BASINWIDE ANALYSIS OF WATER RESOURCES AND POLLUTE TRANSPORT USING A DISTRIBUTED PARAMETER MODEL

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Degree of Master of Philosophy

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Declaration of the Candidate and Supervisor

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Basinwide Analysis of Water Resources and Pollute Transport Using a Distributed Parameter Model

Abstract

The Nachchaduwa sub-catchment (598.74 km^2) of the Malwathu Oya basin is seasonally stressed in the dry periods and its downstream parts undergo intermittent floods during monsoon seasons while the fate and behaviour of excess Nitrogen (N) and Phosphorus (P) added to the waterways due to agricultural fertilizers used in the upstream areas remain unresolved. This study incorporated the Water and Energy Transfer Processes (WEP) model to assess the water resources and pollutant transport of the catchment concerning the present status and six possible future scenarios. The required data for the model runs including meteorological, geographical, hydrological, and data related to water quality and anthropogenic activities, were collected and processed identifying the suitable model parameter values. The amounts of N and P in fertilizers applied in this catchment exceeded the actual plant requirement. In both wet and dry seasons, the differences between the measured water quality parameters in upstream and downstream were not statistically significant. The model results of the hydrological component showed that the catchment response to the rainfall was highly regulated due to reservoir storage effect. The model results of the material transport component showed that, on average, the wet season had about 5~7 times the dry season value of the Total Suspended Solids (TSS) in the streams, and in both seasons, the modelled TSS, NO_3^- and PO_4^{3-} were within the ranges of the previously published results. Scenario analysis found almost all water quality parameters reduced with the reduction of fertilizer input (maximum 30.64% reduction) and with the increase in temperature (maximum 2.27% reduction), but they increased with the increase in rainfall (maximum 13.49% increase). The findings will be useful in identifying best water resources management practices and coping with the residual N and P in streams and water bodies in a more pragmatic manner.

Keywords: Hydrological and material transport models, Nachchaduwa, Nitrogen, Phosphorus, Process-based models

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List of Abbreviations

Abbreviation	Description
APHA	American Public Health Association
ASC	Agrarian Services Centres
BMP	Best Management Practices
BOD	Biological Oxygen Demand
CEA	Central Environmental Authority
CCME	Canadian Council of Ministers of the Environment
CKDu	Chronic Kidney Disease of Unknown aetiology
COD	Chemical Oxygen Demand
DN	Dissolved Nitrogen
DP	Dissolved Phosphorus
DO	Dissolved Oxygen
DON	Dissolved Organic Nitrogen
DP	Dissolved Phosphorus
DSD	Divisional Secretariat Divisions
EC	Electrical Conductivity
FIMS	First Inter Monsoon Season
GCM	General Circulation Models
HERT	Hydrologic Engineering Research Team
HLMC	High Level Main Canal
HMIS	Hydro-meteorological Management Information System
HYV	High-Yielding Varieties
IGCI	International Global Change Institute

IN	Inorganic Nitrogen
IP	Inorganic Phosphorus
IPCC	Intergovernmental Panel on Climate Change
IPCC-TGCIA	Intergovernmental Panel on Climate Change - Task Group on Scenarios for Climate Impact Assessment
IWMI	International Water Management Institute
LB	Left Bank
LBHL	Left Bank High Level
LLMC	Low Level Main Canal
MCM	Million Cubic Meters (10^6 m^3)
MOP	Muriate of Potash
NCP	North Central Province
NEM	North East Monsoon
NGO	Non-Governmental Organizations
OFC	Other Field Crops
ON	Organic Nitrogen
OP	Organic Phosphorus
PBSD	Physically Based Spatial Distributed
PN	Particulate Nitrogen
PON	Particulate Organic Nitrogen
PP	Particulate Phosphorus
RB	Right Bank
RBHL	Right Bank High Level
RBLL	Right Bank Low Level
RSC	Residual Sodium Carbonate

SAR	Sodium Absorption Ratio
SCS	Soil Conservation Service
SLS	Sri Lanka Standards
SS	Suspended Solids
SIMS	Second Inter Monsoon Season
SRES	Special Report on Emission Scenarios
SWM	South West Monsoon
SWMS	South West Monsoon Season
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorus
TSP	Triple Super Phosphate
USACE	United States Army Corps of Engineers
VBA	Visual Basic for Applications
WEP	Water and Energy transfer Processes
WHO	World Health Organisation
WQI	Water Quality Index