

Hydrometeorological Network for Water Resources Development in Karnataka State

By

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Abstract : *Water is most essential resource required for the existence and prosperity of mankind. With the development of civilization and increase in population, water demands for irrigation, hydropower generation, industrial and other uses are ever-increasing. It is essential that available water resources should be accounted properly to conserve and use it for maximum benefit and optimal development.*

For proper water flow monitoring and planning of River valley projects, an adequate net work of hydrological and hydrometeorological observation stations in each river basin is pre-requisite.

The said net work system in Karnataka State is discussed in this paper.

Introduction

Water is most essential natural resource required for existence. We can trace back the history that for this reason, all the ancient civilizations were started near the river banks.

With the advance of civilization and population explosion there is ever increasing demand for water. This has resulted in imbalance in the various components of hydrological cycle. The main source of water is by precipitation, which contributes both for surface water and ground water. Rainfall which is a principal source, is not uniformly distributed all over in space and also not spread over all seasons. As such the occurrence and distribution of water as a result

of large parts face drought conditions while some portions have water logging and flood problems. To have maximum benefits out of this inequality a sound knowledge of water availabilities is essential. This would facilitate in proper planning and utilisation of water resources.

The rainfall records should be adequate to provide reasonable estimates of the average precipitation over the area under study. Adequate net work of raingauge is pre-requisite and the area for such studies is considered to be the river basin. For time distribution of rainfall, data of self recording raingauges are required. Atleast 10% of the raingauges network equipped with self recording raingauge should form the network. Other

hydrometeorological parameters like evapo-transpiration, temperature, wind velocity etc., are important in hydrometeorological studies.

For proper harnessing and utilisation of the water resources through dams and reservoirs some basis studies relating to the above parameters are necessary. Long term flow data of rivers/streams are required which are not generally available for many of the river basins. Only recently the flow measurements have been started and data is available. For estimating and building up the flow series long period meteorological data can be utilised. Adopting special techniques developing models such flows can be assessed. The study of meteorological data is a science known as hydrometeorology. Hitherto, water resources projects were planned on a project oriented approach. But now the concept is changing towards comprehensive basin planning. It has become necessary to prepare long range plans for a rational integrated development of water resources for optimal and economic use of

available water resources. The environmental and social aspects has become more important and the significance of inter-relationships among diverse projects has increased. Hence planning should be more explicitly taking to account a large number of variables and functions.

An integrated plan must identify with factors and inter relationships that form the basis for planning and implementations. Thus for proper and optimal utilisation of available water resources in a basin collection of authentic and reliable hydrological data is of great importance for several hydrometeorological studies.

River System in Karnataka

The total geographical area by Karnataka is 191773 Sq. kms. There are seven river basin with their tributaries draining the State. The name of River basins, the area drained by them and the average annual yield of these rivers, are given below :

Sl. No.	River system	Major River/Tributaries	Drainage Area in Sq. kms	Average Annual Yield in M. Cum.
1	2	3	4	5
1.	Krishna	Tungabhadra Ghataprabha Malaprabha Bhima	1,13,010	27,451
2.	Cauvery	Hemavathy Harangi Kabini Shimsha Arkavathy	36,130	10,980
3.	Godavari	Manjra	4,430	1,415
4.	West Flowing Rivers	Netravathy Sharavathy Aghanashini Bedthi Kali Varahi, etc.	24,533	56,600
5.	Uttara Pinakini	—	6,940	1,130
6.	Dakshina Pinakini	—	3,760	
7.	Palar	—	2,970	
		Total	<u>1,91,773</u>	<u>97,576</u>

Agriculture is predominantly the occupation of the State. Highest priority has been accorded to the water resources development i.e., Irrigation and Power development in the State. In this context proper assessment of water resources at the required site is vital and essential data for proper planning. The East flowing rivers Krishna, Cauvery and their important tributaries like Tungabhadra, Ghataprabha, Malaprabha, Vedavathy, Harangi, Hemavathy, Kabini, Shimsha etc., are sources for irrigating large semi-arid and arid areas.

The West flowing rivers take their origin in in Western ghats at elevations of 1000 to 1500 Metres and are major sources for Hydel power generation and are being exploited for power potential.

Agroclimatic Zones

The State has been divided into ten Agroclimatic regions based on a set of criteria. The criteria taken into account in defining the agroclimatic zones are :

- (a) Rainfall pattern quantum and distribution,
- (b) Soil type texture-depth and chemical quality,
- (c) Elevation and topography, and major crop and vegetation.

Hydrometeorological and Hydrological stations are established in all the different zones to obtain the data by the representative areas.

Raingauges

The most important activity for water resources development is hydrometeorological data collection and compilation. Rainfall data is the important and basic data required for any hydrological study.

Karnataka State has been maintaining raingauges since 1870 and publishing raingauge data since 1899. Rainfall data is available for 110 Stations since 1870. The longest rainfall

record is for 153 years (from 1835) for Bangalore followed by Mysore, Tumkur and Shimoga from 1837, Belgaum 1841. Dharwad 1844 and Bellary 1847. All the 19 District Head Quarters Stations have raingauge data for over 100 years.

India Meteorological Department started functioning in the State from 1894 and the publishing of rainfall data commenced from the year 1899.

The number of raingauges in the State was 349 in the year 1931 and the number of raingauges existed as on 1988 is 1437, shows a fourfold increase over that existed in 1931.

The Directorate of Economic and Statistics is the custodian of rainfall data in the State. The annual rainfall data are published in two parts. The first part contains the general, summary of rainfall conditions during the years. The II part consists of the normal and monthly rainfall recorded at 175 raingauge stations situated in Taluka Head Quarters and also the data of raingauges spread all over the State.

The distribution of raingauge as at present works to an average of 1 raingauge for about 133 Sq. kms. of the State. Although this average is almost highest for any State in India, there are some areas of the State where there are not sufficient number of raingauges. The network is being designed to have adequate raingauges in all the parts, covering the areas where the spatial distributions is uneven and of lesser density.

Government of Karnataka have proposed to install ordinary raingauges at all the Hobli Head Quarters numbering to 745 in the State. The work is taken up in a phased manner and would be completed by 1988-89. This would provide a very close network of raingauges, spread over all the parts of the State evenly. Rainfall data would be available for different agroclimatic areas. The rainfall data is very important for under-taking studies and analysis of hydrological problems.

The data of the ordinary raingauge stations are maintained by the District Statistical Officers and are transmitted to the Bureau of Statistics and Economics, Government of Karnataka, Bangalore. The Bureau publish the rainfall data of all the reporting stations. Rainfall data are being collected by State Government by agencies like P.W.D., Irrigation Department, Revenue Department, Forest Department, India Meteorological Department, Railways, Agriculture Department, Karnataka Power Corporation etc., also have their own raingauges. A number of ordinary raingauges are maintained at the Coffee or Tea Plantations in the State and many of them have rainfall data for several years. The records are maintained in the respective states.

Water Resources Development Organisation, Irrigation Department has established self-recording raingauges at 106 places and there are about 113 self-recording raingauges maintained by other Departments. Thus there are 219 self-recording raingauges totally in State.

Government of Karnataka has proposed to install self-recording raingauges at all the Taluka Head Quarters numbering to 175. The installation is almost nearing completion covering the entire State. Thus the network will be adequately strengthened. The charts from self-recording raingauges are analysed and the hourly rainfall is tabulated for each station.

Self-recording raingauge data will be useful to undertake short duration intensity frequency studies of rainfall for different areas of the State and carry out systematic analysis of part recorded rain storms. The self-recording raingauge records provide information of hourly rainfall as also rainfall over shorter periods of one hour and less upto 5 minutes. Such intensity data are useful for the study of flash floods, flood frequencies and estimation of design flood and probable maximum flood. Such studies are useful for the

design of hydraulic structures whose safety is of great importance without risks.

Besides the quantitative increase of net work of raingauges, the accuracy and reliability of the data depends much on the proper maintenance and scientific and precise collection of data. Hence, it is felt desirable by the Government of Karnataka that an agency for collection and compilation of rainfall data is very important and necessary. Hence, Water Resources Development Organisation, Irrigation Department, Government of Karnataka having a separate hydrology wing with Gauging Divisions exclusively for Hydrological observations, is now entrusted with the work of taking over all raingauges in the State for maintenance and collection of data for effective functioning and ensuring the reliability of data.

The Water Resources Development Organisation is collecting the hydrologic data, water use data and other data of hydrological and hydrometeorological network stations in the State.

Organisation

Water Resources Development Organisation under the Irrigation Department, Government of Karnataka is entrusted with work of investigation of all Major and Medium, irrigation projects in the State and also some minor irrigation projects, deals with Inter-state waters. There is a separate Hydrology wing at the Central Office, where the field data is processed, analysed and compiled and also the important hydrological studies are made.

There are two investigation circles. Under each circle, there is one Gauging Division exclusively for the Hydrological studies. The establishment of hydro-meteorological network, collection and processing of the field data are undertaken by these divisions. Each division has 4 Gauging Sub-divisions for the field observations, maintenance and installations.

Similarly the gauge and discharge measurements of rivers and streams are also carried out by State Government.

At the Hydrological observation sites hydrological data such as water levels, discharge are collected regularly and also sediment analysis is carried out by W.R.D.O. At the hydrometeorological stations, rainfall, temperature, wind speed, evaporation etc., are collected.

Hydrometric Stations

The details of network of stations in the State is given below :

Table 1 : Basin-wise breakup of Gauge and Discharge sites

Sl. No.	Name of the basin	Catchment Area in Sq. kms.	Gauge sites	Gauge & discharge sites
(1)	(2)	(3)	(4)	(5)
1.	Godavari Basin	4,405	1	5
2.	Krishna (excluding Tungabhadra)	56,263	15	42
3.	Tungabhadra	57,008	11	30
4.	Cauvery basin	34,273	10	32
5.	West Flowing Rivers	26,214	28	27
6.	Uttarapinakini basin	7,146	1	2
7.	Dakshina Pinakini	3,638	—	—
8.	Palar Basin	2,826	—	—
	Total	1,91,773	66	138

Hydrometeorological Stations

In addition to the Hydrometeorological observatories established by the India Meteorological Department, Water Resources Development Organisation has established 51 Hydrometeorological Stations in the State and the installation is being expanded in a phased manner. The Stations are located at Major and Medium Projects sites, command areas and also at places of special studies. It is now

Gauging of rivers and streams were taken up by Gauging Sub-Divisions on a systematic basis are scientifically using current meter and other measuring devices.

For most of the sites, the gauged data is available for over 10 years.

There are 138 current meter gauging sites in the State maintained by WRDO. At some sites only stages are observed and discharges are computed by slope area method. The details of river gauges sites are given in the following table 1. Central Water Commission is also gauging some of the important rivers in State.

being installed at all District places and also important Towns to have a uniform spatial distribution to enable to obtain the data of representative hydroclimatical areas and also in the command area of the major projects.

Hydrometeorological stations comprises of the following equipments :

- (1) Ordinary raingauge
- (2) Self recording raingauge

- (3) Stevenson Box with maximum & Minimum thermometers and dry and wet bulb thermometers
- (4) Pan Evaporimeter
- (5) Wind Anemometer
- (6) Wind Direction Indicator
- (7) Sunshine Recorder
- (8) Thermohygrograph

The programme of expanding the establishment of H.M. Stations is taken up on a phased programme to cover the areas where the distribution is inadequate and also at important project area commands etc.

The data on the existing use of water for growth of different crops, humidity, temperature, sunshine hours, wind speed etc., are required to scientifically work out the optimum water requirement for different crops in different seasons.

Table 2 gives the details of locations of the Hydrometeorological stations. The locations of the H.M. Stations are shown in plate No. 1.

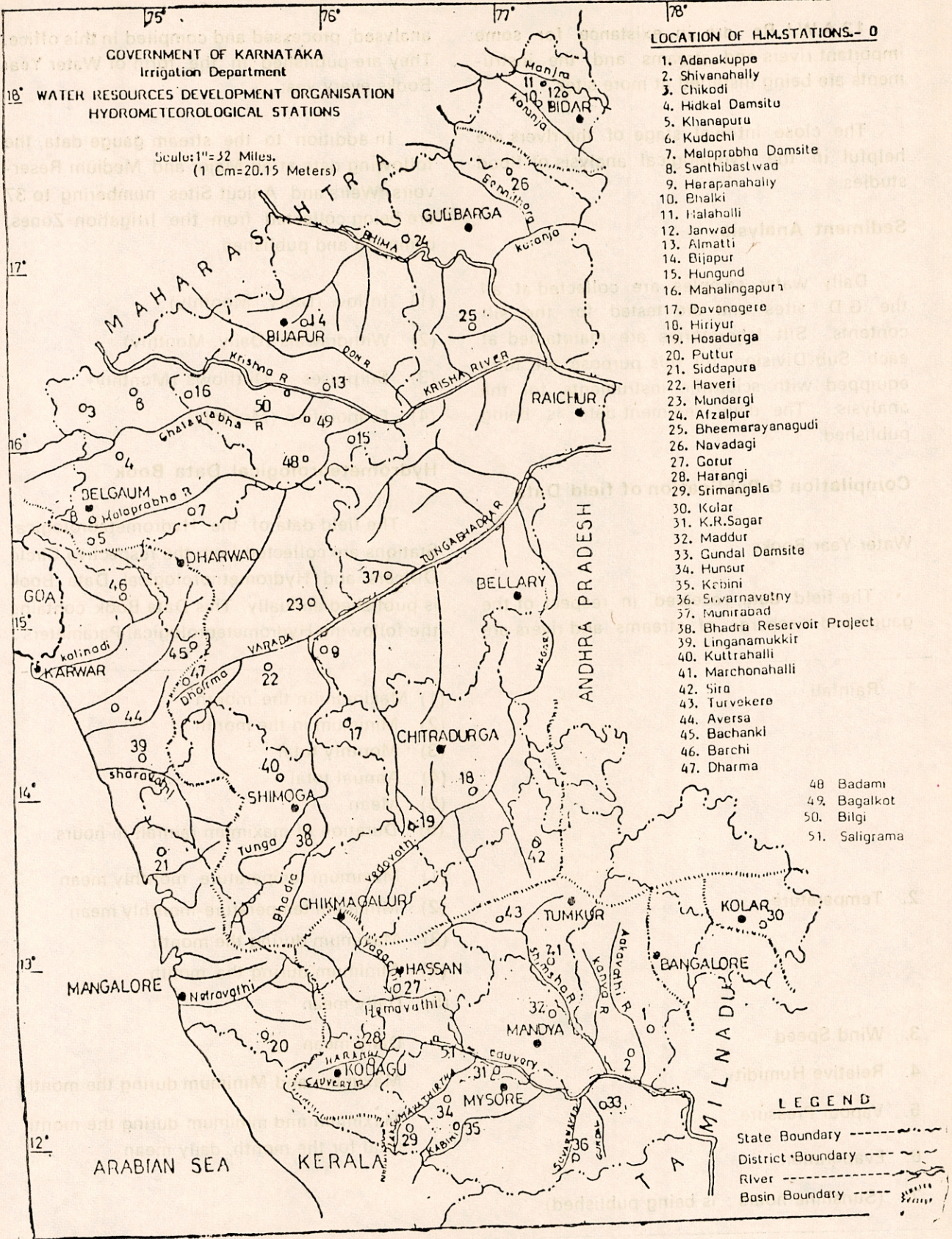
Table 2 : Hydrometeorological Stations in Karnataka

Banglore District	1. Adanakuppa
	2. Shivanahally
Belgaum District	3. Chikkodi
	4. Hidkal Dam site
	5. Khanapura
	6. Kudachi
	7. Malaprabha Dam site
	8. Santhibastwad
Bellary District	9. Harapanally
Bidar District	10. Bhalki
	11. Halahalli
	12. Janwad
Bijapur District	13. Almatti
	14. Badami

	15. Bagalkot
	16. Biligi
	17. Bijapur
	18. Hungund
	19. Mahalingapura
Chitradurga District	20. Davanagere
	21. Hiriyyur
	22. Hosadurga
Dakshina Kannada District	23. Puttur
	24. Siddapura
Dharwad District	25. Haveri
	26. Mundargi
Gulbarga District	27. Afzalpur
	28. Bheemarayanagudi
	29. Navadagi
Hassan District	30. Gorur
Kodagu District	31. Harangi
	32. Srimangale
Kolar	33. Kolar
Mandya District	34. K.R. Sagar
	35. Maddur
Mysore District	36. Gundal Dam stte
	37. Hunsur
	38. Kabini
	39. Saligramm
	40. Suvaranavathy
Raichur District	41. Munirabad
Shimoga Distrct	42. Bhadra Reservoir Project
	43. Linganamukki
	44. Kuttrahalli
Tumkur District	45. Marchonahalli
	46. Sira
	47. Turuvekere
Uttara Kannada District	48. Aversa
	49. Bacharki
	50. Barchi
	51. Dharma

Automatic Water Level Recorder

A continuous graphic record of rise or fall of water level with respect to time is obtained by installing these Automatic Water Level Recorders.



12 A.W.L.Rs are in existence for some important rivers and streams and the instruments are being installed at more sites.

The close interval stage of the rivers are helpful in the hydrological analysis of flood studies.

Sediment Analysis

Daily water samples are collected at all the G.D. sites and are tested for the silt contents. Silt laboratories are maintained at each Sub-Division for this purpose, are fully equipped with scientific instruments for the analysis. The daily sediment data is being published.

Compilation & Publication of field Data

Water Year Books

The field data received in respect of the gauge and discharge of streams and rivers are

analysed, processed and compiled in this office. They are published in the form of Water Year Books every year.

In addition to the stream gauge data, the following data at all Major and Medium Reservoirs, Weirs and Anicut Sites numbering to 37 are being collected from the Irrigation Zones, compiled and published.

- (1) Inflow (Daily, Monthly)
- (2) Withdrawals (Daily, Monthly)
- (3) Surpluses + Outflows (Monthly)
- (4) Evaporation (Monthly)

Hydrometeorological Data Book

The field data of the Hydrometeorological Stations are collected from the respective Circle Officers and Hydrometeorological Data Book is published annually. This Data Book contains the following Hydrometeorological Parameters :

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| 1. Rainfall | (1) Maximum in the month
(2) Minimum in the month
(3) Monthly total
(4) Annual total
(5) Mean
(6) Duration of maximum rainfall in hours |
| 2. Temperature | (1) Maximum temperature monthly mean
(2) Minimum temperature-monthly mean
(3) Maximum during the month
(4) Minimum during the month
(5) Daily mean |
| 3. Wind Speed | Daily mean |
| 4. Relative Humidity | Maximum and Minimum during the month |
| 5. Vapour Pressure | Maximum and minimum during the month |
| 6. Evaporation | total for the month, daily mean |
| 7. (Sunshine hours : is being published) | |
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Water Resources Development Organisation, Irrigation Department, Karnataka State has thus created a large network of Hydrological and meteorological observations. The data collection activity is based on manual observations and storage is also in the form of records which is very much put to use both by the State and Central Organisations. There is great need to modernisation of data storage

and retrieval, requiring support from external assistance through C.W.C., HILTECH, NIH etc. This would enable to have properly designed data collection network, to provide scientifically based hydrological and Meteorological data of required quality and to have a proper data base, which can be conveniently made use of by the planners and users.

