The chemical composition of Transkei river water

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Abstract

The water quality of the rivers flowing through Transkei was determined over a period of two years to afford a general picture of the chemical composition of Transkei river water. The period of study coincided with a relatively dry period in Transkei (and Southern Africa) and all results will have to be evaluated within this context. The more important findings resulting from the study are: Transkei River water generally contains very few dissolved constituents; the south-western parts of Transkei exhibit higher concentrations of analytes compared to north-eastern Transkei; pollution within Transkei is limited to Butterworth (urban contamination; macro elements plus molybdenum) and a number of other sites where very high arsenic concentrations are attributed to the leaching of old cattle dip material into rivers; pollution in the Republic of South Africa adjoining Transkei is at Queenstown (urban contamination; macro elements) and in the Elliot-Ugie-Maclear region (mercury); and silt loads in terms of unit areas of catchment are lower than presently accepted norms.

Introduction

The Republic of Transkei, with an area of approximately 42 000 km², is situated in the south-eastern corner of Southern Africa and is bordered by the Great Kei River in the south, the Drakensberg Mountains to the west, the Umtamvuna River to the north and the Indian Ocean to the east.

Transkei can be divided into three main geographical belts: the coastal plain, the midland plateau and the Drakensberg highlands. The midland plateau comprises nearly 70% of Transkei land area. In this area the rainfall ranges between 500 mm and 1 200 mm per year. Transkei is thus extremely well blessed with a high rainfall resulting in an average annual runoff per unit area far in excess of that of the rest of Southern Africa; only 10% of the country receives less than 750 mm a year. The years 1979, 1980 and 1981 were, however, dry years for Transkei.

Very little information regarding the quality of this water asset of Transkei was available prior to 1978. The Department of Chemistry, University of Transkei, in conjunction with the Department of Water Affairs (previously the Department of Environment Affairs), Republic of South Africa, thus embarked on a monitoring programme to obtain a general picture of the chemical quality of the river water in and around Transkei. An internal report for use in Transkei was tabled during 1983 (Du Preez, 1983) but because of its very limited circulation, and thus impact, this paper is presented so that the Transkei results are more readily available to other research workers.

Materials and methods

Water samples refer to surface water sampled in high-density polyethylene bottles at depths of between 10 cm and 50 cm. Sampling was done during January, April, July and October of each year. Four water samples were collected at each sampling site; 2 x 1 ℓ for analysis at the University of Transkei and 2 x 250 mℓ for analysis by the Department of Water Affairs. For each institution one sample was preserved with nitric acid (5 mℓ concentrated HNO_3 per 1 000 mℓ water for trace element analyses) and the other with mercury(II) chloride (30 mg $HgCl_2$ per 1 000 mℓ water for macro analyses).

Upon receipt in the laboratories, samples were filtered through pre-weighed Whatman No 42 filter papers and then stored at 4 °C until analyses were performed.

Analyses were carried out by the University of the Transkei and the Hydrological Research Institute, Department of Water Affairs. However, conductivity measurements as well as silicon, fluoride and trace element analyses were performed only by the latter.

The chemical parameters determined by the University of Transkei, were carried out according to *Standard methods for the examinations of water and wastewater* APHA (1975) with the following modifications:

- The phenate method was employed to determine ammonia-nitrogen; the catalyst used was sodium nitroprusside.
- The ascorbid acid method was used to determine orthophosphate-phosphorus.
- The salicylate method (Muller and Wideman, 1955) was employed in the determination of nitrate-nitrogen.

A model 407A Ionanalyser or model 201 Digital pH meter (Orion Research), a Cecil CE 303 Grating Spectrophotometer and a Varian model 175 Atomic Absorption Spectrophotometer were used for pH, spectrophotometric and atomic absorption measurements respectively.

Results and discussion

Twenty-eight sampling sites were chosen in and around Transkei (Figure 1). Whenever possible existing river gauging weirs were included in this survey. Additional sites were identified to give a more comprehensive coverage of Transkei.

The most western sampling site was taken at the Komani River just outside Queenstown. Although this site lies outside Transkei it was included in this study because the Komani River is a tributary of the Great Kei River and thus contributes to the river water of Transkei in general; and because Queenstown is a well-developed centre where the results of urban contamination of the water resources should be readily observable.

The Bonkolo Dam on the Komani River acts as the water reservoir for Queenstown but as such also effectively dries up the Komani River. The Komani River was sampled just below the town's sewage works and the river at that point represents the total effluent (treated) from Queenstown. Over the period of sampling, rain and urban stormwater never contributed to the river-flow at the time water samples were taken.

The geometric mean values of all the macro analytes for all

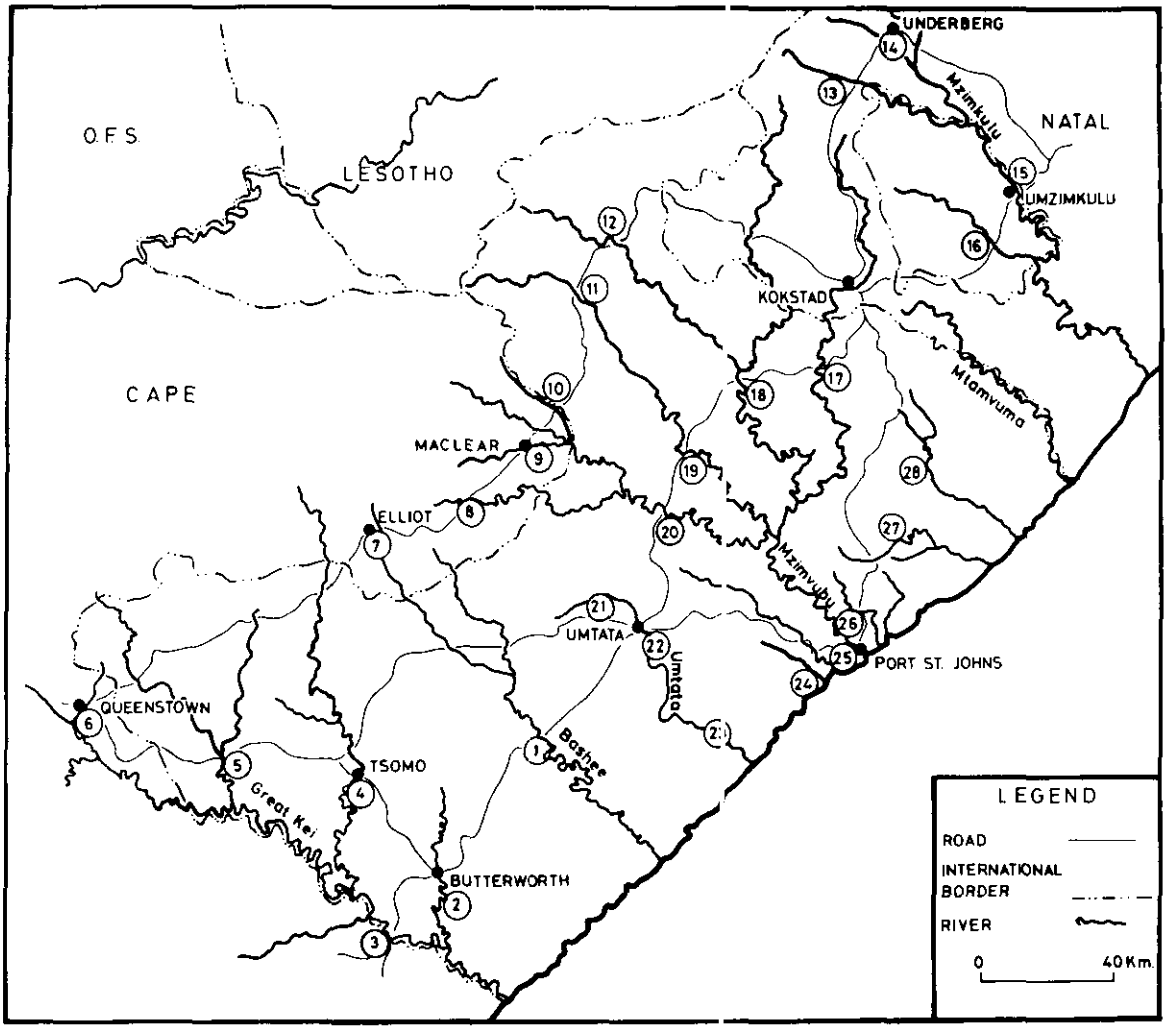

Figure 1
Sampling sites in and around Transkei

sites for the period January 1980 till January 1982 are presented in Table 1.

Profile across Transkei

A number of sampling sites which roughly represent the sampling of river water in a line across Transkei from south-west to north-east, were selected from the twenty-eight sites. The variation of calcium, sodium, conductivity and total alkalinity across Transkei is illustrated in Figure 2; other analytes generally follow the same pattern.

From Table 1 and Figure 2 it follows that concentrations of components are the highest in the west. Komani River, Gcuwa River and the Wit Kei River are the rivers which consistently exhibit relatively high values. Komani River fits this picture because of the reasons given above. Gcuwa River was sampled below Butterworth's sewage works and thus also represents a river contaminated by urbanisation. The Wit Kei River, however, represents a case where no urban or extensive agricultural contamination is possible. Another river in the west, i.e. the Klaas Smits River, is sampled by the South African authorities and the water analysed by the Department of Water Affairs. The sampling site referred to in Table 2 lies just above its confluence with the Komani River and is in fact less than 5 km from the Komani River sampling site. A comparison of the Klaas Smits and Wit Kei Rivers reveals a very similar trend i.e. relatively high concentrations of all components. It would appear as if all four rivers i.e. Klaas Smits, Wit Kei, Komani and Gcuwa, generally have high concentrations of analytes which must be the result of the geological and soil conditions found over the western parts of Transkei and the adjoining parts of the Republic of South Africa. Superimposed on these high values there is the problem of urban contamination at Queenstown (Komani River) and Butterworth (Gcuwa River). Urban contamination manifests itself in the values for potassium, phosphate, nitrate and ammonium ions. For comparative purposes, the Vaal River at Lindeques Drift near Parys (below the Barrage) is also included in Table 2. The Vaal River at that point has already been subjected to severe urban usage. Although these Vaal River values are high compared to the rest of Transkei, phosphate and ammonium contamination is much lower than for those of the Komani and Gcuwa Rivers.

One sampling site along the Umtata River, just below the Umtata sewage works, is included in the comparison studies across Transkei. No appreciable urban contamination is detected. This may be due to the fact that the water flow from the Umtata Dam to feed the hydro-electric power station is sufficient to dilute any potential urban contamination.

Variation of water quality along a river

There are a number of instances where a particular river was sampled at more than one site. A general trend was found for all

TABLE 1
RESULTS OF CHEMICAL ANALYSES OF TRANSKEI RIVERS: ANNUAL GEOMETRIC MEAN VALUES (mg/ℓ) FOR THE PERIOD JANUARY 1980 – JANUARY 1982
(VALUES IN PARENTHESES REFER TO A SINGLE MEASUREMENT)

Station No*	River	Sample Site No	pH	Conductivity (mSm^{-1})	Ca^{2+}	K^{+}	Mg^{2+}	Na^{+}	Cl^{-}	$PO_4^{3-}-P$	SO_4^{2-}	$NO_3^{-}-N$	$NH_4^{+}-N$	Si	F^{-}	Total Alkalinity (as $CaCO_3$)	Total Hardness (as $CaCO_3$)
T1M04	Bashee	1	6,9	15,73	8,97	2,21	5,73	13,50	17,21	0,08	8,93	0,54	0,16	5,58	0,13	33,03	57,20
S7Q01	Gcuwa	2	7,3	76,02	26,80	8,46	17,38	90,93	88,65	1,15	37,71	2,33	0,90	7,69	0,37	138,90	92,70
S7Q03	Great Kei	3	7,3	27,55	20,14	2,46	9,81	22,39	26,18	0,06	3,31	0,75	0,15	6,32	0,44	72,33	(84,82)
S5M02	Tsomo	4	7,0	15,46	11,42	2,91	6,18	11,03	12,29	0,08	3,38	0,46	0,10	7,28	0,18	37,13	76,28
S5Q01	Wit Kei	5	8,0	58,30	35,92	2,71	23,85	49,29	72,84	0,03	13,15	0,80	0,08	4,53	0,53	152,70	279,94
S3Q01	Komani	6	7,2	81,19	39,90	16,96	17,21	83,60	84,10	8,41	65,43	19,73	2,18	7,31	0,33	91,05	161,23
T5Q01	Slang	7	7,2	8,57	4,77	1,20	2,82	6,93	4,72	0,05	4,25	0,18	0,06	5,85	0,08	26,84	23,31
T3Q01	Wildebees	8	6,6	7,00	4,86	0,67	2,24	4,12	2,59	0,01	2,83	0,39	0,06	6,21	0,06	22,89	21,43
T3M09	Mooi	9	6,6	6,60	4,89	0,97	2,00	4,15	2,19	0,01	3,35	0,17	0,05	6,93	0,05	24,64	21,21
T3Q02	Tsitsa	10	6,7	7,75	6,64	1,15	2,58	4,11	1,75	0,01	2,40	0,22	0,06	7,44	0,04	30,11	34,14
T3Q03	Tina	11	6,9	9,36	8,72	0,93	4,01	4,14	2,34	0,02	2,36	0,21	0,06	7,57	0,07	38,90	43,30
T3M02	Kinira	12	7,2	14,75	14,15	1,42	6,75	7,47	3,41	0,06	5,57	0,16	0,09	8,72	0,15	65,37	63,17
T5Q01	Ngwangwane	13	6,6	6,05	5,06	0,63	2,00	4,20	1,78	0,02	3,33	0,32	0,07	5,52	0,02	22,06	16,87
T5M04	Mzimkulu	14	6,5	6,51	4,87	0,42	2,02	4,27	1,50	0,01	3,63	0,28	0,07	5,67	0,03	22,03	45,70
T5M07	Mzimkulu	15	7,1	10,74	8,32	0,76	3,62	8,74	4,27	0,03	3,22	0,35	0,07	6,81	0,06	34,25	60,50
T5M02	Bisi	16	6,7	11,66	6,35	0,83	4,12	7,61	6,61	0,03	2,01	0,61	0,07	7,81	0,06	31,27	129,24
T3M10	Mzinthlava	17	7,4	20,54	14,27	1,24	11,66	10,71	6,04	0,03	5,49	1,10	0,08	8,90	0,14	85,64	87,92
T3M07	Umzimvuba	18	7,3	19,18	15,90	1,20	7,84	8,48	5,30	0,06	10,18	0,32	0,08	8,36	0,19	79,60	87,24
T3M05	Tina	19	6,9	10,79	8,87	1,20	4,56	5,97	3,13	0,03	4,15	0,61	0,07	7,70	0,09	41,56	54,92
T3M06	Tsitsa	20	6,9	10,98	7,63	1,76	4,51	7,03	5,62	0,03	4,89	0,45	0,09	5,87	0,06	39,52	36,77
T2Q05	Umtata	21	6,2	5,67	3,10	0,42	1,78	4,76	5,22	0,03	2,84	0,30	0,06	4,95	0,05	15,68	16,15
T2Q01	Umtata	22	6,6	11,39	6,14	2,98	4,69	9,85	12,85	0,13	6,17	0,70	0,19	5,80	0,12	19,94	20,39
T2Q02	Umtata	23	7,1	19,65	10,08	2,65	6,98	15,44	26,77	0,13	6,10	0,74	0,18	6,51	0,15	46,63	34,21
T7M03	Mngazana	24	7,5	49,32	20,06	0,93	17,67	47,79	71,77	0,03	13,49	0,38	0,06	9,50	0,26	111,97	34,19
T7M01	Mngazi	25	7,1	24,10	12,54	0,94	9,71	19,45	26,30	0,04	3,80	0,62	0,07	9,90	0,17	67,54	66,17
T6M01	Mntafufu	26	7,1	25,40	11,02	0,70	9,74	20,87	34,02	0,02	7,06	0,28	0,05	6,89	0,07	50,55	(66,32)
T6Q01	Msikaba	27	7,7	47,00	26,58	0,84	19,88	31,63	45,81	0,14	10,61	1,44	0,05	7,58	0,07	136,89	(149,59)
T6Q02	Mtentu	28	7,4	32,16	25,27	0,65	14,67	18,70	28,98	0,11	5,60	0,66	0,06	7,62	0,08	93,14	(100,45)

*Department of Water Affairs.

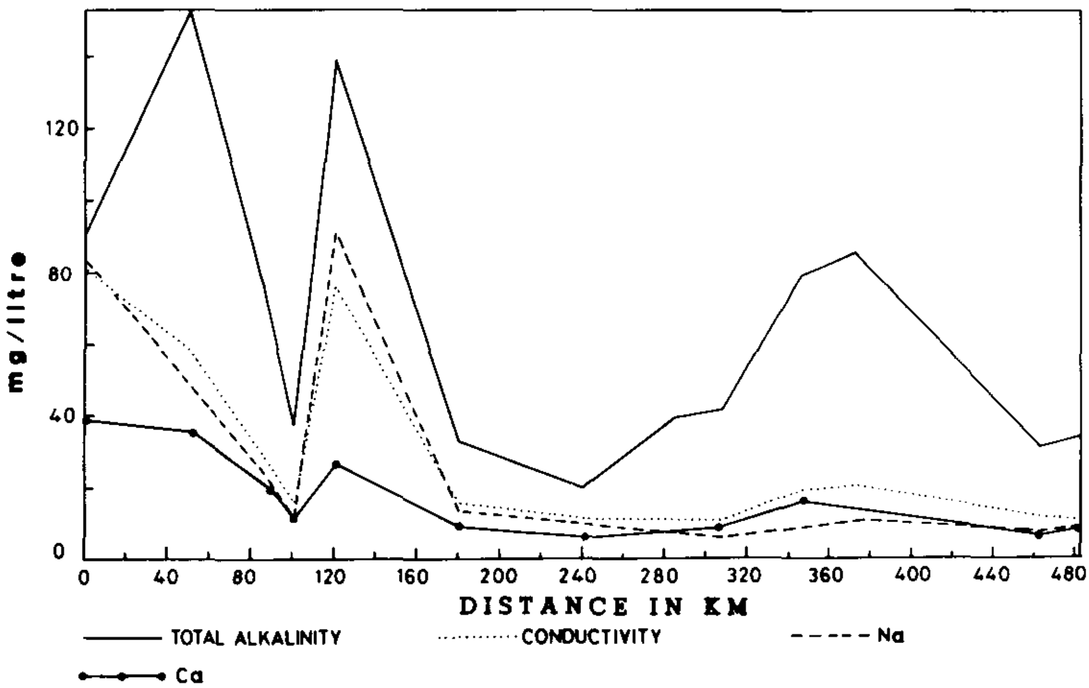

Figure 2
Changes in annual mean values across Transkei

such rivers, namely the marked deterioration in water quality downstream.

Seasonal variation of concentrations at one particular site

For most analytes the concentrations at one site varied with the seasons such that the high values correspond with the dry months (September, July) while low values correspond with the wetter months (e.g. January). It would appear that the rivers contain relatively low and relatively high concentrations of dissolved substances in the rainy and dry seasons respectively. Exceptions to this general trend are nitrate and ammonium values which peak during the wetter months. This may be due to the leaching of adjacent pastural and agricultural lands by summer rain-water; the winter flow of rivers is mostly due to underground water supply (fountains etc.).

Transkei rivers vs. rivers in RSA

Table 2 contains data of a number of rivers in South Africa. The Klaas Smits and Kubisi Rivers in the Eastern Cape are just west of the Transkei while rivers just north-east of Transkei are the Mzinthlava, Mzimvuba, Mtamvuna, Polela and Nkomanzi Rivers. A number of sampling sites in the Orange River or its tributaries near Transkei are also given. The Vaal River is represented by the sampling sites at Standerton (before extensive urban usage) and at Lindeques Drift (after urban usage). Transkei rivers in comparison to these rivers contain relatively few dissolved constituents; the Wit Kei and Gcuwa Rivers as exceptions were discussed earlier.

Silt loads in some Transkei rivers

On two occasions i.e. June 1981 and January 1982, the amount of sediment per litre of sampled water for each sampling site was determined. Where gauging weirs exist, gauge plate readings were also taken, so that the respective water flow data at these sampling sites could be calculated from the respective calibration charts as supplied by the Department of Water Affairs. All sediment in the acid-preserved samples coagulated quite well so that filtration of these samples afforded an easy way of determining the total amount of sediment per sample. The sediment so determined is classified as "suspended" in the sense that it was in suspension at the time of sampling and thus represents both the colloidal and turbulent contributions. The total sediment load of each river at the time of sampling was then calculated by multiplication with a factor of 1,30 (Rooseboom, 1975). Such

TABLE 2
RESULTS OF CHEMICAL ANALYSES OF SOME SOUTH AFRICAN RIVERS

River	Klaas Smits	Kubisi	Mzinthlava	Mzimvubu	Mtamvuna	Polela	Nkomanzi	Vaal	Vaal	Caledon	Kraai	Kraai	Orange	Orange
Station No	S3M06	S6M02	T3M04	T3M08	T4M01	T5M03	U1M06	—	—	—	—	—	—	—
Place	Doorn Hoek	Thornhill	Kokstad	Inungi	Mtamvuna	Himeville	Delos Estate	Standerton	Lindeques Drift	Wepener	Barkley West	Aliwal North	Aliwal North	Bethuli
Period	Jan '77 to Oct '80	Oct '71 to Oct '80	Sep '71 to Aug '80	Sep '71 to Aug '80	Sep '71 to Aug '80	Nov '76 to Oct '80	Jun '76 to Jul '80	Oct '72 to Sept '74 Oct '77 to Sept '79 Oct '81 to Sept '82		May '68 to Apr '72	May '68 to Apr '72	May '68 to Apt '72	May '68 to Apr '72	May '68 to Apr '72
Reference	Department of Water Affairs, RSA							Rand Water Board, RSA		Keulder (1974)				
pH	7,76	7,42	7,11	7,16	6,87	6,74	6,82	8,1	8,3	7,35	7,2	7,39	6,66	7,43
Conductivity (mSm^{-1})	98,2	25,1	12,1	12,6	9,6	5,1	14,1	21,4	70,8	16,3	15,65	15,27	14,24	14,8
Na^+ (mg/ℓ)	93,3	25,3	7,9	8,1	5,8	2,3	13,0	14,5	59,2	7,14	4,15	4,57	4,90	5,1
Ca^{2+} (mg/ℓ)	35,8	12,1	10,7	11,5	5,0	4,4	8,3	19,2	69,3	9,84	7,2	7,94	6,82	7,28
K^+ (mg/ℓ)	3,46	2,04	1,29	2,15	0,47	0,45	1,06	3,7	11,0	2,97	1,58	1,46	1,41	1,55
Mg^{2+} (mg/ℓ)	42,5	7,0	5,5	5,9	4,9	1,9	4,5	12,2	24,2	9,46	7,39	7,68	7,49	7,87
SO_4^{2-} (mg/ℓ)	45,6	3,8	2,1	3,9	2,1	1,0	5,9	15,3	104,2	4,58	3,83	3,28	3,25	3,86
Cl^- (mg/ℓ)	87,5	28,28	4,4	3,2	5,4	1,7	14,2	17,4	57,5	6,80	7,26	6,89	8,49	6,99
PO_4^{3-}-P (mg/ℓ)	0,08	0,07	0,10	0,07	0,05	0,04	0,07	0,50	0,63	0,07	0,06	0,06	0,06	0,06
NO_3^--N (mg/ℓ)	1,92	1,91	0,19	0,31	0,80	0,13	0,54	$<$0,95	1,82	0,72	0,64	0,43	0,85	0,76
NH_4^+-N (mg/ℓ)	0,10	0,06	0,05	0,07	0,05	0,06	0,08	0,47	0,59	—	—	—	—	—
TAL (mg/ℓ)	348,9	76,5	67,2	73,7	39,5	27,2	48	97,0	116,6	39,8	41,7	39,4	36,2	40,2
Si (mg/ℓ)	7,98	7,88	8,29	7,23	7,98	4,86	6,99	13	12	—	—	—	—	—
F^- (mg/ℓ)	0,58	0,11	0,12	0,11	0,07	0,04	0,12	0,22	0,76	—	—	—	—	—

TABLE 3
RESULTS OF TRACE ELEMENTS ANALYSES OF TRANSKEI RIVERS: GEOMETRIC MEAN VALUES ($\mu g/\ell$) FOR PERIOD SEPTEMBER 1980 TO JANUARY 1982

River	Sample Site No	Al	Fe	Cu	Mn	Zn	As	B	Sr	Hg*	Be	Cr	Co	Mo	Ni	Ti	V
Bashee	1	754	543	5	55	6	8	4	30	< 10	1	5	8	3	6	1	4
Gcuwa	2	224	125	7	307	7	9	36	55	< 10	1	5	8	92	9	2	7
Great Kei	3	1290	750	9	201	3	3	9	20	—	1	5	8	5	5	1	13
Tsomo	4	636	558	5	70	6	3	5	15	< 10	1	4	8	3	5	1	2
Wit Kei	5	1170	254	21	84	24	59	31	120	< 10	2	11	21	7	27	5	2
Komani	6	171	96	12	20	58	39	78	58	72	1	7	8	5	5	1	4
Slang	7	458	801	3	54	4	4	2	19	141	1	4	8	2	5	1	2
Wildebees	8	44	367	5	14	3	8	3	13	188	1	4	5	3	7	1	2
Mooi	9	190	332	6	17	12	6	13	8	17	1	5	6	2	9	1	2
Tsitsa	10	51	222	3	25	5	6	2	15	< 10	1	5	11	4	5	2	4
Tina	11	159	235	8	28	5	3	3	18	< 10	1	6	12	5	4	2	9
Kinira	12	707	642	9	27	8	58	5	30	< 10	1	7	8	3	18	2	6
Ngwangwane	13	157	291	4	19	5	4	3	13	< 10	1	4	8	3	7	2	3
Mzimkulu	14	33	168	3	13	6	13	2	16	< 10	1	4	8	3	9	1	2
Mzimkulu	15	382	433	6	47	4	14	4	28	< 10	1	4	13	4	10	1	4
Bisi	16	509	916	7	32	6	14	4	18	< 10	1	5	10	4	9	3	7
Mzinthlava	17	347	387	4	24	20	15	4	47	< 10	1	5	6	2	6	8	4
Umzimvuba	18	471	460	8	31	5	7	4	38	< 10	1	5	10	3	5	2	8
Tina	19	383	379	9	52	16	80	6	34	89	2	9	11	3	16	1	5
Tsitsa	20	545	596	5	28	7	11	3	28	17	1	5	6	2	7	2	3
Umtata	21	321	426	3	17	9	11	4	10	< 10	1	4	6	3	6	1	2
Umtata	22	2150	1760	4	173	4	3	6	25	< 10	1	4	8	3	5	1	5
Umtata	23	1860	1710	18	66	10	3	11	32	< 10	1	4	8	3	7	1	9
Mngazana	24	317	184	5	39	20	56	29	52	< 10	1	8	14	3	12	1	4
Mngazi	25	120	329	5	26	18	70	14	38	< 10	1	6	12	3	10	1	3
Mntafufu	26	209	173	3	24	11	48	11	25	—	1	6	12	4	5	1	2
Msikaba	27	150	107	5	12	12	30	11	24	—	1	6	11	5	7	1	6
Mtenta	28	143	222	5	19	6	14	10	20	—	1	7	11	2	7	1	4

*Single measurements only; January 1981

TABLE 4
RESULTS OF TRACE ELEMENT ANALYSES OF SOME SOUTH AFRICAN RIVERS ($\mu g/\ell$)

RIVER	Berg	Vaal	Ngagane	Vaal	Vaal	12 Cape Rivers	28 Transkei Rivers
STATION NO	G1 W03	C9 W01	V3 W01	—	—	—	—
PLACE	Misverstand (between Moorreesburg and Porterville)	Gamagara (near Delportshoop)	Newcastle	Standerton	Lindequesdrift	Between Knysna and Port Alfred	Transkei
PERIOD	August '80 – Feb '81	May '80 – March '83	May '80 – March '83	October '81 – September '82		May '75 – Aug '81 (intermittently)	Sept '80 to Jan '82
REFERENCE	Department of Water Affairs, RSA			Rand Water Board, RSA		Watling (1982-1983)	Table 3
Al	185	253	2141	780	450	—	498
As	5	12	11	1	1,7	—	21
B	40	150	25	450	520	—	11
Be	2	2	2	—	—	—	1
Co	21	15	35	70	70	0,2	10
Cr	10	33	12	60	60	0,8	5
Cu	15	20	7	40	40	1,9	7
Fe	168	325	1654	350	230	328	481
Hg	2	4	3	1	1	0,03	26
Mn	23	30	38	60	120	27,3	54
Mo	5	11	8	—	—	—	7
Ni	23	22	25	60	60	0,6	8
Ti	2	4	31	—	—	—	2
V	5	6	7	—	—	—	5
Zn	279	66	149	40	40	4,4	11

results, together with the flow rates of the Tsomo, Tina, Mooi and Bisi Rivers, afforded estimates of the monthly silt loads of these rivers. Suspended silt loads expressed in terms of unit areas of the catchment of these Transkei rivers are lower than those of the Tugela (Colenso), Pongolo (Intulembi) and Orange (Aliwal-North) Rivers (Rooseboom, 1978). The values obtained for Transkei are also lower than those predicted by the General Sediment Production map (Rooseboom, 1975). These findings may be due to the fact that there is no simple relationship between sediment flow and water flow, as was assumed here (Rooseboom, 1974). Mean total suspended silt loads can only be obtained from observational data collected over a long period. The justification for such a laborious task is doubtful. Additional periodic surveys of short duration will no doubt indicate whether the present results are truly representative. Further, the situation during normal and above normal rainfall periods should also be compared with this study which, as indicated previously, was performed during a relatively dry period in Transkei.

The determination of suspended material in water by the bottle method i.e. where the determination of the concentration of sediment is done at a later stage and not immediately or directly, has its obvious disadvantages and there is a trend towards the more direct determination of the concentration of sediment in water. Direct determination of the concentration of suspended sediment usually involves the measurement of water transparency. The nephelometric turbidity of the mercury preserved samples (very little coagulation of suspended material occurs) of January 1982 was thus determined. The anticipated linear relationship between the directly measured concentration of sediment (turbidity) and the indirectly measured concentration of sediment (mass determination after filtration) was checked for the 28 river sampling sites. A correlation coefficient of 0,85 was obtained. This relatively poor correlation could be due to the fact that even for rivers the suspended sediment is the dominant, but not only, factor governing water transparency (Walmsley, 1980).

Trace elements

The geometric mean values for the period September 1980 till January 1982 are presented in Table 3. These values refer to the total soluble metal ion concentrations (due to the leaching ability of the nitric acid preservative on unfiltered water samples). Antimony and zirconium are not included in the table because all sites afforded results which are less than the respective detection limits (50 $\mu g/\ell$ for Sb and 20 $\mu g/\ell$ for Zr). Interpretation of Table 3 should be done relatively to data of other rivers in the region. Published results on other rivers in Southern Africa are, however, not readily available. Table 4 therefore provides a handy reference to the interested reader. The data of Watling (1982-1983) refer to river water before entering the various estuaries as discussed in that series of papers.

When Transkei is compared to the rest of Southern Africa (Table 4) then it is apparent that there are generally fewer dissolved trace elements in Transkei river water except for the elements Mn, As, Hg and Fe.

- *Manganese*

Sample sites 2, 3, 4, 5, 22 and 23 exhibit high levels of Mn and the mean annual value for these 6 sites is 150 μ/ℓ. It is interesting to note that the January values are very high while July values are quite low; a mean July value for Mn for the same six sites is 105 $\mu g/\ell$.

- *Arsenic*

Sample sites 5, 6, 12, 19, 24-27 exhibit high values of As and mainly contribute to the high arsenic mean for Transkei. Sample sites 24-27 provide an answer to the arsenic problem. These sites lie within the fairly narrow coastal plain (approximately 40 km wide) which is heavily infested with ticks. Cattle are regularly dipped in communal dips which are always situated next to rivers as the only source of water. Old and non-usable dip material is discarded into soak pits. Arsenic containing dip material was officially in use in Transkei till 1973. Slow leaching of such dip material from the disposal pits into the adjacent rivers is inevitable and must be the source of the high arsenic values also at sites 5, 12 and 19. The high arsenic value at Queenstown (site No. 6) is most probably also due to contamination by humans.

- *Mercury*

High mercury values are found at sample sites 6-9, 19 and 20. Unfortunately these values refer only to single measurements which were made during January 1981. Cross-contamination of trace metal samples by $HgCl_2$ preservative, though highly unlikely, unfortunately cannot be eliminated as a reason for such high mercury values. Geological mercury, if present in significant quantities at those sites, is further not expected to be present in appreciable quantities in river water. The fact that sites 6-9 lie within the RSA may be significant. Mercury contamination of the environment by e.g. farmers has to be considered as a possible reason for the high Hg values. A follow-up investigation will have to be initiated, however, to clarify the present findings.

- *Iron*

Sample sites 1, 3, 4, 7, 12, 16, 20, 22 and 23 exhibit very high values of Fe. January values are again found to be higher while July values are relatively low. The mean values for the above nine sites for January and July are 1 450 $\mu g/\ell$ and 426 $\mu g/\ell$ respectively. The overall high Fe values obtained from Transkei must be related to the natural abundance of "red ochre" (Fe_2O_3). It is generally used by the traditional Xhosa female for cosmetic purposes.

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