Journal of Global Resources
Biannual Peer-reviewed International Journal
ISSN: 2395-3160 (Print) 2455-2445 (Online)
www.isdesr.org
July 2021
Volume 07 (02)
Published by: ISDESR, Jaipur, India

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JAMWA RAMGARH RESERVOIR: STATUS AND FUTURE PROSPECTS

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Abstract: *Urbanization and industrialization have increased size of habitations, and accordingly water requirements also increased. Rajasthan being located in semi-arid area have severe problems of water supply to most of the towns including capital town Jaipur. Initial source water was provided through tanks, Ponds, Baorietc constructed. As population and development happened, it was started from Jamwa-Ramgarh, which is 25 kilometers away from Jaipur city. After drying of Jamwa Ramgarh, government of Rajasthan started Banas water by constructing dam at Bisalpur and there is new plan to tape Himalaya's feed rivers through river linking or any other network of canals. But this process is not sustainable as there is limitation of technical, social issues for long distance transfer of water. The sustainable solution of this ever-increasing problem is rainwater harvesting, construction and scientific management of lakes, ponds etc. The present study is focused on Jamwa-Ramgarh reservoir, which was prime source of drinking water earlier, now dried up due to mis-management and scope of revival of ecosystem its catchment as sustainable source of water. Earlier Ramgarh reservoir was major source of water supply to Jaipur city. After 1990 water supply from Ramgarh reservoir has reduced continuously due to unavailability of water in reservoir. At present dam remain operational only during rainy season and post rainy period (July – November). Using satellite data (IRS-LISS-III and Google Earth) and field investigations, 104 hydrological structures have been identified, which if reached to the Ramgarh reservoir can fill the reservoir up to 32 ft. height, and support Jaipur city in sustainable manner.*

Keywords: Jamwa Ramgarh Reservoir, Canal Network, Banas River, Hydrological Structure

How to cite this paper:
Anamika Kumari, Punia, M.P., and Sharma, Chilka (2021) Jamwa Ramgarh Reservoir: Status and future prospects, Journal of Global Resources, Vol. 07 (02)

DOI:
10.46587/JGR.2021.v07i02.001

Received: 21 March 2021
Reviewed: 10 April 2021
Revised: 11 May 2021
Final Accepted: 27 May 2021

Introduction

The primary source of water in the Rajasthan is precipitation. Rainfall in large parts of the state is inadequate and varies sharply every year. This results into draughts. Water flow in the state rivers is entirely dependent upon the incidence of rainfall. Rajasthan population growth rate is highest in the country. Water demand is increasing continuously because of, development, tourism and recreation Water supply has either remained unchanged or further reduced. Two-thirds of the state suffers from recurrent water scarcity. Ramgarh Lake used to be the major source of water supply in Jaipur city, but due to some negligence and lack of proper management, and maintenance the lake is on the urge of dying. Ramgarh is an artificial lake created by constructing a dam across Banganga River. There are hills at both side of dam and have good storage space. The lake is situated at 25 Km. in northeast direction from Jaipur city, where the temple of Mata and the ruins of the old fort are some of its antiquities. It is good tourist spot for visitors.

Study Area and its Characteristics

The catchment area of Ramgarh Lake hosts variety of flora, fauna and geomorphic landforms, especially an undulating terrain with subdued relief merging into the alluvial tract drained by the river Banganga, which is the major contributory in Ramgarh Lake. The downward flow of river Banganga is in a sinusoidal fashion towards its destination i.e., the Ramgarh Lake, which covers approximately a distance of 59.81 kms.

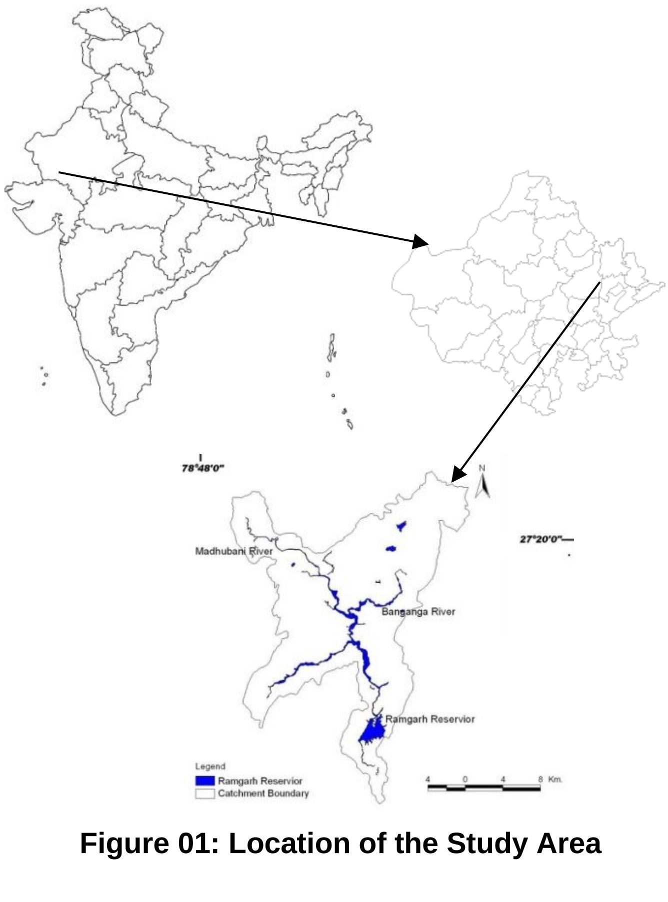


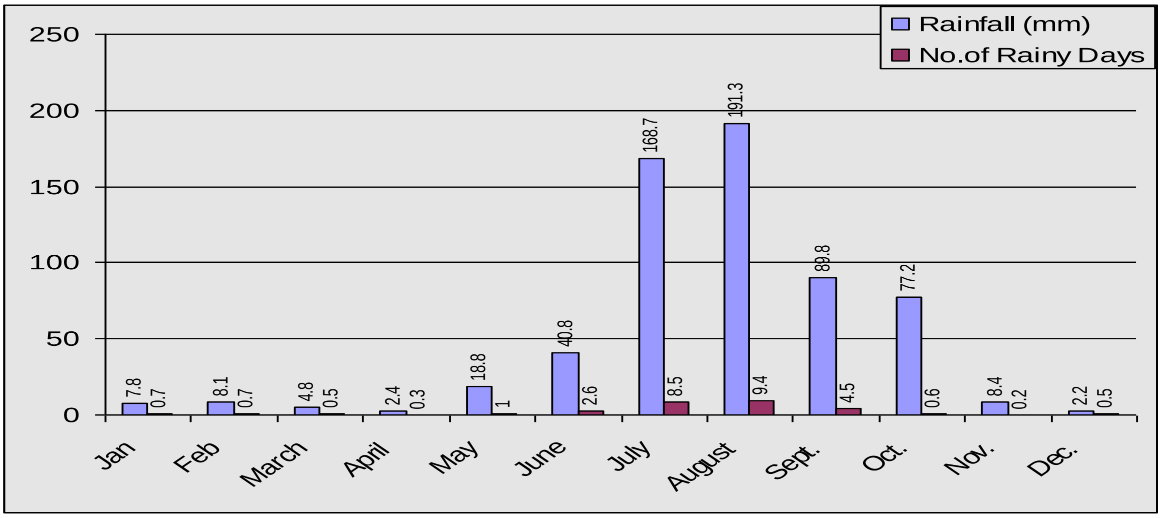
Figure 01: Location of the Study Area

Climate

The Ramgarh lake catchment has a semi-arid type of sub-tropical monsoon climate with dry-hot summers, low scanty monsoon rains, and a cold winter season. The winter commences from October, Summer starts from middle of April and reach its peak in May-June, when average maximum temperature goes up to 40.6℃ in May.

Rainfall

Table 1. shows that most of the rainfall recorded at Ramgarh meteorological station is during the monsoon months i.e., from June to September, whereas, remaining part of the year remains dry or very less rainfall received. It is either due to mid latitudinal western disturbances or due to the local disturbances (fig2). Rainfall data of 21 years of Ramgarh station have been analyzed. Maximum rainfall is recorded in year 1996 (1092.1mm) and minimum in year 1987 (286.1mm) (Table 2).



YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	Total
1985	0	0	0	22	0	32.7	325.7	235	4	90.1	0	8.2	717.7
1986	0	31.3	0	0	30.8	40.5	173.7	99.8	1	26.4	0	0	372.2
1987	10	17	1	0	47.8	10	14.5	162.3	9	0	0	14.5	259.1
1988	2.6	2.1	6.3	0	0	41.8	195.3	197.5	74.4	0	0	0	515.3
1989	17.5	0	0.5	0	0	48.5	137.7	223.9	7	0	0	0	417.6
1990	0	37.6	0	0	1	79.5	143.9	119.8	96.7	0	17.6	0	458.5
1991	0	4	0	0	10	17	157.9	200.7	81.9	0	0	32	499.5
1992	15	0	0	0	0	0	275	291	87	0	0	0	653
1993	0	19	7.2	0	0	147.5	233.4	35	68	0	0	0	491.1
1994	17.2	0	0	5	0	82	199.8	130.8	53.4	0	0	0	471
1995	26	12	5.5	0	2	5	235.2	575.7	35	0	0	0	858.4
1996	9.8	8.8	3	0	21.5	162	168	289	374	56	0	0	1073.5
1997	0	0	3	39	5	64	155.4	150	147.6	223	16	15.4	818.4
1998	0	3	4	0	0	22	203	210	142	38	0	0	619
1999	3	3	0	0	0	53	284	54	54	0	0	0	445
2000	0	0	0	0	10	54	308	177	20	0	0	0	569
2001	0	0	4	3	33	115	90	161	0	0	0	0	406
2002	0	5	0	4	28	27	38	190	14	0	0	35	336
2003	1	62	0	0	8	195	435	212	154	1	0	0	1005
2004	0	0	0	0	66	91	164	426	39	275	0	0	1061
2005	0	2	5	9	0	293	306	18	347	0	0	0	978

Source:IMD.

Figure 02: Average Rainfall & Rainy days in Jamwa-Ramgarh Catchment

Temperature

The average temperature during summer of the Ramgarh catchment is 21.6ºC (table below). However, the mean monthly maximum of the region is 40.6ºC. (fig 3)

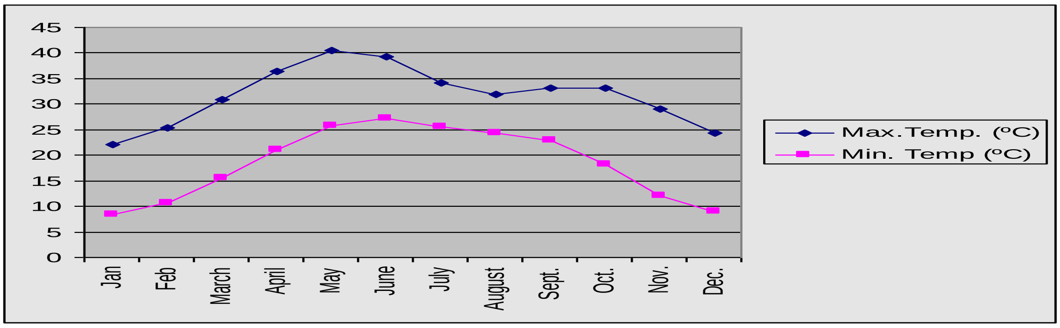


Figure 03: Mean Monthly Minimum and Maximum Temperature

Geology

The basic data of Lithology, synthesized for the catchment area have been incorporated into Arc/Info vector layer (fig 4).

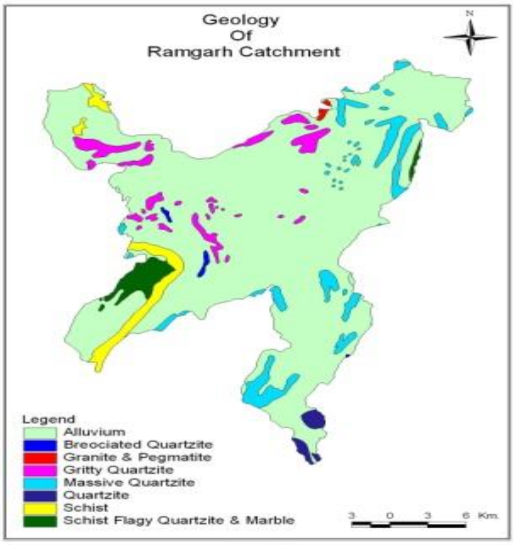


Figure 04: Geology of Study Area

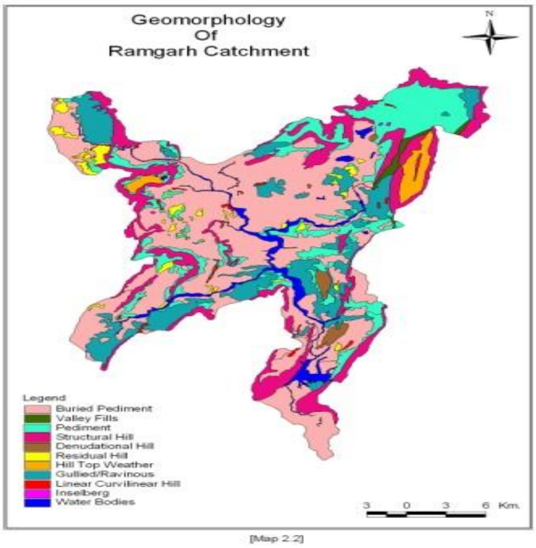


Figure 05: Geomorphology of Study area

Geomorphology

The landform divisions are based on the existing relief features, and provide a basis of the study of geomorphic evolution of the terrain which has been sculptured by a number of erosional cycles represented by various surfaces (Fig 5).

Slope

Slope plays very significant role in determining infiltration, and runoff in any watershed or catchment. Infiltration is inversely related to slope i.e., gentler the slope is, infiltration would be more and runoff would be less and vice-versa. The slope map has been created using DEM of study area while defining a cell size of 23.5 meters.

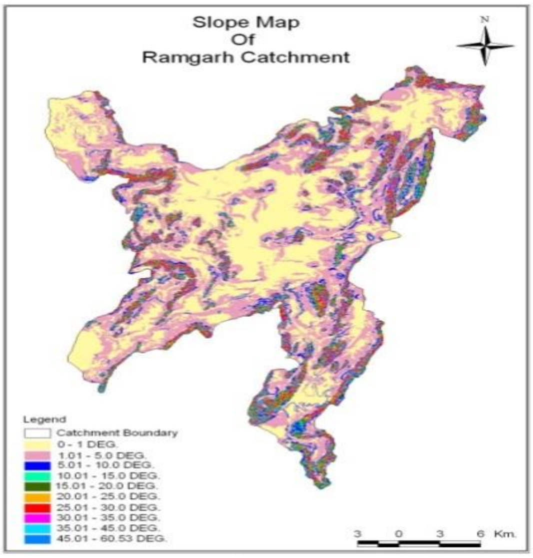


Figure 06: Slope Map

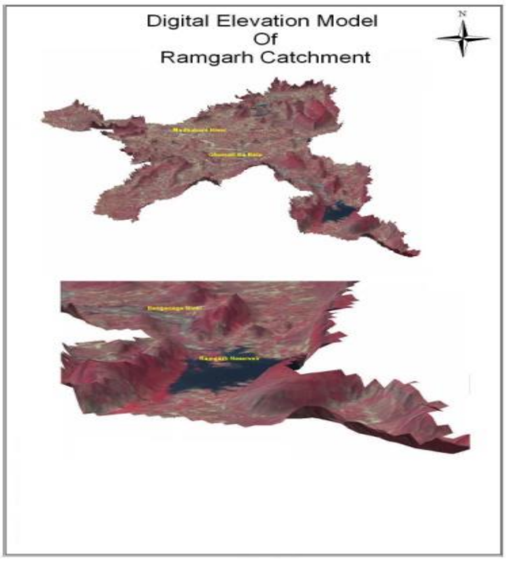
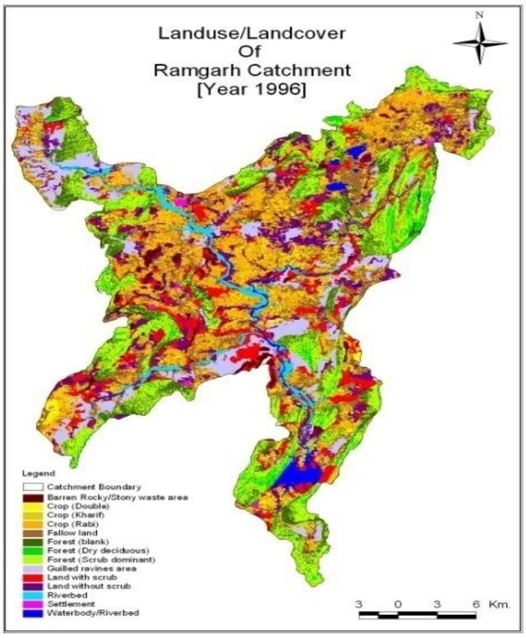


Figure 07: Digital Elevation Model

Land use / Land Cover

The supervised classification for Land use / land cover was done on IRS-ID LISS-III images for years 1996-97 and 2005-06 using maximum likelihood algorithm. Additionally, manual refinement has been done using available topographic maps and ground truth data that has been collected.



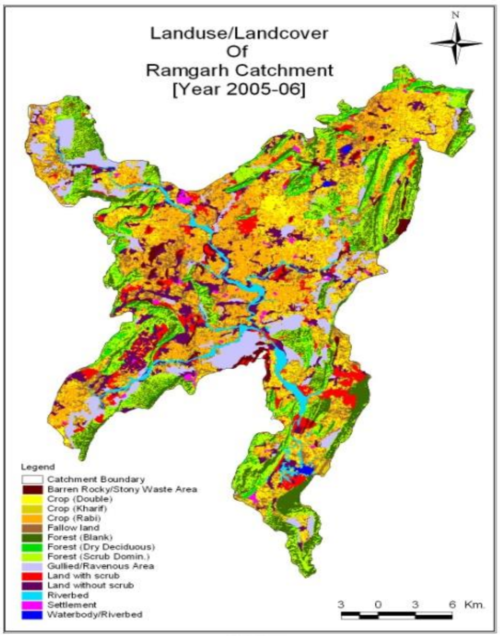


Figure 08: Land use/Land Cover, 1996 **Figure 09: Land use/Land Cover, 2005-06**

Problem Statement

Ramgarh reservoir which was the, prime source of water supply for Jaipur city has dried and is becoming a matter of prime concern. The statistics tells that the water supply is surprisingly reduced as 25 lac liter/day had been supplied against the supply of 425 lac liter/day initially. The water level on April 01, 2006 was R.L. 226 (26 feet) and its capacity was 44.60 Mcft. at the same level. The reservoir was almost dry on March 01, 2007. Thereafter Ramgarh reservoir is not getting any inflow, and dried completely.

Objectives

1. To identify and map the hydrological structures raised in the upper catchment of Ramgarh reservoir.
2. To access the possible effect of these hydrological structures on the storage and inflow parameters at Ramgarh reservoir.
3. To suggest possible interventions to restore the ecological status of reservoir and its catchment.

Methodology

Remote Sensing data of the years 1984 and 2005 were analyzed digitally to understand the patterns of land use / land cover, and changes occurred during this period. The secondary data pertaining to rainfall in the study area from 1984 to 2005, interception, transpiration, inflow, parameters effecting runoff, the river channels, storage capacity at various levels of Ramgarh dam, annual water supply from Ramgarh etc. were collected. Hydrological structures were identified on satellite images of IRS-LISS III images of Google Earth and by field visits. Measurement of length, width and depth of individual structures were measured physical on the ground, and calculated storage capacity of individual structures. Categorizations of hydrological structures have been done into major medium and minor as per their storage capacity. Catchments of individual structures have been demarcated on 1:50,000 toposheets and satellite images. Runoff from each catchment has been calculated as per the stranger's table method and compared with the storage capacity of individual structures to calculate effectiveness of structures in the way of flowing water. Total quantity of water being intervened by hydrological structures have been calculated by analyzing storage capacity and runoff generation from the catchments.

Analysis

To understand the drainage interrelationship morphometric parameter have been calculated at micro watershed level, by GIS this purpose remote sensing and GIS tools are used for drainage delineation and updation. Number and order of stream length, drainage density, stream frequency, bifurcation ratio, shape index, circulatory ratio have been calculated for water resource planning. The first order drainage has a frequency of 2.525, highest amongst all. Although they lack the central part of the area, yet have a good association around, and at the marginal areas of hills and residual hills. During the field work, it has been found that the higher frequency of first order drainage give the villagers an idea for earthen dams constructed by soil, clay and stones at the hill slopes. These areas having high drainage frequency are the same with high drainage density and high run off producing areas. Maximum structures are constructed on these land and abstracting water outflow from these high runoff generating areas. The high frequency of these is probably due to the development of gullies and rills at the margins of hilly area where water strikes with a high velocity. The second order drainage has an average frequency of 1.197 formed due to the meeting of two first order drainage and well distributed all over the study area.

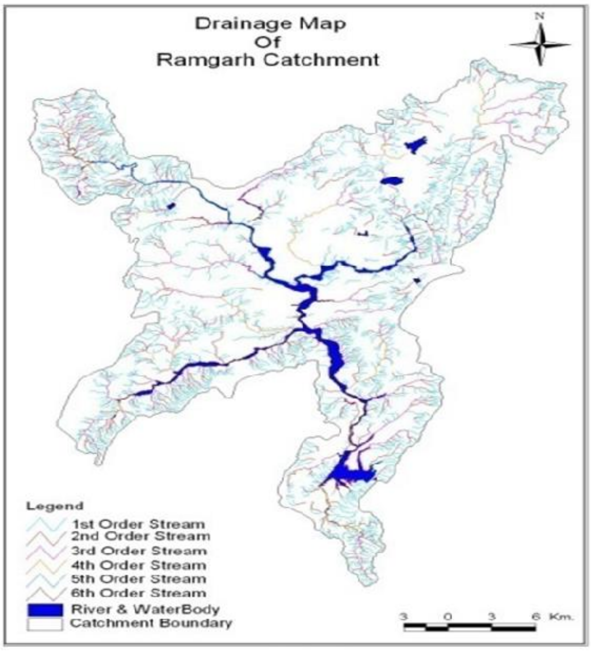


Figure 10: Drainage Density

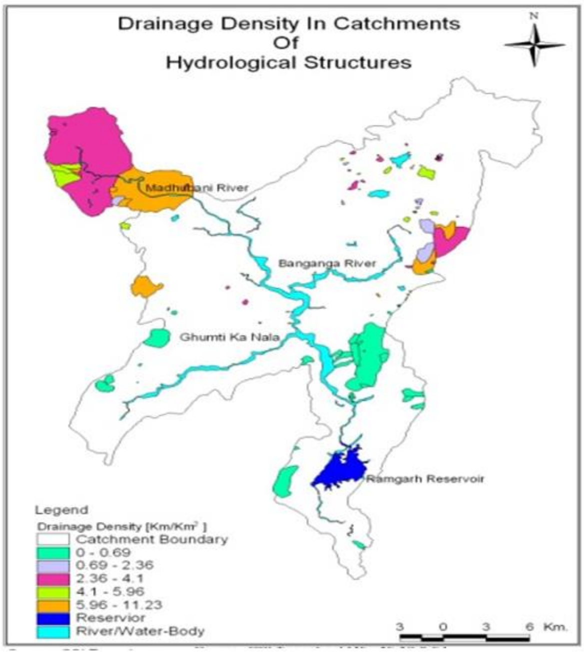


Figure 11: Drainage Map

Hydrological Structures

The study area comprises 12 major hydrological structures, which have storage capacity 0f 5,000 m^3. The total storage capacity of the major hydrological structure is 2334641.226 m^3. Maximum storage capacity is found for hydrological structure (HS) no. 52 with storage capacity of 858593.75 m^3 followed by SH no 104 with the storage capacity of 441773.438. Minimum storage capacity is found for HS no.60 with storage capacity of 5102.5 m^3 only. Whatever amount of water, comes and gets stored in these hydrological structures in the form of rainfall and runoff, gets intercepted in between and severely affect the amount of runoff, which reaches to fill the Ramgarh reservoir. There are 16 medium hydrological structures, with storage capacity ranging from 1000-5,000 m^3. They collectively store total 35447.39 m^3 of water. Apart from the above-mentioned categories, 76 minor structures have been found with storage capacity below 1000 m^3. They collectively can store 19937.68 m^3 water. Major, Medium and minor hydrological structures collectively can store 2390026.296 m^3. Looking to the storage capacities, it is clear that contribution of medium and minor hydrological structures is quite insignificant and accounts for 1.46% and 0.08% of the total storage capacity. Major hydrological structures; restrict the maximum water to reach the Ramgarh reservoir.

The major structures vary widely in storage capacity. Maximum storage capacity is found as 858593.75 & 441773.438 m^3 for hydrological structure number 52 & 104 respectively. Minimum storage capacity is found as 5102.5 m^3 for structure number 60. These structures collectively can store 2334641.226 m^3 of water.

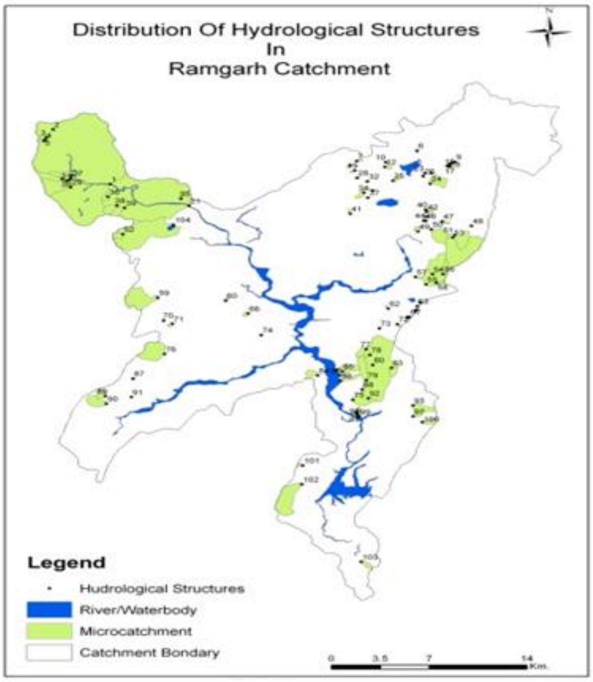


Figure 12: Hydrological Structure

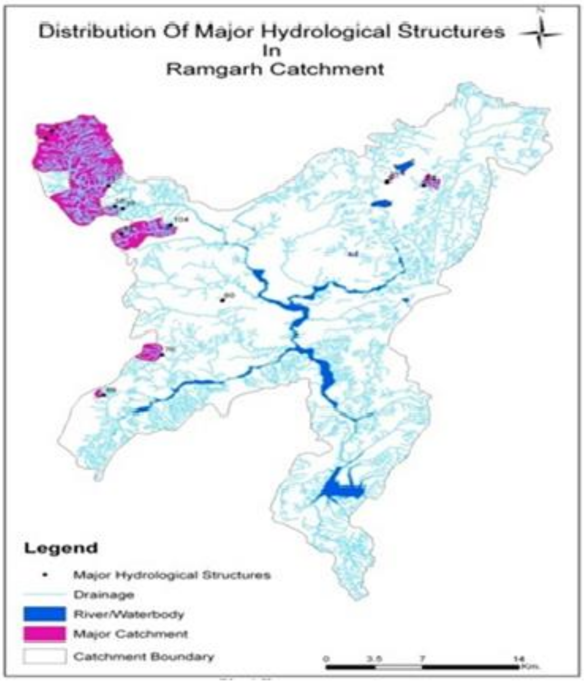


Figure 09: Major Hydrological Structure

Estimation of Total Run-off

For the study we used empirical equation method for calculation of Run-off. Study shows that storage capacity is not of the order of runoff generation from catchment areas. Some major hydrological structures are small than runoff Generation (HS No. 1, 76). Otherwise, hydrological structures are bigger than the estimated runoff. Storage capacity of all major hydrological structures is 2334641.226 m^3 against the runoff Generation of 2259040.91 m^3. One hydrological structure (HS no. 104) constructed across Madhubani river, has water throughout the year.

Imbalance between storage capacity and runoff Generation in case of medium hydrological structures is very high in compared to major structures. Total storage capacity of all the medium hydrological structures is 35447.39 m^3 against the runoff 336662.289 m^3. These structures are mainly constructed on second or third order streams which generally remain dry except in rainy days only and also for few hours. Therefore, the entire runoff is received during few rainy days only and after few days this accumulated water percolate down or evaporates. During rainy season these structures get water many times. Therefore, higher runoff accommodated in these smaller structures. Apart from these medium structures there are many very small earthen structures also constructed for the purpose of soil and water conservation, which store very small quantity of water (may few cubic meters) but are able to distribute flowing water into small water fills and effectively check the incoming water. This water percolate down or evaporate immediately in 2/3 days because porosity of sandy soils is very high and the evaporation rates is also high. Therefore, a medium structure is able to catch more amount of runoff generated from catchment areas in many spaces.

Field Photographs

Medium Hydrological Structure

Minor hydrological structures are very small but are able to stop large quantity of water because they are constructed on Ist or IInd order streams where small quantity of water is reached during rain or may be up to few minutes after actual rains. During gap in rains the water either percolate down or evaporates and these structures become dry and again they get water in next span of rain. This way these structures get water many times in a season and able to catch big amount of water during entire monsoon season. Therefore, these small structures are putting very effective check over runoff from their catchment. Minor structures have storage capacity of 19937.68 m^3 against runoff 2203155.962 m^3.

Minor Geological Structure

Major hydrological structures can store the entire runoff generated from their catchments. (2259040.91) These structures are most affect the inflow of water into Ramgarh reservoir. Storage capacity of medium hydrological structures is 35447.39 m^3 but due to limited number of rain days, when practically runoff is generated, these structures are able to catch 336662.39 m^3 of water. Similarly, all 76 minor hydrological structures collectively can store 19937.68 m3 water at a time but practically they along with the micro structures (hundreds in number) can intercept huge amount of runoff (2203155.96 m^3) during total monsoon season.

Storage Capacity of Ramgarh Reservoir

Water level data of 32 years have been analyzed. It is evident from data that up to year 1986 Ramgarh reservoir got good amount of water, when only few hydrological structures were constructed. During last 32 years water level reached to maximum capacity of 65 feet in year 1975. Thereafter it was never reached to the maximum capacity. During 1985 there was good rains during June, July and August months and the water level was reached to 62 feet. During 1987 because rainfall was abnormally low during these months and as a result water level come down to 27 feet and 9 inches only, which has again raised during 1988-89 due to good rains. Water level observed very low in drought years of 1990, 1991 which was 17' 10" and 27' 8.5" respectively. Period 1992-98 was experienced normal rains and water level was remains at medium level between 37 to 49 feet. After 1998 water level decreased sharply and could not come up because most of the structures are constructed after year 1997 through watershed development programs launched by Department of Forest and Department of Watershed and Soil Conservation. During 2003 there was abnormally high rainfall (1068 mm) but water level in Ramgarh dam could reach only up to 37'8". Thereafter the reservoir is dried except during rainy season, and then dried completely.

Conclusion

The study shows that Jamwa Ramgarh Reservoir catchment has good runoff potential. According to the current study 4.799 million cubic meter (167.965 mcft.) runoff is generated from the catchment but 104 hydrological structures constructed across drainage channels has stopped the runoff to reach the water to the reservoir. This amount of water if reached to Jamwa Ramgarh reservoir it is sufficient to fill this reservoir up to 32 ft. height and can support to meet the water demand of Jaipur city in sustainable manner. Apart from 104 listed hydrological structures there are hundreds of micro structures available in the catchment area but they are so small that their storage capacities are negligible but able to stop process of runoff generation from tail ends of 1st order streams. Due to these micro structures triggering of runoff is affected from many ends, which has resulted into considerable reduction in runoff generation.

References

1. Ashish Pandey and A.K. Sahu (1985). Dept. of Agriculture Engineering North Eastern Regional Institute of Science and Technology, Generation of curve number using Remote Sensing and GIS. Brace, Jovanovich Publishers, Orlando, USA.
2. Binau Kumar Singh (Sr. Scientist) BIT Mesra Extension Center Jaipur, Wasteland mapping of Ramgarh Lake Catchment by Remote Sensing & GIS technique
3. C.F. Tolman (1937). Groundwater, McGraw Hill, New York.
4. C.P. Lo (1986). Applied Remote Sensing, Longman Scientific and Technical, U.K.
5. C. Sorrel, P.E. (2003). Michigan department of engineering quality Geological and land management division July (2003). Computing flood discharges for small ungaged watersheds
6. D.K. Todd (1980). Groundwater Hydrology, John Wiley.
7. E.T. Engman and R.J. Gurney (1981). Remote Sensing in Hydrology, Chapman and Hall, London.

8. George Joseph, Fundamentals Of Remote Sensing by Universities Press (India) Limited
9. H.M. Raghunath (1987). Groundwater, Wiley Eastern.
10. Hong-Yuan Lee, M.ASCE; Ying-Tien Lin, and Yu-Jia Chiu J. (2006). Hydrologic Eng., Volume 11, Issue 4, pp. 362-370 (July/August 2006) Dept. of Civil Engineering and Hydraulic Research
11. H.S. Chen (1985). Space Remote Sensing Systems? An Introduction, Academic Press Inc. Harcourt Brace, Jovanovich Publishers, Orlando, USA.
12. K.D. Sharma and Surendra Singh [CAZRI), Jodhpur Runoff estimation using Landsat Thematic Mapper data and the SCS model.
13. K.R. Karanth (1989). Hydrogeology, Tata McGraw Hill.
14. K. Subramanyam, Engineering Hydrology Second edition.
15. Laboratory, National Taiwan Univ., Taipei, Quantitative Estimation of Reservoir Sedimentation from Three Typhoon Events.
16. Lillesand T M and Kieffer R W (1979). Remote Sensing and Image Interpretation, John Wiley, NY
17. Manual of Remote Sensing (1998). Principles And Applications Of Imaging Radar, ASPRS.
18. Nathanial Vandal Middlebury College, Using GIS to model runoff Time, Quantity and stream flow
19. Pratt William K (1978). Digital Image Processing, A Wiley inter Science Publication, New York.
20. P.A. Longley, D.J. McGuire, M.F. Goodchild and D. Rhind, GIS (Eds.) (1999). Principles and Applications, Longman.
21. P.A. Burroughs and R.A. McDonnell (Eds.) (1998). Principles of GIS, Oxford University Press.
22. P.B. Keith and Thompson (1974). Remote Sensing and Water Resources Management.
23. P.K. Singh Udaipur Watershed Management.
24. R.N. Colwell (Ed.) (1983). Manual of Remote Sensing, Vols. 1&2, Second Edition, American Soc. of Photogrammetry, USA.
25. Robin T. Clarke (1994). Statistical Modelling in Hydrology; John Wiley & Sons, England.
26. Richard J. Mandle, Michigan Department of Environmental Quality, Groundwater Modeling Program.
27. United States Department of Agriculture Technical Release 55 June 1986, Urban Hydrology for Small Watersheds.
28. Victor Mockus and Hydraulic engineer Estimation of direct runoff from storm rainfall. Richard.
29. Y, P, Parks & A, Gustard Institute of Hydrology, Walling ford, Oxon OX10 8BB UK, A reservoir storage yield analysis for arid and semiarid climates.