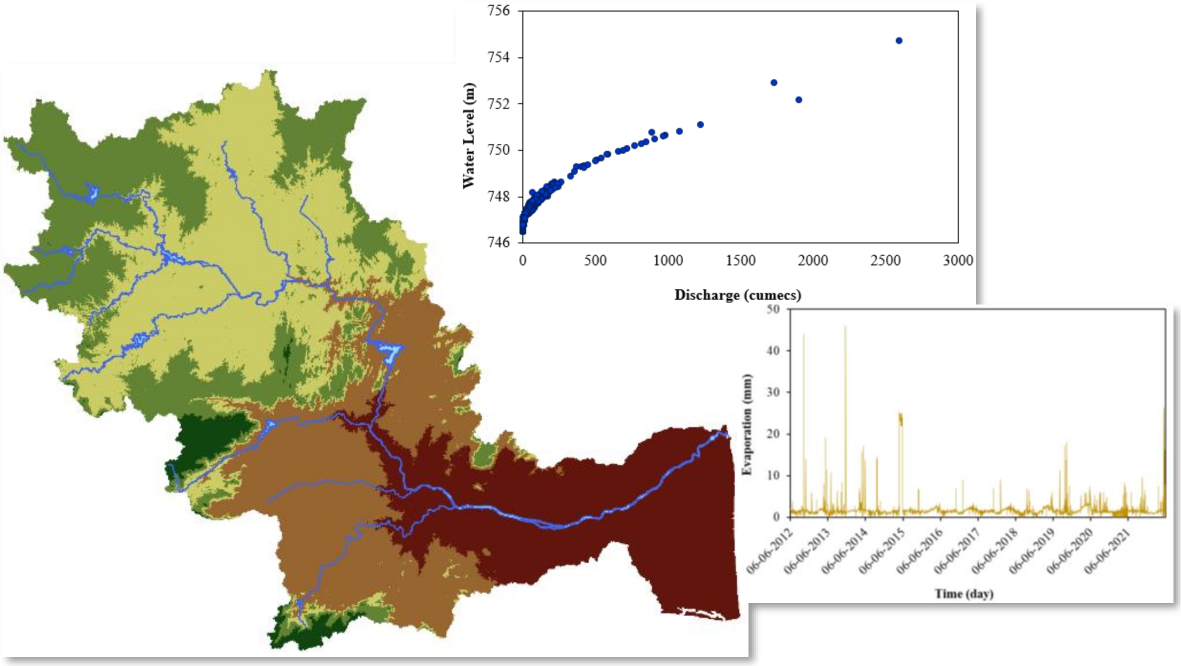
National River Conservation Directorate
Ministry of Jal Shakti,
Department of Water Resources,
River Development and Ganga Rejuvenation
Government of India

Hydrologic Status of Cauvery River Basin



December 2024

Hydrologic Status of Cauvery River Basin

National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development and Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

www.nrcd.nic.in

Centres for CRB Management and Studies (cCauvery)

The Centre for CRB Management and Studies (cCauvery) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by IISc Bengaluru and NIT Tiruchirappalli, under the supervision of cGanga at IIT Kanpur, the centre serves as a knowledge wing of the National River Conservation Directorate (NRCD). cCauvery is committed to restoring and conserving the Cauvery River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.ccauvery.org

Centres for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

Acknowledgment

This report is a comprehensive outcome of the project jointly executed by IISc Bengaluru (Lead Institute) and NIT Tiruchirappalli (Fellow Institute) under the supervision of cGanga at IIT Kanpur. It was submitted to the National River Conservation Directorate (NRCD) in 2024. We gratefully acknowledge the individuals who provided information and photographs for this report.

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Preface

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

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Abbreviations and Acronyms

°	Degree
′	Minute
%	Percentage
&	And
g	Gram
e.g.	For example
l	Litre
m	Mitre
mbgl	Meters below ground level
CGWB	Central Ground Water Board
CRB	Cauvery River Basin
CWC	Central Water Commission
DEM	Digital Elevation Model
GD	Gauge & Discharge
GDQ	Gauge, Discharge & Water Quality
GDSQ	Gauge, Discharge, Sediment & Water Quality
GeoTIFF	Geographic Tagged Image File Format
GIS	Geographic Information System
HGT	Height (commonly used for Digital Elevation Model (DEM) data in SRTM files)
InSAR	Interferometric synthetic aperture radar
ISRO	Indian Space Research Organisation
NASA	National Aeronautics and Space Administration
NGA	National Geospatial-Intelligence
QGIS	Quantum Geographic Information System
RF	Rainfall Station
SRTM	Shuttle Radar Topography Mission

1. Introduction

The Cauvery River originates at Talakaveri in the Coorg District of Karnataka, nestled in the Brahmagiri range of the Western Ghats. It flows through multiple states, including Karnataka, Tamil Nadu, and Kerala, before reaching the Union Territory of Puducherry, covering a vast and diverse landscape along its course. The Cauvery River basin (CRB) is bounded by Tungabhadra sub-basin of Krishna basin on the Northern side and Vaigai basin on the Southern side. The Western ghats form the Western boundary. The Nilgiris, an offshore of Western ghats, extend Eastwards to the Eastern ghats and divide the basin into two natural and political regions i.e., Karnataka plateau in the North and the Tamil Nadu plateau in the South (Arulbalaji et al., 2019; Das & Panchal, 2018, Ramkumar et al., 2019).

Effective CRB management and planning are foundational to ensuring sustainable use of water resources, mitigating the risks of hydrological disasters, and preserving ecological balance. At the core of this complex endeavour lies hydrologic data, quantitative information that describes the behaviour, distribution, and quality of water within the hydrological cycle. Hydrologic data includes a wide range of measurements such as gauge, discharge, evaporation, evapotranspiration, percolation, infiltration, interception, groundwater, and sediment load data. These data are essential for understanding the dynamics of river systems and for formulating informed and sustainable water management strategies (Hannaford et al., 2024, 6. Ijaz et al., 2022). With growing concerns over climate change, urban expansion, population growth, and the increasing occurrence of water-related hazards, the relevance and necessity of reliable hydrologic data have become more pronounced than ever before (Broyles et al., 2022; Collins et al., 2020).

Hydrologic data serve as the foundation for making decisions regarding water allocation, disaster management, infrastructure planning, ecosystem protection, and transboundary water negotiations. It provides the empirical basis for assessing the availability of water in a basin, understanding seasonal and inter-annual variations, and predicting future trends. In the absence of such data, water managers and policymakers would be left to make decisions based on assumptions or incomplete information, which can lead to inefficient or even harmful outcomes. Reliable hydrologic data are especially critical in regions experiencing water scarcity, where precise information is required to balance competing demands among agriculture, domestic use, industry, and environmental flows.

In conclusion, hydrologic data is the cornerstone of effective river basin management and planning. It enables a comprehensive understanding of water availability, variability, and quality, supports infrastructure design and disaster preparedness, and informs equitable and sustainable water use strategies. As global water challenges become increasingly complex, the importance of reliable, timely, and accessible hydrologic data cannot be overstated. The path toward resilient and adaptive water management lies in leveraging the full potential of hydrologic data, integrating it with modern technology, and fostering collaborative and informed decision-making across sectors and borders.

2. Sources of hydrologic data

In India, hydrologic data collection within the Cauvery River Basin (CRB) is primarily managed by the Central Water Commission (CWC), Central Ground Water Board (CGWB), and respective State Water Resource Departments. The CWC maintains a network of 54 observation sites (Fig. 1) across the basin (Table 1), recording critical parameters such as river discharge, stage levels, evaporation, and sediment load as key inputs for hydrologic modelling and flood forecasting. Complementing surface water monitoring, the CGWB systematically tracks aquifer behaviour, providing vital insights into groundwater fluctuations throughout the CRB.

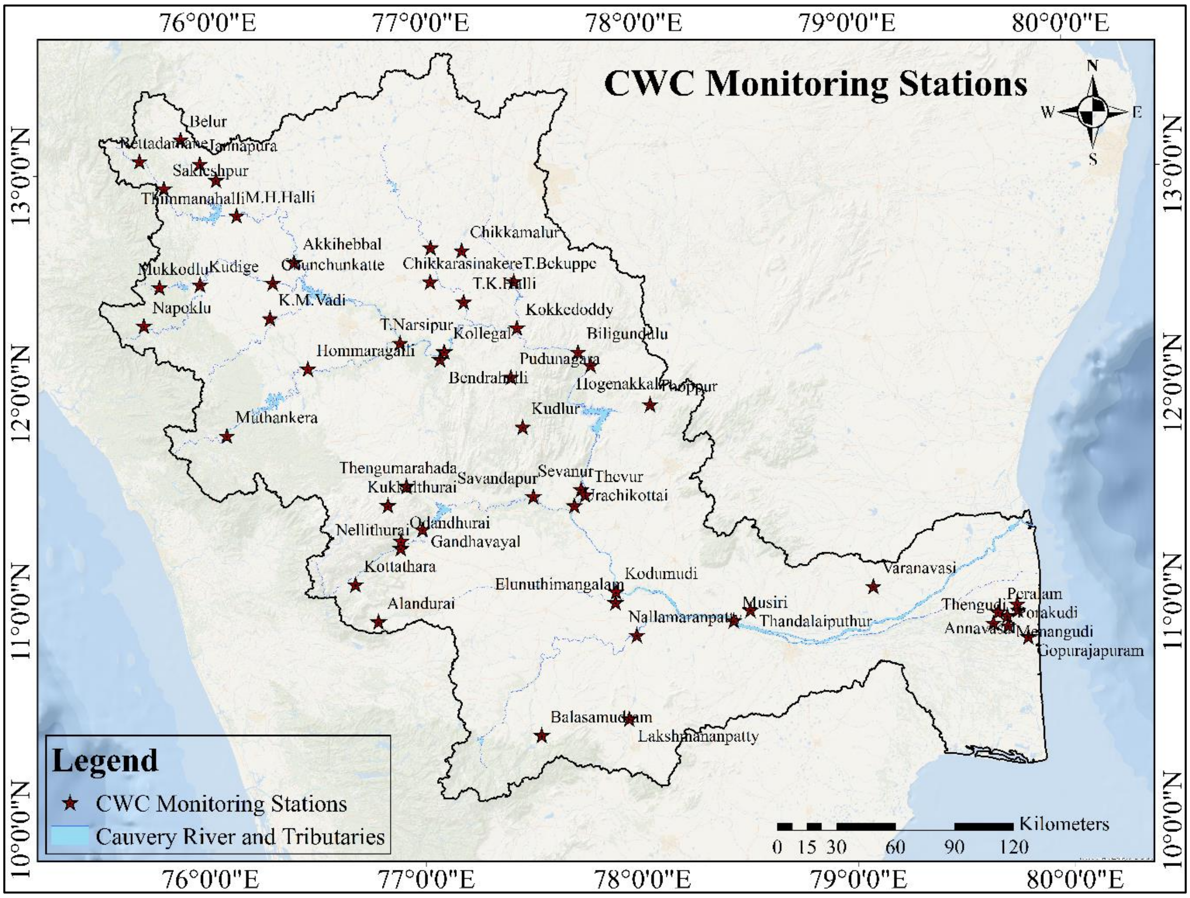

Fig. 1. CWC monitoring stations in CRB

(Source: CWC)

Table 1. Summary of CWC stations and their classification

Sr. No.	Station Name	Latitude	Longitude	Type
1	Akkihebbal	12°36'10	76°24'03	GDSQ & RF
2	Alandurai	10°57'07"	76°47'07"	GDSQ
3	Annavasal	10°58'30"	79°45'14	GDQ & RF
4	Balasamudram	10°25'32"	77°32'22	GD
5	Belur	13°10'08"	75°52'21"	GD
6	Bendrahalli	12°09'13"	77°04'48"	GDQ
7	Bettadamane	13°04'09"	75°40'46"	GD
8	Biligundulu	12°10'56"	77°43'26"	GDSQ & RF
9	Chikkamalur	12°39'09"	77°11'05"	GD
10	Chikkarasinakere	12°30'36"	77°02'12"	GD
11	Chunchunkatte	12°30'34"	76°18'04"	GDQ
12	Elunuthimangalam	11°01'54"	77°53'15"	GDSQ & RF

13	Gandhavayal	11°22'27"	76°59'32"	GDSQ
14	Gopurajapuram	10°51'05"	79°48'00"	GDQ & RF
15	Hogenakkal	12°07'16"	77°46'55"	GDQ
16	Hommaragalli	12°06'52"	76°27'48"	GD
17	Jannapura	13°03'25"	75°57'42"	GD
18	K.M.Vadi	12°20'46"	76°17'16"	GDQ & RF
19	Kodumudi	11°04'52"	77°53'25"	GDSQ & RF
20	Kokkedoddy	12°17'46"	77°26'25"	GDQ
21	Kollegal	12°11'21"	77°06'00"	GDSQ & RF
22	Kottathara	11°07'23"	76°40'46"	GD
23	Kudige	12°30'09"	75°57'40"	GDSQ & RF
24	Kudlur	11°50'26"	77°27'46"	GDSQ & RF
25	Kukkalthurai	11°29'08"	76°49'57"	GD
26	Lakshmananpatty	10°29'53"	77°56'45"	GDSQ
27	M.H.Halli	12°49'08"	76°08'00"	GDSQ & RF
28	Menangudi	10°56'56"	79°42'14"	GDQ
29	Mukkodlu	12°29'26"	75°46'18"	GD
30	Musiri	10°56'36"	78°26'06"	GDSQ & RF
31	Muthankera	11°48'30"	76°05'02"	GDSQ & RF
32	Nallamaranpatty	10°52'51"	77°59'05"	GDSQ & RF
33	Nallathur	11°00'08"	79°45'01"	GDQ
34	Napoklu	12°18'51"	75°41'54"	GD
35	Nellithurai	11°17'16"	76°53'28"	GDSQ & RF
36	Odandhurai	11°19'18"	76°53'34"	GD
37	Peralam	10°57'59"	79°39'41"	GDQ & RF
38	Porakudi	10°54'14"	79°42'26"	GDQ & RF
39	Pudunagara	12°04'12"	77°24'36"	GD
40	Sakleshpur	12°56'37"	75°47'37"	GDSQ
41	Savandapur	11°31'17"	77°30'36"	GDSQ & RF
42	Sevanur	11°33'07"	77°43'55"	GDQ & RF
43	T. Bekuppe	12°30'29"	77°25'39"	GDSQ & RF
44	T.K. Halli	12°25'00"	77°11'33"	GDSQ & RF
45	T.Narsipur	12°13'48"	76°53'39"	GDSQ & RF

46	Thandalaiputhur	10°59'28"	78°30'48"	GDQ
47	Thengudi	10°55'00"	79°38'20"	GDSQ & RF
48	Thengumarahada	11°34'22"	76°55'09"	GDSQ & RF
49	Thevur	11°31'38"	77°45'03"	GDQ & RF
50	Thimmanahalli	12°58'57"	76°02'17"	GDQ
51	Thoppur	11°56'18"	78°03'26"	GDQ & RF
52	Thoreshettihalli	12°39'59"	77°02'24"	GD
53	Urachikottai	11°28'40"	77°42'00"	GDSQ & RF
54	Varanavasi	11°05'33"	79°05'06"	GDQ

Note: GD = Gauge & Discharge, RF = Rainfall Station, GDQ = Gauge, Discharge & Water Quality, GDSQ = Gauge, Discharge, Sediment & Water Quality.

3. Hydrologic data of CRB

3.1. Digital Elevation Model (DEM)

A Digital Elevation Model (DEM) is a spatial raster dataset that represents the Earth's surface topography in digital form. Each raster cell within the DEM contains an elevation value relative to mean sea level. DEMs are critical in hydrological modelling, watershed delineation, flood forecasting, soil erosion studies, and infrastructure planning, as they help accurately represent surface features. In this study, the DEM (Fig. 2) was sourced from the Shuttle Radar Topography Mission (SRTM) Version 3.0, provided by the United States Geological Survey (USGS). The SRTM dataset offers global coverage with a spatial resolution of 1 arc-second (~30 meters), which balances sufficient detail for river basin analysis with manageable data size for computational processing.

The DEM for CRB reveals a diverse topography. The western part of the basin, encompassing the Western Ghats, shows elevations ranging from 900 m to over 2000 m, characterized by rugged and steep terrain. This high-altitude region receives substantial rainfall and is the origin zone for several important tributaries. Moving eastwards, the basin gradually transitions into a central plateau with moderate elevations between 400 and 900 m, displaying gently undulating terrain. Towards the Bay of Bengal in the eastern part, the terrain flattens considerably, with elevations falling below 100 m, resulting in the formation of extensive floodplains and deltaic regions that support intensive agricultural activities.

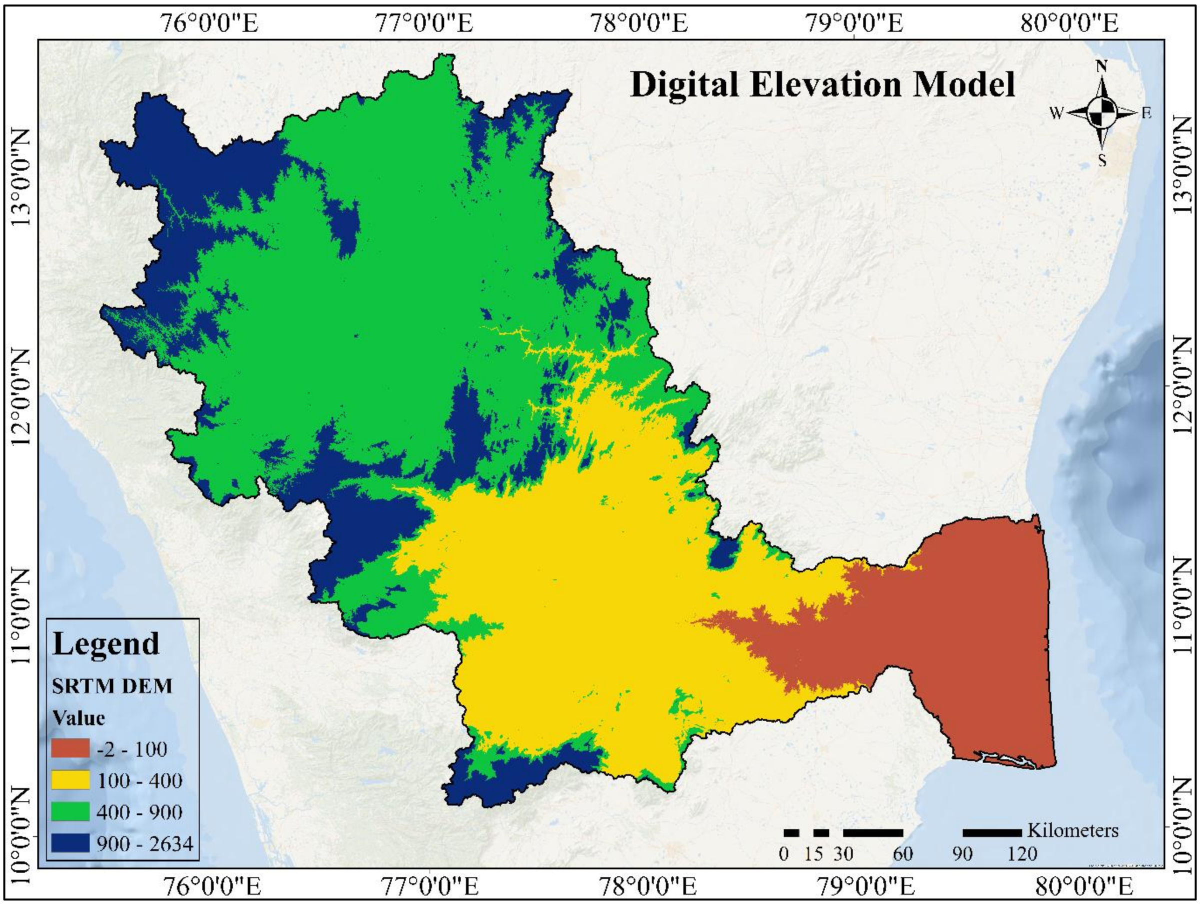

Fig. 2. Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) of CRB (**Source:** USGS)

3.2. Gauge and discharge data

Gauge and discharge data are fundamental components of hydrological modelling, providing essential information for understanding and predicting water flow in river basins. Gauge data refers to measurements from hydrological stations that record water levels (stage height) in rivers, lakes, or reservoirs over time. These data points help in determining variations in water storage, flow regimes, and potential flood events. Discharge data, on the other hand, represents the volume of water flowing through a river or stream cross-section per unit of time, usually expressed in cumecs (m^3/s). It is derived using stage-discharge relationships (rating curves), which correlate gauge height with corresponding flow rates. Accurate discharge measurements are crucial for calibrating hydrological models, assessing water availability, designing hydraulic structures, and managing flood risks. In hydrological modelling, both gauge and discharge data serve as key inputs for model calibration and validation. They help simulate river flow dynamics, predict flood events, and analyse the impacts of land-use changes or climate variability on water resources. Reliable and continuous gauge-discharge records enhance model accuracy, improving water resource planning and decision-making.

The CWC operates a network of 54 hydrological observation stations across the CRB to monitor stage-discharge characteristics essential for water resources management. Among these, the Akkihebbal station provides a representative example of long-term river monitoring, with its stage (gauge height) and discharge data plotted from 2002 to 2021 (Fig. 3). The plotted data exhibit a strong seasonal variability, with distinct monsoonal peaks and inter-annual fluctuations. Notable high-flow events are observed during 2019 and 2020, where discharge exceeded 2500 cumecs, suggesting the occurrence of extreme hydrological events or floods. The corresponding gauge heights, while elevated, do not increase linearly with discharge, indicating a non-linear stage-discharge relationship typical in natural channels due to factors such as channel geometry, roughness, and backwater effects. The data gap between 2007 and 2016 highlights challenges in continuous monitoring, which may impact model calibration and long-term trend analysis. Nevertheless, such datasets are critical for hydrodynamic modelling, flood forecasting, and understanding the spatial-temporal dynamics of flow within the CRB.

Moreover, the scatter plot (Fig. 4) illustrates the relationship between discharge (in cumecs) and water level (in m) recorded at the Akkihebbal station, one of the stations operated by the CWC across the CRB. The graph demonstrates a nonlinear yet monotonic increasing trend, where an increase in discharge corresponds to a rise in water level, indicative of a typical stage - discharge relationship for alluvial river sections. The tightly clustered data at lower discharge values reflects baseflow or normal flow conditions, while the steeper gradient at higher discharges signifies flood stages or extreme events. Analysing such plots is essential for developing rating curves, calibrating hydrodynamic models, and improving flood forecasting systems for water resource management and flood risk reduction strategies.

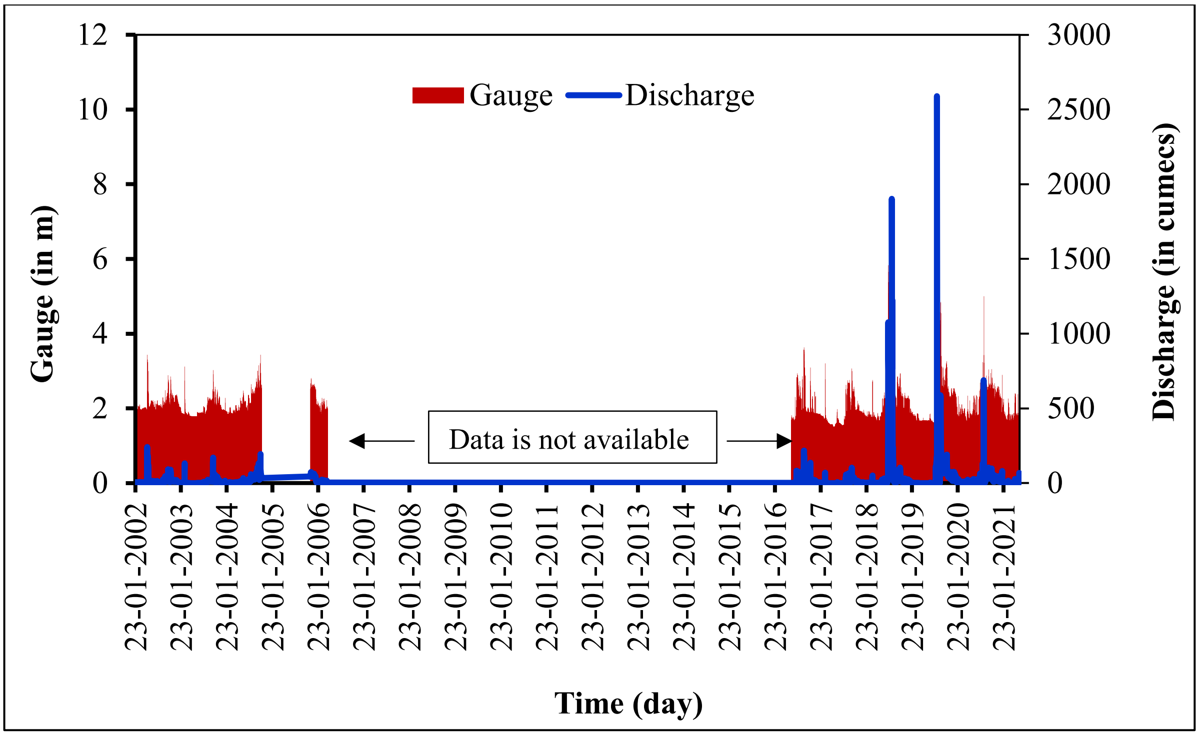

Fig. 3. Gauge height and discharge time series data at Akkihebbal station (**Source:** CWC)

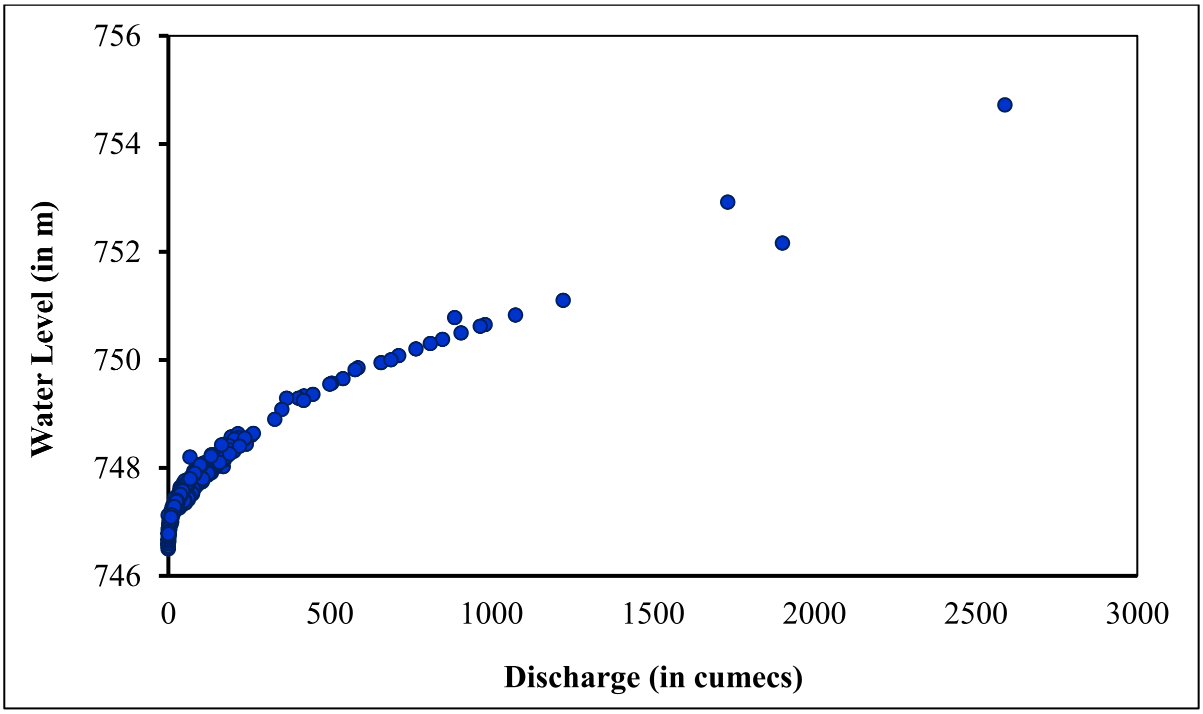

Fig. 4. Relationship between water level and discharge data at Akkihebbal station (**Source:** CWC)

High flood level (HFL) data of CWC observation stations across the CRB represents the maximum water level reached during flood events at specific locations (Table 2) and serves as a critical parameter in hydrologic and hydraulic studies. In this dataset, HFL values range from a minimum of 2.685 m at Gopurajapuram to a maximum of 1496.62 m at Kukkalthurai, with an average HFL of approximately 433.15 m and a median of 335.12 m. This broad range reflects the varying topographic and hydrologic conditions within the basin. HFL data is essential for validating and calibrating hydrologic models, ensuring accurate simulation of peak flows and flood extents. It plays a vital role in designing infrastructure such as dams, levees, bridges, and urban drainage systems by providing reference points for extreme flood scenarios. Furthermore, HFL values support flood forecasting systems, emergency response planning, and flood risk mapping, enhancing the resilience of communities against flood hazards. As climate change alters rainfall patterns and intensifies weather extremes, consistent monitoring and analysis of HFL data become increasingly important for adaptive water resource management in the CRB.

Table 2. CWC observation stations with HFL values recorded in 2022 (**Source:** CWC)

Sr. No.	Station Name	Station Code	HFL (in m)
1	Akkihebbal	CCR00B7	752.56
2	Alandurai	ALANDURAI	447.1
3	Annavasal	CCA21G5	5.485
4	Balasamudram	BALASAM	245.16
5	Belur	039-CDBNG	945.21
6	Bendrahalli	CCN00J5	638.03
7	Bettadamane	038-CDBNG	901.17
8	Biligundulu	CC000N7	264.74
9	Chikkamalur	0048-CDBNG	650.87
10	Chikkarasinakere	0046-CDBNG	618.075
11	Chunchunkatte	CC000V7	757.35
12	Elunuthimangalam	CCF00A4	131.99
13	Gandhavayal	CCG20C8	94.79
14	Gopurajapuram	CCA32D2	2.685
15	Hogenakkal	CCS00A9	256.6
16	Hommaragalli	0043-CDBNG	666.86

17	Jannapura	040-CDBNG	921.26
18	K.M.Vadi	CCQ00E9	769.7
19	Kodumudi	CC000I7	127.83
20	Kokkedoddy	0045-CDBNG	374.25
21	Kollegal	CC000R5	628.52
22	Kottathara	KOTTATHARA	292.5
23	Kudige	CC000Y5	184.88
24	Kudlur	CCK00L9	437.33
25	Kukkalthurai	KUKKALTHURAI	1496.62
26	Lakshmananpatty	LAKSHMN	213.66
27	M.H.Halli	CCR00M8	843.4
28	Menangudi	CCA23N4	6.92
29	Mukkodlu	0044-CDBNG	882.55
30	Musiri	CC000G4	84.3
31	Muthankera	CCP00T8	710.86
32	Nallamaranpatty	CCD00D5	130.88
33	Nallathur	CCA12G3	4.87
34	Napoklu	0035-CDBNG	865.79
35	Nellithurai	CCG00Q8	306.87
36	Odandhurai	ODANDHURAI	329.55
37	Peralam	CCA22S5	8.56
38	Porakudi	CCA20G5	5.33
39	Pudunagara	0047-CDBNG	588.15
40	Sakleshpur	CCR00U6	892.5
41	Savandapur	CCG00E3	184.88
42	Sevanur	CCI00C4	173.8
43	T.Bekuppe	T. BEKUPPE	610.52
44	T.K.Halli	CCM00B9	588.05
45	T.Narsipur	CCP00B1	640.36
46	Thandalaiputhur	THANDALAI	98.83
47	Thengudi	CCA31N6	8.43
48	Thengumarahada	CCGI0E9	340.68
49	Thevur	CCH00C3	172.57

50	Thimmanahalli	CCRI0F7	908.775
51	Thoppur	CCJ00I2	324.33
52	Thoreshettihalli	0042-CDBNG	627.1
53	Urachikottai	CC000K5	165.95
54	Varanavasi	VARANA	59.92

3.3. Evaporation data

Evaporation data is a critical component of hydrological modelling, as it represents the loss of water from open water bodies, soil surfaces, and vegetation due to atmospheric demand. This process plays a significant role in the water balance of a catchment, influencing river flows, groundwater recharge, and overall water availability. Accurate evaporation measurements are essential for understanding hydrological cycles and improving model predictions. It is typically estimated using meteorological parameters such as temperature, humidity, wind speed, and solar radiation. Direct methods, like pan evaporation measurements, provide observed data, while indirect methods, such as the Penman-Monteith or Thornthwaite equations, estimate evaporation using climatic variables.

In hydrological modelling, evaporation data helps refine model simulations by accounting for water losses, thereby improving the accuracy of runoff and water resource assessments. Reliable evaporation estimates are crucial for managing reservoirs, irrigation planning, and assessing the impacts of climate change on water resources. The provided graph illustrates the daily evaporation (in mm) data at the Akkihebbal station located within the CRB, spanning the period from 2012 to 2021 (Fig. 5). This time-series plot reflects the evaporative behaviour of the atmosphere, an important parameter for understanding hydrological balance in the CRB. Daily evaporation values exhibit substantial variability, with most values clustering below 5 mm/day, interspersed with occasional sharp spikes reaching above 20 mm/day, and a few outliers exceeding 40 mm/day, particularly around 2013 and 2015. These peaks may result from short-term climatic anomalies or sensor-related issues and warrant further quality control validation. From 2016 onwards, the data appears more consistent with lower volatility, suggesting either improved instrumentation or a relatively stable climatic phase. Evaporation is influenced by meteorological parameters such as temperature, wind speed, solar radiation, and relative humidity, all of which can fluctuate seasonally and interannually across the basin.

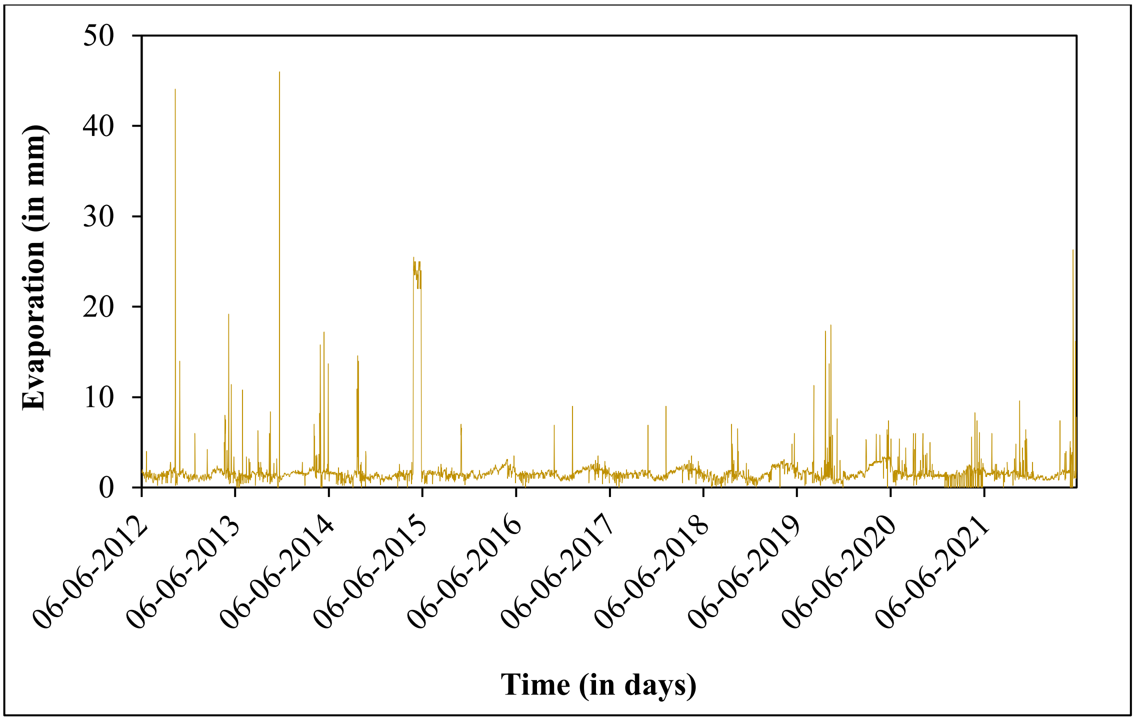

Fig. 5. Evaporation data at Akkihebbal station

(**Source:** CWC)

3.4. Groundwater data

The CRB has been the subject of extensive groundwater studies due to its critical role in regional water resources in Peninsular India. The ground water level data at various monitoring stations in CRB for the year 2019 is shown in Fig. 6, based on data obtained from the Central Groundwater Board (CGWB), India. The groundwater levels are categorized into five depth ranges, revealing significant spatial variation across the basin. Shallow groundwater levels (0.01 - 3.38 m) are predominantly observed in the northwestern and some central parts of the basin, indicating better recharge conditions or lower extraction. In contrast, deeper groundwater levels exceeding 23.96 meters are mainly concentrated in the southeastern and northeastern regions, possibly reflecting over-extraction, reduced recharge, or geological constraints. This spatial variability highlights the need for region-specific groundwater management strategies within the CRB to ensure sustainable water resource utilization. These assessments are crucial for understanding the spatial distribution of groundwater resources and guiding sustainable management practices (Arulbalaji et al., 2019).

In regions like the Berambadi catchment within CRB, intensive groundwater abstraction has led to significant hydrological changes. Studies indicate a well-connected aquifer system, both laterally and vertically, which has evolved from a predominantly lateral to a vertically dominated flow system due to high abstraction rates. This shift has implications for baseflow contributions to rivers, potentially affecting downstream water availability. Continuous monitoring of groundwater levels and abstraction rates is essential to inform management strategies aimed at ensuring the sustainability of water resources in the basin (Collins et al., 2020).

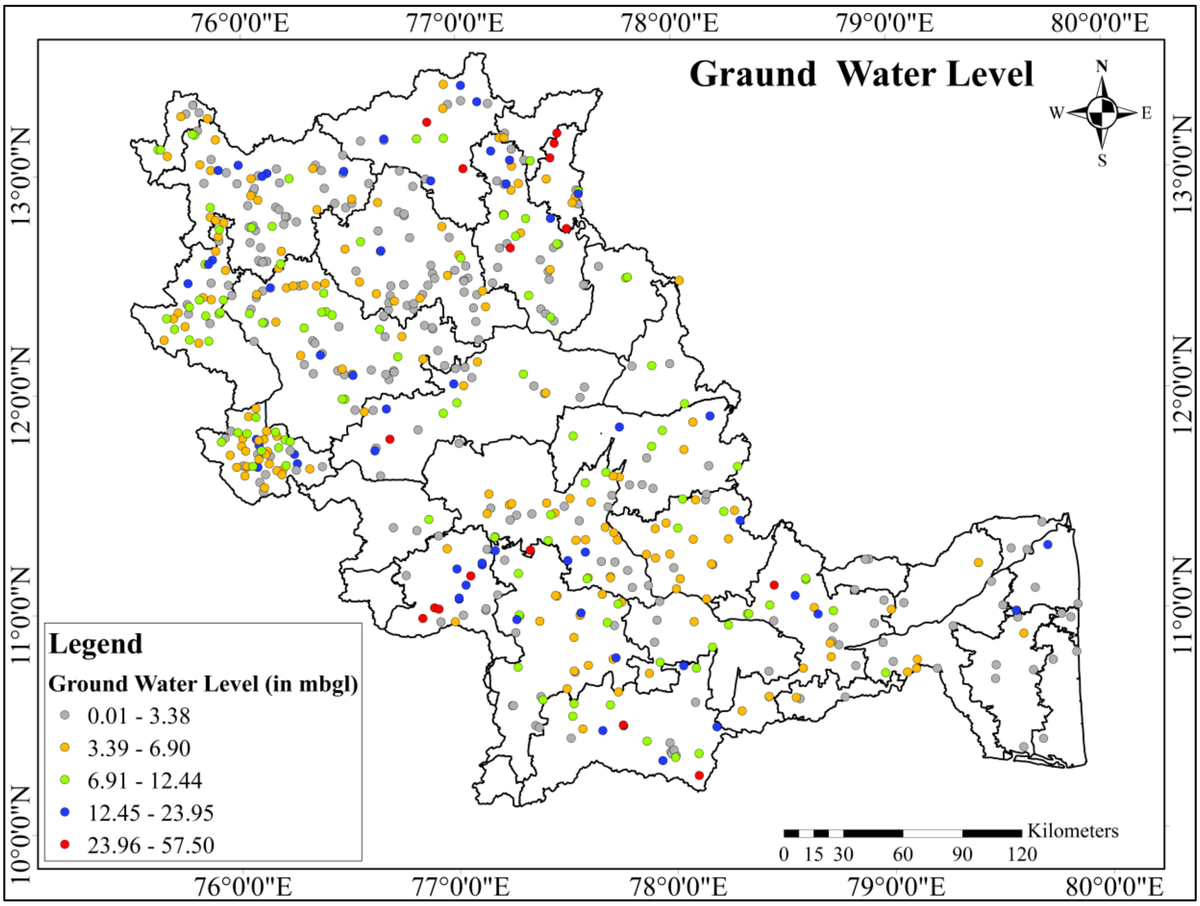

Fig. 6. Ground water level data at various monitoring stations in CRB (Year: 2019) (**Source:** CGWB)

Fig. 7 illustrates the temporal variations in groundwater levels across different months and years within the CRB, based on selected years, i.e., 1996, 2001, 2006, 2011, 2016, and 2019. The data, plotted for the months of January, April, May, August, and November, highlights both seasonal and inter-annual fluctuations in groundwater depth. Notably, most years exhibit a pronounced peak in groundwater levels during May, which may correspond to pre-monsoon withdrawal or recharge dynamics. For instance, the year 2019 shows the highest recorded average level (~10.6 m) in May, indicating possible anomalous hydrological activity or excessive extraction. In contrast, 2016 shows a consistent rise in groundwater levels from January to November, suggesting sustained recharge or reduced abstraction. While earlier years such as 1996 and 2001 display greater seasonal variability, recent years tend to exhibit smoother transitions, though with distinct peaks. These trends underscore the influence of monsoonal rainfall, agricultural water demand, and groundwater management practices on the basin's aquifer dynamics, and reflect the complex hydrogeological responses of the CRB to climatic and anthropogenic factors.

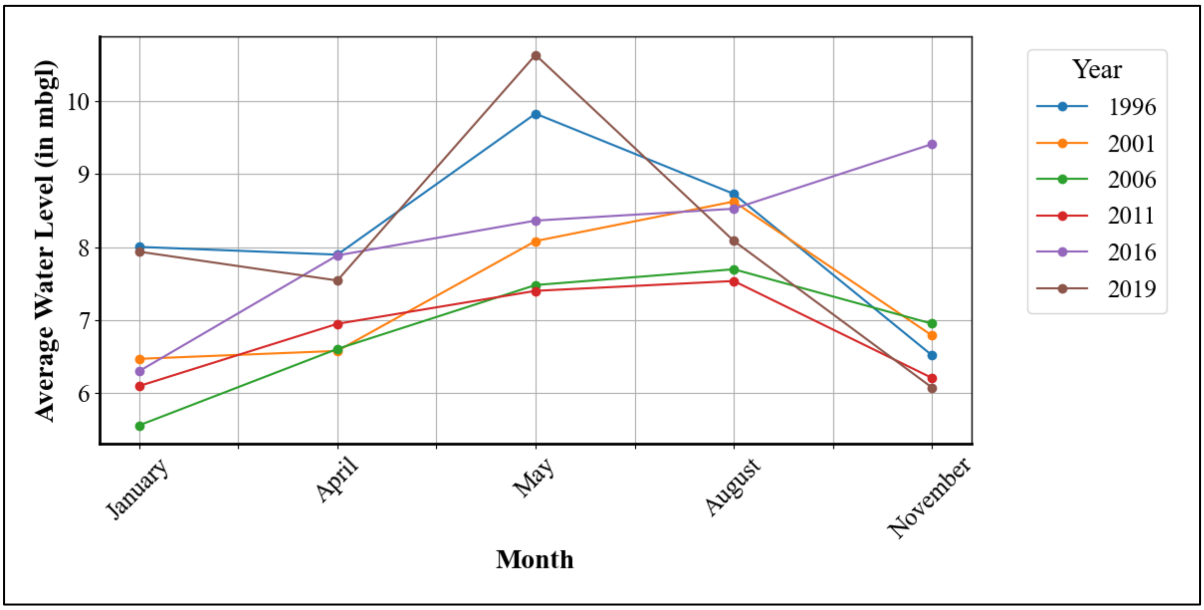

Fig. 7. Temporal variations in groundwater levels across different months and years within the CRB

(**Source:** CGWB)

3.5. Sediment load data

Sediment load data is a crucial parameter in hydrological modelling, providing insights into erosion, sediment transport, and deposition processes within a river basin. It refers to the total amount of sediment, i.e., both suspended and bedload, carried by a river or stream over time. Sediment load data is essential for understanding watershed dynamics, assessing soil erosion rates, and predicting sedimentation in reservoirs, floodplains, and river channels (Hamidifar et al., 2024).

In hydrological modelling, sediment load data is used to evaluate the impact of land use changes, climate variability, and human interventions such as dam construction and deforestation on sediment transport. Models incorporating sediment data help in designing effective soil conservation measures, managing sedimentation in water bodies, and improving riverine ecosystem health. Accurate sediment load measurements, typically obtained from sediment sampling and turbidity sensors, enhance the reliability of hydrological models and support sustainable water resource management. The temporal variation of sediment load at the Akkihebbal station, as recorded by the CWC, India, from 2014 to 2023, is depicted in Fig. 8. The data exhibit predominantly low sediment load values across the observed period, punctuated by episodic spikes that indicate short-duration, high-magnitude sediment transport events. These abrupt increases are most noticeable during mid-2016, mid to late 2018, and again between 2020 and 2022, suggesting the influence of monsoonal floods or intense rainfall events during these periods. Such spikes are likely driven by enhanced surface runoff and upstream soil erosion. The overall pattern reflects the non-uniform nature of sediment transport in the basin, influenced by seasonal hydrological variability, catchment land use, and possible extreme weather events. This analysis highlights the importance of continuous sediment monitoring for effective river basin management and flood risk assessment.

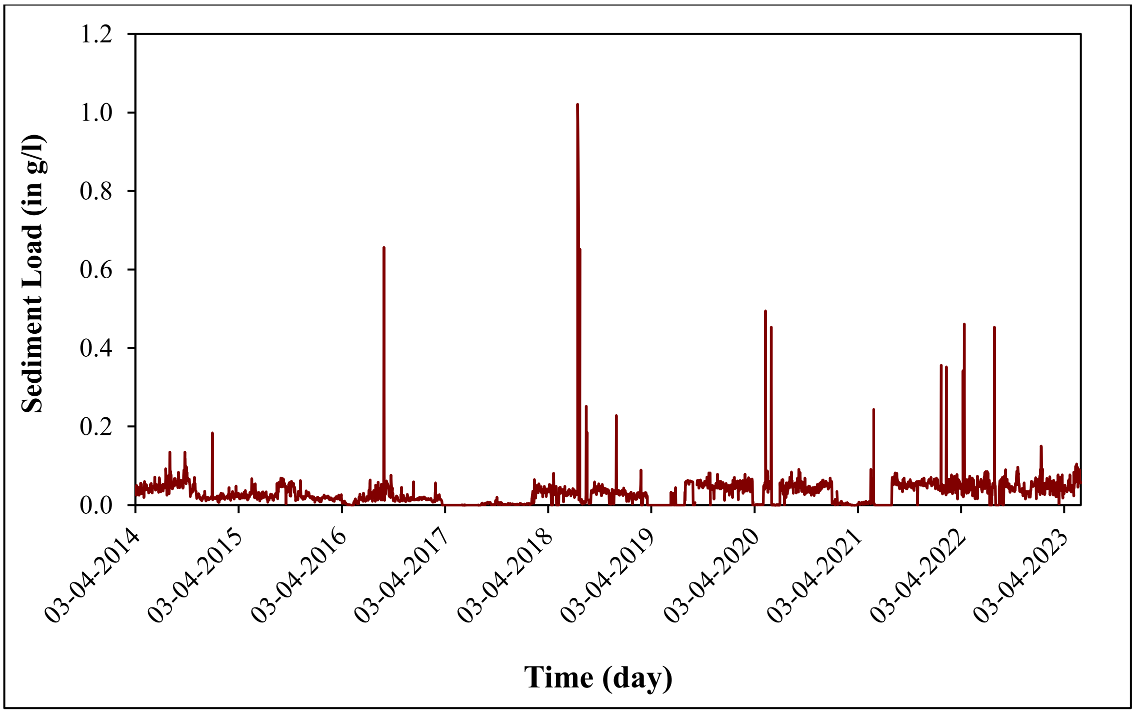

Fig. 8. Sediment data at Akkihebbal station

(Source: CWC)

3.6. Implications for water resource management, flood control, or other applications

Hydrological data plays a critical role in decision-making processes related to water resource management, flood control, agriculture, and environmental sustainability. Accurate and continuous data on river discharge, groundwater levels, and reservoir storage is essential for efficient planning and risk mitigation. Some key implications of the hydrological data are described below.

3.6.1. Water resource management

3.6.1.1. Reservoir and irrigation planning

Reliable hydrological data helps in optimizing reservoir operations, irrigation scheduling, and water distribution for agriculture and drinking water supply.

3.6.1.2. Drought management

Long-term water level and flow data are essential for assessing drought severity, ensuring water conservation, and implementing efficient water use policies.

3.6.1.3. Interstate water disputes

In river basins like the Cauvery, hydrological records support fair water allocation and legal settlements between states.

3.6.2. Flood control and disaster preparedness

3.6.2.1. Early Warning Systems

Real-time monitoring of river discharge and rainfall intensity helps predict flood events and issue timely warnings to vulnerable areas.

3.6.2.2. Infrastructure Design

Data on historical floods and peak flow conditions informs the design of dams, levees, and drainage systems to minimize flood damage.

3.6.2.3. Urban Flood Management

In cities, hydrological models based on reliable data assist in designing stormwater drainage systems to prevent urban flooding.

3.6.3. Hydrological modelling and climate impact studies

3.6.3.1. River Basin Management

Continuous hydrological data supports modelling of river flow patterns, essential for sustainable water governance and conservation efforts.

3.6.3.2. Climate change assessments

Long-term hydrological records help detect trends in precipitation, evaporation, and water availability, aiding climate resilience strategies.

3.6.3.3. Sedimentation and erosion studies

Monitoring river flow and sediment transport supports soil conservation and riverbank stabilization measures.

3.6.4. Industrial and Hydropower Applications

3.6.4.1. Hydropower generation

Water flow data is crucial for optimizing hydroelectric power plants and ensuring efficient energy production.

3.6.4.2. Industrial water use

Many industries depend on river water for operations, making reliable hydrological data essential for sustainable extraction and wastewater management.

4. Challenges and Limitations

The hydrological data for the CRB, sourced from the CWC and CGWB, contains substantial temporal and spatial gaps. Missing records are observed at multiple locations, with durations ranging from a few days to several months or even years. This discontinuity limits the reliability of hydrologic analyses and affects the accuracy of model calibration, flood forecasting, and water resource planning. Furthermore, the CGWB provides groundwater level data only for five specific months, i.e., January, April, May, August, and November, resulting in an incomplete annual dataset that hampers continuous groundwater trend assessment. In addition, the absence of temporal HFL records restricts the ability to evaluate historical flood variability and conduct comprehensive extreme event modelling.

5. Summary and Recommendations

Gauge, discharge, evaporation, and sediment load data are fundamental components of hydrological modelling, each playing a crucial role in understanding and predicting river basin dynamics. Gauge and discharge data help in assessing water levels and flow volumes, essential for flood forecasting, water resource management, and infrastructure planning. Evaporation data contributes to understanding water losses from different surfaces, influencing hydrological balance and model accuracy. Sediment load data provides insights into erosion and deposition processes, which are critical for managing river morphology and maintaining water quality. However, the presence of missing data in the CRB hydrological records, spanning different time intervals and locations, poses challenges to data continuity and model reliability.

Addressing these data gaps is essential for improving hydrological predictions and resource management.

To enhance the reliability of hydrological models, future research should focus on advanced data imputation techniques to address missing records in gauge, discharge, evaporation, and sediment load datasets. Implementing high-frequency monitoring systems and remote sensing technologies can improve data coverage and accuracy. Additionally, integrating machine learning and artificial intelligence approaches for predictive modelling can enhance the estimation of missing data points. Collaborative efforts between research institutions and government agencies should prioritize the establishment of well-distributed, automated monitoring stations to ensure continuous and accurate data collection.

Effective water resource management and flood risk mitigation require robust hydrological datasets. Policymakers should invest in modernizing data collection infrastructure, including real-time monitoring systems and cloud-based data management platforms. Standardized protocols for data collection, validation, and sharing should be established to ensure consistency across different regions and stakeholders. Additionally, incorporating sediment load assessments into watershed management strategies can help mitigate erosion and reservoir sedimentation, improving long-term water availability. Addressing these data-related challenges through policy and technological advancements will enhance hydrological modelling accuracy, leading to more informed decision-making for sustainable water resource planning and disaster risk management.

6. Significance of the hydrological data report

A hydrological data report is crucial for river basin management planning as it provides comprehensive insights into water availability, flow patterns, and seasonal variations (Fig. 9). This data helps in assessing water resources, predicting floods and droughts, and optimizing water allocation for various needs, including agriculture, industry, and domestic consumption. It also supports the design of infrastructure such as dams, reservoirs, and irrigation systems while ensuring ecological balance and sustainability. Additionally, hydrological data aids in climate change impact assessments and policy formulation, enabling informed decision-making for long-term water resource management and conservation in a river basin.

Fig. 9. Significance of the hydrological data modelling

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