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IDENTIFICATION OF FORMATS FOR COLLECTION OF DATA FOR DROUGHT STUDIES

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PREFACE

Effective planning and management of any water resources project small or big, depends to a large extent on the availability of timely and accurate flow of hydrological data and allied information. These data are the key inputs in assessing the hydrologic problems, their impacts and taking remedial decision. A large amount of water resources and allied data are presently being collected by a number of departments/agencies both at Central and State levels. Many times it is not known as to what data is being collected, by which agency and in what format and sometimes these data are not directly accessible to users in time. This also at times leads to duplication of efforts. So there is a need to have a standard format for collecting the data at national as well as state level at specified frequency of collection.

This report describes about the data required for drought analysis. The planning of station network as well as ways of collection of data, their handling and presentation are discussed in brief. Application of computer in data storage and retrieval system proves to be very helpful in this context. Format of data collection for computer storage adopted by various agencies are given. Besides, the available formats of collection of different data, used by different state/central agencies were collected, their drawbacks are discussed and the modified format for each type of data collection are also suggested.

This report entitled "Identification of Format for Collection of Data for Drought Studies" is a part of research work of 'Drought Studies Division' of the Institute. The study has been carried out by Shri V K Lohani, Scientist 'C'; Shri Sudhir Kumar Goyal, Scientist 'B' and Shri Anupam Srivastava, Ex-S.R.A. under the guidance of Dr. G C Mishra, Scientist 'F'. The manuscript has been typed by Mrs. Mary D'Souza, Stenographer of the Division.

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Abstract

Basic hydro-meteorological data are essential for planning and management of water resources projects and therefore are collected over the years with enormous effort and expenditure. For the analysis of drought, those data which are conventionally stored in registers and files without a proper inventory are needed. Often very little effort is put in for their documentation in a scientific manner, resulting in loss/damage to the data, their limited use, and non-availability in time. Besides, data in unprocessed form is of limited use. Hence processed data in the desired form, known as informations are of real importance to the end user.

In this report data required for the drought analysis are discussed. The definitions of drought, problem of drought in India, and type of drought are also discussed. The planning of station network as well as ways of collection of data, their handling and presentation are discussed in brief. Application of computer in data storage and retrieval system proves to be very much helpful in present context. Format of data collection for computer storage adopted by various agencies are given. Besides, the available formats of collection of different data, used by different state/central agencies were collected, their drawbacks are discussed and the modified format for each type of data collection are also suggested. The existing formats for data collection are presented in Appendix I, II, III & IV for different parameters and the modified formats for all these parameters are presented in Appendix V.

INTRODUCTION

1.1 General : Hydrometeorological analysis form an important and integral part of hydrological research. The hydrometeorological analysis comprises of a wide range of studies for providing input for water resources estimation of design storm for determining design flood for hydraulic structures. And since nowadays country is facing a problem of drought, so hydrometeorological analysis is essential to estimate the problem of drought in past and to provide control measure for drought in future. Over the years, drought impacts have been felt in agriculture, energy production, pollution, recreational facilities and other such activities which ultimately reflect on the economy of a nation. The problem of drought is a global phenomenon. World Meteorological studies indicate that in recent past (1968 to 1979-80) severe droughts have affected African sahal, parts of India, part of Brazil, Queensland in Australia, Central America and Mexico.

1.2 Nature and extent of problem : Water even though found abundantly on earth is scarcely available to all for satisfying the basic necessities of life at all times and is becoming one of the most precious commodities. The demand for water has been steadily increasing with industrialisation and with the population explosion.

The effective planning and management of any water resources project small or big, depends to a large extent on the availability of timely and accurate flow of hydrological data and allied information. These data are the key inputs in assessing the hydrologic problems, their impacts and taking remedial decision. As an example, regular and timely data are required for impact assessment and mitigation of disasters like droughts and floods for effective management of water resources projects and solving other hydrological problems like water logging, drainage etc. A large amount of water resources and allied data are presently being collected by a number of departments/ agencies both at Central and State levels. Many times, it is not known as to what data is being collected by which agency and in what format and sometimes these data are not directly accessible to users in time. This also at times lead to duplication of efforts. So there is a need to have a standard format for collecting the data at national as well as state level at specified frequency of collection.

1.3 Present status of data collection in India : The primary object of any data collection programme is to collect the data by using suitable available techniques, process it in a presentable form and store it for future use. Most of the hydrological data collection activities are still based on manual observations. Also, at present the system of transfer of data from place of collection to place of final storage is in a very primitive stage in India. The recording, processing and scrutiny of data are being done manually.

Inspite of technological advancement and improvement on hydrological network, certain deficiencies in data are still noticed mostly due to lack of proper instrumentation. The conventional instruments do not have the necessary range of working under extreme conditions like high flood, heavy storm, low flow etc. Besides they could not be located in accessible areas because of their incapability to be operated by remote control.

These data, collected manually by field observers or termporarily or part time employed persons in the field, and from the field office,data are sent to sub-divisions or sub-offices by messenger or surface mail where computations are performed manually to process data and record it. The data are further transmitted by surface mail or messenger to the head quarters or to the place where data are stored. Normally, there is considerable time lag for the data to reach at the head office or head quarters in the existing systems of data collection. In some of the cases, where rainfall and river gauge data are required instantaneously or at short interval, these data are transmitted by Telex, Telegram and Telephone to the required place where regular record is maintained.

There is no uniform format and system of data storage. The most common form of data storage is to store data on data sheets and registers. Various agencies have their own format of data recording and storage. Another form of data storage and transmission system is in the form of compiled water year books, which is again not so common and considerable time lag exists in preparation of water year books.

With the development of computer facilities in the country, the state and central organisations have started thinking of storing data on computer or micro-computer. The organisations like CWC, CGWB, IMD & NRSA, DST etc. have started using computer for data storage, processing and retrieval.

2.0 DROUGHT

2.1 Definition of Drought - Drought is lack or insufficiency of rain for an extended period that causes a considerable hydrologic (Water) imbalance and consequently water shortage, crop damage, stream flow reduction and depletion of ground water and soil moisture. It occurs when evaporation and transpiration (the movement of water in the soil throught plants into the air) exceeds precipitation for a considerable period (Framji 1986).

The term drougnt is generally taken as a period of abnormal dry spell of weather,sufficiently prolong due to lack of rain. A drought results form a combination of climatic and human factors. Irrational, if not imprudent, human activities, poor cultivation practices, deforestation, overgrazing, overuse of marginal lands are some of the culpable human factors contributing to the recurrence of drought (Krishan 1979).

The problems posed by droughts vary from area to area depending upon the amount of precipitation and its variability and on the demand of water for the specified user. The term drought has different connotation for different users. In general terms, it is lack of water with respect to a specific need in a conceptual supply and demand relationship. Drought is however explained differently by persons of different disciplines. To a meteorologist drought is the absence or sever deficiency of rainfall, to an agriculturist, it is the inadequacy of moisture in soil and to a hydrologist, it is a shortage of water in stream and reservoirs.

A common man generally considers the drought or lack of water in such a extent that the agricultural production is badly affected. The agricultural drought is result of inadequate soil moisture in the root zone of the crops to meet the evapotranspiration needs over a fairly long period affecting seriously the crop yield. The agricultural drought, in other words, is caused by an inadequate amount of soil water available over a critical time period of crop growth, this condition will evidently depends also on plant species and soil type. Agricultural drought distinguished from hydrological drought by a difference in concept of effective rainfall. In agricultural drought, the effective rainfall is the availability of water in the root zone, while in hydrological drought effective rainfall is determined by the portion of rain that escapes through surface or sub surface drainage. But for a common man it means disaster and despair (Sikka 1984).

2.2 Identification of Drought

The ratio of rainfall to potential evapotranspiration gives an indication of the status of soil moisture and this ratio is defined as soil moisture index (SMI). The region where this index is less than 0.66 can be classified as drought prone and the region where this index is less than 0.33 is categorized as arid region and the region where this index is between 0.33 to 0.66 is categorized as semi arid region (Hershfield 1973).

A large part of Gujarat and Rajasthan and some pockets of Southern India are in the arid zone and the annual normal rainfall is generally less than 500 mm.

The semi arid regions cover portions of Maharashtra, Madhya Pradesh, Uttar Pradesh, Haryana and Punjab states and the annual normal rainfall is generally between 500 mm to 1000mm. Some pockets of Bihar, West Bengal and Orissa where the normal rainfall is more than 1000 mm but nct well distributed are also covered under semi arid zone.

The Irrigation Commission 1972, set up by the Govt. of India after making detailed studies of various factors, have given a definition of drought areas which has been now accepted in identifying such areas. The irrigation commission considered the following data furnished by the Indian Meteorological Department and the State Governments

(i) Meteorological data

(ii) Revenue Remissions

(iii) The frequency of famine and scarcity, and

(iv) The availability of Irrigation facilities

After considering the meteorological criteria i.e., the distribution of rainfall and the adequacy of rainfall the commission has sought to identify drought areas and chronically the drought affected areas as follows:

(a) Drought Areas:

Areas having 20% probability of rainfall deficits of more than 25% from the normal.

(b) Chronically drought affected areas:

Areas having 40% probability of rainfall deficits ofmore than 25% from the normal.

They have further stated that such of the Taluks, which enjoy an irrigation of 30% or more of the cultivated area should be excluded from the list of drought affected areas. (R. Chikkanna & T.C.R. Rao).

2.2.1 Drought Indices:

2.2.1(a) Meteorological Drought Indices: According to IMD, the meteorological droughts can be classified as below:

Percentage departure from normal rainfall	Intensity of Meteorological drought
0.0 or above	No drougnt
0.0 to -25.0	No drought
-25.1 to -50.0	Moderate drought
-50.1 or less	Severe drought

Statistical analysis of a long record is carried out to derive long term mean, standard deviation and coefficient of variation(Cv) of rainfall. If annual or seasonal Cv of rainfall is 30% or more, the area is termed "drought prone", or when CV in any of the month is 50% or more, the area is termed drought prone (CWC, 1982).

The probability of occurence of dry spells of short and long duration have been studied by Rao et al (1971), Ramana Rao et al (1976), Victor and Sastry (1979), Correria and Bohra (1980). The sequence of dry and wet spells during the monsoon periods in India using the Morcov chain model have been investigated by Chowdhary et al (1984), Khambeta and Biswas (1981), Ramkrishna et al (1984), and others. Khambate and Biswas (1984) for example use two state mark on chain model of ist order to evaluate sequences of dry and wet weeks during S-W monsoon over dry forming tract of Maharashtra and proposed an index of drought proneness as given below based on parameters of this model.

$$DI = \frac{P \times P_1}{1 - Po} \times 100 \qquad \text{....(1)}$$

where, P_1 and 1-Po are wet and dry sequences

2.2.1(b) Agricultural drought indices

Since rainfall governs the water supply, and evapotranspiration represents the crop water demand, both of these hydrologic variables have been used to define index of agricultural drought by various workers in many ways. In order to replace crude rainfall indices, Presscott (1958) advanced this index in Australia considering the fact that water need of growing plants is dependant on climatic conditions vis-a-vis complex association between soil and vegetation. This index utilises plant soil rainfall interaction concept in any indirect way and uses different ratios of pan evaporation to classify intensity of drought. The CCGI is given as:

$$CCGI = P/(E_w)^{0.75} \quad ...(2)$$

where P = rainfall, and E_w = measured or calculated evaporation rate

Das et al. (1971) modified this equation using potential evapotranspiration (PE) instead of E_w and gave the following equation:

$$CCGI = P/(0.769\ PE) \quad ...(3)$$

On the basis of equivalent rainfall amounts to these limiting CCGI values, four drought classes were defined as given below:

P_i = Nil Severely	growth restricted growth	= 0.4 (0.769 PE)=0.307 PE, influential rainfall required for a break of season
P_d = Restricted	growth	=0.8 (0.769 PE)= 0.615 PE, the minimum rainfall for satisfactory growth of drought tolerant crop
P_h = Satisfactory	growth	= 1.2 (0.769 PE) = 0.992 PE, minimum rainfall for satisfactory growth of average crops & pastures.
P_a = abundant	growth	= 1.6 (0.769 PE)=1.220 PE, the rainfall creating conditions for good growth for most crops, plants and dense growth.
P_{a2} = Surplus	growth	= 2.4 (0.769 PE)=1.844 PE, the rainfall for abundant and dense growth of paddy.

Classification of drought is given below:

Moderate drought = when $P_a/P_n < 1$

Large drought = when $P_h/P_n < 1$

Severe drought = when $P_d/P_n < 1$

Disastrous drought = when $P_i/P_n < 1$

where P_n is the normal rainfall

Das (1980) classified the country into various drought intensity classes using this concept for advocating necessary soil conservation measures. They estimated that nearly 80% of the country is subjected to droughts. While, 6% to disastrous droughts, 36% to severe, 14% to large and 24% to moderate droughts.

2.2.1(c) Hydrological drought indices

Hydrological drought indices are concerned with the effect of rainfall deficiencies in hydrological components such as surface water, ground water and soil moisture. In the direction of hydrological drought the indices in the form of numerical number indicative of drought occurrence are not many. Rather more complex statistical and stochastic hydrologic models are found in the literature. The hydrological drought has been defined by various researchers, Whipple (1966), defined a drought year as one in which the aggregate runoff is less than the long term average runoff. Yevjevich (1967) defined the term hydrologic drought as "the deficiency in water supply or deficiency in precipitation, effective precipitation, runoff or accummulated water in various storage capacities".

Based on Ground Water Levels the common approach to study hydrological drought using ground water data is to construct well hydrographs superimposed with rainfall data using long term historical record. The correct assessment of draft is one of the main problems in judging the impact of drought on ground water. For example, figure 1 presents few typical well hydrographs in Karnataka State depicting the trends of water table over the past few years and this confirms the lowering of water

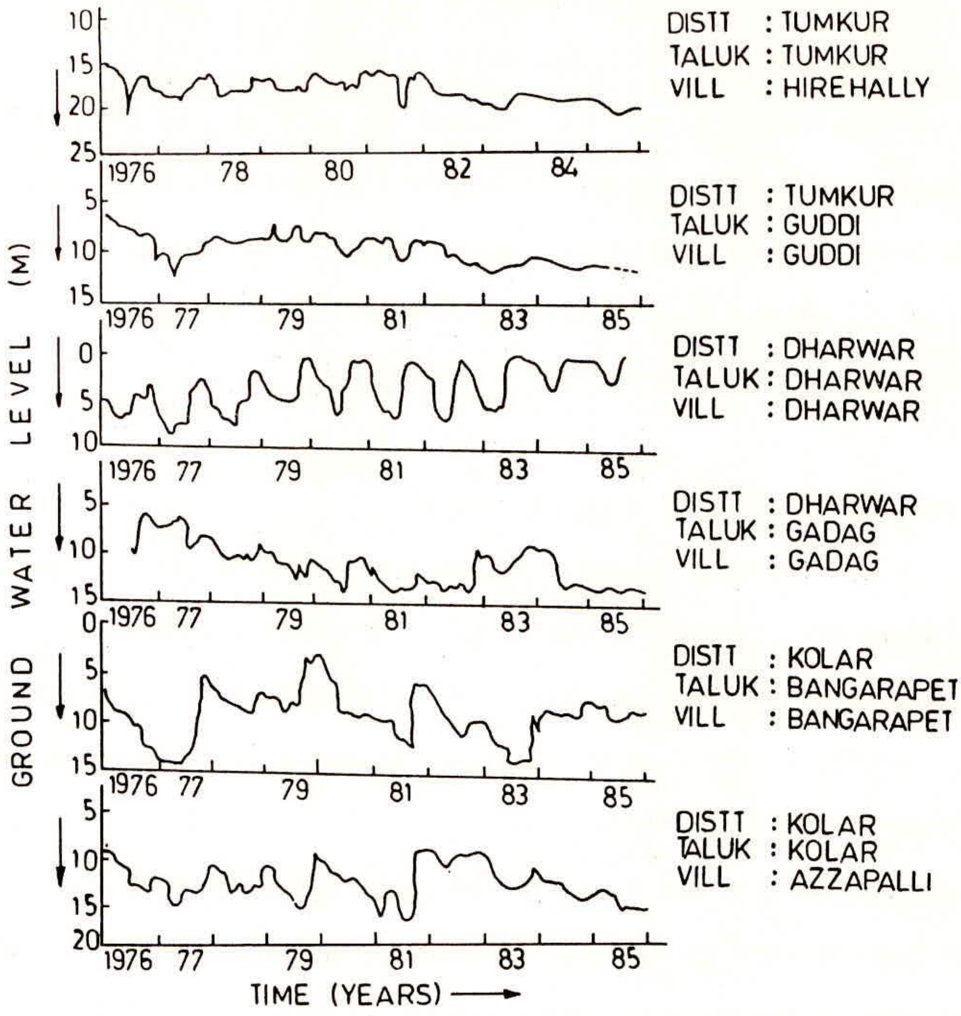

FIG. 1. VARIATION OF GROUND WATER LEVEL (KARNATAKA) ILLUSTRATING DROUGHT IMPACTS

table over the past few years and this confirms the lowering of water table due to drought (Sikka, 1986b). Like other drought indices giving some numerical numbers, there appears to be no such attempts made in this direction to develop indices based on groundwater levels.

2.3 Importance of hydrological drought

The drought characteristics and problems posed by droughts vary from area to area, depending upon the amount & variability of available water supplies and the demand of water for specific users. The drought studies done so far have mainly concentrated on meteorological aspects and by some extent on agricultural aspects. The hydrological aspects of drought are poorly understood and have not been scientifically studied. In order to understand the hydrological aspect of drought and its consequences on water supply, availability of fodder and agricultural production, the drought management strategies have to be developed both as short term and long term measures. There is a need to take up systematic drought studies in a coordinated and integrated manner following interdisciplinary approach.

Yevjevich (1968) defined the term "Hydrological Drought" as the deficiency in water supply on the earth's surface, or the deficiency in precipitation, effective precipitation runoff or in accumulated water in various storage capacities. Linsley et al (1975) defined hydrologic drought as a period during which stream flows are inadequate to supply established uses under a given water management system. Basically a hydrologic drought means a deficit of water supply in time, in area or both. Any hydrologic drought involves the following factors:

I) Duration

II) Aerial Extension

III) Severity (Intensity)

IV) Probability of occurence

V) Initiation (or termination) which means its location in the absolute time.

2.4 Drought in India

Drought is a frequent hazard in India, striking in some part or the other. It is not only confined to arid and semi-arid regions but often visits in potentially good rainfall areas too, which are otherwise productive (i.e. humid and sub humid rainfed agricultural areas). In this century, the Country had severe droughts in the year 1907, 1977, 1918, 1920, 1939, 1951, 1965-67, 1972-73 and 1979.

During the 1979 drought, crops over nearly 35 million hectares in 12 states viz. Andhra Pradesh, Bihar, Madhya Pradesh, Himachal Pradesh, Rajasthan, Orissa, Jammu & Kashmir, Punjab, Haryana, Maharashtra, Uttar Pradesh and West Bengal involving about 200 million people, have been affected in varying degrees. During the 1965-67 drought, which affected 156 districts of the country, expenditure in drought relief was 722 crores of rupees. During the two consecutive droughts of 1971-72 and 1972-73, the expenditure was nearly Rs.790 crores for the 227 affected districts and during the 1979 drought, nearly Rs.160 crores was approved by Govt. of India (Journal 1981). The recurrent incidence of drought has been causing local as well as regional imbalances and continues to be one of the heaviest dragon for the growth of national economy (Krishna 1979).

3.0 DATA REQUIRED IN THE STUDY

3.1 General : Data in science and technology are usually the results of experiments or observations carried out by research workers. In some instances the primary objective of the research is to obtain the data, but more frequently the data are generated for some other purposes, e.g. to confirm the identity of a synthesized compound and are published only if the author deems it necessary to complete his presentation of the main results of the research. As a result some potentially valuable data are not published at all. It is however desirable that such data be submitted to and stored in appropriate data banks and data depositories to facilitate their later utilisation.

Data are usually understood to be numerical representation of magnitudes of various quantities. More exactly, this is expressed by :

physical quantity = numerical value x unit

Data originate usually from measurements carried out in laboratories and in the field using various measuring apparatus. Measurement in the sense is a process of extracting desired information from specimen under inspection.

To evaluate data as to accuracy or reliability, it is necessary to know the internal structure of the apparatus used and details of the principles of the measuring methods. In most ordinary handling of data, however one need not know all such details, which should not be done.

Environmental conditions, such as date, location, temperature, humidity and atmospheric pressure should accompany the recorded data as necessary. Parameters of the measuring instrument, accuracy, precision and calibration method should also be noted because they are essential factors in data evaluation.

3.2 Types and frequency of data needed

Data needed for drought studies and other hydrological studies can be categorised in the following four sub-heads :

a) hydrological variables

b) water use data

c) catchment details

d) other data

The desired frequency of data collection for various hydrological and water use has been given against each item as below, however, the frequency will depend upon the purpose for which data is being collected :

(a) Hydrological Variables

Sl.No.	Variable		Frequency of observation	Time of observation
(1)	(2)		(3)	(4)
1.	Rainfall	(i)	Daily	08.30
		(ii)	hourly	-
2.	Snow		daily	
3.	Glacier		yearly	
4.	Panevaporation		Daily	0830 1400
5.	Interception		selected days during rainy season	-
6.	Infiltration		Hourly/daily	-
7.	Soil Moisture	(i)	Weekly	
		(ii)	Daily	0700

(1)	(2)	(3)	(4)
8.	Evapotranspiration	(i) Daily	1400
		(ii) Hourly	-
9.	Other routine meteo-rological	(i) Daily	0700 hrs (LMT) 1400 hrs (LMT)
		(ii) Hourly	- do -
10.	Stream/river flow Discharge Stage	Daily Thrice a day	Once a day 8, 13 & 18 Hrs.
		Hourly	-
		Four times a day	7, 11, 15 & 19 hrs.
11.	Reservoir (inflow,	(i) Daily	-
	Outflow and levels)	(ii) Fortnightly	-
		tank gauge data	
12.	Ground Water table	(i) Monthly	Once a month
		(ii) 5 times a year	Jan, Apr., June, Aug. and Nov.
		(iii) Seasonal	Pre and post-monsoon.
13.	Sediment load	Daily	Once a day with discharge
14.	River Water quality	(i) Monthly	Once a month
		(ii) Thrice a month	-
		(iii) Forthightly	Twice a month
15.	Ground Water Quality	(i) Pre & Post Monsoon	-
		(ii) Yearly	Once a year
(b)	Water Use		
	Municipal Water use	Daily	
	Agriculture water use	Seasonal	

	Sourcewise Irrigation areas	Seasonal
	Crops & cropping patterns	Seasonal
	Area under each crop	Seasonal
	Area under dry land or rainfed agriculture	Seasonal
	Sourcewise water supply for domestic uses	Seasonal
	Water demands for domestic and cattle uses	monthly
	Industrial water use	monthly
(c)	Catchment details	
	Hydrological structure and gauging sites	Yearly
	Soils, landuse	Yearly
	Wells and tubewells	Yearly
	Irrigation tanks	Yearly
	Percolation Tanks/Ponds	Yearly
	Area affected by flood/drought	Yearly
(d)	General features (Socio-economic details)	
	(i) Population Human and Animal	5 yearly
	(ii) Occupation	5 yearly
	(iii) Land holdings	5 yearly

Source : Draft National Hydrological Monitoring Centre document.

3.3 <u>Handling of data for hydrological studies</u> :

Many of the observations of hydrology resulted in data values which are space and time dependent, and the type of analysis employed is related to the dimensionality of the data. Furthermore, many hydrological observations are made at sites removed from the bulk of their study material and workers must rely upon data in which there are substantial amounts of uncertainity. If the data are statistically independent, a wide variety of standard elementary data analysis techniques can be applied to start and understand better the nature of the data the level of uncertainity and the characteristics of population being examined. Typical procedures include probability analysis, the use of statistics to estimate the parameters of parent population and to test hypothesis about population, the analysis of distribution and analysis of variance. These are straight forward procedures and need no further explanation. Perhaps the main caution in their use in the hydrology is that one be certain that the sometimes rigorous assumptions underlying the different procedures are met before the results of the analysis are relied upon.

Data sets with one or more dimensions pose a somewhat greater analytical challenge. One dimensional data in space or in time can perhaps be visualised as a series of data values occuring in sequence along a line. Two dimensional data can be thought of as a set of data values distributed on a surface (typically involving the analysis of data derived from maps, charts and photographs). Much of the same risk of uncertainity about the samples encountered in spatial data has to be tackled in the new type of data. Similarly, there is an interest in the general tendencies exhibited by the one and two dimensional data, so that one can interpolate between data points, extrapolate beyond the data sequence in the presence of trends, or estimate the characteristics that may be of interest to the hydrological scientist.

Interpolation procedures for data along a line are fairly straightforward in concept. The two dimensional version is, of course, the process involved in contouring a set of points. The first step in interpolation is usually producing a regularly spaced set of values.

When contouring a surface, values at regular arid points may be produced in variety of ways, ranging from estimates derived from the nearest originally observed values, the estimates derived from the fitting of a trend surface. The former approach results in a rather coarsely approximated set of contours, the latter has the disadvantage that none of the original points are likely to be on the generated contours.

Frequently one is not only interested in the magnitude of changes in a sequence or on a surface, but also curious about when these changes occur. If certain assumptions can be justifiably made about the distribution of population on which the samples are collected, statistical tests called "regression analysis" can be performed. The simplest of these is the family of least squares methods for determining a line about which the variance is at a minimum. Linear regression techniques are supplied to fit a line through a series of points with a controlled or atleast a well understood, degree of fit.

4.0 FORMATS FOR THE COLLECTION OF DATA

In India, the work of collection of hydrological, meteorological and other allied data is done by different agencies and each agency has its own way of collecting the data in its own format. All the hydrological data specially for drought studies e.g. rainfall, discharge, groundwater, soil moisture etc. are such that one data is collected by more than one agency in its own format. So there is not a uniformity in data collection, in their way of presentation and in their unit. Some agencies are following newly adopted S.I. or metric unit but some agencies are still using old units. (Ramasastri, 1987).

4.1 <u>Rainfall data format</u>:- At present all rainfall data collected through (i) IMD (ii) State Irrigation departments and (iii) Central Water Commission and other agencies as given in Table I.M.D. maintains about 600 surface observations for collection of meteorological data. Some of the State Irrigation departments and agricultural colleges and universities also collect meteorological data through their own observatories. More than 6000 raingauge stations are maintained by state government & for collection of rainfall data. The formats of collection of data by different agencies are given in Appendix II. As can be seen that there are different formats as CWC, P.W.D., Irrigation Department of states, all are independently choosing the formats of rainfall data collection, which creates problem for the handling of the rainfall data, which is the most important parameter. Hydrological and related meteorological data are required for assessing, developing and managing the water resources of the country and its water related environment, and rainfall is the most important meteorological parameter which determines the quantity of runoff in streams directly as overland flow and individually as sub surface flow and ground water (base

Tab ITEMWISE DATA COLLECTION FROM VARIOUS AGENCIES/ORGANISATIONS

Items	IMD	CWC	CGWB	Min.of Agril.	ICAR	St.Irr. Deptt.	St.GWB	St.Ag. Deptt.	RVA	BES	FRI/St. For.Dept.	PHED/ St. WSB	UNIV./ Ag. Cell	ICRI SAT	Mic Cel.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) Hydrological Parameters															
1. Rainfall	*	*	*	*	*	*	*	*	*	*	*		*		RDSO
2. Snow	*	*							*						SASE/NRS
3. Glacier															GSI
4. Interception								*			*				DST
5. Infiltration				*	*	*		*			*		*	*	SASE
6. Soil Moisture	*			*	*	*		*			*		*	*	
7. Ground Water			*		*		*						*		NGRI
8. Pan Evaporation	*	*		*	*	*			*		*		*	*	
9. Evap.Transpi-ration	*				*	*					*		*	*	
10. Streamflows		*	*	*		*			*						RDSO
11. Reservoir						*			*			*			NRSA
12. Surface Water Quality	*					*			*						CBPCWP/ DOE/St.Pd
13. W.Q.(Sediment)		*		*		*			*						
14. Other Met.Vari-ables.	*	*		*	*	*		*			*		*	*	Board/ NEERI

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B) Water Use (Surface & Ground															
1. Muncipal Water Use						*				*		*			
2. Agriculture				*	*			*		*					
3. Sourcewise Irr.Areas				*		*		*		*					
4. Crops/Cropping pattern				*	*	*		*							
5. Area under Each Crop				*	*	*		*							
6. Area of Dryland/ Rainfed Agri.				*	*	*		*							
7. Fodder & Crop Yields				*				*		*					
8. Sourcewise W.S for Domestic Uses							*			*		*			
9. Water Demand- Domestic & Cattle										*		*			
10. Industrial Water Use										*		*			
11. Other Info : Recreation etc.															

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C) <u>Catchment Details</u>															
1. Catchment				*					*						GSI/SOI
2. Hyd.Structure/ Gauging sites	*	*	*	*		*	*		*						
3. Soils				*	*			*	*		*				NGRI/GSL
4. Land Use				*	*					*	*				
5. Wells & Tube wells			*	*			*	*	*	*					
6. Irrigation Tanks						*	*	*	*						
7. Percolation Tanks/ Ponds				*	*	*	*	*							
D) <u>General Features (Socio-Economic Details</u> :															
1. Population Human & Animal				*						*					
2. Occupation										*					
3. Land Holdings				*											St.Rev.Dept.

1. IMD — India Meteorological Department
2. CWC — Central Water Commission
3. CGWB — Central Ground Water Board
4. Min. of Ag. — Ministry of Agriculture
5. ICAR — Indian Council of Agricultural Research
6. St.Irr. Dept. — State Irrigation Department

7. St. GWB	State Ground Water Board
8. St.Ag.Dept.	State Agriculture Department
9. RVA	River Valley Authorities
10.BES	Bureau of Economics & Statistics
11.FRI	Forest Research Institute
12.St.For.Dept.	State Forest Department
13.PHED	Public Health Engineering Department
14.St. WSB	State Water Supply Board
15.ICRISAT	International Crops Research Institute for Semi Arid Tropics
16.RDSO	Railway Design & Survey Organisation
17.SASE	Snow & Avalanche Studies Establishment
18.NRSA	National Remote Sensing Agency
19.GSI	Geological Survey of India
20.DST	Department of Science & Tecnnology
21.NGRI	National Geophysical Research Institute
22.CBPCWP	Central Board for Prevention & Control of Water Pollution
23.DOE	Department of Environment
24.St.Poll.Board	State Pollution Board
25.NEERI	National Environmental Engineering Research Institute
26.St. Rev.Dept.	State Revenue Department
27.SOI	Survey of India

flow). Thus the amount, intensity and serial distribution of rainfall are essential in any hydrological study. Preliminary processing of rainfall data is essential before it is put to further use in analysis.

4.2 Discharge data format : The total amount of precipitation which reaches the ground in a statical period is expressed as the depth to which it would cover in a liquid form, the horizontal projection of the earth's surface. Snowfall is also expressed by depth of fresh snow covering on even horizontal surface.

The units of precipitation are linear and daily amounts of precipitation should be read to the nearest 0.1 mm. In India all precipitation observations are made at 08.30 hours when measurements of other meteorological parameters are also made at observatories of India Meteorological Department and other departments.

The other important parameter for hydrological studies is streamflow which is required for the efficient day to day management and regulation of a river system. The stream flow data are also required for design, planning and modelling purposes. The stream flow data collected from the field have to be processed or reduced in a manner to seal it for an analysis.

The Appendix I shows the formats for the collection of discharge data, which clearly shows the difference. Some agencies present data in monthly manner and some in daily manner but the way of their presentation is entirely different. These data are collected by State Irrigation departments and Central Water Commission. The Central Water Commission operates 462 gauge and discharge and water quality monitoring sites. Gauges are observed at a hourly intervals during the monsoon season (June-Oct) and thrice daily during the non-monsoon period. The discharge and rest observations are taken once a day and water quality data are taken once in a month.

There are about 1800 stage discharge sets maintained by various states. Other than these, Railways and Road transport agencies are also maintaining gauge sites and measure gauges and discharge at railway/road bridges.

4.3 Ground Water Data Format : Ground water is not an isolated resource because except in specal cases, precipitation and surface water of an area are part of the boundary condition for the ground water body, they are part of the input, output of a complex system. Ground water basin, geology, basin precipitation, surface streams are either inherent properties or boundary conditions of the ground water body. As such, these data may have equal or greater rank than data derived from water level measurement (Mishra 1987).

Ground water data are usually not transferable from one basin to another. Streamflow data can be transfered in the sense that the sequence of flows in different streams can be correlated with meteorological phenomenon that affects, to some extent, all the streams in a region.

Formats of ground water data collection also are given in the Appendix III. The ground water data are collected by Central Ground Water Board and State Ground water Boards or agencies through various observation wells.

4.4 Other type of data formats : Data and location of hydrologic station have also been presented in the Appendix IV. As can be seen the format and the contents, are different because each agency usually give details about their own observation site with latitudes and longitudes.

The population, the ratio of population in terms of male and female, their socio-economic activities are also concerned directly or indirectly for drought analysis of the area. Some central government organisations and Central water Commission also give these details. In the formats of CWC, different formats for human population, population of livestock and poultry etc. are given in the Appendix IV.

Central Water Commission, State departments and other agencies (Central as well as State) and some Agricultural colleges provide data for land use patterns and area under different crops. These are given in Appendix IV and the modified formats which should actually be taken into work are also given in Appendix V.

Formats for Water quality data, Meteorological data etc. which are used by different agencies nowadays needs some modification to meet the requirement of uniformity and simplicity of handling of the data both existing and modified formats are given in Appendix IV & V respectively.

A data collection programme is meaningful only within a problem solving context. In other words, the design of a data collection programme must be in response to an overall plan established to achieve a well specified and feasible objective such as developing and testing appropriate model of a ground water system. The need for hydrological data is related directly to the stresses imposed on the system natural or manmade, because the response to a particular stress may occur at a distant point long after the event. In other words a properly designed system for the collection of ground water data must be organised around solving problems and only on the basis of solving existing or potential problems specific to individual hydrologic system.

5.0 PLANNING OF STATION NETWORK

There is a problem of planning the station network for Ground Water observations. The planning should be such that it gives the best result for the analysis with the help of data obtained from these stations but the economic consideration should also be taken into account. For some times, economic consideration is the ideal approach of planning the station network (O.A. Drozdor 1936).

This network can, first of all, be divided into the basic network and special stations. Special stations are organised for a comparatively short time (a few years). The observational data from these stations are not analysed and stored with the data from the basic netowrk, but are studies separately according to the requirements which each of these stations was organised to meet.

As opposed to the special stations, station of the basic network can only be closed down in exceptional cases. If, as the result of building developments in the area, or for other reasons, a station in the basic network ceases to be representative of the surrounding area, it is permissible for a station to be moved a short distance away. In every case, careful provision should be made of the information on such a transfer. In planning stations of the basic netowrk, it is essential to make every effort to ensure that movements of this kind occurs as rarely as possible.

On the basis of the classification adopted by WMO, stations belonging to the basic network may be divided into three groups:

(1) Stations of the first group carry out observations of atmospheric phenomenon, visibility, cloud amount, precipitation, snow cover, air and soil temperature, humidity of the air, wind, pressure and sunshine

duration. The rational distance between the station of the group is, on an average, 150 to 200km and should be specifically adopted to the physical and geographical conditions of the region.

Amongst the stations of the first group, a number of reference stations should be selected. Reference stations serve essentially two purposes: the study of long term climatic changes and correlating data from other stations. In accordance with these purposes, the stations selected as reference stations should already possess longest possible observational series, and should also be such that the probability of having the transfer them in future is as remote as possible. The apparatus at reference stations should be of the highest quality and should be most carefully verified.

Estimates of the rational density of reference stations should be carried out on the basis of data concerning the statistical structure of the monthly mean values of meteorological elements. There has been hardly any systematic research of th[illegible] as yet. Broadly indicative data suggest that reference stations should be located at distance 300 to 400 km apart, so that approximately every fourth or fifth station of the first group should be a reference station.

(2) The volume of observations carried out at stations of the second group is smaller than the case of the first group. At these stations, observations of sunshine duration and soil temperature at depth are not made. Stations of the second group need not, as a rule, measure atmospheric pressure: but mountain stations are an exception to this. Apart from that, if a station is also a synoptic station, it should determine the so called barometric tendency, i.e. the changes of pressure at the last three hour intervals. For this purpose, however, it is not necessary to measure pressure by a barometer; an appropriate differential instrument

may be used.

The rational distance between station of the second group is, on an average, about 50 to 60 km. This means that approximately every tenth station of the second group is a station of the first group.

(3) The third group of stations consists of so called posts, at which only observations of atmospheric phenomenon, precipitation and snow cover or even only some of these elements are carried out. The rational distance between these stations is on an average 25 to 30 km in flat country and approximately half that distance in mountaineous areas. it is highly probable that the network density requirement for these stations will be considerably reduced in the future, but at present, this method is not sufficiently accurate. Moreover, it must be borne in mind that, even after the introduction of radar installation, it will be necessary for some time to measure precipitation by ordinary methods alongside radar measurement. (Technical report WMO 1970).

6.0 USE OF COMPUTER IN THE STUDY

6.1 Computerised Data Storage and Retrieval System

Computers are capable of performing a series of fixed operations which can be described by three simple steps:

1. Input : read incoming data
2. Processing: Perform arithmetic operations, comparison, data transfers
3. Output: produce outgoing information.

The term data processing is used to describe the procedures defined above. Strictly speaking, data is a collection of incoming facts which need to be processed so that information is produced. Information is defined as structured, processed and meaningful data. That is, data are entered as input, it is processed, and information is produced. Electronic Data Processing (EDP) is the term used to describe the processing of data by computer.

There are three major reasons why computers are used. These are:

(1) Speed: Electronic computers are capable of processing data at a speed typically measured in nano seconds or billionths of a second. Since thousands of arithmetic operations can be performed in a single second by computers, they have a decided advantage over calculators and other mechanical devices.

(2) Accuracy: The electronic circuit of these machines is such that when they are programmed correctly and when incoming data is error-free, the accuracy of output is relatively assured.

Because of their speed and accuracy, computer systems are capable of processing large amounts of data more cheaply than if manned methods were used.

(3) To provide capability that would otherwise be impossible, because computers can operate on data at such phenomenal speed, they can produce results that would simply not be feasible otherwise.(Source: principles of data processing: Robert A Stern).

Present day computers are capable of processing large amount of mathematical, physical, chemical and other data in a very short time. The equivalent of hundreds of pages of numerical or tabular data can be obtained in a few hours or even in a few minutes. The most common output of computerised data handling system is still that of typing or printing. In the past several years, the interaction of computers and type setting devices has attracted a great deal of attention, and increasingly automated techniques have emerged for use in publication and printing process.

The computer based systems for storage and retreival of hydrological data are now in vogue for more than a decade in many countries. In India also, a number of organisations dealing with hydrological data are attempting to develop such systems. These attempts are so far scattered and a consolidated picture is yet to emerge. Moreover, these attempts are so far limited to Central Govt. Departments. As regard State Government Department where bulk of the data lies, a perceptible beginning is yet to be made.

The major central agencies involved in development of computer based storage and retrieval system for hydrological and meteorological data are CWC, CGWB, IMD and NRDMS under DST. The Indian Meteorological Department has been storing meteorological data on punch cards for last four decades. Regarding rainfall data, the daily rainfall data were being punched in 24 cards format since 1971 onwards in this format, the card contains a catchment number subdivision number, latitude and longitude of the station alongwith station number. The IMD has assigned a unique 3 digit catchment number to different catchments in India. In the 31 cards format, the catchment number, sub division number and station number were recorded in each card. For each year, 31 cards were required & each card contained data for a specific date of each month. For storage of data in 24 cards format, 2 records are needed for each month. The field in each record are catchment no., latitude, longitude, station no., year, month and 16/15 rainfall values.

A different scheme is used for storage of hourly rainfall data of the self recording raingauges. This format includes element code, index number of raingauge stations, year, month, date, card number (either 1 or 2) and hourly rainfall values. The second card also has field observation for amount and duration of maximum one hour precipitation during the 24 hours period. These formats are shown in fig. 2.

Quality control check for the data being input is very essential. Several techniques for this are available. It is not known whether these are applied in practice for data checking.

The Central Water Commission is engaged in computerised storage and retrieval of hydrological data for quite sometime. Recently, a major exercise of coding the data was completed. In the approach adopted by CWC the entire country has been divided in 20 basins. These have been further sub-divided in sub-basins. Codes have been devised for these basins and sub basins. The coding for individual station is under process. It is understood that the past data is being converted into the new devised format. The format which has been in use in CWC is shown in Fig. 3.

About five years ago, CGWB, started the work for computerised storage and retrieval of ground water data. At first stage of this work,

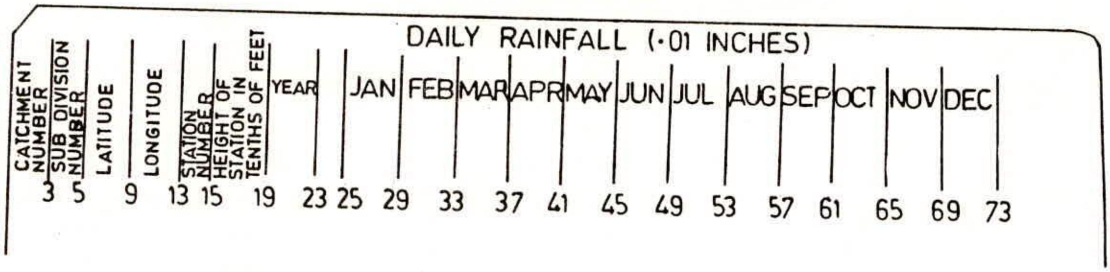

FIG. 2 a. DAILY RAINFALL - 31 CARD FORMAT

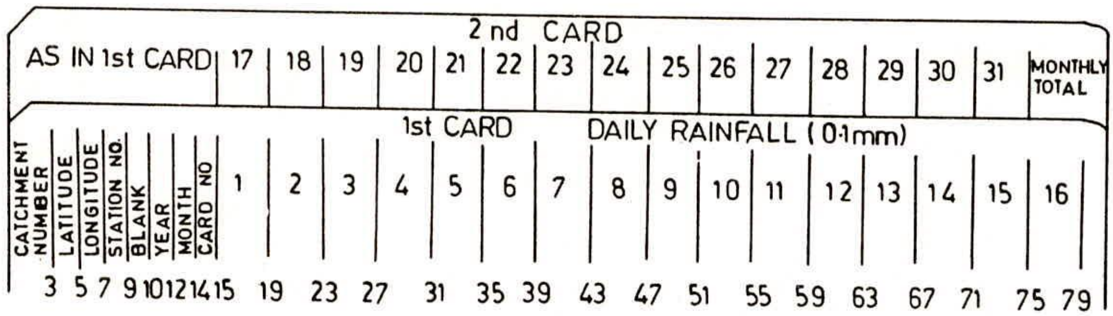

FIG. 2 b. DAILY RAINFALL - 24 CARD FORMAT

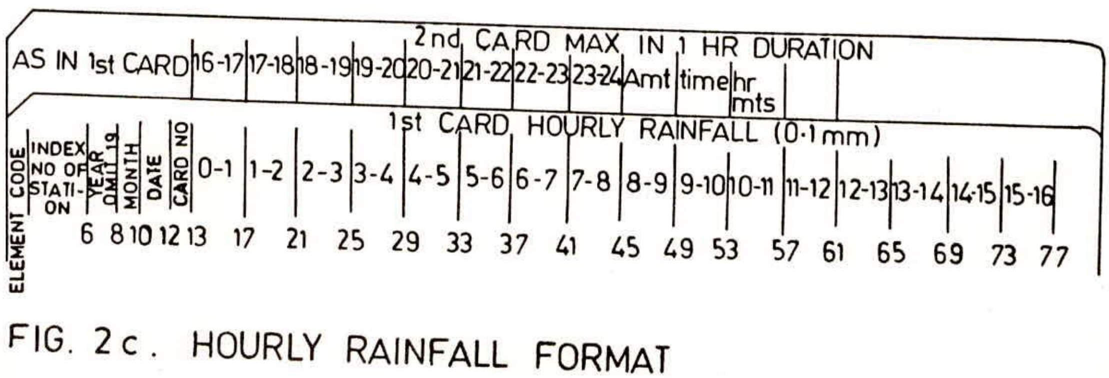

FIG. 2 c. HOURLY RAINFALL FORMAT

CENTRAL WATER COMMISSION
DIRECTORATE OF STATISTICS
STAGE OF DISCHARGE DATA FOR : NARMADA AT DHARMRAI (NAA0220)
BASIN : NARMADA TRIBUTARY :
SUB-TRIBUTARY :

STATE SITE
****

R.L. OF ZERO : 106.11 (METRES) R.L. OF ZERO : 106.11 (METRE)

DATE	APRIL STAGE (METRE)	1966 DISCHARGE (CUMECS)	MAY STATE (METRE)	1966 DISCHARGE (CUMECS)
1	-.44	57.68	-.53	39.05
2	-.44	46.98	-.52	45.53
3	-.45	35.08	-.52	46.81
4	-.45	67.05	-.53	46.16
5	-.45	47.46	-.53	24.86
6	-.47	20.70	-.53	32.31
7	-.49	25.00	-.55	28.77
8	-.49	36.44	-.55	21.83
9	-.49	31.38	-.56	27.41
10	-.47	31.77	-.56	25.51
TOTAL	-4.65	399.55	-5.39	338.24
AVERAGE	-.46	39.95	-.54	33.82
11	-.48	49.36	-.57	25.60
12	-.48	39.81	-.57	34.35
13	-.48	49.98	-.57	25.97
14	-.48	31.63	-.58	35.33
15	-.48	24.78	-.55	34.55
16	-.49	25.17	-.55	42.11
17	-.49	28.94	-.56	27.47
18	-.50	30.10	-.56	26.45
19	-.50	53.18	-.56	35.45
20	-.50	48.90	-.56	33.44
TOTAL	-4.87	381.85	-5.62	318.71
AVERAGE	-.49	38.19	-.56	31.87
21	-.50	37.26	-.58	34.04
22	-.51	25.90	-.59	26.76
23	-.51	28.23	-.60	25.26
24	-.51	29.76	-.60	28.43
25	-.51	33.87	-.60	23.08
26	-.52	30.38	-.61	22.71
27	-.52	27.33	-.61	25.12
28	-.52	24.07	-.59	29.28
29	-.52	22.88	-.59	30.24
30		25.57	-.56	30.24
31			-.57	29.99
TOTAL	-4.61	286.25	-6.50	305.14
AVERAGE	-.51	28.63	-.59	27.74
MONTH-TOTAL	-14.13	1067.66	-17.51	962.09
MONTH-AVERAGE	-.49	35.59	-.56	31.04
MAXIMUM		67.05		46.81
DATE		4		3
MINIMUM	-.52	20.70	-.61	21.83
DATE	29	6	26	8

Figure 3 : Daily data format of C.W.C.

computerisation of data of National hydrograph stations was taken up. An elaborate coding mechanism has been developed by CGWB for this purpose. Codes have been assigned to each state, district and river basin in which the station lies. The information stored also include the latitude, longitude of a well and a well number. Three character codes have been chosen for the geology of the well site and water quality parameters. Further, the lithology of the geological unit have also been codified. The data format adopted is shown in Fig. 4 (a) & (b).

The data has been computerised on IBM PC compatible computers. The software package and BASE III plus has been used for storage and retrieval of data.

6.2 Problem of Man Machine Communication

Man is an indispensable part of many processing systems and sometimes he works as an integral part of the whole system, when information being transferred from the system to him and vice versa. Thus special care must be taken over the way in which man machine dialogue is performed. As human data aquisition capacity is limited, emphasis must be put on the simplification of man machine communication.

Many studies have been performed with the objective of determining the main parameters related to human behaviour. Some of these are based on emperical measurements while others have relied on control theory. Whichever way is chosen, human behaviour is complex to be described because of its enormous verstality. The human in a man machine system is at the top of the hierarchy and he works as an optimal controller. Despite these obstacles, different ways have been proposed in order to increase the knowledge of human response to external stimuli.

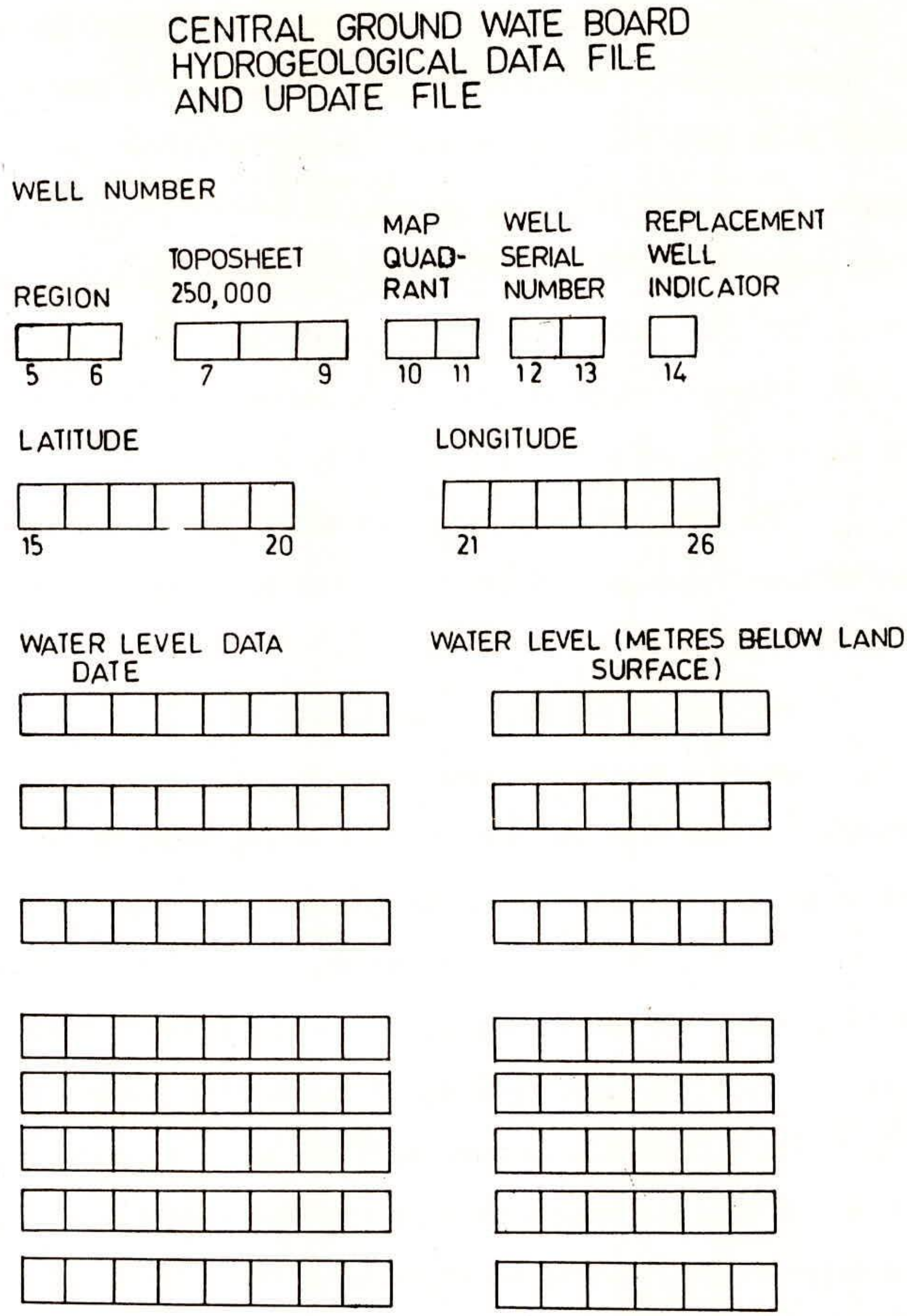

FIG. 4a. FORMAT FOR GROUND WATER STORAGE ADOPTED BY CGWB

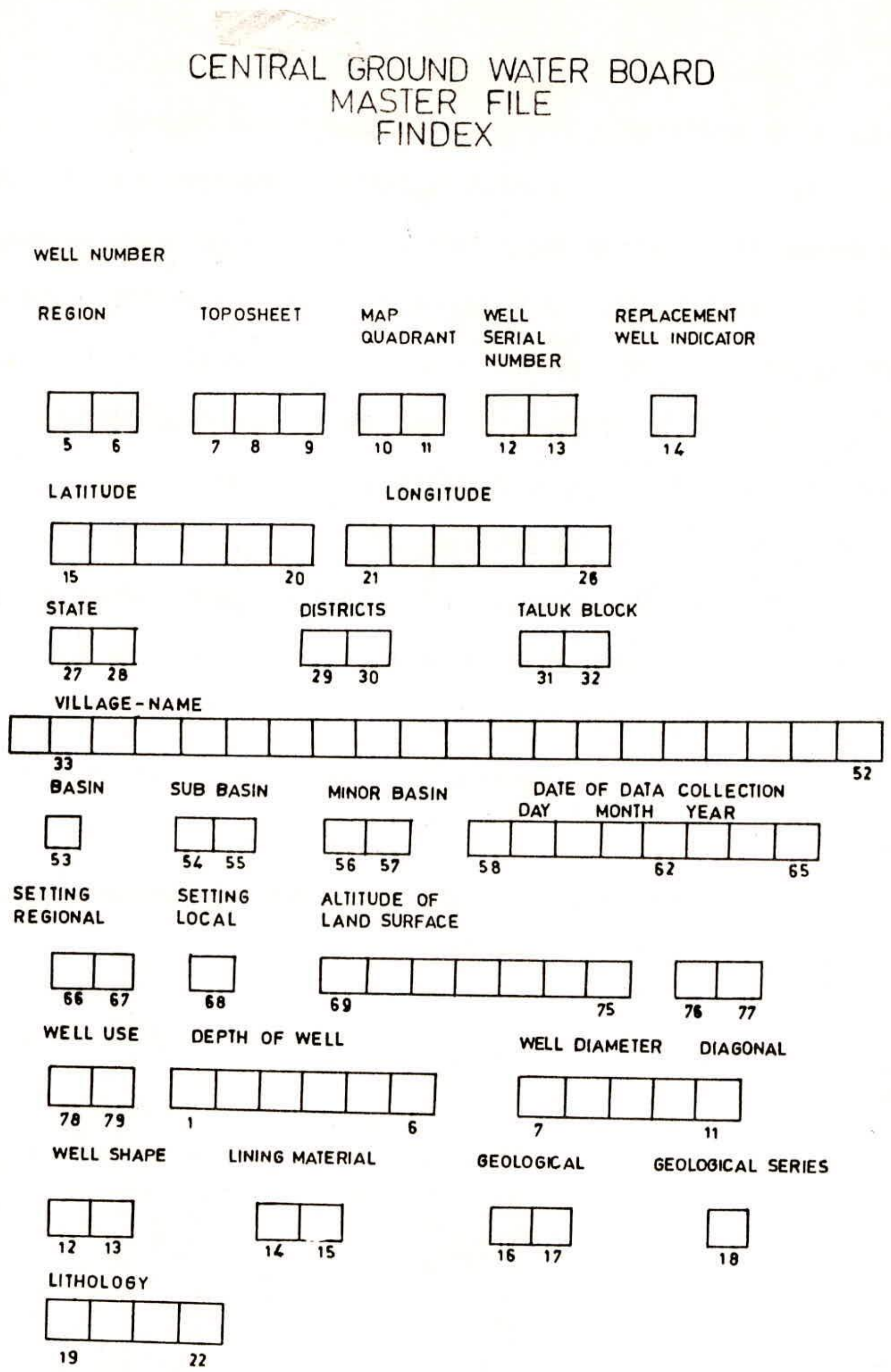

FIG. 4 b. FORMAT FOR GROUND WATER DATA STORAGE ADOPTED BY CGWB

The success of most computer system is dependent on their ability to interact with the user. Despite the internal quality of the programme, it is the users acceptance or rejection of the system which decide its position and life span in the working environment.

Unfortunately, the interaction used to be one of the more neglected parts of many computer systems for several reasons.

1. System builders have been more concerned about, making system work, than the fact that it is supposed to be used by a human being as a tool for problem solving.

2. Man/machine interaction is a fairly poor understood aspect by system builders, because it involves so many factors which probably can't pin down by an algorithm.

3. Human factors involved in communication has not yet been studied.

4. Necessary techniques for utilizing all the human resources in communication have not been available.

7.0 CONCLUSION

India, being a developing country needs thorough research and development of its hydrological resources to maintain its economic growth. For any hydrologic research, data are the first and essential requirement. So it must has a systematic way of collection, storage and analysis of data. In this effort, the use of computer is increasing rapidly and to stand with the other nation's development it will have to modernise our system of collection of data and their handling. For a long time the need of universal format for the whole country is felt so that various discriminaries can be eleminated in the hydrologic research.

The existing system of hydrologic data collection storage and transmission has the following short comings :

(a) There is a lack of centralised place both at Centre and State from where timely data/information of various types, useful for water resources planning and management can be accessed to avoid any delay.

(b) Data of various types are being collected by various agencies but there is no coordination and monitoring cell to regularly monitor the data and develop links between the agencies engaged in collection of surface water, ground water, hydrometeorological, agricultural and other such data so that the hydrological and water resources problems can be looked in overall perspective.

(c) In order to monitor the hydrologic system to desire timely information and assessment of impacts, there should be minimum possible time lag in flow of data from place of collection to place of final storage/usage. Which is not so in the existing system as it uses a primitive way of data transfer and storage.

(d) The storage system available with some of existing agencies like IMD, CWC, CGWB are not very large and fast and there is always a back log of data which are yet to be computerised.

(e) There is no unified format of data storage and indexing system of the type of data, its availability and extent which result in restricted use of data duplication of effort.

(f) There is urgent need to develop a national hydrologic monitoring centre which will monitor the 'National Hydrologic Scene' for preparing the country to deal with extreme hydrologic phenomena like floods and drought.

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<u>Appendix - I</u>

<u>Discharge Data</u>

Station :

R L of Zero Gauge :
(C.A. upto)

River :

Gauge Site :

Month

Date	Gauge in Meter A.M.	Gauge in Meter P.M.	Discharge in M^3/S A.M.	Discharge in M^3/S P.M.	Average	MM^3
1						
2						
3						
4						
5						
6						
7						
8						
-						
-						
-						
-						
29						
30						
31						
	Total :		......	....	.....	......
	Average :		......			
	MM^3 :		......			

Source: PWD Gujarat Hydrological DataII
1977

Discharge Data

Name of Basin .... Year ....

Period	Sub Period	Date	Main River.......	Inflow	Main River.......	Remarks
			Name of discharge site.............	Name of discharge site.............	Name of discharge site.............	
			Discharge in Cusecs	Discharge in Cusecs	Discharge in Cusecs	
1	2	3	4	5	6	7
		1				
		2				
		3				
		4				
		5				
		6				
		7				
		8				
		9				
		10				

Total : ....

Average : .....

Source : C.D.O., P.W.D. Ahmedabad

Actual Observed runoff data of river.................... and discharge station by...........

S.N.	Year	Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual runoff	
		Cumee day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM	Cum. day	MCM

(Months Jan. to Dec. under the heading: Runoff in different Months)

Source : Data produced by Gujarat State Govt.

Hydrological Observations & Flood Forecasting Organisation
(South)

Stage - Discharge data

Site :
Division

Zero of Gauge ....
Year June 19.... to May 19...

Date	June 19..	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
	Water Level Discharge	W.L. Dis.	W.L. Dis.	W.L. Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis.	W.L.Dis
	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.	M M^3/sec.
1												
2												
3												
4												
5												
6												
-												
-												
-												
-												
-												
29												
30												
31												

Source : CWC Govt. of India

Discharge Data

River : .... Basin:...........

Site : .... District : ....

Month of the year	Mean Discharge Data in cum M/c sec				Total volume for the month in M.C.M.
	1-10	11-20	21-31	For the month	
Jan.					
Feb.					
March					
April					
May					
June					
July					
August					
Sept.					
Oct.					
Nov.					
Dec.					

Source : Govt.of Maharashtra Irrigation Department

Flow data

Name of river ....

Site No.		
Latitude	Taluk	Sub basin
Catchment area (in sq.km.)	District	Longitude
		Zero of the gauge

S.No.	Month	Max^m discharge in cumees	Min^m discharge in cumees	Average discharge in cumees	Monthly flow in M. cum
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
-					
-					
-					
-					
-					

Annual Yield
in (M cft)

Source : Water Year Book Vol.II 1984-85 Water Resources Development Organisation

*This is the format for analysed data during the time of publication or for other means.

Flow data

Sub basin : .... Year .... Site : ....

Stream : ....

Date/Month	June M	July M^3/sec
1		
2		
3		
4		
5		
-		
-		
-		
-		
-		
-		
-		
29		
30		
31		
Total		

Source : Water Year Book Vol.II 1984-85
Water Resources Development Organisation
Irrigation Deptt. Bangalore

*This is the format for analysed data during the time of pubiication or for other means.

Appendix - II

Monthly rainfall and allied data

State ....
Distt...........
Taluka...........

Year	Code	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
PE														
NRF	A													
NNORD	B													
NIORF	C													
1961	A													
	B													
	C													
1962	A													
	B													
	C													
1965	A													
	B													
	C													

PE Potential evapotranspiration
NRF Normal rainfall in mm
NNORD Normal No. of rainy days
NIORF Normal intensity of rainfall

A Rainfall in mm
B Rainy days
C Intensity of rainfall

Source : CWC, Govt. of India

P.W.D. Gujarat

Statement for Recording hourly rainfall

Station............

Unit...........mm
Month &.........
Year...........
Period..........

Hours	Date
1	
2	
3	
4	
5	
-	
-	
-	
-	
-	
-	
24	
Raw total	
Mcan S/24	
Max^{m} reading	
Hour/time	
Duration of rainfall	

Source : PWD Gujarat, Hydrological data I 1983

Rainfall Data

Name of Basin : ....

No. of sub basin	Name of sub basin	Name of Rain gauge station	January		Feb.		March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total monsoon runoff	Total annual runoff	Remarks
			Rainfall	Max^m daily rainfall	Rainfall	Max^m daily rainfall													

Source : C.D.O., P.W.D., Ahmedabad

Daily Rainfall for the year 19........

Station :............. District : .... State : ....

Taluka : .... Longitude : .... Latitude :..... in milimeter

Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
-												
-												
-												
29												
30												
31												
Total rainfall												
Total rainy days												

Total Rainy days in the year ....

Max^{m} recorded in one day ....

Annual rainfall ....

Source : PWD Deptt. Gujarat State

Hourly Rainfall in Milimeter

Station .... Distt. ....

Month .... Year ....

Period .... G.T. SkL in meter ....

Hour	Date
8.30 to 9.30	
9.30 to 10.30	
10.30 to 11.30	
11.30 to 12.30	
12.30 to 13.30	
13.30 to 14.30	
Total 'S'	
Means/24	
Intensity of rainfall in mm/minutes	
Max^{m} reading (mm)	
Time in hour	
Duration in H/m	

Source : Irrigation Deptt. Gujarat State

Monthly and Annual Rainfall

Station :
District :
State :

Latitude :
Longitude :
Height :

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual

Source : Monthly & Annual rainfall & No. of Rainy days 1901-50

IMD Part IV B

Number of Rainy Days

Station :   Latitude :

District :   Longitude :

State :   Height :

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual

Source : Monthly & Annual rainfall & NO. of rainy days 1901-50

IMD Part IV B

Appendix- III

Fluctuation of Groundwater table in ....Distt.

S.No.	Year	Name of Taluka	Name of village	Fluction in sub soil water level		Difference
				Premonsoon (m)	Post monsoon (m)	

Source : C.W.C. Govt. of India

Details of Groundwater table & Groundwater quality

1	2	3	4	5	6	7	8	9	10	11	12	13	14
S.No.	District	Taluka	Year	Month	Well No.	Locality with co-ordinate	Type of well	Diameter of well (m)	Depth below measuring point (m)	R.L. of measuring point (m)	Geology	R.L. of land surface	Quality of water of the well

Source : P.W.D. Karnataka

Details of Groundwater use in the District

S.No.	Name of Tehsil	Shallow wells		Govt. Tube well		Private Tubewells		Total area irrigated	Total water use MCM with a delta of 0.3 meter
		Nos.	Area Irrigated	Nos.	Area Irrigated	Nos.	Area Irrigated		

Source : CWC Govt. of India

Results of Representative Existing Tubewells

S.No.	Location	Depth Drilled (m)	Well depth (m)	Water level depth (m)	Screen section (m)	Thickness of aquifer (m)	Discharge (m^3/h)	Draw down (m)	Specific capacity ($m^3/h/m$)	Nature of aquifer

Source : Report produced by Ground Water Survey of the Rajasthan project Area, India 1974

Results of the bore holes drilled by the project

S.No.	Location	Depth Drilled (m)	Zone tested (m)	Screen section (m)	Thickness Tapped (m)	Thick. of aqif. (m)	Depth to water level (m)	Dis-charge (m^3/hr)	Draw down (m)	Quality TDS ppm	Quality CT ppm	Remarks

Source : Report produced by Ground-water survey of the Rajasthan Project Area India 1974

Chemical analysis of water from existing tubewell samples collected

S.No.	Location	Topo sheet No.	Aquifer	PH lab.	Conductivity	TDS mg/1	SiO_2 mg/1	Ca^{++}	Mg^{++}	Na^{+}	Ka^{+}	Lo_3'	HiO'	Cl'	So_4''	No_3'	F	Total mg/1	B mg/1	Hardness	SA

Source : Report produced by Ground Water Survey of the Rajasthan Project Area India 1974

Status of present water use for ali purposes in Distt. During year ....

S.No.	Name of Tehsil	Water use for Irrigation & Agriculture			Domestic purpose	Industrial purpose	Total water used during year.....
		Surface water	Ground water	Total			

Source : C.W.C. Govt. of India

Appendix - IV

Hydrological Stations in........Distt. of ....state

S.No.	Name of river	Name of site	Kind of Record	Name of agency maintained by	Drainage area in sq. km.	Period of date	Remarks
1							
2							
3							
4							
5							

Taluk wise area/population and density of population in 1981 --- Distt.

S.No.	Name of Taluk	Area in sq. km.	Population			Density of population per sq.km.	Remarks
			Male	Female	Taluka		

Source : CWC Govt. of India

Classification of population based on their economical activities in .... Distt.

S.No.	Name of Taluka	Total population	Workers		Cultivators	Agricultural Labour	Total 6+7	Non agricultural sector	% of cal. 9 over 3	Total	% of cal. 11 over 3
			Total	% of cal. 4 or 3							

Source : CWC, Govt. of India

Drinking Water supply facilities in .... Distt.

Name of Taluka	Total No. Viallage	Declared under No. source village Village Hmalet	Water supply scheme completed village/ Hamlet pipe H.P.T. S.W. toal	Urban sector supply sector

Source : C.W.C., Govt. of India

Taluk wise live stock and poultry population of .... Distt.

S.No.	Name of Taluk	Cattle	Buffalos	Sheep	Goats	Others	Total	Poultry

Source : C.W.C., Govt. of India

Land Utilisation Pattern of different year in ....Distt.

A: Area in ha.
B: Percentage

S.NO.	Year	Forest	Uncultivated Land	Land put to non-agriculture areas	Cultivable waste	Permanent pasture grazing land	Current fallen	Net area sown	Area sown more than once	Total cropped area	Preporatory area

Source : C.W.C., Govt. of India

Area under different crop in Kharif/Rabi season for the year....... in Distt.

S.No.	Name of crop	Year	Irrigated area in ha.	% for the total irrigated area	Unirrigated area	% for the total unirrigated area	Yield per ha. in kgs.

Source @ Report on Identification of Drought prone area, CWC, Drought area studies and investigation

Temperature Data

NAME OF BASIN ....

Year	Name of basin	Name of station with class	January	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Name of station with class
			X Y Zd Zw	....	....	.....	...	....	....	....	....	....	...	.....	

REMARKS

X = Monthly average of Max^{m} temp.
Y = Monthly average of min^{m} temp.
Zd = Monthly average of dry bulb thermometer readings
Zw = Monthly average of wet bulbs thermometer readings

Source: C.D.O., P.W.D., AHMEDABAD

Geo hydrological data in.....Distt. in......state......Year ....

S.No.	Item/Taluka	-	-	-	-	-	-	-
1.	Total Geographical area in sq.km.							
2.	Alluvial area in sq.km.							
3.	Hard rock area in sq.km.							
4.	Saline area in sq.km.							
5.	Net suitable area in sq.km.							
6.	Total area under surface Irrigation in sq.km.							
7.	Av. rainfall in mm/year							
8.	Recharge due to rainfall in MCM/year							
9.	Recharge due to return seepage from canal in MCM/year							
10.	Recharge due to return seepage from irrigated field in MCM/year							
11.	Recharge due to return seepage from paddy irrigated field MCM/year							
12.	Recharge due to dams in MCM/year							
13.	Gross recharge in MCM/year							
14.	Recoverable recharge in MCM/year							
15.	Total No. of dug wells.							

S.No.	Item/Talukas	-	-	-	-	-
16.	Total No. of wells with pumpsets					
17.	Total No. of private tubewells					
18.	Total No. of Govt. tubewells					
19.	Total No. of GWRDC tubewells					
20.	Draft due to dugwells in MCM/year					
21.	Draft due to compact in MCM/year					
22.	Draft due to pvt. tubewells in MCM/ year					
23.	Draft due to Govt. tubewells in MCM/year					
24.	Draft due to GWPDC tubewells in MCM/year					
25.	Total draft in MCM/year					
26.	Net draft in MCM/year					
27.	Potential available in MCM/year					
28.	E.S.T. Fractional recharge by existing draft in %					

Appendix - V

STREAM FLOW DATA

SITE :

ZERO OF GAUGE :

DIVISION : WATER YEAR :

Month						
Date	Water Level M	Disch. M^3/Sec.	Water Level M	Disch. M^3/Sec.	Water Level M	Disch. M^3/Sec.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						

MEAN :

DAYS 1-10

DAYS 11-20

REMAINING DAYS

MONTHLY

SURFACE WATER DATA : STREAM FLOW/RESERVOIR

NAME OF THE PROJECT : (MAJOR / MEDIUM) DISTRICT :

STREAM : TRIBUTORY : RIVER :

YEAR : R.L. OF GAUGE :

JUNE				JULY				AUGUST			
IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE

SURFACE WATER DATA : STREAM FLOW/RESERVOIR

NAME OF THE PROJECT : (MAJOR/MEDIUM) DISTRICT :

STREAM : TRIBUTORY : RIVER :

YEAR : R.L. OF GAUGE :

SEPTEMBER				OCTOBER				NOVEMBER			
IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE

SURFACE WATER DATA | STREAM FLOW/RESERVOIR

NAME OF THE PROJECT : | (MAJOR/MEDIUM) | DISTRICT :

STREAM : | TRIBUTORY : | RIVER :

YEAR : | R.L. OF GAUGE :

DECEMBER				JANUARY				FEBRUARY			
IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE

SURFACE WATER DATA :

STREAM FLOW/RESERVOIR :

NAME OF THE PROJECT :

(MAJOR/MEDIUM)

DISTRICT :

STREAM :

TRIBUTARY :

RIVER :

YEAR :

R.L. OF GAUGE :

MARCH				APRIL				MAY			
IN FLOW	OUT FLOW	LEVEL	STO RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE	IN FLOW	OUT FLOW	LEVEL	STO-RAGE

Daily R.L., Inflow, Outflow and Live capacity data

Name of Reservoir   Year :

Date	R.L.	Inflow	Outflow	Live Cap.
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
26.				
27.				
28.				
29.				
30.				
31.				

YEAR : .... DAILY RAINFALL/PANEVAPORATION DATA UNIT: mm/cm

Station : District : State :

Taluka : Long. : Lat. :

Dt.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												
11.												
12.												
13.												
14.												
15.												
16.												
17.												
18.												
19.												
20.												
21.												
22.												
23.												
24.												
25.												
26.												
27.												
28.												
29.												
30.												
31.												
Total Rain-fall												
Normal Rain-fall												

DISTRICT/BLOCK WISE LAND USE DETAILS

YEAR :

District/Block	Total Geographical Area	Forest	Total uncultivated Land	Net Area Sown	Gross Area Sown	Area irrigated	
						Surface	Groundwater
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

PROFORMA FOR WATER USE DATA OF RESERVOIRS

Name of Reservoir ....

Location (Dist./taluka) ....

Designed CCA/ICA..............

Crop Rotation ....

Years	Kharif / Rabi	Area Irrigated (ha)	Crops	No. of Irrigations	Depth of Irrigation	Remarks

Year :

Station :

Taluk :

HYDROMETEOROLOGICAL DATA

District :

Latitude :

Maintained by :

Longitude :

M.S.L. in Mrs :

Sl. No.	Month	Temp.(o) Daily Mean	Wind vel. Km.P.H. Daily	Relative humidity (in %) Daily mean	Vapour Press. (in mb.) Daily mean	Evaporation in mm Daily mean	Sun shine (hrs.) Daily mean
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10							
11.							
12.							

CROP AREA & PRODUCTION DETAILS

YEAR :

District/Block	CROPS							
	1	2	3	4	5	6	7	8
	Area/Prod.	Area/Prod.	Area/Prod.	Area/Prod.	Area/Prod.	Area/Prod.	Area/Prod.	Area/Prod.

PROFORMA FOR DATA OF DOMESTIC, MUNICIPAL AND INDUSTRIAL WATERUSE

A) WATER DEMAND (YEAR WISE)

Sl. No.	DISTRICT	TALUK Block	VILLAGE TOWN	POPULATION & HUMAN POPULATION	DEMAND DEMAND		LIV STOCK DEMAND		TOTAL DEMAND.		INDUSTRY		DEMAN	
					NORMAL TIMES	SCAR CITY TIMES	NOR MAL TIMES	SCAR CITY TIMES	NOR MAL TIMES	SCAR CITY TIMES	INDUSTRY TYPE	NUM BER	NOR MAL TIMES	SCAR CITY TIMES

B) WATER SUPPLY (YEAR WISE)

ACTUAL DETAILS OF WATER SUPPLIED

Sl. No.	DISTRICT	TALUK BLOCK	SOURCE OF WATER SUPPLY	QUANTITY OF WATER SUPPLIED FOR HUMAN USE	LIVE STOCK	INDUSTRIAL	TOTAL

C) DETAILS OF GROUND WATER SUPPLY SYSTEMS (YEAR WISE)

Sl. No.	DISTRICT	TALUK	SURFACE RESERVOIR FOR MUNICIPAL WATER SUPPLY					NO. OF WELLS (TUBEWELLS)	TOTAL DRAFT
			NAME	INFLOWS	DESIGN CAPACITY	ACTUAL STORAGES	RELEASES OUTFLOWS		

DIRECTOR : DR. SATISH CHANDRA

TECHNICAL COORDINATOR : DR. G C MISHRA

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