System of Environmental Economic Accounting

United Nations

UN environment

Towards a method for accounting for ecosystem services and asset value: **Pilot accounts for KwaZulu-Natal, South Africa, 2005-2011**

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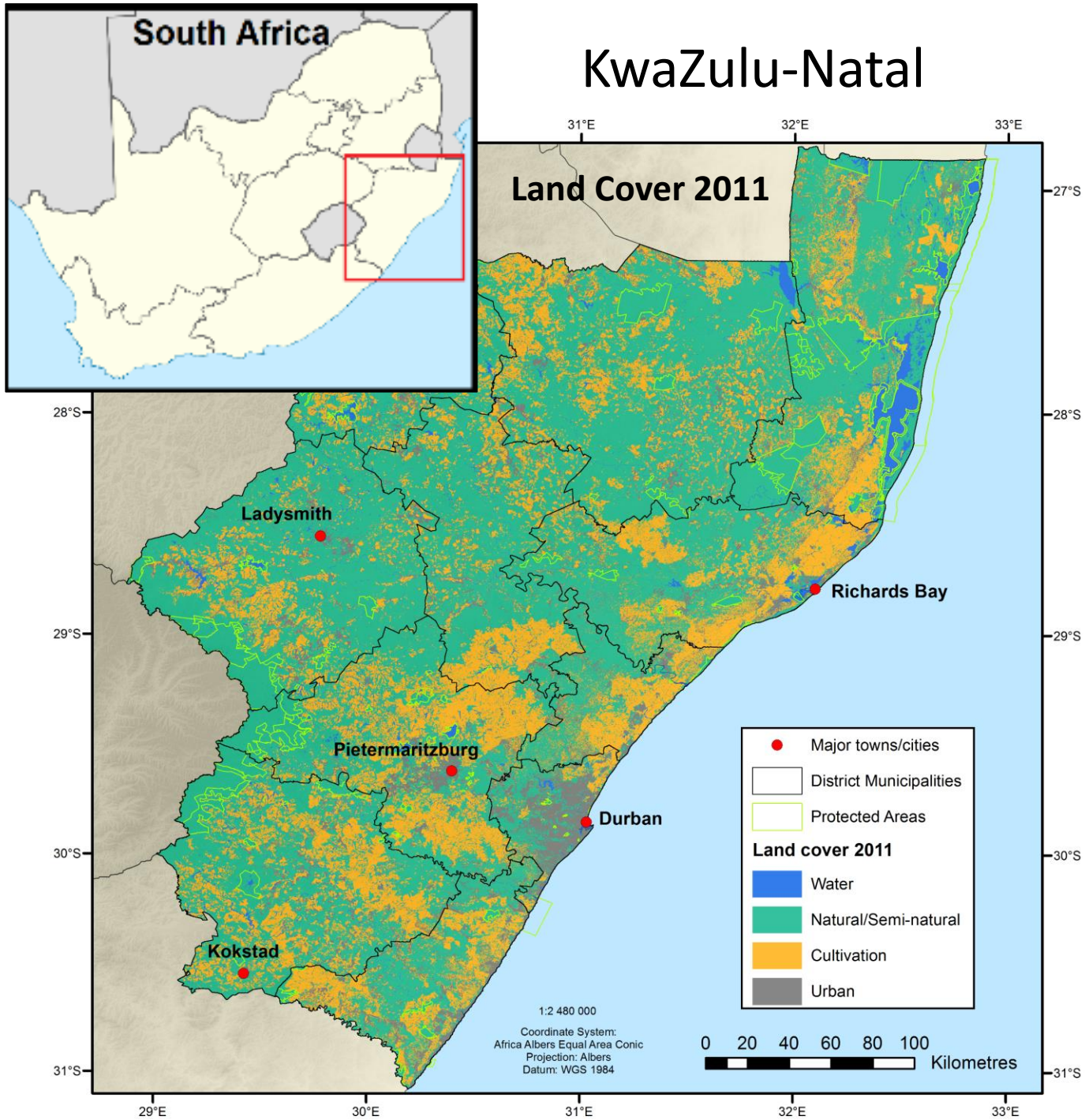
EZEMVELO KZN WILDLIFE
Conservation, Partnerships & Ecotourism

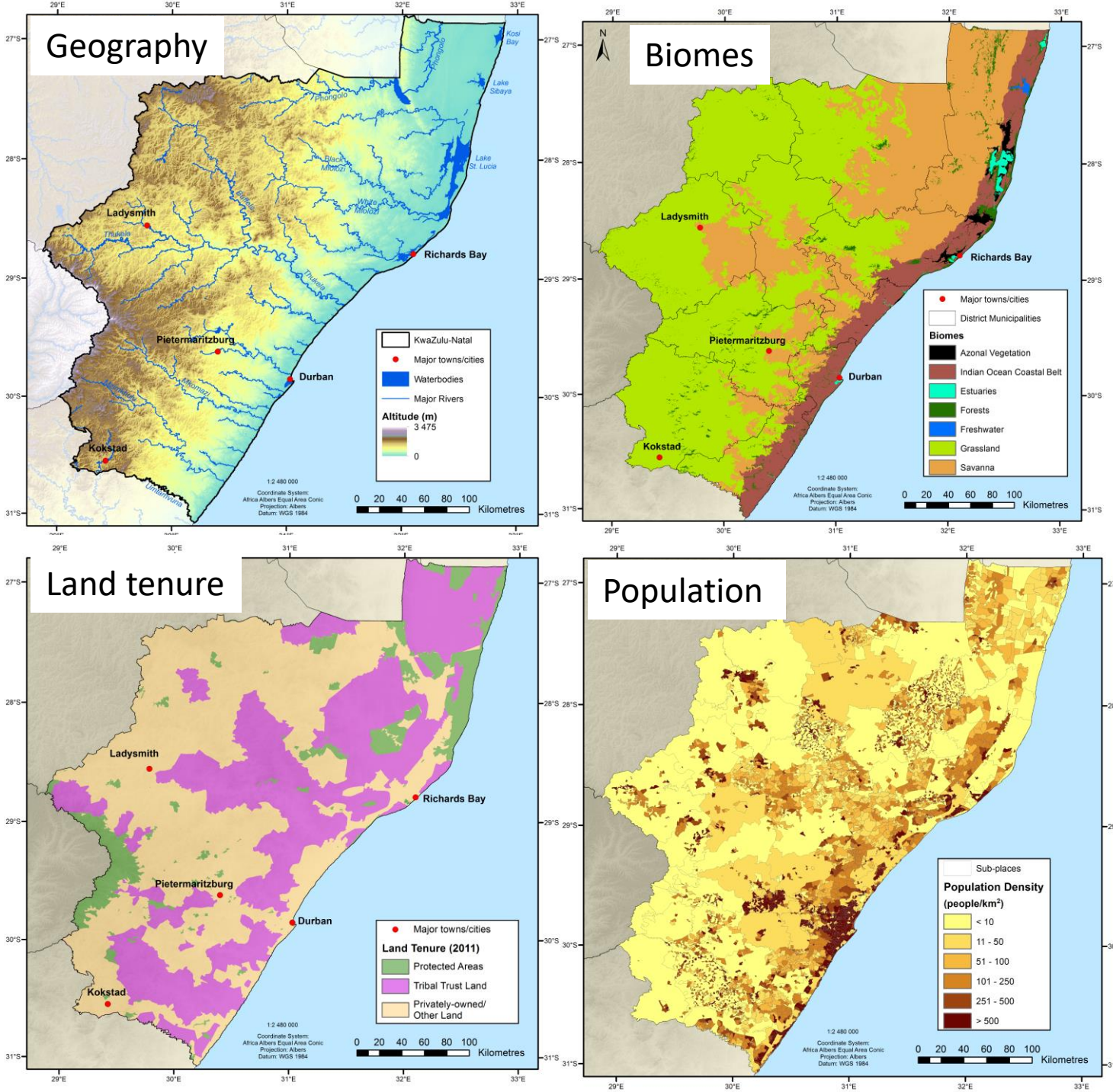
Overview

- Ecosystem services and asset value at province scale (excluding marine)
- 2005 and 2011
- Preliminary estimates of broad range of services
- Basic spatial unit = 1 ha grid
- Summarised by biome
- All monetary values in constant 2010 prices
  - Service flows: R/ha/year,
  - Asset value: R/ha (25y @ 3.66% - Kotchen *et al.* 2019)
  - USD ~ R6.66



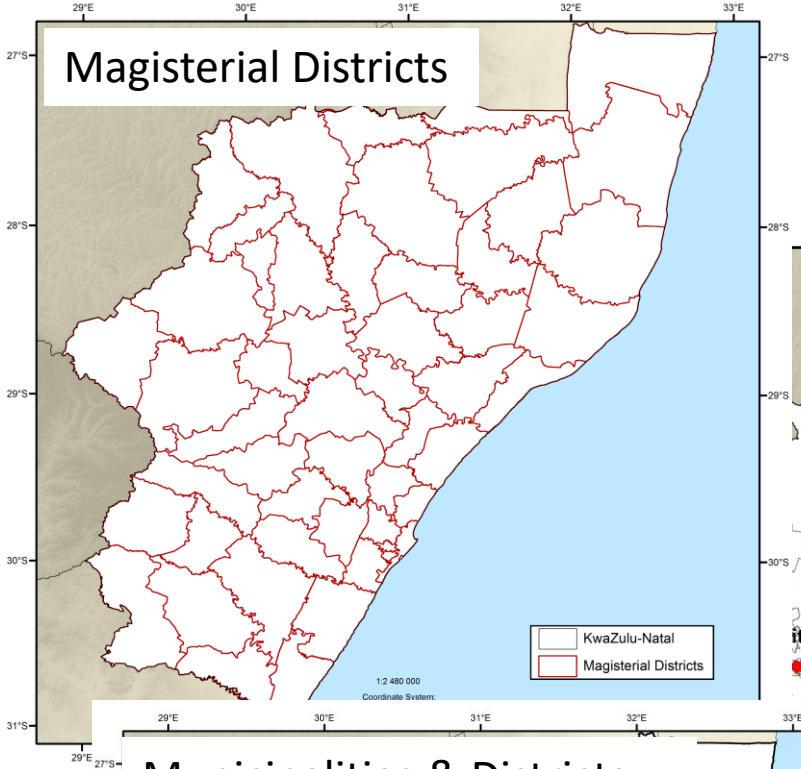
Study area

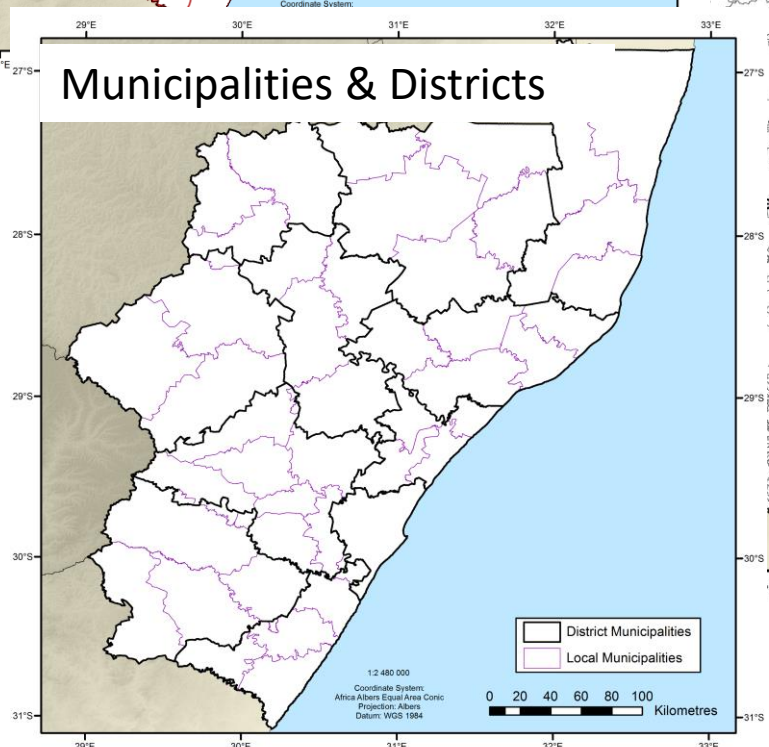
- Watershed to coast
- Diversity of vegetation
  - Grasslands, savanna, coastal bush, forest etc
- About 50% natural
- 9% protected, 39% communal/tribal, 52% private
- Population (2011)
  - 10m (109/ km²),
  - one major city (Durban)
- GDP (2011) R450 bn

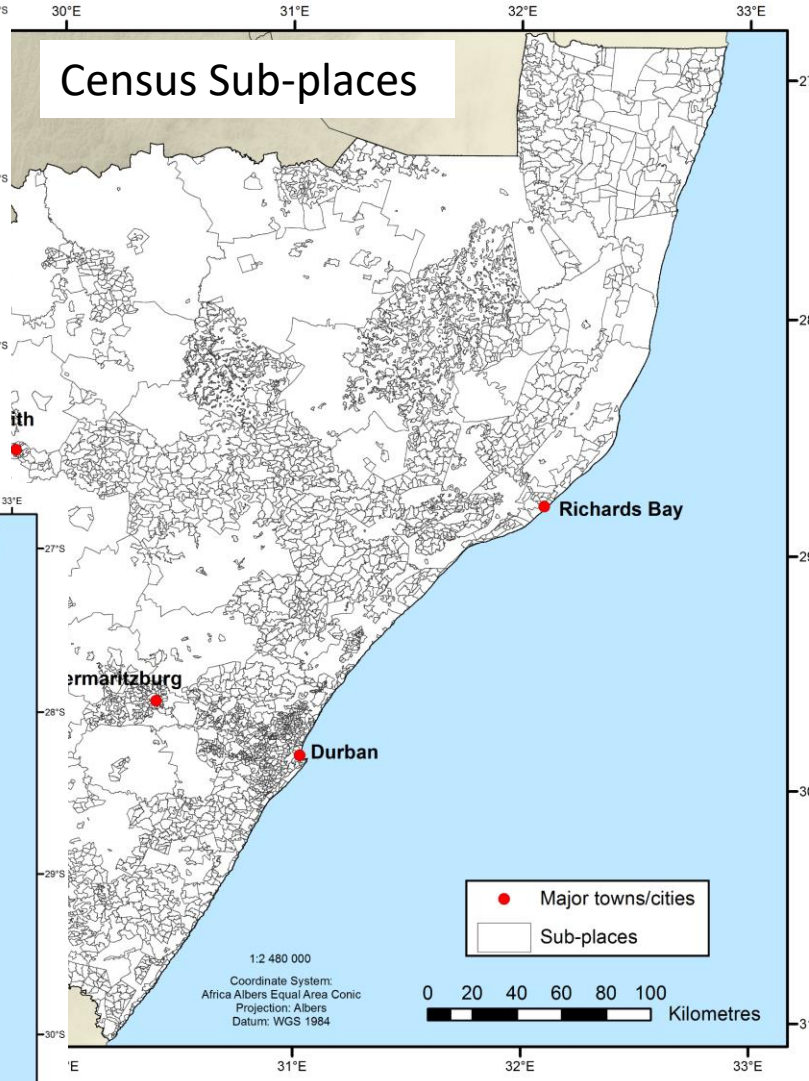


Scales of socio-economic data

- 52 Magisterial Districts
- 43 Local municipalities + 1 Metro
- 11 Districts
- 4198 Census sub-places







Ecosystem services & valuation

Broad category	Ecosystem service		Broad rationale for valuation approach
Provisioning services	Harvested wild biomass		**Used purposely**, through joint contribution of natural and man-made capital and labour. Valued in terms of **residual value**
	Reared animal production		
	Cultivated production		
	Genetic resources		
Cultural services	Experiential value	Property value	
		Local use	
		Tourism	
	Existence (non-use) value		
Regulating services	Sediment retention		**Used inadvertently**, though service can be enhanced to purpose. If lost, could result in damages, but replaceable by engineering solutions. Value = min (**avoided damage or replacement costs**), where 'demanded' Net of human inputs where services are enhanced
	Water quality amelioration		
	Seasonal flow regulation		
	Flood attenuation		
	Carbon sequestration		
	Crop pollination & pest control		
	Refugia and nursery functions		
	Coastal storm protection		

Wild resources

The service

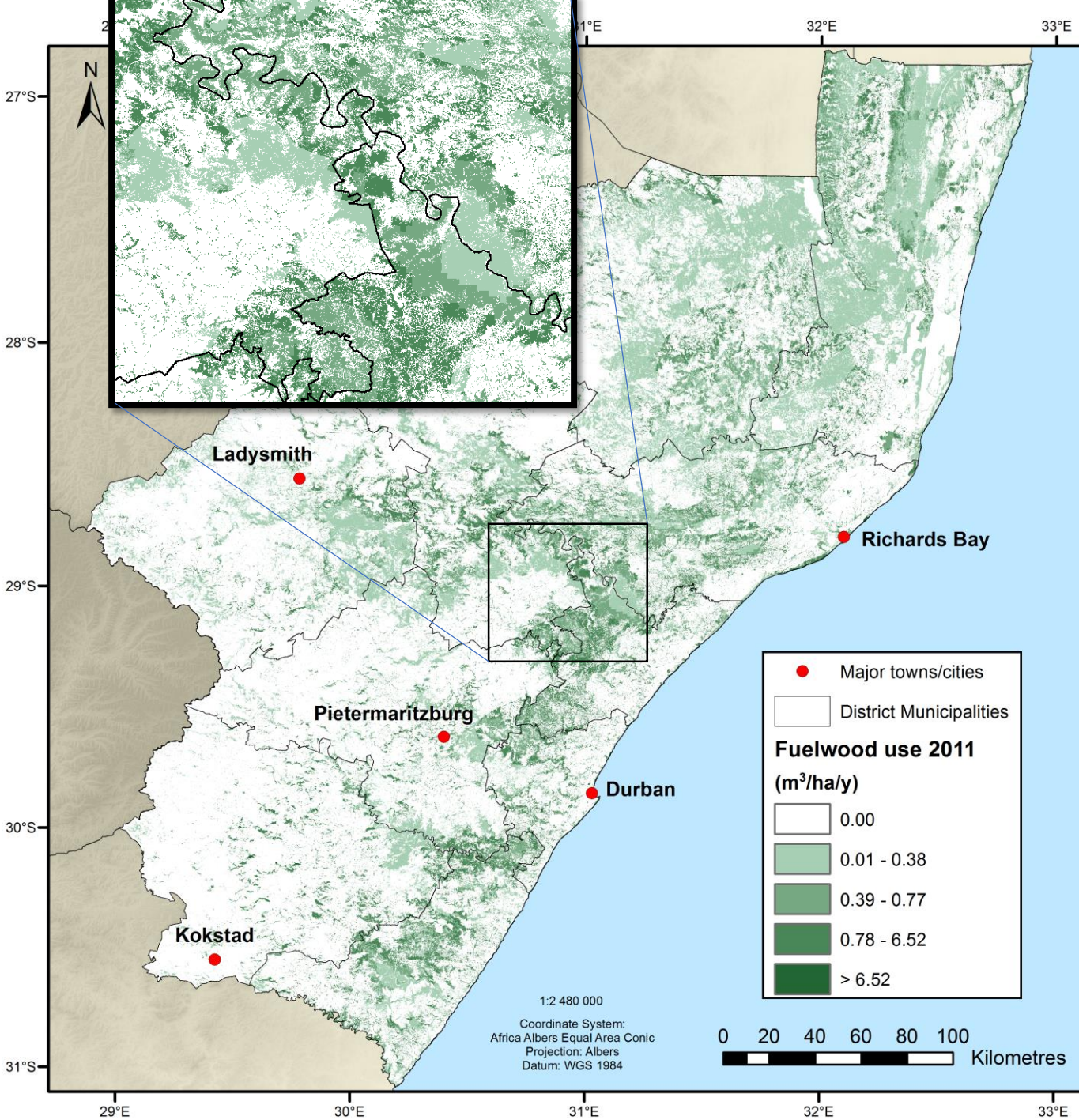
- Major benefit in KZN, millions of people rely on harvesting wild resources
- Large numbers of species involved, grouped for analysis

Wild plant resources	Energy	Wood fuel
	Raw materials	Grass
		Reeds and sedges
		Palm leaves
		Poles and withies
		Timber
	Nutrition and health	Wild plant foods and medicines
Wild animal resources	Nutrition	Bush meat
		Fisheries

Wild resources

Data & methods

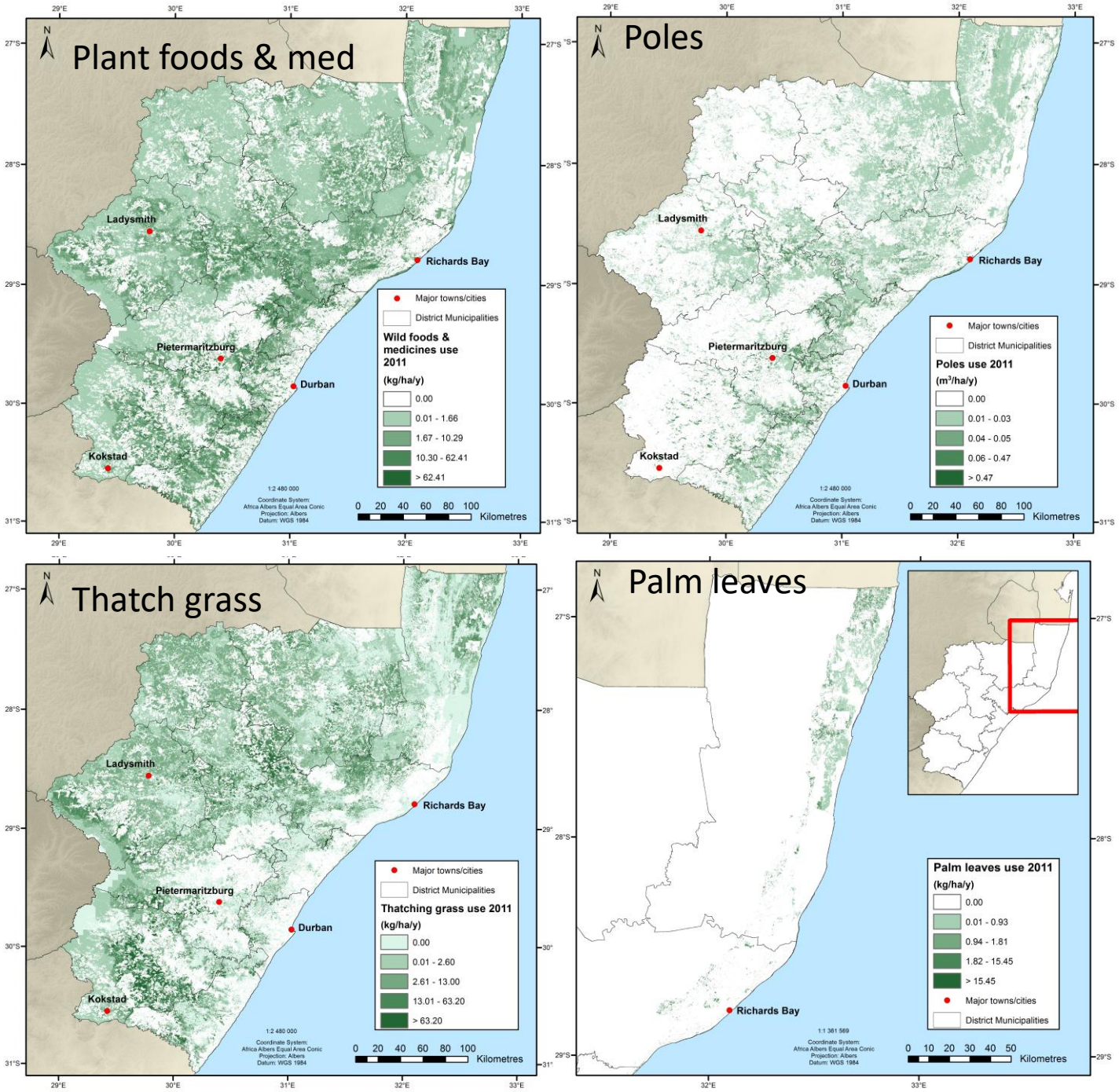
- **Availability** mapped in physical units/ha based on
  - land cover type
  - Info from literature,
  - land tenure.
- **Demand** model based on survey and census data, mapped to residential areas
- **Use** estimated using a GIS-based model under assumption of 5-10 km range of collection, limited by availability
- **Value** based on market prices and input costs from literature



Wild resources

Comments

- Relied on a few household studies
- Data gaps
- Limited info on stocks and availability
- Spatial modelling needs further research and validation



Wild resources – physical supply tables

Summarised by biome

Values in physical units (volume or mass harvested per year)

2005

Resource \ Biome	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	TOTAL
Fuelwood (m^3)	3 341	663 349	223 178	755 244	247 315	158	1 892 584
Poles (m^3)	163	29 645	10 948	28 560	11 165	8	80 489
Timber (m^3)	20	2 643	999	3 491	8 567	3	15 723
Thatching grass (tonnes)	33	25 973	4 935	17 383	59	3	48 384
Reeds & sedges (tonnes)	752	3 801	1 508	2 371	324	22	8 779
Palm leaves (tonnes)	-	-	292	-	-	-	292
Wild foods/med (tonnes)	121	14 483	4 951	13 113	2 327	6	35 001
Bushmeat (tonnes)	6	1 542	338	1 934	179	0	3 998
Fish (tonnes)*	42	315	75	298	22	8	759

2011

Resource \ Biome	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	TOTAL
Fuelwood (m^3)	3 623	577 156	199 665	684 019	228 188	181	1 692 832
Poles (m^3)	162	27 922	9 231	25 318	10 504	7	73 144
Timber (m^3)	16	1 359	415	2 516	8 410	2	12 719
Thatching grass (tonnes)	19	20 465	3 000	12 552	34	2	36 072
Reeds & sedges (tonnes)	598	3 796	1 176	2 578	192	14	8 355
Palm leaves (tonnes)	-	-	235	-	-	-	235
Wild foods/med (tonnes)	145	14 311	3 984	11 265	2 681	7	32 393
Bushmeat (tonnes)	4	1 161	220	1 404	138	0	2 926
Fish (tonnes)*	29	389	65	271	14	6	774

Wild resources – monetary supply tables

R millions per year

Overall decrease

2005

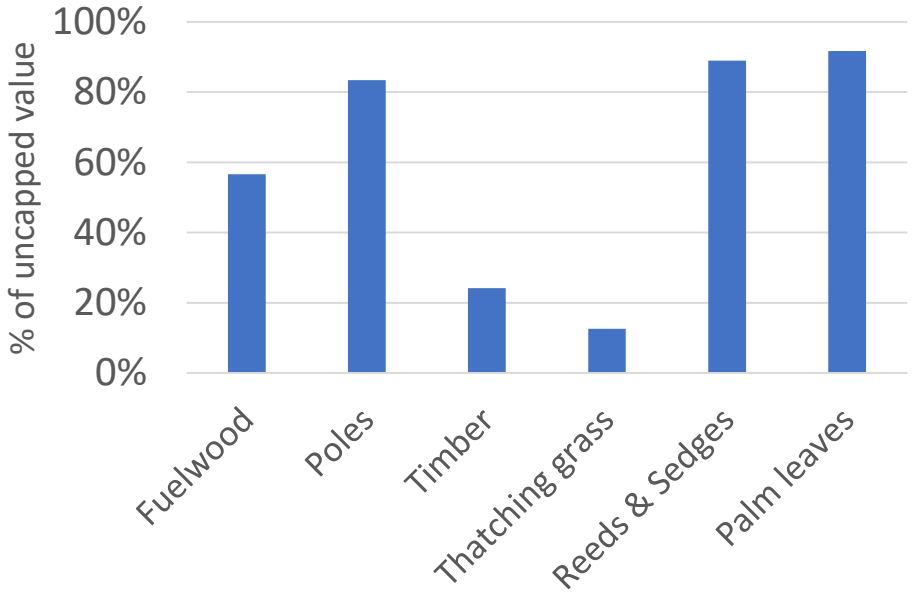
Resource \ Biome	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	TOTAL
Fuelwood	2.89	573.13	192.83	652.53	213.68	0.14	1 635.19
Poles	0.12	21.40	7.90	20.62	8.06	0.01	58.11
Timber	0.03	3.59	1.36	4.75	11.65	0.00	21.38
Thatching grass	0.80	623.34	118.43	417.19	1.41	0.06	1 161.23
Reeds & Sedges	18.81	95.03	37.71	59.28	8.09	0.56	219.49
Palm leaves	0.00	0.00	12.86	0.00	0.00	0.00	12.86
Wild foods & Medicines	1.91	228.10	77.98	206.54	36.64	0.10	551.27
Bushmeat	0.08	23.12	5.07	29.01	2.68	0.00	59.97
Fish	0.46	3.46	0.82	3.28	0.24	0.09	8.35
Total	**25.09**	**1 571.19**	**454.96**	**1 393.19**	**282.46**	**0.96**	**3 727.86**

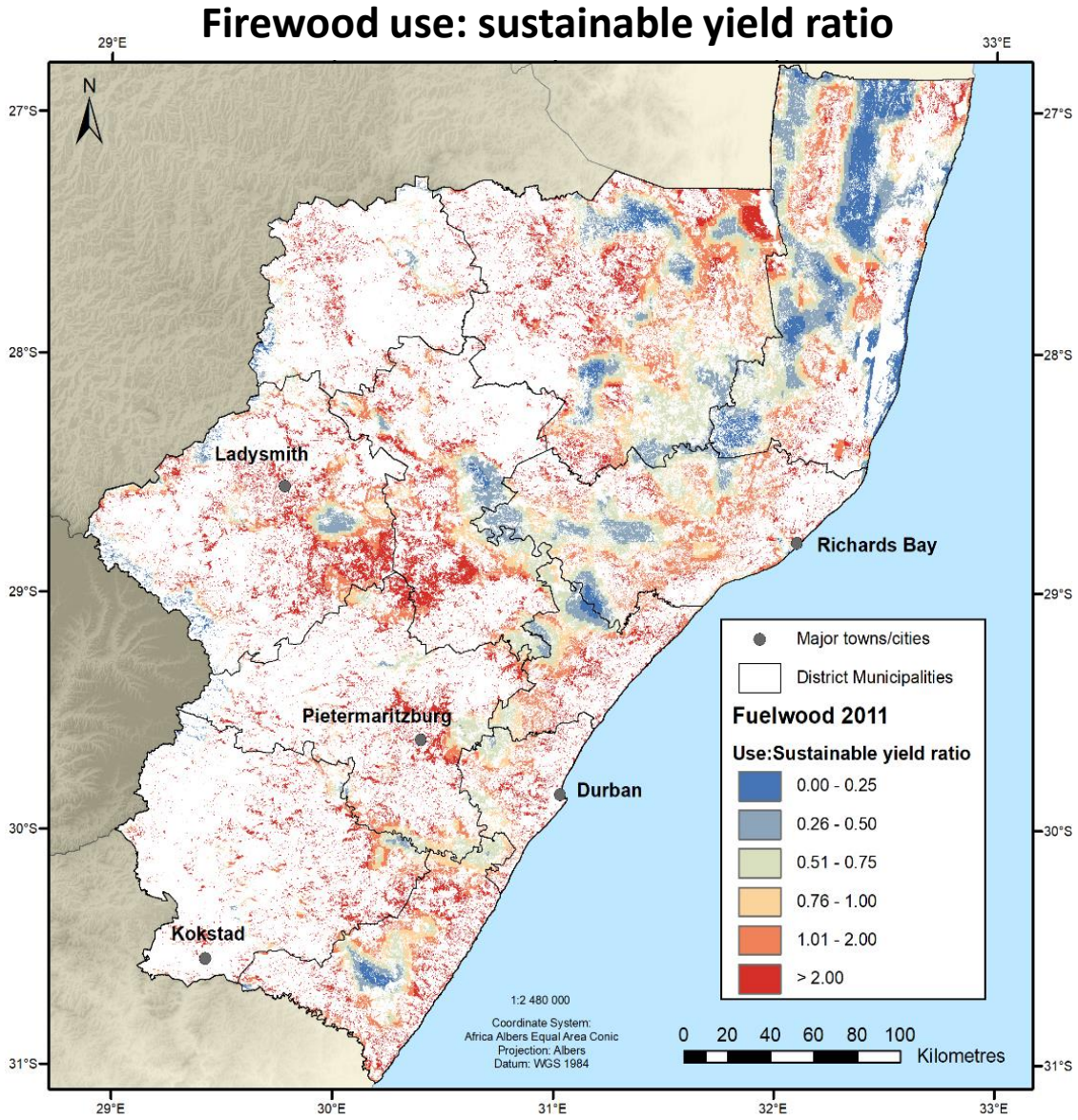
2011

Resource \ Biome	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	TOTAL
Fuelwood	3.13	498.66	172.51	590.99	197.15	0.16	1 462.61
Poles	0.12	20.16	6.66	18.28	7.58	0.01	52.81
Timber	0.02	1.85	0.56	3.42	11.44	0.00	17.30
Thatching grass	0.47	491.15	72.01	301.24	0.82	0.04	865.73
Reeds & Sedges	14.95	94.90	29.40	64.46	4.81	0.35	208.88
Palm leaves	0.00	0.00	10.34	0.00	0.00	0.00	10.34
Wild foods & Medicines	2.29	225.39	62.75	177.42	42.23	0.10	510.19
Bushmeat	0.06	17.41	3.30	21.06	2.06	0.00	43.90
Fish	0.32	4.28	0.72	2.98	0.15	0.07	8.51
Total	**21.36**	**1 353.81**	**358.26**	**1 179.86**	**266.25**	**0.72**	**3 180.25**

Asset value accounts for sustainability

- Ratio of estimated use: sustainable yield used to model stock decline over 25y
- Adjusted NPV modelled for each BSU (pixel)





Reared animals

The service

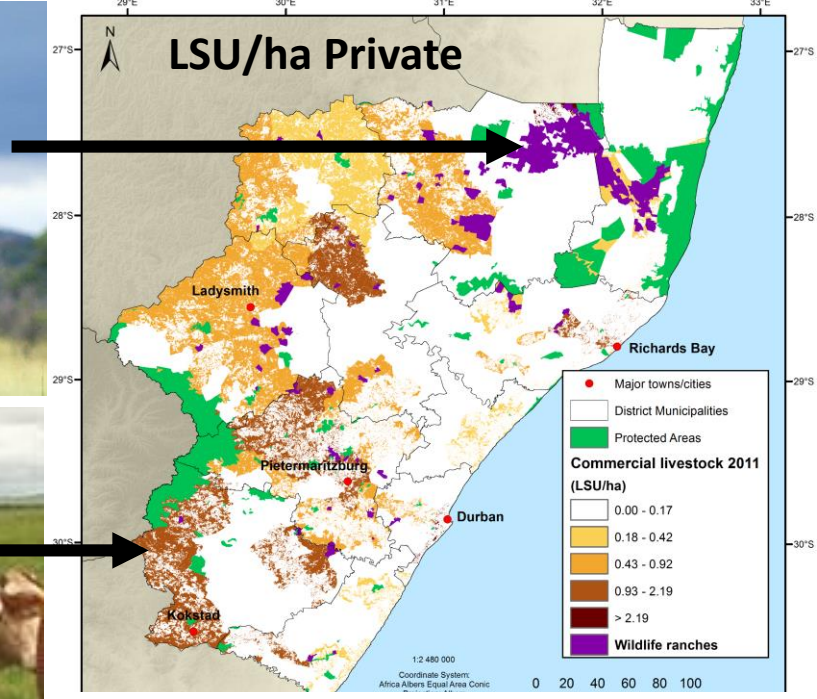
- Land contribution to output

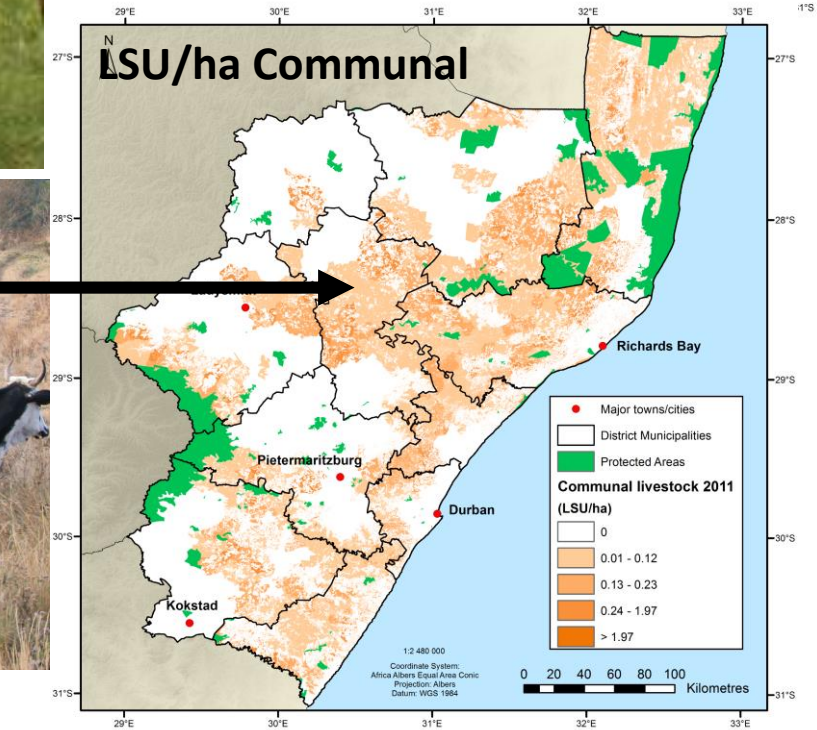
Data & methods

- District level (2002, 2007) and annual provincial data on commercial livestock production and value
- Census data on communal livestock, values from literature
- Wildlife ranching production and income/ha from a 2016 study

Results and comment

- Value decreased R1.47 to R1.15 bn
- Data were coarse and patchy





Cultivation

The service

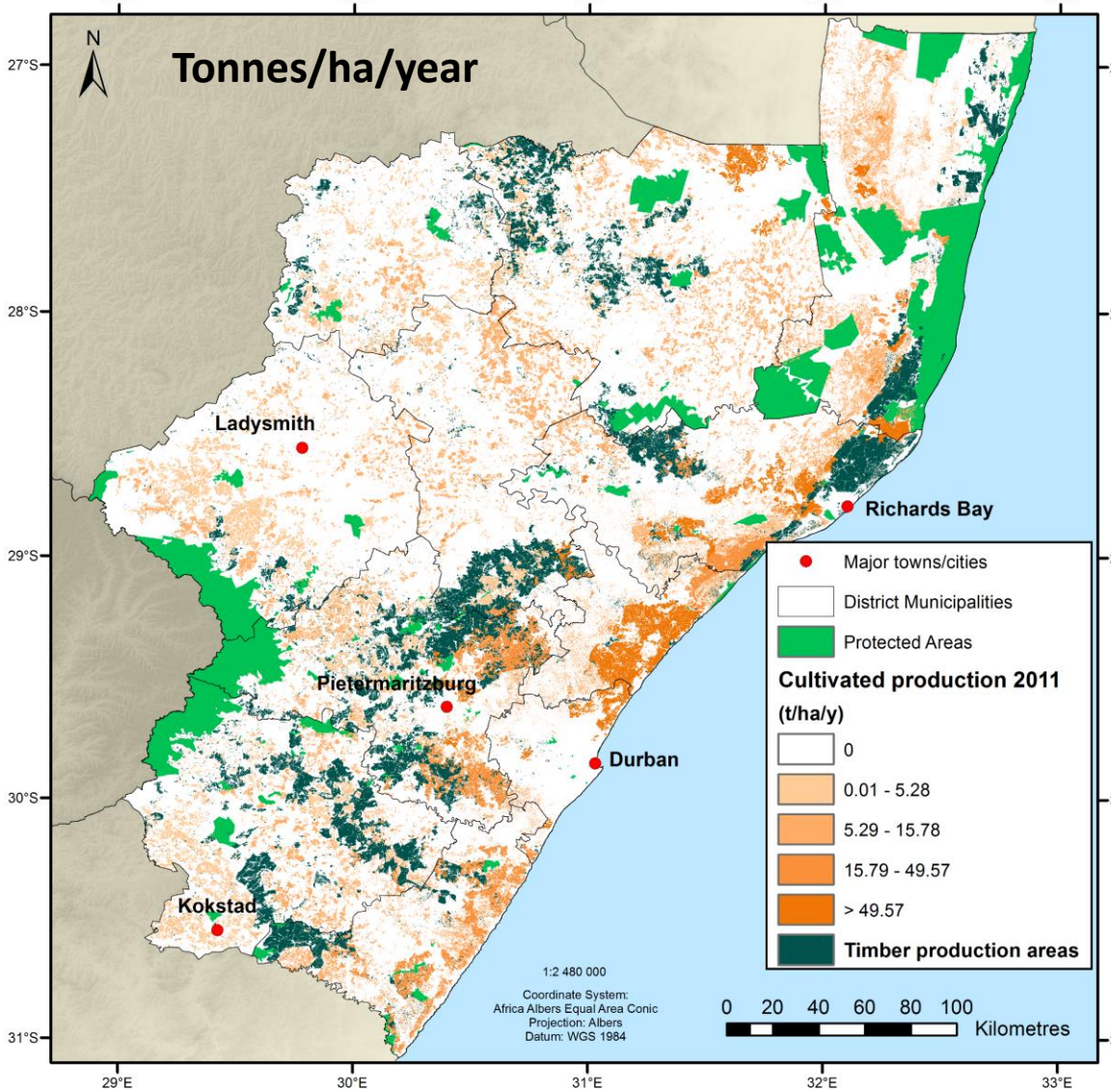
- Land inputs to cultivated production, net of intermediate services (pollination)

Data & methods

- District level (2002, 2007) and annual provincial data on commercial crops and plantation forestry used to estimate 2005, 2011 production and net income/ha, matched to cultivated land cover classes
- Subsistence production and net income/ha from literature (few)

Results and comments

- Increase in area and value R16.6 to R19.3 bn
- Insufficient data a serious challenge

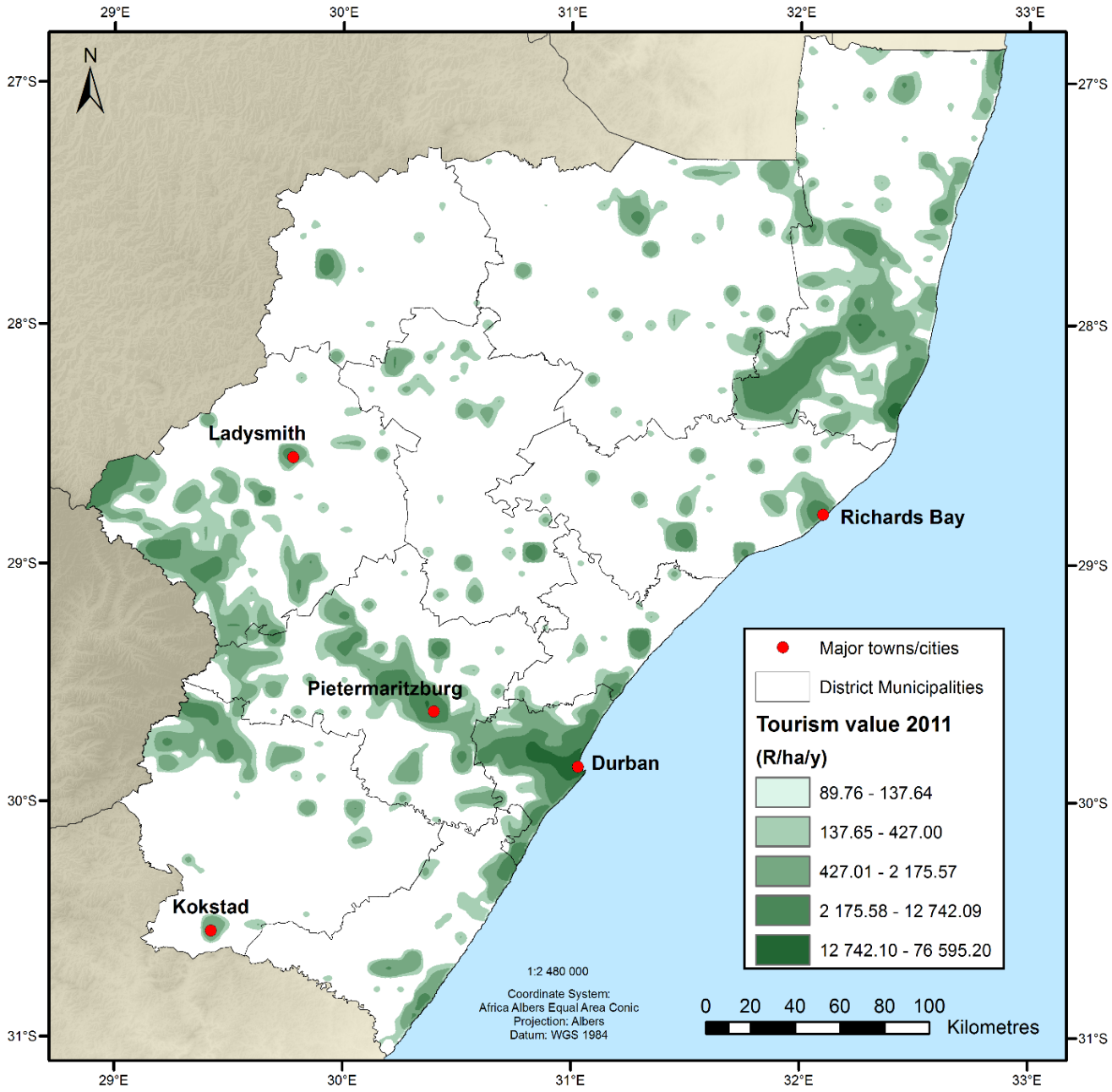


Tourism value

- Direct value added from Tourism Satellite Accounts
- Attraction-based share from SA Tourism reports
- Spatialised using density of geotagged photos
  - Panoramio, Flickr

Results

- Terrestrial natural areas R1.32 to R1.82bn
- But shrinking proportion of tourism
- Mostly protected areas



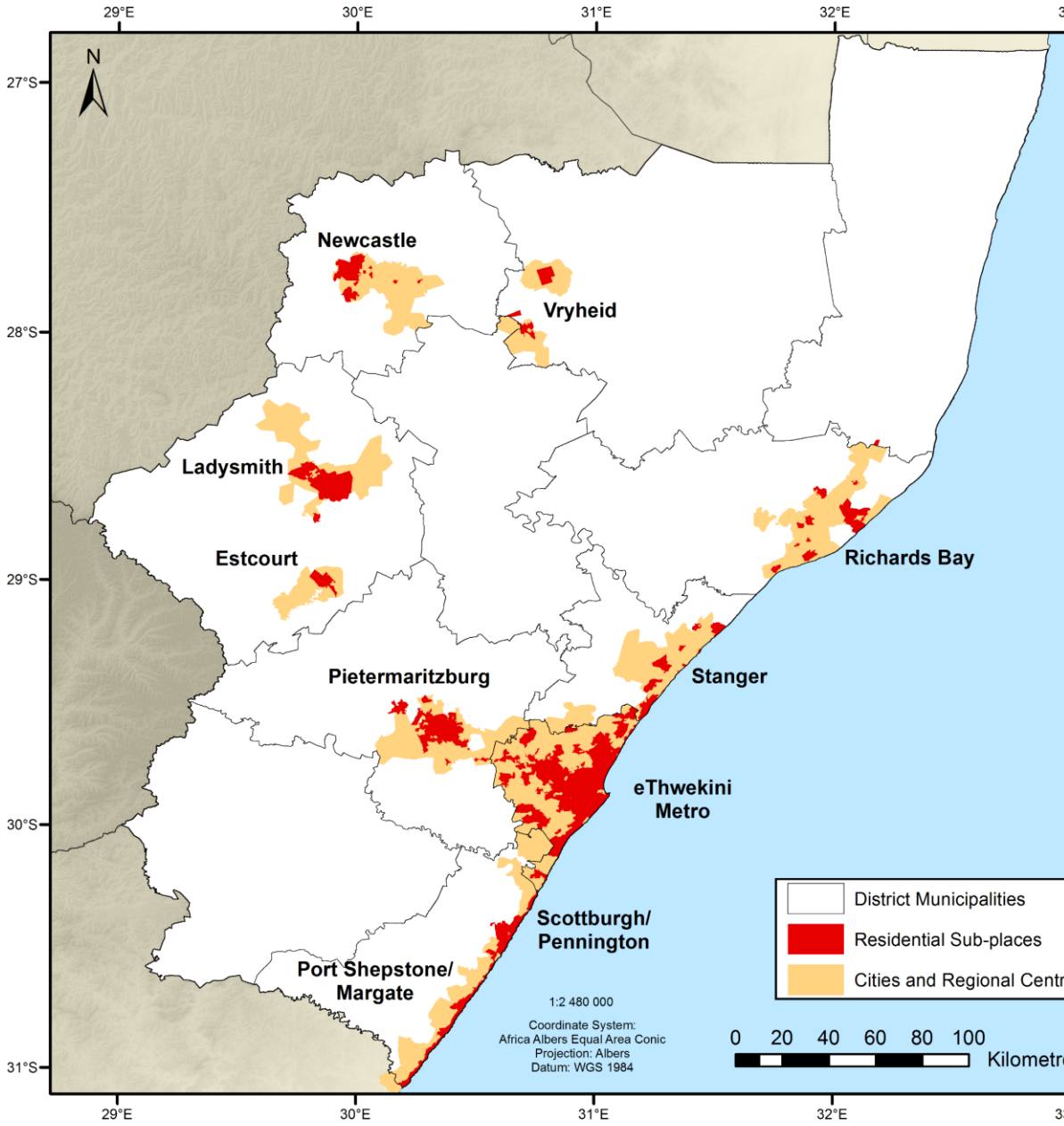
Property premiums from urban green space

Data & methods

- Benefits transfer from a hedonic study of ~16,000 eThekwini (Durban) properties
- Applied to KZN's 10 main towns, based on suburb-level hh income
- Capital value estimate was annualised as cost of capital

Results & comment

- Green space R1.17-R1.33 bn
- need good urban open space data & property sales data (denied by the other municipalities)



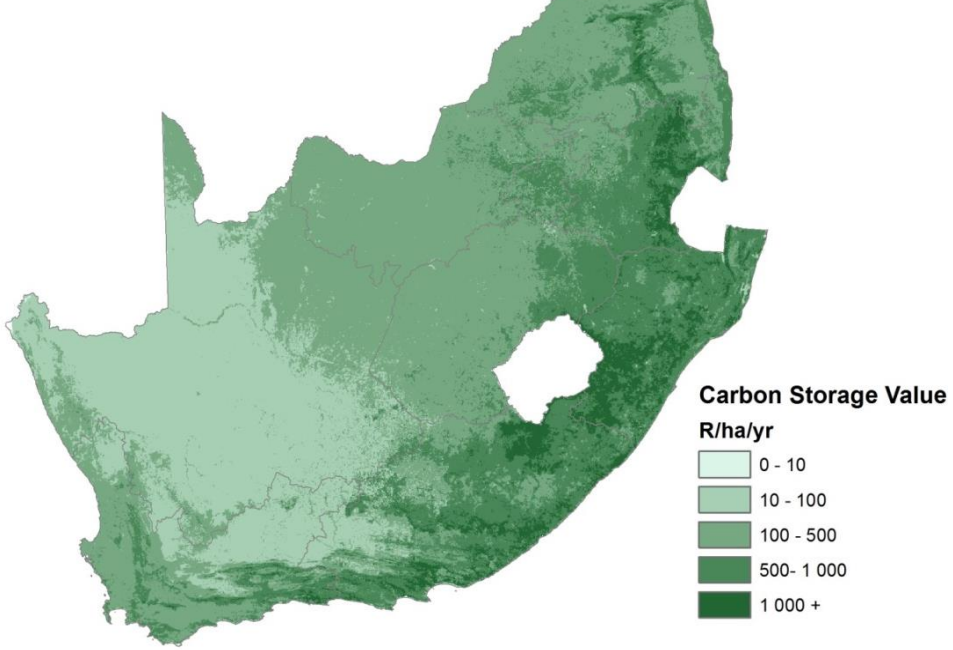
Carbon

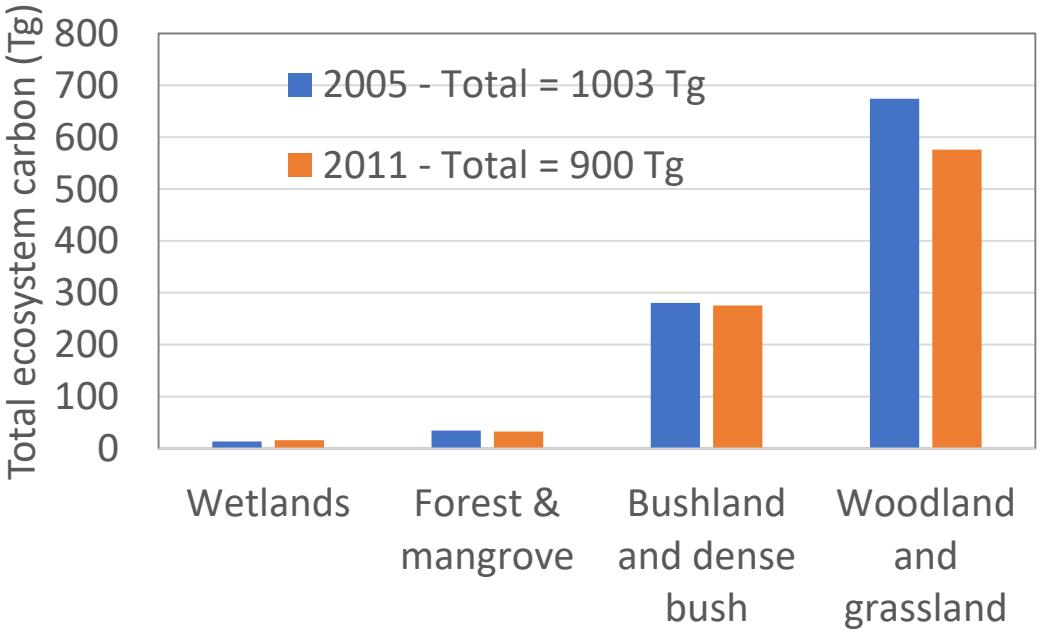
Data & methods

- South African National Carbon Sink Assessment (DEA, 2015)
  - mean g C/m^2 per land cover type
- Valued stocks in terms of avoided social cost to SA and ROW
- $/tonne from Nordhaus
- SA share (0.35%) from African share (Nordhaus) and relative vulnerability within Africa

Results

- Global value $142 to $137bn
- SA value R3.75 to R3.62 bn
- 10% loss from natural ecosystems
- 3.2% net loss





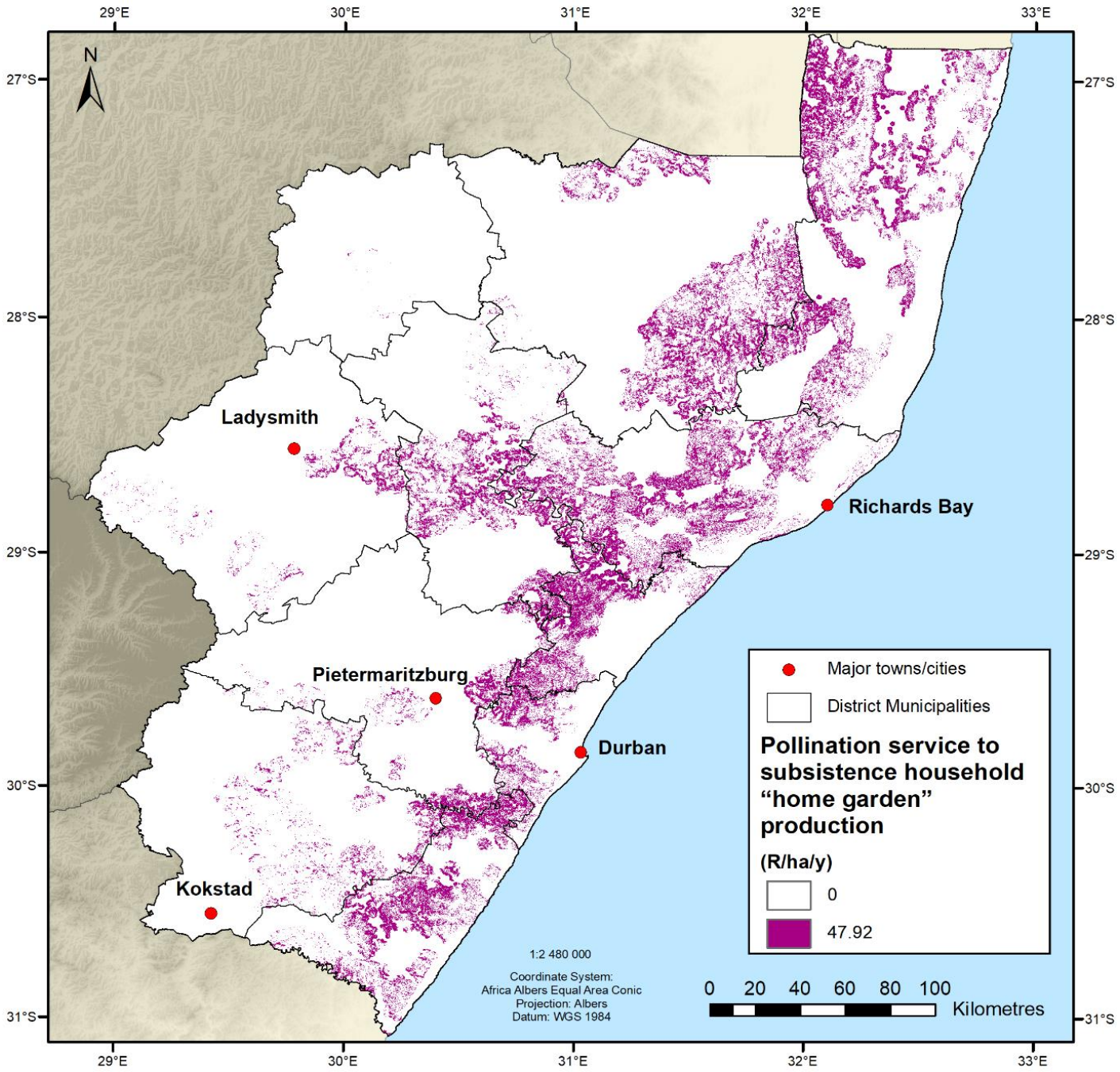
Pollination

Data & methods

- Only considered for low-input subsistence gardens
- Benefits transfer from single Tanzanian study, based on spatial analysis of land cover around rural homesteads

Results

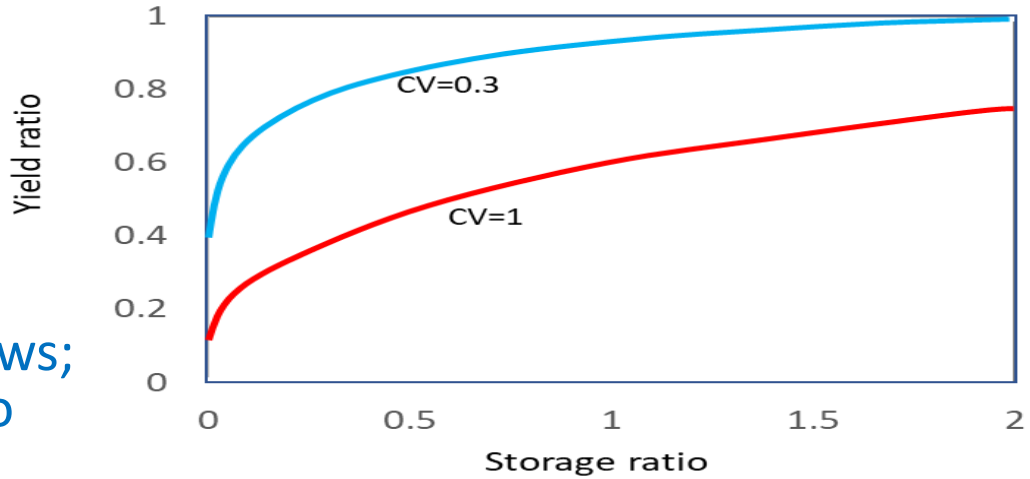
- R51 to R48 million
- Future research requires panel data collection of spatial, production and cost data



Flow regulation

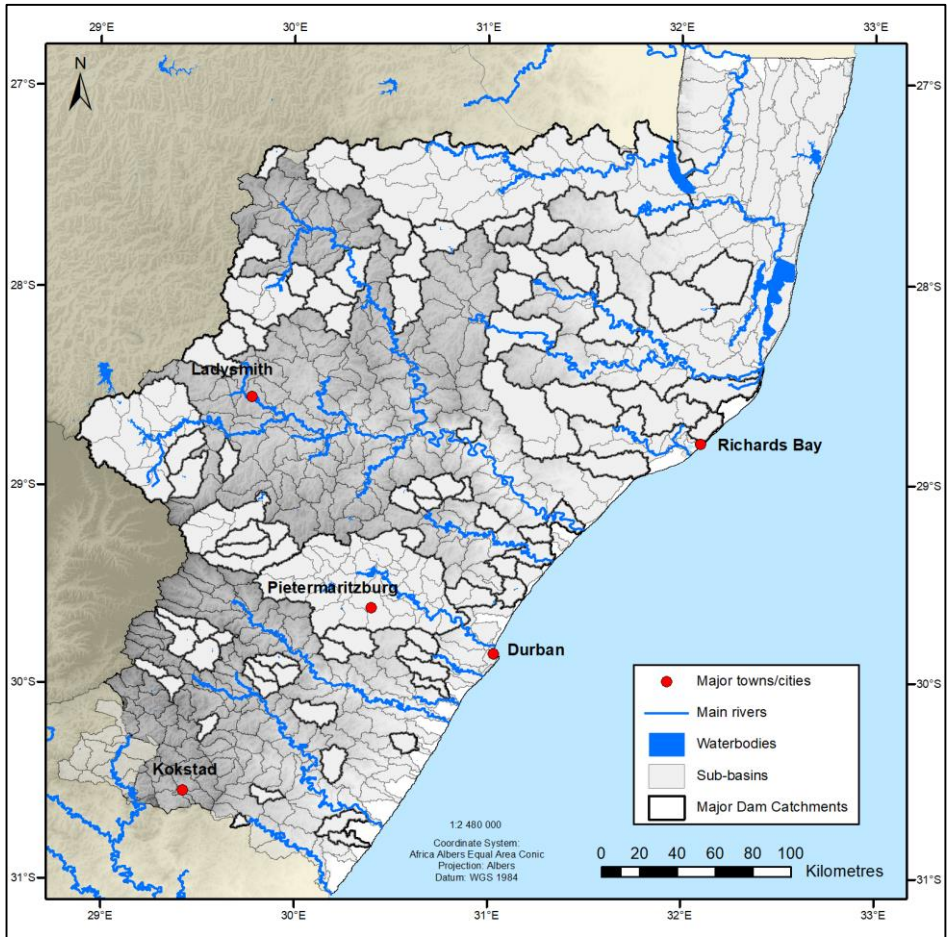
The service

- Infiltration by ecosystems delays water entering streams and reservoirs, decreasing variation in flows; a smaller variation in flows requires less storage to obtain a given yield



Methods

- Hydrological models of all river catchments using SWAT (565 sub-basins)
- Monthly flow variation relative to barren land (40y)
- Difference in storage capacity required **in dammed catchments**, using storage-yield-reliability
  - Average unit cost of built storage (capital and maintenance)
- Avoided water shortages for **run-of-river** household users, based on monthly water demands
  - Unit costs of water purchased from vendors

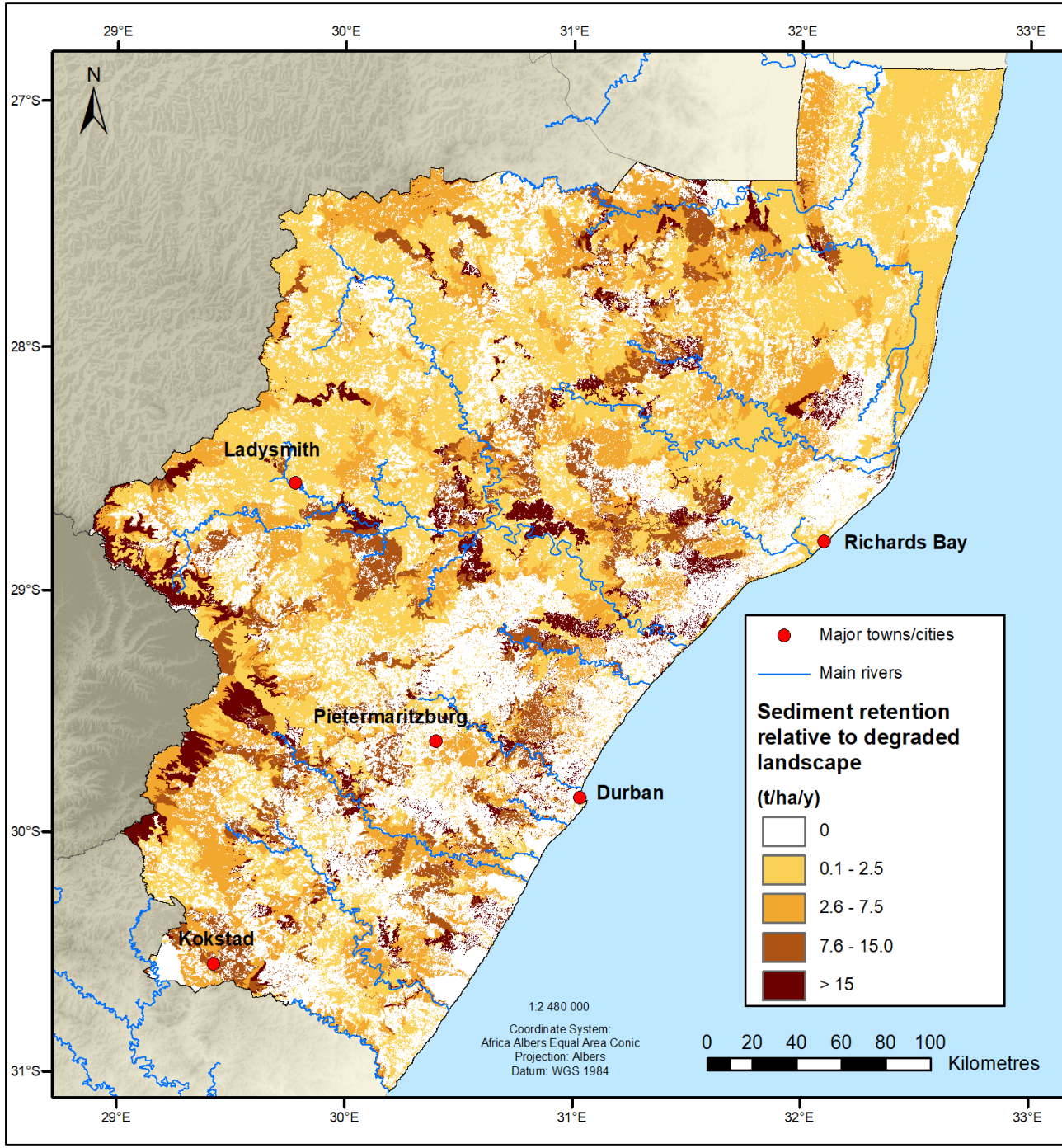


Results

Annual value is modest and decreasing: R1010m to R885m

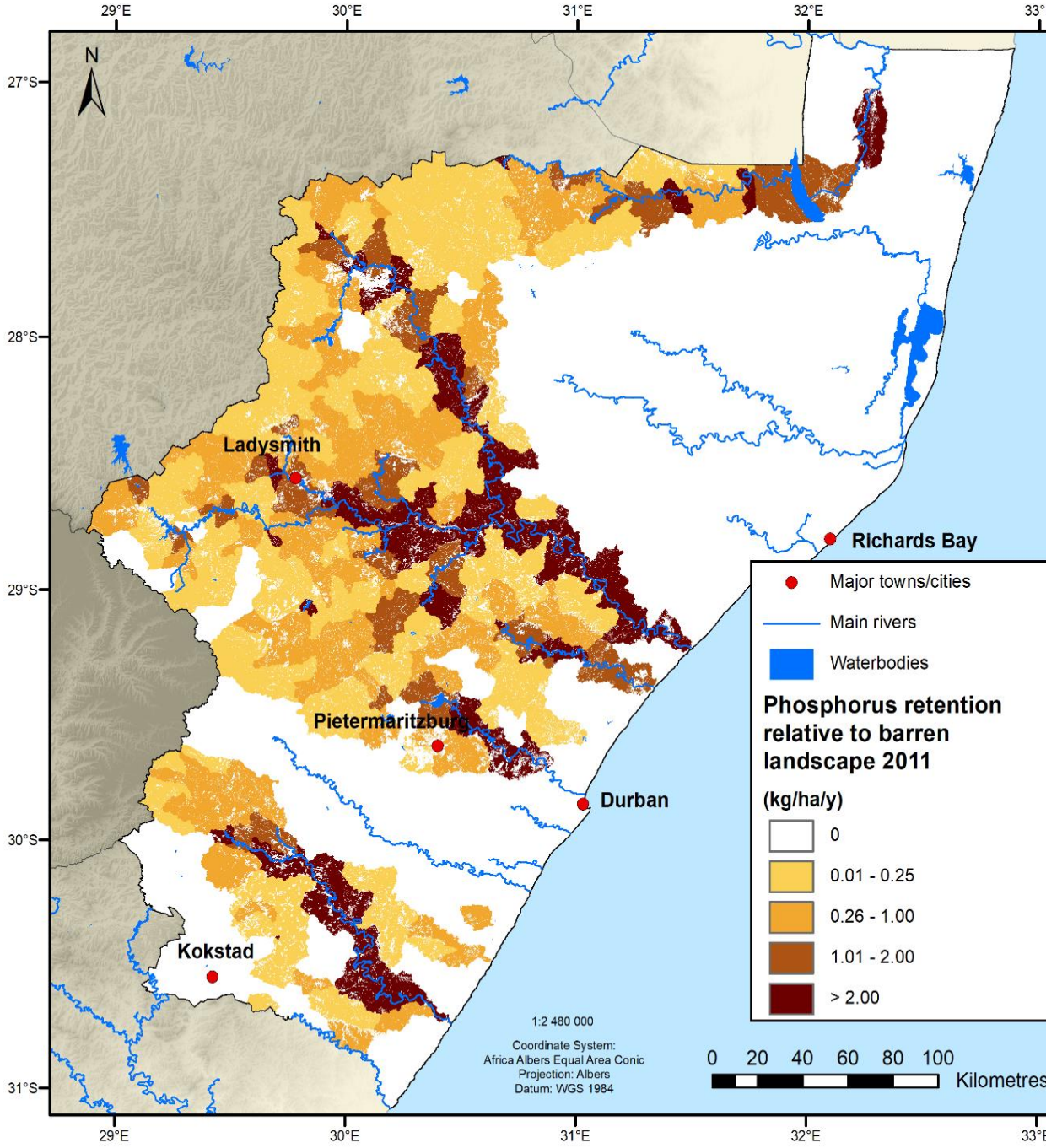
Sediment retention

- In situ sediment retained and eroded sediment loads trapped by vegetated ecosystems
- Modelled using InVEST
- Difference in sediment yields relative to barren land (t/ha, m^3/ha)
- Valued in terms of storage replacement cost (R/m^3)
- R88.7 to R67.3 million due to degradation



Water quality amelioration

- Nutrients trapped by vegetated ecosystems, reducing downstream eutrophication
- SWAT model to estimate differences in phosphorous loads at raw water extraction points relative to barren scenario
- Valued in terms of avoided water treatment costs, based on empirical model from KZN treatment plants & WQ data
- Partial valuation R20.4 to R16.0 million



Supply and use accounts

Supply 2005

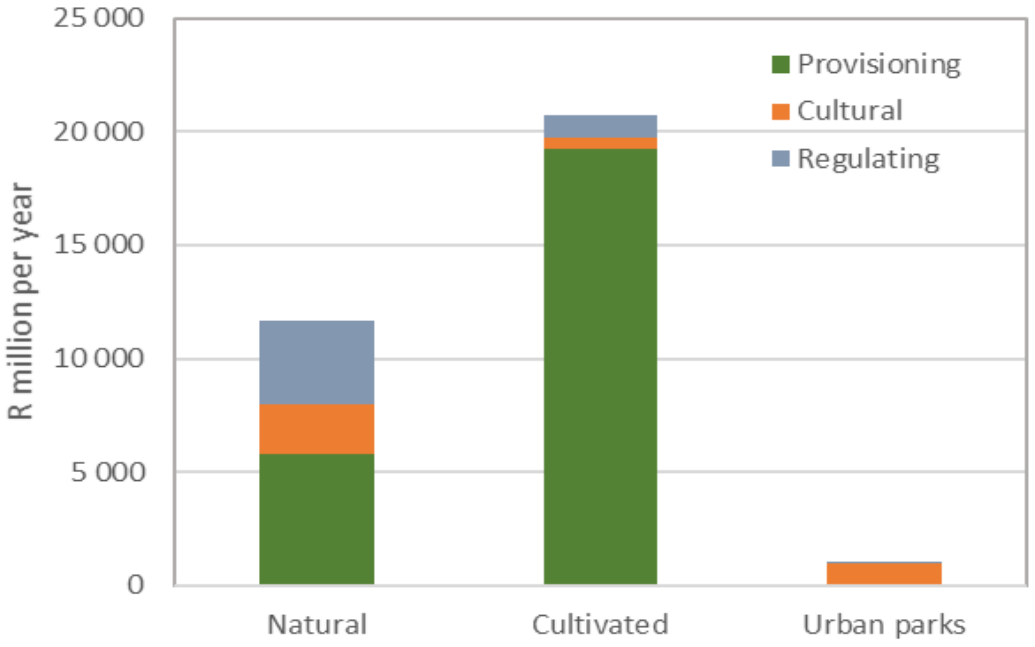
Biome (ha) / Resource	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	Cultivated	Built	Total
	63 131	3 354 881	362 944	2 292 315	181 604	39 425	2 361 582	682 176	9 338 058
Wood products	3.04	598.12	202.09	677.90	233.39	0.15			1 714.69
Non-wood products	22.06	973.05	252.87	715.3	49.06	0.81			2 013.15
Livestock production	4.64	1 865.62	189.32	921.83	6.68	1.16			2 989.25
Crop production							16 601.67		16 601.67
Experiential value	67.82	558.10	356.21	533.00	132.62	64.91	249.39	1250.51	3212.56
Carbon storage	40.4	1 758.7	426.4	577.6	104.6	0.3	846.4		3 754.4
Pollination	0.07	11.87	6.07	31.35	1.88	0.00			51.26
Flow regulation	0.23	654.89	8.43	334.41	8.97	-			1 006.93
Flood attenuation								31.02	31.02
Sediment retention	2.50	41.59	4.21	21.84	17.68	0.90			88.72
Water quality amelioration	-	16.52	0.17	3.21	0.50	-			20.40
Total R millions	**104.58**	**6 452.97**	**1 418.52**	**3 797.64**	**544.30**	**66.05**	**17 697.46**	**916.39**	**30 997.92**
Value R/ha	1 831	1 755	3 268	1 489	2 928	1 671	9 710	1 624	3 322

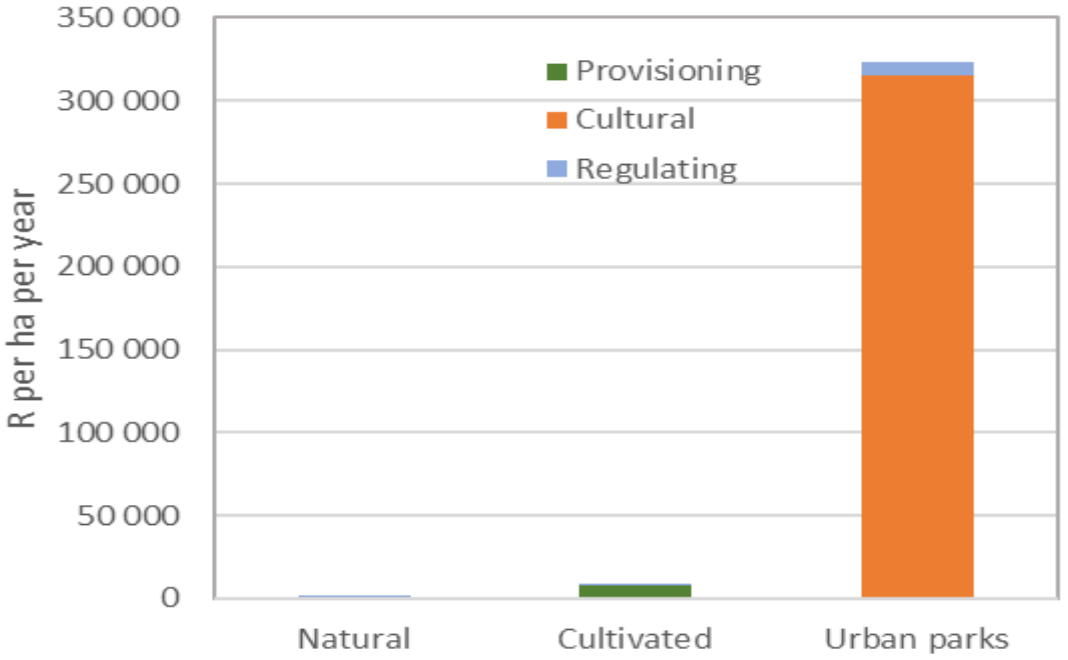
Use 2005

Economic users / Ecosystem service	Agric, Forestry and Fisheries	Water supply	Trade, catering & accommodation	Other sectors	Households	Government	Rest of world	Total
Wood products					1 714.69			1 714.69
Non-wood products					2 013.15			2 013.15
Livestock production	1 544.27				1 444.97			2 989.24
Crop production	15 298.31				1 303.36			16 601.67
Experiential value			1 567.15	1 645.41				3212.56
Carbon storage							3 754.40	3 754.40
Pollination					51.26			51.26
Flow regulation	1 006.93							1 006.93
Flood attenuation					31.02			31.02
Sediment retention		88.72						88.72
Water quality amelioration		20.40						20.40
Total	17 849.51	109.12	1 567.15	1 645.41	6 558.45	-	3 754.40	30 997.92

Summary results

Class	Ecosystem service	2005	2011
		Annual flow R millions	Annual flow R millions
Provisioning	Wild resources	3 722	3 180
	Animal production	2 989	2 636
	Cultivation	16 602	19 258
Cultural	Nature-based tourism	1 567	2 282
	Property	1 165	1 328
Regulating	Carbon storage *	3 754	3 633
	Pollination	51	48
	Flow regulation	1 007	982
	Flood attenuation	31	24
	Sediment retention	89	67
	WQ amelioration	20	16
Total annual value		**30 998**	**33 453**



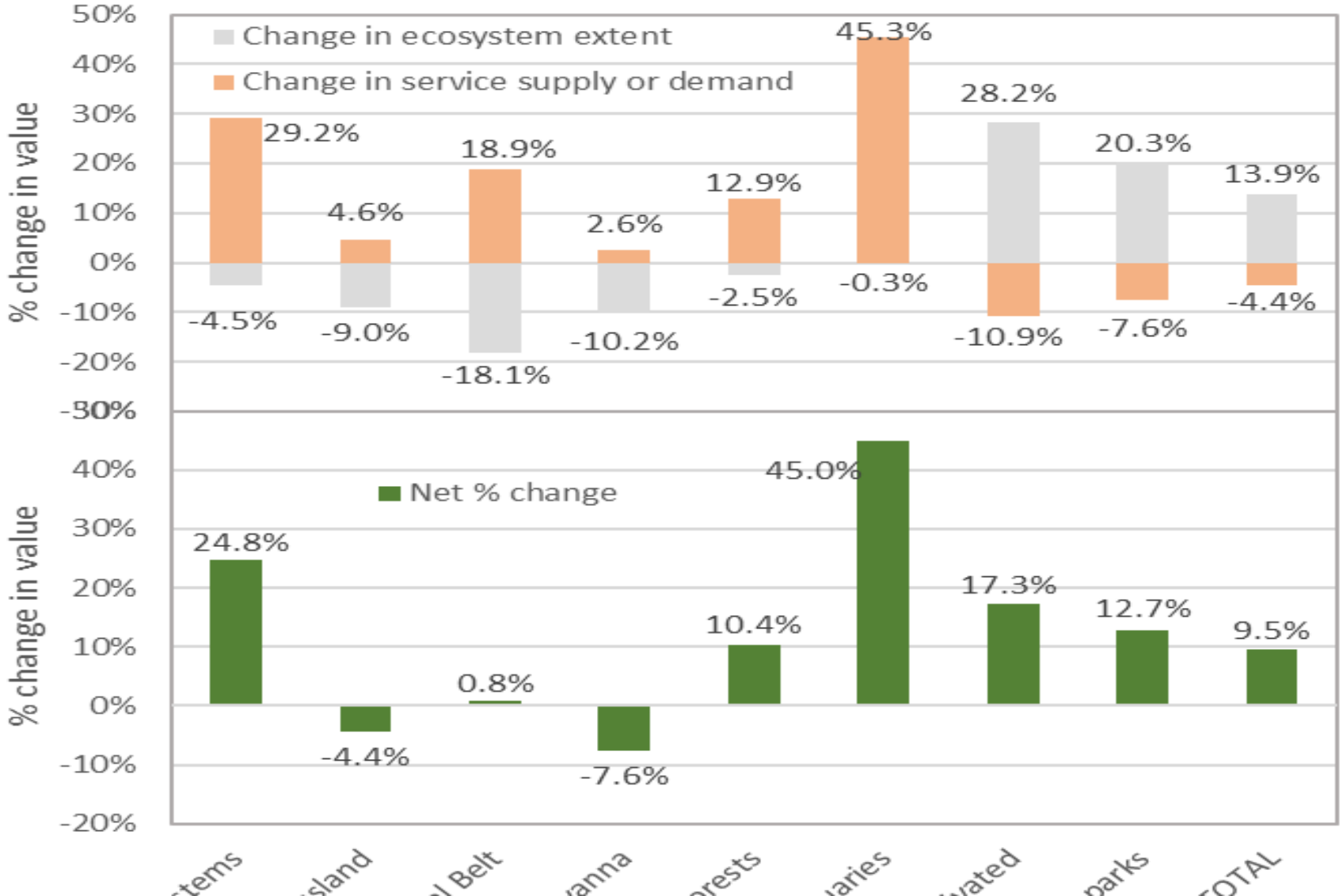


Incomplete, so far 7.4% of regional GDP

Asset account 2005-2011

	Freshwater ecosystems	Grassland	Indian Ocean Coastal Belt	Savanna	Forests	Estuaries	Cultivated	Urban parks	TOTAL
Opening stock (2005)	**1 640**	**89 720**	**19 852**	**52 822**	**7 244**	**1 068**	**286 681**	**14 845**	**473 872**
Change due to change in ecosystem extent	-73	-8 053	-3 588	-5 388	-179	-4	80 748	3 018	66 481
Change due to change in ecosystem capacity and/or service demand	480	4 126	3 749	1 043	971	484	-31 234	-1 135	-21 517
Net change	406	-3 928	161	-4 344	792	480	49 514	1 883	44 964
Closing stock (2011)	**2 046**	**85 792**	**20 014**	**48 478**	**8 036**	**1 548**	**336 195**	**16 727**	**518 835**
Net change %	24.8%	-4.4%	0.8%	-8.2%	10.9%	45.0%	17.3%	12.7%	9.5%

Asset account 2005-2011



Limitations

- Study achieved different levels of completion for different services –
  - e.g. incomplete geographic coverage of pollination, wq amelioration, flood attenuation
- Further work needed to refine and validate models and estimates
- Need to include non-market values
  - E.g. local recreation not captured in property or tourism value, non-use values

Lessons learned

- The first set of accounts is complex, need at least 15-20 person months over 2-3 years
- Highly technical, rapidly evolving – needs independent technical group until streamlined and automated
- Initial stages need rigorous peer review from a number of angles
- Government agencies need clear specifications and mandates for data collection and must supply freely/online
  - Even with SANBI help, we could not leverage all the gov data we wanted
  - Satellite data and generic models are critical but need validation
- Some funding should be allocated to primary data collection and research, especially non-market valuation.

Recommendations

- Land cover and socio-economic data produced **in sync** at 5 year intervals;
- **Detailed and consistent national land cover data series** with ground-truthed measures of ecosystem condition
- Better **agricultural and resource use statistics** including small scale and subsistence activities, and collect empirical (aerial) data on livestock and crops
- Nationally-consistent fine scale **tourism statistics** on visitor activities
- Centrally collated **statistics from water supply entities**
- Undertake **further research and modelling** to improve estimates and fill gaps
- **Explore useful ways to summarise the findings**, for example in terms of ecosystem types and sectoral linkages.

Thank you!

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