water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

NATIONAL DEVELOPMENT PLAN
Our Future - make it work

INVESTIGATION OF GROUNDWATER AND SURFACE WATER INTERACTION FOR THE PROTECTION OF WATER RESOURCES IN THE LOWER VAAL CATCHMENT (WP11380) – Project Progress

Presentation to PMC – Meeting 2

Presented by: K. Sami WSM Leshika

Date: May 2023

Presentation Outline

- Study Objectives
- Summary of Hydrocensus Report
- Summary of Water Resources Assessment Report
- Summary of Recharge and Baseflow Report
- Results of capacity building workshop

PROJECT OBJECTIVES

- Review existing water resource information
- Conduct a hydrocensus on an institutional level
- Conduct a groundwater resource assessment of recharge, baseflow, abstraction, groundwater balance
- Quantify aquifer parameters and describe aquifer types
- Determine groundwater-surface water interactions both in terms of quality and quantity to determine protection zones
- Capacity building and skills transfer to DWS staff

24 Month project duration

RED = covered in this reporting period

Project Progress

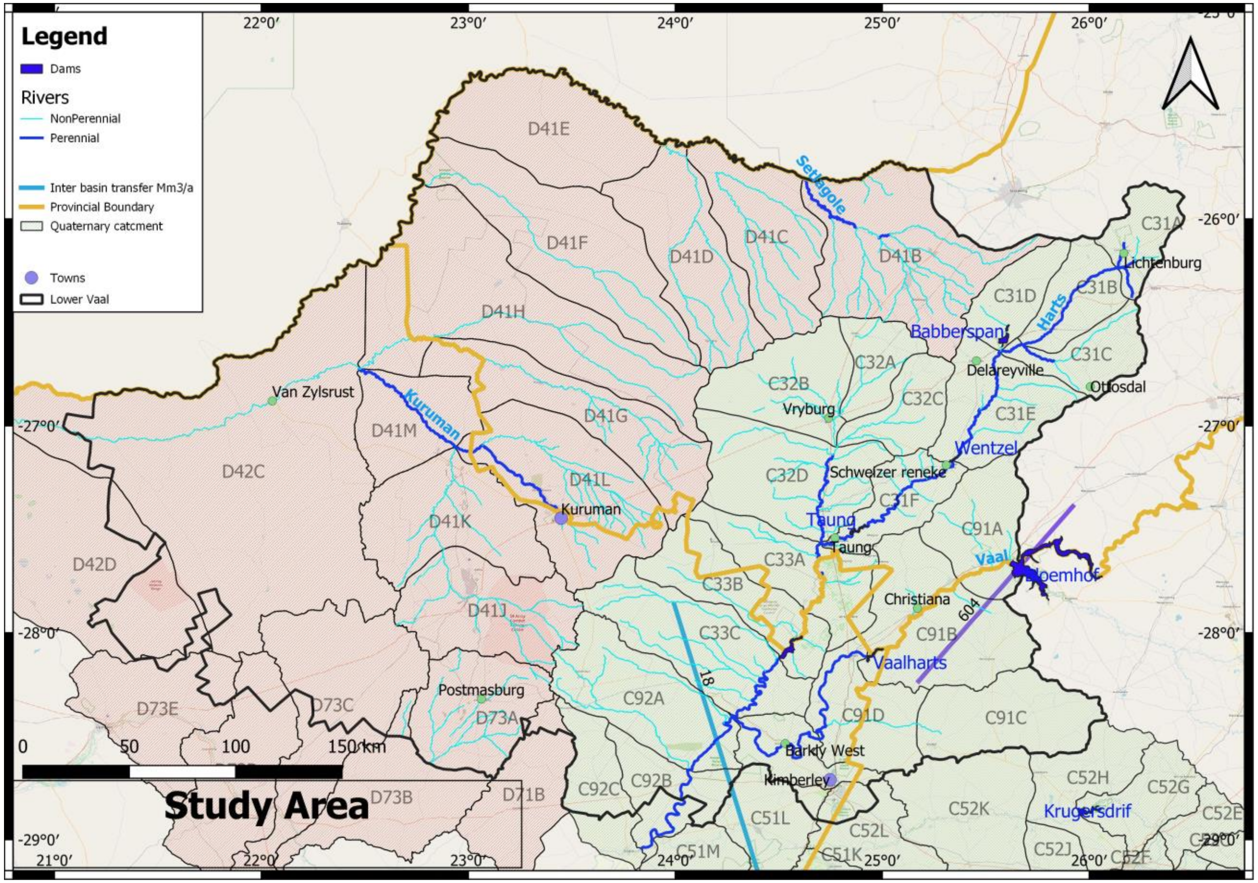
OBJECTIVES

Step	Description	Outcomes	Progress	Status
1	Study Inception	• Inception report: • Work programme • Capacity building plan • Expenditure projections	✓	Complete. Report: RDM/WMA05/00//GWSW/0122: Inception Report

2	Review of Water Resource Information • Literature Review • Data gathering • Hydrocensus • Resource Assessment • Water quality	• Final Report submitted • Final Report Submitted • Final Report submitted • Final Report Submitted • Next Report		This phase complete and results will be presented

3	Surface - Groundwater Interactions • Quantity groundwater recharge and baseflow contributions to rivers • Quantify losses from rivers to groundwater • Categorize groundwater quality • Groundwater levels and their fluctuations • Determination relevance of groundwater contribution to surface water and identify protection zones • Groundwater conceptual model and maps • Present status of groundwater • Compilation of a monitoring programme	• Surface-subsurface interactions using WRSM2000/Pitman and GRDM Methodology – report submitted • Next Report • Map of protection zones • Map of groundwater levels		This phase Is in progress
4	Capacity Building	• Trained officials • Summary document of training process and defining any further training that may still be required • Training workshop • Training materials		Workshop given

Study Area



Legend
Dams
Rivers
NonPerennial
Perennial
Inter basin transfer Mm3/a
Provincial Boundary
Quaternary catcment
Towns
Lower Vaal
Study Area
D41E
D41F
D41D
D41C
D41B
D41H
D41G
D41M
D41L
D41K
D41J
D42C
D42D
D73E
D73C
D73A
D73B
D71B
C31A
C31B
C31C
C31D
C31E
C31F
C32A
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C33A
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C33C
C91A
C91B
C91C
C91D
C92A
C92B
C92C
C51L
C51M
C51K
C52L
C52K
C52H
C52G
C52J
Setlagole
Harts
Kuruman
Vaal
Babberspan
Wentzel
Taung
Bloemhof
Vaalharts
Krugersdrif
Van Zylsrust
Vryburg
Delareyville
Ottosdal
Lichtenburg
Schweizer reneke
Christiana
Barkly West
Kimberley
Postmasburg
604
18
0
50
100
150 km

HYDROCENSUS REPORT

Hydrocensus Visits

Stakeholder Name	Stakeholder Representative	Meeting Date	Results (if any)
Francis Baard Municipality	Rorisang Setshogoe	13th June 2022	The municipality coordinated all the meetings with various municipalities
Magareng Municipality	Tumelo Thage	13th June 2022	Hydrocensus data will be collated, and sent to WSM Leshika Consulting
Dikgatlong Municipality	Desmond Makaleni	13th June 2022	Hydrocensus data will be collated, and sent to WSM Leshika Consulting
Sol-Plaatjie Municipality	Sabelo Mkhize Boy Dhluwayo	14th June 2022	Hydrocensus data will be collated, and sent to WSM Leshika Consulting
Phokoane Municipality	Lubabalo Jange	13th June 2022	Hydrocensus data will be collated, and sent to WSM Leshika Consulting
Vaalhaarts Water	Anita Kooverjee Niel Van Eeden	13th June 2022	Hydrocensus data will be collated, and sent to WSM Leshika Consulting
Sedibeng Water	Frans De Vos	13th June 2022	Ages Report on the Regional Geohydrological Potential Assessment for Ganyesa, North West Province
Naledi Municipality	Leon Pretorius	14th June 2022	Hydrocensus data still being collated

Data Obtained

Data Requirement	Response
Water use data: surface and groundwater monthly water use. Historical, present and forecast.	Data for 2022 only was sent to WSM Leshika from Vaalharts
Water Quality data: water quality analyses, results and frequency;	No data is collected. Collected from DWS
Waste water discharge volumes and quality data;	No data received
Water monitoring: historical to present water levels in monitoring boreholes. Location of boreholes and status (functional, blocked, collapsed etc);	Borehole monitoring still resides with the DWS. This has been obtained from HYDSTRA
Registered water use volume;	Obtained for Vaalharts and from WARMS
Area served: towns and population.	○ Phokwane (Population 65 000) ○ Magareng (Population 25 000) ○ Dikgatlong (Population 45 000) ○ Greater Taung (Sedibeng Water) (Population 180 000) ○ Naledi (Sedibeng Water) (Population 66 000)

Vaalharts Registered Use

Source	Allocation Volume (Mm3/a)	Quaternary	Water use sector
Spitskop dam	3.289	C33C	Irrigation
Vaalharts	28.041	C33C	Irrigation
Vaalharts	0.319	C33C	Industry
Vaalharts	7.266	C33C	Industry
Spitskop dam	0.021	C33C	Industry
Spitskop dam	12.806	C33C	Irrigation
Vaalharts	270.723	C33C	Irrigation
Vaalharts	5.722	C33C	Industry
Vaalharts	31.839	C33C	Irrigation
Vaalharts	2.74	C33C	Irrigation
	362.766		

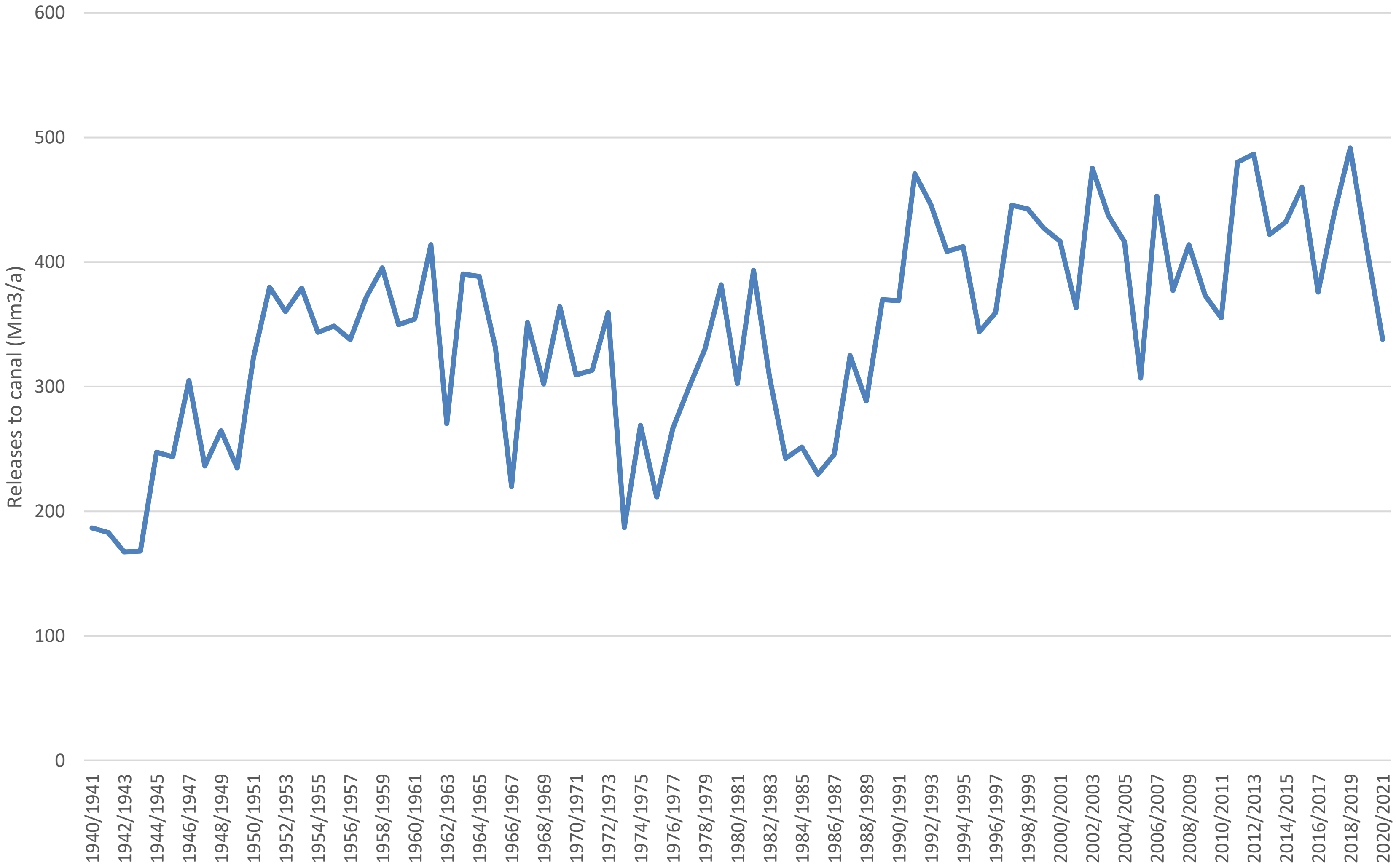
Vaalharts Data on Actual Use

Water Use	Use (Mm3/a)
Agriculture	31.728
Industry	0.068
Water Supply	8.402
Other	0.382
Downstream users	30.398
Total	70.978
Releases	94.986

- Present day use only 26% of registered use
- 94.986 Mm^3/a released.
- 8.402 Mm^3/a utilised for water supply to Phokwane, Dikgatlong and Magareng.
- However, releases to the canal at Warrenton (C9H018), indicate that abstractions from the Vaal have been increasing over time and often exceed 400 Mm^3/a

Year	Mnth	Agriculture (x1000 m3)	Industrial (x1000 m3)	Municipality (x1000 m3)	Household (x1000 m3)	Down stream (x1000 m3)	Other (x1000 m3)	Total used (x1000 m3)	Released (x1000 m3)	Total loss (x1000 m3)	Loss (%)	Alloc used (x1000 m3)	Alloc avail (x1000 m3)	Used (%)	Avail (%)
2022	Mar	0	0	0	9	1 745	0	1 754	5 120	3 366	65.7	0	284 117	0.0	100.0
2022	Apr	1 589	5	1 076	36	2 756	32	5 495	5 977	482	8.1	2 703	281 414	1.0	99.0
2022	May	3 497	5	893	36	2 397	65	6 892	8 040	1 148	14.3	7 162	276 955	2.5	97.5
2022	Jun	3 775	8	1 010	45	3 718	50	8 606	11 697	3 091	26.4	12 006	272 111	4.2	95.8
2022	Jul	4 900	13	1 053	36	3 496	32	9 530	12 613	3 083	24.4	18 005	266 112	6.3	93.7
2022	Aug	2 102	2	0	9	1 087	11	3 212	4 046	834	20.6	20 121	263 997	7.1	92.9
		15 864	**34**	**4 032**	**169**	**15 199**	**191**	**35 488**	**47 493**	**12 005**	**25.3**	**20 121**	**263 997**	**7.1**	**92.9**

Realeases to Vaalharts at Warrenton



Other Schemes

- **Vaal Gamagara Regional Water Supply Scheme: s**upplies water to Dikgatlong, Kgatelopele, Tsantsabane, Gamagara and Joe Morolong LM; Mines and industries, Solar projects, Kalahari East water supply scheme, Lohatla Military Base, Transnet and Eskom; and agricultural stock watering. The current water demand of 25 Mm^3/a should increase to approximately 28 Mm^3/a by the year 2030.
- Some towns supplement with boreholes and taking this into account Municipalities will require 8.02 Mm^3/a from the scheme by 2038. Current water supply is 6 Mm^3/a. Estimates for other users are: mines 15.8 Mm^3/a, solar plants 0.5 Mm^3/a, and Kalahari East Water User Association, government, parastatal entities another 4 Mm^3/a.
- **Kalahari-East Water Supply Scheme** delivers 100 l/s. Water is pumped from the Sishen mine into the Vaal Gamagara pipeline from where the Kalahari-East water supply scheme withdraws water at a maximum rate of 103 l/s

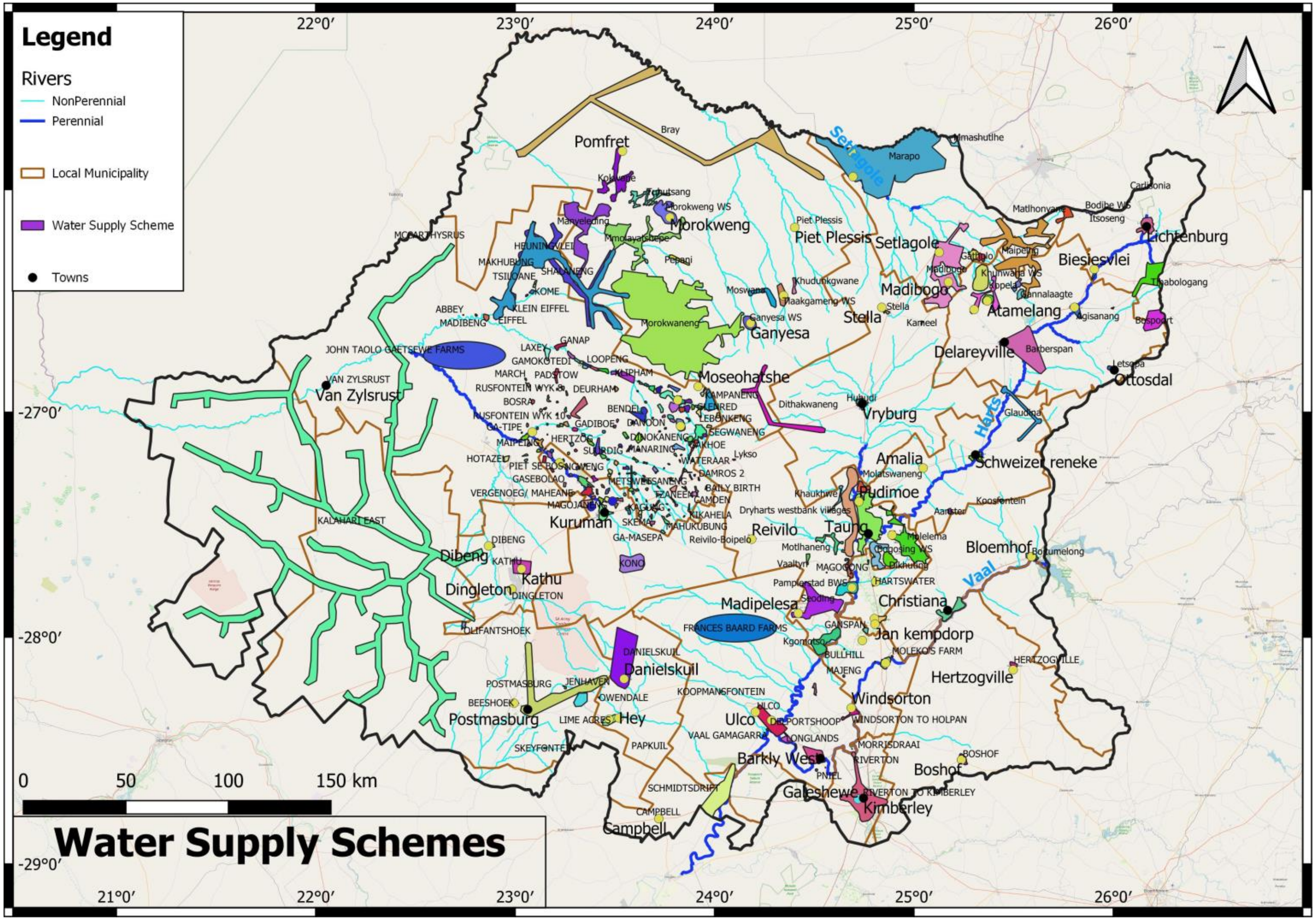
Water Supply Use

Total water use for water supply is 94.798 Mm^3/a, of which 48.179 is from surface water. Average per capita consumption is 145 l/c/d. 6.258 Mm^3/a is from the Vaal via the Vaal-Gamagara scheme.

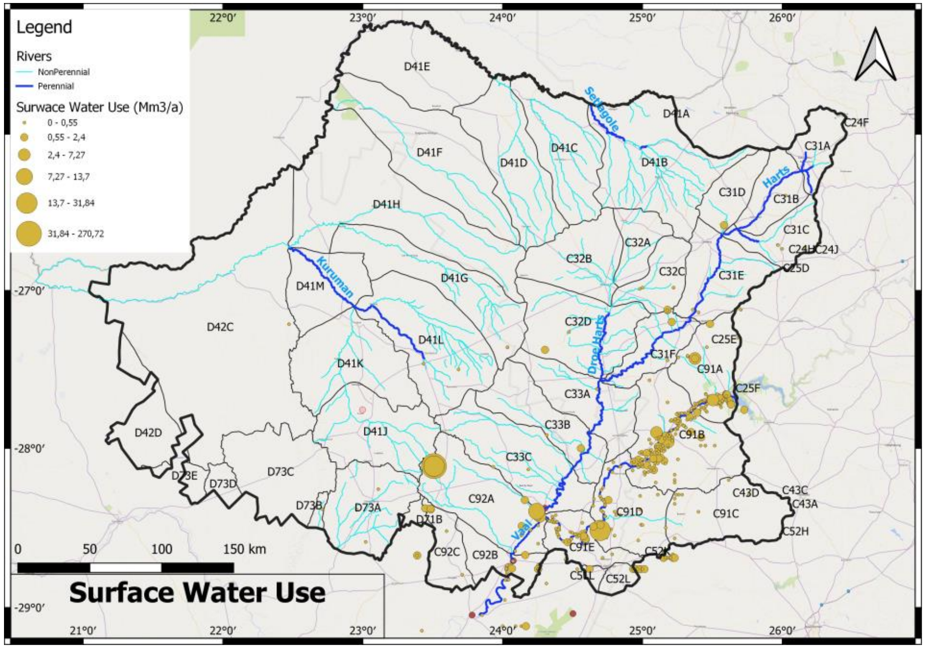
- Broken down by scheme, source, Quaternary in report . E.g.:

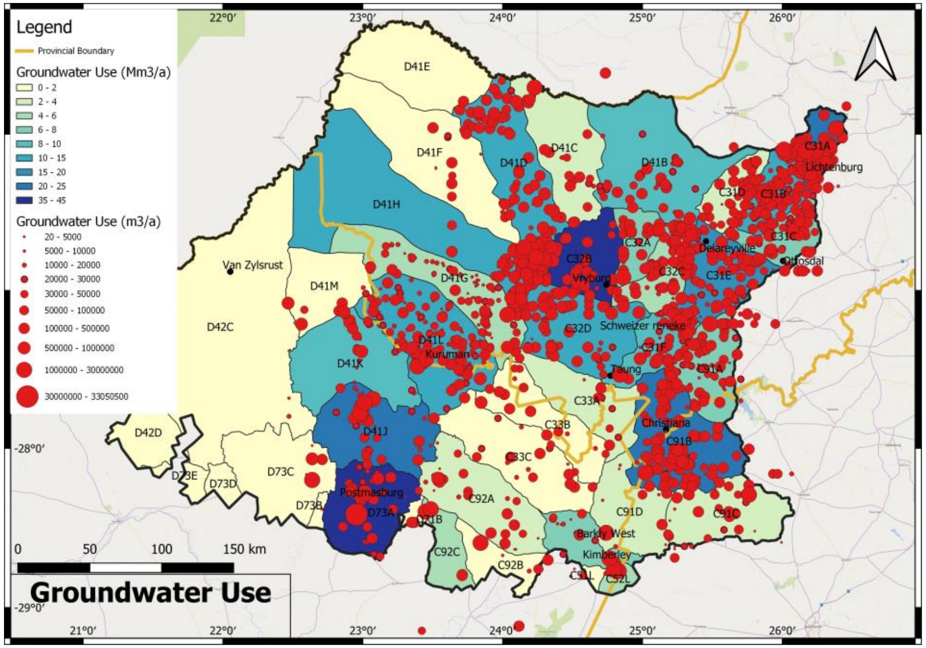
Municipality	Population	Water Supply Scheme	Source	Use (Mm^3/a)	Surface water (Mm^3/a)	Groundwater (Mm^3/a)	l/c/d
Tsantsabane	44455	Postmasburg	Vaal Gamagara pipeline	0.8	0.8		150
			8 boreholes	0.627		0.627	
			Kalahari East	1	1		
Kgatelopele	23356	Danielskuil	2 boreholes	0.69		0.69	238
		Lime Acres, Papkuil, Owendale	Vaal Gamagara	1.2	1.2		
Siyacuna	1662	Campbell	2 springs 3 boreholes	0.142		0.142	234
		Schmidtdrift					
Sol Plaatjie	244206	Kimberley	Vaal at Riverton	18.62	18.62		217

Water Supply Use



Registered Use





Registered Use

Table 4-1 Surface water use by sector

Sector	Use (Mm³/a)	Percent
AGRICULTURE	694.612	91.41
INDUSTRY	16.658	2.19
MINING	15.054	1.98
WATER SUPPLY SERVICE	33.583	4.42

Table 4-2 Registered groundwater use by sector

Sector	Use (Mm³/a)	Percent
AGRICULTURE	183.67	68.98
INDUSTRY	2,664	1.0
MINING	35.77	13.43
WATER SUPPLY SERVICE	44.179	16.59

Total Registered use: 1026.1 Mm^3/a

Schedule 1: 6.9 Mm^3/a

Livestock use: 21.0 Mm^3/a

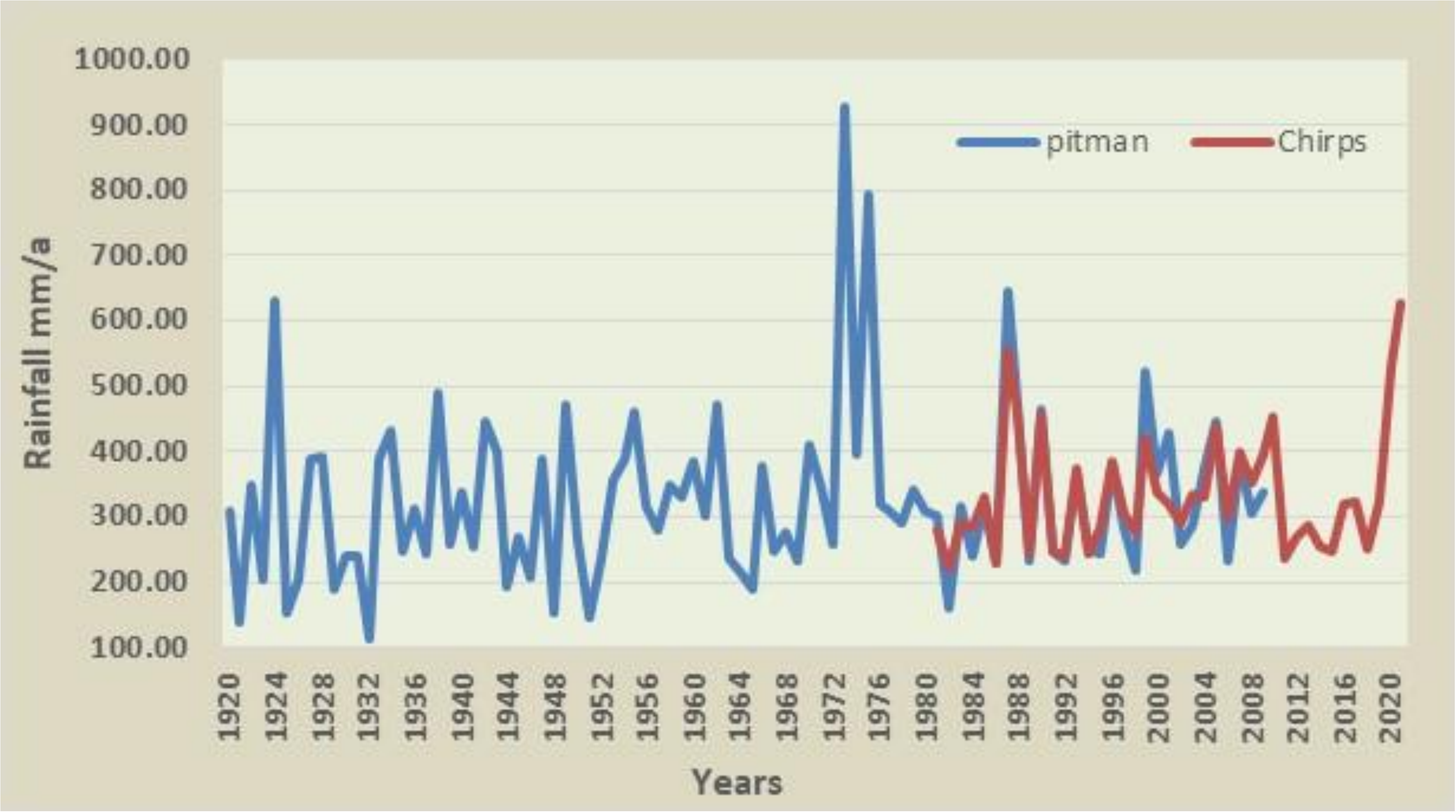
Registered use is lower than actual use (94.8), especially surface water (48.2)

WATER RESOURCES REPORT

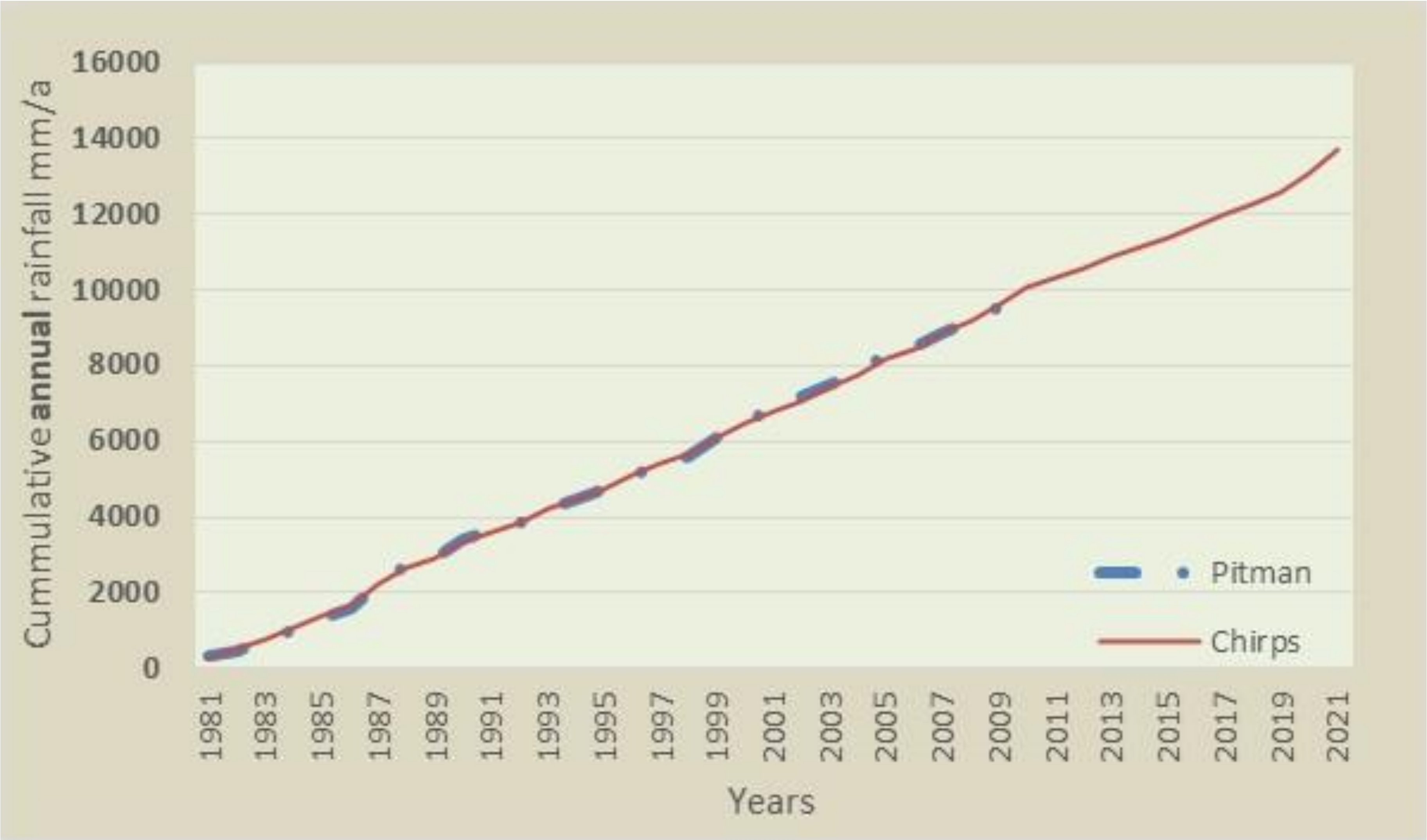
Rainfall

- DWS initiatives to obtain rainfall data from SAWS not successful
- CHIRPS satellite-based database was used. This is a gridded satellite-based precipitation estimates from NASA and NOAA.
- A scientific paper by Mr Allan Bailey and Dr Bill Pitman has recently been vetted on the applicability of the CHIRPS dataset within South Africa.
- The CHIRPS rainfall data only start from 1981. The overlapping period with existing observed rainfall data is thus from 1981 to 2009.

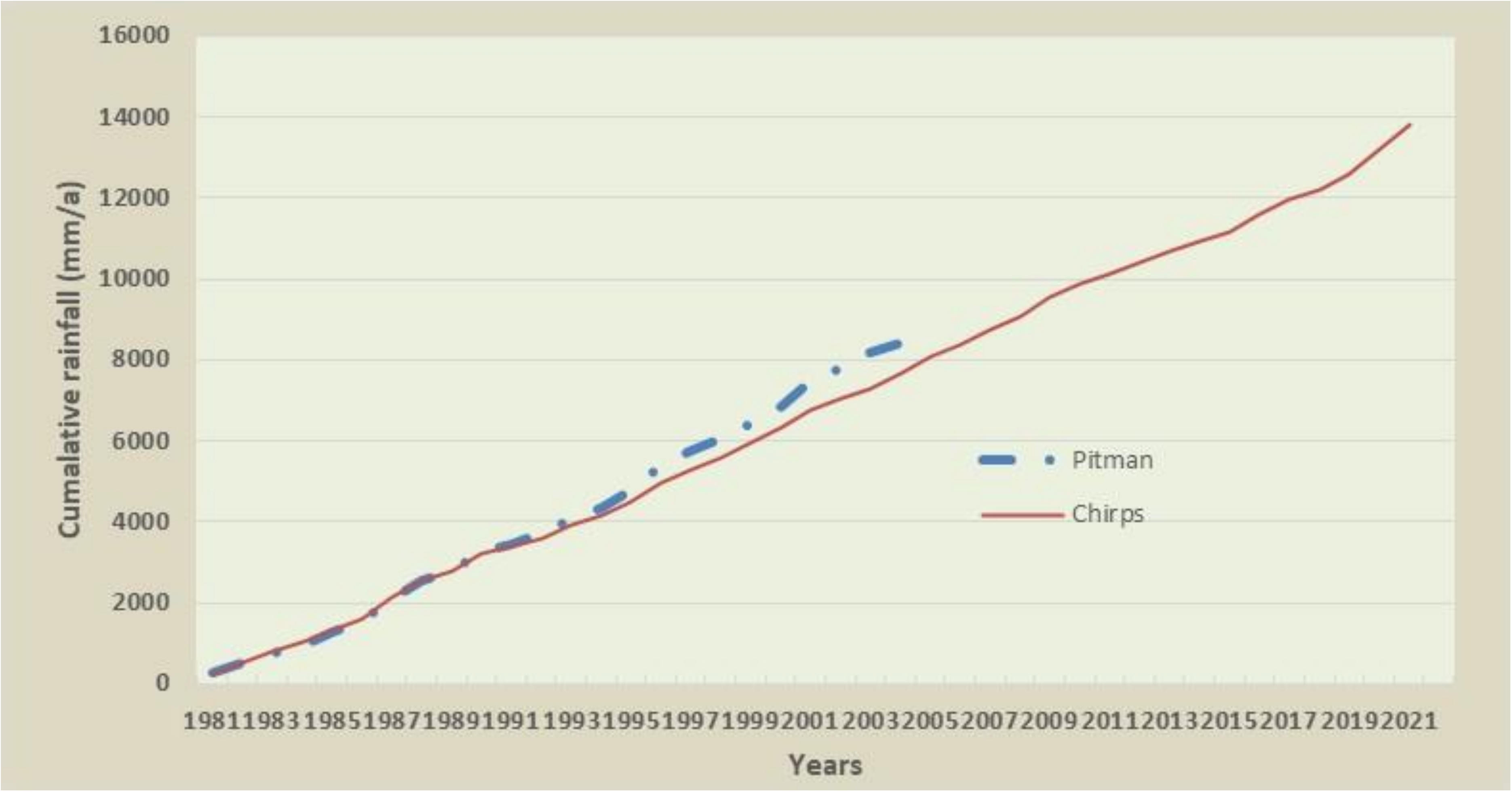
Rainfall Observed versus CHIRPS (C32C)



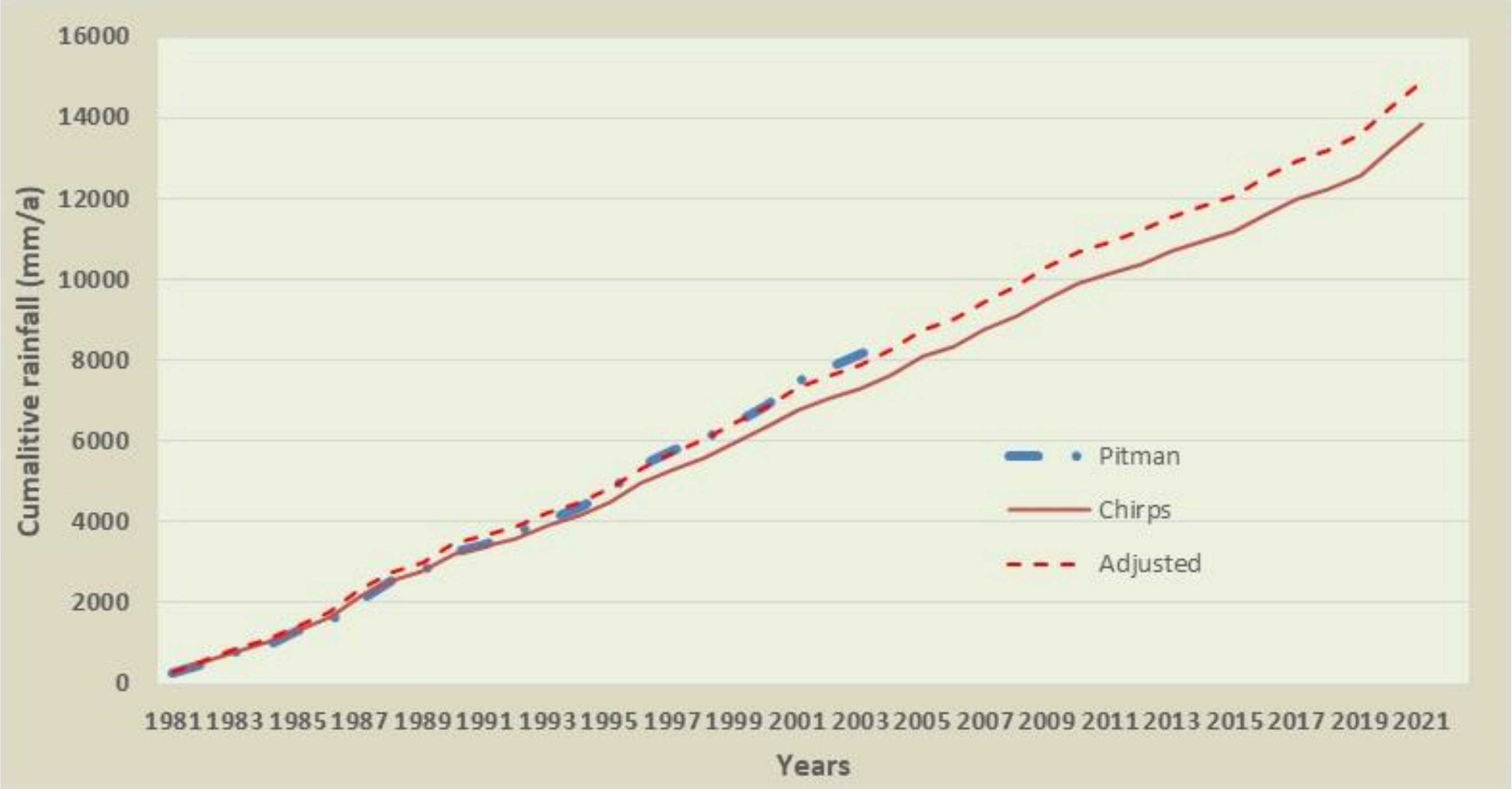
Mass plot – Rainfall Chirps versus observed C23C



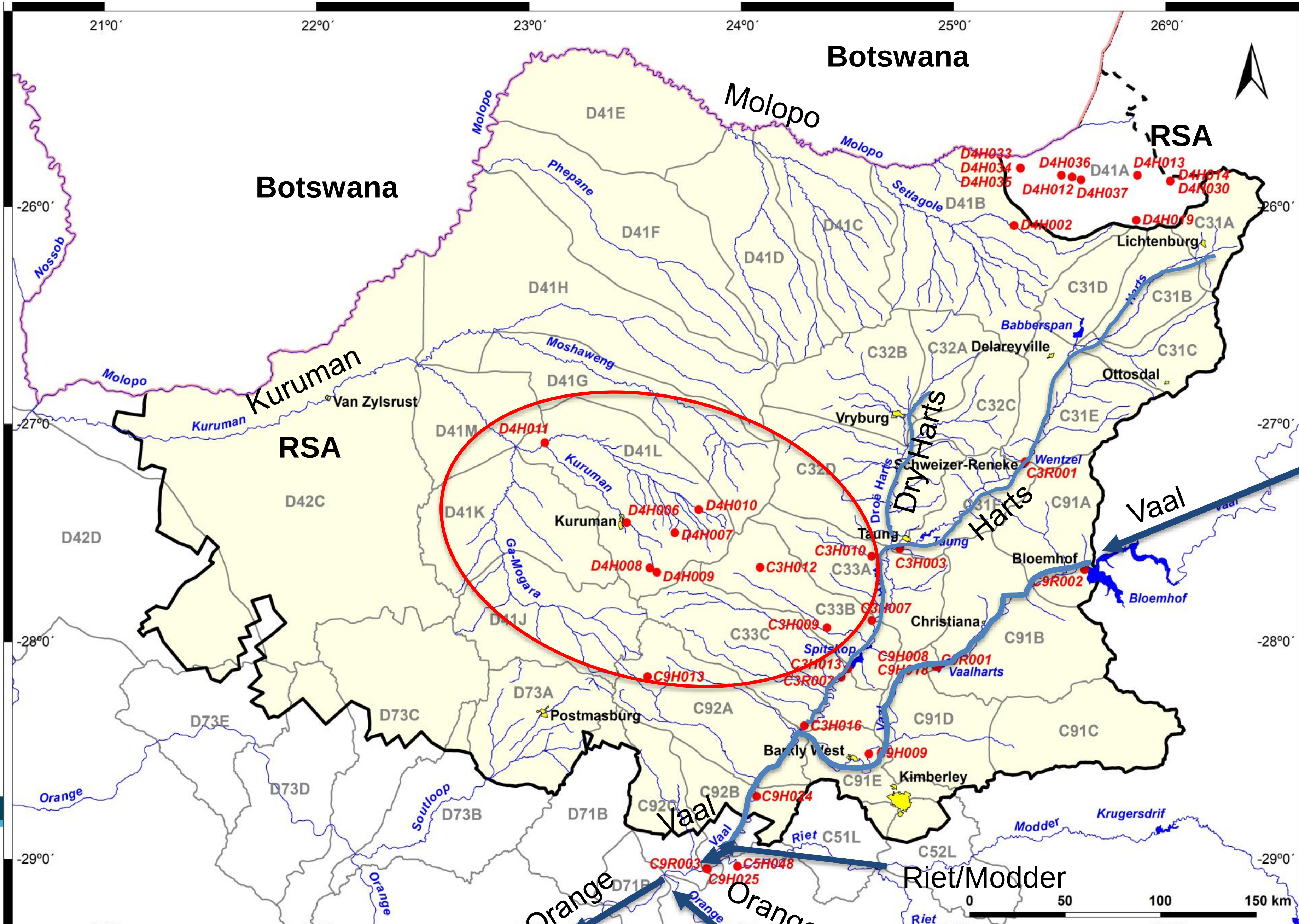
Mass plot – Rainfall Chirps versus observed D41F



Mass plot – Rainfall Chirps adjusted versus observed D41F



Observed Flows

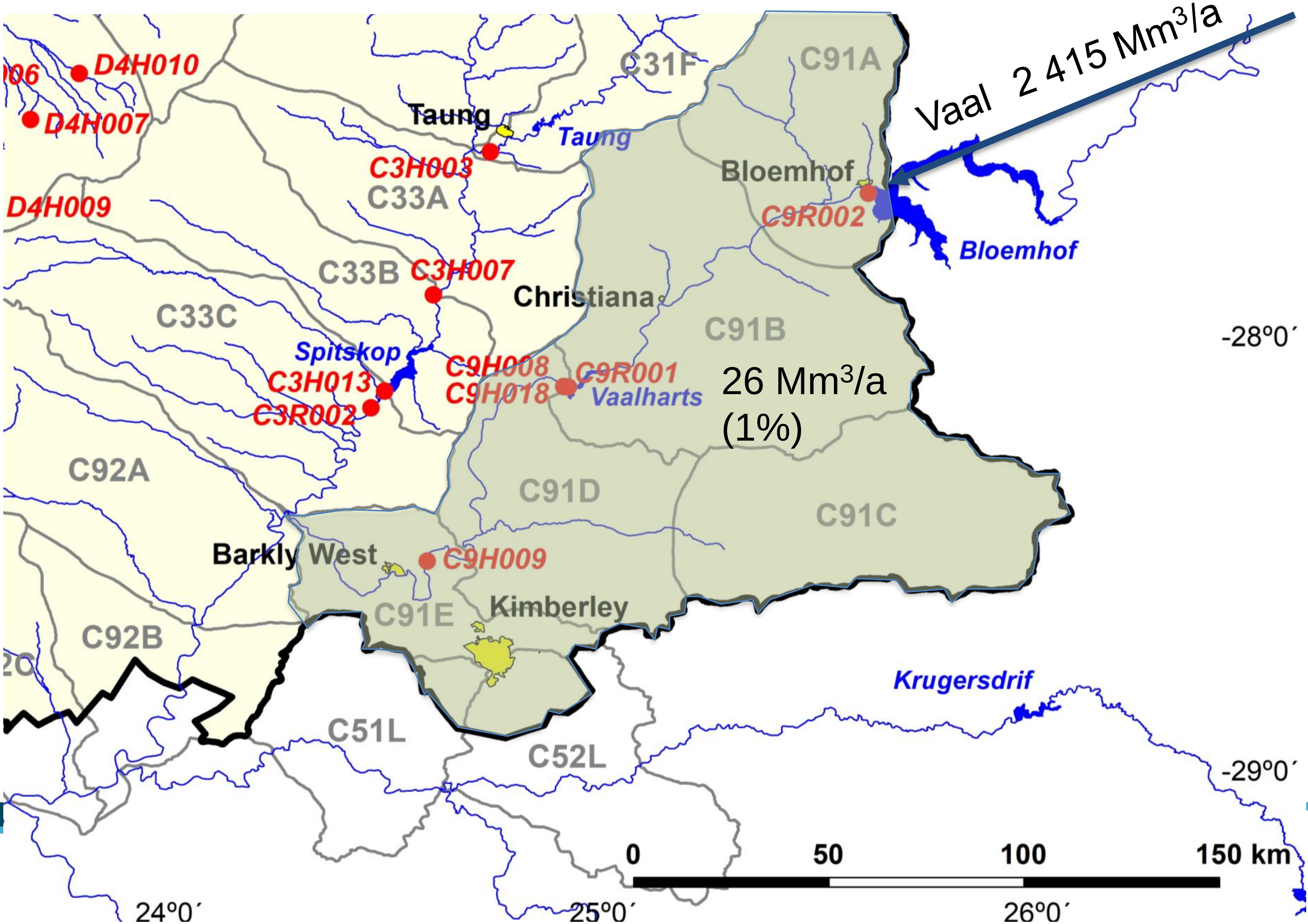


Observed Flows key gauges

Flow gauge number	Flow gauge name	Location	Record period used
Main Vaal River			
C9R002 (inflow)	Bloemhof Dam inflow	Vaal River	1968 to 2021
C9R001 (calibration)	Vaalharts Weir	Vaal River	1947 to 2020
C9H009 (calibration)	De Hoop Gauge	Vaal River	1968 to 2021
C9H024 (calibration)	Schmidtsdrif Gauge	Vaal River	2000 to 2020
C9R003 (calibration)	Douglas Storage Weir inflow	Vaal River	1990 to 2005
Harts River			
C3R001 (calibration)	Wentzel Dam inflow	Upper Harts River	1978 2003
C3H017 (checking)	Harts at Tlapeng	Harts just upstream of Taung Dam	2002 to 2021
C3H003 (calibration)	Harts at Taung	Harts just downstream of Taung Dam	1938 to 2021
C3H007 (calibration	Harts at Espagsdrif	Harts just upstream of Spitskop Dam	1964 to 2021
C3R002 (calibration)	Spitskop Dam inflow	Lower Harts River	1990 to 2005
Molopo River			
D4H033 (inflow)	Molopo at Disaneng		2019 to 2021
Riet River			
C5H048 (inflow)	Zoutpansdrift	Lower Riet River	2009 to 2021

Inflow to Bloemhof Dam

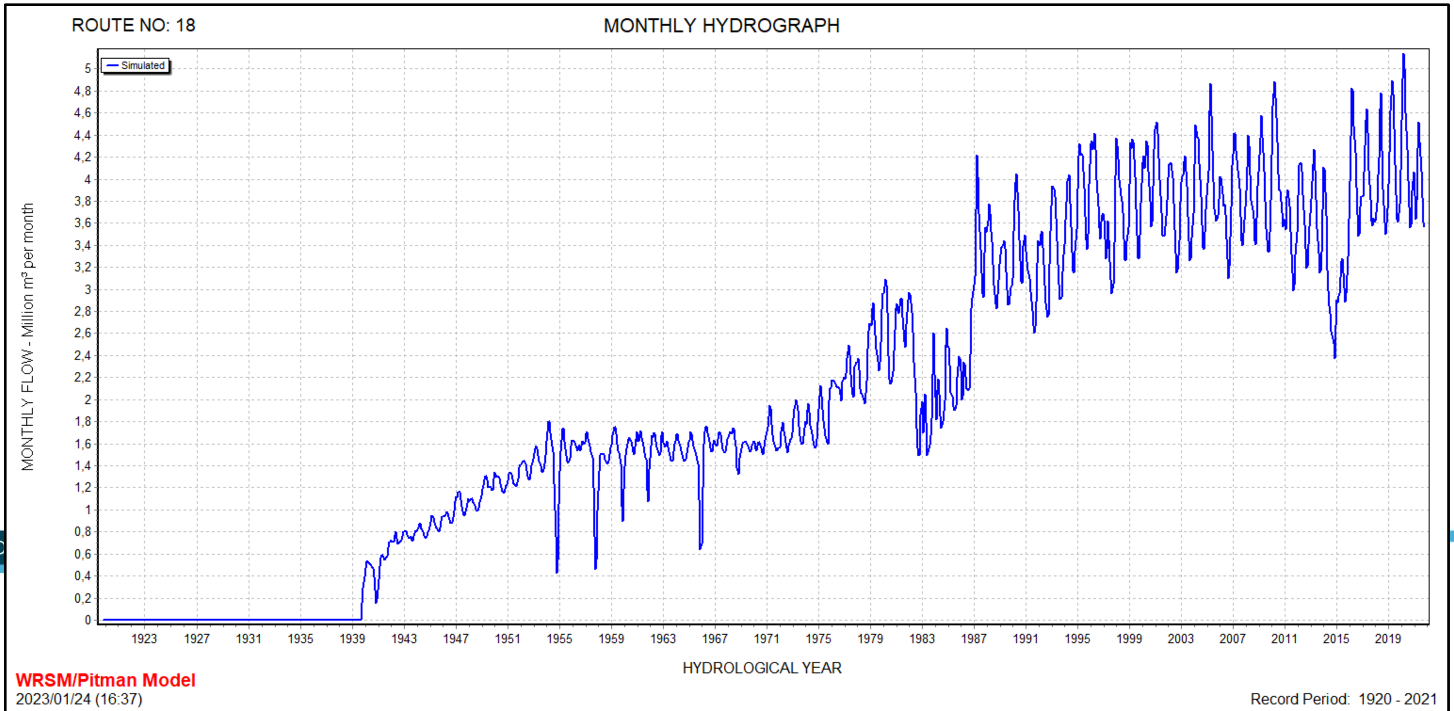
WRSM2012 Simulated Flow 1925 to 1968
Observed inflow 1969 to 2021



Irrigation Return flows from the Vaalharts Scheme (million m^3/a)

Irrigation area	Seepage from irrigation area		Canal tail end Flow	Losses from Return Flow	Net return Flow
	Drains	Natural			
North Canal	21.59	8.32	15.00	6.27	38.63
West Canal	1.82	2.19	3.86	2.28	5.59
Taung	0.00	2.66	1.33	0.56	3.44
Total	23.41	13.17	20.19	9.11	47.66

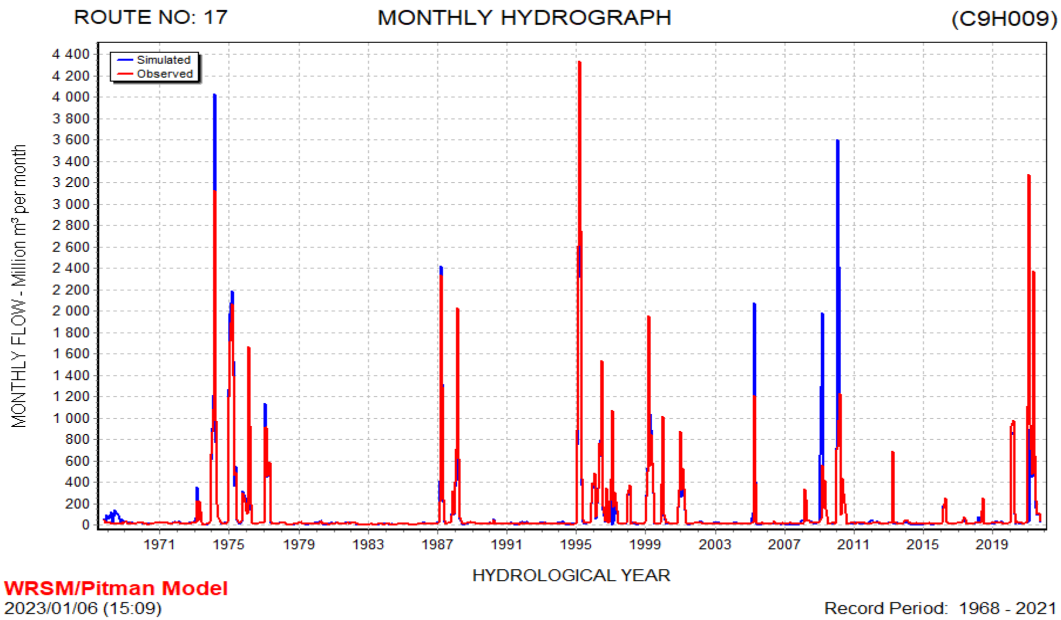
North Canal simulated return flows



Observed versus Simulated Flows Lower Vaal

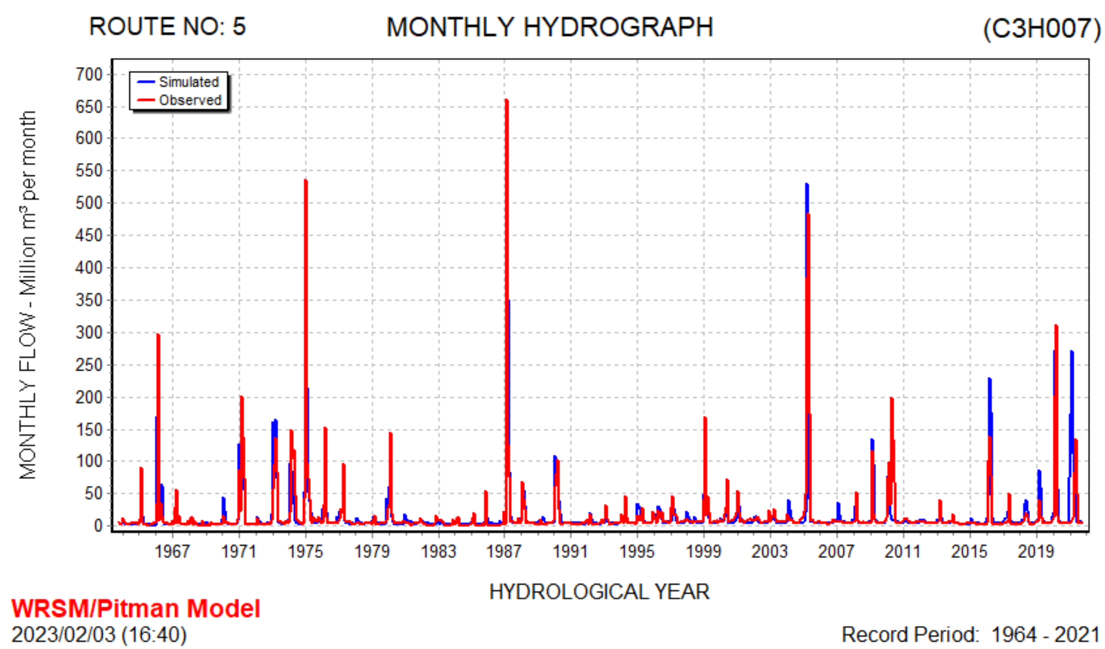
Description	MAR (million m^3/a)	Standard Deviation	Seasonal Index
Vaalharts Weir Inflows 1947 to 2020			
Observed	1993.98	2017.14	29.19
Simulated	1917.91	1943.77	31.35
Percentage difference	3.8%	3.6%	7.4%
De Hoop gauging weir 1968 to 2021	< 4%	< 6%	< 8%
Observed	1446.92	2262.13	42.24
Simulated	1446.32	2148.23	42.96
Percentage difference	0.0%	5.0%	1.7%
Espagsdrif Flow gauge (C3H007) Record period 1964 to 2021			
Observed	200.02	228.47	41.41
Simulated	199.24	230.34	44.43
Percentage difference	0.0%	1.0%	7%

Simulated versus observed Flows - Monthly Flows

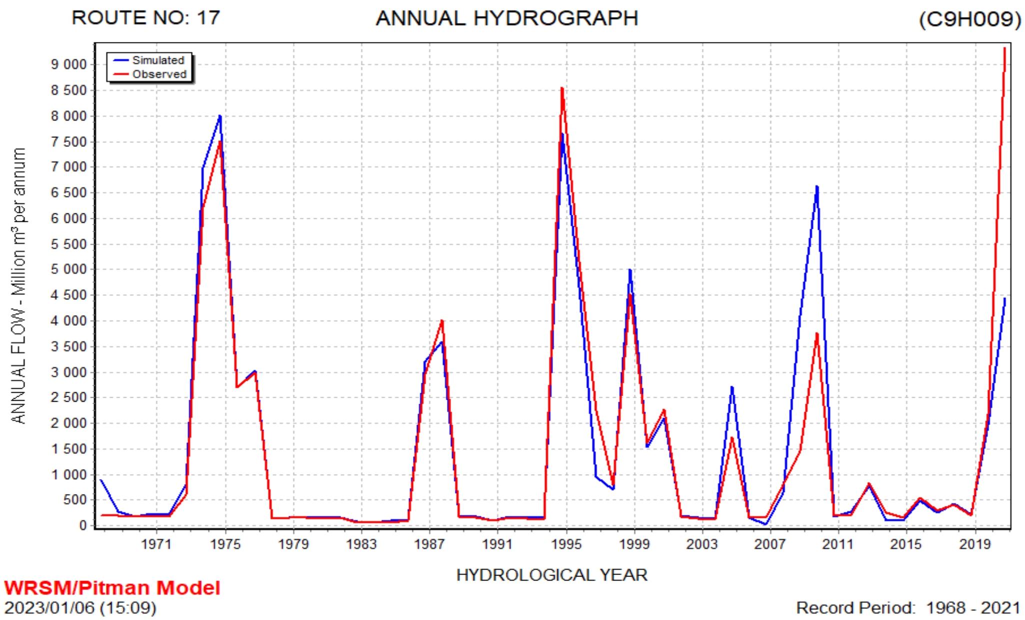


De Hoop
C9H009

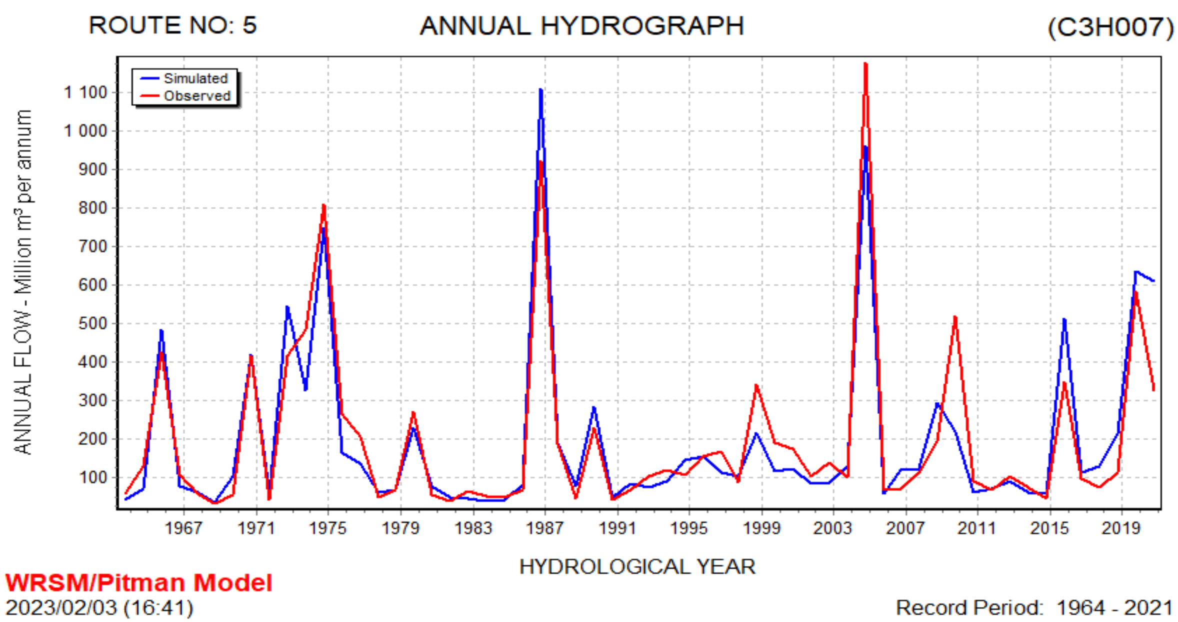
Espagsdrif
Weir C3H007



Simulated versus Observed Flows – Annual Flows

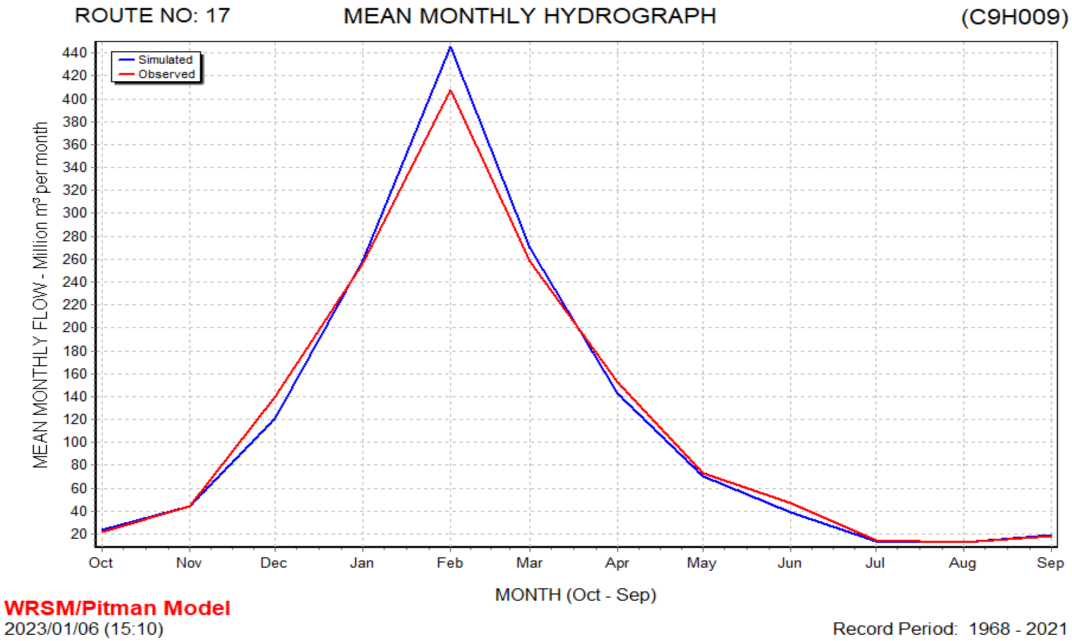


De Hoop
C9H009



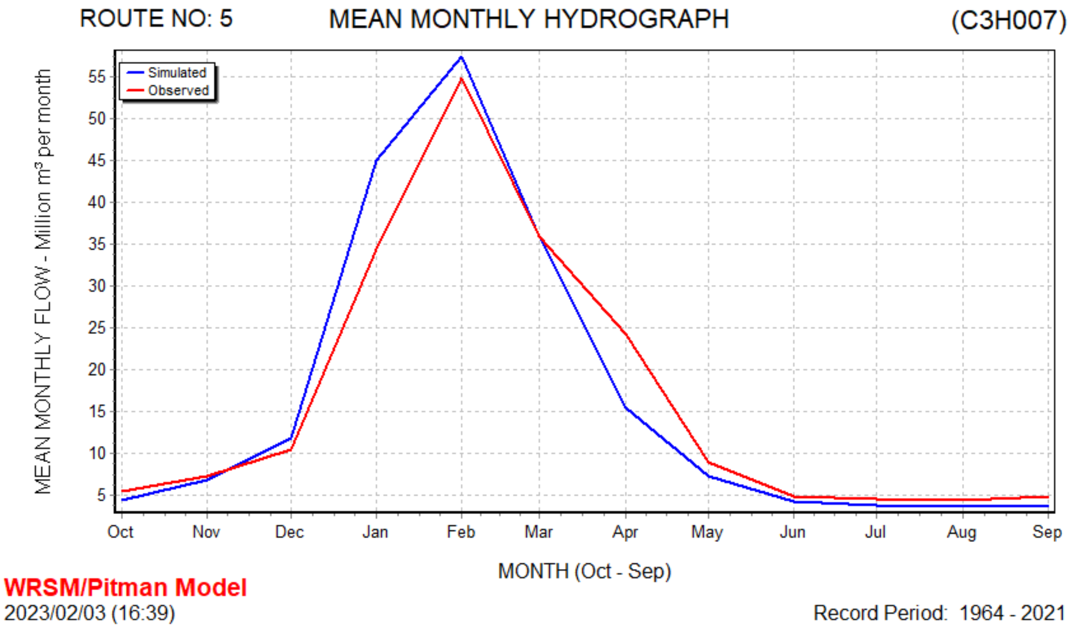
Espagsdrif
Weir C3H007

Simulated versus Observed Flows – Mean Monthly Flows

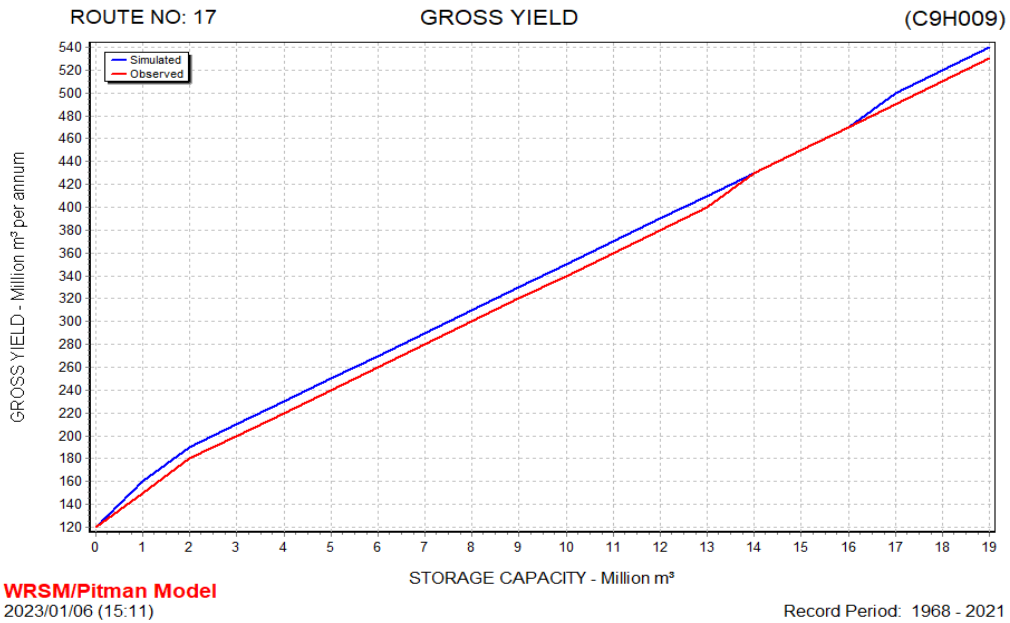


De Hoop
C9H009

Espagsdrif
Weir C3H007

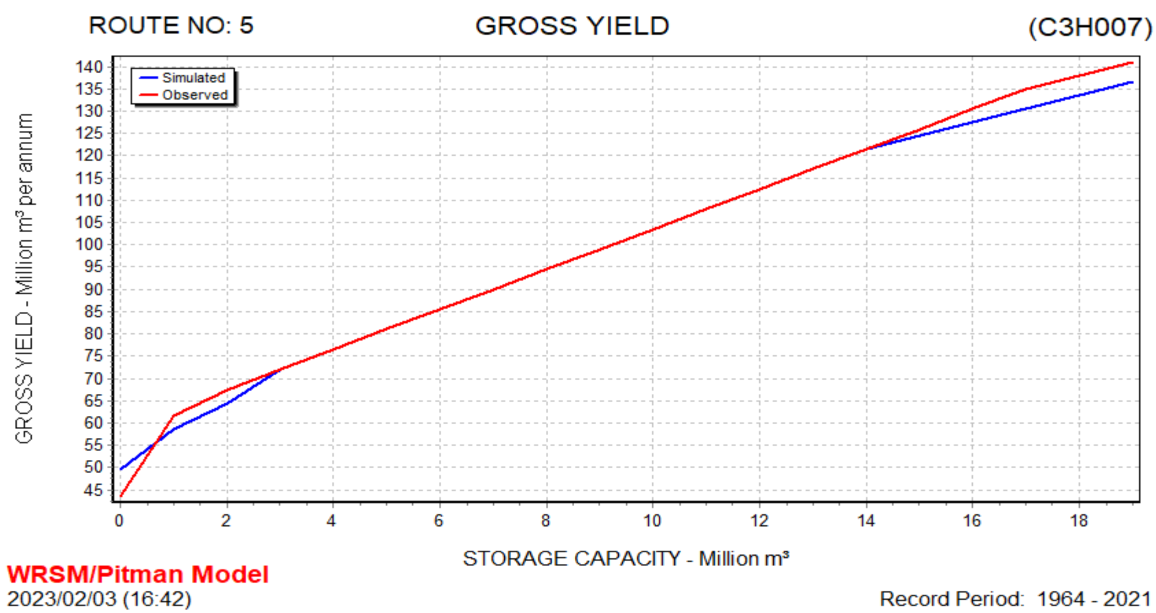


Simulated versus Observed Flows – Gross Yield



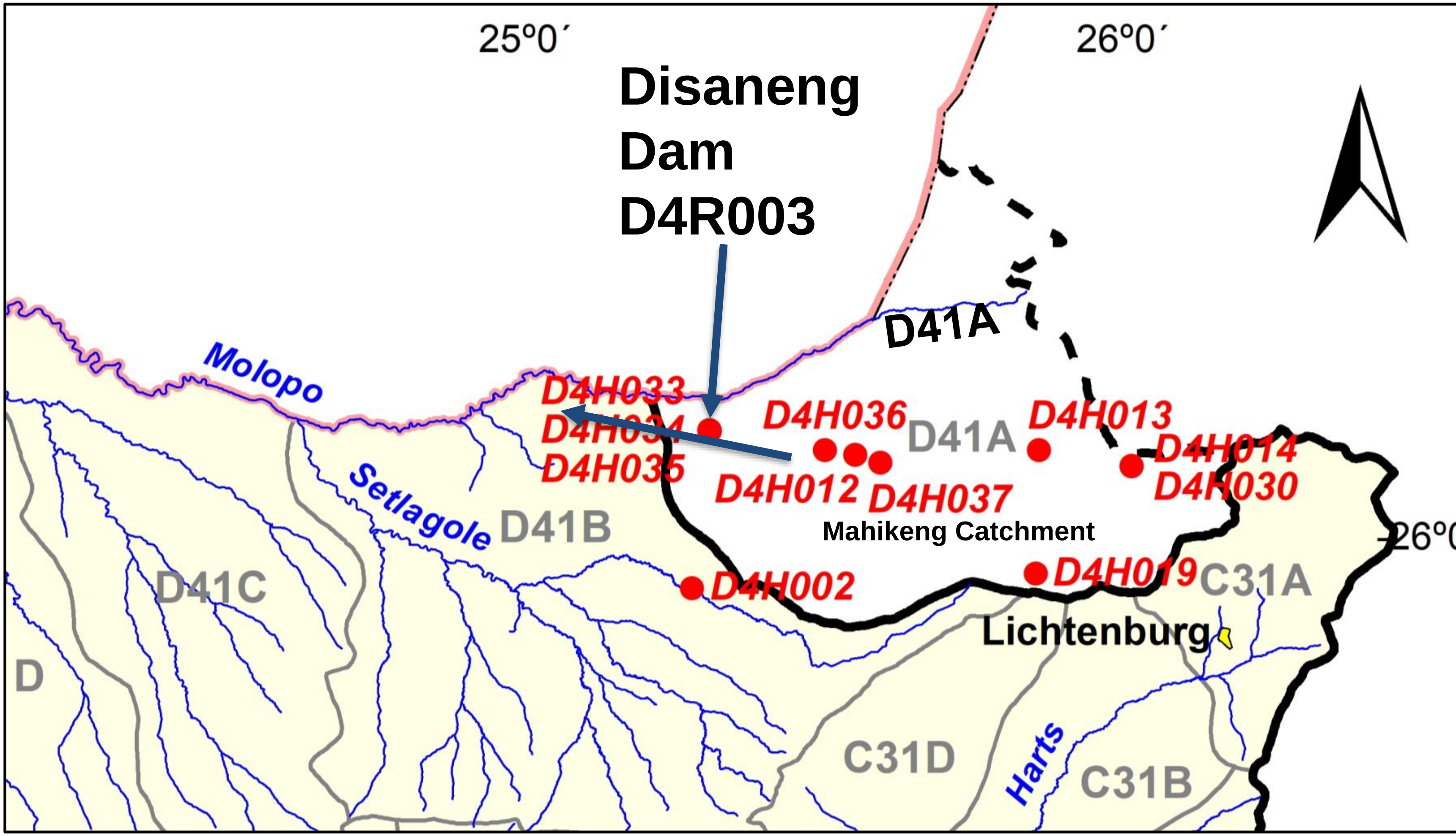
De Hoop
C9H009

Espagsdrif
Weir C3H007



Flow from D41A to D41B

Simulated Flow 1920 to 2018
D4H033 -Observed inflow 2019 to 2021



Lower Vaal Simulated Flows - Natural Conditions (Draft)

Catchment Description	Tertiary	MAR (Natural flow)		
		WR2012	Updated	
		2020 - 2009	2020 - 2009	2020 - 2021
Upper Harts	C31	56.73	54.21	55.10
Dry Harts	C32	33.76	64.89	69.04
Lower Harts	C33	27.84	54.85	59.48
Bloemhof to De Hoop	C91	26.42	25.31	26.37
De Hoop to Douglas	C92	16.61	16.62	16.17
Total Lower Vaal		**161.36**	**215.87**	**226.16**

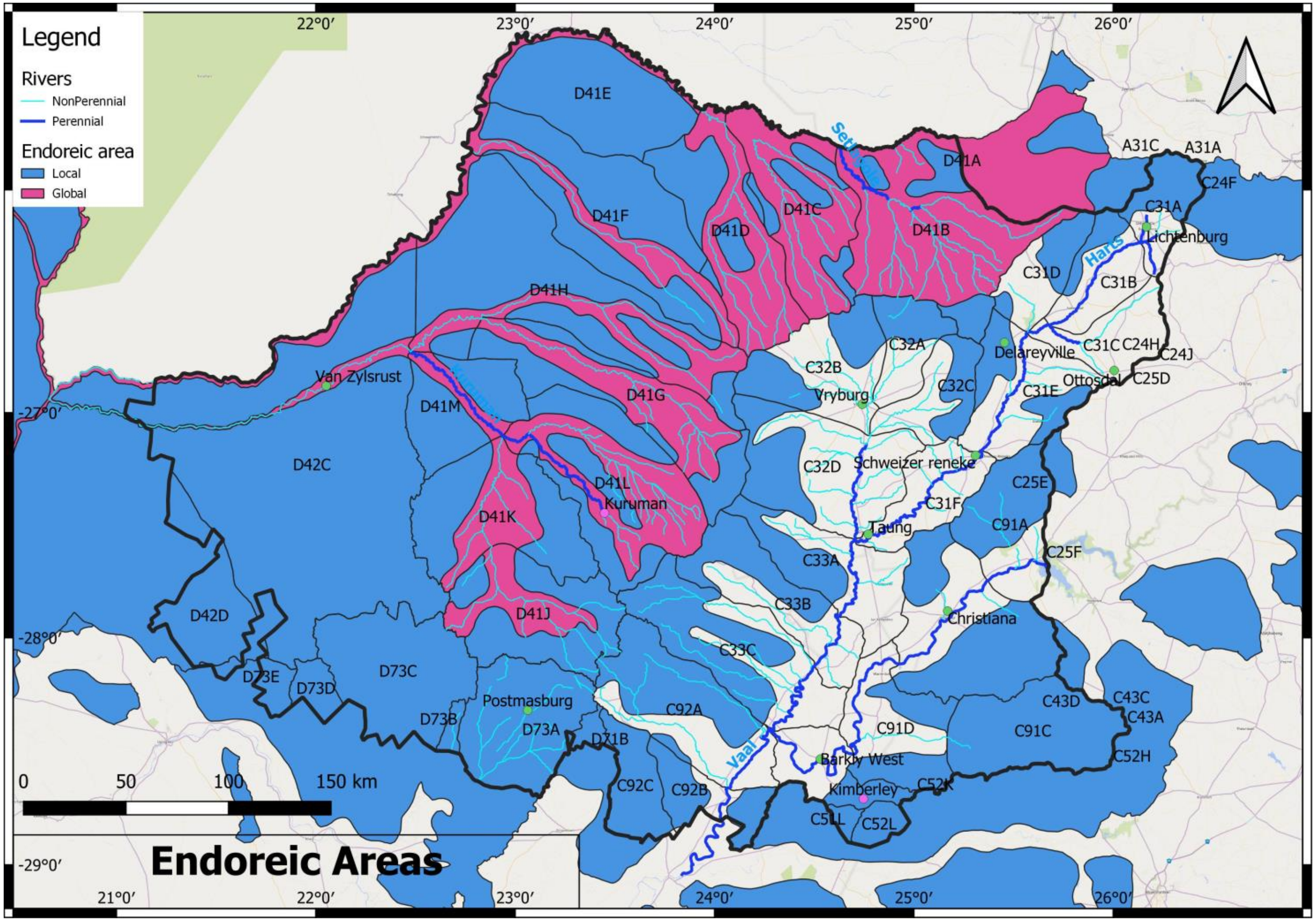
Molopo and Kuruman river catchments
Simulated Natural and simulated Historic outflows (Draft)

Catchment Description	Quaternary	MAR (Natural flow)			
		Natural before losses		Total outflow	Reduction
		2020 - 2009	2020 - 2021	2020 - 2021	2020 - 2021
Upper Molopo (Sb1)	D41A to D41D+Bot	18.42	20.55	5.63	14.92
Middle Molopo (Sb2)	D41E,D41F,0.38D41H+Bot	23.29	23.48		
Up & Mid Molopo	**D41A to D41F,0.38D41h+Bot**	**41.71**	**44.03**	**3.62**	**40.41**
Lower Molopo (SB3)	0.15D42C	0.62	0.62		
Total Molopo		**42.33**	**44.65**	**2.73**	**41.92**
Moshaweng (S1)	D41G, 0.62D41H to	9.34	11.17	5.82	5.35
Upper Kuruman (S2)	D41J to D41M	27.67	29.81	13.44	16.37
Lower Kuruman (S3)	0.85D42C	1.04	1.00		
Total Kuruman		**38.05**	**41.98**	**12.09**	**29.89**

Recharge and Baseflow – Existing data

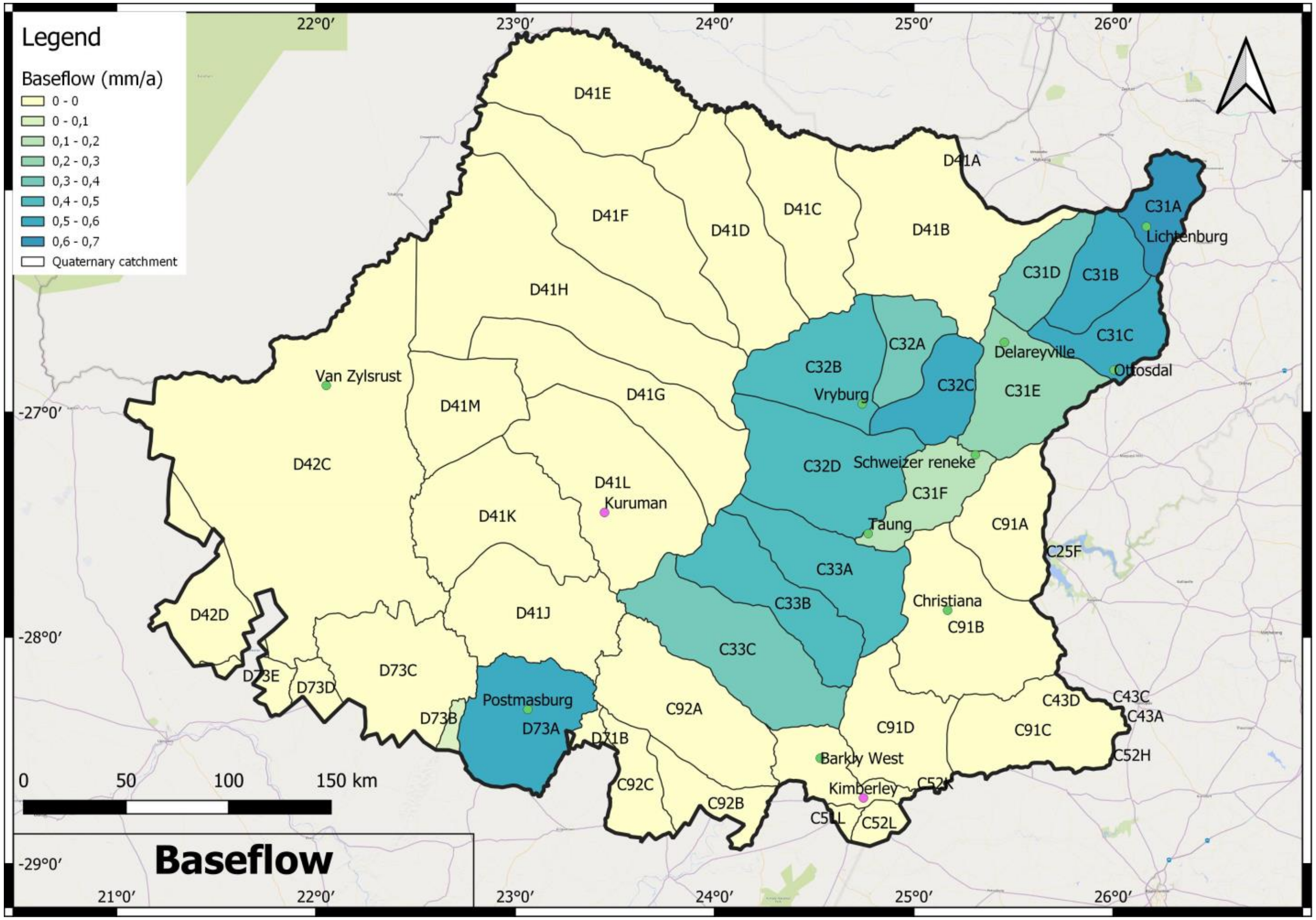
- Existing recharge data in GRAII derived from Cl method and doesn't form a complete SW and GW balance
- Baseflow in WR2012 not complete due to endoreic areas, so not indicative of real baseflow
- Baseflow shown to be restricted to C31 to C33, yet dolomitic eyes in the Ghaap Plateau are baseflow
- Recharge to dolomitic catchments underestimated. Gives large stress indices and cannot account for flow from eyes
- Large difference in aquifer recharge and recharge in GRAII due to effect of WR2012 being based on nett area, not Gross area

Endoreic areas

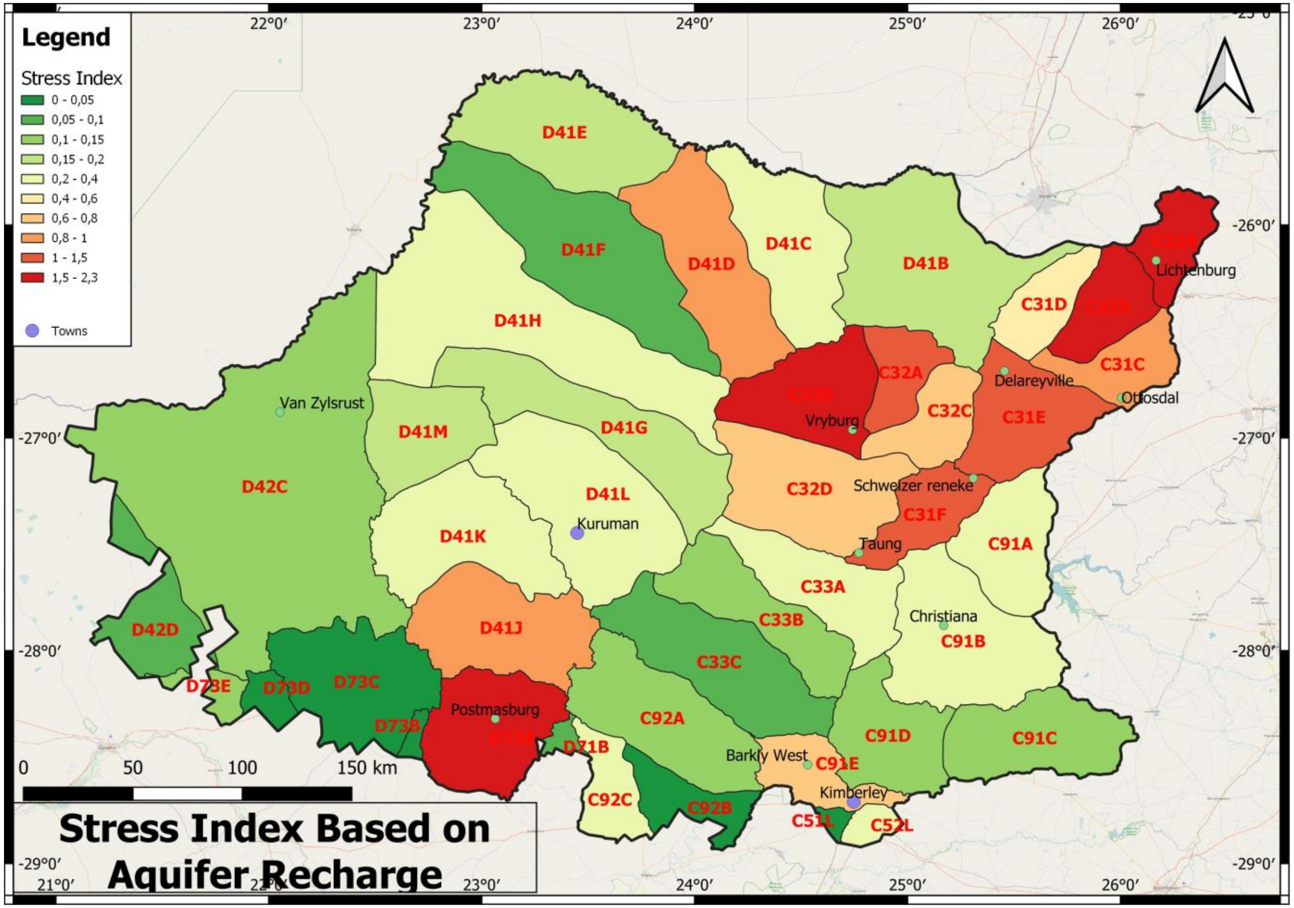


Quat	Area (km2)	Recharge (Mm^3/a)	Aquifer Recharge (Mm^3/a)	GEP (Mm^3/a)	GRAIIGEP (Mm^3/a)	Groundwater Use (Mm^3/a)	Stress index	Class
C31A	1402.24	34.90	11.20	76.28	296.64	24.806	2.215	III
C31B	1742.95	38.37	9.36	36.31	56.36	13.974	1.493	III
C31C	1635.12	35.29	9.08	24.61	20.89	7.182	0.791	III
C31D	1493.27	32.72	7.42	22.39	35.50	3.524	0.475	II
C31E	2958.11	50.67	11.98	36.25	30.21	15.361	1.283	III
C31F	1787.16	22.50	6.60	14.87	9.63	9.063	1.373	III
C32A	1403.35	17.33	7.42	14.81	10.45	7.268	0.980	III
C32B	2997.30	40.81	17.01	54.04	49.30	36.716	2.158	III
C32C	1657.01	22.76	10.32	14.90	12.77	5.650	0.547	II
C32D	4133.91	70.69	25.13	119.11	114.29	12.789	0.509	II
C33A	2855.22	40.01	16.24	61.69	58.77	2.983	0.184	I
C33B	2830.55	44.27	15.38	87.27	80.54	1.487	0.097	I
C33C	4140.95	50.07	20.01	102.40	94.53	1.282	0.064	I

Baseflow in WR2012



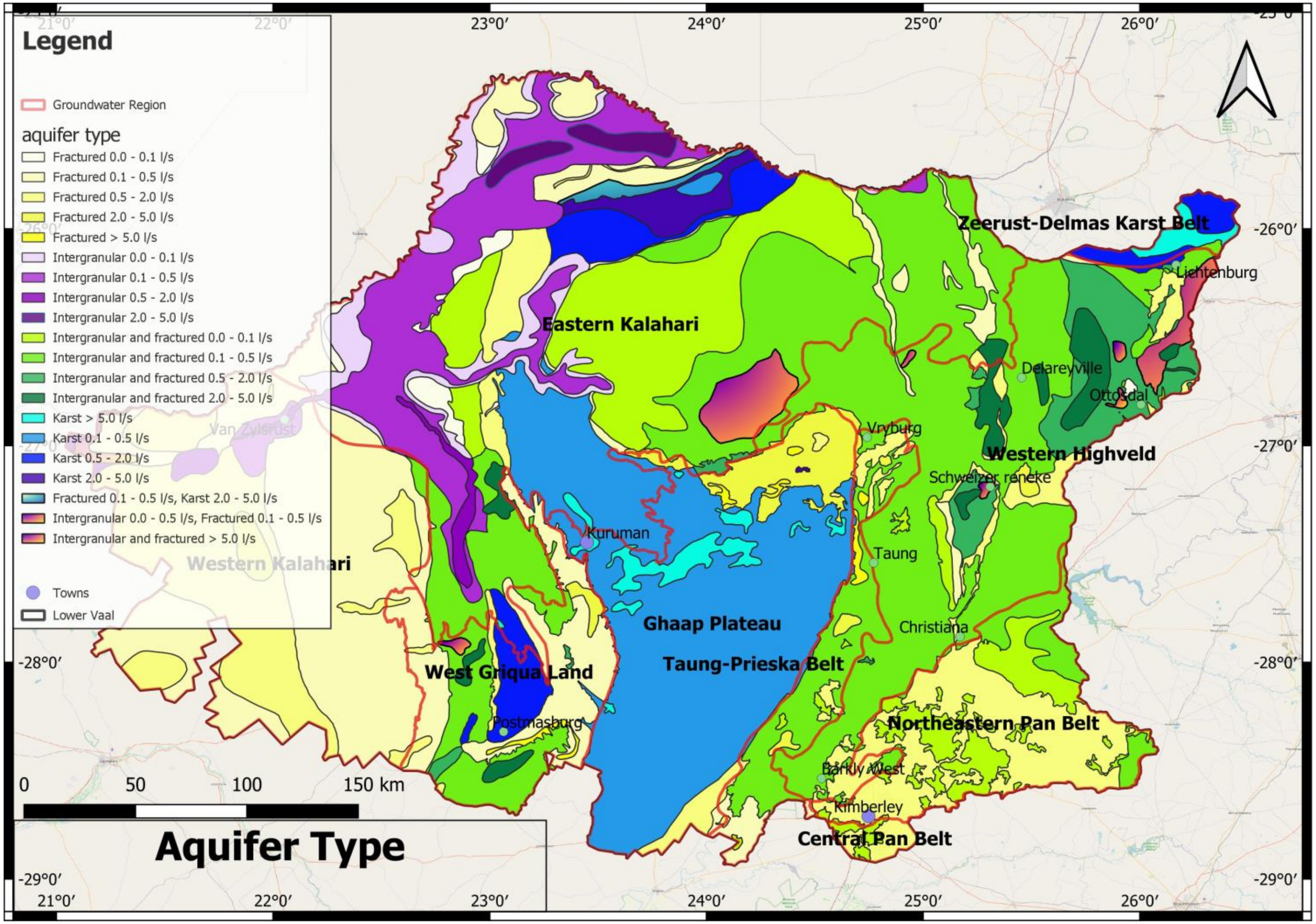
Stress Index



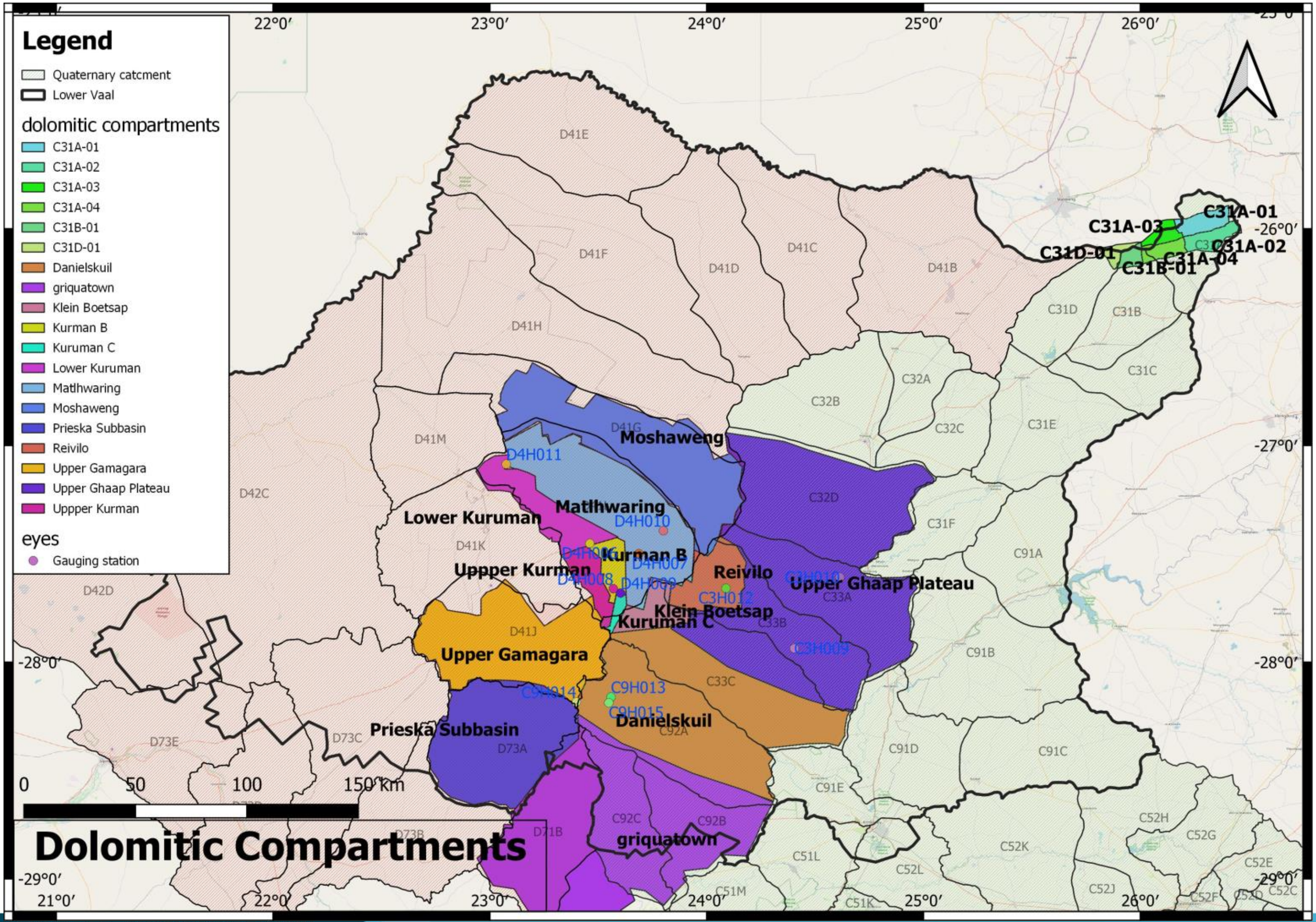
Interactions – Conceptual Model

Type	Catchment
Groundwater Baseflow	C31-C33, C92A
Groundwater baseflow from dolomitic springs	C31A, C31B, C31D, C32D, C33A-C, D41G, H, J, L, D73A, C92B-C
Transmission losses	C33, C91, D41, D42
Evapotranspiration from groundwater	Entire basin
Interflow	Unlikely

Aquifer Types – Geology, Aquifers and Parameters



Dolomitic Compartments – Model Runoff Unit delineation



Simulation of Interactions

- Groundwater use: surface and groundwater use were as calculated during the hydrocensus
- Runoff unit delineation: Each dolomitic compartment/subcompartment separate RU. Compartment boundaries used instead of catchment boundaries.
- Channel losses: Losses of discharge from dolomitic eyes and surface water.
- Endoreic areas: Normally excluded from the gross catchment area since they don’t contribute runoff to main river stems. However:
  - recharge occurs over the gross catchment area
  - baseflow is generated from dolomitic eyes

Simulation of Interactions

- Gross Area: to derive a groundwater balance of all recharge and baseflow. Runoff which does not reach the main stem was lost via transmission losses.
- Calibration of recharge and baseflow: Calibration of low flow of simulated vs observed discharge using histograms of low flow, mean monthly flows, and cumulative frequency of low flows. Simulated discharge was then naturalised
- Parameters: Dolomitic compartments with flow records were used for calibration. Compartments with Kalahari sand cover over the dolomite have reduced recharge from smaller rainfall events

Observed data

Table 4-2 Groundwater management units and springs

Dolomite Compartment	GMU	Quaternary	Gauging Station	Average Discharge (Mm^3/a)	Present Discharge (2010-2020) Mm^3/a)
Lichtenburg	C31A-01	C31A			
	C31A-02				
	C31A-03		C3H011	No data available	
	C31A-04				
Dudfield	C31B-01				
Itsoseng	C31D-01				
Upper Ghaap Plateau		C32D, C33A-C	C3H009, C3H010	0.286 (1960-1992) 0.408 (1960-1981)	0 ?
Moshaweng		D41G			
Matlhwaring		D41L	D47007, D4H010, D4H011	1.57 (1958-2022) 0.82 (1960-1992) 0.09 (1960-1994)	0.7 ? ?
Reivilo		C33B	C3H012	0.62 (1968-1992)	?
Upper Kuruman		D41L	D4H005, D4H006, D4H008, D4H009	10.7 (1930-1990) 0.89 (1987-2011) 0.59 (1959-2003) 0.96 (1959-2021)	? 0 0 0.36
Klein Boetsap		C33C			
Danielskuil		C33C C92A	C9H013 C9H014 C9H015	0.56 (1987-2003) 0.12 (1987-2011) 0.21 (1987-2011)	0 0 ?
Upper Gamagara		D41J			
Prieska		D73A			
Griquatown		C92B, C92C			

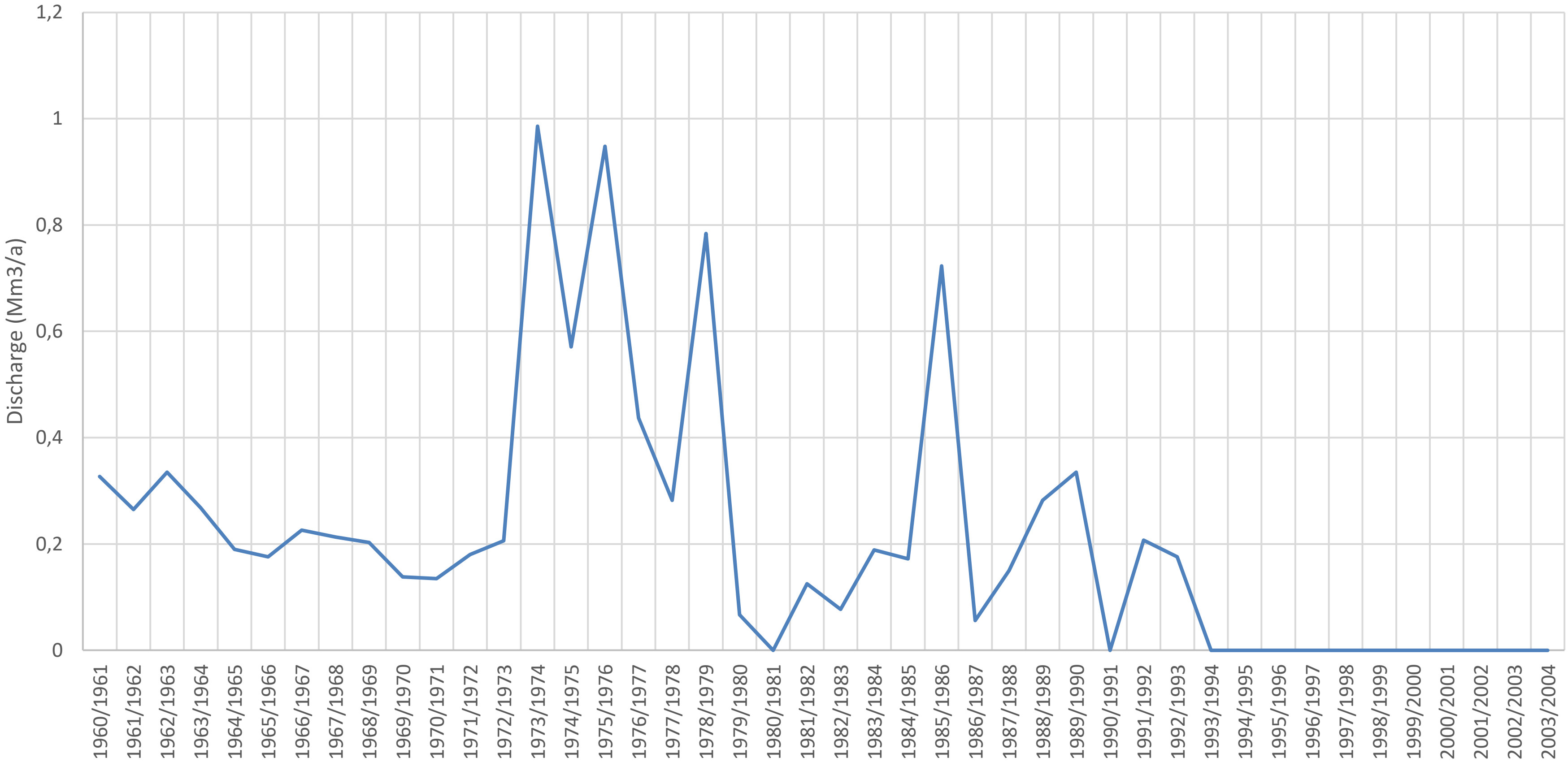
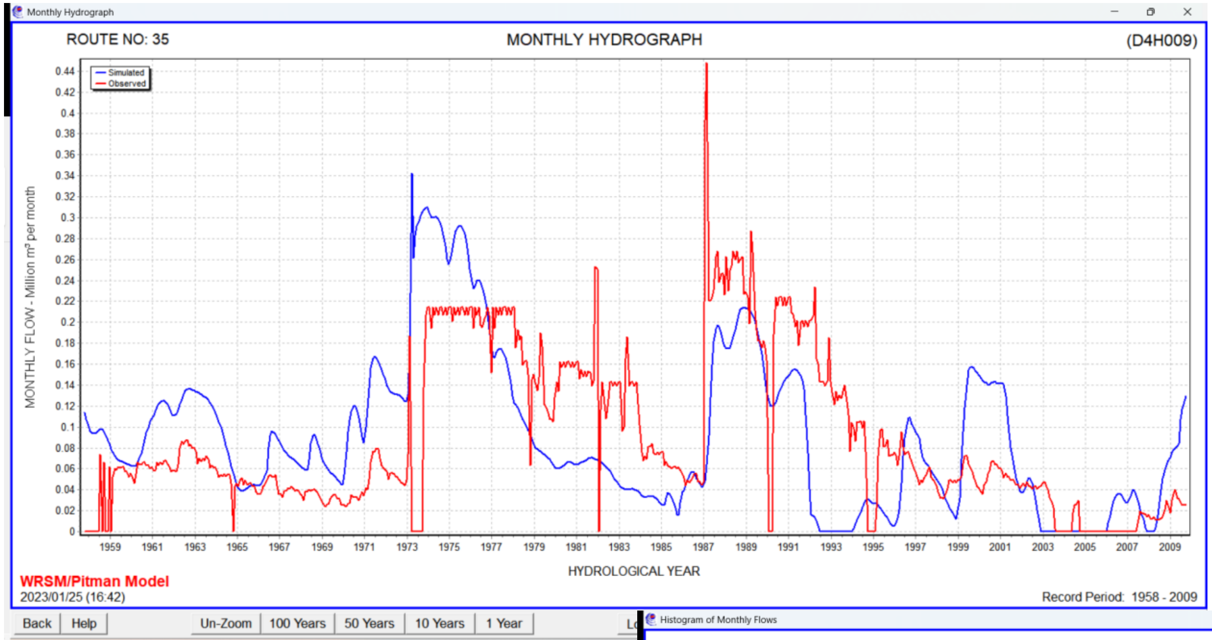


Figure 4-14 D4H009 Upper Ghaap Plateau



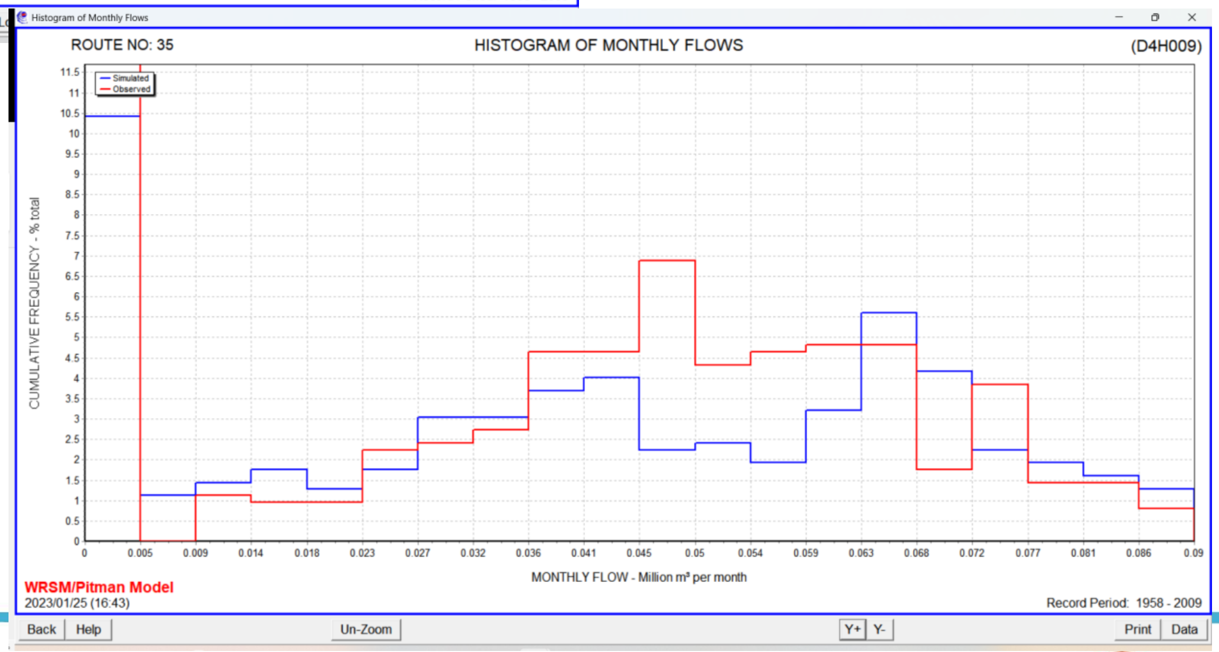


Figure 4-14 D4H009 Upper Ghaap Plateau

Simulation of Interactions

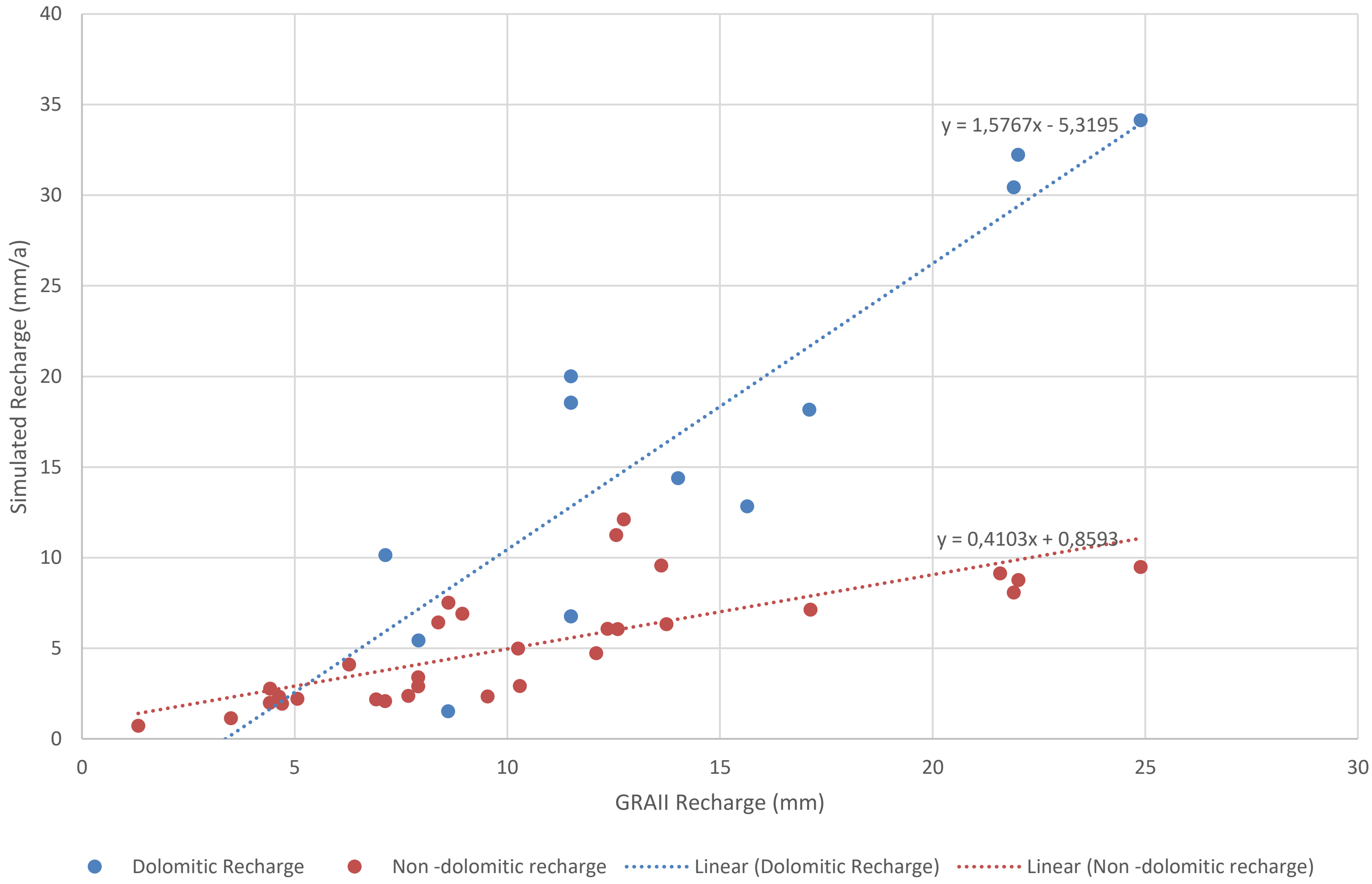
Quaternary	Gross Area	Subarea area/ Nett area	MAP	MAR	GRAII Baseflow	Simulated Baseflow	GRAII Recharge	Simulated Recharge		Recharge (% of rainfall)	Use	Stress Index
	Km^2	Km^2	mm/a	Mm^3/a	Mm^3/a	Mm^3/a	mm/a	mm/a	Mm^3/a		Mm^3/a	
C31A	1 402	649	577	6.46	0.95	0.01	24.89	8.21	5.33	1.42	5	0.94
C31A Lichtenburg		753	577	9.32		9.32	24.89	34.14	25.7	5.92	19.36	0.75
C31B	1 743	1 358	553	10.53	0.9	0.02	22.01	7.58	12.44	1.37	12	0.96
C31 B Dudfield		102	553	1.19		1.19		32.23	3.27	5.83	2.59	0.79
C31C	1 635	1 635	566	14.35	0.95	0.06	21.59	7.92	12.95	1.4	8.17	0.63
C91A	2 546	2 546	464	4.04	0	0.03	12.73	12.12	30.86	2.61	5.72	0.19
C91E	1 509	1 509	371	2.07	0	0	8.37	6.42	9.69	1.73	0.73	0.08
C92A	3 923	554	367	3.66	0	0.01	10.29	2.92	29.82	0.8		0
C92A Danielskuil		2 873	367	12.63		12.62		10.38	3.53	2.83	4.56	0.15
D41L Matlhwaring	5 383	1 408	403	3.6	0	3.55		18.55	26.12	4.6	3	0.11
D41L D4H011		1 982	403	1.96		1.87		6.76	13.4	1.68	4	0.3
D41L Kuruman A		461	403	8.43		8.43		18.55	8.55	4.6	1	0.12
D41L Kuruman B		334	403	3.01		3		18.55	6.19	4.6	4	0.65
D41L Kuruman C		84	403	1.38		1.28		18.55	1.55	4.6	2	1.29
D41L Lower Kuruman		972	403	0.94		0.9	11.5	6.76	36.39	1.68	2	0.05

Simulation of Interactions

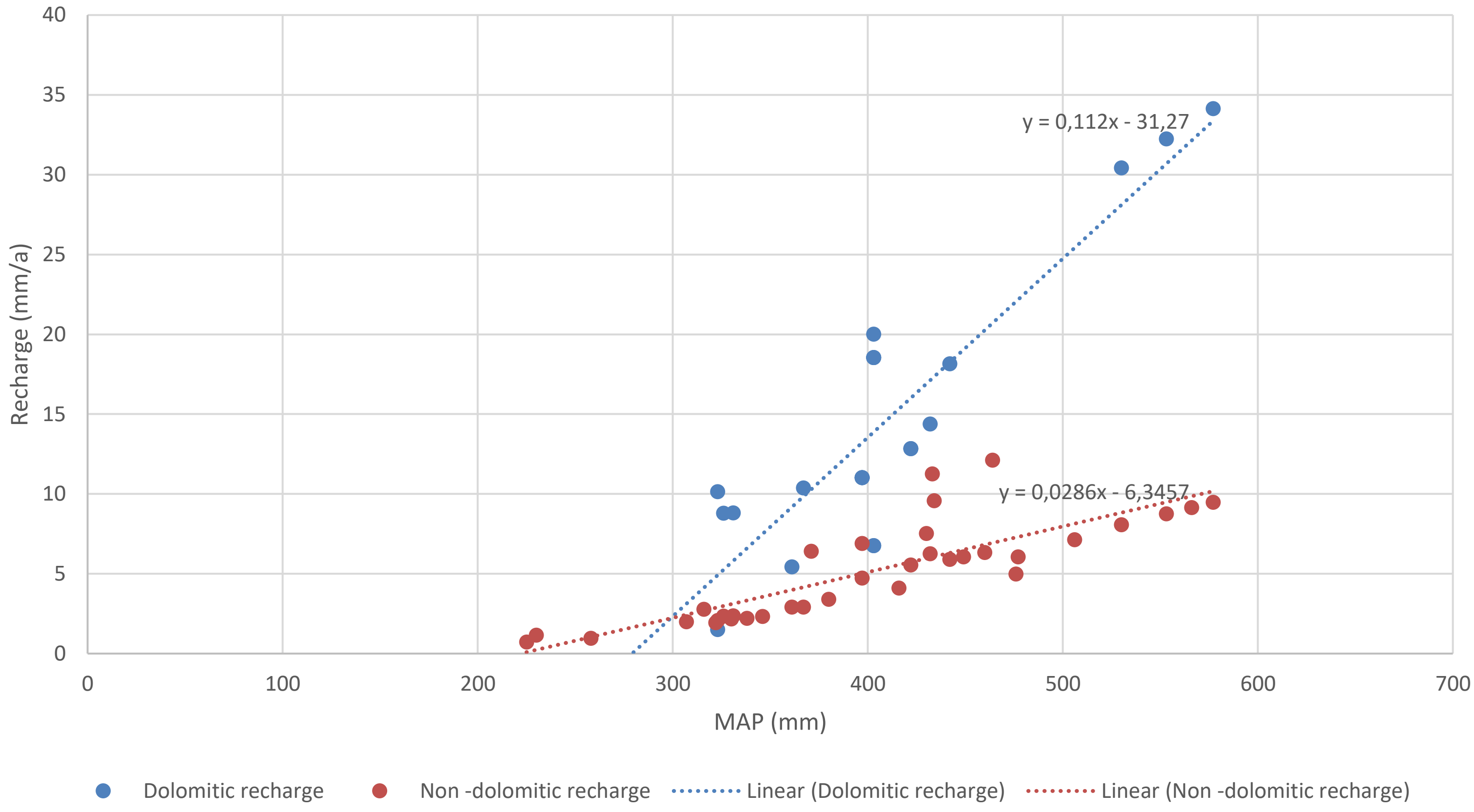
	Area (km^2)	MAR (Mm^3/a)	WR2012 MAR (Mm^3/a)	Baseflow (Mm^3/a)	Recharge (Mm^3/a)	Groundwater Use (Mm^3/a)	Channel Losses
Lower Vaal	144576	305.12	223.58	108.92	815.46	293.97	224.25
Botswana		5.64					

- Difference with WR2012 as WR2012 does not include runoff from endoreic areas, many of which contain discharge from dolomitic eyes
- The runoff and baseflow they generate was accounted for with evaporation losses and channel losses.
- The entire catchment generates 815.46 Mm^3/a of recharge
- 108.92 Mm^3/a emerges as baseflow.
- 105.39 Mm^3/a of the baseflow is from dolomites.
- Channel losses are 224.25 Mm^3/a, of which 96.4 Mm^3/a are in the Vaal and consist of runoff generated upstream and released from the Bloemhof dam
- 130.25 Mm^3/a are losses of the baseflow generated largely from dolomites, and of surface runoff from non-dolomitic areas. Herold and Bailey 33-63 x $10^6 m^3$ /a in Harts from canals. Those Quats have baseflow.

Simulation of Interactions



Simulation of Interactions



Summary

- CHIRPS rainfall compared to WR2012 rainfall did in general not always provide a good fit. Improved with an adjusting factor for each quaternary
- Adjusted CHIRPS rainfall was well aligned with observed rainfall data. This adjustment further improved the MAR and Std Dev from the CHIRPS rainfall.
- Average discharges from dolomite affected by the non-stationarity of flow records.
- Simulated recharge is significantly higher than GRAII in dolomites, and significantly lower in non dolomitic sub-areas.
- The rainfall recharge relationship shows a distinct difference between dolomitic and non-dolomitic aquifers, with a variation between dolomitic aquifers overlain by Kalahari sand and those not.

Subsequent phases of the project will calculate interactions in terms of:

- Channel losses and Evaporation from groundwater
- Impacts of present-day abstraction patterns on interactions
- Revised recharge and baseflow maps

Capacity Building

- 4-day training workshop was held in Pretoria in November 2022.

(1) General dissemination of information regarding groundwater concepts;

(2) Discussion around groundwater-surface water interactions;

(3) The groundwater understanding needed by water resource managers

(4) Hand on-training with interaction modelling in WRSM/Pitman

- Formal presentations on groundwater in RDM process, sources of data, data problems, interaction processes and how they are simulated in WRSM Pitman.
- Formal training was given on identifying errors in GRAII data and how to correct them,
- What managers should look for to identify bad data,
- How to calibrate the WRSM Pitman model.
- Given a model setup to calibrate (D41A),
- Download a network of their choice from the WR2012 website and calibrate it.
- Skills fed back into Project (Avela Zilani) Setting up model and calibration

Capacity Building - Outcomes

- First SW-GW modelling in WRSM ever provided:
- Do the delegates think they learnt enough to understand processes and modelling to help them become proficient in participating in model studies or to question results as the older generation fades away?
- Do the skills provided help the DWS in managing and quantifying water resources in an integrated manner?
- Should the course be repeated on other RDM projects?
- Was the content relevant and what should be added or excluded?
- Should a subsequent module be added to include more complex systems with interflow and large volumes of surface water runoff?
- Group composition: Too big, too small, should managers be included etc. Target group (which directorates), more surface water or groundwater practitioners?

THANK YOU