THE REPORT

OF

THE CAUVERY WATER DISPUTES TRIBUNAL

WITH THE DECISION

IN THE MATTER OF WATER DISPUTES REGARDING THE INTER-STATE RIVER CAUVERY
AND
THE RIVER VALLEY THEREOF

BETWEEN

1. **The State of Tamil Nadu**
2. **The State of Karnataka**
3. **The State of Kerala**
4. **The Union Territory of Pondicherry**

VOLUME III

AVAILABILITY OF WATER

NEW DELHI
2007

VOLUME III

Availability of Water

(Issues under Group II)

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Chapter 1

SURFACE FLOWS

The yield of a river system is the annual virgin flows at its terminal site. The yield or the total available quantum of water in a river system depends upon rainfall pattern, catchment area characteristics including soil and vegetal cover, and various climatic parameters affecting evaporation and evapo-transpiration in the basin. The annual yield of a given basin varies from year to year depending upon the occurrence of the rainfall, its intensity and distribution in time and space. In a virgin river system, i.e., a river basin where the natural river flows have not been withdrawn for any use, the assessment of the total yield becomes easy, based on the gauge and discharge observations. However, such a situation is hard to come across, because practically in every river system, there have been withdrawals of water for different uses by man. Therefore, to assess the available yield in a river system, the observed flows at different gauge and discharge sites have to be considered along with the withdrawals of water for different uses like irrigation, hydro-power generation, domestic and industrial water use etc. above each such gauging station. The computation of total annual flow including upstream withdrawals at the terminal site is termed as yield of the river system. Since the annual yield of a river varies from year to year depending upon the rainfall distribution, consequent run-off and withdrawals etc., such data is collected for a number of years to assess the reliable yield. In order to take care of wet and dry cycles, and to even out their effect, it is preferred that data for as many years as is available should be considered, provided that data is homogeneous and reliable.

2. For more than a century disputes are being raised between the then States of Madras and Mysore now the States of Tamil Nadu and Karnataka in respect of sharing of the waters of river Cauvery. Such disputes are often raised when an inter-State river or international river passes through different States or nations. Courts are faced with the situation as to how to sort out the claim of each State or the nation, as the case may be, on some reasonable and rational basis. These disputes obviously are linked with more demand for the water of such inter-State or international rivers in connection with different development projects including generation of electricity. Each State or country through which inter-State or international river passes treats the water within their State or nation as a divine gift which has to be utilised by that State or nation exclusively for its development and to fulfil its necessities. In this process, the upper riparian States are in privileged position as upper riparian State claims exclusive right to utilise the water within its territory. This attitude is bound to affect the lower riparian State if the water in such river is not sufficient to cater the needs of all States through which such river passes. A booster came in the year 1895 to such claims and rights for exclusive use of the water of the river by a particular State irrespective of the necessity and need of the lower riparian States when the Attorney General Harmon of the United States put forward a doctrine that riparian States have exclusive or sovereign rights over the water flowing through their territories. There was a clear anomaly in this doctrine while implementing the same specially in cases where the water of such river was not sufficient for all the States through which it passed. In many cases, it was discovered that total appropriation of the water by upper riparian State led to

deprivation of the right to use of the water of such inter-State river by lower riparian State. The higher riparian State claimed its exclusive right to utilise the waters on basis of the aforesaid Harmon doctrine claiming that it had sovereign right to utilise the water in whatever manner it likes within its territorial jurisdiction. On the other hand, the lower riparian States asserted that they were entitled to water of such inter-State or international rivers in their natural flow without any interference or alteration in their character. Both types of claims and assertions by the upper riparian and lower riparian States created not only disharmony, but also anomaly. At different forums thinking started, that when the nature had provided such inter-State or international rivers for common benefit of the community as a whole through whose territory they flowed how any territory through which such rivers pass could be deprived or could be given the exclusive right to utilise the waters of such rivers.

3. In one of the earlier cases, in which the Supreme Court of United States had to consider this question is *Kansas* v. *Colorado* {206 U.S.46 (1906)} and the conflicting claims by upper and lower riparian States was resolved. That case and other cases which followed thereafter including the opinion of the Supreme Court in a reference under Article 143 of the Constitution by the President of India in connection with this very river Cauvery have been discussed in chapter under the heading 'Principles of apportionment of waters of an inter-State river'. On the basis of those judgments now it can be said that it is almost settled that right of a State through which an inter-State river flows is subject to certain restrictions with respect to the quantity of water which the said State is entitled to receive or utilise. The other riparian States have the same right in

respect of the reasonable enjoyment of it. Each riparian State has a right of action in respect of any unreasonable use of the water by another riparian State. A higher riparian State must not use the water so as to cause any material injury to the lower riparian State which has the equal right to use of the water. The cardinal rule underlying between the different riparian States in respect of use of the water of an inter-State river is that of equality of right. Each State stands on the same level with all the rest. This principle is being described as the principle of equitable apportionment between the different riparian States in respect of the waters of an inter-State river. No doubt, the principle in respect of equitable apportionment of the water is settled, but what shall be the equitable apportionment in respect of different riparian States so far the water of such inter-State river is concerned is itself a big question. It becomes all the more complicated if the apportionment of the waters relates to a river which does not have enough water to cater the needs of different riparian States. Cauvery is one such river. If each riparian State starting from Kerala, Karnataka, Tamil Nadu and Union Territory of Pondicherry wish to utilise its water to their satisfaction and desire, it cannot fulfil their need and necessity. It is not in dispute that the total amount of water available in river Cauvery through surface flows and alternative resources are much less than what the different States claim and require for their irrigation, electricity, drinking water and to run different projects. In this background, the task of the Tribunal has become very difficult as to how to apportion the waters of river Cauvery between the different States so that river Cauvery remains a blessing and not a river of sorrow for these States.

4. In order to settle the dispute between the different riparian States like States of Kerala, Mysore, Tamil Nadu regarding sharing of the waters of the Cauvery and its tributaries, efforts were being made by the then Minister of Irrigation Dr. K.L. Rao and in that connection a meeting was held on 29th May 1972 at New Delhi between the Chief Ministers of Mysore, Tamil Nadu and Kerala. The Union Minister for Irrigation and Power alongwith others were present in the said meeting. The notes of discussions regarding Cauvery held on the said date were duly recorded and were signed by the Union Minister for Irrigation and Power and the three Chief Ministers of Mysore, Tamil Nadu and Kerala. It is advisable to reproduce the same which is as follows:

> "Union Minister for Irrigation and Power stated that river problems are best settled through negotiations and this was the course the Central Government was adopting for the last few years in settling the differences on the use of waters of Cauvery. Earlier, it was aimed to arrive at an interim agreement to be valid till 1974, when the earlier agreement of 1924 would have come up for review after 50 years, as provided in the agreement. Now, as 1974 is near, this attempt has been given up in favour of finding an overall approach to solve the problem amicably amongst the several States. The discussions amongst the Chief Ministers revealed general consensus on the three following points as in para 2.
>
> 2.1 A serious attempt should be made to resolve by negotiations the Cauvery dispute between the States as early as possible.

2.2 The Centre may appoint a Fact Finding Committee consisting of Engineers, retired Judges and, if necessary, Agricultural Experts to collect all the connected data pertaining to Cauvery waters, its utilisation and irrigation practices as well as projects both existing, under construction and proposed in the Cauvery basin. The Committee will examine adequacy of the present supplies or excessive use of water for irrigation purposes. The Committee is only to collect the data and not make any recommendations. The Committee may be asked to submit its report in three months' time.

2.3 Making use of the data, discussions will be held between the Chief Ministers of the three States to arrive at an agreed allocation of waters for the respective States.

3. Union Government will assist in arriving at such a settlement in six months, and in the meanwhile, no State will take any steps to make the solution of the problem difficult either by impounding or by utilising water of Cauvery beyond what it is at present.

Sd/- K.L. Rao, 31.05.72. Sd/- D.Devaraj Urs, 31.05.72.
Union Minister for Irrigation & Power Chief Minister for Mysore.

Sd/- M. Karunanidhi, 31.05.72. Sd/- C. Achutha Menon, 31.05.72.
Chief Minister of Tamil Nadu. Chief Minister of Kerala."

(Ref. TN Vol. XV Exh. 839, Pages 1 & 2)

5. Pursuant to the said agreement a Fact Finding Committee was constituted by the Govt. of India vide resolution No. 14/6/72-WD dated 12.6.1972 consisting of engineers, a retired Judge of the High Court and other experts to collect all the connected data pertaining to Cauvery waters, its utilisation and irrigation practices as well as projects both existing, under construction, and

proposed in the Cauvery basin. The Committee was only to collect the data and not to make any recommendation. The terms of the reference of the Committee were:

> "(i) To collect all the connected data pertaining to Cauvery waters; its utilisation at different points of time; irrigation practices; as well as projects both existing, under construction, and proposed in the Cauvery basin.
>
> (ii) to examine adequacy of the present supplies or excessive use of water for irrigation purposes.
>
> (iii) to collect data relevant to the use of water in different States like the physical and other features; cultivated areas; existing and proposed uses for domestic and industrial water supply; hydro-electric power generation, navigation, salinity control and other non-irrigation purposes.
>
> (iv) Any other connected matters."

The Committee was to commence its work with effect from 15th June 1972 and to submit the report to the Government of India by 15th September 1972. The Central Water and Power Commission was asked to provide technical and secretarial staff for assisting the Committee.

6. As the data from the different States were not received by 15th September 1972 the term of the Committee was extended upto 15th December 1972. The data were received from Kerala on 21st September 1972; from Mysore on 19th October 1972 and from Tamil Nadu on 24th October 1972. Both Mysore and Tamil Nadu supplemented their data during the discussions with the Committee at New Delhi from 7th to 14th November 1972.

7. During the discussions with the Cauvery Fact Finding Committee, the States of Kerala, Tamil Nadu and Mysore filed statements giving their assessment of the total yield in the Cauvery basin. According to the State of Kerala, the total yield of the Cauvery basin was 663.24 TMC; according to the State of Tamil Nadu, the total yield was 600 TMC; and so far as the State of Mysore was concerned, according to them, the total yield of the whole Cauvery basin was 760 TMC. In the statements, the three respective States also gave break-up of the yield in the three States separately and then the total thereof (Vide page 113, 115, & 117 of TNDC Volume XIV). In the proceedings of the meeting held on 10.11.1972 at New Delhi with the Cauvery Fact Finding Committee, the fact that the yield calculations were presented by the Mysore representatives is also recorded as under:-

> "The Mysore representatives then furnished the yield calculations for the Cauvery Basin in Mysore, Kerala and Tamil Nadu and according to this statement, the total yield worked out for the whole of the Cauvery Basin is 760 TMC."

8. Some clarifications had been asked from the States during the discussions and during the visit of the Committee to Mysore and Tamil Nadu. In the report the Committee has pointed out that the data supplied by the three States was in 20 volumes. Apart from that, the States also gave the project reports for study of the Committee which was in 36 volumes. After careful examination and scrutiny, the Committee submitted its report on 15th December 1972. During this period the members of the Committee visited different States and sites for collecting the data on different questions including the availability of the total run-off i.e. water in the Cauvery basin. In view of the stand taken by the

three States the Committee thought it advisable to scrutinise the data with a special reference to the years 1901, 1956 and 1971. As desired by the different States to inspect the data supplied by the other States the Committee made available the data supplied by different States for inspection of the other States and permitted to offer their comments which the Committee had taken into consideration. The Committee had pointed out that discussions were held in cordial and free manner with exchange of data and clarifications. After discussions it was decided that periods for consideration of the water uses should be considered with a specific reference to the years 1901, i.e. the commencement of the century , 1956 at the time of the re-organisation of the States and at the mid-point of these two (i.e. 1928) and then lastly in the year 1971. The States supplied revised figures of withdrawal and areas under irrigation for these periods and these data were also exchanged between the States. The Committee also took into consideration report of the Second Irrigation Commission 1972 which had dealt at length with the problems of these States and particularly of the Cauvery basin. They also collected relevant material available with the Planning Commission, Central Water and Power Commission, Ministry of Irrigation and Power, Ministry of Food and Agriculture, Registrar of India, India Meteorological Department, Water Technology Centre of I.A.R.I. and other sources.

9. It will appear from the report of the Committee that it is very exhaustive and illuminative with all the relevant data on different questions that have been furnished. In the beginning, the details of the Cauvery basin with reference to the different States and areas within those States have been mentioned;

thereafter the Cauvery river system has been discussed in detail mentioning the origin of river Cauvery and its different tributaries in different States. Thereafter the claims presented by the States on Cauvery waters have been discussed. First, the case of the Kerala has been discussed on the basis of Memorandum submitted before the Committee. In the said Memorandum it had been impressed that though the catchment area in Kerala territory is the least but substantial contribution to the total run-off (as much as one-third) was being made by the catchment lying in Kerala on account of very high rain-fall in the said area. After mentioning the requirement of Kerala for water for successful paddy cultivation and hydro-power resources and generation it has been said that according to the Government of Kerala their territory contributes about 214 TMC of water to the Cauvery basin out of which they propose to utilise 208.7 TMC for irrigation and power production including 50.7 TMC for diversion from east to west.

10. The State of Mysore claimed that it needed water for irrigation and domestic water supply for the State which in future shall be about 410 TMC against their estimated contribution of 480 TMC.

11. Tamil Nadu claimed that it had very few water resources and the Cauvery delta was a rice bowl of the State where bulk requirement of rice is produced. Although there were other rivers in the State, but Cauvery was the only dependable one. It was also said on behalf of the Tamil Nadu that for dependable supplies to the delta the State had to depend on upstream catchment in Kerala and Mysore. According to the Tamil Nadu their present use at that time was 573.4 TMC and the ultimate planned utilisation to meet the

needs of irrigation, domestic, industrial uses etc. could be 641.5 TMC. The Committee has noted that according to Tamil Nadu schemes for modernisation have been taken up and in that connection it has been stated:

> ".....To improve the existing irrigation and achieving better water management control; to avoid over-withdrawal by some areas and to avoid complaints at the tail end, the Cauvery Delta system is proposed to be modernised. This shall be achieved by construction of several important works including sinking of filter points to provide irrigation supplies in early nursery period and late maturity periods when it may not be possible to release waters from Mettur." (Ref. TN Vol. XV, Exh. 840, Page 43, Para 4)

12. Then the Committee has said under heading 'Total requirements of Cauvery Waters as claimed by the States' as follows:

> "It can be seen from the above that according to the Government of Kerala the present use of Cauvery waters within that State is 142 M.cu.m. (5 TMC) and the ultimate planned utilisation to meet the needs of irrigation, power production (by westward diversion), domestic and industrial uses etc. would be 5910 M.cu.m. (208.7 TMC).
>
> According to the Government of Mysore their present use is 4848 M.cu.m. (171.2 TMC) and the ultimate planned utilisation to meet the needs of irrigation, domestic and industrial uses etc. would be 11613 M.cu.m. (410.1 TMC).
>
> According to the Government of Tamil Nadu their present use is 16237 M.cu.m. (573.4 TMC) and the ultimate planned utilisation to meet the needs of irrigation, domestic and industrial uses etc. would be 18168 M.cu.m. (641.5 TMC) (including requirements of Pondicherry).

According to these claims the total planned proposed utilisation, after taking into account existing projects, projects under construction and future projects by the three States would thus be 35693 M.cu.m. (1260TMC) from the Cauvery waters. This is made up of 1435.7 M.cu.m. (50.7 TMC) for power generation by westward diversion, 26321 M.cu.m. (929 TMC) for Major and Medium irrigation works in the Cauvery Watershed, 1246 M.cu.m. (44 TMC) for irrigation use outside the Cauvery Watershed, 3846 M.cu.m. (135.8 TMC) for minor irrigation works, 1218 M.cu.m. (43 TMC) for reservoir evaporation losses and 1614 M.cu.m. (57 TMC) for domestic and industrial requirements.

Thus the total present utilisation of Cauvery waters as indicated by the States is about 21238 M.cu.m. (750 TMC) against the total planned use of 35693.00 M.cu.m. (1260 TMC)." (Ref. ibid. Pages 43-44)

13. It may be pointed out that before the Committee the State of Kerala had admitted that by the year 1972 they were utilising 5 TMC of the water only. Similarly, Mysore had admitted that they were utilising only 171.2 TMC. Tamil Nadu, however, was utilising 573.4 TMC. Taking all present utilisation the Committee recorded that the present utilisation was 750 TMC although the total planned use was 1260 TMC. Again at page 51 of TN Vol. XV under the heading 'SUMMARY OF EXISTING IRRIGATION AND OTHER CONSUMPTIVE USES' the present use of the waters of the Cauvery by different States have been discussed with reference to the years 1901, 1928, 1956 and 1971 and it has been summarised as follows:

"**Kerala**

The utilisation of Cauvery waters by the Kerala State was very little in 1901 and even by 1928 the utilisation was only 3 M.cu.m. (0.1 TMC) for a few minor schemes. By 1956, this had increased to 42 M.cu.m. (1.5 TMC) and by 1971 it is estimated to be 142 M.cu.m. (5.0 TMC). All this utilisation was purely for minor irrigation schemes, there being no major and medium irrigation schemes.

Mysore

At the commencement of this century, irrigation in Mysore was mainly from direct diversion channels from rivers to the extent of nearly one lakh acres. The system of tank irrigation was very wide-spread and nearly 80940 hectares (2 lakh acres) were under irrigation from such tanks in the basin. 770 M.cu.m. (27.2 TMC) was withdrawal for major and medium schemes and 1288 M.cu.m.(45.5 TMC) for the minor schemes. No definite information is available regarding the domestic and other industrial uses. By 1928 also there was no appreciable change in irrigation systems. With the construction of Krishnarajasagar Reservoir which came into operation in 1931, development of irrigation had received a fillip and by 1956 the irrigation from major and medium schemes had increased to nearly 121410 hectares (3 lakh acres). The minor irrigation registered a small increase of about 8094 hectares (20,000 acres). The total withdrawals were 2435 M.cu.m. (86 TMC) for major and medium, 1416 M.cu.m. (50 TMC) for minor and 113 M.cu.m. (4 TMC) for domestic and industrial uses, evaporation losses from reservoirs being about 159 M.cu.m. (5.6 TMC). Subsequently;, a few other reservoirs were also constructed like the Nugu, Marconahalli etc. and the extent of irrigation increased to nearly 174212.8 hectares (4,35,532 acres) by 1971 and minor irrigation registered further increase of nearly 8094 hectares (20,000 acres). The withdrawals for major and medium schemes was 2976.4 M.cu.m. (105.1 TMC) and for minor schemes 1549 M.cu.m. (54.7 TMC) and 142 M.cu.m. (5 TMC) for domestic and industrial uses. Evaporation losses from

Reservoir were about 181.25 M.cu.m. (6.4 TMC). In addition, a large-scale programme of irrigation development has been initiated by the Government of Mysore and construction of several projects has been taken up. According to their Master Plan, the State Government has indicated that about 2621.6 M.cu.m. (92.57 TMC) is the requirement for such projects which have not yet come into operation but are under construction.

Tamil Nadu

The irrigation development in Tamil Nadu started much earlier and some of the systems like the Cauvery Delta are centuries old. By 1901 nearly 566580 hectares (14 lakh acres) were being benefited from major and medium schemers and 89034 hectares (2.2 lakh acres) from minor irrigation works. The development of tank irrigation in the basin was also very widespread. The withdrawals were 10899 M.cu.m. (384.9 TMC) for major and medium schemes 1274 M.cu.m. (45 TMC) for minor irrigation and 34 M.cu.m. (1.2 TMC) for domestic and industrial uses. By 1928, there was no improvement except for slight increase in domestic and industrial consumption which increased to 59 M.cu.m. (2.1 TMC). With the construction of Mettur Dam which came into operation in 1934 and the Lower Bhavani and Amravathi reservoirs, there has been addition to the areas being benefited by irrigation and by 1956 nearly 837729 hectares (20.7 lakh acres) were being benefited from major and medium schemes and 97128 hectares (2.4 lakh acres) from minor irrigation schemes. The withdrawals were 13745 M.cu.m. (485.4 TMC) for major and medium irrigation schemes, 1360 M.cu.m. (48 TMC) for minor irrigation schemes, 88 M.cu.m. (3.1 TMC) for domestic and industrial uses and about 23 M.cu.m. (0.8 TMC) was evaporation loss. By 1971, there has been further increase in the irrigation, nearly 10,23,890 hectares (25.3 lakh acres) being benefited from major and medium irrigation schemes and 116000 hectares (2.9 lakh acres) from minor irrigation schemes. The withdrawals were 14198 M.cu.m. (501.4 TMC) for

major and medium schemes, 1642 M.cu.m. (58 TMC) for minor irrigation schemes and 142 M.cu.m. (5 TMC) for industrial and domestic uses, 255 M.cu.m. (9 TMC) being evaporation losses.

Thus the existing consumptive use in the basin as indicated by the States is 142 M.cu.m (5 TMC) by Kerala, 4848 M.cu.m.(171.2 TMC) by the Mysore and 16237 M.cu.m. (573.4 TMC) by Tamil Nadu, giving the total consumptive use of 21226 M.cu.m. (749.6TMC) or say 21238M.cu.m. (750 TMC).The areas receiving benefits of irrigation and the consumptive uses from time to time, are tabulated in statement form at the end of this chapter." (Ref. ibid. Pages 51 to 53)

14. The utilisation of Cauvery water in the years 1901, 1928, 1956 and 1971 by different States have been tabulated including the areas under irrigation and the water use for irrigating those areas by different States. A copy of the same reproduced in the succeeding pages.

Statement attached at the end of this volume

Statement attached at the end of this volume

15. Thereafter the Committee has discussed the different projects in different States, land-use, cultivated areas and agriculture practices, geology, soils and minerals. It has also given the details of the climate, rainfall and water resources in different States.

"**Climate, Rainfall and Water Resources**

CLIMATE

The climate of Cauvery river basin may be described as essentially a tropical monsoon type, which is a product of the interplay of the two opposing air masses of the South-West and North-East Monsoons. The following four distinct seasons occur in the basin.

1. Cold weather period (January-February)
2. Hot weather period (March-May).
3. South-West Monsoon period (June-September).
4. North-East Monsoon period (October-December).

Cold Weather Period or Winter Season

The Winter season commences from December and continues till the end of February. During cold weather period, the weather is usually dry and sunny and generally free from rains. In December, which may be taken as representative of the winter months, the mean – daily minimum temperature over the Cauvery catchment varies from 8.6^0C at Kodaikanal to 22.8^0 C at Nagapattinam indicating that the mean daily minimum temperature increases from West to East. The minimum temperature ever recorded was 2.8^0 C on 30th December 1922 at Kodaikanal.

Hot Weather Period or Summer Season

The hot weather period begins with March and increases in intensity towards the end of May. The month of May is the representative of this season, during which the mean daily maximum temperature ranges from 20.4^0 C at Kodaikanal to 35.5^o C at

Nagapattinam. This period is usually dry except for occasional pre-monsoon showers.

South-West Monsoon Period

The Cauvery basin receives the major portion of its rainfall from the South-West Monsoon. The South-West Monsoon usually sets in about the end of May or early in June. It continues with some intervals till the end of September. 48.3% of the annual rainfall occurs during this period. During July which may be taken as representative of the monsoon months, the mean daily maximum temperature is 11.5^0 C at Kodaikanal and it increases to 26.3^0 C at Nagapattinam. Heavy showers of rainfall generally occur in association with the monsoon depression from the Bay of Bengal and Arabian Sea. Heavy rainfall generally comes in the form of torrential storms during the period of the South-West monsoon usually with a peak in September.

North-East Monsoon Period

The North East monsoon period is from October to December. It is during this period that the eastern coastal belt gets most of rain. 33.5% of the annual rainfall occurs during this period in the basin while 52.5% of the annual rainfall is recorded for the basin from its confluence with Amaravathi upto the mouth of the Cauvery. The mean daily maximum temperature recorded at Coimbatore is 30.4^o C during October while the mean daily minimum temperature recorded at Mercara is 14.6^0 C during December.

……

Rainfall

There are in all 224 existing raingauge stations (Reporting to India Meteorological Department) inside the Cauvery basin. These raingauge stations are more or less uniformly distributed over the entire basin and their number is fairly adequate. In view of the reasonably good net-work of raingauge stations in this basin, sub-catchments and sub-basins rainfall averages have been worked out

as the arithmetic means of the normals of the raingauge stations in the respective sub-catchments and sub-basins.

The rainfall in the basin varies from State to State. In the State of Kerala, normal annual rainfall in the basin is about 2872.8 m.m. In the high ranges of the Western Ghats it is as high as 4435 m.m. at Vayithri in Kozhikode District but is as low as 1348.9 m.m. at Marayur in Kottayam District. Most of the rainfall occurs in the Cauvery basin during the South West Monsoon which commences from June and lasts till September end. A notable feature of rainfall in this region is that the coefficient of variation (%) is as low as 15.

In the Coorg District of Mysore lying in the Cauvery basin, the normal annual rainfall is of the order of 2400 m.m. and the most of the rainfall is received during the South-West Monsoon. The variation of normal annual rainfall in the district is very much marked as the normal annual rainfall at Bhagamandala is 6032.3 m.m. while it decreases to 1120.0 m.m. at Fraserpet in the north of the district. The other districts of the Mysore State constituting the Southern Maidans, through which the river flows, and which fall in the rain-shadow zone of the Western Ghats, receive on an average about 691 m.m. (for Mandya district) to 761.9 m.m. (for Mysore district).

In Tamil Nadu, the average annual rainfall in the Cauvery basin upto the confluence with Amaravathi, is 1010.4 m.m. The average annual rainfall is maximum in the Nilgiris wherein the average annual rainfall at Devala is 4045.8 m.m. The contributions of both the South West monsoon and North East monsoon towards the rainfall in the basin upto the confluence with Amaravathi are almost equal and are of the order of 390.4 m.m. and 387.9 m.m. respectively. The districts of Tanjore and Tiruchirapalli are influenced more by North East monsoon. The rainfall contribution by the North East monsoon to this portion of the basin between the confluence with Amaravathi to the confluence with the Bay of Bengal is 526.7

m.m. while South-West monsoon contributes an average rainfall of 299.1 m.m. only.

Both the monsoons are of great importance to the Basin, especially the South-West monsoon. The North-East monsoon is chiefly important as the source of water supply for tanks, where the topography and soil types allow their construction. Apart from the two monsoon periods, some rainfall takes place in all the districts of the basin, during the hot months (March-June). In the Nilgiris, substantial rainfall takes place during the period March to May. The district has a much higher rainfall and a much better distribution over the year. The average annual rainfall in the Nilgiris district is about 1930 m.m.

The Cauvery basin upto Mettur Dam is under the influence of the South-West monsoon. Downstream of Mettur Dam, the Cauvery catchment is under the influence of the North-East monsoon and the high floods due to this monsoon usually occur in November."

16. Under the heading 'Water Resources', surface waters in different States in different years have been mentioned and discussed at pages 82 to 92 as follows:

"*Surface Waters*

The water potential of the Cauvery river system has been assessed at different times by different authorities. The first assessment was made by the First Irrigation Commission. This Commission used the records of the surface flow of the Cauvery from a greater part of its catchment extending back over a large number of years to estimate the average flow as accurately as possible. According to the above assessment, the total annual surface flow in the Cauvery, the Vennar and the Palar rivers was 56634 M.cu.m. (1999.75 TMC)[1].

[1] Report of the Indian Irrigation Commission (1901-03)

In 1949, when the basin-wise assessment of the water resources of the country was done on the basis of Khosla's formula, the annual runoff of the Cauvery river system was estimated to 9991 M.cu.m. (352.78 TMC).[2]

In 1960, the Central Water & Power Commission while conducting irrigation potential studies, assessed the total annual runoff of the Cauvery river system to be 18601 M.cu.m. (656.80 TMC)[3] on the basis of Strange's Co-efficient for average catchments.

Gauge and discharge observations were started on the Cauvery as early as 1873 when the first observation site was established at the Upper Anicut by the Irrigation Department of Tamil Nadu.

Subsequently, in the year 1879, three more gauge and discharge sites were established by the State across the Coleroon at the Lower Anicut and two on its tributaries, at the Kodiveri Anicut across the river Bhavani and the Pallapalayam Anicut across the river Amaravathi. The observation stations were increased from time to time and at the time of Independence, there existed five gauge and discharge sites across the main Cauvery and four on its major tributaries in Tamil Nadu viz., Bhavani, Noyil and Amaravathi. In the First Five Year Plan, one more site was established at the Sedarpalaiyam Bed Regulator across the main river. In addition, observations were also started at the Lower Bhavani dam across the river Bhavani and the Kunnimathur Anicut across the river Noyil. The table given below shows the details of the various gauge and discharge sites in Tamil Nadu.[4]

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[2] An Appraisal of Water Resources by Dr. A.N. Khosla, UNESCO.

[3] @ Report of the technological possibilities of Irrigation projects in India, Central Water & Power Commission (unpublished)

[4] Inventory of gauge and discharge sites in Tamil Nadu, Directorate of Statistics, Central Water & Power Commission (unpublished).

Gauge and Discharge sites in Tamil Nadu

Sl. No.	Name of the river	Name of the tributary	Location	Whether G or GD	Started in	Agency
1.	Cauvery	-	Mettur Dam	GD	1934	SID
2.	-do-	-	Sedarpalaiyam Bed Regulator	GD	1952	SID
3.	-do-	-	Kulittalai Bed Regulator	GD	1952	SID
4.	-do-	-	Upper Anicut	GD	1873	SID
5.	-do-	-	Grand Anicut	GD	1891	SID
6.	Cauvery (Coleroon)	-	Lower Anicut	GD	1879	SID
7.	Cauvery	Bhavani	Lower Bhavani Dam	GD	1953	SID
8.	-do-	"	Kodiveri Anicut	GD	1879	SID
9.	-do-	"	Kalingarayan Anicut	GD	1880	SID
10.	-do-	Noyil	Noyil Anicut Chitrachavadi	GD	1880	SID
11.	–do-	"	Kunnimathur	GD	1952	SID
12.	–do-	Amaravathi	Pallapalayam Anicut	GD	1879	SID

G = Gauge observations.
GD = Gauge and discharge observations
SID = State Irrigation Department

In Mysore, the Gauge and Discharge observations on the Cauvery were first started in the year 1916 when a gauge and discharge observation site was established by the State Government at Sivasamudram. In 1922, observations were started at Chunchanakatte site on the Cauvery, at Akkihebbal on the Hemavathi and at Unduvadi on the Lakshmanathirtha. In 1947 one more gauge and discharge site was established at Dhangere by the State Electricity Board. Observations are also made at the Krishnarajasagar. Among other tributaries, observations are made on the Kabini at Hullahalli (established in the year 1916) and on Nugu at Birwal (1922). The table given below shows the various gauge and discharge observation sites in the Cauvery basin in Mysore State.

GAUGE AND DISCHARGE SITES IN MYSORE

Sl. No.	Name of the river	Name of the tributary	Location	Whether G or GD	Started in
1.	Cauvery	-	Chunchanakatte	GD	1922
2.	-do-	-	Krishnarajasagar	GD	1956
3.	-do-	-	Dhangere	GD	1947
4.	-do-	-	Sivasamudram	GD	1916
5.	-do-	Hemavathi	Akkihebbal	GD	1922
6.	-do-	Lakshmanathirtha	Unduvadi	GD	1922
7.	-do-	Kabbini	Hullahalli	GD	1916
8.	-do-	Nugu	Birwal	GD	1922

G= Gauge observations

GD = Gauge and discharge observations.

Under the programme of establishing and maintaining centrally operated key hydrological stations in the country, the Central Water and Power Commission has included five gauge and discharge sites in the Cauvery basin, namely (1) on the Cauvery at Kallighat, (2) on the Cauvery below its confluence with the Arkavathi, (3) on the Kabbini above its confluence with the Cauvery in Mysore, (4) on the Cauvery below its confluence with the Bhavani, and (5) on the Cauvery above its confluence with the Aiyar river in Tamil Nadu. In addition, they have suggested that three gauge and discharge sites, namely (1) on the Cauvery at Chunchanakatte, (2) on the Hemavathi at Akkihebbal, and (3) on the Lakshmanathirtha at Unduvadi in Mysore and two sites namely (1) on the Bhavani at the Kodiveri Anicut and (2) on the Amaravathi above its confluence with the Cauvery, may be maintained by the State Governments concerned.

Assessment by the Committee

In view of the long-term record available for the main Cauvery at Krishnarajasagar, Mettur and Grand Anicut/Lower Anicut, the Committee

has estimated the yield at 50%, 75% and 90% dependabilities. Since, there are reservoirs at Krishnarajasagar and Mettur, the yield figures would be of high degree of reliability. Mettur also serves as a guide to estimate the yields at the boundary of Mysore and Tamil Nadu, as there is only a small catchment of Tamil Nadu, upstream of Mettur. The terminal usage point on the river is the Lower Anicut and the data of the Grand Anicut/Lower Anicut has been taken for estimating the total yield of the basin.

Yield at Krishnarajasagar:

The volumes of observed inflow into Krishnarajasagar are available from 1933-34 to 1970-71. For obtaining the annual historical flow, the volumes of withdrawals for each of the year due to Major, Medium and Minor schemes upstream of Krishnarajasagar dam are added to the observed flow for the corresponding years for the period (1933-34 to 1970-71). The existing (1971) utilisation due to four Major and Medium Irrigation Schemes above Krishnarajasagar (viz. Hemavathi, Cauvery, Lakshmanathirtha and Yagachi) is of the order of 637.20 M.cu.m. (22.5 TMC) as given in annexure VI (Mysore State). This annexure also gives the area irrigated and total utilisation by existing irrigation works in Cauvery Basin in Mysore State as in 1971, while Annexure I (Mysore State) gives the areas of the ayacut as in 1901 and 1951. Volumes of water utilisations have been worked out in proportion to the area under irrigation in these years, for 95940 acres of area, volume of water used has been given as 637.20 M.cu.m. (22.5TMC). Having obtained the utilisation values for the three years 1901, 1951 and 1971, a smooth curve has been drawn to compute or interpolate the utilisation due to these medium schemes upstream of Krishnarajasagar for each of the years for the period 1933-34 to 1970-71. To this the use by major schemes is added. The withdrawals due to minor schemes upto Krishnarajasagar have been computed as in 1901, 1928, 1956 and 1971 in proportion to the catchment area upto Krishnarajasagar to the catchment area of Cauvery basin in Mysore State. Having derived the

volumes of utilisation due to Minor schemes upto Krishnarajasagar for these four years, a smooth curve is drawn to interpolate the utilisation values for each of the years for the period 1933-34 to 1970-71.

The volumes of withdrawals due to Major, Medium and Minor schemes for each of the years are added to the corresponding observed volumes of flow at Krishnarajasagar to obtain historical flow series for the period 1933-34 to 1970-71.

50%, 75% and 90% dependable runoff or yield is worked out, by the frequency analysis of the 38 years historical runoff series at Krishnarajasagar. These are 6213.441 M.cu.m. (219.4 TMC), 5318.50 M.cu.m. (187.8 TMC) and 4746.43 M.cu.m. (167.6TMC). As against this in the table on page 41 of the write-up supplied by the Government of Mysore on 13-10-72 the 50% yield upto K.R. Sagar has been indicated by them to be 6400.32 M.cu.m. (226TMC). This fairly agrees with the 50% dependable runoff as estimated by the Committee.

Mettur Reservoir

The observed flow data of river Cauvery at Mettur Reservoir is available from 1934-35 to 1971-72.

The volumes of withdrawals at Krishnarajasagar are also available from 1934-35 to 1971-72. The volume of withdrawals above Mettur i.e. in Mysore State due to anicut channels as in 1971 is also given as 1345.20 M.cu.m. (47.5 TMC) for an irrigated area of 77782.4 hectares (194456 acres). Applying the ratio of the area irrigated in 1971, to the areas under irrigation for the years 1901 and 1951, the utilisation at these points of time, viz., 1901, 1951 and 1971 are obtained and a smooth curve drawn through these three points to obtain the utilisation due to anicut channels for each year of the period 1934-35 to 1971-72. The withdrawals or utilisation due to reservoirs at Marconhalli, Byramangala, Kanva, Nugu, Hebbahla, Mangala and Chikhole, equal to 113.28 M.cu.m. (4 TMC), 28.32 M.cu.m. (1 TMC) 33.98 M.cu.m. (1.2 TMC), 169.92

M.cu.m.(6 TMC), 11.33 M.cu.m. (0.4 TMC) and 16.99 M.cu.m.(0.6 TMC) respectively and the utilisations in the Chinar schemes in Tamil Nadu have also been added from the respective years of operation of these reservoirs to arrive at the total utilisation or withdrawals upstream of Mettur Reservoir due to Major and Medium Irrigation schemes.

The withdrawals due to Minor Irrigation schemes in Mysore State for 1901, 1928, 1956 and 1971 have been indicated by Mysore to be 1288.56 M.cu.m. (45.5 TMC), 1302.72 M.cu.m. (46 TMC), 1416.00 M.cu.m. (50 TMC) and 1549.10 M.cu.m. (54.7 TMC) respectively. Yearly withdrawals for the period 1934-35 to 1971-72 have been interpolated with the help of a smooth curve drawn through these four points of time in 1901, 1928, 1956 and 1971. Withdrawals due to evaporation and domestic uses have been determined on an ad hoc basis and series of historical flows obtained for the 38 years from 1934-35 to 1971-72.

Applying the frequency analysis, the 50%, 75% and 90% dependable yields at Mettur Reservoir thus work out to be 14380.90 M.cu.m. (507.8 TMC) 12783.65 M.cu.m. (451.4 TMC) and 11730.14 M.cu.m. (414.2 TMC) respectively.

From the inflows indicated in Volume II (Tamil Nadu) the 50% dependable inflows at Mettur work out to be 9827 M.cu.m. (347 TMC). These include the runoff from the catchment of Tamil Nadu above Mettur taken to be 792.96 M.cu.m. (28 TMC). During discussions the Government of Tamil Nadu estimated the withdrawals by Mysore to be 3993.12 M.cu.m. (141 TMC). Adding this to the 50% dependable inflows the yield at 50% dependability works out to 13820.16 M.cu.m. (488 TMC) against the figure of 14380.90 M.cu.m. (507.8 TMC) worked out by the Committee.

During discussions the representative of Tamil Nadu indicated the average inflow at Mettur to be 10704.9 M.cu.m. (378 TMC) and withdrawal by Mysore to be 3993.12 M.cu.m. (141 TMC). Deducting the yield by catchment in Tamil Nadu of 792.96 M.cu.m. (28 TMC) the

average inflow from the catchment of Mysore and part catchment of Kerala (Kabbini sub-basin), is estimated by them to be 13905.12 M.cu.m. (491 TMC).

Thus, the Government of Tamil Nadu estimated the average yield from Mysore portion of the catchment to be 11696.16 M.cu.m. (413 TMC) assuming the flow from Kerala portion of Kabbini to be 2208.96 M.cu.m. (78 TMC). They also estimated the yield from Kerala portion of Pambar and Bhavani sub-basins to be 1162.12 M.cu.m. (41 TMC). The Government of Mysore estimated the contribution from their catchment to be 11554.56 M.cu.m. (408 TMC) and that of Kerala portion of Kabbini to be 2208.96 M.cu.m. (78 TMC).

Contribution from Kerala portion of Kabini sub-basin:

In the Memorandum, Government of Kerala has estimated the yield from Kerala portion of Kabbini sub-basin as 4332.96 M.cu.m. (153 TMC). The computations are based on a comparison of the Inglis ghat formula; observation of discharge by surface floats for a part of the catchment and rainfall-runoff relationship. In extrapolating the observed runoff from the higher rainfall area which is gauged to the entire catchment, the lower rainfall in the ungauged catchment has not been allowed for. Similarly, in establishing rainfall runoff relationship, in the lower areas, lower runoff factor has not been allowed for. The Government of Mysore has been observing regular gauges just upstream of the Hullahalli Anicut in Mysore. These gauges had been correlated with discharge observations downstream of the anicut jointly by the Government of Tamil Nadu and the Government of Mysore in the years 1924-25 and 1936. The average yield at the Hullahalli Anicut is 3568.32 M.cu.m. (126 TMC). Application of the Inglis ghat formula to the Kerala catchment and Inglis non-ghat formula to the Mysore portion of the catchment indicates that yield of 5210.88 M.cu.m. (184 TMC) would be resulting from the catchment upto Hullahalli against the observed 3568.32 M.cu.m. (126 TMC). The catchment area of this Sub-basin in

Kerala is 1916.60 sq. km. (740 sq. miles), whereas the catchment area upto Hullahalli is 4706.03 sq. km. (1817 sq. miles). But the average rainfall in the Kerala catchment is nearly 299.72 cm. (118 inches), whereas the rainfall in Mysore portion is about 33 inches. The Government of Mysore have indicated the yield of Kerala portion to be 2208.96 M.cu.m. (78 TMC) by reducing the yield of 5210.88 M.cu.m. (184 TMC) using Inglis formula and scaling it down proportionately to the observed yield of 3568.32 M.cu.m. (126 TMC), assuming 3228.48 M.cu.m. (114 TMC) as the yield from the Kerala catchment by applying Inglis formula.

It is also found that the Government of Mysore have observed yields at Kabini dam site (catchment area of 847 sq. miles – 2193.73 sq. km.) and the average yield of the current meter observations for 13 years is about 3823.20 M.cu.m. (135 TMC), which is much higher than the observed yield at Hullahalli. This raises a doubt about the accuracy of the yield at Hullahalli. The Committee during the inspection observed that lot of repairs had been carried out to the anicut, which might have affected the gauge-discharge relationship arrived at in 1936. In the opinion of the Mysore engineers, the discrepancies are purely due to personal errors of observation at the Kabbini dam site and they place more reliance on the Hullahalli observations. Further according to them, the site at Kabbini dam is not satisfactory.

In view of the conflicting position of the figures of yield being contributed by the Kabbini sub-basin from Kerala, it is difficult to make any valid guess.

Grand Anicut

The figures of utilisation at the Grand Anicut for the 38 years from 1934-35 to 1971-72 have been supplied by the Government of Tamil Nadu. To these, the annual realisations, the surplus at Upper Anicut for the corresponding year have been added to arrive at the realisation at

Upper Anicut. For arriving at the utilisation at Lower Anicut, the difference in flow at the Lower Anicut and the releases of surplus from the Upper Anicut and the Grand Anicut is obtained and added to the realisation at Upper Anicut. Thus the realisation worked out would represent the yield from the Cauvery basin upto Grand Anicut and the yield of the Coleroon river but would exclude the runoff from the Cauvery/Vennar systems which are drained by these systems into the sea. The realisations have been worked out on the following basis:-

i) Withdrawals due to Major, Medium and Minor Irrigation schemes, domestic uses and evaporation losses from reservoirs, upstream of Mettur reservoir have been computed for each of the year for the period 1934-35 to 1970-71.

ii) Withdrawals due to Major and Medium irrigation schemes between Mettur and Upper Anicut in Tamil Nadu are available as in 1901, 1928, 1934, 1954, 1958, 1959 and 1971. These are 4332.96 M.cu.m. (153 TMC), 4511.38 M.cu.m. (159.3 TMC), 4791.74 M.cu.m. (169.2 TMC) and 4791.74 M.cu.m. (169.2 TMC) respectively.

iii) Withdrawals due to the Minor schemes in Tamil Nadu upstream of Upper Anicut are also given in 1901, 1928, 1956 and 1971 and are 1246.08 M.cu.m. (44 TMC), 1246.08 M..cu.m. (44 TMC), 1359.36 M.cu.m. (48 TMC) and 1642.56 M.cu.m. (58 TMC) respectively. The withdrawals for each year during the period 1934-35 to 1971-72 have been worked out by linear interpolation.

iv) Withdrawals due to domestic and industrial uses are also shown for the years 1928, 1956 and 1971 and are 59.47 M.cu.m. (2.1 TMC), 87.79 M.cu.m. (3.1 TMC) and 141.60

> M.cu.m. (5 TMC) respectively. The withdrawals for each of the years during the period 1934-35 to 1971-72 have been worked out by linear interpolation.
>
> The realisations indicated do not take into account the effect of carry over storage in the Mettur Reservoir and necessary modifications, therefore, has been made to arrive at the historical flow. Applying the frequency analysis, the dependable yields of 50%, 75% and 90% at Lower Anicut are worked out to be 20956.8 M.cu.m. (740 TMC), 18974.40 M.cu.m. (670 TMC) and 17643.36 M.cu.m. (623 TMC) respectively. "

[Emphasis supplied]

17. It appears that the committee gave sufficient weightage to the existence of Krishnarajasagar and Mettur reservoir and has accordingly relied upon the data from 1933-34, since when both these reservoirs were in position. The yield at the terminal point of the basin, namely, Lower Coleroon Anicut was assessed by the Committee as 740 TMC at 50% dependability, 670 TMC at 75% dependability and 623 TMC at 90% dependability. The Committee on basis of different data supplied by the States and their own investigation for the total yield within the Cauvery basin taking into consideration the gauge and discharge readings at different places in different States the dependable yields at 50%, 75% and 90% were worked out at 740 TMC, 670 TMC and 623 TMC respectively.

18. The report of the Committee was considered by the Chief Ministers of the States on 29.4.1973 and they agreed with the report of the Committee regarding the total yield within the Cauvery basin. Unfortunately, the Memorandum of that is not available on the record. The party-States had agreed

in respect of the total yield estimated by the Committee is established by referring to the Statement given by then Minister for Irrigation and Power Dr. K.L. Rao on the floor of the Parliament on 7.5.1973. On May 7, 1973 in the Lok Sabha there was a debate in respect of the dispute relating to the sharing of the water of river Cauvery between the different States. A copy of the proceeding of the Parliament of that date has been produced from which it appears that the then Deputy Minister in the Ministry of Irrigation and Power gave details of the report of the Fact Finding Committee. He also stated that the Committee had submitted its report in December 1972 which contained the necessary data on availability of waters, existing utilisation apart from other questions referred to the Committee. Thereafter he stated that there were discussions with the Chief Ministers of Kerala, Mysore and Tamil Nadu on 29th April 1973 about the report of the Committee. During these discussions there was a general consensus on the total yield of the river as given in the Committee's report. Then Dr. K.L. Rao, the then Minister for Irrigation and Power in his statement before the Parliament after giving the other details about the Fact Finding Committee stated as follows:

> "In this particular case, the quantum of water flowing in the river has been agreed to as between the three parties. That is a great thing which has been done. Normally they could have easily agreed in regard to the quantum at one point. But in this case, actually, they have agreed at three vital points, namely Krishnarajasagar, Mettur and Lower Anicut. These are the three very important points which have got a bearing on the settlement of the allocation of water between the various States, and I am happy that on this matter, at these three points, at the very first meeting, after the fact-finding committee published their report, the three Chief Ministers have agreed to it. That is half the battle won."

(Emphasis supplied)

(Ref. TN Vol. 36, Exh. 1364, Page 38, Right Col. & Page 39)

19. By a letter dated May 1, 1973 Dr. K.L. Rao, the Minister for Irrigation and Power had informed the then Prime Minister in respect of the agreement between the Chief Ministers in respect of availability of water as assessed by CFFC:

> "The first stage was taken up for a consideration at the meeting. The Report of the Fact Finding Committee, which had been appointed by the Ministry of Irrigation & Power, was very helpful in this regard. The figures assessed by the Committee as to the water availability in the river were agreed to by the Chief Ministers. This is a big step forward. Generally, this is an area where considerable amount of time is spent with difference of estimation continuing to persist evading reconciliation."

20. It appears that as desired by the Chief Ministers, the Government of India revived the Cauvery Fact Finding Committee for a period of three months with effect from 15th May 1973 with the following terms of reference:-

> "The Committee shall review the data supplied to it earlier by the State Governments in respect of area cropped, net area irrigated, irrigated cropped area and other data relevant to water utilisation at different points of time and undertake such verification as is necessary, from other data available with the State Governments, especially those published."

(Ref. TN Vol. XV Exh. 841, Page 127)

It may be pointed out that there was no reference in respect of quantum of water flowing in the river Cauvery as there was no controversy in respect of the same

after the agreement of the Chief Ministers of three States on the assessment of the Cauvery Fact Finding Committee in its report.

21. After revival, the Committee held discussions with the Chief Engineers of Kerala, Mysore and Tamil Nadu on 23rd and 26th May 1973 and the following decisions were reached:

"(i) The States will collect necessary data to enable the CFFC to carry out verification of the data furnished in tables at pages 30, 39, 40, 40A and 51 of the CFFC's printed report of December, 1972.

(ii) The State Chief Engineers will signify acceptance of such of the data which they consider correct and appropriate, and furnish their comments in respect of data with which they differ. The Chief Engineers will also furnish their comments, if any, regarding the data pertaining to other States, as furnished in the tables, referred to at (i) above.

(iii) The Chief Engineers will indicate corrections, if any, in the figures given in the published report of CFFC of December, 1972.

(v) It was agreed that ten copies of the material along with the books and registers in support of the data (accepted and contested) will be kept ready for inspection and perusal of the CFFC by the Chief Engineers during their scheduled visits as given in the programme below:

12th to 15th June, 1973	- Kerala
19th to 21st June, 1973	- Mysore
22nd to 25th June, 1973	- Tamil Nadu.

v) After conclusion of the visits to each State, a joint meeting will be held at New Delhi from 21.7.73 to 23.7.73 where the data obtained from the different States will be made available to others for comments."

(Ref. ibid. Pages 127 & 128)

22. The Committee accordingly visited Kerala, Mysore and Tamil Nadu according to the schedule fixed for the same. It also held meetings with the representatives of the States at Delhi from 21st to 24th July 1973 and each State Government was made available the notes submitted by other States. Some corrections in the original report were suggested with which for the present we are not concerned. From Tamil Nadu (Documents) Volume XV it shall appear that at page 139 the Committee again examined the utilisation of water at different points of time by different States. About the utilisation of the water of river Cauvery by Kerala it was said:

> "In Kerala the first crop of paddy is of long duration and lasts from May to December and second crop lasts from January to April. Three short duration crops are also grown. The areas and yields under the autumn, winter and summer paddy crops are tabulated below. These are averages for the period from 1962-63 to 1970-71…… ……
>
> The figures of 0.5 TMC and 1 TMC for domestic and industrial supply in 1956 and 1971 are quite high, considering that only 0.1 TMC was indicated as the use for this purpose by the State Government earlier. However, the total quantity being very small, the figure of utilisation of 5 TMC as given in the CFFC report for 1971 need not be modified. The irrigation in 1971 was 21550 ha. (53,400 acres as shown in the Land Use Statistics)."

23. Regarding Mysore also utilisation in 1901, 1928 and 1956 were re-examined but the relevant part of the report for our purpose is the utilisation in the year 1971 about which it was said as follows:

"The area irrigated from schemes constructed prior to 1928 has increased to 1.821 lakh acres in 1971 from 1.417 lakh acres in 1956 and the utilisation has increased to 47.08 TMC from 36.46 TMC. The area irrigated from schemes which came into operation between 1928 to 1956 has increased to 2.236 lakh acres from 1.312 lakh acres in 1956 and the utilisation has correspondingly gone upto 54.320 TMC from 48.420 TMC according to the State authorities. The committee has, however, raised the figure of utilisation for Krishnaraja Sagar to 46 TMC as discussed earlier. This would raise the figure of 1956 utilisation to 52.82 instead of 48.42 adopted by the State Government.

For schemes which came into operation between 1956 to 1971, (vide Statement at pages 20-22) the areas and utilisation are taken from the project authorities but it is not known whether these have actually been achieved in the field. The general experience is that full utilisation and Ayacut as planned in the Project Report are not realised in practice. In the case of Nugu Project, however, the utilisation of 7 TMC is the average of about 10 years as verified from the working tables of the reservoir. It has to be made clear that except for Nugu, no corroborative evidence is available for other schemes which came into operation between 1956 and 1971.

For the minor irrigation schemes, the areas have been taken from the Statistical Abstract of Mysore for 1970-71 published by the Bureau of Economics and Statistics, Government of Mysore in 1971 and utilisation for this is 54.7 TMC based on utilisation of 4.4 acres/Mcft.

The total utilisation for all categories of schemes in 1971 is 176.82 TMC as per statement at pages 20-22."

(Ref. ibid. Page 145)

From page 148 of the said volume it shall appear that on re-examination the utilisation by Mysore was raised from 171.2 TMC in the original report to 176.82 TMC.

24. So far Tamil Nadu is concerned, similarly utilisation in the years 1901, 1928, 1956 and 1971 were re-examined. Regarding utilisation in 1971 it was said:

> "The areas of first crop in Cauvery delta system as indicated in the Administration Reports from 1966-67 to 1969-70 varied from 9.2 lakh acres to 9.5 lakh acres and of the second crop from 2.7 lakh acres to 4.4 lakh acres. Thus the Cauvery Delta system has registered a substantial increase in the second crop over that of 1956 which was 1.6 lakh acres. The latest areas as reported by the District Revenue Officers of 9.34 lakh acres for the first crop and 3.56 lakh acres for the second crop have been adopted. The average withdrawal for the period of 38 years i.e. from 1934 to 1972 is 234.8 TMC. The withdrawals have been continuously declining while the area has been increasing.
>
> In the case of Lower Coleroon anicut the figures of first crop (1.32 lakh acres) and second crop (0.3 lakh acres) which were reported by the District Revenue Officers have been adopted. The average withdrawal for the last 38 years is 38.3 TMC.
>
> The Cauvery-Mettur Project has registered an increase in the area of first crop from 2.07 lakh acres to 2.56 lakh acres, and the second crop from 0.35 lakh acres to 0.67 lakh acres from 1956 to 1971 as reported by District Revenue Officers. The withdrawal of 55 TMC which is an average of 32 years from 1940-41 to 1970-71 is adopted.
>
> In the case of Lower Bhavani Project, the area irrigated as reported by the District Revenue Officers is 2.07 lakh acres and the

withdrawals over 18 years period i.e. 1954-55 to 1971-72 average to 32.6 TMC against 36 TMC planned under the rules and regulation. In this project there is no double cropping.

In the case of Mettur Canal, the area irrigated as reported by District Revenue Officers is 0.45 lakh acres and the average withdrawals for 15 years from 1957-58 to 1971-72 are 12.6 TMC against 9.6 TMC planned. There is no double cropping in this project also.

Three schemes viz., Amaravathy Reservoir Scheme, New Kattalai High Level Canal and Pullambadi Canal Scheme have come into operation after 1956. The figures in respect of areas irrigated under these schemes, as furnished by the District Revenue Officers are 0.215, 0.206 and 0.221 lakh acres respectively. The withdrawals under the Amaravathy Reservoir are 4.8 TMC, being average of 14 years i.e. from 1958-59 to 1971-72, while that of Kattalai and Pullambadi Canals are 5.3 TMC and 3.5 TMC respectively, being the average of 10 years from 1962-63 to 1971-72.

The withdrawals for minor irrigation have been computed as for 1928 and 1956 on the basis of 5 acres per Mcft.

In case of utilisation for 1956, five years before and five years after have been considered for the average utilisation. In the case of 1971, for obvious reasons, as figures after 1971 cannot be had and also to account for vagaries of good and bad years, the series of 38 years from 1934 –71 has been adopted for working out the average utilisation." (Ref. ibid. Pages 152 to 154)

25. As already mentioned, tables were annexed to the said report regarding the area and utilisation of water by the States of Kerala, Mysore and Tamil Nadu in 1901, 1928, 1956 and 1971. One such relevant table in respect of Tamil Nadu is at pages 155-157 of the said volume. For the year 1971 the

utilisation so far the State of Tamil Nadu is concerned, it has been ascertained at 566.60 TMC. It may be mentioned that in the original report it was 573.4 TMC. In other words, for Mysore it was increased from 171.2 TMC to 176.82 TMC so far year 1971 was concerned, whereas in respect of Tamil Nadu it was reduced from 573.4 TMC to 566.60 TMC. The aforesaid additional report was signed on 14.8.1973. In the additional report of the Fact Finding Committee there has been some change so far utilisation by different riparian States are concerned, but there has been no change so far the ascertainment and assessment of the total yield of river Cauvery is concerned because in view of the agreement between different States that question had not been referred to the Committee.

26. A meeting was held in October 1973 of the Chief Ministers of three riparian States and the Minister for Irrigation and Power, Government of India. In the said meeting it had been agreed that it was necessary for all the concerned States to effect economies in the use of water so as to make it possible to meet the legitimate needs of other projects which were feasible in the Cauvery basin. Thereafter, Mr. C.C. Patel, Additional Secretary in the Ministry of Irrigation and Power was asked to carry out the detailed studies on the scope for economy in the use of Cauvery waters. Mr. Patel after completing his studies suggested some concrete proposals in his report which were considered in the meeting of the Chief Ministers along with the Union Minister for Irrigation in June 1974. The proposals were as follows:

> "Finding of Sri C.C. Patel, the then Additional Secretary, regarding possible savings in the use of cauvery waters.
>
> *****

The following savings can be effected on a very conservative assessment by various measures as indicated below:

	Savings in TMC
Tamil Nadu	
(a) Improvement and Modernisation of Irrigation systems etc.	50
(b) Providing a lined irrigation channel between Upper Anicut and Grand Anicut	20
(c) More intensive use of ground water	30

1. In addition to the savings quantified above, further savings are possible by taking the following measures:

   (i) Continuous assessment of requirement below Mettur and monitoring of releases to ensure efficient tie up between rain-fall, water requirements and releases from reservoirs thereby saving, a part of the wastage from Tail end regulators.

   (ii) Installation of water measuring devices, standing wave flumes and gauge runs at key locations in the distribution system for improving duties.

   (iii) Storage in tributaries downstream of Mettur and improved pondage capacity upstream of the lower Coleroon/Grand Anicut/Upper Anicut.

   (iv) Exploitation of ground water potential in Grand Anicut and other irrigated areas (excluding old delta area).

   (v) Integrated operation of reservoirs.

Karnataka	
(a) Savings be effected by Modernisation of existing systems, improved agriculture and water management practices and diversification of crops.	20

(b) Integrated operation of Mettur, Krishnarajasagar, Harangi, Hemavathi and Kabini reservoirs." 5

(Karnataka Vol.2, Exh.180, pp.548-549)

27. Subsequently, the Government of India vide their letter dated 15.2.1975 sent a draft of agreement on the use and development of Cauvery waters as proposed by the State of Kerala to the Chief Secretary, Tamil Nadu wherein in the terms and conditions of the proposed agreement, Kerala has stated as under:-

> "The Fact Finding Committee constituted by the Government of India during the negotiations has found that 740 TMC of water is available in the Cauvery system in an average year and this has been accepted by the Chief Ministers of Karnataka, Kerala and Tamil Nadu." (Ref: TN Vol. XVI, Exh. 847, Pages 4, 6 & 7)

28. An inter-State meeting was held at Madras on 5-10-1980, on Cauvery Waters Issue. Shri C.C. Patel, Secretary, Ministry of Irrigation, Shri M.N. Venkatesan, Member (W.R.), Central Water Commission and other officers of the Ministry of Irrigation were present on behalf of the Central Government. The Commissioner and Secretary to the Government of Tamil Nadu, Public Works Department along with other Chief Engineers and Shri A. Mohanakrishnan, the then Special Officer, Inter-State Waters, Govt. of Tamil Nadu were present on behalf of the Tamil Nadu. On behalf of the Government of Karnataka, Special Secretary to Government Public Works Department, Shri Shankar Rao, Chief Engineer (Retired) and Shri Raghuram, the then Technical Assistant was present. Similarly representatives of Kerala and Pondicherry attended, details whereof have been given in the Summary Record of the

Meeting. (T.N.D.C. Vol. XVI, Exh.861, Pages 186-191). In paragraph 4 of the Minutes of the Meeting it has been stated as under:

> "Secretary, Ministry of Irrigation clarifying the position categorically stated that as far as the Central Government was concerned, no doubts have been expressed any time regarding the various figures incorporated in the understanding of 1976. However, he stated that Central Government will not have any objection if the concerned States can arrive at an understanding on the basis of some other figures which are mutually acceptable. Representative of Karnataka then stated that his State accepts the figure of 740 TMC if the other States do not reopen this issue. In case the issue is re-opened, Karnataka reserves the right for expressing its views."
>
> (Emphasis added)

29. In the Statement of Case filed before this Tribunal on behalf of the State of Tamil Nadu at page 55, Volume I, it has been stated that the report of the Cauvery Fact Finding Committee was submitted in December 1972 which was considered by the Chief Ministers of the three States on 29th April 1973 at a meeting held in New Delhi. It has been further stated that at the request of Chief Ministers, the Government of India revived the Cauvery Fact Finding Committee for a further period of 3 months with a mandate that "the Committee shall review the data supplied to it earlier by the State Governments in respect of area cropped, net area irrigated, irrigated cropped area and other data relevant to water utilisation at different points of time and undertake such verification as is necessary, from other data available with the State Governments especially those published." Thereafter there is reference to the additional report dated 14th August 1973 submitted by the Cauvery Fact Finding Committee in respect of utilisation of the water by different riparian States and other questions referred

to the said Committee as already mentioned above and it has been stated in the statement of case that the data compiled by the Committee were reviewed and accepted by the Chief Ministers in the meetings convened on 29.4.1973 and 9.10.1973. In that connection it has been stated as follows:

> "The data compiled by this Committee were reviewed and accepted by the Chief Ministers in the meetings convened on 29.04.73 and 09.10.73. Salient details of the findings of the CFFC are as follows:
>
> 1. Total yield of the river: 740 TMC at 50% dependability basis.
>
> 670 TMC at 75% dependability basis
>
> 623 TMC at 90% dependability basis
>
> 2. Ayacut & Utilisation

	Tamil Nadu	Karnataka	Kerala	Total
Ayacut as on 1972 (gross)				
(Lakh Acres)	28.208*	6.825	0.534	35.567
Lakh ha.	11.424	2.764	0.216	14.404
Utilisation (TMC)	566.60	176.82	5.00	748.42

> * Includes 0.43 lakh ac. (0.174 lakh ha.) in Pondicherry."
>
> (Ref: TN-I Statement of Case, pages 55-56)

30. It can be said that so far the State of Tamil Nadu is concerned it has not disputed at any stage the assessment made by the Cauvery Fact Finding Committee in respect of the river flow and total yield of river Cauvery to be at 740 TMC at 50% dependability, 670 TMC at 75% dependability and 623 TMC at 90% dependability. It has also accepted about the utilisation by the three riparian States – Tamil Nadu, Karnataka and Kerala as found by the said Committee in its additional report to be 566.60, 176.82 and 5.00 T.M.C.

respectively. Again in the counter statement on behalf of Tamil Nadu to the Statement of Case filed by the State of Karnataka (TN Vol.3) at page 9, paragraph 4.2.3 it has been stated as follows:

> "4.2.3. In the above factual context, the following further facts are significant:
>
> (a) The States of Karnataka, Kerala and Tamil Nadu (as also the Union Territory of Pondicherry) accepted and acted upon the Cauvery Fact Finding Committee's original Report dated 15.12.1972 as well as the Additional Report dated 14.8.1973.
>
> (b) At no stage, thereafter, did Karnataka or Kerala communicate to Tamil Nadu any objection on the Cauvery Fact Finding Committee's Report or questioned the collection and analysis of data or the Cauvery Fact Finding Committee's conclusions including its assessment of the availability of waters in the Cauvery basin.
>
> Suffice it to say, Karnataka never communicated to Tamil Nadu or Kerala or the Central Government any rejection of the Cauvery Fact Finding Committee's Reports. On the contrary, even now in its Statement of Case (Page 121-122 Para 19.9), Karnataka has quoted from and relied upon the said Reports.
>
> (c) Moreover, as a sequel to the Cauvery Fact Finding Committee's Reports, on 25.8.1976, a draft understanding was presented by the Government of India, in an Inter-State meeting in which the States of Karnataka, Kerala and Tamil Nadu participated, regarding the use and development of Cauvery waters, wherein "fixing utilisation of Cauvery waters is agreed as 671 TMC, comprising 489 TMC by Tamil Nadu, 177 TMC by Karnataka, and 5 TMC by Kerala" (see Tamil Nadu's Statement of Case Annexures Volume, Enclosures XVIII at Internal pages 72-73). The said utilisation figures were the average figures for the five

consecutive years upto 1971-72 and they were based upon and derived from the data collected by the C.F.F.C.

(d) As a further sequel, on 5.10.1980, an Inter-State meeting on the Cauvery waters issue was held at which representatives of Government of India and the four party States were present. In the summary record/minutes of the said meeting dated 5.10.1980, as circulated under cover of Government of India's letter No.6/2/78-WD dated 21.10.1980, the following significant passages occurred:

"The Representative of Karnataka stated that there are no serious differences with regard to figures mentioned in 1976 Agreement but they had basic difference to the approach of 1976 understanding……"

"The Secretary, Ministry of Irrigation, clarifying the position categorically stated that as far as the Central Government was concerned, no doubts had been expressed any time regarding the various figures incorporated in the understanding of 1976. However, he stated that the Central Government will not have any objection if the concerned States can arrive at an understanding on the basis of some other figures which are mutually acceptable. The Representative of Karnataka then stated that his State accepts the figure of 740 TMC, if the other States do not reopen this issue. In case, the issue is re-opened, Karnataka reserves the right for expressing its views".

(e) Even now, in its Statement of Case filed on 18.9.1990 before this Hon'ble Tribunal, Karnataka has neither averred, nor submitted, either expressly or by necessary implication, that it rejects C.F.F.C's Reports or that C.F.F.C's assessment on availability of water in the Cauvery basin is erroneous or that C.F.F.C's Reports cannot be taken into consideration, and relied upon by or before this Hon'ble Tribunal. In other words,

> Karnataka has accepted and affirmed both by record and by conduct, that the C.F.F.C's Reports and its assessment of availability of waters in the Cauvery basin are correct."

31. In this connection, reference was made on behalf of the State of Tamil Nadu to the rejoinder filed on behalf of the State of Karnataka to the Statement of Case of Tamil Nadu (Karnataka Vol.3) at page 173 wherein it has been said as follows:

> "38.3 Extracts from the report of the CFFC reproduced at pp.56 of the Statement of Case of Tamil Nadu have no relevance. It was acknowledged by the CFFC that "it has not been possible to do full justice" to the examination and scrutiny of data. The yield data computed by the CFFC was not acceptable to the State of Karnataka. The comments of Karnataka on the yield computations were communicated to the Government of India in June 1973. The figures of utilisation of water of 566.63 TMC for Tamil Nadu indicated by the CFFC was also not correct as is evident from the further studies carried out by the Study Team headed by Sri C.C. Patel, which modified the utilisation of Tamil Nadu to 489 TMC. The figure of utilisation as furnished by the CFFC merely concerned the average withdrawals from the irrigation system in Tamil Nadu. The alleged utilisation of 566 TMC in Tamil Nadu was not the actual utilisation based on the requirement of the crop. It only comprised the flows reaching the delta. This consisted, apart from irrigation requirement, the drainage flows as well, going waste into the sea, and are therefore liable to be ignored. Consequently the quantities of 566 TMC is not the requirement of crop in Tamil Nadu and the said figure has to be appropriately curtailed by deleting the flows going waste to the sea, and further adjusted by taking into account the utilisable ground water."

32. On basis of the aforesaid statement in the said rejoinder it was urged on behalf of the State of Tamil Nadu that State of Karnataka never seriously contested the finding of the Cauvery Fact Finding Committee about the total yield of river Cauvery as mentioned in the Report of the CFFC. It was also pointed out that a letter dated 13.6.1973 was addressed by the Chief Minister of Mysore to the Minister of State for Irrigation and Power, Government of India about which reference has been made in the aforesaid paragraph 38.3. No specific stand has been taken that the finding of the Committee about the total yield was not correct. That letter (Karnataka Document Vol.2 page 478) says as follows:

> "It is seen from the report appearing in the press that during the last week while replying to a Call Attention Notice, you have stated in the Lok Sabha that during the meeting of Chief Ministers held on 29th April, it was agreed that the yield in Cauvery was 740 TMC ft.
>
> It is seen from the report of the Cauvery Fact Finding Committee that the "historical" 50% dependable yield upto Lower Anicut works out to 740 TMC ft. This figure is stated to have been based on historical flows after taking into consideration the effect of carry over storage of Mettur. It has been worked by the Chief Engineer of Mysore that the current 50% dependable yield in Cauvery is much more than 740 TMC ft. the historical yield. A note in this regard is enclosed for your information as we are concerned with the current yield for utilisation.
>
> It is suggested therefore, that the Committee may examine this aspect also.
>
> With regards."

33. From the note which was enclosed with the said letter (at page 479 of the same volume) it appears that a request was made on behalf of the State of Mysore to ignore the yields prior to 1954-55. The relevant part of the request in respect of the assessment of the total yield is as follows:

> "Under these circumstances, the correct procedure to ascertain current yields appears to be to ignore the years prior to 1954-55, when the utilisation was of low order. If this were to be done and only the 18 years after 1954-55 to 1971-72 are considered, it is found that the 50% dependable yield is 811 TMC ft. (inclusive of surplus of 86 TMC ft.)"

34. It is difficult to appreciate the stand taken by Mysore in the aforesaid enclosure that the calculation of the yield should be made only with reference to years after 1954-55 to 1971-72 (18 years only) and the flow and yield of river Cauvery during the years prior to 1954-55 should be ignored. It is well-known that while assessing yield of a river it is always safe and desirable to take note of the yield of maximum number of years for which reliable data is available to come to a conclusion as to what is the total yield of that particular river.

35. On the basis of the materials referred to above and data collected by the Cauvery Fact Finding Committee in respect of total yield of river Cauvery at 50%, 75% and 90% being 20956.8 M.cu.m. (740 TMC), 18974.40 M.cu.m. (670 TMC) and 17643.36 M.cu.m. (623 TMC) respectively which had been accepted by all riparian States including the then State of Mysore. If there was any objection on behalf of the then State of Mysore, then in normal course a request would have been made to refer also that question while referring again to the Cauvery Fact Finding Committee the questions regarding utilisation of the water

of river Cauvery by different riparian States. At no stage the then State of Mysore or State of Karnataka objected about the said assessment of the total yield of river Cauvery by the Cauvery Fact Finding Committee. That is why the then Minister for Irrigation and Power Dr. K.L. Rao made a categorical statement on the floor of the Parliament quoted above. The letter written on behalf of the State of Mysore referred to above merely requested that for purpose of ascertaining the total yield, only yield years 1954-55 to 1971-72 should be taken into consideration and not the yield of the said river available prior to the years 1954-55. From all angles and aspects, this was not a reasonable request on behalf of the then State of Mysore. For ascertaining the yield of a particular river, data if available for a longer period then that period should also be taken note of instead of few years only. During arguments the State of Karnataka has taken this very stand that flows since 1900-1901 should have been considered by the C.F.F.C.

36. The Irrigation Commission, 1972 had considered this aspect and recommended that:

> "Hydro-meteorological data are basic to the formulation of river valley schemes. Due to variations in precipitation and river flows, from year to year, the data should span fairly a long period, say 30 years, to cover the dry and wet cycles. The longer the period for which data are available, the sounder would be the base for project formulation."
> (Ref: TN-III, Page 25, Para 4.3.11)

The homogeneity and reliability of the data, namely, rainfall, observed river flows at various gauge and discharge sites and withdrawals from the river system at different locations in the entire basin are of utmost importance.

37. During the hearing of the arguments an oral direction was given by the Tribunal to the States of Karnataka and Tamil Nadu to furnish flow series for 38 years i.e. from 1934-35 to 1971-72. Pursuant to that direction, Karnataka furnished flow series for 72 years from 1900-01 to 1971-72 on 7.11.2002. Tamil Nadu furnished for years from 1934-35 up to 1971-72. Copies of the same along with the covering letters have been marked as K.R.Vol. 64, Exh.517 and T.N. Vol.45, Exh.1663 respectively are attached at the end of this Chapter. From a bare reference to the flow series filed on behalf of the State of Karnataka on 7.11.2002 for the period 1900-01 to 1971-72 the average yield is shown as 792.3 TMC; and at 50% it has been shown as 752 TMC. In the covering letter dated 7.11.2002 it has been stated that average yield in the Cauvery river basin above and up to delta based on long-term data from 1900-01 to 1971-72 was 792 TMC and the details of the calculation of the yield of the Cauvery basin at lower Coleroon anicut was enclosed. Tamil Nadu on basis of the flow series from the year 1934-35 up to 1970-71 has claimed the total yield at 50% dependability to be 740 TMC. On the other hand, Karnataka calculated the total yield as 752 TMC on 50% dependability. Therefore, the difference is only of 12 TMC in the flow series filed on behalf of Tamil Nadu and Karnataka. As already mentioned above that according to the statement filed on behalf of the State of Mysore before the CFFC on 10.11.1972 (Vide TNDC Volume XIV page 117), the stand taken on behalf of the State of Mysore was that the total yield of the Cauvery basin was 760 TMC.

38. Our Assessors have analysed the flow series for 38 years from 1934-35 to 1971-72 for working out the dependable yield of the river. They have

adopted the formula M/N x 100. Regarding this formula, the Krishna Water Disputes Tribunal in its report has stated as under:

> "For ascertaining the percentage dependability of the flow at a given point of stream where a continuous record of flow for a number of "N" years is available, the flow discharge data is arrayed in descending order. Each year's flow so arrayed is assigned the serial number from the top and if M be the serial number of the flow in any year, the percentage dependability for the flow of that year is calculated by applying the formula $\frac{Mx100}{N}$.
>
> Some authorities say that the percentage dependability should be arrived at by applying the formula $\frac{Mx100}{N+1}$ but all the parties in this case have adopted the formula $\frac{Mx100.}{N}$
>
> If flow at a particular dependability is to be computed and is not directly available from the flow series as mentioned hereinbefore then the flow data for the two consecutive years – one just above the required dependability and the other just below the required dependability is taken into consideration and proportionate adjustment is made to arrive at the flow at that particular dependability."
>
> (Ref: KWDT Report Vol.I, Page 74, Para 2, Left Col.)

In the case of Cauvery, the State of Tamil Nadu has adopted the above formula i.e $\frac{M}{N}$ x100 for calculating 50% dependability.

(Ref: TN Vol.45, Exh.1663, Working Sheets – Statement II)

39. The State of Karnataka has submitted series for 72 years from which the data pertaining to 38 years (1934-35 to 1971-72) has been analysed by the Assessors for working out the dependable yield using the same formula namely;

The result c $\frac{M}{N}$ x100. given in the following table:-

Figures in TMC

Period	Dependable Yield	
1934-35 to 1971-72	50%	75%
Tamil Nadu series	740	651
Karnataka series	734	649
CFFC assessment	740	670

40. By analysing the Karnataka flow series of 38 years from 1934-35 to 1971-72 the dependable yield at 50% shall be about 734 TMC, whereas that of the Tamil Nadu it shall be 740 TMC which almost tally with the earlier assessment made by the Cauvery Fact Finding Committee.

41. It may be pointed out that some inconsistent stands have been taken on behalf of the State of Karnataka in respect of the total yield calculated by CFFC. The Chief Minister of the State of Mysore in the meeting of the Chief Ministers along with the Central Minister for Irrigation and Power Dr. K.L. Rao held on 29..4.1973 accepted the total yield calculated by CFFC in its report and on basis of that Dr. K.L. Rao made a categorical statement on the floor of the Parliament about acceptance of the total yield aforesaid by riparian States including State of Mysore. Dr. K.L. Rao also informed the then Prime Minister by his aforesaid letter dated May 1, 1973 about the general consensus between the States on the total surface yield of river Cauvery. Then a letter dated 13th June 1973 was sent on behalf of the Chief Minister of Mysore saying that the yield of the Cauvery basin at 50% dependability was more than 740 TMC, if calculation is made only on the basis of the yield of 18 years flows and utilisation from 1954-

55 to 1971-72 instead of 1934-35 to 1971-72. Now before this Tribunal a stand has been taken that calculation should be made on basis of the flow series since 1900-01 to 1971-72 i.e.for 72 years instead of 38 years. In the statement showing yield of the Cauvery river basin up to delta, based on the data from 1900-01 to 1971-72 Karnataka has itself calculated the yield for that period (1900-01 to 1971-72) at 50% dependability to be 752 TMC vide Karnataka Vol.64 Exh.No.517 filed on 7.11.2002; the difference is of 12 TMC only than what was calculated by CFFC for the period 1934-35 to 1971-72. It will amount to repetition only that the State of Mysore itself filed a statement before the CFFC on 10.11.1972 that the total yield in Cauvery Basin within the States of Mysore, Kerala and Tamil Nadu was 760 TMC (vide TNDC Volume XIV Page 117).

42. According to the State of Karnataka the yield for the period 1900-01 to 1971-72 at 50% dependability is 752 TMC, but the average yield is 792.3 TMC (KR Volume No.64, Exhibit No.517). It was submitted on behalf of the State of Karnataka that the total yield should not be calculated on 50% basis, but on average flow. In other words, the total yield should be calculated on the basis of average of flow series from 1900-01 upto 1971-72 which should be 792.3 TMC. In the Statement of case filed on behalf of the State of Karnataka before this Tribunal, at page No.79, it has been stated:- “Average flow is close to 50% dependable flow.” Average flow has been calculated after adding the year-wise flows from 1900-01 upto 1971-72. The Supreme Court of United States in the case of Wyoming V. Colorado (259 US 419) has observed that the average annual flow was not a proper measure because “crops cannot be grown on

expectations of average flows which do not come……" The Supreme Court arrived at a volume, which it regarded as a "fairly constant and dependable flow materially in excess of the lowest", but below the average. At page 484, the Supreme Court observed:-

> "We have already indicated that, as to such a stream as this, the average flow of all years, high and low, cannot be taken as a proper or reasonable measure of what is available for practical use. What then is the amount which is available here? According to the general consensus of opinion among practical irrigators and experienced irrigation engineers, the lowest natural flow of the years is not the test. In practice they proceed on the view that within limits, financially and physically feasible, a fairly constant and dependable flow materially in excess of the lowest may generally be obtained by means of reservoirs adapted to conserving and equalizing the natural flow; and we regard this view as reasonable."

43. Narmada Water Disputes Tribunal while considering the question of apportionment on the basis of average flow relying on the aforesaid judgement of the Supreme Court of United States said :-

> "8.5.3 In examining the problem of apportionment, the possibility of maintaining a sustained flow through storage facilities is a relevant factor. The Volume of water in any stream varies from year to year. By the use of a high volume of water as the basis for apportionment, the upstream-state in a controversy will be favoured against a lower state in years in which the volume is below the amount used as the basis for the apportionment. In the dispute between Wyoming and Colorado before the Supreme Court, Colorado urged that the average yearly flow was the proper measure of apportionment of the river waters. Wyoming claimed that the lowest annual stream flow was proper to be taken into account." It was held by the Supreme Court

> that the average annual flow was not a proper measure because "crops cannot be grown on expectations of average flows which do not come …"/. Consequently the Supreme Court arrived at a volume which it regarded as a "fairly constant and dependable flow materially in excess of the lowest but below the average"/.

44. In this background, we have to proceed on the basis that the total yield has to be determined taking into consideration as to what is the dependable flow in the cauvery river system. The State of Karnataka itself has calculated the yield on the basis of flow series from 1900-01 to 1971-72 at 752 TMC on 50% dependability and 673 TMC at 75% dependability (KR Volume No.64, Exhibit No.517).

45. The Karnataka State produced Prof. Rama Prasad as an expert witness and his statement is on "Reconstruction of surface flows". Prof. Rama Prasad has made study of the gauged flows of four Central Water Commission gauge and discharge stations, namely, Billigundlu, Urachikottai, Kodumudi and Musiri. He has also analysed the gauged river flows for four nodal points located within Tamil Nadu, namely, Mettur reservoir, Upper Anicut, Grand Anicut and Lower Coleroon Anicut. He has not made any study in respect of Central Water Commission stations maintained within Karnataka, or any gauge and discharge sites maintained by the Karnataka State – in particular, Krishnarajasagara, Kabini and Hemavathy reservoirs. Prof. Rama Prasad has concluded that the gauged data of Central Water Commission is consistent, whereas the same for Tamil Nadu stations is inconsistent and, therefore, he has attempted to correct the Tamil Nadu gauged flows at Mettur, Grand Anicut and Lower

Coleroon Anicut. Thereafter, using 19 years gauged flows of Musiri (1971-72 to 1989-90), he has corrected flows of LCA, and used the same to hind cast total river flows from 1900-01 to 1989-90 (for 90 years).

46. He has thereby assessed the total yield at LCA, as per his reconstructed flows as under:-

i) Average flow - 834 TMC

ii) 50% dependable flow - 802 “

iii) 66.67% dependable flow- 732 “

iv) 75% dependable flow - 695 “

as against the CFFC’s assessment of 740 TMC at 50% dependability and 670 TMC at 75% dependability. In the statement of Professor Rama Prasad, which has been filed on behalf of the State of Karnataka, it has been stated by him on affidavit that he had been working in the Indian Institute of Science, Bangalore in various capacities involving Teaching, Research and Consultancy since 1965. Since the year 1982 he had been working as Professor in the Department of Civil Engineering. In the year 1990, he was approached and requested to be a Member of the Technical Committee, Cauvery Water Disputes, to advise on the Cauvery Water Dispute pending before this Tribunal. He claims that he had gone through the records of the case and relevant materials made available to him by the office of the Chief Engineer, Water Resources Development Organisation, Government of Karnataka, Bangalore. On basis of those materials, he has reconstructed the surface flows of river Cauvery. First he has given the details in respect of stream gauging by current meter and

as to how the average velocity multiplied by the area of cross section gives the total discharge. The discharges thus measured at various stages (i.e, water levels) of the river are sometimes used to establish a rating curve, which then gives the discharge for a measured stage. The discharge at dams can be determined from calibration of the spillway, sluices, turbine gates and other outlets and the area-elevation-capacity tables. The Cauvery is gauged at several stations through out its length. The downstream-most station is at the Lower Coleroon Anicut (LCA). The gauging stations are – Grand Anicut (GA), the Upper Anicut (UA), Musiri, Kodumudi, Urachikkottai, Mettur reservoir and Biligundlu upto Tamil Nadu, Karnataka border. Out of these, the Central Water Commission (CWC) operates the stations at Musiri, Kodumudi, Urachikkottai and Biligundlu. The Tamil Nadu State operates the remaining stations. It may be mentioned that Central Water Commission has established the gauging stations at Musiri (1972), Kodumudi (1971) and Urachikkottai (1979) within the State of Tamil Nadu and Biligundlu (1971) at the border of Tamil Nadu and Karnataka. On the basis of readings of the flows at Musiri, Kodumudi, Urachikkottai and Biligundlu, he has purported to reconstruct the total surface flow within the Cauvery basin for the period from 1900-01 to 1989-90 and has come to the conclusion that:-

> “(a) The gauged (by Tamil Nadu) flows at Upper Anicut, Grand Anicut and Lower Coleroon Anicut are inconsistent with each other and therefore cannot all be correct.

(b) The gauged (by Central Water Commission) flows at Biligundlu and Urachikottai on the one hand and Kodumudi and Musiri on the other, are consistent with each other and therefore can be considered correct.

(c) The gauged flows (by Tamil Nadu) at Grand Anicut and Lower Coleroon Anicut are underestimated as revealed by their comparison with the gauged flows (by Central Water Commission) at Musiri.

(d) The gauged flow (by Tamil Nadu) at Mettur are underestimates as revealed by their comparison with the gauged flows (by Central Water Commission) at Biligundlu.

(e) There is a well defined linear relationship between the flows computed on the basis of Musiri (by Central Water Commission) gauging at Grand Anicut and Lower Coleroon Anicut on the one hand and the gauged (by Tamil Nadu) flows at those stations on the other.

(f) Since Central Water Commission gauged flows are available only from 1971-72 onwards and Tamil Nadu gauged flows from 1900-01 onwards, a correction of the Tamil Nadu gauged flows from 1900-01 to 1989-90 is necessary to arrive at the average flows and flows at various dependability levels.

(g) The linear relationship referred to in (e) above is determined by the well known method of regression analysis, which is widely used in similar situations. With the help of this relationship, the Tamil Nadu gauged flows are corrected. A long term series of gross flows at Lower Coleroon Anicut has been developed considering upstream withdrawals.

(h) This developed series leads to the following conclusions about the gross flows at Lower Coleroon Anicut:-

(i)	Average flow	=	834 TMC
(ii)	50% dependable flow	=	802 TMC
(iii)	66.67% dependable flow	=	732 TMC
(iv)	75% dependable flow	=	695 TMC"

47. It may be said at the outset that it is an admitted position that Prof. Rama Prasad has not considered the records of any gauging stations maintained either by Central Water Commission or the State of Karnataka within the territory of the State of Karnataka. He has also not considered any gauging stations in the State of Kerala for the purpose of surface flows of Cauvery river system. He has mentioned that the methodology for consistency check is:-

"If A is an upstream station and B a downstream station, and the flows at these stations are Q_A and Q_B respectively, then the following equation should be satisfied:

$Q_B = Q_A + R_{AB} - S_{AB} - W_{AB}$ …… (1)

Where R_{AB} is the runoff from the intermediate catchment between A and B,

S_{AB} is the final storage minus initial storage in reservoirs, if any, between A and B during the time interval considered and W_{AB} is the total withdrawal/diversion between A and B, including evaporation losses from reservoirs, if any.

> The method for checking consistency is to calculate the right hand side of eq. (1) using the measured values of Q_A, S_{AB} and W_{AB}, and an estimated value of R_{AB}, since usually no measurement of intermediate catchment runoff is available. For estimating this runoff, the average rainfall in the intermediate catchment during the monsoon season is first calculated from the measured monthly rainfall values in the catchment, and then the corresponding runoff is read from Strange's Tables. The right hand side of eq (1), calculated in this way, is here called the "calculated flow" at B, and Q_B is called the "gauged flow" at B.
>
> If the gauged flows at A and B are free from errors, then the calculated and gauged flows at B should be equal. However, since all measurements are subject to random errors, these flows cannot be expected to be exactly equal in any individual year. If the gaugings are consistent, the calculated flow will be higher than the gauged flow for about half the number of years on record, and less for the other half. If the calculated flow is plotted against the gauged flow the points will be scattered evenly about a 45 degree line (1 : 1 line) for the case of consistent gauging excepting points which fall outside the general trend due to unknown factors. If the gaugings are inconsistent, the points will be scattered unevenly about the 1: 1 line with a larger number of points lying on one side of the line than the other. This is the test for consistency applied here."

According to his own statement for estimated runoff, the average rainfall in the intermediate catchment during the monsoon season is first calculated from the measured monthly rainfall values in the catchment, and then

corresponding runoff is read from Strange's tables and he has applied Strange's tables for his conclusions regarding the total yield.

48. In this connection, it may be mentioned that the INDIAN STORAGE RESERVOIRS WITH EARTHEN DAMS: By STRANGE was published in 1902. The relevant part is at page 57 of TN Volume No.36, Exhibit No.1371. Paragraph 19 of the said publication says as follows:-

> **"Estimation of the Run-off from the Daily Rainfall. –** The proper way to estimate the run-off, in the absence of observations of it, will be to proceed on the lines of the above table, and, if a few discharge observations have been taken, to construct the table with reference to them……"

Thereafter it has been said:-

> "Such estimates are but approximations, and should be resorted to only in the absence of actual discharge observations. It is a matter of the first importance to have such observations for as many years as possible, and, therefore, no large scheme should be proceeded with until a record of at least ten years has been obtained……"
>
> (Emphasis supplied)

49. From the well known publication by COL. ELLIS (COLLEGE OF ENGINEERING MANUAL – IRRIGATION), the relevant part of which has been annexed to TN Note No.16 of Group – 2. In Para No.54 (Chapter III) page 35, his opinion is:-

> **"54. Measurements of run-off much to be preferred to estimates based on rainfall**.—An estimating of run-off based on even the most accurate and reliable records of rainfall is liable to very great error, and it should be clearly borne in mind that even approximate gaugings of actual discharge are wherever

> procurable much preferable to estimates wholly based on rainfall data……"

In Paragraph No.56, it has been said:-

> "……In the absence of records of actual stream flow, an estimate of run-off must be made from rainfall records but the problem is a very complex one and the estimate is liable to considerable errors. Generally the rainfall is the only factor influencing run-off, of which exact measurements are available and the others are not susceptible of exact measurement and are stated only in general terms."
>
> (Emphasis supplied)

50. The Ministry of Irrigation and Power published the Report of the Krishna- Godavari Commission in the year 1962 (TN Volume No.36, Exhibit No.1379). Chapter IX deals with the river flow. At Pages No.123 to 129 of K.G. Commission report while discussing utility of empirical formulae, it has been mentioned as under:-

> "9-34 Binny's percentages and Strange's Table may have had some merit sixty years ago, with the modern knowledge of hydrology, these are, in the Commission's view, completely outmoded and unreliable."

51. A paper co-authored by Prof. Rama Prasad was presented in a "National Seminar on Water Resources Development" in October 1986, wherein the reasons for large discrepancy in the estimated and actual yield of Gundal project were analysed. Gundal Reservoir project was designed on the basis of Strange's table in the State of Karnataka within Cauvery basin. Later, it was revealed that the estimated yield was very high {against the estimated yield of 1.84 TMC (51.62 Mm^3), the actual

yield was found to be only 0.28 TMC (7.96 Mm^3)}. One of the reasons mentioned in the paper was "inapplicability of Strange's table of runoff" for estimating the yield of Gundal project. Prof. Rama Prasad could not give any satisfactory reply to the factual position during the cross examination by the learned counsel for the State of Tamil Nadu. Attention of Prof. Rama Prasad was drawn to the aforesaid paper, which had been co-authored by him. Question No.1036 and reply there to are at page No.241-242 of Volume I of his deposition:-

> "Q: 1036 Now, turn to page 13-2, the next page, second paragraph it is stated:
>
> > "Runoff is one of the basic hydrologic data and its estimation plays an important role in the design of the above mentioned irrigation project. Otherwise the design with scanty hydrology data may result in failure of the purpose for which the project is designed."
>
> Then it says:
>
> > "In the present case, the Gundal reservoir project in Karnataka State has failed since the yield estimated at the time of planning the project has not been realised after the construction of the project."
>
> Have you seen that?
>
> A: Yes."

52. Attention of Prof. Rama Prasad was drawn to the relevant paragraphs of Mr. Strange's publication "INDIAN STORAGE RESERVOIRS WITH EARTHEN DAMS' in Questions No.559, 560 & 578 (Page No.123 and 127) of Volume-I:-

"Q:559 If you go back to the previous exhibit, which I gave you, that is 1371 the learned author has himself delineated the conditions to which his work should be subjected. Please see the conditions, at page 18, under the heading "19 Estimation of the run-off from the Daily Rainfall." It starts by saying: "The proper way to estimate the run-off, in the absence of observations of it, will be to proceed on the lines of the above table, and, if a few discharge observations have been taken, to construct the table with reference to them." With reference to that, at page 19, the learned author qualifies it by saying: "Such estimates are but approximations, and should be resorted to only in the absence of actual discharge observations." Do you find that?

A: Yes.

Q:560 According to Strange himself, run-off from rainfall is an approximate method prescribed by him, and such a method could be resorted to only if you do not have the actual discharge observation and data. Right?

A: Yes.

Q:578 I have shown you the most important note of caution drawn by Dr.Strange, when he said that this table gives you an estimate of approximation and should be strictly resorted to only in the absence of actual discharge observations being available. This is the author's note of caution.

A: Yes."

[Emphasis supplied]

53. The witness agreed that he was aware of the caution by the author Strange that his Table should not be used if the actual observed data is available.

> "Q.No.1011. Please come to page l9. This is what the learned author said further about his own table. He says:
>
> "Such estimates are but approximations, and should be resorted to only in the absence of actual discharge observations."
>
> So, the author has cautioned repeatedly, do not use this table. If you have the actual observed data. Is that right?
>
> A. Yes". [Emphasis supplied]

54. In view of the aforesaid opinions of experts on the subject, including Mr. Strange himself, Strange's formula should be applied only when actual gauge readings for surface flow are not available. Where gauge readings for a sufficiently long time are available, no expert has said to our knowledge that even in that situation any formula, including .Strange's table, should be applied, who has himself described it as an approximate estimate. The gauge readings for a considerable period of time are more reliable.

55. In the present case, Additional Advocate General for Tamil Nadu has shown in the common format data supplied to CWDT (Exhibit E-18, page 15 and page 17) as also in the data supplied to CFFC (Exhibit 834, Vol. TN XIV, page 195-196) that discharge tables used for calculating discharges at Grand Anicut and Lower Coleroon Anicut are based on current meter observations. Same was the case in respect of other

structures. He has also indicated that in UNDP Report, Vol. I, page 38, last para, a mention has been made that the Public Works Department has taken discharge measurements at the head of three channels viz. the Cauvery, the Vennar and the Grand Anicut Canal for 24 years (1946 to 1970) at the Grand Anicut using current meter method and are regarded as accurate.

56. As already mentioned above, Karnataka and Tamil Nadu both have filed flow series on the basis of gauging stations within the States of Karnataka and Tamil Nadu before this Tribunal in November, 2002. The State of Karnataka has furnished the flow series for 72 years from 1900-1901 to 1971-72 on 7th November, 2002. Tamil Nadu furnished the flow series for 38 years from 1934-35 to 1971-72 on 15th November, 2002. The same, along with the covering letters, have been marked as KR Volume No.64 – Exhibit No.KR-517 and TN-Volume No.45 – Exhibit No.1663 respectively. (Copies thereof are enclosed at the end of this chapter). It is difficult to appreciate, when the State of Karnataka has relied on the flow series since 1900-01 upto 1971-72 before this Tribunal as late as on 7.11.2002 then how those very flow series can be ignored or rejected on basis of a theoretical reconstruction of flows done by Prof. Rama Prasad on basis of the four gauging stations at Musiri, Kodumudi, Urachikkottai and Billigundulu established by Central Water Commission after 1971. On basis of the readings of those three stations, which are all within the State of Tamil Nadu and one at Biligundlu at the boundary of the State of Tamil Nadu and Karnataka, it is difficult to reject the flow

series submitted before this Tribunal saying that these are not reliable. Not a single gauging station of Central Water Commission in Karnataka has been examined. It would be relevant to point out that at no stage either for fifty years during the continuation of the Agreement of the year 1924 or thereafter Mysore/Karnataka questioned the flow data based on the gauging stations within the State of Madras/Tamil Nadu and Mysore/Karnataka. This is apart from the fact that the State of Mysore/Karnataka admitted the finding of the total yield as estimated by Cauvery Fact Finding Committee in the meeting of the Chief Ministers in the year 1973 and even in the meeting of the Chief Engineers held in the year 1980. If the flow series since the year 1900-01 upto the year 1971-72 has not been disputed by the State of Karnataka even before the Tribunal how Prof. Rama Prasad had the occasion to reconstruct another flow series and to estimate the total yield of river Cauvery on basis of Strange's table.

57. Then reference was made on behalf of the Karnataka to the report of the Narmada Water Disputes Tribunal, Volume-I, Chapter IV, page 42 in support of their stand that flow series for longest period should be taken into consideration. From that report it shall appear that flows at three sites were taken into consideration for the period 1948-49 to 1969-70. Then it was decided to hind-cast the run-off figures based on the available rainfall data for the earlier years. Khosla Committee had also felt that earlier rainfall data for the periods prior to 1915 was for stations few and far between and as such would not correctly represent the rainfall

over the catchment. Ultimately on basis of those figures an agreement was reached between the party-States in respect of dependable yield at 75% to be 28 MAF. How this part of the report helps Karnataka, when they themselves have filed flow series for a longer period than what was available before the Narmada Water Disputes Tribunal.

58. Reference was also made to the affidavit of Prof. A. Mohanakrishnan, Witness on behalf of the State of Tamil Nadu where it has been stated:

> "31. As the rate of flow is pulsating, so also, the annual yield in a river system is a variant. Depending on the incidence and the intensity of the rainfall, the run-off in the river system varies with time and also from year to year. The statistical characteristics of stream flow series are useful for the prediction of future stream flows in terms of the probability of occurrence over a period of years. The World Meteorological Organisation adopts the data over a period of 30 years block for analysing the rainfall and other relevant parameters. A block of 30 years will even out the variations and would contain a series fully representing the possible peaks and dips expected in the meteorological phenomena."

59. Our attention was also drawn to cross-examination of Prof. A. Mohanakrishnan, on behalf of the State of Karnataka vide deposition of Tamil Nadu Witness No.I, Prof. A. Mohanakrishnan, Vol.I pages 181-193. In the questions it has been repeatedly put to the said witness on basis of several publications that for flows or for rainfall, longer the series, better the results, to which he has replied that series for 30 years was enough for analysis.

60. The flow data submitted on behalf of the States is for the period 1933-34 to 1971-72 i.e. for 38 years. The period of 38 years is not a small period and on basis of the annual flows during that period the conclusion about the total yield can be arrived at along with other materials. But as already pointed out earlier, even before this Tribunal the Karnataka itself has filed flow series for 72 years starting from 1900-01 to 1971-72. On basis of that Karnataka itself has calculated the dependable yield at 50% to be 752 TMC.

61. As regards the stand of Karnataka that this Tribunal should take into consideration the flow series for periods after 1972, it may be mentioned that none of the party-States has filed annual flow series for the period after 1972 for important nodal points, namely, Krishnarajasagar, Mettur and Lower Coleroon Anicut. Unless flow series after 1972 are made available, it is not possible to come to the conclusion that there has been a material change in the total yield within the basin. After 1974 with the expiry of 50 years none of the States appear to be interested in disclosing the correct information in respect of withdrawals because of which the details furnished in respect of flows and withdrawals by the party-States in the common format after 1972 are disputed – by the States of Tamil Nadu and Karnataka. Both States have alleged that the information in respect of withdrawals furnished by either party was not acceptable. The party States have furnished data in the Common Format for the period 1971-72 to 1989-90. The Common Format data covers several aspects of water resources development in the States including

irrigated areas, water utilization, river supplies and releases besides the co-efficient of discharge of various structures on the basis of which discharge observations are made during operation of the system. However, while commenting on each other's data, the party States, namely, Karnataka and Tamil Nadu, in particular, have not accepted the data furnished by either of them to the Tribunal.

(Ref: Exh. E-8 – Comments of Karnataka on Tamil Nadu's data; Exh.E-7 and E-9 – Comments of Tamil Nadu on Karnataka's data)

Kerala

62. So far the State of Kerala is concerned since the initial stage, it has supported the finding of the Cauvery Fact Finding Committee that 740 TMC of water was available in the Cauvery system in an average year. It also supported Tamil Nadu that the Chief Ministers of Karnataka, Kerala and Tamil Nadu had accepted the said finding of the Cauvery Fact Finding Committee. In the Statement of Case filed on behalf of the State of Kerala (Volume No.I) at Page No.39, it has been stated:-

> "4.1.4 Kerala contributes 147 TMC of water to the Cauvery basin. Out of 740 TMC available for the entire basin, it works out to 20% of the total yield……."

63. Again at page No.47 while summing up the claim on behalf of the State of Kerala, it has been stated:-

> "4.2 To sum up:
>
> 1. Contribution of the Cauvery Basin within the State of Kerala is about 20% of the total yield of 740 TMC and considering the peculiar needs of Kerala as an overpopulated and industrially underdeveloped State with considerable potential for

development claims of the State of Kerala for a reasonable share of the water of Cauvery – worked out at 99.8 TMC – is only just and fair and this has to be allocated to Kerala……"

64. Regarding the findings of the Cauvery Fact Finding Committee, it has been stated at page No.9-10:-

"1.11 Chief Minister's meeting on 29.4.1973

1.11.1 A meeting of the three Chief Ministers was convened by Dr. K.L. Rao on 29th April, 1973. In the meeting the report of the Cauvery Fact Finding Committee was considered. The following decisions were made;

(1) The assessment of the yield in the Cauvery basin (av. 740 TMC) by the Committee was generally agreed by all States. ……."

65. Before this Tribunal, in the rejoinder filed on behalf of the State of Kerala to the Counter Statement of the State of Tamil Nadu page 13-14, it has been stated:-

"The CFFC estimated the flow at 740 TMC in the Cauvery based on 50% dependability. There is no reason to depart from such a approach. Any attempt to reopen the issue by a fresh approach would not only be unwarranted but would delay the settlement of the dispute."

66. It shall appear that by letter dated 15.2.1975 Government of India had sent a draft on the use and development of Cauvery waters as proposed by the State of Kerala to the Chief Secretary, Tamil Nadu. In the terms and conditions of the proposed agreement, Kerala had stated:-

> "The Fact Finding Committee constituted by the Government of India during the negotiations has found that 740 TMC of water is available in the Cauvery system in an average year and this has been accepted by the Chief Ministers of Karnataka, Kerala and Tamil Nadu."
>
> (Ref. TN Vol. XVI, Exh. 847, Pages 4, 6 & 7)

Having accepted the finding of the Cauvery Fact Finding Committee in respect of the total yield of the Cauvery basin being 740 TMC at 50% dependability, during arguments a stand was taken on behalf of the State of Kerala that the total yield was more than 740 TMC. Several grounds have been mentioned in the Note No.7 on Group No.2 filed on behalf of the State of Kerala challenging and questioning the finding of the CFFC in respect of the total yield of the Cauvery basin being 740 TMC. In this connection reliance was also placed on the evidence of Prof. Rama Prasad, the Witness No.5 examined on behalf of the State of Karnataka on the total yield of the Cauvery basin. The evidence of Prof. Rama Prasad has already been discussed and considered while dealing with the claim of the State of Karnataka and there is no necessity to repeat the same.

67. In this background, it is not open to the State of Kerala to claim before this Tribunal, during arguments that the total yield of the Cauvery basin is more than 740 TMC when it was their consistent stand since 1974 upto the stage of arguments before this Tribunal that the total yield was about 740 TMC at 50% dependability.

Union Territory of Pondicherry

68. The Union Territory of Pondicherry during the course of arguments have stated as under:-

> "The Union Territory of Pondicherry respectfully submits that the Cauvery Fact Finding Committee (CFFC) has correctly determined the total quantity of water in the river Cauvery and there is no reason to doubt or make a reassessment of the same.' (Ref: Union Territory of Pondicherry Notes of Arguments on Issues under Group-2, para 2)
>
> The Union Territory of Pondicherry have further pointed out that all the party States accepted the finding of the Cauvery Fact Finding Committee as to the yield in the river Cauvery. This is reflected in the meeting held on 29.4.1973 by the Minister of Irrigation & Power, Government of India and with the Chief Ministers of Kerala, Mysore and Tamil Nadu."

69. The Union Territory of Pondicherry stated that at the meeting of the Chief Ministers of the three States on 29.4.1973, request was made to the Government of India seeking revival of the CFFC. The terms of reference related only to a review of the data supplied to it earlier by the State Governments in respect of areas cropped, net area irrigated, irrigated cropped area and other data relating to water utilization at different points of time and to undertake such verifications as is necessary, from other data available with the State Governments. There was no reference for a re-assessment of the yield of the river Cauvery. Even the additional report of CFFC there is no change in the assessment of yield made by it in the main report.

70. In such a situation on basis of the materials produced before this Tribunal and referred to above, the total yield of the Cauvery basin at 50% dependability is about 740 TMC and at 75% dependability is about 670 TMC.

KARNATAKA

Exh.. KR No 517

Vol No. 64

Mohan V.Katarki, Advocate,
Supreme Court,

Cauvery Water Cell,
Karnataka Bhavan , August Kranthi Marg,
New Dclhi - 110049

3

Date: 7-11-2002.

To:

The Registrar,
Cauvery Water Tribunal,
Janapath Bhanvan,
Janapath, New Delhi.

Sir,

Sub: The aVerage yield in the Cauvery River Basin above and upto delta based n long term data.

Ref: 1. Letter No.PWDI3/LCA/80(P.m dated: 2.2.1981. From the Special Secretaly, Government of Kama taka to The Secretaly to Government of India, Mittistry of Inigation & Agnculture, New Delhi, - filed in KRD Vol. II SI.No.185 •. Page568.- . ..

2. Draft_Agreement_for Development and Use' of the Waters of the Cauvery Basin, Kamataka January 1981 - filed before CWOT in KR.D Vol.ll Sl..N0.191,Page 592 to 593.

****

With reference to the above the Statement showing the average yield in the Cauvery River Basin above and upto based on the long term data from 1900-01 to 1971-72 is 792 ~. The detail calculation of the yield of Cauvery Basin as at Lower Colcroon Anicut is enclosed herewith.

The above document as please be taken on record.

Yours faithfully,

(Mohan V.Katarki)

Year	Flow at LCA as per Col. 27: of River Register;	Upstream utilisation under channel	Withdrawals at Hullahalli	Gross yield at LCA.
1	'2	3	4	5
1900-01	702.2	212.5	10.5	925.2
1901-02	437.1	212.8	10.5	660..4
1902-03	486.3	213.1	10,5	709.9
1903-04	881.1 .'	213.4	10.5	.1105.0
1904-05	400.4 .	213.7	10.5	624.6
1905-06	485.0	. 214.0	10.5	709.5'
1906-07' .	467 .. 3 : , ,	214.3	10.5	692.1
1907-08	. 602.1 ,	214.6	10.5	827.2
1908-09	465.5 .	214.9	10.5	690.9
1909-10	775.2	215.2	10.5	1000.9
1910-11	1095.0	21.5.5	10.5	1321.0
1911-12	615.6	215.8	10.5	841.9
1912-13	657.3	216.1	10.5	883.9
1913-14	502.1	216.4	10.5	729.0
1914-15	485.9	216.7	10.5	713.1
1915-16	412.9	217.0	10.5	640.4
1916-17	683.7	21'7.3	10.5	911.5
1917-18	425.7	217.6	10.5	653.8
1918-19	236.3	217.9	10.5	464.7 -- ..
1919-20	605.7	218.2	10.5	834.4
1920-21	694.4	218.5	10.5	.923.4
1921-22	600.5	218.8	10.5	829.8
1922-23	584.0	219.1	10.5	8111.4
1923-24	936.0	219.4	10.5	1166.1
1924-25	986.6	219.7	10.5	1216.8
1925-26	460.0	220.0	10.5	690.5
1926-27	444.3	220.3	10.5	675.1
1927-28	471.6	220.6	10.5	702.7
1928-29	363.5	220.7	105	594.7
1929-30	520.5	220.7	10.5	751.7
1930-31	677.3	220.7	10.5	908.5
1931-32	654.3	220.7	10.5	, 885.5
1932-33	696.8	220. 7	10.5	928.0
1933-34	945.6	220.7	10.5	1176.8
1934-35	345.5	220.7	10.5	576.7
1935-36	415.9	221.3	10.2	647.3
1936-37	441.3	221.9	9.8	673.0
1937-38	400.8	. 222.5	7.8	. 631.1
1938~3	375.3	223.1	9.0	607.4
1939-40	539.3	223.7	9.8	772.8

. Year	Flow at LCA' as per Co/.27 Of River Register	Upstream utillsation under Anicut channel etc	Wllithdrawals at Hullahalli	Gross yield at LCA.
1	2	3	11	5
1940-41	663.7	224.3	9.5	897.5
1941-42	528.0	225.2	11.0	764.2
1942-43	536.6	226.1	10.8	773.5
1943-44	613.8	227.0	11.2	852.0
1944·45	495.5	227.9	9.8	733.2
1945-46	326.5'	228.8	10.6	565.9
1946-47	831.5	229.7	11.0.	1072.2
1947-48.	492.7	230.6	10.7	734.0
1948·49	486.1.	231.5	10.6	728.2
1949-50	356.5'	232.4	10.2	599.2
1950-51	468.2	;?33.3	10.0	711.5
1951-52	344.9	234.2	9.4	566.5
1952-53	271.7	235 . 1	9.3	516.1
: 1953-54	618.1	230.0	9.8	803.9
1~)5"-55 .	G09.9	230.9	11.2	850.0
1955-56	352.4	237.9	10.8	601.1
1956-57	711.7	239.0	10.5	961.1
1957-58	.535.4	242.0	9.9	787.3
1958-59	557.6	245.0	10.8 ~ .	813.4
1959-60	826.0	248.0	10.5	1084.5
1960-61	520.6	251.0	9.9	781.6
1961-62	924.7	254.0	11.2	1189.9
1$62-63	720.8	257.0	13.0	990.8
1963-64	413.0	260.0	11.1	684.1
. 1964-65	705.9	263.0	11.7	980.6
1965-66	267.0	266.0	11.4	544.4
1966-67	471.5	269.0	9.3	749.8 .
1967-68	367.7	272.0	10.8	650.5
1968-69	380.8	275.0	11.3	667.1
W69-70	389.8	270.0	11.5	679.3
1970-71	430.0	2B1.0	11.5	722.5
1971-72	490.0	283·O	10.2	784.1

ABSTRACT

Period	Average	50%	75%
1900-01 To 1971-72 .	792.3	752.0 .	673.0

Source: DELIBERATIONS AND CORRESPONDENCE REGARDING

CAUVERY WATERS (August 1978- February 1982) Pages 123-125.

C. PARAMASIVAM, M A . M L
Advocate, Supreme Court

Resi. Cum. Off :
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New Delhi - 91, Phone: 011-2714490

15th November 2002

To

The Registrar,
Cauvery Water Disputes Tribunal
Janpath Bhawan,
Janpath, New Delhi.

TAMIL NADU
Exh. T.N. No. 1663.
Vol. No. **45**

SIr,

Sub: River Cauvery - Yield series considered by the CFFC - Furnished

The learned Assessors in an informal meeting convened, in which Prof. A. Mohanakrishnan from Tamil Nadu and Shri. A.V. Shankar Rao from Karnataka participated, requested them. to furnish the yield series that was considered by the CFFC while arriving at the 50% dependable yield as 7Zl0 TMC and 75% dependable yield as 670 TMC. It was also agreed that Tamil Nadu will furnish such a series to Karnataka and it was agreed to meet the Assessors for a discussion on the series on the 09th of October 2002. Accordingly the yield series as worked out by Tamil Nadu was faxed to Shri. Shankar Rao on the 05th of October 2002.

The meeting proposed by the learned Assessors for the 09th October 2002 was later cancelled on intimation sent over phone.

It is now learnt that Karnataka has filed their yield series on Cauvery formally on the 11 th November 2002.

As required by the Assessors, the yield series as worked out by Tamil Nadu for the dependable yield figures adopted by the CFFC at KRS, Mettur and LCA as already sent to Karnataka by fax, is now formally furnished for information and record.

Any clarification on this can be furnished if necessary.

Yours faithfully,

C-.~

(C. PARAMASIVAM)

Encl: Yield series with working sheets. (9 Sheets)

Source: Col.3: As per Working sheet II(a)
Col.4: As per Data given to CFFC - Working Tables- TNDC Vol.X
Col.6: As per working sheet II(b)

GROSS YIELD AT METTUR AND LOWER COLEROON ANICUT — Figures in TMC

Sl. No.	Year	Abstractio above Mettur	Inflow at Mettur	Yield at Mettur Col.	Total Abstractio below Mettur	Domesti use in Tamil Nadu	Surplus at LCA	Total yield at LCA Col. 3 + 6+7+8	Col.5 in Descending order	Col.9 in Descending orde
(1)	(2)	(3	(4	(5	(6	(7)	(8)	(9)	(10	(11)
1	1934-35	97.842	282.178	380.020	446.335	1.607	32.683	578.467	929.097	1205.212 i
2	1935-36	117.616	289.410	407.026	470.138	1.675	59.880	649.309	802.961	1102.698
3	1936-37	119.364	334.670	454.034	503.555	1.743	55.738	680.400	744.553	1089.388
4	1937-38	118.271	280.670	398.941	446.775	1.811	72.468	639.325	718.060	1018.709
5	1938-39	117.342	301.322	418.664	432.653	1.879	56.150	608.024	673.738	1006.995
6	1939-40	128.982	327.356	456.338	487.783	1.946	157.726	776.438	661.201	973.942
7	1940-41	136.296	430.197	566.493	494.016	2.014	273.849	906.175	659.956	906.175
8	1941-42	119.512	349.506	469.018	510.882	2.082	140.800	773.276	621.735	876.653
9	1942-43	138.159	367.410	505.569	551.791	2.150	94.507	786.607	621.009	876.001
10	1943-44	144.895	476.840	621.735	540.459	2.218	168.998	856.570	612.359	856.570
11	1944-45	124.949	302.617	427.566	509.711	2.286	99.248	736.194	566.493	829.876
12	1945-46	130.784	234.689	365.473	413.785	2.354	23.363	570.286	554.259	802.293
13	1946-47	156.972	516.766	673.738	574.247	2.421	355.748	1089.388	547.308	798.314
14	1947-48	146.050	375.955	522.005	487.910	2.489	103.699	740.148	533.087	786.607
15	1948-49	137.554	395.533	533.087	521.444	2.557	74.002	735.557	533.040	781.489
16	1949-50	127.950	326.159	454.109	456.043	2.625	20.469	607.087	533.032	776.438
17	1950-51	134.941	389.525	524.466	495.873	2.693	61.931	695.438	524.466	773.276
18	1951-52	151.126	288.371	439.497	429.674	2.761	17.274	600.835	522.005	760.71 **j**
19	1952-53	121.480	272.048	393.528	389.053	2.829	9.682	523.044	505.569	740.148
20	1953-54	172.147	489.054	661.201	588.738	2.896	112.872	876.653	497.878	736.194
21	1954-55	154.004	458.355	612.359	609.100	2.964	109.933	876.001	487.049	735.557
22	1955-56	131.934	290.938	422.872	434.321	3.032	40.425	609.712	483.581	716.929
23	1956-57	176.093	541.967	718.060	619.323	3.100	175.426	973.942	469.018	696.653
24	1957-58	152.156	402.103	554.259	529.007	3.227	117.904	802.293	456.338	695.438
25	1958-59	168.891	452.118	621.009	572.157	3.353	85.474	829.876	454.109	680.40n
26	1959-60	174.244	628.717	802.961	653.456	3.480	271.518	1102.698	454.034	671.856
27	1960-61	176.411	370.897	547.308	563.041	3.607	55.256	798.314	439.497	670.200
28	1961-62	178.937	750.160	929.097	663.007	3.733	359.535	1205.212	439.024	653.115
29	1962-63	180.763	563.790	744.553	598.785	3.860	235.301	1018.709	435.090	649.309
30	1963-64	168.695	329.183	497.878	478.011	3.987	45.961	696.653	427.566	639.325
31	1964-65	183.306	476.650	659.956	681.955	4.113	137.620	1006.995	422.872	609.712
32	1965-66	159.944	188.768	348.712	352.751	4.240	24.595	541.530	418.664	608.024
33	1966-67	157.301	277.789	435.090	504.595	4.367	94.450	760.713	407.026	607.087
34	1967-68	174.910	264.114	439.024	438.012	4.493	35.699	653.115	398.941	600.835
35	1968-69	177.137	306.444	483.581	485.456	4.620	2.987	670.200	393.528	578.467
36	1969-70	182.845	304.204	487.049	461.650	4.747	22.615	671.856	380.020	570.286
37	1970-71	186.178	346.854	533.032	492.531	4.873	33.346	716.929	365.473	541.530
38	1971-72	185.785	347.255	533.040	539.407	5.000	51.297	781.489	348.712	523.044
	Total	5711.765	14330.582	20042.347	19427.429	115.832	3890.429	29145.455		
	Averaae	150.310	377.121	527.430	511.248	3.048	102.380	766.986		
	Yield at 50% dependabilitv			505.569				740.148		
	Yield at 75% dependabilitv			437.057				651.212		

Col.7: As per data given in CFFC's additional report-TNDC Vol.XV.
Figures given for 1928, 1956 and 1972. Figures for 1934-35 to 1971-72 are worked out adopting linear variation
Col.8: As per Data given to CFFC - Working Tables - TNDC Vol. X

Chapter 2

What should be the basis on which the availability of waters be determined for apportionment - whether at 50% or 75%.

Dependable Yield:

The natural annual virgin runoff of a river at its terminal site is called the yield of the river system in a water year (1st June to 31st May of next year). Yield of a river system depends upon rainfall, catchment area characteristics, including soil types, land vegetal cover alongwith various climatic parameters affecting evapo-transpiration in the basin. The annual yield of a river basin varies from year to year depending upon the occurrence of rainfall, its intensity and distribution in time and space. Although, water is a renewable resource, it is not unlimited in quantity, more so, the supply of water in a tropical region like Cauvery basin is seasonal depending upon two monsoon seasons (namely south-west and north-east) and may not be available when required, where required and in the quantity required, unless it is properly conserved/stored. Since the annual yield varies from year to year, it is important to work out a figure of sustainable utilizable flow which could be considered for allocation among the party States. It is here that the dependability of the available flows (yield) assumes importance.

2. There are two aspects for consideration of dependability factor:-

i) For allocation of shares from the total utilizable flows amongst the party States, what should be the dependability factor?

ii) For designing individual irrigation projects, what should be the dependability factor?

3. With the increasing demand for water, consistent efforts are being made by the party States for enhancing the availability of utilizable waters by constructing new storage reservoirs within the Cauvery basin, and Karnataka has already taken a lead in this. Since bulk of surface flow is used for agriculture purposes where the raising of crops and their production is highly dependant upon timely support of irrigation water at critical stages of crop growth, the regulated releases from the storage reservoirs becomes imperative. In view of the above consideration, the allocation of available utilizable water needs to be made keeping in view the dependability factor based on the facilities for storage of water available during any rainy season.

4. The State of Tamil Nadu having not disputed the finding regarding the yield of river Cauvery as recorded by the Cauvery Fact Finding Committee, took a stand that the dependability of the yield should be calculated at 75% and not on the basis of long term average which is the stand of the State of Karnataka.

5. The State of Karnataka in their Statement of Case has pleaded as under:-

> "16.7 The dependable flow which is to be distributed equitably among the basin States should be the average of the measured flows over the largest number of years for which reliable data are available. The average flow is obtained from the data by adding the flows of all the series of reliable years divided by the number of years over which the reliable measurements are taken. Except by an agreement the mean/average flow is the only correct estimate of the flow in the river to be distributed. Any higher dependability of flow means wastage in larger number of years than the normal or average year flow. Higher dependability is only used for domestic use, and power generation purposes. In the case of irrigation, the internationally accepted norm is to use the average flow for distribution. The latest example is that of the Ravi-Beas and earlier the Indus Basin. Separate provision is to be made for the distribution of surplus flows and deficit flows from the average flows. Average flow is close to 50% dependable flow……."
>
> (Emphasis supplied)
>
> (Ref. KAR-I, Pages 78-79, Para 16.7)

6. Before we examine this aspect of the matter as to whether the total yield of river Cauvery should be calculated at 50% dependability or 75% dependability, a special note has to be taken that in none of the disputes relating to sharing of the waters of any particular river in India in respect of which Tribunals have been constituted, there was so much of shortage and scarcity of the total yield of water in those rivers. Cauvery as already observed earlier is a river of blessing for the States including Union Territory of Pondicherry through which it passes before merging in the sea. But because of the very low total yield in comparison to other

rivers in India at times it has proved to be a river of sorrow and has led to disputes for sharing of the water of the said river between the different riparian States specially between the States of Mysore/Karnataka and Madras/Tamil Nadu. The dispute is going on for more than 150 years, details whereof have already been given in earlier volume of the report. The first agreement in respect of Cauvery was entered into between the States of Mysore and Madras after correspondence between the two States for several years, in the year 1892 referred to above. Then another agreement about sharing of the water of the said river Cauvery and its tributaries was entered into in the year 1924. That agreement is to be reviewed and re-examined for purpose of fresh allocation of water between the different riparian States in terms thereof. In this background, it has to be determined as to what is the dependable percentage 50% or 75%. It has also to be borne in mind that Tamil Nadu being a lower riparian State is naturally interested in assuring the dependability at 75%.

Utilizable water resources:

7. Utilization of water resources can be taken as the quantum of withdrawal of water from its place of natural occurrence such as river or ground water. This approach has been used more commonly and was also used by the Central Water Commission in assessing the water resources of the country.

8. Within the limitations of physiographic conditions, hydro-meteorological parameters and socio-political environment, legal and

constitutional constraints and the available technology of development, utilizable quantities of water from the surface run-off have been assessed by different authorities differently. These are indicated below:-

(i) Irrigation Commission 1972, placed the country's utilizable quantity at 666 cubic km (1 cubic km = 35.283 TMC) from surface structures (i.e. storages and diversion structures Anicut, Barrages etc.); it amounts to 35% of the surface water resources of the country (annual run-off).

(ii) Dr. K.L. Rao put the utilizable quantity much more and has suggested that the quantum should be about 50% of the country's available annual surface water resources.

(iii) The National Commission on Agriculture, 1976 have estimated the utilizable quantity as 750 cubic km. This quantum constitutes about 56% of the annual average flow of the river.

It may be mentioned, that the above estimates have been made independently by the two Commissions and Dr. K.L. Rao, renowned water resources Expert. (Ref. CWC Publication No.30/88 on Water Resources of India, Page 22)

Improving utilizable flows:

9. The development and utilization of river waters for agriculture purposes consumes the bulk of the available flows in a river and only a small percentage is utilized by way of domestic, industrial and other beneficial uses. In the earlier times when the development of irrigation was in primitive stages, water was withdrawn from streams and rivers by diverting small quantities only, whereas the bulk of the flows were

running in the rivers downstream, which emptied into the sea. Since the quantities withdrawn were very little, their assurance was almost 100%. Later on, with the increase in the demand for irrigation, regular anicuts and other diversion structures were constructed and more quantities of water withdrawn from the rivers. Even at that stage, the withdrawn quantity was almost fully assured. With the further development of technology in water resources as well as agriculture sector, the extension of irrigation facilities in larger areas became necessary and along with that, some small and medium storage reservoirs came to be built. The design of projects fed by such storages was again of a higher dependability.

10. When the planned development of irrigation was undertaken in the country, larger storage reservoirs had to be built for impounding flood flows of the rivers and utilizing the same in a regulated manner for needs of agriculture and other uses. Keeping in view, the economic consideration and other factors, the design of these large reservoirs was limited to 75% dependable flow at these reservoir sites and, projects to be served by those reservoirs were assured 75% dependability i.e. the farmers could normally receive designed supplies for their crops in every three years out of four year period; of course, this stipulation restricted the area to be covered by such projects.

11. Later on when the demand of water for agriculture and other uses further increased and difficulties were experienced, specially in the arid and other water-short regions of the country for raising crops, much

larger storages which could trap river flows at 50% dependability, were permitted. Such larger storages obviously required greater financial investments but they helped greatly in improving the quantum of utilizable flows of a river system. From the above, it would be seen that increase in the quantum of utilizable flows had been gradual and linked with the demand of water for agriculture and other beneficial uses.

12. Coming to the Cauvery river basin where the demand of water is almost twice the quantum of available flows and the concerned riparian States having already constructed the reservoirs, which would impound larger quantities of river flows will it be proper to calculate the dependability at 75%? Here, it may also be mentioned that the consideration of utilizable quantum of water in a river system is of much more importance than the 75% or 50% dependability factors. For example, even in the Cauvery basin, the delta region, which receives heavy precipitation during the north-east monsoon, bulk of which flows down to the sea, is not considered for being counted in the available yield of the river. This is simply because that quantum of water cannot be stored for any beneficial use, rather it creates problems of flood congestion in the delta region and consequent damage to the standing crops.

13. India is blessed with several major river systems. The rivers in the north like Ravi, Beas, Sutlej, Ganga, Yamuna and Brahamputra etc. are perennial rivers fed by rainfall and snow-melt from the Himalayan ranges. In the central and southern parts of the country, major rivers like

Narmada, Godavari, Krishna, Chambal etc. are mainly fed by the south-west monsoon, which occurs during June to September. Further south, it is only the Cauvery river basin, which comes under greater influence of two monsoon seasons namely: south-west monsoon and north-east monsoon.

14. As mentioned earlier, the dependability factor indicates the degree of assured supply available on the basis of which a project/scheme for any particular use has been designed. Since heavy financial investments are involved in the projects for development of water resources, it is obvious that the assessment of availability should be fairly reliable. In order to economize on the cost of construction of storage reservoirs, a criterion of 75% dependability was adopted. In this connection, the Bureau of Indian Standards has prescribed as under:-

> "The active or conservation storage in a project should be sufficient to ensure success in demand satisfaction, say 75 per cent of the simulation period for irrigation projects, whereas for power and water supply projects success rates should be 90 per cent and 100 per cent respectively. These percentages may be relaxed in case of projects in drought prone areas……."
>
> (Ref. I.S. Code: Fixing the Capacities of Reservoirs, IS 5477 (Part I): 1999, Para 4.2.2)

By the above provision, it is meant that at a particular storage site, the construction of a reservoir was designed to store about 75% dependable

flows of the river, passing at that point. Accordingly, the project areas where irrigation facilities were to be provided were also restricted in extent and only that much area was considered for providing irrigation facilities, which could be covered by 75% dependable flows. These provisions related only to the construction and operation of the irrigation projects and accordingly, the areas to be covered by irrigation were restricted.

15. As more than 1/3rd of the country is occupied by arid and semi-arid areas, which got affected by droughts, due to low rainfall, which is also erratic, the rainfed agriculture in such areas used to suffer a lot. It was, therefore, considered necessary to over-come this difficulty. In such situations, the dependability factor is further lowered while designing the project. The Govt. of India, therefore, permitted construction of larger storages, which although involved higher investment in their construction, but at the same time, would be capable of storing more water during good rainfall years; thus increasing the quantum of utilizable water. In this connection, the Govt. of India in the year 1983 issued a circular to all the States, permitting them to make investments for construction of storage reservoirs to store 50% dependable flows in water short areas.

16. It may be mentioned that the States of Karnataka and Kerala while furnishing information in the Common Format, have indicated that most of their projects have been designed on 50% dependability.

[Ref. Hemavathi reservoir – KAR Vol. VIII, Page 1, Item 4 and E 65, Page 2, Item 4.

Harangi reservoir – KAR Vol. IX, S.No.302, Page 21, Para 4.8 and E 69, Page 2, Item 4

Kabini reservoir – KAR Vol. VII, Page 8 & Page10, Chapter 2, Para 1(iv) and E-68, Page 3, Item 4]

17. As regards the State of Kerala, the information on different projects filed before the Tribunal indicates that they have worked out the yield adopting Empirical Formula (Inglis Formula), which they call as available yield. They have further mentioned that since water utilization in their different projects is in small quantities compared to the available yield, their projects will be successful.

18. Even in Tamil Nadu, in the case of Lower Bhawani reservoir project, which came into operation from the year 1953 onwards, the intermittent system of allowing supplies to the area was followed from the years 1953-54 to 1958-59. But paddy cultivation was on the increase and it resulted in scarcity of supplies especially at the tail ends. Hence, a zonal system of irrigation is being followed from the year 1959-60. According to this system one half of the entire ayacut area will get supply from 15th August to 15th December and other half from 16th December to 15th March. There will be no crop restriction during the first turn season, and the ryots are free to raise paddy. During the second turn season, only dry crops are permitted. (Ref. TN Vol. XI, Exh.710, Page 98, item 28). From the above, it would be seen that when water scarcity is felt,

the State Governments themselves resorted to rotational system of wet and dry crops to minimize consumption of water. This principle needs to be followed by all the States as far as possible in the interest of cooperation amongst them and equitable benefits accruing to their farmers.

19. While dealing with the utilization of flows of lower dependability, the Irrigation Commission 1972 has observed as under:

> "……It is obvious that the higher the dependability, the less the quantity of water available for utilization. Availability can, however, be improved by providing an extra capacity in the reservoir for carrying over supplies from surplus years to lean years. By adopting this device, a project can be designed on river flows of lower dependability to provide a larger volume of water to irrigators, with the same degree of assurance. But the provision of carry-over capacity in a reservoir entails additional cost and it becomes a matter of evaluating the additional supply against the additional cost. The more precious the water in an area, as in drought areas, the greater is the justification for providing a carry-over……."
>
> (Ref: Report of the Irrigation Commission 1972, Vol.I, Page 125, Para 6.53)

20. On the issue of determination of available waters and the basis (dependability) for the same, the Krishna Water Disputes Tribunal in their report has mentioned as under:-

> "Dependable flow is the magnitude of river flow which may be assuredly expected at a given point on the river on some scientific or rational basis inspiring confidence."
>
> (Ref. KWDT Vol.I, Chapter IX, Page 74, left column, second para)

After hearing the parties to the dispute, the Tribunal concluded as under:-

> "With the able assistance of the parties and after thorough examination of all the material on record and after a careful consideration of the matter, the Tribunal directed that the series of discharge data from 1894-95 to 1971-72 be prepared on the lines indicated by the Tribunal, which represented the views of the Tribunal on all matters in controversy between the parties. The States of Maharashtra, Mysore and Andhra Pradesh submitted on the 4th May, 1973 separate documents marked X, Y and Z containing the annual flow series at Vijayawada for the years 1894-95 to 1971-72. The 75 per cent dependable flow from each of these series works out to 2,060 TMC."
>
> "After scrutinizing the documents the parties submitted an agreed statement stating that the 75 per cent dependable flow of the Krishna river at Vijayawada for the purpose of the case may be adopted as 2060 TMC. This statement which is Ex. MRK-343 is set out at the end of this Chapter. It is a matter of great satisfaction that the dispute on a very crucial matter in the case which had been the subject matter of serious controversy between the parties and which was mainly responsible for the prolongation of the trial in this case

has been thus satisfactorily resolved. We place on record our appreciation of this attitude adopted by the parties.

The Tribunal hereby determines that for the purpose of this case the 75 per cent dependable flow of the river Krishna upto Vijayawada is 2060 TMC."

(Ref. KWDT Vol.I, Chapter IX, Page 81, Right column, First three paras)

21. While considering relevancy of dependable flows, Narmada Water Disputes Tribunal has stated as under:

> "In examining the problem of apportionment, the possibility of maintaining a sustained flow through storage facilities is a relevant factor."

The Narmada Water Disputes Tribunal in its final order and decision under Clause II has mentioned as under:-

> "Clause II: Determination of the utilizable quantum of Narmada waters at Navagam Dam Site.
>
> The Tribunal hereby determines that the utilizable quantum of waters of the Narmada at Navagam Dam Site on the basis of 75 percent dependability should be assessed at 28 Million Acre Feet (34,537.44 M.Cu.M.)"
>
> (Ref. NWDT Final Order Chapter XX, Clause II)

A reference to Clause IX of the final orders of the Narmada Water Disputes Tribunal indicates that although the actual inflow at 75% dependability, was only 27.01 MAF (1 Million Acre Feet = 43.56 TMC) at Sardar Sarovar dam, but, this quantum was brought upto utilizable

quantum of 28.00 MAF, by means of carry-over in various reservoirs allowing for evaporation losses and regeneration. This decision was taken as per the agreement between the concerned parties. For distribution amongst the various parties, utilizable quantity of 28 MAF was considered and apportioned.

(Ref. NWDT final order Chapter XX, Clause IX, Para 1)

22. From the Godavari Water Disputes Tribunal report it shall appear that the States of Maharashtra, Karnataka, Madhya Pradesh and Orissa had been agitating their claim in the Godavari basin in connection with different projects. However, all States in respect of different projects agreed that dependability be calculated at 75%. The States of Maharashtra and Karnataka entered into an agreement on 4th August 1978 in connection with Polavaram project in Godavari basin. On that basis dispute was settled regarding the percentage of the dependability. Similarly, in respect of Indravathi project there was an agreement at 75% dependability between the different contesting States. As the dispute whether the dependability should be fixed at 75% or 50% was settled by an agreement with the aforesaid cases pending before the Krishna Water Disputes Tribunal, Narmada Water Disputes Tribunal and Godavari Water Disputes Tribunal, it can hardly be used as precedents for determination of that question when the party States are not agreeing. There the reason for agreement was obvious because those rivers and basins were not such deficit rivers and basins as is the case of Cauvery. The river Cauvery and its basin is not only deficit so far the total yield is

concerned, but the demands of the riparian States are much more. CFFC as referred to above at page 44 of T.N.D.C. Vol. XV has said:

> "Thus the total present utilization of Cauvery waters as indicated by the States is about 21238 M.cu.m. (750 TMC) against the total planned use of 35693.00 M.cu.m. (1260 TMC)."

[Emphasis supplied]

23. The report of the Ravi & Beas Waters Tribunal, 1987 mentions in Chapter-6, Page 19 of the report as under:-

> "After partition the surplus Ravi-Beas waters available for utilization, excluding the pre-partition use of 3.13 MAF, were worked out to be in the order of 15.85 MAF based on the mean supplies, 1921-1945 series. On 29th January, 1955, the Minister of Works and Power, Govt. of India, succeeded in securing an agreement between the concerned States whereunder 15.85 MAF of the waters of the Ravi and the Beas came to be allocated between the concerned States……."
>
> (Ref: Report of the Ravi & Beas Waters Tribunal, Chapter VI, Page 19, last 8 lines of second para)

[Emphasis supplied]

24. On behalf of Tamil Nadu reference has been made in support of their stand that the dependability should be based at 75%, to the observations and findings in connection with sanctioning of projects, i.e. in respect of construction of reservoirs and the areas to be irrigated from

such reservoirs. Those observations do not relate in respect of a case where different reservoirs have already been completed in the States of Karnataka and Tamil Nadu before the dispute for apportionment of the waters of river Cauvery was referred to this Tribunal. Here we are not to sanction any new project in any of the States. Here the question is as to what shall be the just and equitable dependable flow on basis of which the total available water in the river Cauvery and basin thereof should be apportioned. The Supreme Court of United States in the case of Wyoming v. Colorado 259 US, 419 at 484 said:

> "…… According to the general consensus of opinion among practical irrigators and experienced irrigation engineers, the lowest natural flow of the years is not the test. In practice they proceed on the view that within limits, financially and physically feasible, a fairly constant and dependable flow materially in excess of the lowest may generally be obtained by means of reservoirs adapted to conserving and equalizing the natural flow; and we regard this view as reasonable."
>
> (Emphasis supplied)

25. Here, it would be pertinent to mention that for maximizing the availability of utilizable water resources, the Government of India, in the National Water Policy, 1987 have made a stipulation as under:-

> "Maximizing Availability
>
> 3.1 The water resources available to the country should be brought within the category of utilizable resources to the

maximum possible extent. The resources should be conserved and the availability augmented by measures for maximizing retention and minimizing losses."

(Ref. Tamil Nadu pleadings TN-II Exh.No.942 page 4 para 3.1)

26. From the yield series furnished by the States of Tamil Nadu and Karnataka during 38 years period from 1934-35 to 1971-72 the lowest recorded yield was during the years 1952-53 at 523 TMC according Tamil Nadu and 516 TMC according to Karnataka. It shall also appear that in Cauvery basin the fluctuation of the flows is not as high as in Krishna or Narmada basin. The extent of fluctuations in the case of Cauvery between the lowest yield, the dependable yield is within 30% whereas in the case of Krishna it is 56% and in the case of Narmada 70%. This is because of the influence of two monsoon seasons in this basin. In the case of Cauvery river system it may be emphasized that there are many reservoirs in the States of Karnataka and Tamil Nadu. Krishnarajasagar in Karnataka, Mettur and Lower Bhavani in Tamil Nadu were in existence before the report of the CFFC. Several reservoirs have been built by the State of Karnataka thereafter.

27. Recognizing that a particular dependable flow may not be available every year and there will be some years of varying deficit or excess, in the allocation of river water amongst claimant States, the dependability factor assumes importance. Some of the States press for adoption of higher dependability percentage, thereby showing lower availability of water for distribution; whereas some other States would

press for adoption of lower dependability percentage, thereby showing higher availability of water for allocation.

28. Coming to the CFFC report, wherein historical run-off series of river Cauvery at Lower Coleroon Anicut was analysed to work out 50%, 75% and 90% dependable yields, adopting scientific method of frequency analysis, as also, making some modifications on account of carry-over storage at Mettur, concluded that 50% dependable yield would be of the order of 740 TMC and 75% dependable yield of the order of 670 TMC.

29. As directed by the Tribunal while Karnataka has furnished flow series for 72 years from 1900-01 to 1971-72, Tamil Nadu has furnished flow series for 38 years from 1934-35 to 1971-72. Examination of these two flow series indicates that there is hardly any change in 50% dependable yield of 740 TMC as assessed by CFFC. The Karnataka series when analyzed for 38 years period from 1934-35 to 1971-72 gives 50% dependable yield at 734 TMC, whereas the Tamil Nadu series gives a figure of 740 TMC. They almost tally with the earlier assessment made by CFFC. These series indicate that the lowest flow observed at LCA was in the year 1952-53, the lowest value as per Tamil Nadu series is 523 TMC and Karnataka series is 516 TMC. This position indicates that the run-off series of Cauvery river system is quite robust, as difference between the minimum and 75% dependable yield is only of the order of 22% and 23% respectively. The following table gives storage capacities of various reservoirs (live capacity more than 1 TMC

each) then in position (i.e. before 1972). It may be seen that nearly 197 TMC water could be stored in these reservoirs.

Storages built (1.00 TMC and above) before 1972 in Cauvery Basin

S. No	Name of Reservoir and Sub-basin	Year of		Storage Capacity (TMC)	
		Start	Comple-tion	Gross	Live (Effective)
1	2	3	4	5	6
I	**KERALA**				
II	**TAMIL NADU**				
(A)	Irrigation:				
1.	Mettur (Cauvery)	1925	1934	95.660	93.500
2.	Lower Bhavani (Bhavani)	1948	1953	32.800	32.055
3.	Amaravathy (Amaravathy)	1953	1952	4.047	3.968
	Total of (A)			132.507	129.523
(B)	Power:				
1.	Mukurthi (Bhavani)	1937	1941	1.800	1.792
2.	Pykara (Bhavani)	1946	1956	2.000	1.950
3.	Upper Bhavani (Bhavani)	1956	1962	3.572	3.012
4.	Porthimund (Bhavani)	1960	1967	2.123	1.993
5.	Emerald (Bhavani)	1956	1962	3.365	3.300
6.	Avalanche (Bhavani)	1956	1962	2.171	2.136
7.	Pillur (Bhavani)	1960	1967	1.568	1.233
	Total of (B)			16.599	15.416
	Total of (A) + (B)			149.106	144.939
III	**KARNATAKA**				
1.	Krishnarajasagar (Upper Cauvery)	1911	1931	49.452	45.051
2.	Marconahalli (Shimsha)	1938	1940	2.400	2.260
3.	Nugu (Kabini)	1946	1959	5.440	4.893
	Sub-Total (Karnataka)			57.292	52.204
	Grand Total (I+II+III)			206.398	197.143

30. After 1972, several major and medium reservoirs have been constructed in the Cauvery basin. Table given below indicates the live storage capacities of various reservoirs which have been completed

(after 1972) having live storage capacity of more than 1 TMC. Nearly 82 TMC live storage capacity has been created in Cauvery basin after 1972.

Storages built (1.00 TMC and above) after 1972 in Cauvery Basin

S.No.	Name of Reservoir and Sub-basin	Year of		Storage Capacity (TMC)	
		Start	Completion	Gross	Live (Effective)
1	2	3	4	5	6
I	**KERALA**				
1.	**Karapuzha (Kabini)**	1974	-	2.700	2.541
2.	Attappady (Bhavani)	1975	-	2.295	2.144
3.	Banasurasagar (Kabini)	1980	-	5.889	5.050
	Sub-Total-I			10.884	9.735
II	**TAMIL NADU**				
1.	Palar-Porandalar (Amaravathy)	1970	1978	1.524	1.404
	Sub-Total-II			1.524	1.404
III	**KARNATAKA**				
	Kabini (Kabini)	1959	1974	19.520	16.000
2.	Harangi (Harangi-Upper Cauvery)	1964	1974	8.500	8.073
3.	Suvarnavathy (Suvarnavathy)	1965	1984	1.260	1.259
4.	Hemavathy (Hema Upper Cauvery)	1968	1979	37.103	35.760
5.	Manchanabele (Arkav	1970	-	1.222	1.061
6.	Taraka (Kabini)	1970	-	3.940	3.205
7.	Arkavathy (Arkavathy)	1975	-	1.587	1.430
8.	Votehole (Hemavathy-Upper Cauvery)	1976	-	1.510	1.366
9.	Yagachi (Hemavathy-Upper Cauvery)	1984	-	3.601	3.269
	Sub-Total-III			78.243	71.423
	Total (I+II+III)			90.651	82.562

31. Apart from the above, the projects proposed by the State of Kerala having live storage of more than 1 TMC each, indicated in the following table, will add another 19 TMC of live storage capacity in the basin.

Storages (1.00 TMC and above) proposed in Cauvery Basin

S.No.	Name of Reservoir and Sub-basin	Year of		Storage Capacity (TMC)	
		Start	Completion	Gross	Live (Effective)
1	2	3	4	5	6
I	**KERALA**				
1.	Noolpuzha (Kabini)			3.030	2.702
2.	Thirunelly (Kabini)			3.602	3.496
3.	Thonder (Kabini)			2.895	2.225
4.	Peringottupuzha (Kabini)			3.355	3.205
5.	Kallampathy (Kabini)			2.702	2.502
6.	Kadamanthodu (Kabini)			1.805	1.706
7.	Cheghat (Kabini)			1.700	1.501
8.	Chandalipuzha (Kabini)			2.101	1.992
	Total of (A)			21.190	19.329
II	**TAMIL NADU**			Nil	Nil
III	**KARNATAKA**			Nil	Nil
	Grand Total (I+II+III)			21.190	19.329

32. In addition, about 12 TMC of storage capacity (live) would be available from the small reservoirs with capacity of less than 1 TMC each.

Summary of storage capability in Cauvery basin

S. No.	Period	Capacity (in TMC)	
		Gross	Live
i)	Storages built before 1972	206	197
ii)	Storages built after 1972	90	82
iii)	Storages proposed in Kerala	21	19
iv)	Small storages below 1 TMC capacity	13	12
	Total	330	310

33. Thus, it would be seen that about 42% of 740 TMC (i.e. 50% dependable yield) could be stored in all the storage reservoirs in the Cauvery basin. This in itself is an important aspect for consideration in the development and utilization of water resources of a river basin. From the above discussion, it would be clear that adoption of 50% dependable flow for apportionment amongst the party States in the prevalent situation of Cauvery basin which is supported by two monsoon seasons and with ample available storage facilities would be quite fair, and, the system could be further strengthened by integrated operation of important reservoirs. This is all the more necessary keeping in view the status of water utilization in the Cauvery basin, which has already crossed 75% dependable yield. The above approach would eliminate the difficulties, which would otherwise be faced by the concerned parties. While it is for the parties to adopt specific norms to ensure success of irrigation & power projects as per regional characteristics, social needs & economic considerations, it is felt that in determination of basin yield for apportionment, what is more important is to arrive at sustainable utilizable quantum which will meet expectations of the people of different regions in the basin optimally.

Chapter 3

Ground water – whether an additional/alternative resource

Ground water is one portion of the earth's hydrological cycle. Ground water originates for all practical purposes as surface water. Water infiltrates into the ground from natural recharge of precipitation, stream flow, lakes and reservoirs. The stream flow shall also include canals. Once under ground water moves downward under force of gravity, discharge of ground water represents a return of the water to the earth's surface. A spring flow and evaporation are other modes of discharge. Pumping from wells is the primary artificial discharge method. Recharge of the ground water takes place from natural resource like rainfall and artificial modes like application of water to irrigate crops, flooding of areas caused by over-flowing of streams to their sides, seepage from unlined canals, tanks and other sources of recharge of the ground water in any particular area. The role of the ground water cannot be minimised so far hydrological cycle is concerned, because it is an important source of irrigation and according to the Central Ground Water Board, Ministry of Water Resources, Government of India, ground water caters to more than 45% of total irrigation in the country.

2. According to the State of Karnataka while making apportionment of the waters available within the Cauvery basin ground water available within the Delta areas should also be taken into consideration. It may be mentioned at the outset that according to the

State of Tamil Nadu ground water cannot be considered to be an additional/alternative resource available in the delta area of the Cauvery basin. In that connection, it was pointed out that so far as the delta is concerned, the said ground water is mainly derived from recharge by supplies from Mettur. In other words, it is the water of river Cauvery and its tributaries which by process of recharge becomes ground water within the delta area in the State of Tamil Nadu and the same is being utilised by the farmers for raising of early nurseries, ahead of releases from Mettur and for irrigating belated crop after stoppage of Mettur releases. As the ground water in the delta area is replenished by releases from the Mettur, it cannot be considered to be an independent source of irrigation or an alternative means of irrigation. In this background, the ground water within the Cauvery basin should be ignored for all purposes while making apportionment of the waters of river Cauvery and its tributaries.

3. The Central Ground Water Board, Ministry of Water Resources, Government of India along with other agencies has been trying to ascertain the availability of ground water in different States in India as well as the proportion of utilisation of such ground water. In their report “Ground Water Resources of India” which was published in the year 1995 in the preface it has been said as follows:

> “As per the National Water Policy, development of ground water resources is to be limited to utilisation of the renewable part of the naturally occurring ground water available in sub-surface domain. The present development policy, obviously forbids utilisation of the secular reserve to prevent ground

water mining. Precise assessment of replenishable ground water resources and its development in terms of area which can be irrigated in the framework of land availability, cropping pattern, etc. is, therefore, key to our plans to develop ground water resources for various uses. The complexities of processes governing occurrence and movement of ground water make the problem of ground water assessment somewhat difficult, as not only vast volume of data is required to be collected but also many disciplines of science have to be involved in a co-ordinated manner for space time location of ground water in quantity and quality. The gravity of the situation can, however, be gauged through one of the conclusions drawn in the International Advanced Research Workshops on "Estimation of Natural Recharge of Ground Water" in 1987 at Antalay, Turkey. It says "no single comprehensive estimation technique can yet be identified from the spectrum of methods available, all are reported to give suspect results". But in view of the rapidly expanding urban, industrial and agricultural water requirements, assessment of ground water resources with best possible accuracy is of fundamental importance for planning the resource use on scientific and economic considerations.

In India, the efforts in this direction were initiated immediately in post-independence era and the approach and methodologies utilised since then have undergone gradual changes based on the refinement of our understanding in the field of ground water. The methodology, recommended by "Ground Water Resource Estimation Committee" in 1984 is in a true sense the logical scientific approach for assessment of country's ground water resources in volumetric terms. The resources so assessed volumetrically have by and large been accepted. The real problem, however, arose when the

volumetric resources were converted in terms of area which can ultimately be irrigated. The figures originally computed gave rise to differences and controversies. Keeping this in view, the Central Ground Water Board made a realistic effort for resolving these issues in coordination with Central Water Commission, National Water Development Agency, National Institute of Hydrology, National Bank for Agriculture and Rural Development and State Ground Water Organisations, under the overall guidance of Ministry of Water Resources. After an in-depth discussion and analysis, the figures reflected in this Report have been firmed up. The aspects like land availability, water requirement for prevalent cropping pattern, ground water development strategy, etc. were accounted for which have now resulted in realistic figures. There is, however, always a scope for improvement in methodology and revision of information contained herein on quantum of ground water resource and the resultant irrigation potential. This in fact will be a continuous process as ground water is a dynamic resource and science is in continuous search for better understanding. Based on the developments in science and situation, the Board in consultation with State and other Organisations would continue to update these figures in future as per the covenants of the National Water Policy."

4. Thereafter under the heading 'GROUND WATER RESOURCES OF INDIA' the said Board in its aforesaid report has said:

"Ground water is an important source of irrigation and caters to more than 45% of the total irrigation in the country. The contribution of ground water irrigation to achieve self-sufficiency in food grains production in the past three decades is phenomenal. In the coming years the ground water utilization is likely to increase manifold for expansion of

irrigated agriculture and to achieve National targets of food production. Although the ground water is annually replenishable resource, its availability is non-uniform in space and time. Hence, precise estimation of ground water resource and irrigation potential is a pre-requisite for planning its development.

A complexity of factors – hydro-geological, hydrological and climatological, control the ground water occurrence and movement. The precise assessment of recharge and discharge is rather difficult, as no techniques are currently available for their direct measurements. Hence, the methods employed for ground water resource estimation are all indirect. Ground water being a dynamic and replenishable resource, is generally estimated based on the component of annual recharge, which could be subjected to development by means of suitable ground water structures.

For quantification of ground water resources proper understanding of the behaviour and characteristics of the water bearing rock formation known as Aquifer is essential. An aquifer has two main functions – (i) to transit water (conduit function) and (ii) to store it (storage function). The Ground water resources in unconfined aquifers can be classified as Static and Dynamic. The static resources can be defined as the amount of ground water available in the permeable portion of the aquifer below the zone of water level fluctuation. The dynamic resources can be defined as the amount of ground water available in the zone of water level fluctuation. The replenishable ground water resource is essentially a dynamic resource which is replenished annually or periodically by precipitation, irrigation return flow, canal seepage, tank seepage, influent seepage etc.

The methodologies adopted for computing ground water resources, are generally based on the hydrological budget techniques. The hydrologic equation for ground water regime is a specialized form of water balance equation that requires quantification of the items of inflow to and outflow from a ground water reservoir, as well as of changes in storage therein. A few of these are directly measurable, some may be determined by differences between measured volumes or rates of flow of surface water and some require indirect methods of estimation. These items are elaborated as below:-

"**I. Items of supply to ground water reservoir:**

1 Precipitation infiltration to the water table.

2 Natural recharge from steam, lakes and ponds.

3 Ground water inflow into the area under consideration.

4 Recharge from irrigation, reservoirs, and other schemes especially designed for artificial recharge.

II. Items of disposal from ground water reservoir:

1. Evaporation from capillary fringe in areas of shallow water table, and transpiration by phreatophytes and other plant/vegetation.
2. Natural discharge by seepage and spring flow to streams, lakes and ponds.
3. Ground water outflow.
4. Artificial discharge by pumping or flowing wells or drains.

Over the years the ground water assessment techniques have evolved from progressive understanding of ground water occurrence and movement, recharge and discharge processes……."

5. Both surface and ground water are replenished by rainfall and form part of the circulatory pattern of the hydrologic cycle. If the water table at the top of the zone of saturation is above in level of the water surface in a stream, ground water seeps into the stream; but when the water table is below this level, there is seepage from the stream into the porous layers of rocks. Thus, ground water supplies the relatively stable and uniform base flow of the stream and is, in its turn, replenished by the stream flow. Depletion of ground water by pumping or otherwise may reduce the stream flow somewhere else in the river basin. Ground water may furnish alternative means for satisfying the State's irrigation needs. Moreover there may be such a close connection between the surface and ground water resources of a river basin that it may be necessary to limit the use of ground water to prevent diminution of the water supply downstream.

6. It is well known that for irrigation there are three sources:

(1) Rainfall;
(2) Surface flow of any river which can be taken to different areas through canal system; and
(3) Ground water which can be taken out through open-wells or tube-wells.

7. The three sources of irrigation indicated above – one is beyond the reach of human being i.e. the rainfall. There is some fluctuation in the time and quantity of the rainfall in different parts of the river basin affecting the plantation and growth of the crops. So far the second source i.e. surface flow of a river within a State is concerned, it is

dependent on the system for taking such waters to different areas through canals or by storing them in different reservoirs to be utilised from time to time. The third source is the ground water which is being utilised for irrigation and other purposes in different parts of the country. So far Cauvery basin is concerned, it appears to be an admitted position that the variability in time and quantity of rainfall from the south-west monsoon and the north-east monsoon in some years create problems. This also affects the surface flow of river Cauvery and its tributaries which in its own turn affects the storage in different reservoirs like Krishnarajasagar, Mettur etc. The surface flow and the rainfall are not enough in some years for the cultivators within the different States of the Cauvery basin and this has led to conflict and confrontation from time to time specially between Mysore/Karnataka and Madras/Tamil Nadu. In this background, the ground water, if available assumes importance.

8. The stand of Tamil Nadu is that ground water cannot be considered as an alternative source of irrigation. It was also pointed out that by mere reference to the pleadings of the State of Karnataka filed before this Tribunal, it shall appear that according to Karnataka the ground water which is being utilised for irrigation by Tamil Nadu is mainly in the delta area. It is the case of Tamil Nadu that the ground water which is being utilised for early seedlings and in hour of distress in the delta areas are only recharge from the flows of river Cauvery and as such that cannot be considered to be an alternative source.

9. All water that exists below the surface of earth in the interstices of soil and rocks may be called sub-surface water; “that part of sub-surface water in interstices completely saturated with water is called groundwater”. (Walton W.C. 1970 Ground Water Resource Evaluation, McGraw Hill Book Co., New York). Of practical concern is the portion of groundwater that can be extracted by dug/tube wells or that forms the base flow of surface streams/rivers.

10. Dr. Ven Te Chow, a renowned hydrologist has written a book “Hand Book of Applied Hydrology” which even to this day is used for reference in universities and departments all over the globe. In Chapter 13 on Ground Water Resources (page 3), he has described groundwater in the hydrologic cycle as under:-

> “Groundwater is one portion of the earth’s hydrologic cycle…….. Permeable formations in the earth’s crust serve as conduits for transmission and as reservoirs for storage of water. Essentially, all groundwater is in motion; velocities range from a few feet per day to only a few feet per year. As such, groundwater provides large, widely distributed sources of water supply. Groundwater discharging into streams maintains stream flow during periods of no surface runoff. In arid zones, pumped water is the only available supply for large portions of each year.
>
> Ground water originates for all practical purposes as surface water. Water infiltrates into the ground from natural recharge of precipitation, stream flow, lakes, and reservoirs. In addition, efforts by man constitute artificial recharge. Once underground, the water moves downward, under the action of

gravity. When a zone of saturation is reached, the water flows in a direction controlled by the hydraulic boundary conditions. Discharge of groundwater represents a return of the water to the earth's surface. Most discharge is into surface-water bodies. Spring flow, evaporation, and transpiration are other modes of discharge. Pumping of wells is the primary artificial discharge method."

11. Recharge of groundwater takes place from natural source like rainfall and artificial modes like application of water to irrigate crops, flooding of areas caused by over flowing of streams to their sides and also by artificial methods – such as injecting water into wells during rainy season, besides, recharge also take place due to seepage from unlined canals, tanks etc.

Total annual recharge = Recharge during monsoon + non-monsoon rainfall recharge + seepage from canals + return flow from irrigation + inflow from influent rivers etc. + recharge from submerged lands, lakes etc.

(Source: Ground water resources of India – Page 14, Central Ground Water Board {CGWB} Publication 1995)

12. As regards underground water fluctuation, Dr. Ven Te Chow in his hand- book in Chapter 13, Page 33, has described about the secular and seasonal effects as under:-

"Secular variations are those extending over periods of several years or more. These are commonly produced by alternating series of wet and dry years in which rainfall is above or below the mean……. As rainfall is the primary source of recharge in

many aquifers, variations of rainfall and groundwater levels are closely correlated. The correlation is imperfect, however, because differences in rainfall intensity and distribution produce different amounts of recharge from the same total annual rainfall.

Where overdraft is a continuing phenomenon in a groundwater basin, a downward trend in water levels over a period of years is apparent."

13. Dr. Ven Te Chow has also mentioned about stream flow effects on groundwater recharge as under:-

"Where a stream channel is in contact with an unconfined aquifer, water may flow from the stream into the ground, or the reverse, depending upon the relative water levels. An influent stream supplies water to aquifers; an effluent stream receives water from the aquifer. A stream may be influent in one location and effluent in another; also, changes can occur with time as stream stages relative to nearby groundwater levels shift.

During a flood period groundwater levels may be temporarily raised near a channel by inflow from the stream. This water is known as `bank storage'……..

Groundwater discharging into a stream forms the base flow of the stream. This may vary from total flow during periods of no surface runoff to a negligible fraction of the total flow during periods of high surface runoff."

14. The availability of groundwater for use is limited to the annual recharge, which could be withdrawn and again gets replenished by natural rainfall/artificial modes of recharge mentioned above. Groundwater is naturally inter-related with surface water; groundwater

feeds springs and even surface streams, and in turn, surface water replenishes groundwater aquifers/reservoirs.

15. It is very important to understand that the annual withdrawals of groundwater in any region need to be in equilibrium with the annual replenishment of groundwater in that region. Over-withdrawals made from an aquifer at rates in excess of the net recharge are described as “mining” of groundwater, because it lowers the groundwater level permanently to the extent these over-withdrawals are made. In such situation of over-withdrawals, the problem becomes serious if the practice continuous over a period of time resulting in decline of groundwater table and making the pumping of water more and more expensive because of greater depth from which water needs to be pumped. It is, therefore, imperative that adequate care is taken in assessment of the actual recharge of the groundwater resources and balancing the same with annual water withdrawals.

16. Government of India in the year 1982 constituted “Ground Water Estimation Committee” with the members drawn from various organizations engaged in hydro-geological studies and groundwater development. This Committee after reviewing the data collected by Central and State agencies, research organizations, universities etc. recommended methods for groundwater recharge estimation in the year 1984.

a) Ground Water Level Fluctuation and Specific Yield Method:

"The water table fluctuation and specific yield approach has been recommended for recharge estimation …….. The utilizable recharge is estimated based on pre-monsoon (April-May) to post-monsoon (November), water level fluctuations for the areas receiving south-west monsoon. Similarly, for the areas receiving north-east monsoon, water level fluctuations of pre-monsoon (November) and post-monsoon (March) have been taken into consideration."

"The specific yield values of the geological formations in the zone of water table fluctuation as computed from pumping tests were utilized in this recharge estimation. As a guide following values computed in different studies are recommended:-

(i)	Sandy alluvial area	12 to 18 percent
(ii)	Valley fills	10 to 14 percent
(iii)	Silty/Clayey alluvial area	5 to 12 percent
(iv)	Granites	2 to 4 percent
(v)	Basalts	1 to 3 percent
(vi)	Laterite	2 to 4 percent
(vii)	Weathered Phyllites, Shales, Schist and associates rocks.	1 to 3 percent
(viii)	Sandstone	1 to 8 percent
(ix)	Limestone	3 percent
(x)	Highly Karstified Limestones	7 percent"

(Ref: Ground water resources of India – Pages 10 & 11; CGWB – Publication 1995)

17. For estimation of groundwater recharge by water level fluctuation method, the report of the Groundwater Estimation Committee 1984 stipulates as under:-

"For estimating the groundwater recharge, water level fluctuation and specific yield approach should be applied as far as possible. The monitoring of water level net-work stations should be adequate in space (about 1 station for 100 sq km area) and time (about six times in a year) to monitor effects of groundwater development on groundwater regime. Efforts should be made to install continuous water level recorders wherever possible." (Ref ibid Page 27, Para 5(b))

The recharge is broadly calculated as under:-

Recharge = Area (sq km) x Water level fluctuation (m) x specific yield.

b) Rainfall Infiltration Method:

"In areas where groundwater level monitoring is not adequate in space and time, rainfall infiltration may be adopted. The norms for rainfall infiltration contributing to groundwater recharge are evolved based on the studies undertaken in various water balance projects in India……."

(Ref. CGWB publication 1995, Page 12)

18. The norms for recharge from rainfall under various hydrogeological situations as recommended are given in the table below (Ref . ibid page 13):

Rainfall infiltration factor in different hydrogeological situations

S.No.	Hydrogeological Situation	Rainfall Infiltration Factor
1.	Alluvial Areas	
	a. Sandy Areas	20 to 25 percent of normal rainfall
	b. Areas with higher clay content	10 to 20 percent of normal rainfall
2.	Semi-Consolidated Sandstones (Friable and highly porous)	10 to 15 percent of normal rainfall
3.	Hard rock areas	
	a. Granitic Terrain	
	(i) Weathered and Fractured	10 to 15 percent of normal rainfall
	(ii) Un-Weathered	5 to 10 percent of normal rainfall
	b. Basaltic Terrain	
	(i) Vesicular and Jointed Basalt	10 to 15 percent of normal rainfall
	(ii) Weathered Basalt	4 to 10 percent of normal rainfall
	c. Phyllites, Limestones, Sandstones, Quartzites, Shales, etc.	3 to 10 percent of normal rainfall.

19. The Central Ground Water Board in their publication “Ground Water Resources of India – 1995” have commented on the scope of groundwater resources availability of various States of the country. As regards party States in this dispute namely: Karnataka, Kerala and Tamil Nadu, they have stated as under:-

> “i) Karnataka -
>
> The heterogeneity of hard rock formation and discontinuous nature of aquifers require proper location of wells for their success. Remote Sensing techniques along with Geophysical Surveys are needed for success of a well. Small land holdings do not permit a bankable groundwater development scheme for institutional financing. Proper siting, along with suitable

spacing is needed for regulated groundwater development to avoid local over-development of groundwater resource. Dug wells, dug-cum-bore wells and bore wells are the main ground water structures feasible in the State.

(Ref: ibid, Page 20)

ii) Kerala -

The groundwater development for irrigation has commenced recently in the State. The main constraints for speedy groundwater development are high rainfall, substantial surface water availability, limited land for groundwater development and small and fragmented land holdings. The community well scheme is recommended for speedy development of ground water. In alluvial areas, the tubewells are the main groundwater development structures, whereas dug wells and bore wells are feasible in hard rock areas.

(Ref: ibid, Page 20)

iii) Tamil Nadu –

In hard rock area the dug wells and bore wells are common structures for groundwater development. In alluvial areas deep tubewells are feasible. The groundwater development in most of the parts of State is high resulting in lowering of water level in many areas. Regulated development of groundwater is required specially in hard rock areas. In the coastal areas, a cautious approach has to be adopted for groundwater development due to salinity hazards."

(Ref: ibid, Page 21)

The report does not offer any comments regarding the U.T. of Pondicherry. A small part of which namely: Karaikal region falls within the Cauvery basin.

20. The State of Karnataka had produced Dr. K.R. Karanth, geo-hydrologist expert as a witness. He was cross-examined in great detail during the proceedings of the Tribunal. A book namely “Hydrogeology” (Tata Mcgraw-Hill Publishing Co.Ltd- Second reprint 1996) written by Dr. K.R. Karanth, was also presented before the Tribunal. Dr. Karanth has observed that while one can make an assessment of surface water which is visible, assessment of groundwater resource is a complex exercise involving many parameters that can be evaluated only indirectly. In his introduction chapter, Page 5, Para 1.3, he has mentioned as under:-

> “1.3 Hydrogeological Evaluation
>
> Surface water and groundwater are two interdependent phases of the hydrologic cycle. Each resource needs to be evaluated and quantified for planning their utilization in an integrated manner. While one can make an assessment of surface water which is visible, assessment of groundwater resource is a complex exercise involving many parameters that can be evaluated only indirectly. All the parameters that are needed for evaluation of surface water resources can be measured on the surface of the earth - precipitation, infiltration, runoff, topographic slopes, land use, etc. and interrelationships can be developed. At present, there are a vast number of reservoirs, which are gauged and the data of which are available for evaluation of basin yields under different conditions. On the other hand, the quantification of groundwater resources is beset with many constraints. Adequate information on the geometry of groundwater basins, storage and yield properties of water-bearing formations, groundwater inflows and outflows, is lacking in many areas. Besides, some of these parameters are not only not measurable on the surface, but, are also diverse and

unpredictable, in their variations in space and time. In planning groundwater supply systems one is confronted with posers like how much fresh water is available, where, at what depth and what is the reliability of supplies. In order to answer these questions one should know the dimensions of the producing horizons, their disposition, properties and interconnection with sources of replenishment and disposal, through hydro-geological studies which may consist of surface inspection supplemented with geophysical studies and exploratory drilling, wherever necessary."

21. The Irrigation Commission (1972) in their report, while dealing with groundwater conditions in the Deccan area have quoted from the report of Fact Finding Committee for the survey of scarcity areas in Bombay State (1960) as under:-

> "6.50 In regard to Maharashtra, the Fact Finding Committee for the survey of scarcity areas in Bombay State (1960), in their report has stated that:
>
> Unlike the alluvial plains in the country, such as those in the Punjab and Uttar Pradesh, the Deccan conditions present altogether a different and complicated problem in so far as groundwater and its flow is concerned. In the Indo-Gangetic plains, striking water in wells is not at all an uncertain factor as it is related to a water-table which spreads all over the area. . . . In the Deccan, however, there is no such thing as a water table. The wells derive their supply from the water seams the exact location of which cannot be predicted. Any well sunk in the Deccan has to be excavated in rock to some extent except in certain regions where the rock level happens to be very low and excavation is limited to the upper layer consisting of MAN or CHOPAN. The cost of sinking wells in the Deccan varies from about Rs.3,000 to Rs.5,000. A normal well in the Deccan

plateau is about 12 to 15 m. deep and water is struck at a depth of about 8 to 12 m. The capacity for irrigation of a normal well in the Deccan (not within the commands of irrigation canals) is noticed to be between three to five acres. The supplies of these wells are adequate for irrigation up to about the middle of March and then dwindle rapidly, giving barely sufficient water for drinking purposes at the end of the hot weather. As a matter of fact, a number of wells are known to get dry by the end of April. Well irrigation should therefore be resorted to where the other more economic modes of providing irrigation are not available or where an adequate and copious supply of underground water with a low lift exists, for example, in the areas under command of major irrigation works."

(Ref: Irrigation Commission 1972 report, Vol.III [Part 2], Page 197, Para 6.50)

22. Similarly, in the compilation "The Law of International Drainage Basins" by A.H. Garretson, Editor, Chapter 8, Page 312, it has been mentioned as under:-

"……With much variation in the quantity of flow in any particular channel, confusion over the correct stream was likely. The course of a river is indicated traditionally only by its surface flow and geographers as well as lawyers are accustomed to having a fairly well defined channel with which to work. Here flat marshy land confounds the issue. And the important role of underground water flow, though known to the hydrologist, is not fully calculable from the technical point of view and, therefore, not fully cognizable as yet from the legal point of view." (Source: TN Note No.19 on Group-II, Document No.9, Page 35 - Para 4 of Page 37)

23. Since the river flows (surface water) could be measured every year to an acceptable degree for apportionment, it is well nigh not possible to measure the available groundwater for planning its utilization during the course of the year. Moreover, there is great interdependence of the availability of groundwater on rainfall, various other parameters, affecting its recharge and availability in different pockets/zones in any river basin.

24. Keeping in view the important relationship between surface and ground water resources as also the conspicuous role being played by groundwater in the overall development of use for irrigation and other beneficial purposes, the mention for encouraging conjunctive use of groundwater with the available surface waters seems to be quite pertinent. Dr. Ven Te Chow in his book – "Hand Book of Applied Hydrology", in Chapter 13 page 41 has observed regarding conjunctive use of water resources as under:-

> "Future demand for water requires planning for the maximum utilization of all existing supplies. This can most economically be attained by conjunctive use of surface and ground water reservoirs …… During normal and wet years, surface storage will meet most needs, while ground water storage can be retained for use during years of sub-normal precipitation. Ground water levels will be raised during wet periods and lowered during dry periods. Artificial recharge (Sub Section VIII) is necessary to store a maximum volume of water underground when it is available at the surface."

25. Dr. K.R. Karanth has in his book “Ground Water Assessment, Development and Management” (1987) made observations regarding conjunctive use at page 685 of his book in para 16.3, that, because of the inter-relationship existing between surface and ground water, it is possible to utilize, during critical periods, the surplus of one to tide over the deficit of the other. Thus ground water may be used to supplement surface water supplies in order to reduce peak demands for irrigation and other uses, or to meet deficit in years of low rainfall. On the other hand, surplus surface water may be used in over-draft areas to increase the ground water storage by artificial recharge.

26. The Irrigation Commission, 1972 in their report have generally reiterated the comments of above mentioned experts. The Commission has further observed as under:-

> “It can also take the form of irrigating pockets exclusively with ground water in a canal command, especially where the terrain is uneven. Planning for combined use of surface and groundwaters calls for greater ingenuity than is needed for their separate use. It has to be admitted that, so far, no projects have been planned on the basis of such combined use of water. Such combined use, as is now practiced, was not pre-planned, but has come into being out of necessity.”
>
> (Ref: Irrigation Commission 1972 Report Vol.-I, Page 96, Para 5.38)

At page 97 para 5.41, the Irrigation Commission has observed as under in respect of Cauvery delta: -

> “In certain parts of the Cauvery Delta, farmers have installed their own filter-points in the irrigated area to raise paddy

> seedlings early in June before the canal system is opened. The first crop is harvested by the end of September before the onset of the north-east monsoon. A second crop is raised on these lands which is harvested in January or February. The filter-points enable the farmers to give a watering to the crop after the closure of the canals wherever necessary, particularly in areas in the tail-reaches which suffer from scarcity even when canals are open. Some cultivators raise even a summer crop of cotton or groundnut, with the help of these filter-points and give irrigation support to sugarcane. Thus, with the conjunctive use of the surface waters of the Cauvery and groundwater, it has been possible for farmers in the Cauvery Delta to raise two and sometimes three crops."

The Irrigation Commission at page 99 para 5.50 have, however, given a caution in respect of conjunctive use as under: -

> "In advocating conjunctive use, we are aware that indiscriminate exploitation of groundwaters may lead to serious difficulties. It is in this context that the need for legislation to regulate the exploitation of groundwaters becomes important. We are of the view that tubewell construction should be regulated by law in areas where there is a risk of over-exploitation, so that the size and spacing of tubewells is controlled to facilitate the systematic exploitation of the groundwater resources in a particular area."

27. Since the uncontrolled exploitation of groundwater in some regions of the country has resulted in mining of water and such areas have been declared as "dark", the Government of India in the Ministry of Environment and Forest has taken serious note about the damage which mining of groundwater would cause and re-constituted the earlier

“Central Ground Water Board” into a “Central Ground Water Authority” vide notification dated 14.01.1997 (which has been reconstituted from time to time, the last amendment being on 06.11.2000). The Chairman of the Central Ground Water Board will continue to work as Chairman of the newly constituted Central Ground Water Authority alongwith all other members and in addition, some more members have been taken in, from Oil & Natural Gas Corporation Limited, Central Water Commission, Ministry of Environment etc. The Authority would, however, function under the administrative control of the Ministry of Water Resources. One of the functions of the Authority is “regulation & control, management and development of groundwater in the country and to issue necessary regulatory direction for this purpose.” It may be mentioned that after the formation of this Authority under the Environment (Protection) Act, 1986, the State Governments would have to further set up some mechanism, where by, they would be allowing development of groundwater within their jurisdiction in a properly regulated manner, so that, no over-exploitation of this replenishable resource is done and the development is limited only within the quantum of water that is naturally replenished annually.

28. The Tata Services Ltd. bring out annual “Statistical Outline of India", through their Department of Economics and Statistics for the entire country, measuring large number of economic parameters of development. In their publication of 2002-2003 at Page 49, Table 46, they have given details regarding area irrigated by sources in the country

as a whole for 1970-71, 1980-81, 1990-91, 1996-97 and 1997-98. These figures are reproduced below in a tabular form:-

Area irrigated by sources

	1997-98	1996-97	1994-95	1990-91	1980-81	1970-71
	(million hectares)					
Government canals….	16.6 (30.4)	16.9 (30.7)	16.8 (31.7)	17.0 (35.4)	14.5 (37.5)	12.0 (38.6)
Private canals…….	0.5 (0.9)	0.5 (0.9)	0.5 (1.0)	0.5 (1.0)	0.8 (2.1)	0.9 (2.9)
Tanks……..	3.1 (5.7)	3.3 (5.9)	3.3 (6.2)	2.9 (6.5)	3.2 (8.2)	4.1 (13.1)
Wells and tubewells……..	30.9 (56.6)	30.8 (55.9)	28.9 (54.5)	24.7 (51.5)	17.7 (45.7)	11.9 (38.3)
Others……. …….	3.5 (6.4)	3.6 (6.5)	3.5 (6.6)	2.9 (6.0)	2.6 (6.7)	2.3 (7.4)
Total net irrigated area	54.6 (100.0)	55.1 (100.0)	53.0 (100.0)	48.0 (100.0)	38.7 (100.0)	31.1 (100.0)

Note:i) Figures in brackets show percentages to total irrigated area.
ii) Figures for 1994-95 taken from Tata Services Publication 1999-2000 (page 64).

From the above, it would be seen that even country as a whole the area irrigated by groundwater (through wells and tubewells) was around 56.6% of the total irrigated area in 1997-98. Further, it is seen that in 1970-71, the area irrigated by Government canals and wells and tubewells was almost equal being about 38% in each case, which has increased in the case of groundwater to 56.6% and decreased in the case of Government canals from 38.6% to 30.4%. Also, the area irrigated from tanks has fallen from 13.2% in 1970-71 to 5.7% during 1997-98. Thus, contribution of groundwater is quite substantial in the development of irrigation.

29. Sourcewise development of irrigation in the party States (entire State) and Union Territory of Pondicherry as percentage of total irrigation is given in the table below:-

Source-wise net irrigated area (as percentage) 1994-95

Sl. No	State	Major/ Medium and Minor	Groundwater	Other sources
1.	Karnataka	50.5%	35%	14.5%
2.	Kerala	46%	21%	33%
3.	Tamil Nadu	52.3%	47.2%	0.5%
4.	Union Territory Of Pondicherry	39%	61%	-

(Source : Water and Related Statistics CWC publication February, 2000 - Page 107-108, Table 2.10)

The above figures are indicative of the role played by groundwater, in meeting irrigation requirements in party States.

30. It is noticed that development of ground water has taken place mostly in private sector, where, the owners have many a time, over-exploited the available groundwater resources resulting in gradual lowering of water table. In several areas, the groundwater table has been falling at a fast pace with the result that the existing dug wells and shallow tube wells have got dried up and much of the investment has been lost; in some cases, new tube wells are being installed to greater and greater depth below the ground surface. Likewise, in some coastal areas, over-exploitation of groundwater has resulted in intrusion of seawater and has thus polluted the quality of groundwater in the vicinity of coastline. This has rendered ground water in the affected areas not only unfit for human consumption but also for use in agriculture.

31. As per National Water Policy, groundwater development is limited to annual replenishable groundwater resources; hence groundwater exploitation is not permitted in over exploited areas. The behaviour of groundwater level is a deciding factor to stop further groundwater development in areas where long term decline in the groundwater levels is witnessed, even though the groundwater resource assessment may be indicating surplus availability of groundwater. (Source: Ground Water Resources of India, CGWB publication 1995 page 15-16).

32. Krishna Water Disputes Tribunal in their report 1973, Vol.I, Chapter VIII, Page 71(left column) and Page 72(right column) have observed as under:-

> "For equitable apportionment of waters of an inter-State river system, the underground water resources of a State is a relevant factor. Groundwater may furnish alternative means for satisfying the State's irrigation needs. Moreover, there may be such a close connection between the surface and groundwater resources of a river basin that it may be necessary to limit the use of groundwater to prevent diminution of the water supply downstream.[2]
>
> "However, groundwater flow is not fully calculable from the technical point of view and, therefore, not fully cognizable as

[2] Arizona v/s California 376, U.S. 340. (Clause IV of the decree); Masters Report in the same case cited in A.H. Garretson and others, The Law of International Drainage Basins 1967. pp. 525-526, see also ibid pp. 585-586.

yet from the legal point of view.[5] Being invisible, groundwater resources baffle quantitative measurement[6]……."

"On a consideration of all relevant materials, we propose to pass the following order:-

The Tribunal hereby declares that the States of Maharashtra, Karnataka and Andhra Pradesh will be free to make use of underground water within their respective State territories in the Krishna river basin……"

33. In view of the lack of precise calculability of the underground water and as agreed to by the parties, the underground water resources of the States concerned were not taken into account for purposes for equitable apportionment of the waters of the river Krishna and physical basin (river valley) thereof. Thus, the Tribunal decided that the concerned States will be free to make use of underground water within their respective State territories in the Krishna river basin.

34. Narmada Water Disputes Tribunal in their report of 1978, Vol.I. Chapter IX, Page 118, Para 9.4.1 have observed as under:-

"Ground water

9.4.1 For equitable apportionment of the waters of an inter-State river system, the underground water resource of a State is a relevant factor. The reason is that underground water may furnish alternative means for satisfying the State's irrigation needs. But the difficulty is that groundwater flow cannot be accurately estimated from the technical point of view, and,

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[5] A.H. Garretson and others, The Law of International Drainage Basins(1967) p. 312; L.A. Teclaff' The River Basin in History and Law, p.10.

[6] The Nation's Water Resources, United States Water Resources Council 1968, pp. 3-2-1, 3-2-7.

> therefore, not fully cognizable as yet from the legal point of view. In view of this difficulty, we are of the opinion that groundwater should be omitted altogether in the consideration of legal problems of the river basin……".

35. The Narmada Water Disputes Tribunal in their report of 1979, though considered underground water resources of a State as a relevant factor for equitable apportionment of the waters of an inter-state river system but because of the difficulty that groundwater could not be accurately estimated, were of the opinion that this resource was not fully cognizable from the legal point of view and, therefore, the groundwater was altogether omitted from the consideration.

36. Godavari Water Disputes Tribunal in their report of 1979, Vol.I, Chapter IV, Page 32 have observed as under:-

> "The underground water resources of an inter-State river basin is a relevant factor for the equitable apportionment of the waters of a river basin. Underground water may furnish alternative means for satisfying irrigation needs. Moreover, there may be such a close connection between the surface and groundwater resources of a river basin that it may be necessary to limit the use of groundwater to prevent diminution of the water supply downstream.
>
> Further, groundwater flow is not fully calculable from the technical point of view and, therefore, not fully cognizable as yet from the legal point of view. Being invisible, groundwater resources baffle quantitative measurement.
>
> In the present case, however, we are dividing the waters of the river Godavari on the basis of the agreements already arrived at between the parties. The question of furnishing alternative

means for satisfying the irrigation needs of a State does not, therefore, arise."

37. As mentioned earlier, the stand of the State of Tamil Nadu in respect of the ground water is that it is not a relevant factor for purpose of calculation of the total yield of the basin or for apportionment. In this connection, Krishna Water Disputes Tribunal, Narmada Water Disputes Tribunal as well as Godavari Water Disputes Tribunal have said – For equitable apportionment of waters of an inter-State river system, the underground water resources of a State is a relevant factor but they declined to investigate the question regarding availability of the ground water and quantity thereof on the ground that ground water flow cannot be accurately estimated from the technical point of view and, therefore, was not fully cognisable as yet from the legal point of view.

38. In this connection, reference was also made to the Irrigation Commission Report (1972) Volume-I, Page-54, in which it has been said:- 'no systematic quantitative assessment of ground water has so far been made in India for the various river basins and that assessment can be made only on the basis of complete data (yet to be collected) on sub-surface geology, rainfall, evapo-transpiration, percolation zone, extent of saturation, hydraulic gradient, acquifer characteristics, geo-chemistry of water, etc."

39. Teclaff's "River Basin in History & Law-1967", pages -9-10, it has been said:-

> "The derivation of stream flow from underground sources is thus very complex and can often be traced only by detailed study of the geology of the basin. For this reason it has been recommended that groundwater be omitted altogether in the consideration of legal problems of the river basin."

40. In the book – "The Law of INTERNATIONAL DRAINAGE BASINS" by A.H. Garretson and others published in the year 1967, at page No.312 it has been said:-

> "The course of a river is indicated traditionally only by its surface flow, and geographers as well as lawyers are accustomed to having fairly well defined channel with which to work. Here flat marshy land confounds the issue. And the important role of underground water flow, though known to the hydrologist, is not fully calculable from the technical point of view and, therefore, not fully cognizable as yet from the legal point of view."

41. But in the book - 'The Law of International Watercourses' by STEPHEN C. McCAFFREY in Chapter dealing with the Special Case of Groundwater at page No.420-421, it has been said:-

> "Perhaps because of the increasing understanding of hydrology, the trend among modern agreements on shared freshwater resources is to include groundwater within their scope. For example, the Agreement between Nigeria and Niger concerning the Equitable sharing in the Development, Conservation and Use of their Common Water Resources provides that a reference to the shared river basins shall include a reference to underground waters contributing to the flow of surface waters.; Groundwater not so related to surface water is also within the scope of the agreement, provided it straddles a border between contracting states. Similarly, as has been seen, both the 1995 SADC

> Protocol and the 2000 Revised Protocol defined the watercourses they cover to include groundwater. More generally, the 1994 Convention on Cooperation for the Protection and Sustainable Use of the Danube River defines 'catchment area' of the Danube River to mean 'the hydrological river basin'; a definition that would include ground water, as we have seen. And reflecting the special importance of groundwater in arid regions, this resource is specifically provided for in the 1994 Treaty of Peace between Israel and Jordan. That agreement allocates not only 'Jordan River and Yarmouk River waters' but also 'Araba Arava ground water'.

42. The Central Ground Water Board, Ministry of Water Resources, Government of India, along with other agencies has been trying to ascertain the availability of the ground water in different States in India. In the report published in the year 1995 quoted in detail earlier, it has been mentioned:-

> "But in view of the rapidly expanding urban, industrial and agricultural water requirements, assessment of ground water resources with best possible accuracy is of fundamental importance for planning the resource use on scientific and economic considerations….."
>
> "Ground water is an important source of irrigation and caters to more than 45% of the total irrigation in the country. The contribution of ground water irrigation to achieve self-sufficiency in food grains production in the past three decades is phenomenal. In the coming years the ground water utilization is likely to increase manifold for expansion of irrigated agriculture and to achieve National targets of food production……."
>
> [Emphasis supplied]

43. “The Ground Water Estimation Committee” constituted by the Government of India in the year 1982 with members drawn from various organisations engaged in hydro-geological studies and ground water development, the recommendations whereof have been quoted in detail above, has said about Tamil Nadu:-

> “Tamil Nadu –
>
> In hard rock area the dug wells and bore wells are common structures for groundwater development. In alluvial areas deep tubewells are feasible.
>
> The groundwater development in most of the parts of State is high resulting in lowering of water level in many areas. Regulated development of groundwater is required specially in hard rock areas. In the coastal areas, a cautious approach has to be adopted for groundwater development due to salinity hazards.”

44. Even the Irrigation Commission’s Report of the year 1972, has referred to the use of ground water in the Cauvery delta area, which has been quoted earlier in para 26.

45. The National Water Policy published by Government of India, Ministry of Water Resources in April,2002 says about ;Ground Water Development as under:-

> “Ground Water Development
>
> 7.1 There should be a periodical reassessment of the ground water potential on a scientific basis, taking into consideration the quality of the water available and economic viability of its extraction.

7.2 Exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity. The detrimental environmental consequences of over-exploitation of ground water need to be effectively prevented by the Central and State Governments. Ground water recharge projects should be developed and implemented for improving both the quality and availability of ground water resource.

7.3 Integrated and coordinated development of surface water and ground water resources and their conjunctive use, should be envisaged right from the project planning stage and should form an integral part of the project implementation.

7.4 Over exploitation of ground water should be avoided especially near the coast to prevent ingress of sea water into sweet water aquifers."

(Emphasis supplied)

46. It has been reiterated that exploitation of ground water resources should be so regulated as not to exceed the recharging possibility, but it has been also said that there should be integrated and coordinated development of surface water and ground water resources for their conjunctive use. With increase of the use of surface water for purposes other than agriculture and as well as because of the increase of the acreage under irrigation, the importance of ground water has been increasing in most of the States in India where there is necessity of conjunctive use of ground water resources with surface water.

47. The fresh water resources of the basin include both the surface water and the ground water. In many cases the surface flow may contribute to the ground water in any particular area apart from the rainfall. In such situation it can be said that there is a close connection between the surface and the ground water. The rainfall is also not only the source of surface flow but also of the ground water by vertical infiltration. The same rainfall may contribute to the ground water in the basin if the topography so permits by lateral entry through streams and canals. The State of Karnataka in the Statement of Case have also referred to the Irrigation Commission 1972 report wherein the Irrigation Commission had stated that:-

> "Modern planning of river basins has to be on the basis of the totality of the available surface and groundwater resources in the basin. The concept of the integrated use of surface and groundwater is now universally recognized. It would be incorrect and even harmful to allow them to develop in isolation."

(Ref: Irrigation Commission 1972, Vol.I, Page 281, Para 12.18)

48. Also, Karnataka State has made a reference to the report of National Commission on Agriculture, 1976 recommendations, wherein, the Agriculture Commission has observed that "there are tracts in the Country……. that are rich in both surface water and groundwater, and it becomes a matter for consideration as to how best the two can be utilized for irrigation……." (Ref: Agriculture Commission Report Page 26, Para 15.6.7)

49. At the very outset Shri Divan, learned Senior Counsel arguing the case on behalf of Karnataka stated that ground water available in the delta area only should be considered for assessment and allocation; the ground water in respect of non-deltaic area both in Tamil Nadu and Karnataka within the Cauvery basin need not be considered for assessment and allocation. His plea was that the non-deltaic basin area in Tamil Nadu is similar to Karnataka which does not possess aquifer conditions and consist of hard rocks of the types like granite, gneiss, schist, etc. They are hard, and fractured. They have limited storage of low yielding capacities.

50. The State of Karnataka had produced Dr. D.M. Nanjundappa, socio-economic expert, as one of their witnesses who was cross-examined by the learned senior counsel on behalf of State of Tamil Nadu. During the course of his cross-examination, Tamil Nadu submitted Exh. No.1352 (TN Vol. 35) which gives details about all marginal and small farmers and their number of holdings along with total number of land holdings in the Cauvery basin. The position in Tamil Nadu area of Cauvery basin is as under:-

Marginal farmers below 1.0 ha holding	-	15.67 lac
Small farmers (1 to 2 ha holding)	-	4.63 "
Others (more than 2 ha holding)	-	3.30 "
Total	-	23.60 lac

51. Thus, it would be seen that about 66% holdings are below 1 ha and 19.6% holdings are between 1 and 2 ha and about 14% are the land holdings, which are more than 2 ha in area. It is abundantly clear that

the bulk of the farmers are falling in the category of marginal and small farmers. The additional Advocate General of Tamil Nadu during the course of arguments emphasized that in the delta area, if large extractions are made from the groundwater by the State, it could create adverse socio-economic problems due to fall in the water level of dug wells of small/marginal farmers.

52. In November 1964, following the request of the Government of India, the United Nations team visited Tamil Nadu, then known as Madras State, to study the possibility of augmenting domestic water supplies for Madras city and adjoining metropolitan areas. Later the Government of India submitted another request to United Nations Development Programme for extension of the ground water investigation into the Cauvery Delta alone. A three-man Mission from United Nations visited the Cauvery Delta in January 1968. As will appear from the 'Abstract' which is at the beginning of the report of Volume I, the object of the project was to investigate the hydrology of the Cauvery Delta to assess its ground water potential for irrigation and to carry out certain agricultural and soils- studies. During the investigation in association with team of Experts of Tamil Nadu, data were collected geological mapping, etc. were carried out, details whereof have been mentioned in the said report. In the beginning of Volume I of the report under the heading 'Abstract' at pages xiv and xv it was said by the UNDP team as under:-

“The Pliocene and Quaternary deposits form the shallow aquifer which extends over most of the delta area. The recharge of the shallow aquifer is by infiltration of surface irrigation water and precipitation. There are indications that water-levels in shallow aquifers can be lowered more and still fully recover by the end of the north-east monsoon. The yearly quantity of groundwater that can be extracted by using centrifugal pumps is: in the Cauvery sub-basin 954 million m^3 (33.7 TMC); in the Vennar sub-basin, 157 million m^3 (5.4 TMC); and in the New Delta area 923 million m^3 (32.5 TMC).

An additional quantity of 1,600 million m^3 (56.5 TMC)/year of ground water can be made available in the Cauvery sub-basin by lowering seasonally groundwater level to 10 metres depth below the regional groundwater level and substituting high-yielding medium-depth tube wells equipped with turbines for the low-yield filter points with centrifugal pumps……”

“The total yearly quantity of replenishable groundwater that can be extracted from the shallow aquifer in the delta through high-yielding medium-depth tube wells equipped with turbine pumps is 3,650 million m3 (129 TMC).

The medium-depth wells equipped with turbine pumps are costly, but their production can be shared by several farmers. Such a well when used for irrigation of early rice nurseries and for irrigation of summer short-term cotton would pay for itself in one or two years time.

The idea of co-operatives, however, does not at present appeal to the farmers of the delta who prefer to have each his own well. It will take some time and some effort to convince the people of the economic benefit of medium-depth tubewell and co-operation. At present and for some time to come therefore, groundwater will have to be developed by the existing method, that is, shallow wells, dug wells and filter points equipped with

centrifugal pumps. The total yearly quantity of groundwater that can be extracted from shallow aquifers in the delta by using centrifugal pumps is about 1,170 million m^3 (41.3 TMC). This represents about one third of the volume 2of groundwater which could be lifted by turbine pumps."

53. At page 130 of the UNDP Report - Volume-I, the conclusions of the ground water investigation in the delta have been stated. In Paragraph 7 at page 131, it is stated:-

"The ultimate additional quantities of groundwater of good or acceptable quality for each stage and for each of the sub-basins are tabulated below.

Stage	Sub-basin (area in sq.km)				Total
			New Delta		
	Cauvery (2,650)	Vennar (447)	NE corner (328)	Remaining (1,582)	
First objective(Mm^3) Shallow aquifer, seasonal depletion level 4-5 metres.	954 (33.7 TMC)	157 (5.54 TMC)	55 (1.94 TMC)	-	41.17 TMC
Second objective (Mm^3) Deep aquifer	135[a/] (4.77 TMC)	-	-	-	4.77 TMC
Third objective (Mm^3) Shallow aquifer, seasonal depletion, level 9-10 metres.	1,600 (56.5 TMC)	-	-	868 (30.66 TMC)	87.06 TMC

a/ Leakage potential for 30-metre piestic head relief over 300 sq. km already included in the shallow-aquifer system, recommended for a limited development only."

54. According to the aforesaid report in Cauvery sub-basin, the quantity of ground water has been estimated to be 954 million m^3 = 33.7

TMC; in Vennar sub-basin 157 million m^3 = 5.4 TMC and in the New Delta area 923 million m^3 = 32.5 TMC, the total being 70.16 TMC. According to UNDP the ground water available in the old Delta consisting of Cauvery sub-basin and Vennar sub-basin along with part of the new Delta (N.E. corner) which is in the Cauvery basin is about 41.17 TMC. This quantity is recommended for exploitation under the first objective i.e. seasonal depletion level 4-5 metres. The said report mentions that additional quantity of 1600 Mm^3= 56.5 TMC can be available as ground water in the Cauvery sub-basin area by lowering seasonally ground-water level to 9-10 metres depth below the regional ground water level and substituting high-yielding medium-depth tubewells equipped with turbines for the low-yield filter points with centrifugal pumps. The suggestion which was given by the UNDP team to lower the level to 10 metres depth and substituting tubewells equipped with turbine pumps was to take out water from still lower levels. It is the case of the Tamil Nadu, that because of the high cost involved in purchasing these equipments and in lowering the depth upto 10 metres by different cultivators in the delta, it was not practicable and un-workable. Apart from that this would have resulted in drying of all the existing drinking water wells. It is not correct to say that UNDP had assessed the total available ground water to be 129 TMC. The figure of 129 TMC can be achieved only if the ground water level is lowered by 10 metre depth and then they are substituted by high-yielding medium depth tubewells equipped with turbines for the low-yield filter points with

centrifugal pumps. For introduction of any such scheme, the cultivators of the delta must have the capacity to meet the expenses apart from the risk of existing wells becoming dry.

55. The stand of Karnataka is that if the recommendation of UNDP made in the year 1973 had been implemented, then the aquifers in the delta would have been recharged by north-east monsoon rainfall which could be utilised during the period between June to October next year. Unless either at the instance of the State Government or the cultivators the aforesaid recommendation to tap the additional resource of 56.5 TMC by lowering the ground water level to 10 metres depth and substituting high-yielding medium-depth tubewells equipped with turbine pumps for the low-yield filter points with centrifugal pumps are implemented, it is difficult at this juncture, to take that amount of 56.5 TMC into account for purpose of determination as to what is the total ground water available in the delta. It is not in dispute that second and third objectives mentioned in the aforesaid report at page 131 have not been achieved.

56. It appears that CFFC had referred the question regarding quantity of the ground water in the delta to the Central Ground Water Board for their opinion. Since reply from the Central Ground Water Board was not received until the submission of the report by the Committee, no opinion has been expressed by CFFC regarding ground water. The Government of India vide its letter dated 19th/20th September, 1973 forwarded the opinion of the Central Ground Water Board to the

Government of Tamil Nadu (Exhibit No.TN-842, TNDC Volume No. XV (Page No.161-166). A three Member team consisting of Shri A.K. Roy, Chief Hydrogeologist, Shri D.S. Deshmukh, Director, Southern Region and Dr. K.V. Raghava Rao, Superintending, Hydrogeologist, Central Ground Water Board visited Madras and held detailed discussion with the State Ground Water Directorate Officials as well as with other officers of the irrigation department. The team also scrutinised the available technical information collected through UNDP Project and allied studies in the Cauvery delta. At page165 (para.6) is the SUM-UP

"On the basis of the data made available to the Team, the following consensus is arrived at:-

i) The surface water released from Mettur Dam does definitely contribute to the recharge of the upper aquifer now being intensively developed for large scale extraction of water for irrigation purposes in the Cauvery Delta.

ii) The benefit from the north-east monsoon (November-December) to recharge shallow aquifers is not being fully utilised at present. If the water table in the shallow aquifers is kept suitably depressed till the onset of North-East monsoon, it is felt that adequate recharge to the shallow aquifer can also be effected. The contention of the State Government that the upper aquifers are blanketed by an impervious clay bed to prevent percolation of precipitation all through the system is not convincing.

iii) In order to implement as in (ii) above the adverse socio-economic impact has to be given careful consideration, as it would involve changing over or designing of the existing extraction system as a whole of the filter points and open wells (i.e. centrifugal pumping).

iv) The data collected through the UNDP project study and as presented by the State Government also substantiate that the deeper confined aquifer (Tertiary aquifer) is not prolific enough to support 1000 heavy duty tubewells as originally planned under Cauvery Delta Modernisation proposals. This stands to reason."

57. The question regarding the utilisation of the ground water with a special reference to the delta area in Tamil Nadu was again examined by a team of Central Ground Water Board, and the opinion was forwarded vide letter dated 5th September, 1974 addressed by the Government of India and to the Government of Tamil Nadu (TN Exhibit No.843, TNDC Volume No. XV (Page -166). The Central Ground Water Board examined the ground water potential of Cauvery delta, the details whereof have been mentioned in the report enclosed to the letter aforesaid. In para 5 of TNDC Volume XV (Page 170-172), points emerged through the assessment have been stated:-

"i) The quantitative estimates made for the release of the water from the ground water reservoir for the shallow as well as deep aquifer systems in the delta for two set of depletion of the water level (4 to 5 metres and 9 to 10 metres) is acceptable but for the adjustments stated below.

i) The ground water potential of the shallow aquifer is estimated under UNDP study based on phreatic conditions for the aquifer system, ignoring the possibility of the shallow ground water reservoir functioning initially as a confined aquifer system with low storativity efficient for large scale pumping. As such, till the system attains phreatic conditions (the piezometric head of the aquifer system drops below the clay bed) the

contribution from the ground water reservoir cannot be of the magnitude of 20% specified as assumed in the UNDP study. In view of this, the ground water potential shown against first stage development of the shallow aquifer in the old delta may not be of the order of 1110 Mm3 (40 TMC). It may have to be slightly lesser than this figure. As a first approximation, reduced figure of 30 TMC may be reckoned.

ii) The limited ground potential of 135 Mm3 (5TMC) from the deep aquifer systems (upto 100 metres) exclusively in the Cauvery sub-basin may also be utilised by pumping through tube wells.

iii) The fairly large potential of ground water from the shallow aquifer in the Cauvery sub-basin 1600 Mm3 (58 TMC) with water level depressions created close to 10 metres (and above if feasible) could only be made available for gradual and phased development. This, however, would necessitate a change in the design of ground water extraction structures (tube wells) and the extent of its utilisation would depend on its effective recharge from the North East Monsoon due to the depletion created in the water levels in the shallow aquifer system through sizeable extraction of ground water. This situation may induce better recharge condition to the aquifer system from the North East Monsoon and reduce its heavy run-off (as is being experienced now) on the expectation that the persistence clay-bed would not as a leaky confined bed in the changed conditions and the unlined drain channels may also function as better recharge points to the shallow aquifer. While utilising this additional recharge, however, it will be desirable to limit the pumping to a safe limit between the salt water and fresh water zones and no ingress of salt water takes place. As a rough first approximation, it is reckoned that it may not be safe to utilise more than 50% of the potential.

On this reckoning the ground water potential available from the delta works out to 1780 Mm^3 (64 TMC). The break-up for the same is given below.

		Mm^3	TMC
i)	From the shallow aquifer system In the Cauvery & Vennar Sub-Basin (old delta) with 4-5 metres Depletion.	840	30
ii)	Deep aquifer exclusively in Cauvery sub-basin	135	5
ii)	From the shallow aquifer system in Cauvery sub-basin with depletion close to 10 metres (and above if feasible) with suitable and gradual introduction of ground water extraction structures (tube wells) and scope for recharge from the North East Monsoon to the shallow aquifer.	812	29
		1787	64
	(say)	1789	"

58. From the above estimation made by the Central Ground Water Board, as quoted above, it appears that according to them ground water potential available from the delta works out to 64 TMC which includes 5 TMC from deep aquifer (upto 100 meter deep). The break up whereof has been mentioned towards the end of the report. From the shallow aquifer system in the Cauvery & Vennar sub-basin (old delta) with 4-5 metres depletion, the estimate was made at 30 TMC. However, another 29 TMC can be added to this if the shallow aquifer system in cauvery sub-basin with depletion close to 10 metres and above is feasible with suitable and gradual introduction of ground water extraction structures

(tubewells) and a scope for recharge from the North East Monsoon. It is obvious from the report that no estimation then had been made in respect of the portion of the new delta.

59. It appears that the Central Ground Water Board in its report was of the opinion that the work carried out by the UNDP in collaboration with the State PWD Department (1969-72) in the Cauvery delta and its follow up was not only systematic but also brought out substantial information on functional behaviour of the shallow and deeper aquifers both in the old and New deltas.

60. **Cauvery Delta Modernization Project**

(The Groundwater Resources of the Cauvery Delta with Special Reference to Conjunctive Use of Surface Water and Groundwater By W. Barber, Consultant, World Bank)

The Report was forwarded vide letter dated 30th April,1985 to the Government of Tamil Nadu (TNDC Volume XV – Page No.173). Mr. W. Barber (Consultant) World Bank, who had examined the delta area in its different aspects and contours along with the UNDP report; has given a table of Gross Groundwater Abstractions from Cauvery Delta between the years from 1971 to 1983 (Page 190, TNDC Volume No. XV). The table is extracted below:-

Table 7 GROSS GROUNDWATER ABSTRACTIONS FROM CAUVERY DELTA

Year	Cauvery Sub-basin	Vennar Sub-basin	New Delta S.B.	Total	
	Mm3			Mm3	TMC
1971	99	22	9	130	(4.58)
1972	159	35	15	209	(7.38)
1973	127	30	13	170	(6.00)
1974	204	39	13	256	(9.04)
1975	254	50	16	320	(11.30)
1976	533	84	149	766	(27.05)
1977	656	95	152	903	(31.89)
1978	409	68	152	629	(22.22)
1979	387	92	102	581	(20.52)
1980	524	86	108	718	(25.36)
1981	398	98	111	607	(21.44)
1982	689	103	105	897	(31.68)
1983	572	93	165	830	(29.32)

61. Regarding the available ground water resources for conjunctive use, It is mentioned in the said report as under (Volume No. TNDC-XV (page No.192-193):-

> “35. Given that the aquifer system fills before the end of the monsoon and the end of the main irrigation season, and thus rejects further potential recharge, one approach to defining the maximum available groundwater resource would be to determine the amount of pumping required to create the necessary fill-able storage in the aquifer system so that rejection was minimized or eliminated. This type of approach was postulated in the UNDP report as an ultimate development scenario with the aquifer being dewatered each year to a depth of 9-10 m below ground surface. However, the scenario does not give proper weighting to the interaction of the rainfall and surface water irrigation regimes with the groundwater system, and the fact that the main monsoon crop is one or other variety of rice for which the paddies must be

kept flooded. This relationship is particularly sensitive during the south west monsoon period when both rainfall and surface irrigation water may be in short supply. The large volume of groundwater storage created under the scenario, presumably largely by dry season pumping, could only be refilled at the expense of increased deep percolation losses from the surface water supply (both in the conveyance and on the field) and by increased deep percolation of rainfall, thus reducing the effectiveness of these sources of water to sustain a rice crop. Hypothetically, it might be possible to make more effective use of groundwater by changing the cropping pattern from early rice to a dry crop, but the Government rejects any such solution, considering the importance of the Cauvery Delta for the State's rice production. Moreover, implementation of the deep water level scenario would put most of the very large number of shallow tubewells owned by the farmers, and many of the village water supply wells, out of commission. It would demand large investments in redesigned facilities, probably involving installation of electric submersible or vertical shaft driven turbine pumps. The Government rightly rejects such a development plan for the foreseeable future.

36. A more acceptable scenario for development of groundwater for conjunctive use envisages creation of groundwater storage down to about 4.5 m below land surface in the tubewell and filter point areas (mainly in Cauvery and Vennar sub-basins) and to about 9 m below land surface in the dug-cum-bored well area (limited to the New Delta sub-basin) where infiltration rates are lower and hydrogeological conditions demand this type of facility. This level of development would keep the existing private facilities in commission without major modifications. The available water

resource at full development of the above scenario has been estimated as follows for the three sub-basins, after elimination of areas of poor quality water and salt marsh.

Table 8: ESTIMATE OF AVAILABLE GROUNDWATER IN THE PLIOCENE-QUATERNARY SYSTEM OF CAUVERY DELTA UNDER THE LIMITED DRAWDOWN SCENARIO

	Sub-basins			Totals
	Cauvery	Vennar	New Delta	
Total area (Km^2)	3282	2434	2084	7800
Rejected area (Km^2)	632	1987	174	2793
Usable water area (Km^2)	2650	447	1910	5007
Water availability (Mm^3/yr)				
By tubewells and filter points	765	50	40	855
By dug-cum-bored wells	-	-	605	605
	765 (27.03 (TMC)	50 (1.76 TMC)	645 22.77 (TMC)	1460 (51.56 TMC)

37. It should be noted that the above estimates refer to net abstraction. Table 7 indicates that gross abstraction has, to date, never exceeded about 900 Mm3 (31.79 TMC) in any year and a considerable proportion of the water pumped would have recirculated back to the aquifer. Thus, it is evident that there is considerable scope for further groundwater development under the limited drawdown plan. This is confirmed by the fact that water levels at present fall to 4 m below land surface in only a limited area of the tubewell zone of the delta (Figure 7) and this is located in the tail reaches of the surface system, where surface irrigation water is in short supply and the farmers have a high incentive to pump groundwater."

62. Regarding recharge of the groundwater in the delta, it was said as under (TNDC Vol. No. XV - Page 186-187):-

"24. The main components of recharge to the Pliocene-Quaternary aquifer system are:

(a) recharge from rainfall;

(b) recharge from influent seepage from the delta rivers;

(c) deep percolation of seepage losses from the canal system;

(d) deep percolation of irrigation water applied to the fields;

(e) deep percolation from temporary flood waters; and

(f) return flows of groundwater abstraction.

25. It will be noted that in almost every year, most of the aquifer system fills to near land surface long before the end of the monsoon rains and the end of the main irrigation season. Under these circumstances, the system may be regarded as rejecting potential recharge. This is not necessarily a disadvantage overall, as the main crop is rice and the aim is to minimise losses from the paddies, as happens at full saturation of the aquifer system. It should also be noted that system water levels are at their lowest just before the onset of the southwest monsoon. Mettur reservoir releases are often made in advance of the monsoon becoming fully established, and southwest monsoon rainfall is rarely adequate to fully support a rice crop. Thus, it may be argued that a considerable proportion of the early Mettur reservoir releases go to aquifer replenishment through deep percolation from river channels, canals and fields. This situation is of significance when deciding optimal groundwater development involving creation of groundwater reservoir storage, a considerable proportion of which may have to be refilled from the surface water resource."

63. As regards recharge of shallow aquifer in the delta area from the releases of the Mettur is supported even from the reports of the UNDP Volume No.I – Page 78 under heading ‘Water-level fluctuation in the shallow aquifer and its recharge’.

> “2. (b) The shallow aquifer in the Cauvery basin is usually fully recharged in about two months after the water from the Mettur dam has been released over its area. This fast recharge is due to the fact that most river channels cut through the 3 to 5 metre semi-confining deposits and water from them recharges the shallow aquifer directly by lateral infiltration. Consequently, when the peak monsoon rainfall is reached in October/November practically all of it runs off as surface water into the sea.
>
> The semi-confining deposits in Vennar sub-basin are deeper. The river channels, therefore, are not in a direct hydraulic contact with the shallow aquifer and lateral infiltration from the rivers carrying irrigation water is negligible. The main recharge of the shallow aquifer comes from infiltration mainly from the fields which becomes maximum during the period of the peak monsoon rainfall. The difference in recharge pattern in Cauvery and Vennar sub-basins is reflected by their hydrographs of cumulative change in ground-water storage.
>
> In New Delta area the recharge of the shallow aquifer is by infiltration from the fields of the surface irrigation water from Mettur Dam. This water recharges the semi-confining deposits and subsequently the shallow aquifer zone but after a time-lag of 7-10 days. The time-lag was ascertained by a comparative study of the recovery pattern of the shallow observation wells and of 7 piezometers in the shallow aquifer. The shallow aquifer and the semi-confining deposits are usually fully

saturated before the peak monsoon rainfall which therefore is rejected and as a surface water runs off to the sea."

64. The earlier Tribunals in 1970s had observed that since the groundwater resources are not properly calculable, the groundwater cannot be considered for apportionment and on this account the yield assessment cannot be recognized under law. Although because of the pressure on the demand of groundwater, this resource is being exploited but mostly remains in the private sector. In our country even for agricultural purposes, it is generally the farmers who install dug wells, filter points and tubewells; statistics have shown that so far the States of Karnataka and Tamil Nadu who are the major parties in this dispute do not have a single tubewell owned by the Government for agricultural purpose.

65. The State of Tamil Nadu has repeatedly stressed that the recharge of groundwater in the delta area is mainly due to releases from Mettur reservoir. This view to a greater extent has been supported by UNDP, the Central Ground Water Board and Mr. Barber of World Bank. However, It appears to be an admitted position that in the year 1989 Tamil Nadu utilised 47 TMC of ground water. According to the State of Tamil Nadu, the scope for conjunctive use of ground water was to the extent of only about 30 TMC. (Ref. Pleadings TN Vol.III, page 187, para 16.8.10).

66. In TN Pleadings Vol. VI at page No.141-142, it has been said:-

> "The above facts and figures supported by the U.N.D.P., Central Ground Water Board, the World Bank Consultant and further data collected by the State Ground Water Department during 1972-1991 prove that the utilisable ground water potential is limited and it is not an additional source from the point of availability of water resources for irrigation. It is only an extra facility available in the Delta for supplementing surface water for irrigation during water shortage periods. The available potential has been utilised to the maximum extent possible through 41,800 energised pump sets, 15,000 diesel pumpsets and 1,00,000 non-energised irrigation and domestic wells now available in the Delta. The total ground water extraction during the year 1989 is estimated as 28.4, TMC in the Cauvery sub-basin, 7.3 TMC in the Vennar Sub-basin and 11.3 TMC in the Grand Anicut Canal area."

The total of the ground water utilised in the aforesaid three sub-basins shall be 47 TMC. It may be mentioned that Grand Anicut Canal area is known as New Delta area.

67. In TN Pleadings Vol.III at page No.186-187 (para 9-10), it has been said:-

> "9. It may be seen from the above that there has been a general consensus in the opinions expressed by the competent expert agencies who studied in great detail the availability of the ground water in the Cauvery Delta at different points of time, 1972 (UNDP), 1974 (Central Ground Water Board and Govt. of India) and 1985 (World Bank Mission).

> 10. Thus in the old Delta, there is scope for conjunctive use of ground water to the extent of only about 30 TMC. The present extraction in the old Delta is already nearing about this level, the extraction in 1989 being 28 TMC. Extraction of ground water in excess of 30 TMC is ruled out in view of the adverse socio-economic impact of depleting the aquifer beyond 5 m depth. It is also relevant to note that ground water is being used only for supplementary irrigation such as raising of early nurseries ahead of release from Mettur and supporting belated crop on ground after stoppage of Mettur releases and during critical shortage periods. Since only Mettur releases replenish the ground water, the ground water cannot be considered as an additional or a separate resource in the Cauvery Delta."
>
> [Emphasis supplied]

68. In Tamil Nadu Pleadings Vol. III at page 180 (para 4), it has been said:-

> "4. Tamil Nadu has been in the forefront in the country in identification and utilisation of ground water potential. The Irrigation Commission (1972) Volume I, Page 97, Para 5.40, has observed that conjunctive use of ground water and surface water was already in vogue in the Cauvery Delta. The detailed investigation for ground water taken up with the assistance from UNDP in 1966 is the first of its kind in the country. In the study carried out in the Cauvery Delta during 1966-72, voluminous data have been collected and documented for interpretation. Aquifers were identified, their hydraulic characteristics determined and potential estimated."
>
> (emphasis supplied)

69. From the aforesaid Statements, it is apparent that Tamil Nadu has been strongly supporting the investigation and collection of data as

well as the estimate of ground water made in the delta area by UNDP throughout, but during the course of arguments at a later stage, on the basis of the Report of the Ground Water Resource Estimation Committee 1997 (GEC), the correctness of the estimation of ground water by UNDP was questioned.

70. On behalf of the State of Tamil Nadu, it was urged that in view of the new norms prescribed in the year 1997 by the Ground Water Resource Estimation Committee (hereinafter referred to as 'Committee') more observation wells should have been dug in the delta area by UNDP for better observation and collection of data to estimate accurately the quantity of ground water available in the delta area. It was pointed out that UNDP had 39 observation wells since 1966 and in the year 1969, 46 more were added, a total 85 observation wells in the delta, of which area is about 8000 sq. km. In other words, one observation well for 100 sq. km. approximately. On the basis of the aforesaid report of the Committee prescribing better parameters for evaluation of the aquifer, the exercise done by the UNDP, should not be accepted on its face value. It was objected to on behalf of the State of Karnataka that merely because some better parameters have been prescribed for assessment of the ground water in the report of the Committee in the year 1997, the reports regarding the availability of the ground water by the UNDP, cannot be now questioned. In that connection, it was urged by Karnataka that although the proceedings before the Tribunal, were pending since 1990, still Tamil Nadu has not

examined any expert to say that if the calculations are made on basis of the parameters prescribed in the year 1997 by the Committee aforesaid, a different result in respect of the estimation of the ground water would have followed and further that this Tribunal cannot re-calculate the quantity of the ground water available in the old and new delta by applying some change in the norm in respect of observation of fluctuations of the water level in the aquifers within the delta area. It was also urged by Karnataka that if Tamil Nadu wanted to verify the correctness of evaluation by UNDP, the data collected by the UNDP, should have been checked first by a team of experts applying parameters suggested by the Committee in the year 1997 and one of such experts could have been examined and the other riparian States should have been given an opportunity to cross examine him for showing that new parameters hardly make any difference in so far as the earlier estimation of the ground water is concerned. The observation, collection of the data and estimation of the ground water are in accordance with the requirements prescribed in the report of the Ground Water Resource Committee in the year 1984. Although there is no necessity to express any opinion as to what changes in the parameters have been prescribed, but as a first impression it amounts to only fine tuning of the norms, which have been used by the UNDP and prescribed by the same Committee in the year 1984. At page 26, the Committee has observed in respect of ground water assessment in accordance with the 1984 guidelines as follows:-

> "While alternate methodologies for ground water recharge assessment are possible, the ground water level fluctuation method, based on the concept of ground water balance, is the most suitable and reliable at this point of time, considering the type and extent of data available. As the ground water assessment has to be done all over the country at each block/taluk/mandal level, there is also a need to retain the alternate empirical approach based on specified norms, for application in areas without adequate water level data. The two approaches recommended by the GEC – 1984 can therefore still form the basis for ground water assessment."

71. It will be relevant to mention that the Committee was prescribing the norms for whole of India, but UNDP which collected the data from different observation wells between1966 to 1972 was concerned only with the delta area of Tamil Nadu. Tamil Nadu, having applauded and fully supported the collection of data, investigation and estimation, done by UNDP throughout till the late stage of the argument, suddenly raised the question of calculating the availability of the data on the basis of new parameters, which prescribe more observation wells per 100 sq. km. of area. In any case, unless as already mentioned above, some expert who had examined the data calculated by UNDP in the light of the new norms prescribed and examined before the Tribunal, this Tribunal cannot take into consideration the changes in the parameters, if any.

72. Reference was also made on behalf of the State of Tamil Nadu to the cross examination of Dr. K.R. Karanth, the first witness examined

on behalf of the State of Karnataka, in respect of its case that so far ground water in the delta areas is concerned, there is contribution from the releases made from by Mettur reservoir. This aspect has already been discussed in the Report of UNDP, Cental Ground Water Board and Mr. Barber. They have said that the releases from Mettur to the delta area, contribute to the re-charge of ground water by lateral infiltration where it is possible according to topography of the land. There is also re-charge by infiltration after the said water released from Mettur, enters and remains on the paddy fields. So far the infiltration from the paddy fields to the aquifers are concerned, that shall be part of the ground water like rainfall over the said fields. If the infiltration by the surface flow or the rainfall are also excluded from the quantity of the ground water, then it is difficult to imagine any other source of availability of ground water in any particular area including the delta. So far the lateral re-charge from the releases in any part of the delta is concerned, that is a question to be determined whether the said amount of water can be counted while estimating the ground water in the delta. The reason is obvious. In dispute regarding apportionment of the surface water and ground water the same amount of surface water released from the Mettur cannot be counted twice; first as surface water and then as ground water.

73. It is an admitted position that in no other river basin in India so much of investigations have been done and data have been collected

from time to time, by group of Experts in respect of ground water in which process Tamil Nadu was always associated.

74. Several documents and reports were shown to us as well as the evidence of Dr. Karanth, the witness examined on behalf of Karnataka as to how in the year 1987 the Mettur releases started in the month of November due to shortage of water, still Kuruvai crop was grown in about 65,000 acres of land. In that year, on the advice of experts there was direct seeding of samba crop in about 4.5 lakh acres in the delta with good results. Karnataka argues that Tamil Nadu should be directed to grow samba crop by direct seeding as was done in the year 1987. But the fact remains that if the stand of Karnataka is accepted that there should not be any release from Mettur prior to October-November, then as a logical sequence a direction has to be given that cultivators of Tamil Nadu should not cultivate kuruvai and thaladi paddy crops in the delta area which they have been growing for nearly a century. Kuruvai crop is grown early with the help of ground water and releases from Mettur. This variety of paddy takes much less time to mature than samba crop. The cultivation of kuruvai starts in June – July and is harvested by September. Then thaladi is planted in the same field. This practice is being followed at least since the beginning of twentieth century and has been recognised under the agreement of the year 1924. Prior to the agreement of 1924, Kuruvai was being grown on about 95,000 acres of land and under the terms of

agreement, the then Madras Presidency was permitted to extend the said area by 70,000 acres. The total area being 1,65,000 acres.

75. The Learned Counsel for Karnataka during the course of arguments referred to the evidence of Dr. M.S.Swaminathan (TNW-4) examined on behalf of Tamil Nadu, who had particularly referred to the excellent water management done by the Distt. Administration of Thanjavur during the year 1987 when the releases from Mettur were made as late as on 9th November and the State of Tamil Nadu had successfully faced the situation arising out of meagre release of only 62 TMC of water from Mettur Reservoir, but still the State was able to harvest a bumper crop of rice. Day to day details were recorded by Mr. V.Palaniappan (Agriculture Department, Tamil Nadu) in the document namely "1987 – The Year of Challenge" (Ref.: KAR Note 9 on Issues Group No. 2, page 24, para 8.5) produced during the examination of Dr Swaminathan. Karnataka contended that although during the year 1987-88, the releases from Mettur started on 9th November, 1987, still Kuruvai was grown by the cultivators of Tamil Nadu on about 65,000 acres of land and this must have been done mainly with the help of ground water available before November and further that considering that roughly 5,000 acres of paddy require one TMC of water, it seems reasonable to assume that the said Kuruvai in about 65,000 acres was grown with the help of 10 to 12 TMC of ground water without any contribution from Mettur. On behalf of the State of Tamil Nadu, it was said that the rainfall in the year 1987-88 was exceptionally good and

timely because of that Kuruvai could be grown in 65000 acres without the releases from the Mettur. In support of the stand that in the year 1987-88 there was exceptionally good rainfall, a statement prepared by Tamil Nadu was filed on 5th December, 2003. It was pointed out from that Statement that in the year 1987-88, the rainfall in the month of September was 98.5 mm., in October 328.7mm., in November 134.7 mm. and in December 340.1 mm., which was much more than any of the years between 1984 to 1987 and then 1988 to 1991.

76. The State of Karnataka had produced Dr. K.R. Karanth (KR-W1) as an expert witness on ground water. He recommends that ground water is available for exploitation during any month of the year and can be used for irrigation and to that extent surface water could be saved. Paddy cultivation in the delta area is from June to September and October to January. The former period is the period of south-west monsoon and the latter period is of north-east monsoon. The only consideration could be to raise nurseries of Kuruvai during the early months i.e. June till July by tapping ground water in the event of delay/decrease in releases from Mettur. Similarly, whenever there is a dry spell during the rainy season or late requirement of water for standing crop nearing maturity cultivators can use ground water. This position has also been accepted by Tamil Nadu State in their pleadings. (Ref: E-101, page 77, para 5.4.3).

77. The suggestion of Dr. Karanth that large scale pumping should be done during the months of June to September so that the empty

underground reservoir could be filled by north-east monsoon and also to pump water during north-east monsoon from October to January, so that whatever pumping is done during that season is also replenished from north-east monsoon, does not seem to be workable at all, if agro climatic conditions and periods of raising crop are kept in view.

78. Dr. Karanth had also presented in his statement an assessment of rainfall component for recharge of ground water by two methods. In the first method, changes in the ground water storage have been considered using the rainfall for the months of September and October. Thereafter, increase in ground water storage due to rainfall in the months of November and December has been worked out on pro-rata basis adopting the rainfall of September and October. Using this methodology he has worked out recharge component of annual rainfall for the delta area. In his second method, he has analyzed two aspects of recharge namely surface irrigation and total recharge, and, worked out the percentage of overall annual rainfall that goes to recharge the ground water. Dr. Karanth in his first affidavit of 3.8.1993, has referred to the report “Ground Water Estimation Methodology” of the Ground Water Estimation Committee (1984), set-up by the Govt. of India. He mentions about the following ad-hoc norms given in the guidelines:-

> “Recharge from Rainfall:
>
> (i) Alluvial areas –
>
> In sandy areas - 20-25% of normal rainfall
>
> In areas with higher clay content -10-20% of normal rainfall”

The study of Dr. Karanth for assessing the rainfall component for recharge of ground water specifically pertains to the year 1987 on the plea that during this year, Mettur releases were made only on 9th November, 1987. Thus, during the period from June to end of October, there were no releases from Mettur reservoir and consequently, the component of recharge from Mettur releases was insignificant. (Ref: Supplementary affidavit of Dr. Karanth, page 129, para 162)

79. He further seems to have not considered the rainfall in the delta area during the period from June to August which was as under:-

Year	Project		June	July	Aug.	Sept.	Oct.
1987-88	Cauvery Delta System	Rainfall mm	28.3	18.2	90.2	98.5	328.7
		River releases Mcft.	30	43	1254	97	537
-do-	New Delta (G.A. Canal)	-do-	35.2	3.6	81.2	75.0	215.9
			38	10	137	223	824

(Ref: E-19, pages 136 and 156)

Thus, during the period June to October, the total rainfall in Cauvery Delta system and New Delta has been 563.9 mm and 410.9 mm respectively. As regards the releases, the total releases during this period of June to October in Cauvery Delta has been 1961 mcft. (1.96 TMC) and in New Delta 1232 mcft. (1.23 TMC). From the above, it is clear that Dr. Karanth has taken into consideration only the rainfall for the month of September/October ignoring the rainfall from June to August; and as regards recharge from the river releases, he has totally ignored the same for the period June to October. In other words, contribution towards recharge from the above sources seem to have been ignored in his study.

80. Dr. Karanth during his cross-examination by the learned Counsel of Tamil Nadu on the above aspects has stated as under:-

> "Q: 1367 ……. I asked you – what are the factors which are important and which have a bearing in the case of recharge from rainfall. You say 1, 2, 3, 4 factors. You answer the question one by one.
>
> A: Rainfall is one factor. Topography is another factor. Soil characteristics is the third factor. Then the land use is another factor. All these 3 to 4 factors have a bearing.
>
> Q: 1368 Surely, when you say 'rainfall', the duration of the rainfall, then the time and spacing of the rainfall, intensity of the rainfall. Are these important factors?
>
> A: Yes, correct.
>
> Q: 1370 Mr. Karanth, do you suggest that if you have a higher rainfall on a particular day, the recharge will be more. Is that your suggestion?
>
> A: There will be more runoff."

It also appears that recharge of ground water from irrigation during the months of November and December when Mettur releases were made, had not been considered by Dr. Karanth as will appear from his following cross-examination:-

> "Q: 1697 All right. You have not ignored. Where have you indicated the effect of irrigation in November and December? Please show us at page 130 calculations.
>
> A: There is no need to indicate it at all. You are calculating rainfall recharge, what it would be. It is quite likely that in some year there may not be any irrigation release. If there is irrigation supplies, there

would be recharge. Nobody can dispute that. I have not disputed it. But there is no need to mention it separately, because it is implied; it is obvious.

Q: 1698 It is obvious that you have taken into account recharge in these two months of November and December which will take place from irrigation supplies, in your calculation? ……..

(Mr. Chairman: He has admitted that for November and December, he has not taken recharge from irrigation, but only rainfall…….)

Q: Contd. Mr. Karanth, Am I right in saying that in your calculations here, when you are calculating the recharge factor for November and December, you did not take into account the irrigation supplies and its impact, for the purpose of this calculation?

A: Yes.

Q: 1699 If in these two months, November and December, there is irrigation supplies and also rainfall, is it possible to ascertain how much is the recharge from out of rainfall and how much recharge has taken place on account of irrigation supplies? Is it possible to ascertain? Can you bifurcate the two?

A: If both are concurrent then you can not identify how much is from what.

Q: 1701 If I understood you correctly, if in the same months of November and December you have both irrigation supplies and rainfall, you cannot discern which quantity has been responsible for recharge due to rainfall and which quantity of recharge is due to irrigation supply. Is that not correct?

A: Correct."

81. From the above cross-examination, it is clear that although there were releases from Mettur during the months of November/December 1987, the effect of these releases on the recharge was ignored by Dr. Karanth who only arrived at a general conclusion assuming that in a year when there will be no releases from Mettur for irrigation during November and December, the recharge component from rainfall will be as worked out by him. This assumption is hypothetical, as hardly there will be any year in which there would be no releases during June to December. Therefore, his study is only a theoretical exercise.

82. In this connection, it would be pertinent to mention that the infiltration from rainfall is dependent on various parameters namely: the intensity of rainfall, its duration and frequency, for example: if 100 mm of rainfall occurs during one hour, the same will create much more runoff than 100 mm of rainfall occurring in 3-4 days. Thus, giving same weight to the rainfall of November/December as that of September/October, ignoring the effect of intensity of rainfall for calculating recharge is questionable.

83. During the course of cross-examination, Dr. Karanth was shown relevant portion of Irrigation Commission Report 1972 (Vol. III, Part II, page 304, paragraph 10.20) which is reproduced below:-

> "In general, highest rainfall in the Cauvery basin usually occurs in July or early August upto the point where the Mettur Dam is situated, the area comes under the influence of the south-west monsoon, and from this point downwards, the

catchment is within the influence of the north-east monsoon, and the high floods due to this monsoon usually occur in November. This pattern of rainfall is conductive to a fairly high flow during the irrigation season from June to January, except for a short period of about six weeks from when there is a break in the monsoon. While the south-west monsoon supply is copious and dependable, the north-east monsoon supply is irregular and subject to frequent failure."

And cross-examined on the point:

"Q: 1722 Do you agree with the last two sentences that the south-west monsoon is dependable whereas the north-east monsoon is not dependable, it is irregular. Even today, My Lord he has seen the kind of rainfall. Do you agree, Mr. Karanth?

A: "Frequent failure", I am not aware that this is so.

Q: 1723 Do you agree that it is irregular?

A: "Copious and dependable", this only an agricultural scientist can say whether that is dependable for his crops, an irrigation engineer can say whether it is dependable for his run-off.

Q: 1724 You talk about the north-east monsoon, you have seen the north-east monsoon.

A: If you want to get a technical reply, I can say only hydro-meteorologist. But if it is……..

(After, the Tribunal pointed out that the witness may take note of the fact that the Irrigation Commission Report 1972 which contain all these findings must be constituted of experts on the subject – the witness then replied that as it comes from the Irrigation Commission, I accept it in toto.)" (Ref:Dr. Karanth deposition, Vol.III, page 523 to 525)

84. From the above deposition of Dr. Karanth (Q. Nos. 1722 to 1724), it would be seen that Dr. Karanth has admitted that he has done the study as a Hydrogeologist for assessing rainfall component of recharge. In reply to further questions, he has clearly stated that he is not a Hydrometeorologist or Agricultural Scientist or Irrigation Engineer who could answer, questions pertaining to the pattern of rainfall, its intensity and dependability and whether the rainfall is sufficient for the crop etc. Thus, Dr. Karanth has conducted the study only from the viewpoint of a Hydrogeologist without taking into consideration the characteristics of rainfall and its adequacy or otherwise for the crops during the normal years.

85. The State of Tamil Nadu in their Statement of Case, TN 1, page 25, para 29(b) have stated as under:-

> "The upper part of the Cauvery basin which is above Mettur is influenced by the South West monsoon, while the lower part is influenced by the North East monsoon. …….. The South West monsoon is more intensive, unfailing and dependable, spread over a long period. The co-efficient of variation of rainfall for this season in this part of the region is 15 to 25% from normal. …….. The coastal areas and the delta occasionally receive heavy intense rains of very short duration, most of which can neither be conserved nor utilized in the delta. Damages also occur. The worst damage suffered by the farmers is when their first crop harvests are hampered and the grains soaked or washed away."

86. It will be pertinent to mention here that it is not only the Irrigation Commission but the CFFC Report also had held similar view as

regards the northeast monsoon is concerned – that the northeast monsoon is irregular and subject to frequent failure, and also the high floods due to this monsoon usually occur in the month of November in view of the nature and pattern of northeast monsoon which occurs as a result of cyclonic formation in the Bay of Bengal which bring torrential rainfall in the eastern coast in delta area. It results in large surface runoff which many a time even damage the standing paddy crop. As such, calculation of ground water recharge component of this rainfall on pro-rata basis with the recharge component from rainfall of September-October does not seem to be justified.

87. But according to the UNDP report (Phase II, Volume I -1973-page xiv-para 4), the yearly quantity of ground water that can be extracted by using centrifugal pumps has been estimated as under:-

> In the Cauvery sub-basin 954 million m3 (33.7 TMC); in the Vennar sub-basin,157 million m3 (5.5 TMC) and in the New Delta area 923 million m3 (32.6 TMC-upto 9 to 10 metres) the total being 71.08 TMC. However the UNDP report (Volume I page xv para 4) mentions that:-
>
> "At present and for some time to come therefore, groundwater will have to be developed by the existing method, that is, shallow wells, dug wells and filter points equipped with centrifugal pumps. The total yearly quantity of groundwater that can be extracted from shallow aquifers in the delta by using centrifugal pumps is about 1,170 million m3 (41.3 TMC)".

88. According to the Central Ground Water Board from the shallow aquifer system in Cauvery and Vennar sub-basins (old delta), the

available ground water is 30 TMC (Reference: TNDC Volume XV-Page 172). The Central Ground Water Board did not examine the availability of ground water in the new delta. From the report of Mr. Barber, it appears that according to him the available ground water in cauvery sub-basin is 765 million m3 (27.03 TMC); in Vennar sub-basin 50 million m3, (1.76 TMC) and in New Delta 645 million m3 (22.77 TMC), the Grand Total of which is 1460 million m3 (51.56 TMC) (Reference: TNDC Volume XV-Page 193). In other words, whereas according to UNDP report in the old delta about 39.2 TMC of ground water was available, according to the Central Ground Water Board; it is only 30 TMC. Mr. Barber estimated 28.79 TMC. As regards the New delta UNDP estimated 32.6 TMC and Mr.Barber estimated 22.77 TMC.

89. The area which is located North of Coleroon river falls outside the delta area which is confined mostly to South of Coleroon river. It is also noticed that neither CGWB nor Mr. Barber while estimating the ground water availability in the delta area have considered this area (falling north of Coleroon river) as delta area, apart from the fact that no detailed investigation has been done to estimate and to locate ground water in the area which is located north of Coleroon river, although being part of the Cauvery basin.

90. The Central Ground Water Board after having discussions with the Tamil Nadu State officials and scrutiny of the data observed as under:-

> "(a) In order to assess whether release of Mettur waters in June has substantial influence…….. Hydrographs have revealed a downward trend for the period ending from January to almost end of May indicating not only the drop in the seasonal fluctuation of the regional water-table but also its reflection to the large scale extraction of ground water through pumping from the shallow aquifer. This is followed by a steep rise in June-July period depending on the release of the Mettur waters. Though in every case, the recharge has not brought back the regional water table to its original level or almost to the bottom of the upper confining clay bed, a small peak is observed usually during November-December period indicating a slow rise in the water table and this may be attributed to recharge from North-East monsoon to the extent the vacuum in the ground water reservoir permits……" (Ref:TNDC Vol. XV, Exh. 842, page 163)

91. The State of Tamil Nadu have furnished data regarding observation wells in the Common Format, Exh. E-20 from page 352 onwards. 14 observation wells pertain to Tanjavur distt. as indicated in the table at page 352 and details thereof are given from pages 411 to 424. An examination of the water level fluctuation in the observation wells indicates that the aquifer was almost full by the end of north-east monsoon i.e. December/January indicating thereby that the under ground reservoir in the delta rises to its maximum level only by the end of north-east monsoon and it becomes lowest (water levels fall below the ground level to the maximum) depending upon the extraction from the ground water. This position is during the period 1971 to 1991 for which data has been furnished in the Common Format.

92. As regards the new delta area, because the canal system is manmade there is hardly any chance of lateral infiltration from the river waters.

93. As indicated by Mr. Barber, World Bank expert, the State of Tamil Nadu has been using ground water right from the year 1971 and gradually increasing it depending upon the availability of surface water as also other considerations of available ground water structures and power for running the same. As mentioned above, different agencies have suggested exploitation of different quantities of ground water, but limiting the withdrawal from the upper portion of shallow aquifer i.e. a depth of 4-5 metres in the old delta (Cauvery and Vennar Sub-basins). This according to even Tamil Nadu seems to be acceptable. In the Cauvery Delta Modernisation Project (covering old delta area), they projected conjunctive use of about 30 TMC. Of course, that State is pleading that bulk of it comes from Mettur releases and only insignificant component is from rainfall recharge."

94. In the above background, it is clear that in a normal year when there would be regular releases of water from Mettur, the bulk of contribution to the ground water in the Cauvery sub-basin would be from such releases. However, the contribution from surface irrigation and rainfall (occurring both during south-west and north-east monsoon seasons) cannot be overlooked.

95. The special feature of the assessment of the ground water in the delta is that in no other river basin in India so much investigations

and assessments have been made in respect of ground water. However, considering the severe limitations in the assessment of ground water resource, it would be safe to assume in the present case that the ground water to an extent of 20 TMC may be used by Tamil Nadu conjunctively with surface water. This quantum is after excluding the component of ground water recharge from river water by lateral infiltration.

UTILISATION OF CAUVERY WATERS IN YEARS 1901,1928,1956 AND 1971

Sl. No.	Name of State	Schemes in Operation prior to 1928		Schemes in Operation between 1928-56		Schemes in Operation between 1956-71		Total of Major and Medium schemes		Evaporation losses	Minor Irrigation		Domestic water supply		Total use	
		Area	TMC	Area	TMC	Area	TMC	Area	TMC	Area TMC	Area	TMC	Popul.	TMC	Area	TMC
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
								YEAR 1901					Lakhs			
1.	Tamil Nadu	13.853	384.9	--	--	--	--	13.853	384.9	--	2.190	44.00	--	1.20	16.043	430.13
2.	Mysore	1.110	24.463	--	--	--	--	1.110	26.463	--	1.991	45.50	--		3.101	71.96
3.	Kerala	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	TOTAL	14.963	411.363	--	--	--	--	14.963	411.363	--	4.181	89.50		1.20	19.144	502.09
								YEAR 1928								
1.	Tamil Nadu	13.853	384.9	--	--	--	--	13.853	384.9	--	2.210	44.00	--	2.10	16.063	431.00
2.	Mysore	1.110	26.463	--	--	--	--	1.110	26.463	--	2.039	46.00	--	--	2.149	72.46
3.	Kerala	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	TOTAL	14.963	411.363	--	--	--	--	14.963	411.363	--	4.249	90.00	--	2.10	18.212	503.46

Sl. No.	Name of State	Schemes in Operation prior to 1928		Schemes in Operation between 1928-56		Schemes in Operation between 1956-71		Total of Major and Medium schemes		Evaporation losses	Minor Irrigation		Domestic water supply		Total use	
		Area	TMC	Area	TMC	Area	TMC	Area	TMC	Area TMC	Area	TMC	Popul.	TMC	Area	TMC
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
								YEAR 1956					Lakhs			
1.	Tamil Nadu	15.375	384.9	5.384	100.60	--	--	20.759	485.5	8.00	2.412	48.00	--	3.10	23.171	514.6
2.	Mysore	1.395	34.211	2.059	56.20	--	--	3.454	90.411	5.34	2.200	50.00	--	4.00	5.654	149.751
3.	Kerala	--	--	--	--	--	--	--	--	--	0.063	5.00	--	0.100	0.063	5.100
	TOTAL	16.770	419.111	7.443	156.80	--	--	24.213	575.911	13.34	4.675	103.00	--	7.20	28.888	699.451
								YEAR 1971								
1.	Tamil Nadu	18.911	384.9	5.746	100.6	0.642	15.9	25.299	501.4	9.00	2.909	58.00	--	5.00	28.208	573.4
2.	Mysore	1.862	45.79	2.049	56.20	0.359	7.81	4.280	105.10	6.40	2.409	54.70	7.138*	5.0	6.680	171.20
3.	Kerala	--	--	--	--	--	--	--	--	--	0.063	5.00	0.063	0.100	0.063	5.10
	TOTAL	20.773	430.69	7.895	156.80	1.001	23.71	29.579	606.50	15.40	5.381	117.70	7.138*	10.1	34.951	749.70

*= Population