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INTEGRATED CATCHMENT MANAGEMENT APPROACH FOR MANAGEMENT OF LAKES AND RESERVOIRS USING REMOTE SENSING AND GIS

(A Case Study for Manchanabele Reservoir Catchment, Ramanagaram District, Karnataka, India)

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ABSTRACT

Water is the basis of life on earth. It is the main component of the environment and an essential element for human life to survive. Water is also fundamental for sustaining a high quality of life and for economic and social development. But the essential resource is under threat. Increasing demand and untreated waste water discharge aggravates stress on water bodies. The water quality of a lake is a reflection of the condition of its catchment. The intensive agricultural practices and landuse changes due to residential development in the catchment have reduced the inflow into these reservoirs. The lakes and reservoirs, all over the country without exception, are in varying degrees of environmental degradation. The degradation is due to encroachments, eutrophication and siltation. There has been a quantum jump in population during the last century without corresponding expansion of civic facilities resulting in deterioration of lakes and reservoirs, especially in urban and semi-urban areas becoming sinks for the contaminants. The degradation of reservoir and lake catchments due to deforestation, stone quarrying, sand mining, extensive agricultural use, consequent erosion and increased silt flows have vitiated the quality of water stored in the reservoirs. The study area viz., Manchanabele reservoir catchment has an areal extent of 340 sq.km. It is encompassed by E Longitude 77º07'15"- 77º18'10" and N Latitude 12º38'58"- 12º59'11". The paper discusses the integrated catchment studies for better management of reservoir. The physico-chemical and bacteriological analyses of surface and ground water samples in the reservoir and its catchment reveal that water is polluted at certain locations. Water samples were analyzed for irrigation requirements and USSL diagram, Piper trilinear diagram were plotted for classification of water samples and spatial distribution of water quality parameters is carried out using GIS Arc-Info software. Remote sensing data are used for mapping land use and land cover, physical and chemical analyses of soil samples in the catchment area reveals low fertility index in certain locations. Morphometric analyses were also carried out for the entire catchment to determine the linear, areal and relief aspects of the catchment. Double- ring infiltrometer is used for field infiltration measurements. Evapotranspiration studies were carried out using Penmen-Monteith method, soil erosion potential zone mapping is done using Universal Soil Loss Equation (USLE) which shows severe erosion at certain locations in the catchment area. Estimation of runoff is carried out using SCS-Curve number method using GIS. The Integrated Reservoir Management approach will be an effective tool for sustainable management of lakes and reservoirs. The paper also discusses various management plans for effective management of reservoirs through integrated reservoir catchment management approach.

INTRODUCTION

Many of the present cities previously emerged as settlements, along water bodies. The relation between settlements and water is unique and important. The paradigm here is water is considered a source, which sustains life, nurtures occupations and supports religious beliefs. The water bodies in an urban set up include the rivers, streams, nalas, lakes, tanks, wells, etc. Lakes are vital parts of fresh water ecosystems of any country. A fresh water lake when maintained free from pollution can offer many beneficial uses in an urban area. Urban lakes more commonly act as thermal cooling, reaction centres and de-stressing points in the highly-stressed urban life nowadays due to pressure from activities like urbanization, industrialization, as well as the asthetical beauty of the water body and the commercial value of the surrounding area is improved. Lakes provide life to various forms of aqui flora and fauna livelihood for fishermen community, food for the local populace, pollution sink ground water recharge leading to rise in the water table and as flood mitigators. The urban population can free themselves from the polluted urban air and find solace in the cool air by the lake side and relax in recreational activities such as swimming, boating, fishing and strolling along the lake shores.

The ill-effects of negating water have caused urban ecological imbalance, pollution, unhygienic conditions, and floods during rains. The trends of development and increased land demands have caused encroachment of tank beds, sewage disposal into tanks and nalas. As a result of increased population growth, intensified use of surface waters exploitation of adjacent lands and properties, and other human pressures, inland lakes increasingly are being threatened.
Restoration means returning an ecosystem to a close approxiamation of its condition prior to disturbance. This ensures that the ecosystem structure and function are recreated or restored, and that natural dynamic ecosystem processes operate effectively again. The physical, chemical and biological integrity of surface water is achieved by- Correcting nonpoint source pollution problems; Restoration of all types of habitats with priority to the habitats of endangered species. The most wide spread problems facing lakes in Bangalore are sewage from domestic sector, effluents from industrial sector (point sources), and agricultural nonpoint runoff of silt and associated nutrients and pesticides. This has led to eutrophication, due to excessive inputs of nutrients and organic matter. Hydrologic and physical changes and siltation from catchment activities have resulted in special decline. Lakes are sinks for incoming contaminants that recycle and maintained that impaired conditions. There is an urgent need to take up the restoration of lakes.

Lake vival/rejuvenation/restoration is a much talked about subject in the recent years. Lakes are being destroyed by putting the lake land for different uses in its entirety are the peripheral area encroached upon or the inlet valleys changed/diverted/destroyed and if the lake land is untouched it is used as a dumping yard for the solid wastes/waste water (sewage, sullage)/effluent from the urban developments in the catchments of the water body.The above factors hassled to either loss of the lake in its entirety or reduction in the area of the water body or the lake being deprived of aquatic life and choked with aquatic weeds leading to depletion of dissolved oxygen in lake water and release of obnoxious gases due to anaerobic reaction in the lake water. Mosquitoes breeding leads to various vector diseases on the surrounding areas of the lake.

Due to inadequate infrastructure facilities for waste disposal in the urban areas the urban lakes get polluted due to its natural topography and invariable at as collection points for the waste from the haphazard urban settlements. As a result of this and a number of other compounding factors most of the urban lakes area getting degraded beyond the point of recovery. Encroachments, accumulation of silt, weed infestation, discharge of domestic sewage, industrial effluents are the main causes for degradations of these lakes. Declining water quality, nuisance algae blooms, excessive weed growth, deteriorating fisheries, sediment infilling, eutrophication, contamination, bund erosion, water-use conflicts, impaired scenic qualities and upward appreciation of property values around the lake due to rapid urbanization are common problems being experienced by lake over seers as a result of human activities. These and other critical problems are avoidable. The lakes are prone to the causes of deterioration and degradation.

STUDY AREA

The Manchanabele reservoir is constructed across the Arkavati river after having been drained by ‘Chiktore’ stream near Manchanabele is located in Magadi taluk of Ramanagaram district. It is about 10 km South of Chamarajasagar reservoir which is also across the river Arkavathi near Tippagondanahalli that feeds water to certain parts of Bangalore City. The catchment and the command of Manchanabele reservoir with a total extent of 153 sqkm is bound between E Longitude 77º12'27"- 77º22'32" and N Latitude 12º42'12" – 13º2'58" ,covered in parts of Survey of India topographic maps No 57G/4,G/8/H/1 and H/5 of 1:50,000 Scale. The subject area constituting a part of semi-arid tract is in the agroclimatic environs of East Dry Zone of Karnataka in part of Magadi and Nelamangala taluk of Ramanagaram and Bangalore rural district respectively.

Geology of the study area

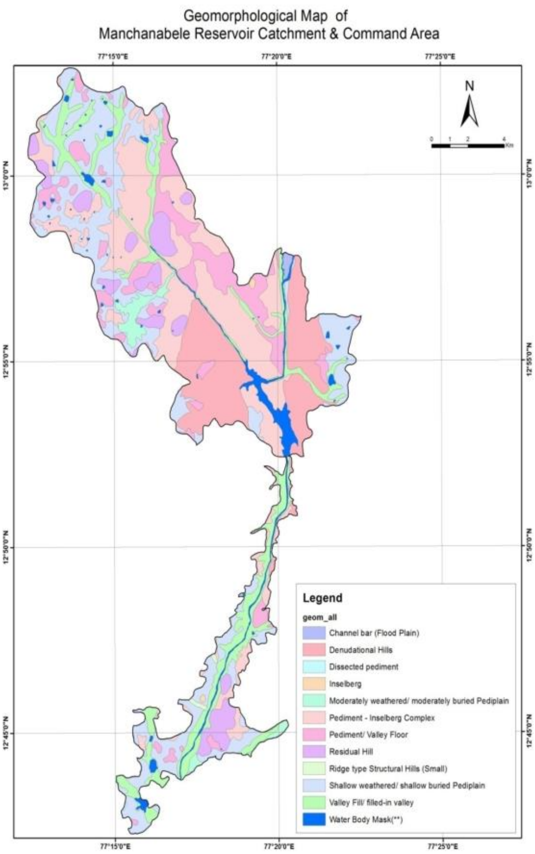
The Manchanabele reservoir catchment and its command i.e west of E Longitude77º 20'forms a robust Closepet Granite belt. Only a small part bound between E Longitude 77º 20'– 77º 22' 32" i.e the mid eastern boundary forms a part of Younger Gneissic complex.

The gneissic formations which are minor in extent, have its spread around the revenue limits of Madapatna, Hulvenahalli, Kurubarapalya and Sulevara villages of Magadi taluk. These rocks are weathered to a limited depth and exhibit vertical to easterly dip. Dip joints are prominent. The gneissic rocks are bound to the west by the hefty hills of Younger granites i.e., Closepet granites. The mineral foliations of the gneissic formations are NNW trending.

The 'Closepet Granites' in the area are represented in the area by both pink and grey varieties and thus indicating it as not a single mass of granite.As in the Kanva reservoir catchment, the granite suite is represented by granite Porphyries with huge phenocrysts of Potash feldspar. Apart from granite porphyries, the area is well represented by coarse grained grey and pink granites too.

Geomorphology and Drainage Features

The eastern boundary with gneissic incursions forms a moderately undulating terrain, whereas the granite belt represents, pediment, and pediment-iselberg complex and a hilly zone. The Arkavati river and Chiktore stream courses are shear/ fault controlled. They are comparatively deep narrow, compact and with steep banks. They are mainly rock cut valleys. While the Arkavati river is along N-S Trending fault traversed over by E-W Trending fault (West of Huluvenahalli to South of Viregowdanadoddi), the entire course of Chiktore from Byadarahalli to Virapura and beyond is along South easterly Trending fault plane.



METHODOLOGY

The physico-chemical and bacteriological analyses of surface and ground water samples in the reservoir and its catchment reveals that water is polluted at certain locations. Water samples were analyzed for irrigation requirements and USSL diagram, Piper trilinear diagram were plotted for classification of water samples and spatial distribution of water quality parameters is carried out using GIS Arc-Info software. Remote sensing data are used for mapping land use and land cover, physical and chemical analyses of soil samples in the catchment area reveals low fertility index in certain locations, Morphometric analyses were carried out for the entire catchment to determine the linear, areal and relief aspects of the catchment. Double- ring infiltrometer is used for field infiltration measurements. Evapotranspiration studies were carried out using Penmen-Monteth method, soil erosion potential zone mapping is done using Universal Soil Loss Equation (USLE) which shows severe erosion at certain locations in the catchment area. Estimation of runoff is carried out using SCS-Curve number method using GIS.

RESULTS AND DISCUSSION

Morphometric characteristics of the catchment area

The morphometric analysis of drainage basin and its stream channel system can better be achived through the measurements of linear, areal relief aspects of channel network and contributing ground slopes.Drainage network map and slope maps were prepared using Survey of India (SOI) toposheets on 1:50,000 scale. The various morphometric parameters were presented in table1 and 2.

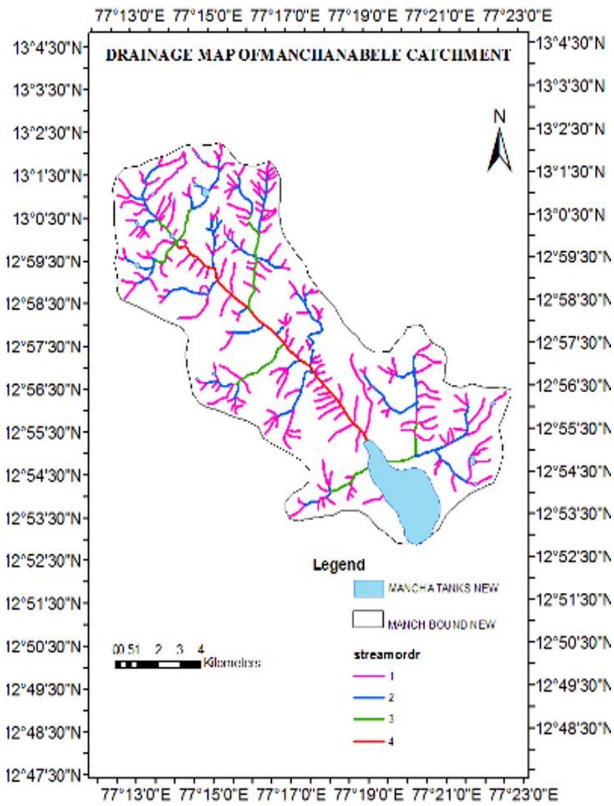


Fig 2 Drainage Map of the Manchanabele Catchment

Stream order	1	2	3	4
No. of Segments N_u	224	97	14	2
Total Length (Km) L_u	142.32	52.8	14.58	12.73
Bifurcation ratio (R_b)	-	2.31	9.93	7.00
Mean Length (Km)M_{sm}	0.64	0.54	1.04	6.37
Cumulative Length(Km) $\sum L_u$	224	321	335	337
Stream Length Ratio R_L	-	1.17	0.52	0.16
Drainage Density (Km/Sq.km) D_d	1.45			

Table1. Catchment Morphometric Characteristics

Sl No	Catchment Parameters	Units	Values
1	Catchment Area (A)	Sq.km	152.99
2	Perimeter of the Catchment (P)	km	63.82
3	Catchment Stream Highest Order		4
4	Maximum Length of catchment	km	20.74
5	Maximum width of Catchment	km	9.62
6	Cumulative Stream segment		337
7	Cumulative stream length	Km	222.4
8	Drainage density	km/Sq.km	1.45
9	Length of overland flow	km	0.725
10	Constant of channel maintenance	Sq.km/km	0.45
11	Stream frequency	No/Sq.km	2.20
12	Bifurcation ratio		3.1
13	Length ratio		1.86
14	Form factor		0.46
15	Shape factor		2.81
16	Circularity ratio		0.69
17	Elongation ratio		0.67
18	Compactness coefficient		1.45
19	Total Catchment relief	Km	0.12
20	Relative Relief		0.001
21	Ruggedness Number		0.27

Table 2.Drainage characteristics of the catchment

The elongation ratio of the catchment is 0.67 which is associated with strong relief and steep ground slopes. The length of overland flow is 0.725 Km which indicates surface runoff entering the stream will be quicker. The value of drainage density is 1.45 km/Sq.km which indicates the catchment area is coarse textured. The value of constant of channel maintenance is 0.45km^2/km which confirms the presence of structurally controlled stream system within the catchment.

Water and Soil quality aspects.

Ground water samples were collected from catchment and command area of the reservoir and surface water were collected from lakes and the reservoir during september2011. Physico-chemical and biological analysis was carried out for the water samples collected from various locations using standard procedures recommended by APHA-1994.. The results can be used for classifying water for irrigation requirements and drinking water standards.

The suitability of ground water for irrigation purposes depends upon its mineral constituents. The general criteria for judging the quality are (i)Total salt concentration as measured by electrical conductivity (ii)Relative proportion of sodium to other principal cations as expressed by SAR,(iii) Soluble sodium percentage.(iv)Residual sodium carbonate (v) Residual sodium bi carbonate.

Wilcox classified groundwater for irrigation purposes based on percent sodium and Electrical conductivity. Eaton recommended the concentration of residual sodium carbonate to determine the suitability of water for irrigation purposes. The US Salinity Laboratory of Department of agriculture adopted certain techniques based on which the suitability of water for agriculture is explained. Classification of irrigation water based on sodium water content is mapped.

$$\%Na = (Na^{+} \text{ X } 100/ (Ca^{+2}+ Mg^{+2} +Na^{+}+K^{+})$$

Where the quantities of Ca, Mg, Na and K are expressed in milliequivalents per litre (epm).

The classification of watersamples with respect to soluble sodium percent is shown in Table 3. In water having high concentrations of bicarbonate,there is a tendency for calcium and magnesium to precipitate as water in the soil becomes more concentrated. As a result, the relative proportion of sodium in the water is increased in the form of sodium carbonate RSC is calculated using the following equation.

$$\mathbf{RSC= (HCO_3^{-} + CO_3^{-2}) – (Ca^{+2} +Mg^{+2})}$$

Where all the ions are expressed in epm

Salinity hazard class	EC (micro-mohs/cm)	Remark on water quality	Water samples
C1	100- 250	Excellent	NIL
C2	250-750	Good	395.6-626 4samples
C3	750- 2250	Moderately good	763.2-1756.1 11 samples
C4	2250-6000	Unsuitable	NIL
C5	>6000	Highly Unsuitable	NIL

Table 3 Soluble sodium percentage Classification

Sodium%	Water class	Water samples
< 20	Excellent	W11
20-40	Good	W1,W6,W7,W8,W14,W15,W9
40-60	Permissible	W2,W3,W4,W5,W10,W12,W13
>60	Not suitable	NIL

Table 4: Classification of water based on RSC(Residual sodium carbonate**)**

According to the US Department of Agriculture, water having more than 2.5epm of RSC is not suitable for irrigation purpose. RSC classification of Water samples of the study area is represented in the Table-4

RSC(epm)	Remarks on water quality	Water samples
<1.25	Good	All the samples belongs to this category
1.25-2.5	Moderate	Nil
>2.5	Unsuitable	Nil

Table 5: Classification of water for sodium hazard based on USSL Classification

A better measure of the sodium hazard for irrigation water is Sodium adsorption ratio (SAR) .which is used to express reactions with the soil. SAR is computed as

$$\mathbf{SAR= Na^{+}/[\ (Ca^{+2}+Mg^{+2})/2]^{1/2}}$$

Where all ionic concentrations are expressed in epm

The graphical representation of results of SAR and Specific conductance for all the water samples as per USSL diagram is done. The classification of water samples from the study area with respect to SAR is represented in Table 5.

Sodium Hazard class	SAR	Remarks on water quality	Water samples
S1	10	Excellent	Range 1.06 to 3.16 All water samples belongs to this category
S2	10-18	Good	NIL
S3	18-26	Moderate	NIL
S4	>26	Unsuitable	NIL

Table6: Classification of water for salinity hazard

The total concentration of soluble salts (salinity hazard) in irrigation water can be expressed in terms of specific conductance. Classification of water based on salinity hazard is presented in Table 6.

Plate 1 Catchment area of Manchanabele Catchment. Plate 2 Areal view of Manchanrabele Catchment.

Sample No	**Sodium Adsorption Ratio SAR**	**Soluble Sodium Percentage SSP**	**Chlorides in meq/l**	**Calcium+ Magnesium in meq/l**	**Magnisium Hazard Mg Hazard meq/l**	**Residual Sodium Carbonate meq/l RSC**	**Residual Sodium Bi-Carbonate RSBC meq/l**	**Permiability Index PI**	**Keley's Ratio KR**
MA-W1	1.022	22.473	1.184	6.2635	0.305	-1.5855	1.221	51.811	0.289
MA-W2	2.526	44.500	4.524	5.6141	0.347	-2.1049	-0.158	64.115	0.801
MA-W3	2.677	42.961	2.547	5.6286	0.414	0.0061	3.586	67.463	0.753
MA-W4	2.565	50.348	0.561	2.5016	0.298	0.0034	3.033	86.002	1.014
MA-W5	2.919	43.565	1.323	6.4772	0.303	0.0018	4.267	67.609	0.771
MA-W6	2.470	31.684	5.991	12.818	0.280	-0.762	0.587	47.503	0.463
MA-W7	2.529	34.895	5.255	10.768	0.316	-0.803	2.351	53.354	0.536
MA-W8	1.243	23.489	2.631	1.9988	0.210	-0.0028	0.116	47.429	0.307
MA-W9	2.061	36.933	5.684	5.6951	0.464	-2.3259	0.357	56.449	0.585
MA-W10	2.484	51.371	2.510	3.371	0.437	-0.002	1.206	80.596	1.056
MA-W11	1.088	15.843	4.409	14.5121	0.434	-2.2681	2.793	33.471	0.188
MA-W12	2.421	52.382	1.410	1.8313	0.322	0.3282	1.877	89.256	1.100
MA-W13	2.711	46.139	3.876	3.9773	0.384	-0.0043	1.925	70.196	0.856
MA-W14	1.295	23.138	2.296	7.7371	0.233	-0.2511	0.385	45.840	0.301
MA-W15	1.796	34.058	2.777	4.421	0.392	0.002	1.606	59.102	0.516

Table 7 Water quality based on irrigation water requirements in the catchment and command area.

Sample no	Name of the village	pH	EC mmhos/cm	Organic Carbon %	Available Phosphorus (P) Kg/acre	Av. Potash (K) Kg/acre	Available Micro nutrients			
							Zn ppm	Cu ppm	Mn ppm	Fe ppm
MB-S1	Madapatna	6.6	0.04	0.41 L	9 L	240 H	2.2 S	1.6 S	37.4 S	41.0 S
MB-S2	Yellapanapalya	6.5	0.31	0.61M	9L	221 H	4.1 S	2.4 S	42.1 S	22.8 S
MB-S3	Adakamaranahalli	7.2	0.05	0.25L	8L	192 H	2.1 S	3.8 S	35.5 S	39.2 S
MB-S4	Vengalappanahalli	6.8	0.41	0.25 L	18 M	212 H	3.0 S	1.4 S	30.3 S	13.8 S
MB-S5	Lingegowdana doddi	6.9	0.09	0.53 M	5 L	100 M	1.0 S	4.6 S	38.0 S	48.5 S
MB-S6	Rampura	6.6	0.06	0.47 L	8 L	240 H	12.2 S	3.4 S	42.2 S	39.2 S
MB-S7	Agalahalli	7.3	0.08	0.39 L	18 M	160 H	3.5 S	3.3 S	40.7 S	55.2 S
MB-S8	Gollarapalya	8.0	0.06	0.35 L	12 M	370 H	2.13 S	3.6 S	40.1 S	33.7 S
MB-S9	Virapura	6.1	0.17	0.46 L	4 L	223 H	9.71S	3.1 S	40.1 S	29.2 S
MB-S10	Harti	6.2	0.32	0.39L	10	129H	3.45S	4.1S	33.2S	43.5S
MB-S11	Dubbikatige	7.1	0.09	0.52M	9L	134H	6.71S	2.7S	45.6S	22.6S
MB-S12	Chikatorepalya	8.1	0.21	0.46L	12M	165H	3.10S	1.9S	38.9S	41.4S
MB-S13	Tagachaguppe	6.6	0.12	0.48L	11M	149H	2.46S	3.2S	40.5S	22.3S
MB-S14	Byadarahalli	6.1	0.15	0.71M	8L	252H	1.76S	1.8S	37.2S	29.8S
MB-S15	Viregowdanadoddi	6.3	0.09	0.59M	13M	198H	4.32S	1.5S	44.6	40.2S
MB-S16	Lakshmipura	7.2	0.08	0.27L	11MM	212H	2.31S	2.6S	22.3S	32.9S

Table8 Results of Chemical analysis of soil samples in the Study area.

Where, H-High, L-Low, M-Medium, S-Sufficient, D-Difficient

Field Infiltration measurements

Infiltration characteristics of soil are very important for scientists, engineers and planners. Hydrologists mostly need infiltration data for the estimation of peak rates and volumes of runoff in the planning of dams, culverts and bridges etc. It is also useful for minimizing the erosional hazards. Most important use of infiltration is to the agriculturists and ecologists who are concerned with the availability of soil moisture in the root zone of crops and plants. Hortons equation is used to characterize the infiltration rate in the catchment area of the present study. Double Ring Infiltrometer is used for Infiltration measurements. The Hortons equation is as shown below.

$$fp=fc+(fo-fc)^{e-kt}$$

Where fo is the infiltration rate at the beginning of the storm, fc is the ultimate or final infiltration capacity attained when the soil profile becomes saturated, fp is the infiltration capacity at time‘t’ and k is an empirical constant. Horton suggested the above equation for separating rainfall into rainfall excess and infiltration. This equation is applicable only when the rainfall rate exceeds fp. The constant k depends upon both the basin and rainfall characteristics; fo depends upon initial moisture condition of the basin and fc varies depending upon the season.

Sl no	Location	Horton's equation
1	Madapatna	$F = 1.80 +1.935\ e^{-1.5817t}$
2	Adakamaranahalli	$F = 4.80 +0.5511\ e^{-5.1048t}$
3	Gollarapalya	$F = 8.5 +6.2535\ e^{-8.8374t}$

Table 9 Field Infiltration studies

Evapotranspiration measurement

Evapotranspiration (ET) includes water that is needed for both evaporation and transpiration.ET is defined by the US Geological Survey as the water lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwatertable. Evapotranspiration is considered to be one of the key elements in the water cycle that needs to be quantified to achieve better water management. In the present study FAO-56 Penman-Monteith method is used for the computation of Reference evapotranspiration.The max and minimum values of monthly evapotranspiration is shown for 3 locations for past 5years is shown in Table 10. The FAO-56 Penman-Monteith Equation for computation of reference evapotranspiration is shown below.

$$ET_{o=}\frac{0.408\Delta(R_n-G)+\gamma\frac{900}{T+273}U_2(e_s-e_a)}{\Delta+\gamma(1+0.34u_2)}$$

Table 10 : Monthly ET_O values in mm/month for various locations

Location	Adakamaranahalli		Lakshmipura		Manchanabele	
Year	Min	Max	Min	Max	Min	Max
2008	84.24	128.38	84.13	123.92	84.16	128.28
2009	74.79	122.56	74.72	122.46	74.70	122.44
2010	69.88	128.46	69.79	128.32	69.81	128.33
2011	83.98	124.43	83.86	124.30	83.88	124.32
2012	87.08	124.01	86.99	123.87	86.96	123.91

Soil Erosion Studies

The soil loss in the Kanva catchment area is estimated using Universal Soil Loss Equation (USLE).The inputs for the model such as Soil map, Land use land cover map and slope map were derived from satellite Images of IRS PAN+ LISS –III after suitable ground truth studies. The slope map is prepared from SRTM data. Following formula is used in computation of Soil loss.

$$A=RKLSCP$$

Where, A is the computed soil loss in tons/hectare/year. R is the rainfall factor which is also called as erosion index EI which is taken from Isopleths for the present study it is taken as 250. K is the Soil erodibility factor which depends on the soil type. For the present study the weighted average value is calculated as 0.31.Lis the slope length factor and S is the slope steepness factor and the value of LS for the present study is calculated using Arc-Info GIS software. C is the crop management factor which is derived using land use and land cover map. P is the conservation practice factor. Since the study area comprises of field bunds the conservation factor is taken as unity.The above map layers were overlayed using Arc-Info GIS software and soil loss is computed in the Catchment The soil loss in the Catchment varies between 0 to 50 tonns per hectare per year. The soil erosion map is shown as Fig-8.

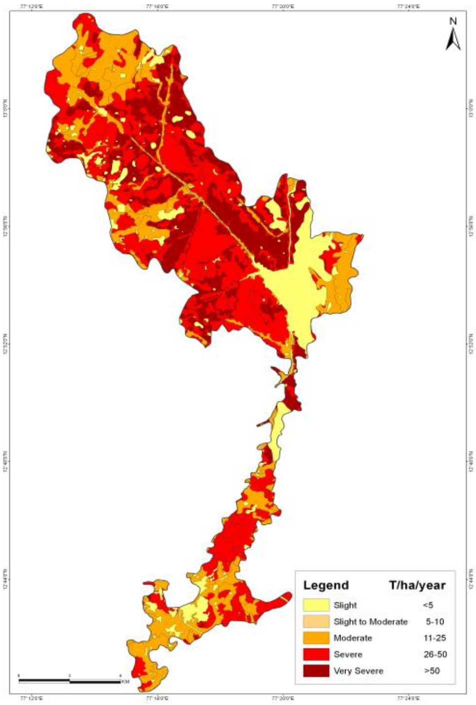


Fig 8 Soil Errosion Map of Manchanabele cathment and command area.

The (USDA, 1977) SCS Curve Number method is the most enduring method for estimating the volumes of direct,i.e., surface runoff from ungauged small catchments. In the present study SCS Curve Number method is used to estimate the surface runoff. The weighted curve number is derived by superimposing Hydraulic soil Group classification map and Land use and land cover map using GIS Arc-Info Software. The weighted Curve number of 68 obtained for the catchment is used to estimate the Runoff using the following equation.

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$S = \left[\frac{25400}{CN} - 254\right]$$

Where Q is the Runoff in mm, P is the Rainfall in mm and S is the maxium soil water retention parameter and CN is the weighted curve number for the Catchment. The seasonal runoff is estimated using the seasonal rainfall data. For monsoon rainfall of 389mm for the year 2011 the estimated runoff is94.03mm.

CONCLUSIONS

The results of the morphometric analysis helps in priotorising the sub catchments. The morphometric characters derived will help better management of the reservoir catchment which further helps in the management of the reservoir. The results of analysis of water and soil samples at various locations of catchment area revels that water is not suitable for irrigation and potable purpose and soil samples at various locations are deficient of Zinc, low organic carbon and low phosphorous, hence precautions should be taken to identify pollution potential zones and take prevention measures. From the results of field infiltration studies it is concluded that soils of the study area have medium to high infiltration capacities. It is observed from the computations of ET_O by Penman-Monteith method for 5 years duration is between 74.79mm/month to 128.46mm/month. From soil erosion studies it is concluded that very severe erosion is observed in the catchment area hence proper measures has to be taken to prevent further soil erosion, which also helps in reduction of sediment upload into the reservoir. Thus SCS-CN method is an effective tool for estimating the runoff into the reservoir and also helps to analyse the reasons for reduced inflow into the reservoirs due to the various land use changes. The remote sensing and GIS is an effective tool of management of Reservoir catchment which in turn helps in the management of reservoir.

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