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WATER RESOURCE OF KARNATAK

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ABSTRACT : Water is one of the basic rosources of mankind. It has numerous uses and is vital to all forms of life. Water, a biological necessity, is of great economic significance. It is supreme economic wealth even more than coal or gold.

Water resource is much freely and easily available natural resource and it has many fold roles. It is used for drinking and domestic purpose, irrigation, power generation, cooling and washing of the machines, used as a media of transportation and recreation. Of late water is becoming a scarce commodity every where. What was free has now become an economic commodity on account of increase in population and industrial development.

Karnataka, the eighth largest and important state in the country in the field of agriculture, mining and industry, certainly needs plenty of water for its use. In the present paper an attempt has been made to study the water resource of Karnataka. The study covers the following aspects in regard to the appraisal of water resource. Firstly, state has been divided into major river basins. Secondly, surface water, reservoir water, under-ground water has been dealt. Thirdly, water resource and population in relation to per capita consumption has been studied. Fourthly, water resource requirement for drinking, domestic, irrigation and industry has been studied. Lastly wastage of water resource by natural factor and potential water resource of Karnataka have been dealt.

Introduction

Water is one of the basic resources of mankind. The life of all organisms entirely depends upon water. Water is also a source of power, an industrial ingradient, a medium of transport, a waste removal and purifying agent, as well as a recreational asset and a maker of boundaries. (Garland, 1950). One cannot imagine man separated from water any more than one can imagine him separated from land (Brown, 1944). Among the natural phenomena with which man is linked geographically almost as closely as with air, water deserves a place of first rank (Kayastha, 1968). Water, a biological necessity, is of great economic significance. It is the supreme economic wealth even more than coal or gold. There is no house or human habitation in building of which man has not to take into account the proximity of water (Brunhes, 1952). Every organic process can occur only in the water medium.

Of late water is becoming a scarce commodity everywhere. What was free, has now become an economic commodity. Water resource includes not only the

resources of fresh water as found on land, but also of other elemets of hydrological cycle that can be recovered. Hence, in the evaluation of resources, each one of these elements has got to be considered in the proper perspective. The aim of this paper is to measure the water resource in respect of river basins, surface water, water resource and population, water used for drinking, domestic, irrigation, power generation, industry and potential water resource in the state.

River Basins

River basin study of any region is essential from the point of its irrigational potentiality. As Karnataka is suffering from inadequate rainfall, this situation has necessitated the development of river basins in the state. Karnataka comprises vast area of mountains and hilly topography, as a result of it, state has got good number of river courses like Krishna, Tungabhadra, Malaprabha, Ghataprabha and Bhadra in the northern part, Cauvery and Pennar in the southern part, Kali, Netravati, Sharvati, Aghanasini and Bedti in the western part. Rivers of northern and sourthern parts of the state have been considered as major river systems and the rivers which are flowing in the western part are classified as medium rivers in the national cotext. Again, some of the west flowing rivers like Chakaravati, Sita, Swaran and Gurpur have been considered as minor rivers (Fig. 1). In order to know the total area of different river basins, irrigation capacity etc., study has been made in the proceeding discussion.

East Flowing :

Godavari Basin

River Manjra, a tributary of Godavari is flowing in the Bidar district. The share of catchment area of this river to the totai catchment area of the Godavari is only 1.4 per cent or 30,844 sq. km. The river Manjra originates from Balaghat in Bidar district and it has two tributaries namely Tuna and Kanaya. The total length of this river is 724 km. and the average annual yield of this river is 7,640 million cubic metres. The low amount of annual yield is due to scanty rainfall over the catchment area of the river. Totally 2,000 hectares of land is irrigated with the help of this river.

Krishna Basin

The river Krishna, which is flowing in northern part of Karnataka through Belgaum, Bijapur and bordering Gulbarga and Raichur districts, has a total length of 450 km. and it has a total catchment area of 1,13,938 sq. km. in Karnataka. The state Government has started to construct two dams across this river. Upper Krishna project stage-I is under progress to complete dam, one at Almatti and another one at Siddapur in Bijapur district. Totally these dams are expected to irrigate about 4 lakh hectares in Bijapur and Raichur districts.

The important tributaries of Krishna river in the state are Ghataprabha, Malaprabha, Bhima and Tungabhadra. Western Ghat is the source for all these rivers. Ghataprabha has two sub-tributaries, namely, Hiranyakeshi and Markandeya. The total length of the river is 283 km. and the total catchment area is 8,829 sq. km. Malaprabha has no big sub-tributaries, the length of the river is 306 km. and the total catchment area is 11,549 sq. km. Bhima has three sub-tributaries, namely, Mula, Muthaghod and Nira, the total length of the river is 330 km. and the total catchment area is 29,363 sq. km. Tungabhadra is an important river in the northern part of Karnataka apart from Krishna. It has two sub-tributaries, namely Varda and the Hangari, the total length of the river is 531 km. and the total catchment area is 71,417 sq. km.

The average annual yield of Bhima river is 12,690 million cubic metres and the annual average yield of Ghataprabha, Malaprabha and Tungabhadra is 5380, 1980 and 16,000 million cubic metres respectively. With the help of all the rivers,

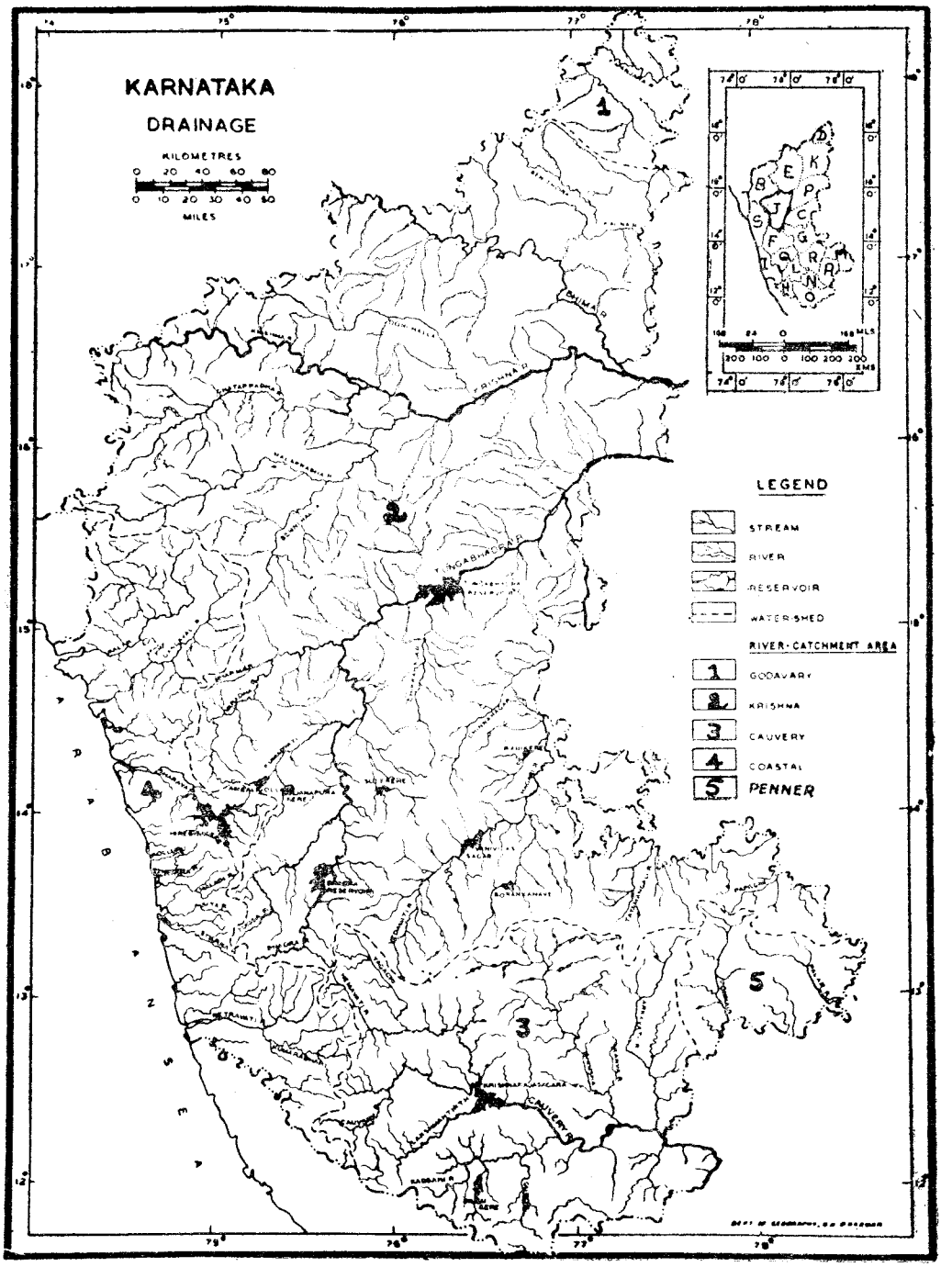
KARNATAKA
DRAINAGE
KILOMETRES
0 20 40 60 80
0 10 20 30 40 50
MILES
LEGEND
STREAM
RIVER
RESERVOIR
WATER-SHED
RIVER-CATCHMENT AREA
1 GODAVARY
2 KRISHNA
3 CAUVERY
4 COASTAL
5 PENNER
ARABIAN SEA
BAY OF BENGAL

Fig. 1

totally 9,37,000 hectares of land is irrigated in the northern districts of the state,

Dams have been constructed across these rivers at various places, namely, Hidakal and Dupadal dams across Ghataprabha, a dam (Saundatti) across Malaprabha river in Belgaum district. All these dams are irrigating 1.92 lakh hectares annually in Belgaum and Bijapur districts. Tungabhadra river has two dams. One across the Bhadra river at Lakkaval li village in Shimoga district and other one at Mallapuram near Hospet in Bellary district. Tungabhadra project irrigates nearly 1,82 lakh hectares of land in Bellary and Raichur districts. In addition to irrigation facilty, Tungabhadra project is also generating 18,000 kws. of electricity. Bhadra project irrigates 11,371 hectares of land in Chikmagalur, Chitradurga and, Shimoga districts. Apart from irrigation this reservoir also generates 25,000 kws. hydel power.

Pennar Basin

Pennar river originates from Chennakesava Hills in the Tumkur district. The total length of this river in the state is 45 kilometres and the total catchment area of this river is 6,625.6 sq. kms. Jayamangali is the tributary of Pennar in the state and the total lengh of this tributary is 55 kms. No doubt the catchment area of Pennar river is vast but the annual flow of water is too less due to lack of rainfall over the river basin. Hence, Pennar and its tributaries are not helping much for irrigation.

Cauvery Basin

Cauvery river originates in the Brahmagiri range of the western ghats in Coorg district. It is acting as a district boundary between Mandya, Mysore and Bangalore districts. The total length of this river is 330 km. and the total catchment area is 36,478.5 sq. km. in the state. River Cauvery has many tributaries and sub-tributaries in the state. The prominent tributaries of Cauvery are Harangi, Shimsha, Arkavati, Lakshmantirtha, Hemavati, Kabini and Suvarnavathi.

Harangi takes its birth from Coorg district, runs to the length of 35 kms. before joining the Cauvery. The catchment area of this river is 540 sq. km. Hemavati originates in Chikmagalur distict and it has two sub-tributaries namely Yagchi and Algur. The total length of this river is 165 kms. and the total catchment area is 5200 sq. km. Kabini originates in Mysore district, the total length of this river is 210 kms. and the total catchment area accounts to 6,693 sq. km. Suvarnavathi is the only tributary which is rising in Tamil Nadu and joining Cauvery in Karnataka, flowing towards north to the length of 64 kms. The total catchment area of this river is 1,689 sq. km.

The mean annual flow of all the tributaries of this river is huge due to good amount of rainfall over the catchment area of respective rivers. The mean annual flow of Harangi river is 1,130 million cubic metres, flow of Hemavati river is 2,520 million cubic metres and Shimsha river yields 1700 million cubic metres. The mean annual flow of river Arkavati, Lakshmantirtha, Kabini and Suvarnavathi is 850, 425, 2,600 and 620 million cubic metres respectively. River Cauvery and its tributaries are irrigating nearly 1,70,000 hectares of land in the state In addition to irrigation, Cauvery and Shimsha are generating 25,000 and 15,000 Kws. hydel power respectively.

West Flowing River Basins :

West flowing river basins consists number of rivers. All these rivers are short in length and run through the Western Ghats. West flowing rivers are not suitable for irrigation but they have huge hydel power potentiality

The prominent west flowing rivers are Kalinadi and Sharavati. Kalinadi originates in Belgaum district, runs to the length of 1,365 km. and finally joins the Karwar Bay. The Pandhi is its important tributary. The total catchment area of Kali river is 5,179 sq. km. A major-electric project has been bulit near Supa across this river. The total power generating capacity of this project is 910 Kws.

Sharavati has a catchment area of 2,209 sq. km. The world famous Gersoppa (Jog) falls is along this river course. A huge hydro-electric project with 890 and 120 Mw. installed capacity has been constructed on the river bypassing the falls. The Bedti river takes its origin near Dharwad in Dharwad district. The total length of this river course is 161 km. It has two tributaries, namely, Shalmala and Souda. After the confluence of Souda tributary, Bedti has been called as Gangavalli river. The remaining rivers of this basin are small in length and catchment areas. Thus, harnessing of these rivers seems to be more uneconomical at present.

Karnataka is fortunate enough to have good number of river courses in its administrative territory. The present use of all this river water either for irrigation or for power generation has not slowed down the demand of water for irrigation and power generation. Thus, it is high time to use the potentials of irrigating as well as power generating capacity of all these rivers in order to meet out the existing demand.

Surface Water Resource of Karnataka

Surface water has been a pivotal point in the development of civilization. It is an essential element in the evolution of the overall availability of ground water (Arogyaswamy, 1971). Surface water resource of Karnataka is controlled by rainfall. Due to the fluctuation in rainfall, surface water resource also varies tremendously. Because of this fact, some parts of the state are affected by floods in rainy season and the same regions are experiencing deficit of water in dry season.

Table I shows the seasonwise surface water resource availability.

Table - I

Seasonwise Water Resource Availability

1970-71 (Million cubic mts)

Seasons	Availability of water	Percentage to the total
South-west monsoon	147917.21	71.96
North-east monsoon	34271.56	16.67
Cold Weather	1519.70	0.73
Hot Weather	21841.68	10.64
Total	205550.16	100.00

Calculation based on "Ground Water Studies Department of Mines and Geology, Government of Karnataka". (See Appendix).

The above table gives a clear picture of water availability and its concentration during some parts of the year. More than Eighty-eight (88.63) per cent of surface water is available during south-west and north--east monsoon period.

Total Water Resource of the State

The total water resource includes surface water, Ground water and water available from the man made reservoirs. Table II shows the total water resources of the state.

Karnatka has more than 2.2 lakh million cubic metres of water resource and most of it is from rainfall and reservoirs. Very limited amount of water is added by ground water resource, because ground water survey in the state has not yet covered the whole area as such figures in detail are not yet available.

Table II

Total Water Resource of Karnataka

Source of Water	In Million Cubic Mts.	Percentage to the total
Surface Water	205550.16	91.154
Reseriovr Water	20104.80	8.842
Underground Water	9.80	.004
Total	225664.76	109.00

Districtwise total water resources of Karnataka shows the regional concentration and imbalance of water resource. This is due to the additional water resource from different reservoirs, constructed for irrigation and power generation. (See Table III A).

Daxin Kannada district has the highest amount of water resource in the state and it is followed by Uttar Kannada, Shimoga Chikmagalur, Belgaum, Gulbarga and Bijapur. Some of these districts have good number af dams but others have been supported by physiography and access to the sea which are causing heavy rainfall in these districts. Mandya district has the lowest amount of water resource in the state due to less rainfall and absence of reserviors.

Water Resource and Population

Water is an ingredient of human life Every state and indeed every human establishment is an amalgam made up of a humanity, a little soil and a little water (Kayastha, 1968). In the preceding para the study of water resource in relation to population of the state is dealt with.

The state as a whole, per capita availability of water is 7.70 thousand cubic metres, but it varies fron district to district. Uttar Kannada district ranks first in the per capaita water resource availability in the state and it is followed by Coorg, Chikmagalur, Daxin Kannada, Bellary and Gulbarga. It is due to the access of water availability. Bangalore district has the lowest per capita water resource in the state. This is mainly because of higher population in proportion to available water. The problem of water is growing day by day due to urban and industrial development in this district (See Table No. III B).

Water Resource Requirement for Domestic and Drinking Purpose

Water is inevitable for drinking and other domestic purpose. Domestic water use varies with the climate and with the stage of sophistication of the urban community (Pereira, 1977). It is allowed at the rate of 45.5 litres per day in the rural areas and 137 litres per day in the urban areas (Rao, 1975) (See Table No III C).

The state as a whole requires 725 million cubic metres of water for domestic and drinking purposes. Of this, rural population requires 368.64 million cubic metres of water and urban population requires 356.44 million cubic metres of water. Our population has grown above the normal expcetations and so has the amount of water needed to produce food and fibre and to fill the countless other needs of people for water (Kohler, 1969).

Bangalore district requires maximum amount of water for urban population than rural population due to higher proportion of urban population. It is followed by Dharwad, Mysore, Belgaum, Bijapur, Daxin Kannada and Kolar. This is due to the above factor. Coorg district requires lowest amount of water for drinking and domestic purpose due to lower proportion of population.

Table III

Districtwise Distribution of Water Resource

	Districts	A	B	C	D	E	F	G	H	I
A	Bangalore	6259.61	1.86	118.32	7431.85	5708.30	–	2085.5	0.86	4040·83
B	Belgaum	12834.29	5.30	56.91	30169.47	1905.68	–	4200.9	2.52	8541·84
C	Bellary	9268.12	8.28	28.84	10748.91	11231.28	35.4	3099.7	3.88	6078.32
D	Bidar	4809.56	5.94	17.67	4245.79	52.43	–	1623.2	6.15	3165.82
E	Bijapur	10152.66	5.11	47.07	10454.50	600.62	–	3500.6	3.58	6590.41
F	Chikmagalur	16124.38	21.79	16.08	1892.90	522.13	11.8	5293.9	1.29	10799.90
G	Chitradurga	7051.66	4.44	32.68	106556.95	1033.32	–	2067.1	0.31	4089.41
H	Coorg	11041.11	29·06	8.24	43.30	–	–	3680.4	3.12	7349.45
I	Daxin Kannada	32700.51	16.86	45.36	6544.45	657.84	–	10900.2	3.73	21744.07
J	Dharwad	9353.04	3.99	63.59	2385.95	63.10	–	3117.7	3.04	6166·27
K	Gulbarga	11230.69	6.45	39.24	3376.00	1582.75	–	3743.6	10.43	7441.91
L	Hassan	6998.48	6.36	23.31	2902.63	1411.71	–	2332.8	–	4637.97
M	Kolar	5918.48	3.92	35.67	11011.56	98.70	–	1972.8	1.87	3888.06
N	Mandya	3379.11	5.94	24.48	14166.59	1107.50	24.3	1126.3	–	2188.76
O	Mysore	10397.30	5.00	52.21	3557.59	946.53	–	3465.8	52.27	6822.52
P	Raichur	8302.52	5.85	30.79	14803.95	698.74	–	2767.5	3.24	5485.46
Q	Shimoga	20284.25	15.47	31.90	7328,73	32831.55	55.7	6704.4	5.33	13275 97
R	Tumkur	7156 71	4.39	33.41	7553.89	858.51	–	2385.7	–	4729.19
S	Uttar Kannada	31973.46	37.62	19.14	2034.58	7957,65	–	10657.8	9.82	21276.77
	Other Sources	349.00	7.70	725.08	151309.57	69368.35	127.2	74726.9	111.44	149583.75
	State	225644.94								

Note : A – Districtwise total water resource in million cubic metres. (See Appendix for details)
B – Per capita water resource availability in '000 cubic metres.
C – Drinking and domestic water requirment in million cubic metres.
D – Water used for irrigation in '000 cubic matres.
E – Water used in the industries in '000 cubic metres.
F – Water used for power generation in million cubic metres.
(Data collected from respective power stations).
G – Annual evaporation in million cubic metres.
H – River run off in million cubic metres.
I – Potential water resource in million cubic metres.

Water Used for Irrigation Purpose

Next to drinking and domestic purposes, agriculture which has held a dominent position in the country's economy depends entirely on water supply, but this major occupation is rendered hazardous by scanty rainfall in large areas and erratic monsoons elsewhere. Partial failure or even delayed arrival of the monsoon can cause extensive damage to the concerned crops. (Memoria, 1975). Hitherto our Government has not fully developed the irrigation in the state. The amount of water used for irrgation varies from place to place and crop to crop due to the local climatic and soil factors. Now a days Government is giving lot of encouragement and importance for the irrgation of more land in order to increase foodgrain production in the state (See Table III D).

Karnataka is using every year more than 150 million cubic metres of water for irrigation. But the amount of water used for irrigation varies from district to district In this respect Belgaum district stands first and it is followed by Raichur, Mandya, Kolar, Bellary, Chitradurga, and Bijapur. As many of these distticts come under dry area they require more water, specially for irrigation. Coorg district uses lowest amount of water for irrigation in the state. It is due to lack of irrigation which is controlled by physiography and heavy rainfall in the districts.

Water Used for Industrial Purpose

Industries require several primary resorces for their production. Among them water is one of the important natural resources without which industry cannot function. Water as a localizing factor has become of increasing importance in recent years. As a result of new technology in many industries the demand for water has increased greatly (Miller' 1962). Water is needed in several ways, it starts from the cleaning of the raw materials to the cooling of the machine. Water is also necessary in manufacturing the products and there is no other similar resource in the world which can replace the water in industrial use. Thus water plays an important and essential role in the industrial producttion and establishments. Water used in industries varies from one industry to another according to their variety of products. (See Table III E).

The state is using more than 69 million cubic metres of water for industries. Shimoga district ranks first and it is followed by Bellary, Uttar Kannada, Bangalore, Belgaum, Gulbarga, Hassan, Mandya and Chitradurga. This is due to the presence of good number of large and small scale industries. Bidar district uses very little amount of water for industrial purpose. It has few industries in the state.

Water Used for Power Generation

Water has been used for centuries to help man in his work, but power secured from water in the modern sense is a recent development (Chaudhari, 1970). Hence water is one of the most important resource for power generation. Karnataka State is not endowed with enough coal or oil but has enough water power potentials. So Karnataka is one of the most important power generating states in India. (See Table III F).

The State is using annually more than 127 million cubic metres of water for power generation. Shimoga district stands first in the consumption of water for power generation and it is followed by Mandya, Bellary and Chikmaglur. This is on account of the existence of the major power projects. Kali project, which is under construction, will be the biggest power producing station in Asia. First phase of Kali provides 4100 million units (Kwh) (Probhuswami, 1973).

Wastage of Water by Natural Factors

There are several ways through which surface water is wasted. Among them evaporation and run off by the river courses and land are important agents. The rate of evaporation of water is high, hence, large amount of water is lost from reservoirs and

natural water bodies through this process (Huberty, 1959). Evaporation and transpiration together take a toll of soil water in response to a number of conditions (Ackerman et-al. 1960). As a result Karnataka is losing more than 74,000 million cubic metres of water annually through evaporation (See Table III G &H).

Daxin Kannada district loses highest amount of water through evaporation and it is followed by Uttar Kannada, Shimoga, Chikmagalur, Belgaum, Coorg, Bellary, Bijapur and Gulbarga. This is mainly due to their location in the tropical belt. The districts like Daxin Kannada, Uttar Kannnda, Shimoga, Chikamaglur, etc., have large areas nnder forests and thereby lose lot of water through evaporanspiration. But Bellary, Gulbarga and Bijapur districts are loosing huge amount of water due to eccessive evaporation.

The State is loosing more than 100million cubic metres of water annually by river runoff. Mysore district loses the maximum amount of water through river runoff and it is followed by Gulbarga, Uttar Kannada, Bidar, Shimoga, Bellary, Daxin Kannada, Bijapur, Raichur, Coorg and Dharwad. This is mainly due to the presence of major rivers in these districts. However Chitra durga district is losing veary little amount of water through runoff. It is mainly due to the small and scanty river system.

Potential Water Resource of Karnataka

The State has nearly 1.5 lakh million cubic metres of potential water resource for future use. It gives us a clue to the economic and industrial boon in the state in the near future, because water is a vital resource, and without which no occupation and activity will be carried out. The potential water resource varies from district to district. Chikmagalur and Coorg districts stand first in water potentlality and these are followed by Belgaum, Daxin Kannada, UttarKannada, Gulbarga, Hassan, Raichur, Shimoga, Tumkur, etc. because all these districts have extensive geographic area and also receive good amount of rainfall. Bijapur and Bang galore are the only districts in the state which are facing water defficiency. This is mainly due to high demand for water in Bangalore districts and scanty rainfall in Bijapur districts (See table III, I).

Conclusion

Even the though state has abundent water resource, yet it is in the stage initial scarcity. It is due to the lack of technological development in case of utilizing available water resource. Thus, it is necessary to implement quick growing crops in order to use the abundent rain water during different seasons. Further, it is also necessary to construct few more dams and interconnecting canals between different rivers. Such type of use may reduce the scarcity of water resources and help to increase the economy of the state.

Appendix

(For Table - III)

A. 1 mm rainfall over one hectare land area will yield 8,76 cubic metres of water. Ground water studies, Department of Mines and Geology, Government of Karnataka.

C. **Water for Drinking and Domestic Purpose (K. L. Rao)**

Water is required for drinking and other domestic uses and is allowed at the rate of 45 o litres per day in the rural areas and 137 litres per day in the urban areas (p. 178).

D. Water Consumption by Crops (K. L. Rao).

For one ha, 100 mm depth would mean 1000 cubic metres for example, for wheat the depth of water required is 500 mm that is the quantity of water for the crop will be 5000 cubic metres. If we assume the yield as 2.5 tons per hs. the water required for producing one ton of wheat is 2000 cubic metres or 2 million litres (p120).

Rice	- 12 mm per day on clay soil 18 mm per day on loams.
Sorghum	- 500 to 600
Pearl millet	- 500 to 600
Maize	- 500 to 800

Wheat	- 500 to 600
Sugarcane	-2000 to 4000
Cotton	- 700 to 750
Tobacco	- 500 to 600
Groundnut	- 600
Potato	- 450-600
Onion	- 700 - 800

E. Water Requirements for Industries (K. L. Rao)

Sugar	...	15000 litres per ton
Vanaspati	....	15000 litres per ton
Pulp and paper	...	125000 to 200000 litre per ton
Cotton cloth	...	10 litres per sq. yard.
Iron and Steel	...	60000 to 130000 litres per ton.
Aluminium	...	80000 litres per ton
Cement	...	1500 litres per ton

(P. 177)

G. **Annual Evaporation** : Calculation is based on ; K. L. Rao, " Scope of Hydrology in India " in Bhagirath, July 1965, p. 61. (unit of evaporation : 0.39 million cubic mts. per sq. km.).

H. River run off :

This figure for the river systems of Karnataka is taken from Table 4.3 to 4.6 (page No. 46, 48, 49 and 50) of K. L. Rao, water wealth of India.

I. Potential Water Resource :

It has been calculated using the following formula :

$$p = \left(1 - \frac{x}{y}\right) \times 100$$

P = Potential water resource
x = Total watar resourec used
y = Total water resource available

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