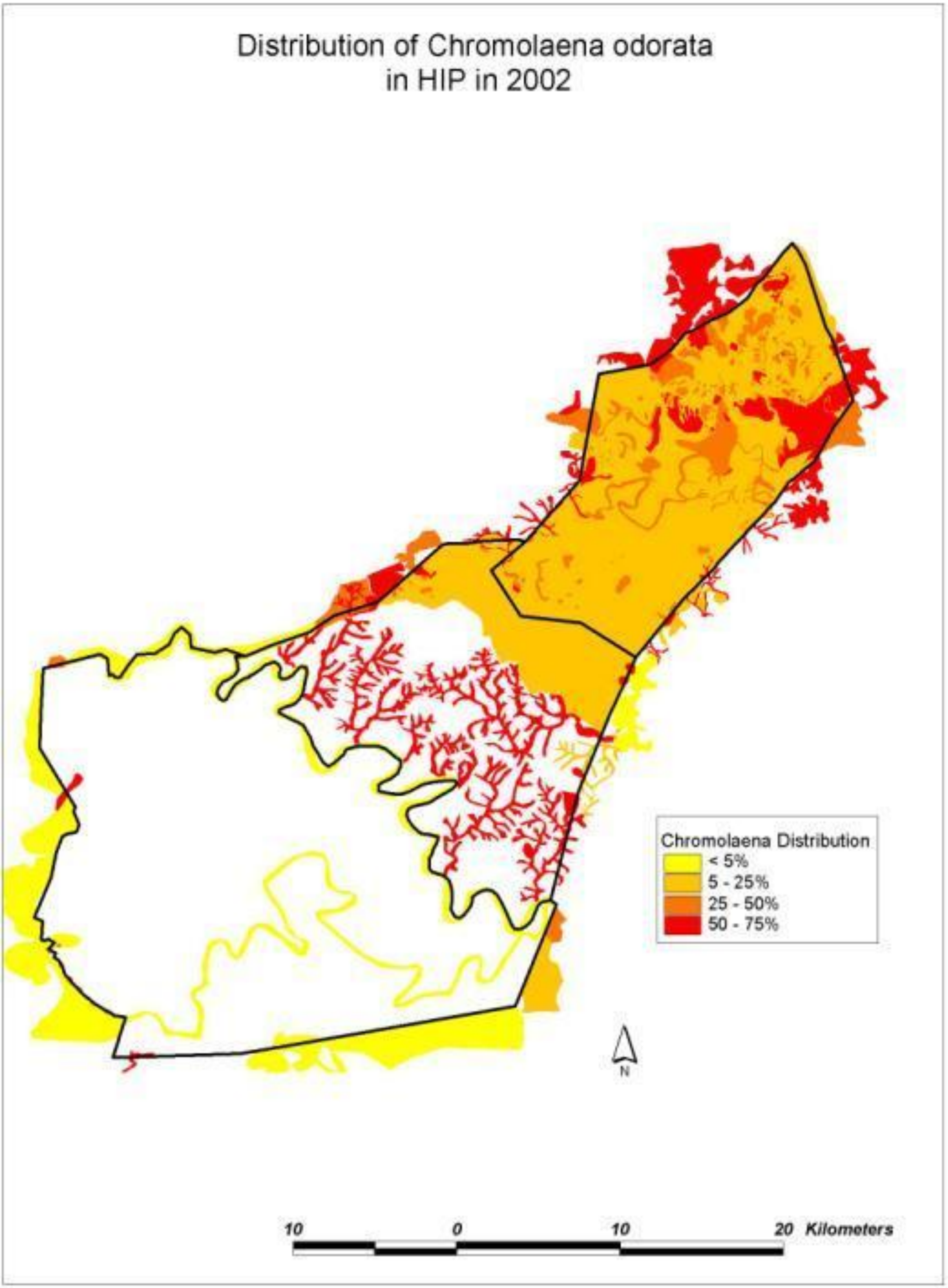
In South Africa's Hluhluwe-Imfolozi Park, what looks like land with a high carrying capacity for game, is being invaded by *Chromolaena.*



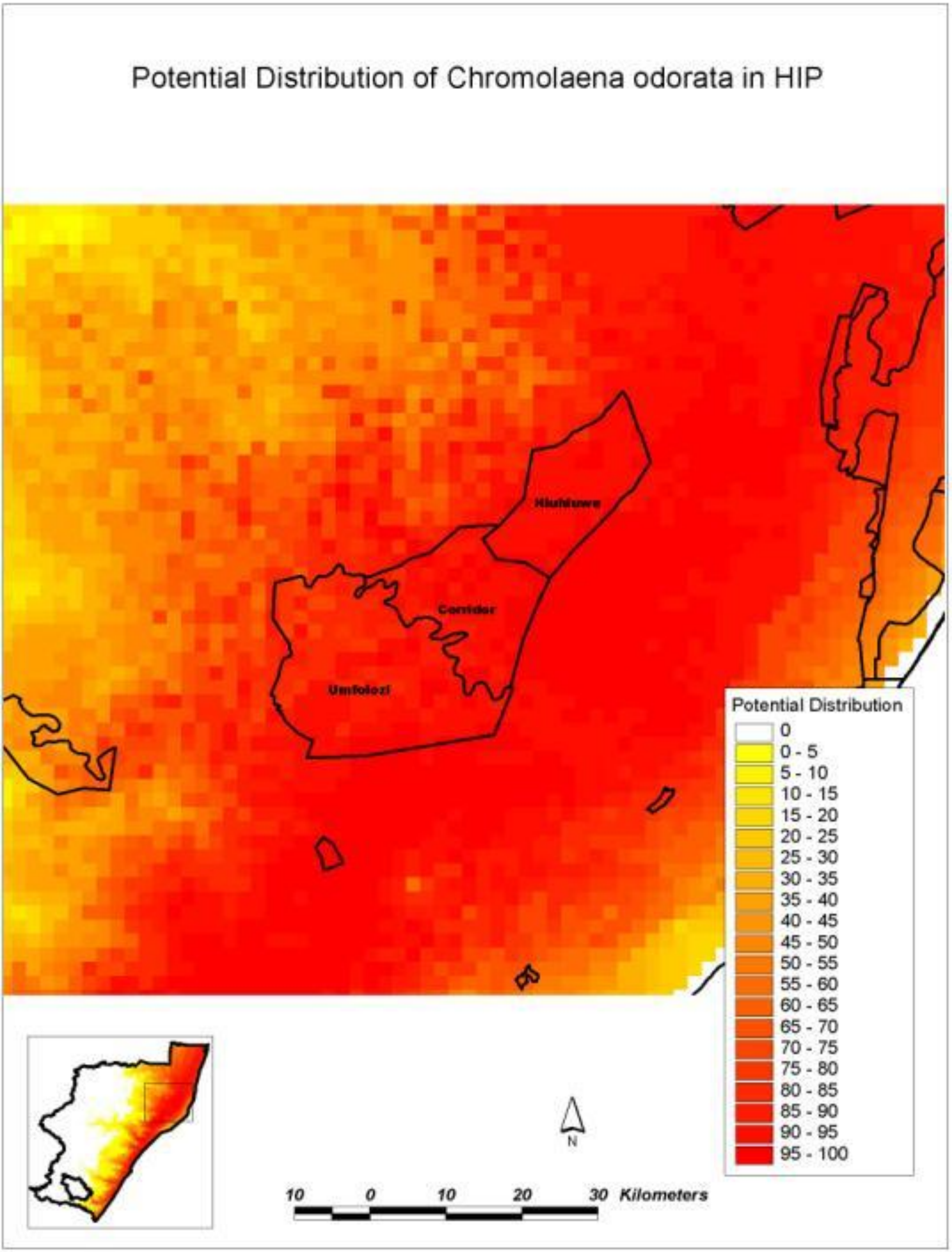
Chromolaena was mapped when invading the north-east section of the Hluhluwe-Imfolozi Park in 1985.



By 1998, the *Chromolaena* was far more widespread in the Park, although still at low densities.

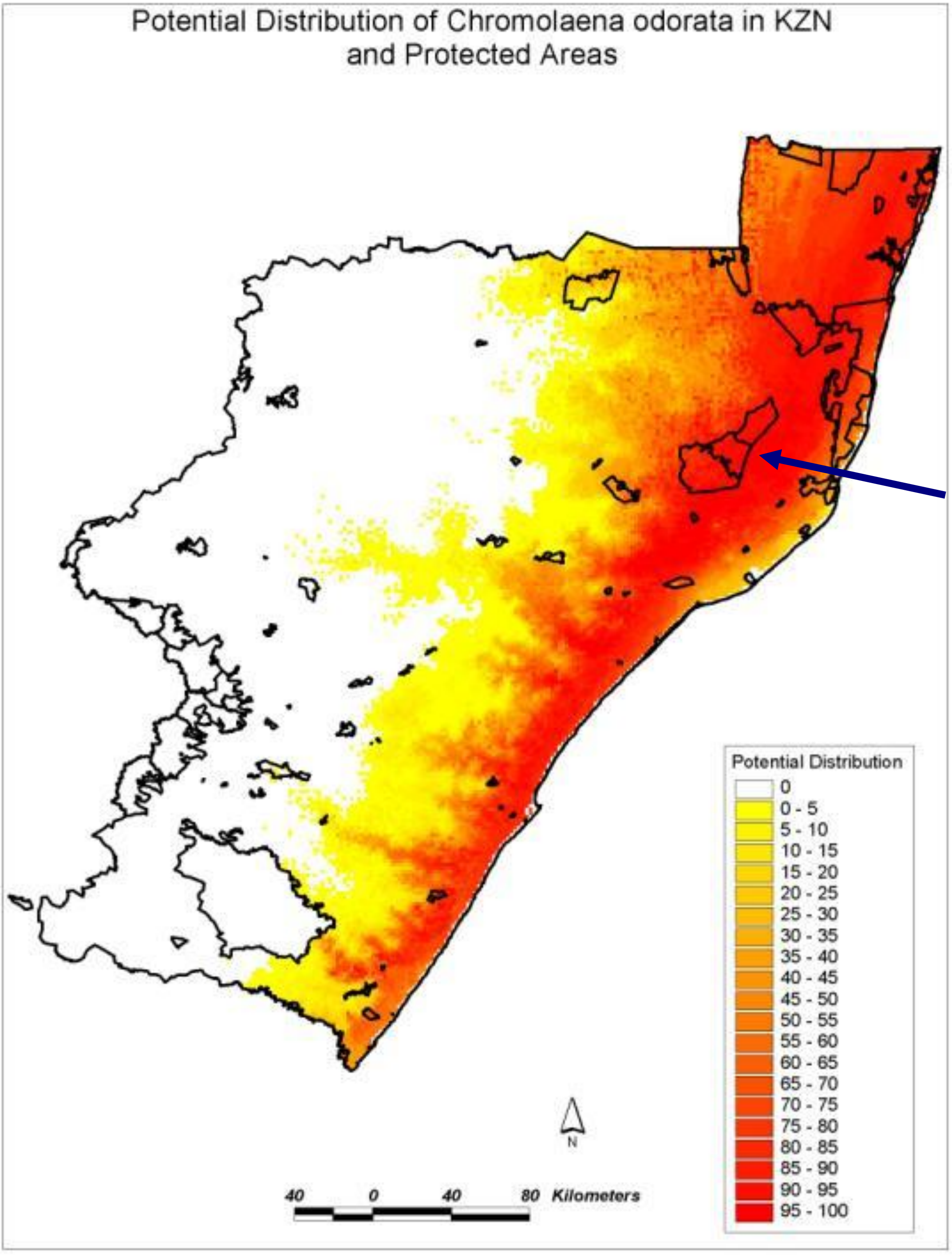


However, by 2002 (just four years' later) the level of invasion had changed dramatically. The *Chromolaena* had spread and grown across much of the Park, and the densities had become far greater as well.

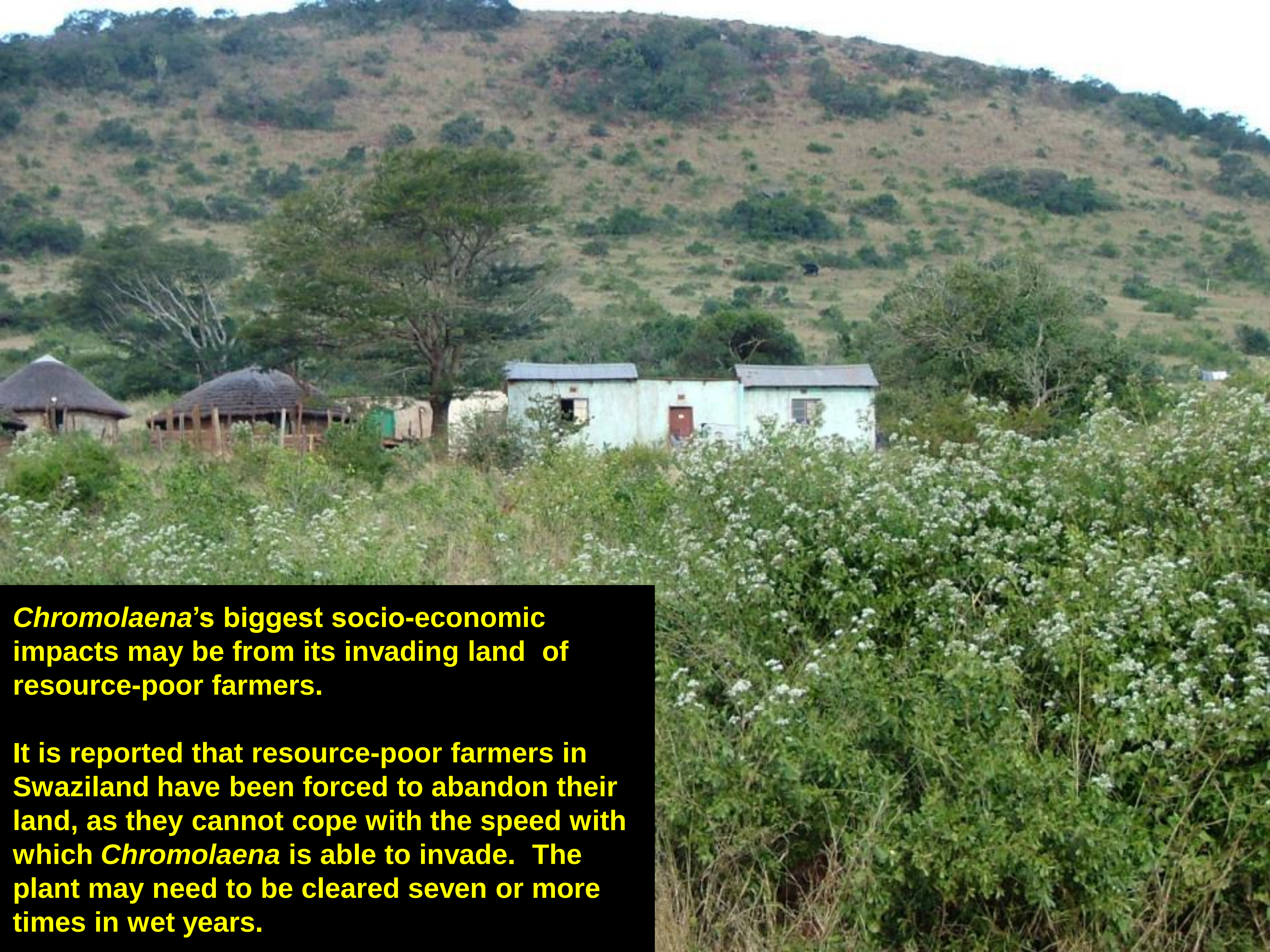


Our 2005 assessment of the invasion by *Chromolaena* was that it could engulf Hluhluwe-Imfolozi Park within ten years. If that was allowed to happen, then the impacts would be predictable:

- Little for animals to eat.
- No animals, no tourists.
- No tourists, no jobs.
  (Loss of 3,000 jobs.)
- Loss of R100 million p.a. revenue.
- Devastating impact on local economy, in an impoverished part of the country.
- The biggest financial impacts would, however, be felt by the broad support industries that benefit from the tourism in the Hluhluwe-Imfolozi Park – and all of the other Parks that would inevitably face the same fate.



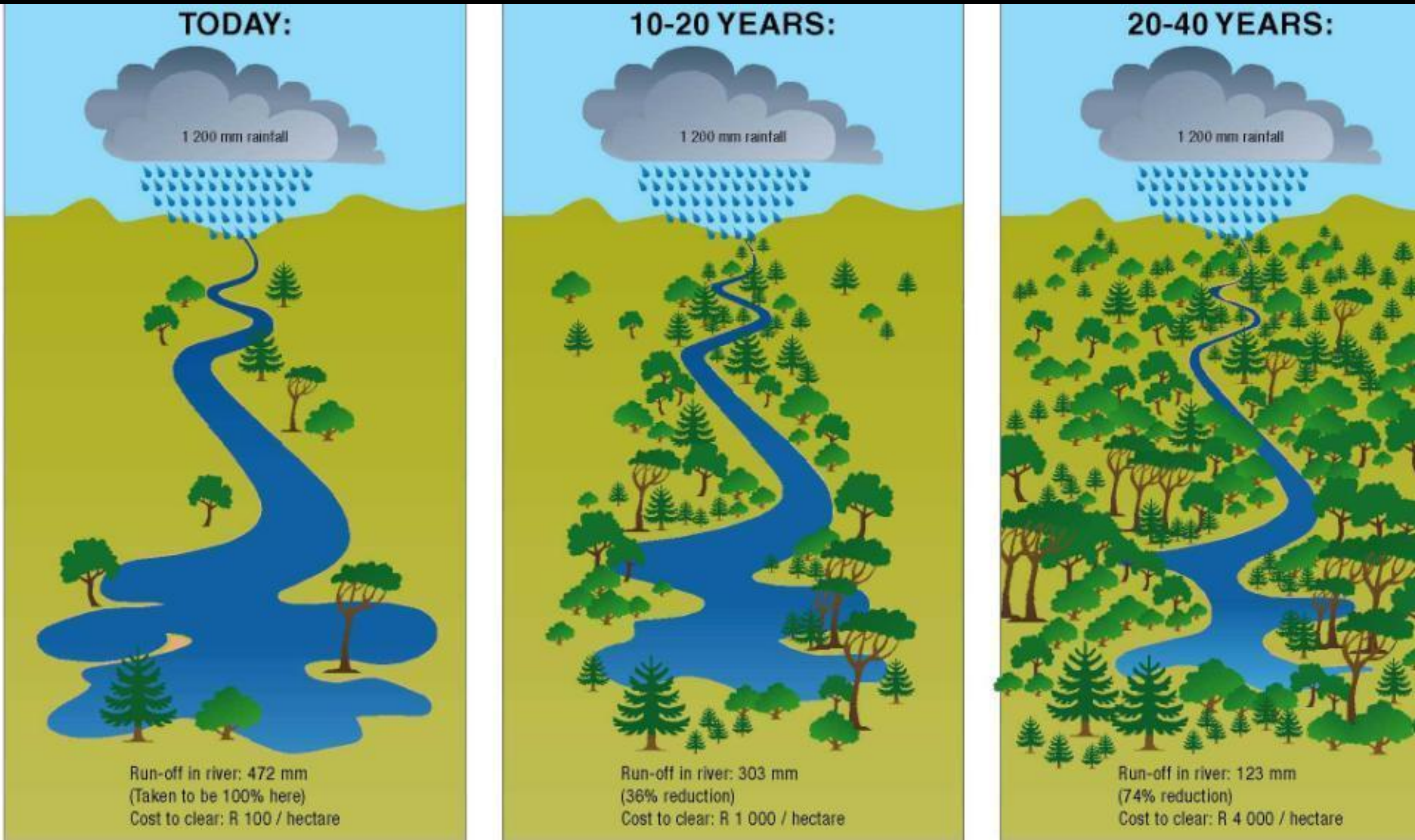
It's not just the Hluhluwe-Imfolozi Park that is being threatened by *Chromolaena*, but all lower-lying areas of KwaZulu-Natal and adjacent provinces in South Africa, as well as Swaziland and Mozambique. This shows the potential spread of the invasive alien plant in KZN.



***Chromolaena*'s biggest socio-economic impacts may be from its invading land of resource-poor farmers.**

It is reported that resource-poor farmers in Swaziland have been forced to abandon their land, as they cannot cope with the speed with which *Chromolaena* is able to invade. The plant may need to be cleared seven or more times in wet years.

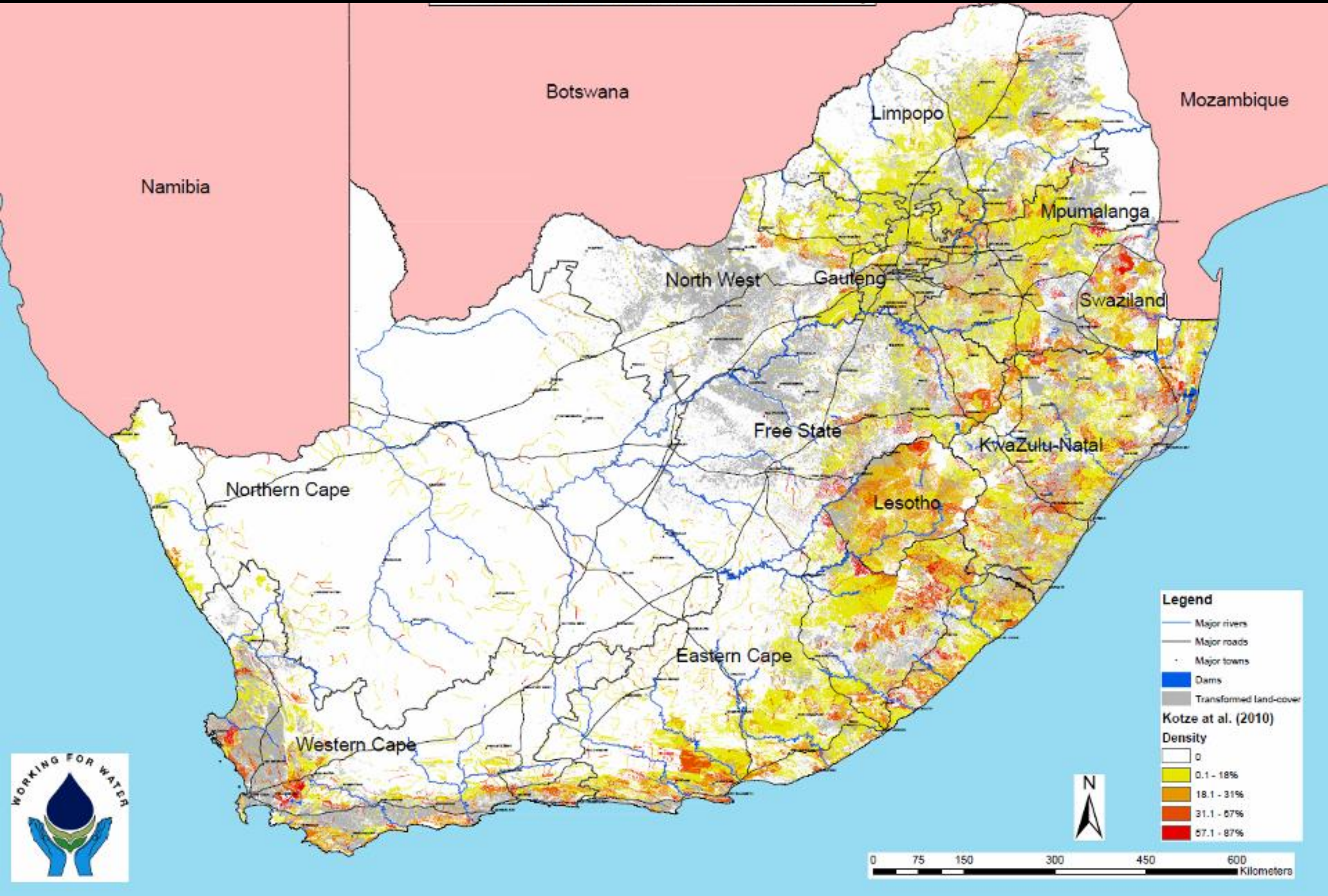
Recent research has indicated that *Chromolaena odorata* may have impacts on water similar to those of large invasive trees like gums, pines and wattles. It is also known as the "paraffin bush", for the intensity with which it burns.



Water hyacinth (*Eichhornia crassipes*) on Roodeplaat Dam, near Pretoria/Tshwane. It leads to an increase of about 40% in evaporation levels; exacerbated water quality costs (including toxic algae problems); damage to infrastructure; eutrophication and fish deaths; loss of recreational activities; diseases problems, and more.

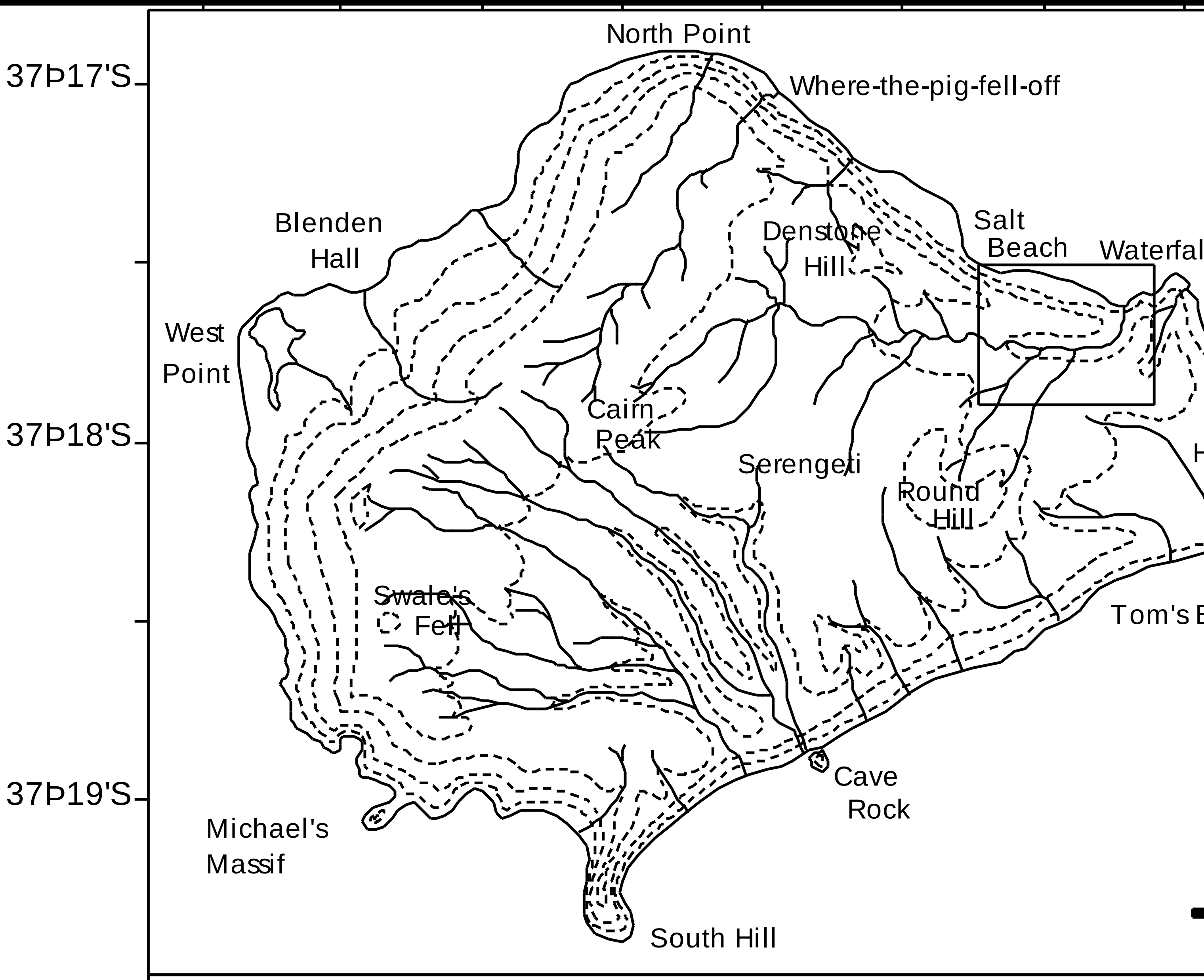
In the growing season, water hyacinth can double the surface area it invades in just one week.

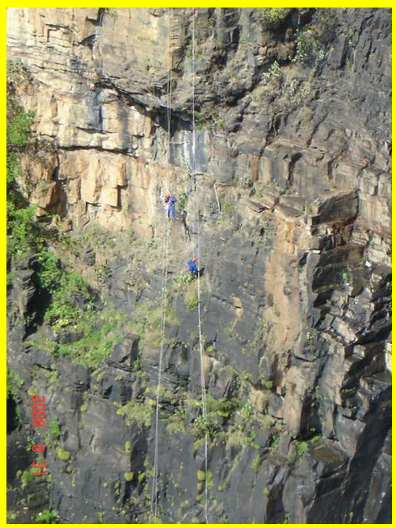
Twenty million hectares of South Africa were found to be invaded – an area twice as large as previous estimates (i.e. the 1997 rapid reconnaissance using an expert-knowledge approach).



Pines invading the watersheds – the "water factories" – from a plantation in the Western Cape. If the invasion is not controlled, building any new dams in the area would be fruitless expenditure!

High-altitude invasives are a priority. Left alone, they will reach thresholds where it is not possible to control them. It took two workers 12 hours to kill eight invasive New Zealand flax plants on Inaccessible Island, as they had to abseil down 1,000 foot cliffs.





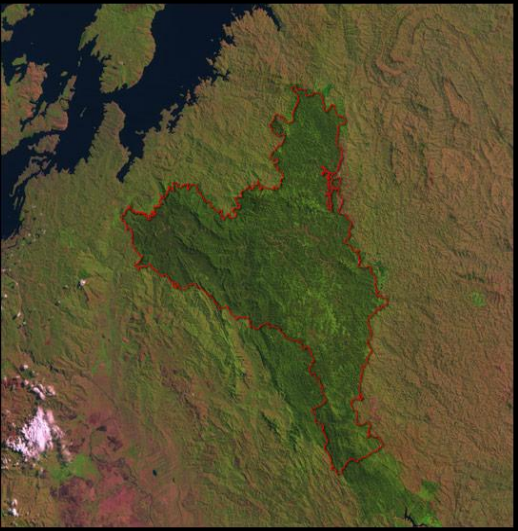
Invasives invade. Wild fires accelerate invasions, and exacerbate impacts. The costs escalate disproportionately. There is a threshold beyond which the control of invasions in mountains is unaffordable – even though there are simultaneously unaffordable impacts for water security.

What resource economic analysis has been done, to ascertain the water security costs and benefits of building desalination plants, such as this 15 megalitre-per-day plant (~5.5 million kilolitres per annum) in Mossel Bay , built at a reputed cost of R210 million, and with very high operating costs that will become more and more expensive? And what would R210m spent on managing the catchment have yielded?

The “Lethal Cocktail" of Environmental Change

Invasive Alien Species:

invasive grass in China



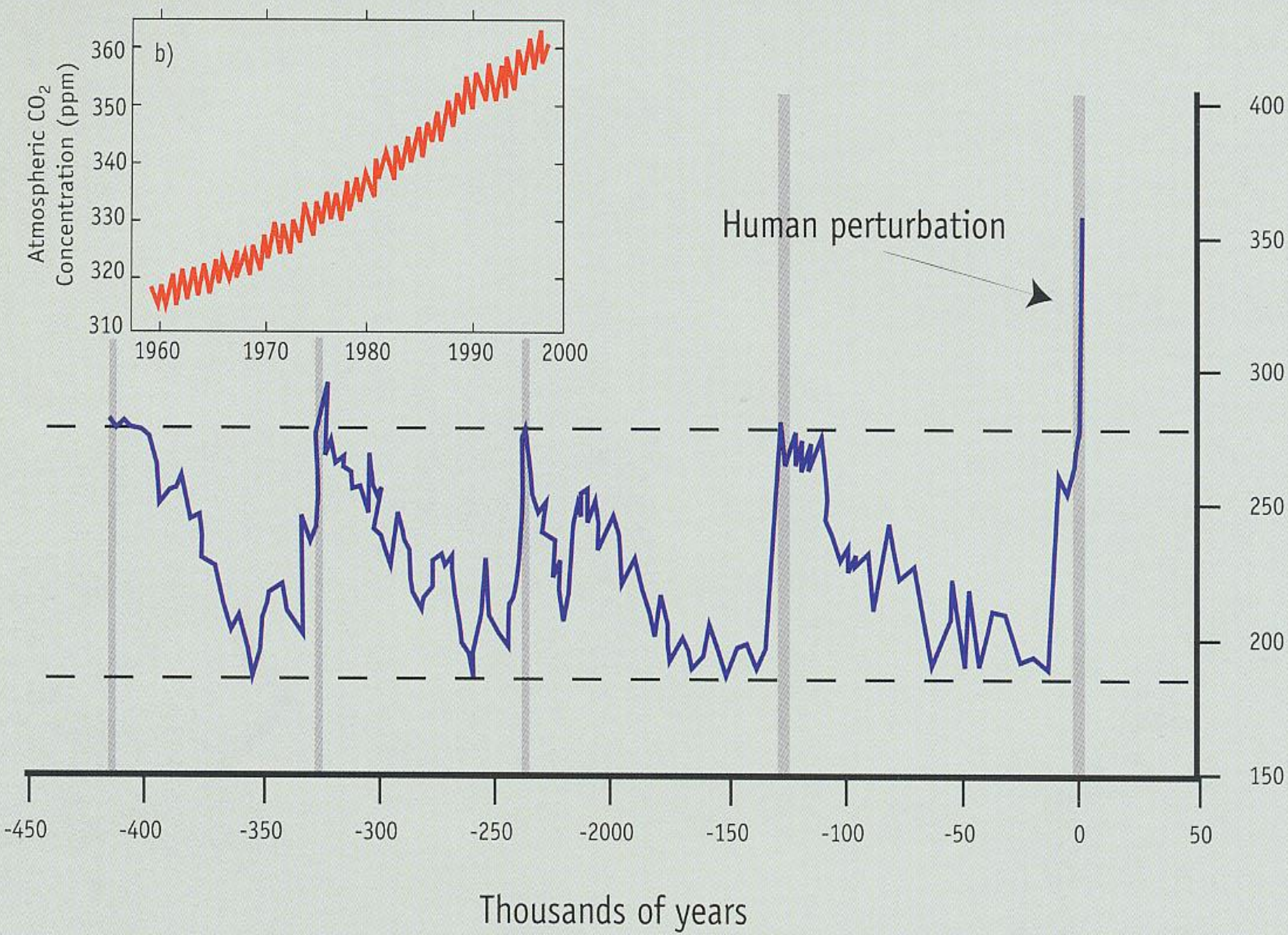
Habitat destruction:

Nyungwe National Park, Rwanda

Climate Change: Melting glaciers:

Torres del Paine National Park, Chile

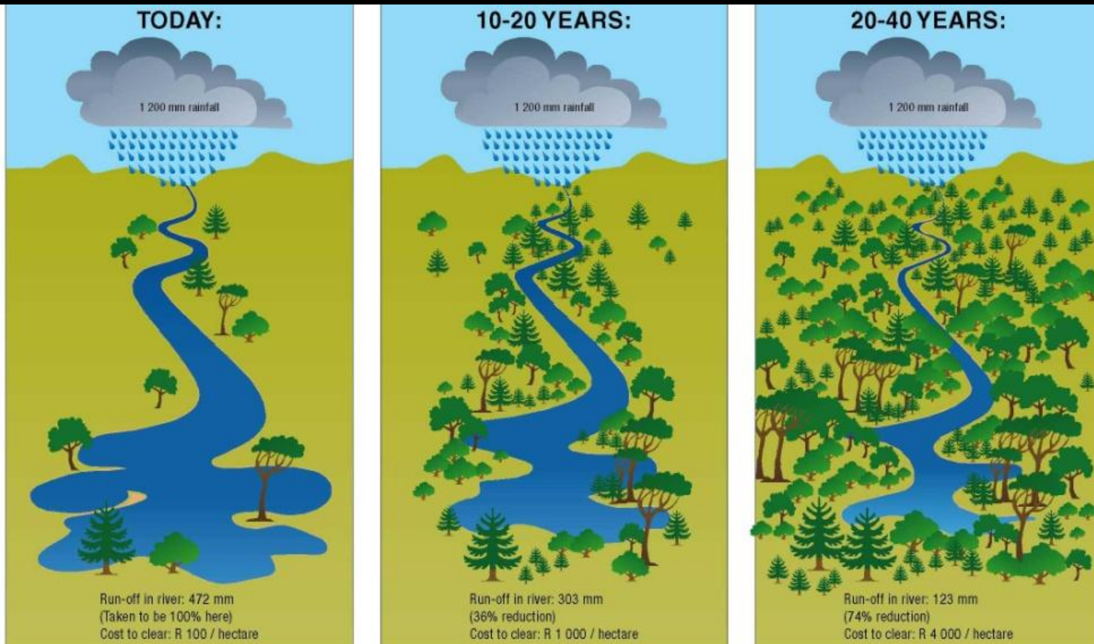
The recent human influence on the carbon cycle



Root and shoot growth of sweet thorn (*Acacia karoo*) at different parts-per-million of atmospheric carbon dioxide (CO_2)

The already problematic mesquite (*Prosopis* species) in the Northern Cape are well-adapted to take advantage of climate change, with disastrous implications for rivers, keystone ecological species, groundwater and human livelihoods.

The long-term water-related impacts of invasive alien species ...



← R5.8 Billion per annum loss of water quantity per annum – before impacts of new invasions, and climate change (CSIR, 2010). Up to 25% of Mean Annual Runoff could be lost to invasives (currently 7%).

Water-borne disease impacts of invasives are not yet calculated (eg, malaria, bilharzia). ↑

↑ Water quality impacts of invasives have not yet been calculated, but are also significant.

← The impacts of invasives on the ecological functioning of estuaries has also not calculated, but is important (including for breeding of marine fishes).

The (massive) impacts of invasives on soil erosion, siltation and mudslides have yet to be quantified.

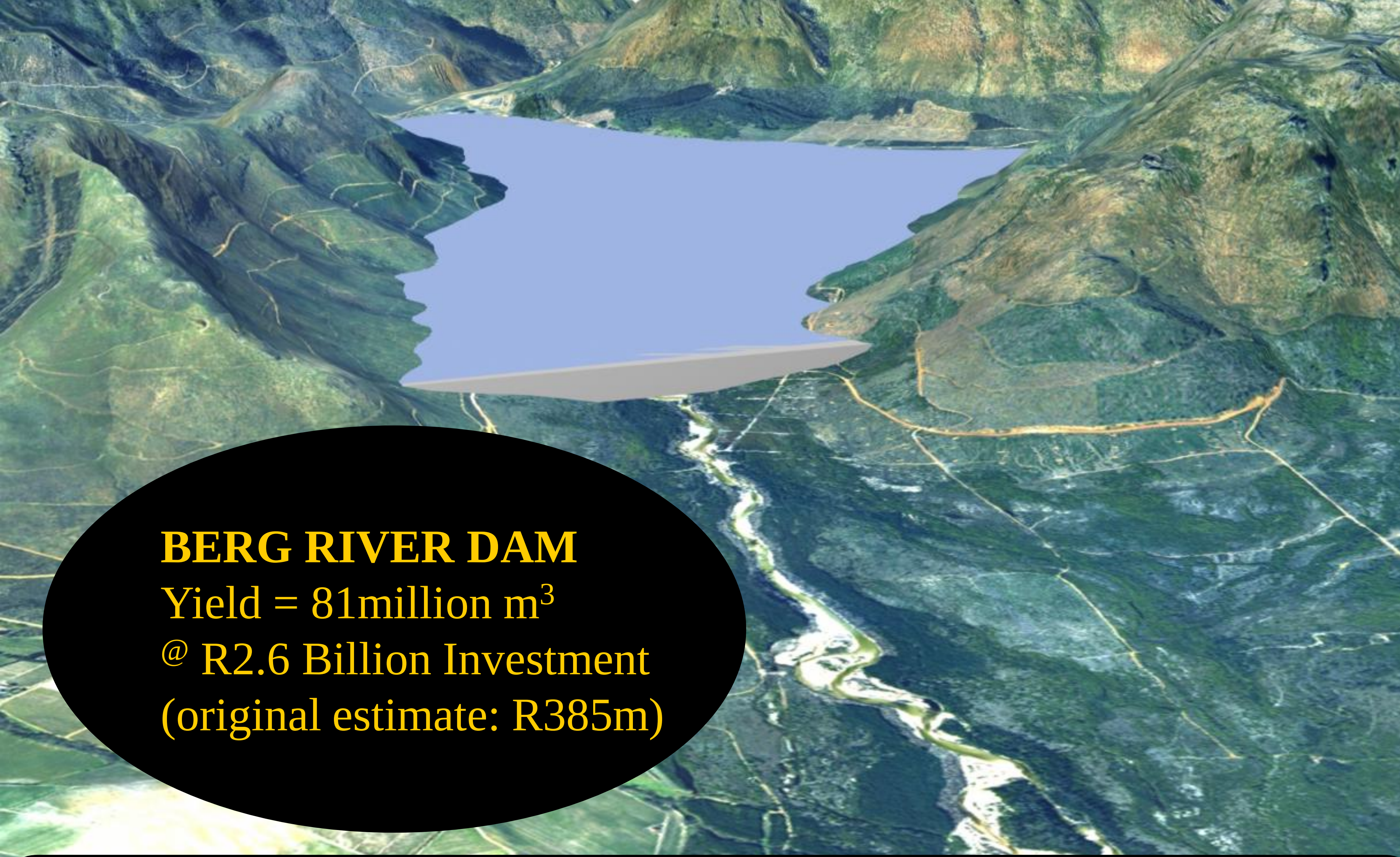
The carrying capacity of Large Stock Units could decrease by 71% if invasive alien plants are allowed to spread to their full potential, at a cost of R337m per annum (CSIR, 2010).

Blue Ridge Platinum Mine –
Water (from clearing invasives) for Growth and Development

- Invasive plants in catchment cleared over 10-year period
- Water yield 1,859,000 m³ / year secured
- Cost to company of R119 million
- Over 980,000 persondays of clearing work created
- A R5.8b mine / R2.3b foreign exchange per year is viable
- Up to 2,000 permanent jobs created

AND

Additional run-off of over 2.1 million m³ / year available for the Environmental Reserve of the highly stressed Olifants WMA



The clearing of invasive alien plants in riparian areas alone between 1998 and 2006 increased yield by more than 30 million m^3 or 40% of the yield of the Berg River (Skuifraam) Dam, at an investment of only R116 million (less than 5% of the capital cost of the dam and its water purification facility).

The management of plantation forestry has improved regarding where and how trees are planted, but the impact of invasions from the plantations remains a massive problem in too many cases, where the costs are imposed on others, the environment, wild fires, and certainly water security.

Clearing Invasive alien plants and dams

- Clearing invasive alien plants will increase flows, particularly dry-season flows, especially where there were riparian invasions.
- Restoring vegetation will tend to increase transpiration but should increase infiltration and reduce quick flow volumes; the result would be a reduction in total runoff but an increase in dry season runoff.
- Building new dams limited by consideration that there is a finite amount of water in the system.
- IAP invasions have limited impacts on yields if a dam's yield is not being fully exploited.
- Yield reductions will match the flow reductions when the dam is fully exploited (ie, during extended below-average rainfall periods), and will affect a dam's yield.
- IAP invasions will continue to increase. Their impacts on runoff will increase if they are not managed . They will eventually have to be cleared – and at much greater cost.
- There is a need for more experimental research to demonstrate to what degree the management of invasive alien plants can enhance yield from dams, and how this aligns with modeling.

Invasive alien plants, rivers and dams

How does the management of invasive alien plants affect yield from rivers, as opposed to yield from dams?

- The effect from NRM is direct, resulting in changes in flows (particularly increases in dry-season flows) that are critical for people dependent on run-of-river or water supply systems which only hold a few days' or weeks' water.

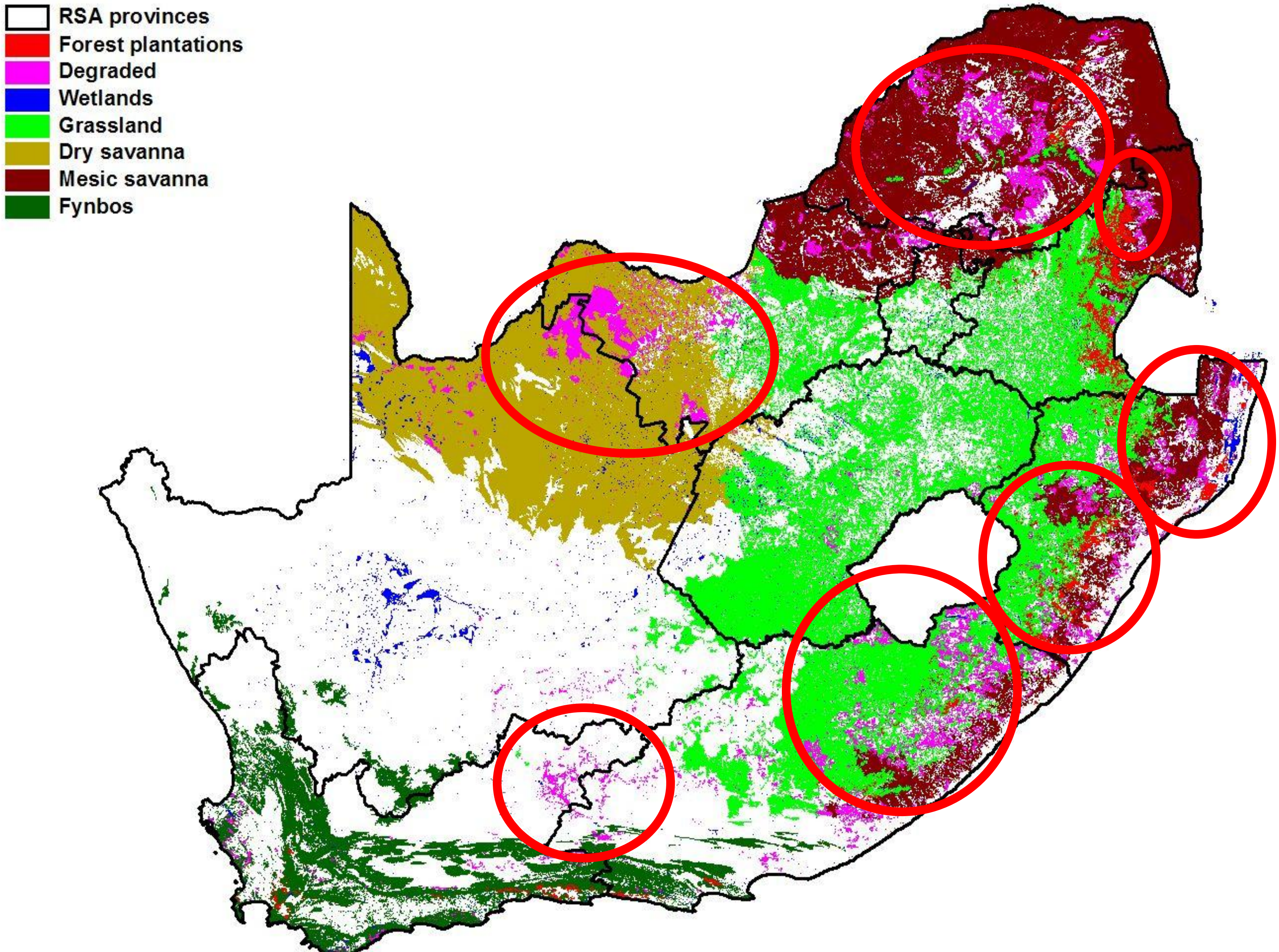
- Studies in Ethiopia suggest the livelihood benefits of catchment restoration are manifold and substantial. We need to quantify these for South Africa.

- It is unlikely that we can reach most rural communities by building large dams and pipe networks; the costs would be prohibitive. NRM is the only real option for river users.

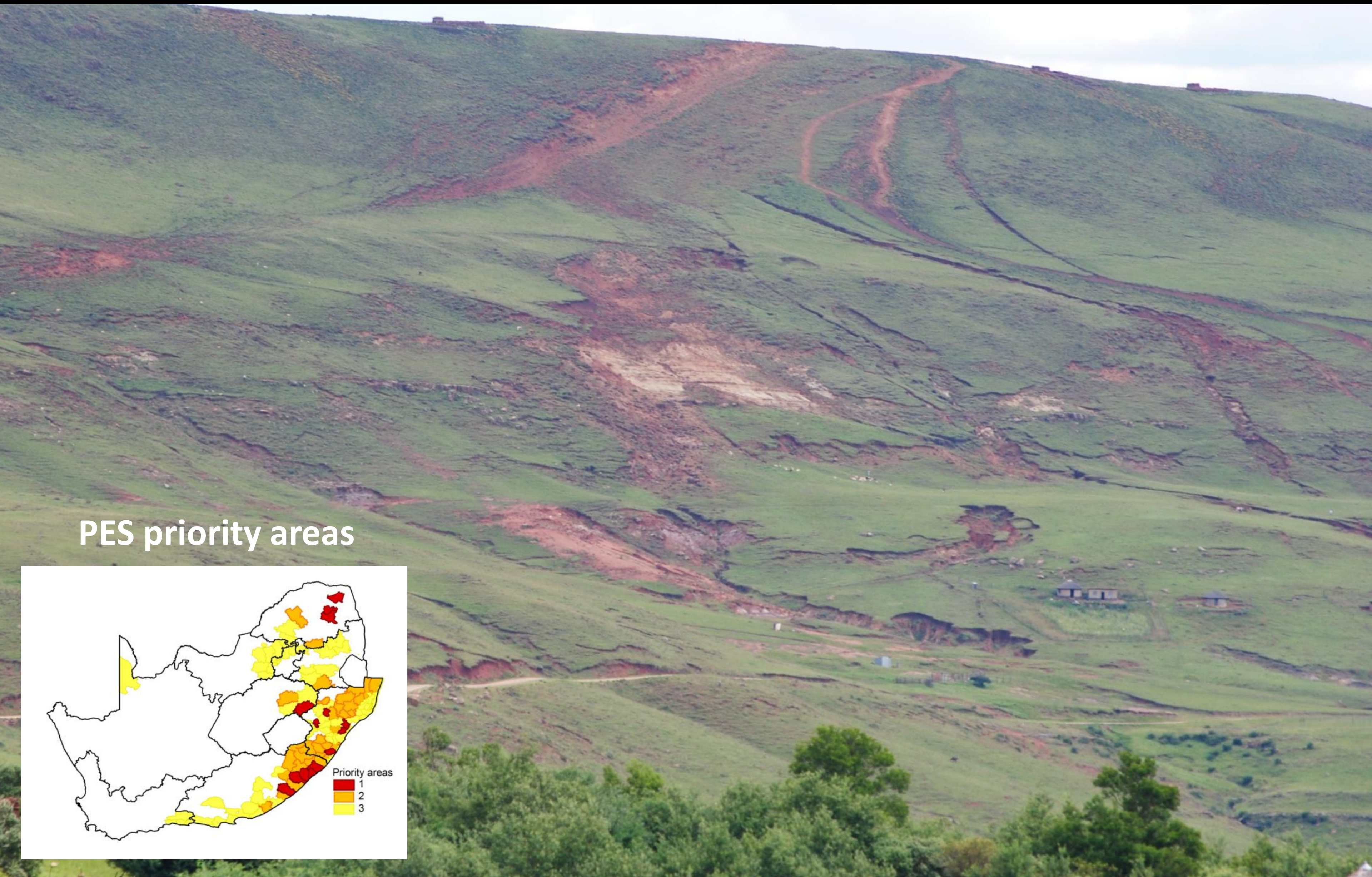
Dr Dave le Maitre

2. Water Security and the Management of Water Catchment Services

Untransformed fire-prone vegetation, forest plantations, degraded vegetation & wetlands

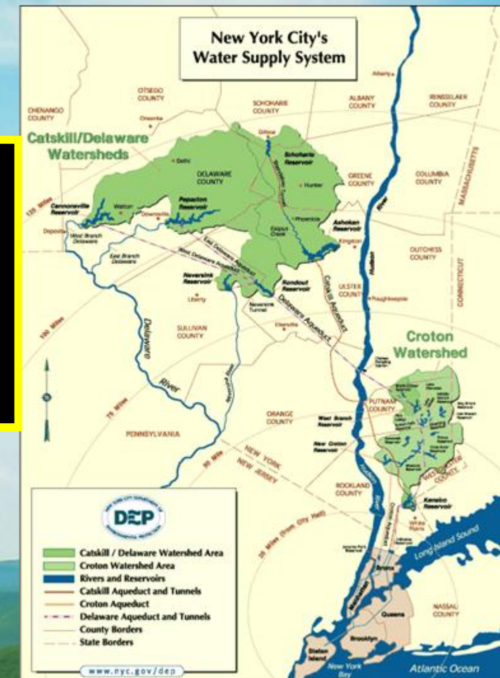


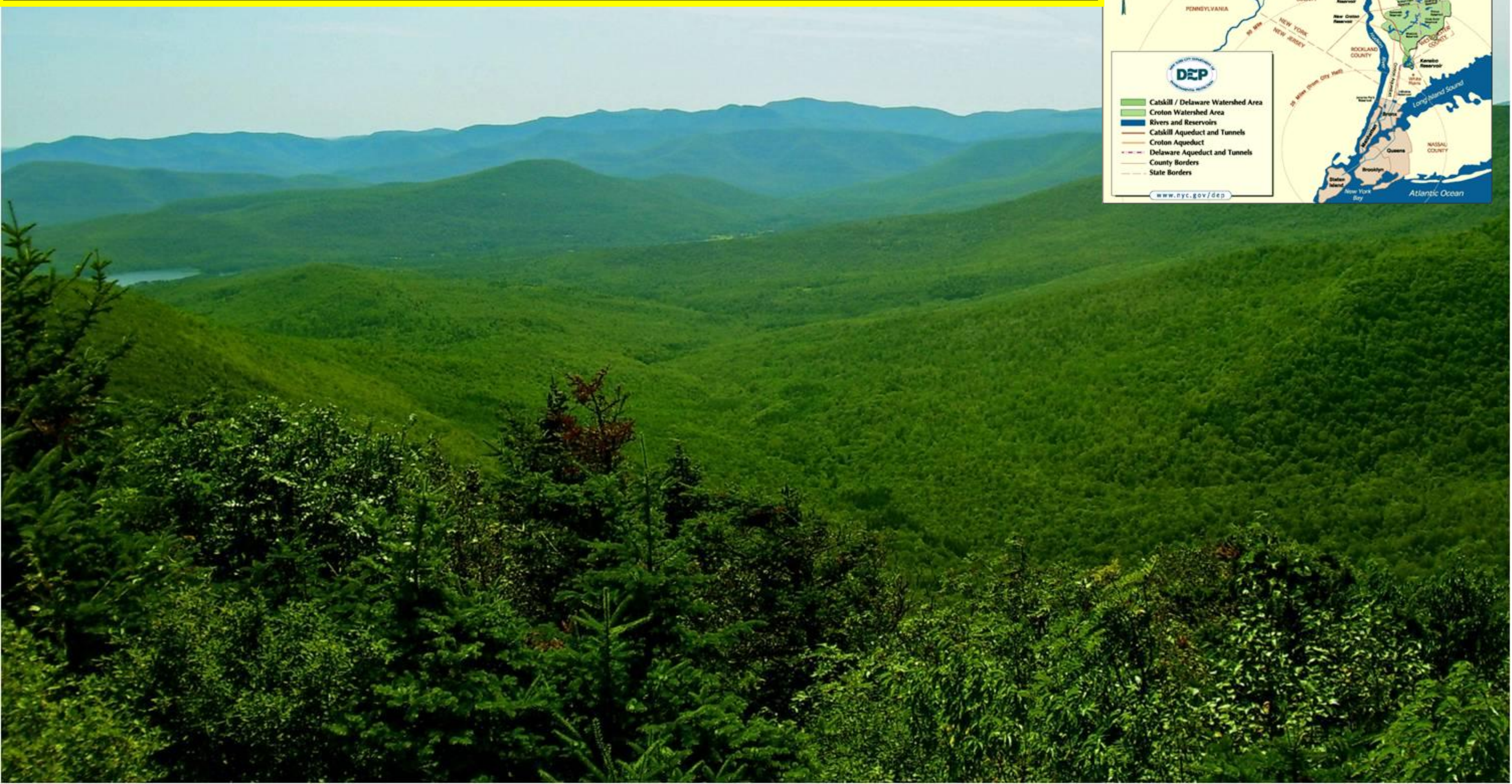
There is massive potential for *Working for Land* in the Eastern Cape, to address the erosion, desiccation, siltation of dams, food insecurity and loss of ecosystem services caused by poor land-use practices.



New York's investment in Catskill Watershed

Risk of development, agricultural run-off, impervious surfaces, wastewater.
Invested US$1.3 billion to protect 830,000 hectares in Catskill catchment.
5 million m^3 of naturally filtered water to 9 million people in New York per day.
Cost saving of US$8 billion for new filtration facility.
Up to US$300 million savings per year in Operational and Maintenance costs.





Kouga Dam and “river”

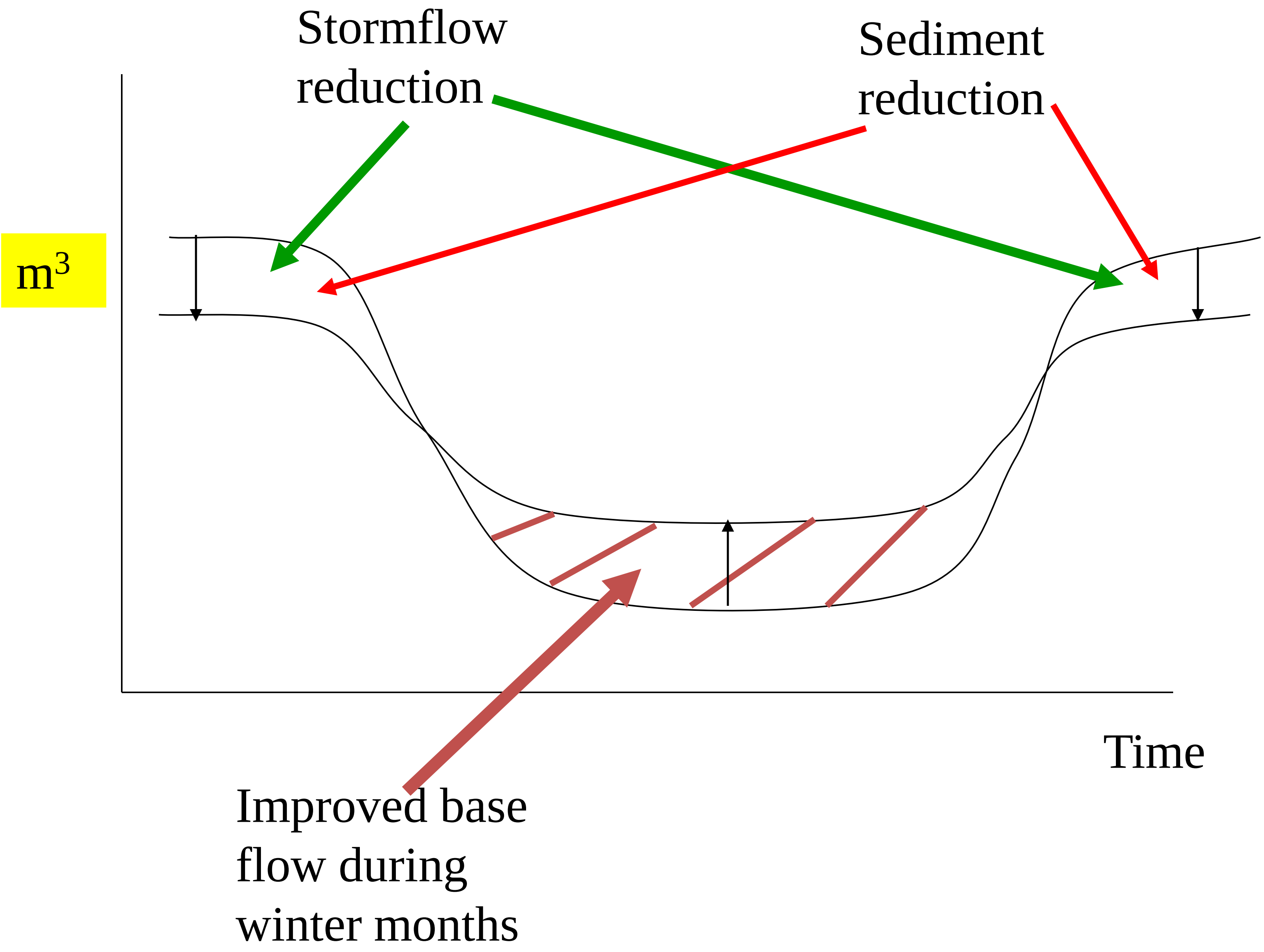
Baviaanskloof

The Baviaanskloof River and Kouga River feed the Kouga Dam. About 100 million m^3 of water is spilled from the dam, each year on average.

Through catchment management, including control of invasives and repair work (which brings in many additional benefits, including carbon credits), it may be possible to reduce this spillage by 12% or more.

The repair of the system was well described by economist, Myles Mander: “Feel the soil. If it is wet, you have a dam under your feet.” Part of the benefit of this project is to restore the water-retention and slow release functions of the ecosystem. It’s like building a 12 million m^3 dam.

Value of improved land management



PAYMENTS FOR ECOSYSTEM SERVICES

Thukela (per annum)

1. 12.8 m^3 river base-flow additional in winter
2. 23% increase in allocable water in Thukela basin
3. (320% increase, from 3 million m^3, in Upper Thukela)
4. Sediment load reduced by 1.2 million m^3

5. Sale value of R3.8 million for additional water
6. Sediment reduction saves R4.1 million
7. Value to economy of up to R88.7 million
8. Carbon sequestration (CDM) value of R8.7 million

9. Total revenue of R16.7 million
10. Restoration cost of R4.6 million (for seven years only)
11. Management costs of R3.8 million

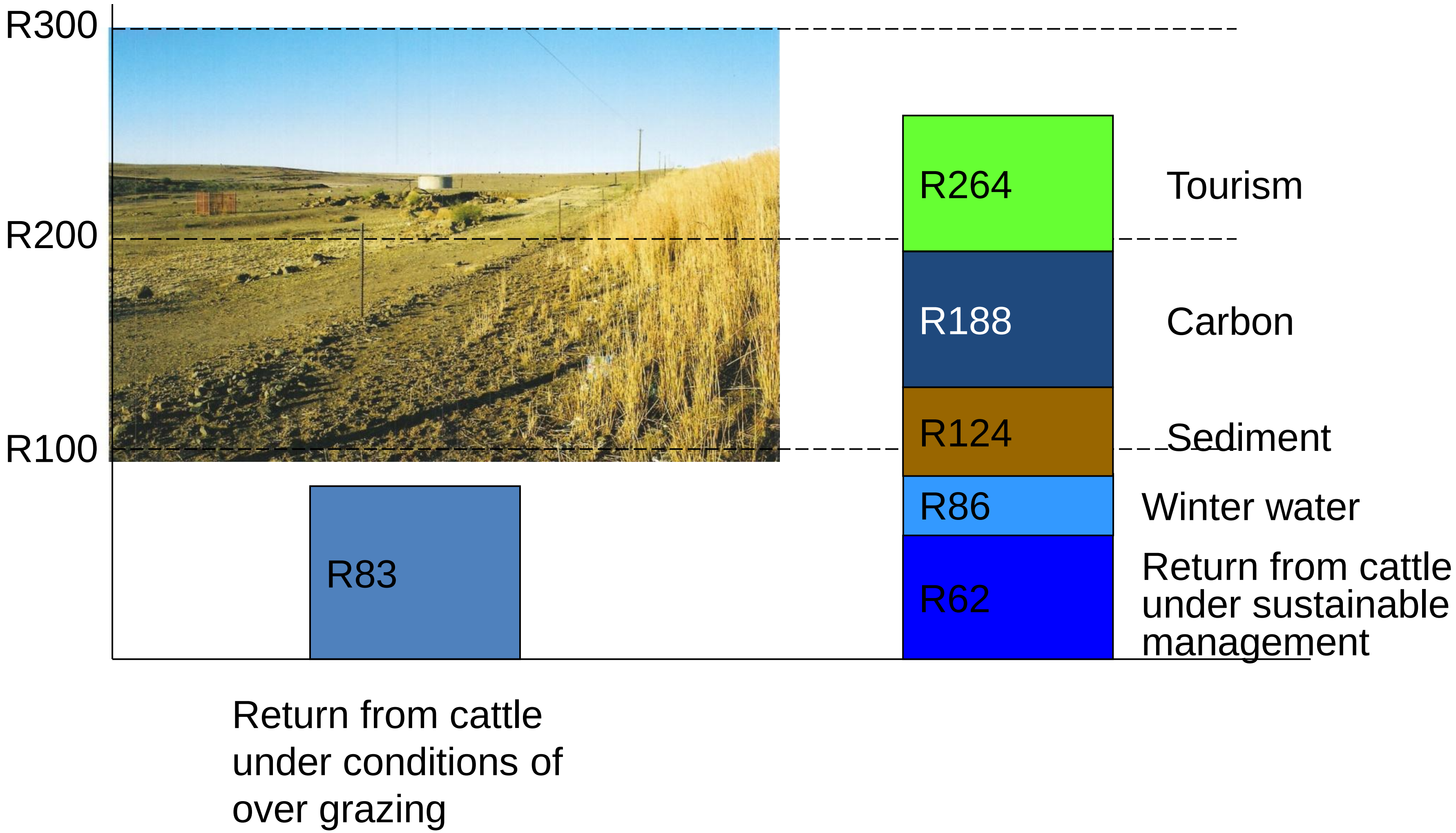
12. Employment for 127 people in catchment management
13. Approximately 450,000 persondays work in restoration

14. Figures exclude the water benefits (eg, 4.9m m^3/yr) from clearing invasives
15. Benefits for flooding (up to 40% reduction), water quality, biodiversity, rural poverty, fires, wetland management and human health are not quantified.

Myles Mander

The Ukhombe case

The value of one hectare (profits)

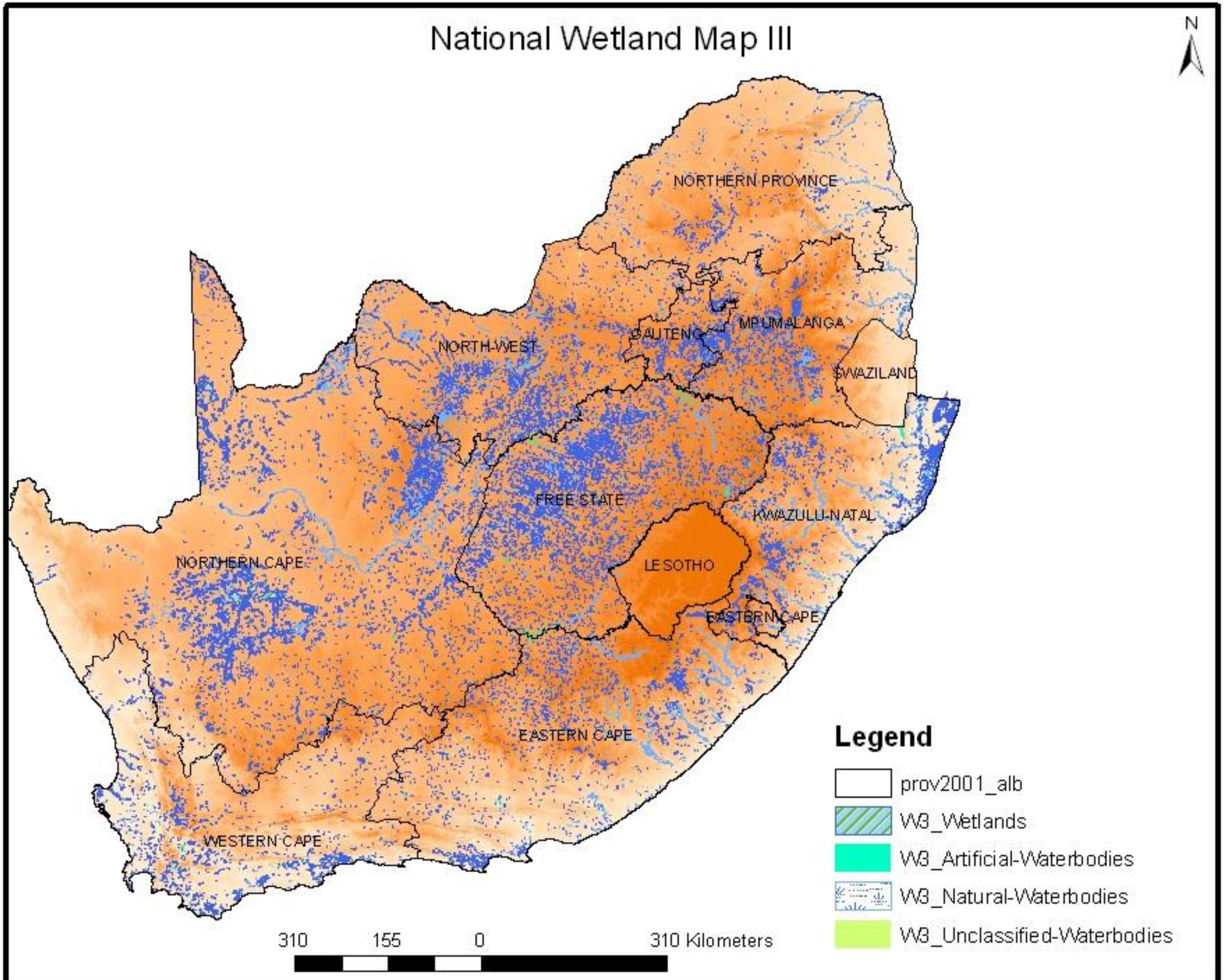


To the right of the fence is degraded thicket which is the result of over-stocking with angora goats. On the left is intact spekboom-rich thicket delivering a range of ecosystem services to humans, such as retaining topsoil, supporting judicious livestock farming and storing carbon. (L. Ezzy)

Carbon sequestration potential over 15-year period through *Working for Land* (restoration and land-use management)

	Degraded	Natural	Total rest. cost	Rest: Jobs	Mngm cost	Mngm: Jobs	CO2 seq
	Ha	Ha	Rmill	Person years	Rmill	Person years	Rmil
Eastern Cape	1,211,183	14,202,949	12,112	403,728	1,079	35,966	1,508
Free State	185,698	9,204,346	1,857	61,899	657	21,910	356
Gauteng	11,473	969,158	115	3,824	69	2,288	118
Kwa-ZuluNatal	830,713	6,008,777	8,307	276,904	479	15,959	1,493
Limpopo	1,333,933	9,182,926	13,339	444,644	736	24,539	2,433
Mpumulanga	142,105	5,333,435	1,421	47,368	383	12,776	641
Northern Cape	653,919	35,548,505	6,539	217,973	2,534	84,472	1,067
North West	789,150	7,117,220	7,892	263,050	553	18,448	764
Western Cape	120,746	10,282,432	1,207	40,249	728	24,274	598
Total	5,278,920	97,849,748	52,789	1,759,640	7,219	240,634	8,978

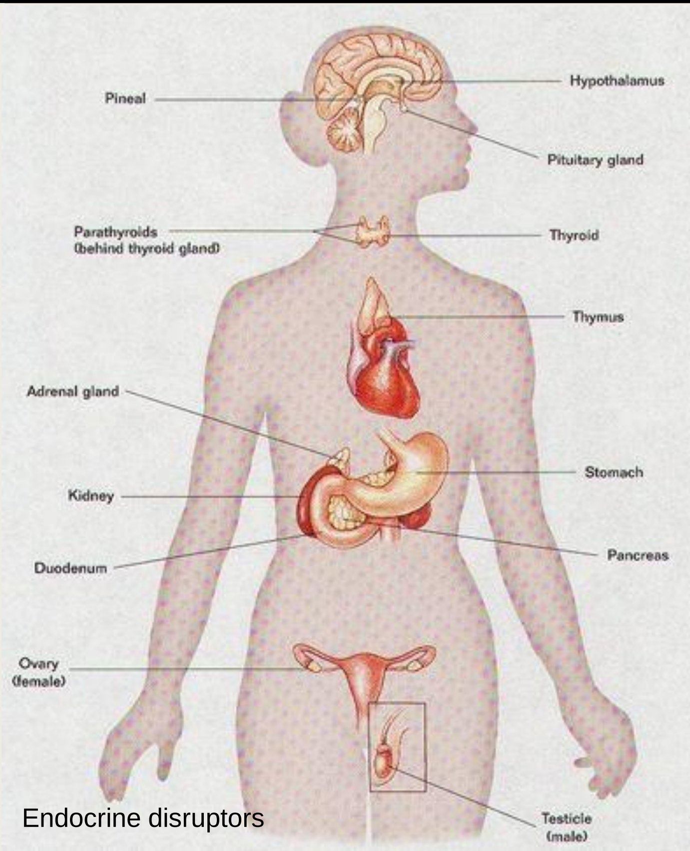
3. Water Security and the Management of Wetlands

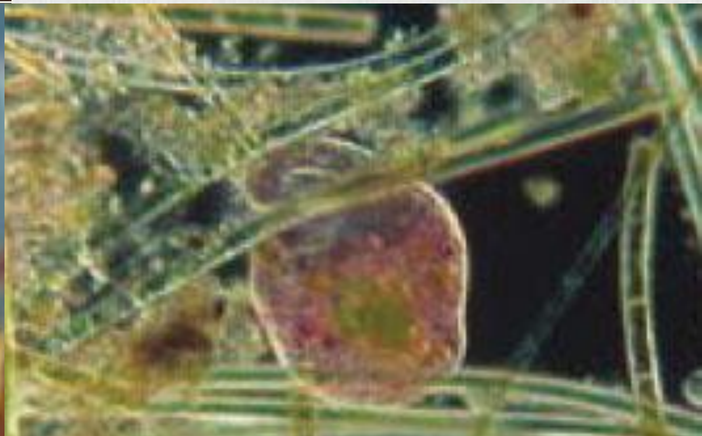

National Wetland Map III
N
NORTHERN PROVINCE
NORTH-WEST
GAUTENG
MPUMALANGA
SWAZILAND
FREE STATE
KWAZULU-NATAL
NORTHERN CAPE
LESOTHO
EASTERN CAPE
EASTERN CAPE
WESTERN CAPE
Legend
prov2001_alb
W3_Wetlands
W3_Artificial-Waterbodies
W3_Natural-Waterbodies
W3_Unclassified-Waterbodies
310
155
0
310 Kilometers

Working Wetlands: Flood Management

Working Wetlands: Water Quality

Working Wetlands: Disease Management





Working Wetlands: Water Quantity

Source: Professor Roland Schulze

4. Water Security and Demand-side Management

Mopani Water and Energy Conservation ("User-pays") Savings

Water and Electricity Use Per Person Per Day

Winter:	Litres	N	Mean	KWh	N	Mean
Control	124 707	844	148	2 929	630	4.65
Experimental	30 416	798	38	1 797	798	2.25
% Saving:		74%				52%

Summer :	Litres	N	Mean	KWh	N	Mean
Control	184 794	1186	156	8 403	1186	7.09
Experimental	41 723	960	44	2 368	980	2.42
% Saving:		72%				66%

AVERAGE SAVINGS: WATER : 73% ELECTRICITY: 60%

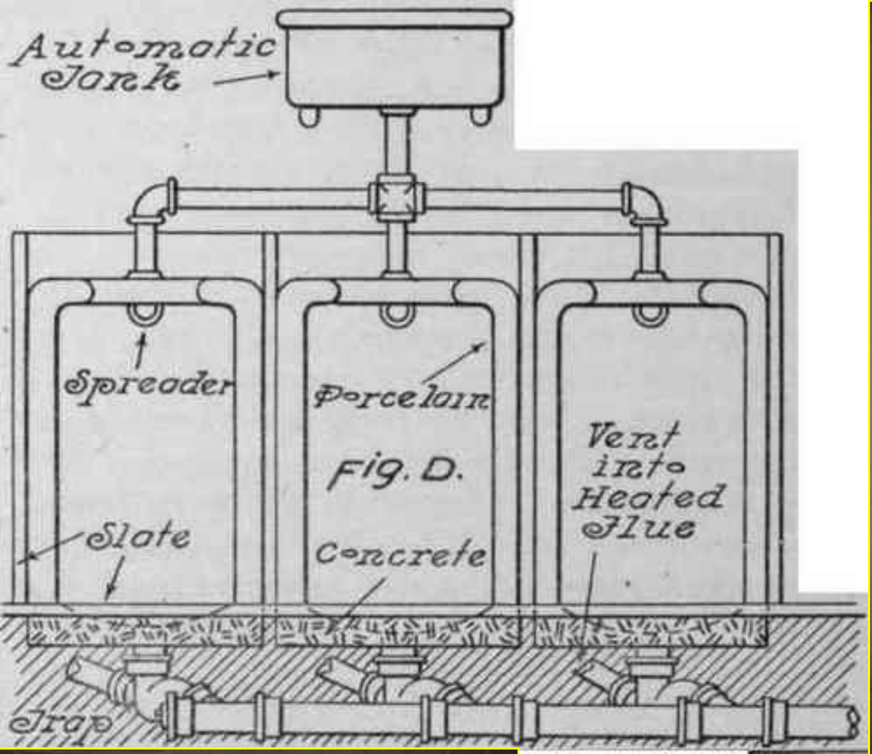
Greater Hermanus Water Conservation Programme

12-Point Plan

1. An assurance-of-supply tariff
2. An 11-point escalating block-rate tariff
3. Informative billing
4. Intensive communication
5. Schools' audit
6. The Hermanus *Working for Water* project
7. Retrofitting project
8. Water-wise gardening
9. Water-wise food production
10. National water by-laws
11. Water loss management
12. Masekhane (Security / Pre-payment) Meter Project

GREATER HERMANUS
WATER CONSERVATION PROGRAMME

Year	Litres	Erven	Litres/Erf	Rainfall
1993/4	11 900	7 900	1 506	140 mm
1994/5	12 075	8 200	1 473	120 mm
1995/6	10 842	8 600	1 261	192 mm
Average	11 606	8 233	1 410	151 mm
1996/7	8 644	9 000	960	168 mm
Savings:	**25,5%**	**[9,3%]**	**31,9%**	**[11,3%]**



Automatic-flushing urinals epitomize poor planning.

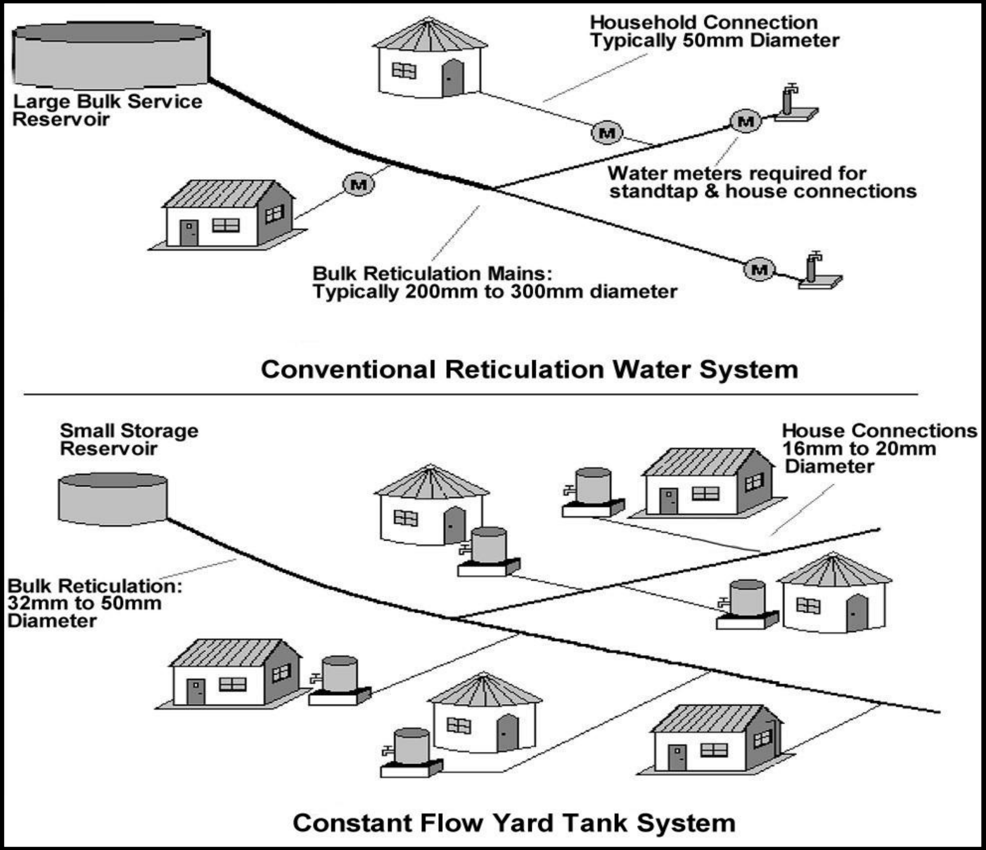
There are other examples (like ice cubes in urinals on the left, and design challenges on the right) that illustrate how far we still have to go!

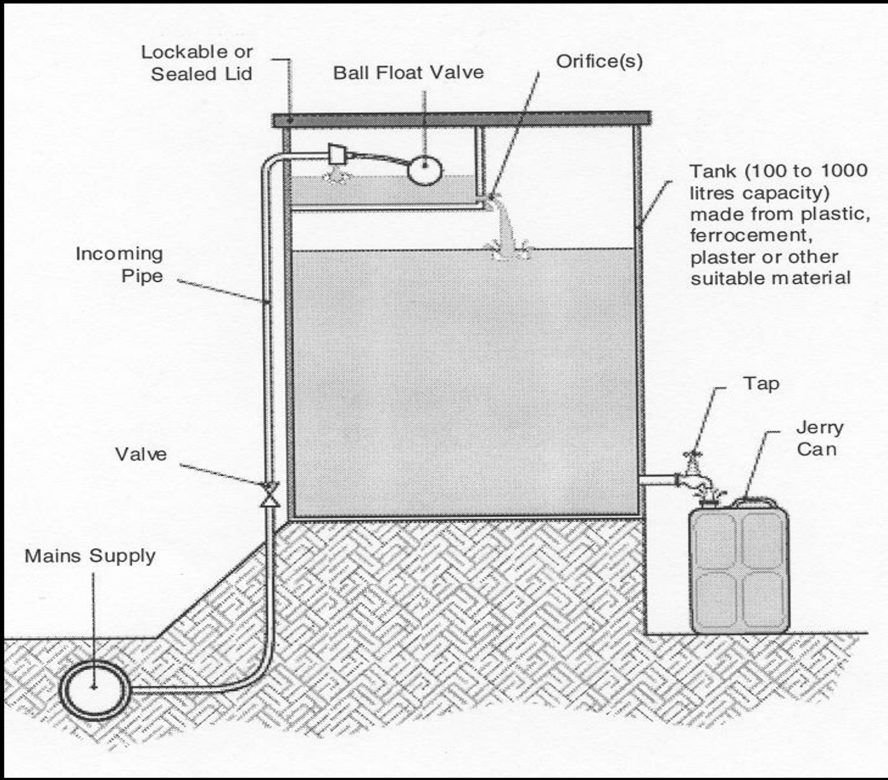
Why dam-builders and water managers need to connect (#116):

Hely Hutchinson & Woodhead Dams on Table Mountain – all their water, and that from the other three dams along the Table Mountain chain, is what is used to flush automatic-flushing urinals when no-one is using them. It costs about R50 to change an automatic-flushing urinal into a user-operated urinal. There is still no law banning automatic-flushing urinals, despite our proposing this in 1997.

Hely Hutchinson Dam after the automatic flushing of urinals. Two percent of Cape Town's water comes from the five major dams along the Table Mountain chain – the same amount as is used to flush automatic-flushing urinals in Cape Town!

Yard Tanks: Research vs Practice





Yard Tank Background (1)

- In 2001, Minister Ronnie Kasrils agreed to a pilot approach to be done in the provision of water to the Mzinyathi community.
- The Department had previously sanctioned Umgeni Water to manage this project.
- Umgeni Water assessed the cost at R70 million for providing a tap in the yard of each of the 5,100 households.
- The Durban Metro cost was R20.5 million to provide a Yard Tank for each household. This was adjusted to R24 million, after a DWAF assessment of Durban's "absorbed" costs.
- The Durban Metro cost included a double-pit latrine for each household – the Umgeni Water / DWAF Stand-pipe approach did not deal with sanitation.

Yard Tank Background (2)

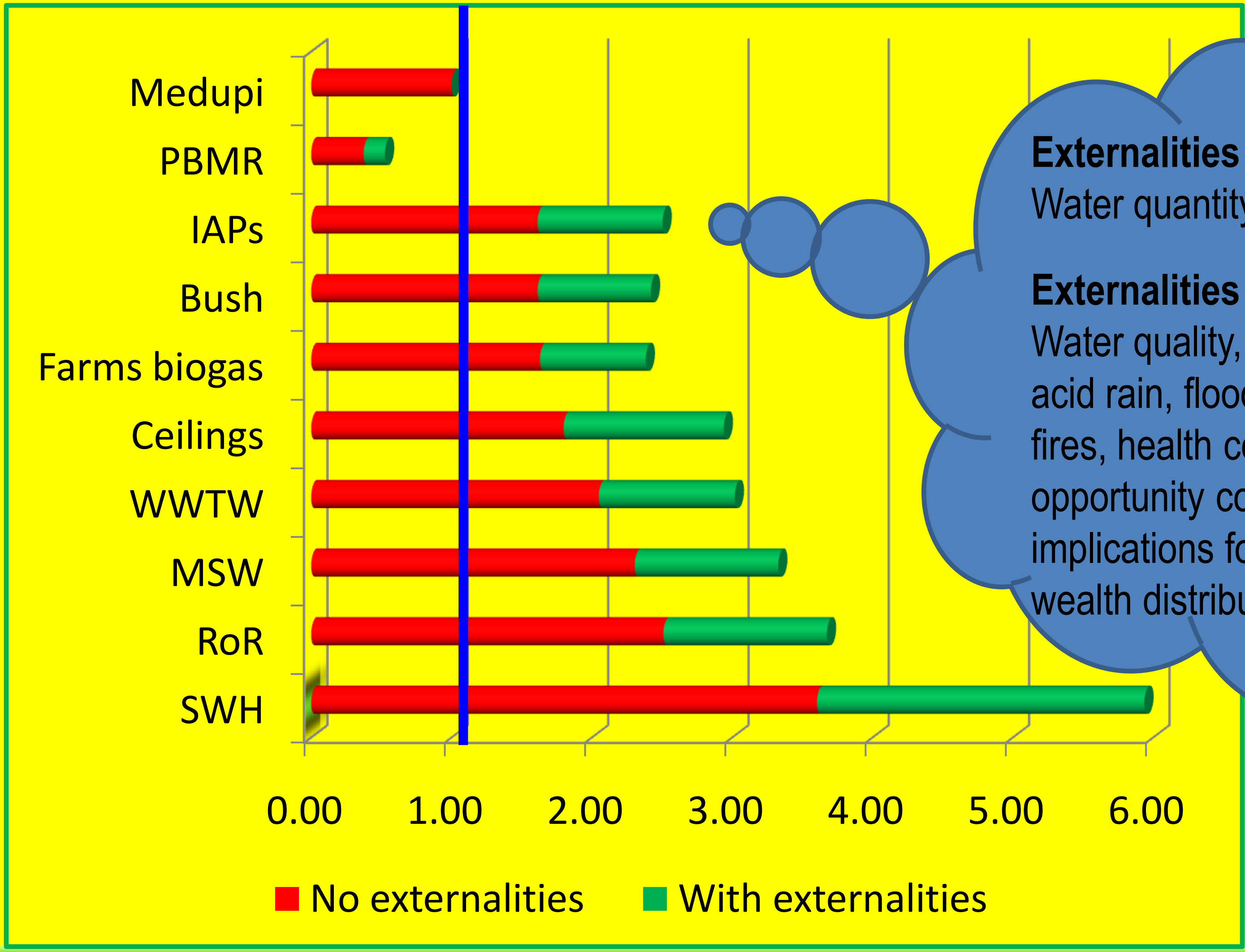
<u>Analysis by Hugh Sussens:</u>

- A 25% reduction in diarrhoeal diseases, using Yard Tanks rather than Stand-pipes.
- 10% water losses for Yard Tanks versus 50-60% for Stand-pipes.
- For 60 l/c/d, Yard Tanks and Stand-pipes had similar capital and O&M costs. Implementation confirmed this – and that Yard Tanks can be cheaper (dependent on housing density).
- The main challenges for Yard Tanks were a limited daily supply (although this is upgradeable) and community acceptance.
- At R5,800 per household, Yard Tanks are affordable within the Municipal Infrastructure Grant.
- Moving from Communal Stand-pipes to Yard Tanks had a Benefit:Cost ratio of 19:1.
- This did not include the sanitation benefits associated with the urine-diversion, double-pit latrines (versus the “ascaris pits” that exist in many places, let alone those without access to safe and dignified sanitation).

5. Water Security and Energy

Benefit-Cost Ratio Comparison with Medupi = 1 (taken over 20 years with a discount rate of 6%)

Overall Comparison (with externalities):
WfE BCR = 4,9



Externalities include:
Water quantity, carbon & jobs

Externalities exclude:
Water quality, bio-diversity, acid rain, flood attenuation, fires, health considerations, opportunity cost of coal, implications for food security, wealth distribution, & more.

OFF THE SCALE ...

HH biogas: 5,4 & 12.0

DSM: 19.0 & 31.2

1. Medupi Coal-fired Power Station
2. Pebble-Bed Modular Reactor
3. Energy from Invasive Alien Plants
4. Energy from Bush Encroachment
5. Energy from Farm Biogas
6. Conservation from Ceilings
7. Waste Water Treatment Works
8. Municipal Solid Waste
9. Energy from Run-of-River
10. Solar water heating
11. Energy from Household Biogas
12. Demand-side Management

Electricity generation using invasive plant species and bush encroachment

	Preliminary estimate of total utilisable biomass: t	Biomass per year over 15 years: t	Installed capacity: MW	Electricity generated at 75% op. time: MWh	Value of electricity at 65c/kWh: Rmill	Value of carbon sales at R100/tCO2 Rmill	Total value Rmill
Eastern Cape	22,713,750	1,514,250	144	946,406	615	95	710
Free State	2,532,856	168,857	16	105,536	69	11	79
Gauteng	355,418	23,695	2	14,809	10	1	11
KwaZulu-Natal	7,056,731	470,449	45	294,030	191	29	221
Mpumalanga	13,462,610	897,507	85	560,942	365	56	421
North-West	22,538,617	1,502,574	143	939,109	610	94	704
Northern Cape	19,822,231	1,321,482	126	825,926	537	83	619
Limpopo	19,717,087	1,314,472	125	821,545	534	82	616
Western Cape	5,393,102	359,540	34	224,713	146	22	169
TOTAL	**113,592,402**	**7,572,827**	**720**	**4,733,017**	**3,076**	**473**	**3,550**

Creating 115 million persondays of work (for 50,000 people) per year for 15 years

Annual water from trees cleared for *Working for Energy*

Water Management Area	Shortfall in 2000	Current losses due to invasive alien trees	Potential future losses due to invasive alien trees	Economic value of water currently lost, in Rmill, for various values		Potential future loss in the economic value of the water, in Rmill, for various values	
	Million m^3	Million m^3	Million m^3	R1.4/m^3	R6.9/m^3	R1.4/m^3	R6.9/m^3
Limpopo	23	18 (78)	63 (274)	25	124	88	435
Levuhu/Letaba	36	11 (31)	67 (186)	15	76	94	462
Olifants	194	69 (36)	133 (69)	97	476	186	918
Inkomati	258	49 (19)	166 (64)	69	338	232	1,145
Thukela	103	48 (47)	261 (253)	67	331	365	1,801
Mvoti-Umzimkulu	241	126 (52)	420 (174)	176	869	588	2,898
Lower Orange	9	8 (89)	88 (978)	11	55	123	607
Gouritz	63	23 (37)	79 (125)	32	159	111	545
Olifants-Doring	35	5 (14)	52 (149)	7	35	73	359
Berg	5	19 (380)	66 (1320)	27	131	92	455
Total	967	376 (39)	1,395 (144)	526	2,594	1,953	9,626

6. Water Security and Externalities

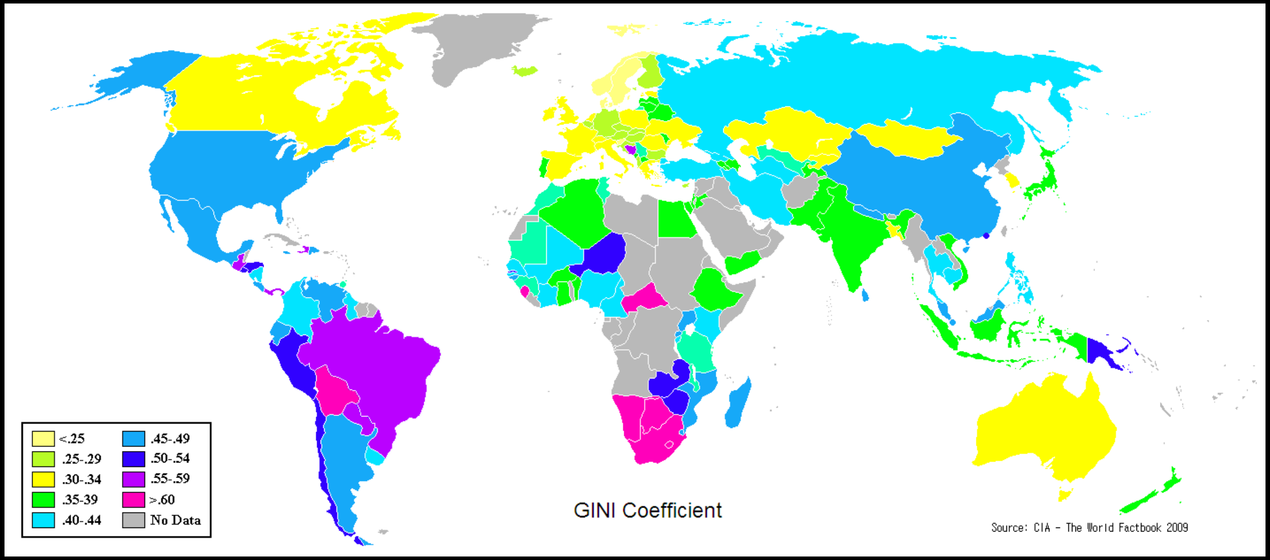
DBSA Analysis of Green Job Opportunities

	2012		2017		2025	
	Number of FTE's	Total budget requirement	Number of FTE's	Total budget requirement	Number of FTE's	Total budget requirement
	#	R'mill	#	R'mill	#	R'mill
Working for Water	15,416	1,238	42,979	5,438	111,632	24,010
Working for Energy (Biomass)	-	-	14,293	2,370	38,480	14,713
Working for Land	3,485	281	23,941	3,058	63,749	15,073
Working for Wetlands restoration	1,266	119	4,936	739	6,945	1,782
Working for Wetlands prevention	509	25	2,115	164	2,976	395
Working on Fire	3,239	220	7,042	758	7,042	1,299
Total	**23,915**	**1,882**	**95,305**	**12,527**	**230,824**	**57,271**

In August 2007, the wild fires in the northern and eastern provinces of South Africa were estimated by Forestry South Africa to have cost the country over R3.6 Billion for the Forestry industry alone. According to the then CEO of Forestry South Africa, the damage would have been double that, were it not for the *Working on Fire* partnership.

The *Working on Fire* programme has heavily invested in the equipment necessary to fight fires (both ground and aerial capacity), and to ensure the safety of its fire-fighters.

Will what water-management options we choose decide between: another refurbishment of the kitchen in the mansion of the rich, or more jobs for an unemployed people living in poverty?



Conclusions

1. The Water Research Commission has been responsible for some progressive research necessary to inform decision-making about the relative merits of different potential interventions regarding water security in a water-scarce country, and notably for the six areas that I have focused upon in this talk.
2. That said, insufficient research has been done. This is partially because the WRC is part of the water sector, and a limited vision within the sector has also meant that not enough implementation of research has been taken. Equally important, there has been a limited retrospective analysis (M&E of what the research said would happen).
3. Conventional supply-side interventions, such as dams, have not been interrogated sufficiently, and has allowed a continued focus on what may be sub-optimal choices in terms of priorities for interventions.
4. Research to estimate the full costs and benefits associated with the various options is necessary.
5. The discrepancies between what the decision-makers are told will be the cost of dams and augmentation options, and their final costs, must be researched.
6. The returns on investment from the control of invasive alien plants, from catchment management, wetland management and demand-side management are substantially higher than is reflected in both the research focus devoted to their development, and more so the resources spent on them as key priority options for water security.

THANK YOU

(and thank you to the Water Research Commission!)

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