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A situation analysis of the water quality in the Hartbeespoort dam catchment: nutrients and other pollutants' assessment on rivers entering the dam

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ABSTRACT

The water quality study of the rivers in the Hartbeespoort Dam catchment as well as its outflow has been conducted over a period of 6 months (i.e. from January 2004 to July 2004). The research effort has focused on nutrient concentrations (i.e. phosphorus and nitrogen) and their load at chosen points of the catchment. The occurrence of different phosphorus (P) and nitrogen (N) species as well as other water quality parameters at the selected points of the catchment have been examined. Situational analysis of sources of pollution in the catchment has also been carried out. The load of P and N into the dam was estimated and compared with values computed from the chosen water quality models. Following the analysis of the data generated in the research, the Crocodile River was identified as the river contributing the highest yearly TP load measuring 316.3 t/y into the Hartbeespoort Dam. Of this load, 52% is from the Jukskei River, 47% is from Hennops River and lastly 1% is from the Upper Crocodile River catchment. The Magalies and Swartspruit contributed a small percentage of the load to the Dam. The measured total inorganic nitrogen loading from Crocodile River was 2 330.2 t/a of which 49% is from Jukskei River, 35% was from Hennops and 16% from the Upper Crocodile River Catchment. The Magalies and Swartspruit also contributed a small percentage of the load to the Dam. Natural runoff from the Dam's Catchment is approximately 50% of the total runoff and another 50% is the discharge of effluent from 10 waste water treatment plants (WWTP) situated in the Catchment. It has also been noted that a large contribution was runoff from the urban areas. Analysis of data from WWTP's reveals that most of the P and N measured in the catchment emanate from these operations in spite of the fact that most of them comply with effluent discharge standards. Wet season's runoff contributes in the nutrient load. Non-point sources have been identified as informal settlements, cultivated land, developments, urban runoff, golf courses, parks and burnt pastures.

The study concluded that despite the implementation of the stricter effluent discharge standards in the catchment the P load is still very high to maintain the likely meso-eutrophic conditions in the Dam. In order to maintain the dam in mesotrophic conditions, the annual load of TP should be kept within the range of 10 to 15 t/a. It is suggested that abatement strategies to reduce the load into Crocodile River be applied on the subcatchments.

DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the Degree of Master of Science in Engineering in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

…….

(Maxwell Zanoyise Dudula)

_____Day of _____ (year)_____.

This research is dedicated
to my sisters, brothers, my son Bahle and his mother,
and my late parents.

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NOMENCLATURE

AHP	Acid Hydrolysed Phosphorus
Alkal.	Alkalinity
ATP	Adenotriophosphate
BOD	Biological Oxygen Demand
C	Carbon
Ca^{2+}	Calcium
$CaCO_3$	Calcium carbonate
Chl	Chlorophyll
Cl^-	Chloride
COD	Chemical oxygen Demand
CSIR	Institute of Science Research
DEA	Department of Environmental Affairs
DEAT	Department of Environmental affairs and Tourism
DOC	Dissolved Organic Carbon
DWAF	Department of Water Affairs and Forestry
e.g.	For example
et al.;	and others
EC	Electrical Conductivity
EDTA	Ethylene diethyl tetraacetic acid
EIA	Environmental Impact Assessment
elec. cond.	Electrical conductivity
EMLC	Eastern Metropolitan Local Council
etc.	Etcetera
GS	Gauging stations
Hard.	Hardness
H_2SO_4	Sulphuric acid
H_2O	Water
HBS	Hartbeespoort Dam

i.e.	That is
macrophy.	macrophytes
max.	maximum
min.	minimum
MMLC	Midrand Metropolitan Local Council
MnO_2	Manganese oxide
N	Nitrogen
Na^+	Sodium
NaOH	Sodium hydroxide
NEMA	National Environmental Management Act
NH_3	ammonia
NH_4^+	Ammonium
NO_2^-	Nitrites
NO_3^-	Nitrates
NOx	Nitrous oxides
NIWR	National Institute of Water Research
NWP DACET	North West Province Department of Agriculture Conservation Environment and Tourism
O_2	oxygen
^oC	Degrees centigrade
OECD	Organisation of Economic Co-operative Development
OP	orthophosphorus
P	Phosphorus
PO_4	Phosphate
REGM	Rand Estate Gold Mine
SW	South West
SS	Suspended solids
t/a	tonnes per annum
TDP	Total Dissolved Phosphorus
TDS	Total Dissolved Solids

temp.	Temperature
TN	Total nitrogen
TOC	Total Organic Carbon
TP	Total phosphorus
WBG	World Bank Group
WQ	Water Quality

RIVER STATIONS NOTATION

CROC 1	Crocodile River upstream before the confluence with Jukskei River
CROC 2	Crocodile River downstream before the Dam
CROC 3	Crocodile River downstream after the Dam Wall
JUKS	Jukskei River
HNPS	Hennops River
MAG	Magalies River
SWRT	Swartspruit River
A2H045	Crocodile River at Vlakfontein before confluence with Jukskei River
A2H012	Crocodile river after the confluence with Hennops River
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