MAHADAYI WATER DISPUTES TRIBUNAL

THE REPORT-CUM-DECISION

OF

THE MAHADAYI WATER DISPUTES TRIBUNAL
(Under Section 5(2) of The Inter-State River Water Disputes Act, 1956)

IN THE MATTER OF

REFERENCE NO. 1 OF 2011 RELATING TO WATER DISPUTES OF THE INTER-STATE RIVER MAHADAYI AND THE RIVER VALLEY THEREOF

BETWEEN

THE STATE OF GOA

AND

THE STATE OF KARNATAKA

AND

THE STATE OF MAHARASHTRA

VOLUME - VII

(V O L U M E S I - XII)

New Delhi
14th August 2018

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HYDROLOGY AND WATER AVAILABILITY

767. The Mahadayi river is a west flowing river, which is also known as Mandovi river or Madei river in the State of Goa. It drains a total drainage area of 2032 sq.km. in the Western Ghats before falling into the Arabian Sea. Out of a total catchment area of 2032 sq.km., 375 sq.km. of catchment area lies in the State of Karnataka and 77 sq.km. in the State of Maharashtra. Rest of the Catchment area i.e., 1580 sq.km. lies within the State of Goa.

768. Three party States, namely the States of Goa, Karnataka and Maharashtra have indicated different values of water availability at different points in the Mahadayi river basin and at different dependability, through their respective Statements of Case / Statement of Claims or Affidavits of the Expert Witnesses or through the evidence of the Expert Witnesses during the course of Cross Examinations which are as under.

a. Water availability at 75% dependability and 50% dependability, is assessed, by the State of Goa for:

i. Entire Mahadayi basin i.e., for the catchment area of 2032 sq.km.

ii. Usable yield from catchment area of 1523 sq.km. (i.e., after deducting 509 sq.km. from total catchment area of 2032 sq.km. to assess the 'usable yield', which according to State of Goa is generated from an area of 1523 sq.km. only)

iii. Kotni Dam (independent catchment) with catchment area of 93.19 sq.km., Bhandura dam with catchment area of 32.25 sq.km., Bailnadi with catchment area of 32.33 sq.km., Kalasa (including Haltara and Surla diversions) with catchment area of 25.50 sq.km., Irti Diversion with catchment area of 8.78 sq.km., Irti pickup dam with catchment area of 9.91 sq.km., Katla-Palna Diversion with catchment area of 22.50 sq.km., Diggi Diversion with catchment area of 15.60 sq.km., and Viranjole Diversion with catchment area of 9.50 sq.km.

b. Water availability at 75% dependability and 50% dependability, is assessed, by the State of Karnataka for:

i. Entire Mahadayi basin i.e., for the catchment area of 2032 sq.km.

ii. Catchment area of Mahadayi basin in Karnataka territory (i.e., for catchment area of 375 sq.km.)

iii. Kalasa dam (including Haltara and Surla diversion) with catchment area of 25.50 sq.km., Bhandura dam with catchment area of 32.25 sq.km., Kotni Dam site

(including Bhandura dam catchment and diversion of Irti, Bailnadi) with catchment area of 125.44 sq.km., Kotni Dam site (independent catchment) with catchment area of 93.19 sq.km., Bailnadi dam (diversion) with catchment area of 32.33 sq.km., Irti dam (diversion) with catchment area of 8.78 sq.km., Irti Pickup Dam (Independent Catchment) with catchment area of 9.91 sq.km., Katla-Palna diversion with catchment area of 22.50 sq.km., Diggi diversion with catchment area of 15.60 sq.km., and Viranjole diversion with catchment area of 9.50 sq.km.

c. Water availability at 75% dependability, 50% dependability and also the average water availability is assessed by the State of Maharashtra for:

   i. Entire Mahadayi basin i.e., for the catchment area of 2032 sq.km.

   ii. Catchment area of Mahadayi basin in Maharashtra territory i.e., catchment area of 77 sq.km.

769. The Tribunal notices that the State of Karnataka and the State of Maharashtra have estimated the water availability for the entire Mahadayi basin with catchment area of 2032 sq.km. However, the State of Goa has estimated (a) the water availability for the entire Mahadayi basin with total catchment area of 2032 sq.km., and also (b) the water availability from catchment area of 1523 sq.km. The water availability from the

total catchment area has been termed as “runoff over the entire catchment” i.e., yield from the catchment area of 2032 sq.km. The State of Goa has estimated the water availability from catchment area of 1523 sq.km. i.e., after excluding an area of 509 sq.km. from the total catchment area of 2032 sq.km. It has been termed as ‘Usable Yield’ in his report by Shri Chetan Pandit, Expert Witness for the State of Goa.

Exclusion of 509 sq.km. from total catchment area of 2032 sq.km. by the State of Goa for assessment of yield of the Mahadayi basin

770. From the Issue No. 10 relating to water availability, it is apparent that the State of Goa has used three different terms namely (a) annual runoff, (b) annual yield, and (c) annual safe yield. The State of Goa has used: (a) the term ‘annual runoff’ in respect of water availability from the entire catchment area of 2032 sq.km. of the Mahadayi basin; (b) the term ‘annual yield’ in respect of water availability from catchment area of 1523 sq.km. i.e., after excluding an area of 509 sq.km. from the total catchment area of 2032 sq.km. of the Mahadayi basin; and (c) the term ‘annual safe yield’ in respect of water availability from

catchment area of 982 sq.km. i.e., after excluding an area of 1050 sq.km. from the total catchment area of 2032 sq.km. of the Mahadayi basin.

771. Tribunal notices that Issue No. 24 framed for determination is specifically related to exclusion of an area of 1050 sq.km. from the total catchment area of 2032 sq.km. of the Mahadayi basin. Issue No. 24 reads as under.

> "**Issue No. 24**: Does the State of Goa establish that for the purpose of estimation of water yield at different dependability, an area of 1050 sq. km. (out of total catchment area of 2032 sq. km.) is required to be excluded?"

772. The Tribunal finds that at Para 179D, pages 214 to 216 of the Statement of Case filed by the State of Goa (Volume 131), State of Goa has also raised the issue of non-inclusion of an area of 1050 sq.km. from the total catchment area of 2032 sq.km. of Mahadayi basin in the CWC Report of 2003, for the purpose of determination of 75% and 50% dependable yield. It is, however, noticed by the Tribunal that subsequently at Para 179N, page 222 (Volume 131), the State of Goa has mentioned that a Report of IIT, Bombay has assessed the catchment area to be excluded as

501 sq.km., and not 1050 sq.km as mentioned at Para 179D. The Tribunal also finds that on the other hand, Shri Chetan Pandit, in his Report of August 2016 (Volume 191), has considered 509 sq.km. as the area to be excluded to assess the water availability in the Mahadayi river basin.

773. Shri Chetan Pandit, Expert Witness of the State of Goa has discussed the related matter under Para 15, page 55 of his Report of August 2016 (Volume 191) and has concluded as under.

> "Thus, in this case of Mandovi River basin while the total yield may be estimated for a catchment area of 2032 SqKm, usable yield has to be estimated only on the area 1523 Km^2 being = 2032-509 Km^2."

774. The above statement of Shri Chetan Pandit, presents an entirely different scenario from what is reflected in the specific issue framed for determination i.e., Issue No. 24 which is based on averments made in Para 179E, page 217, Para 179L, page 221 and Para 179M, pages 221-222 of the Statement of Case of the State of Goa (Volume 131).

775. The issue of exclusion of a part of the catchment area for assessment of yield of the basin has not been addressed in

the Affidavits or the Reports of the Expert Witnesses of the States of Karnataka and Maharashtra.

776. On the suggestion of Shri Chetan Pandit, Expert Witness for the State of Goa, to exclude an area of 509 sq.km. from the total catchment area of 2032 sq.km. of Mahadayi basin, several questions were put to him during the cross examination by the learned Counsel of the State of Karnataka. In reply to questions No. 98 put to Shri Pandit on 3.10.2016, Shri Chetan Pandit stated as under.

> "The words I have used are "Thus, in this case of Mahadayi River Basin while the total yield may be estimated for a catchment area of 2032 Sq. Km., usable yield has to be estimated only on the area 1523 Sq. Kms. being = 2032 – 509 Km^2". <u>The word "Usable" is important.</u>"
>
> (Emphasis supplied)

777. At Para 15, pages 54-55 of his Report titled "Yield Study for Mahadayi River Basin" filed on 4.8.2016 (Volume 191), Shri Chetan Pandit has mentioned that, exclusion of a part of the catchment from the yield studies, is a standard practice and in this regard, he has cited the following cases.

- The Hon'ble Krishna Water Disputes Tribunal has allotted the yield of the Krishna basin only up to Prakasam barrage.
- The Hon'ble Narmada Water Disputes Tribunal has allotted the yield of the Narmada basin only up to the Sardar Sarovar dam site.
- The Hon'ble Cauvery Water Disputes Tribunal has allotted the yield of the Cauveri basin only up to an anicut known as the Lower Anicut.
- The Hon'ble Godavari Water Disputes Tribunal has allotted the yield of the Godavari basin only up to the Dowleshwaram anicut.

778. During the course of cross examination by Shri Mohan V. Kataraki, learned Counsel for the State of Karnataka, Shri Pandit admitted that excluded area in case of Krishna basin was only about 0.72% (reply to question No. 106) and that the excluded area in case of Mahadayi basin was about 25.05% (reply to question No. 107). In reply to question No. 108 put by Shri Mohan V. Kataraki, learned Counsel for the State of Karnataka, Shri Pandit, has further stated that he had not come across a case where about 25% of the basin area was excluded from

computation of the basin yield in India. Question No. 108 and his reply thereof are reproduced hereunder.

> "Q. No. 108. During your career in the Central Water Commission and as a consultant after your retirement, have you come across any other basin in India or outside India, where such a large area of 25% of the catchment was excluded from the estimation of the yield of the basin?
>
> Ans. I have not studied any basin outside India. But within India I have not come across a case where about 25% of the area was excluded from computation of the yield. Having said that I must clarify that the percentage of area excluded is determined by the topography. Mahadayi is, to the best of my knowledge, the first instance of a Western Ghat basin which is being thus adjudicated. The Western slope of the Western Ghats is a very narrow strip. If a similar study was to be made for other Western Ghat rivers, the results would be comparable."

779. Further, in reply to Question No. 173 put by the Tribunal on 6.10.2016 on this issue, Shri Chetan Pandit, inter-alia, stated as under.

> "In the Paragraph 179L and 179M of State of Goa's Amended Statement of Case, filed on 23.04.2015, there is reference to "The said Report". Perhaps this is a yield Report prepared by Prof. V. Jothiprakash. In that report

> the terms run-off and yield were used in a particular manner. He used the run-off to indicate the water accruing from rainfall over the entire catchment and the term 'yield' to indicate the usable part of the run-off by excluding some part of the catchment, from where the run-off cannot be utilized for various reasons. In CWC we did not use these terms in the way he has used them. …"
>
> (Emphasis supplied)

780. Apart from the fact that the area not considered for the purpose of assessment of water availability of Krishna basin for apportionment among the party States, is only about 0.72%, the Tribunal notes that the decision to assess the water availability up to Vijayawada weir by Krishna Water Disputes Tribunal I and up to Prakasham barrage by Krishna Water Disputes Tribunal II, was in view of general agreement. At Para 234 of Chapter IX on page 73 of the volume I of the Report of the Krishna Water Disputes Tribunal – I, it is stated that "it is generally agreed that the volume of water which passes over and through the Vijayawada Weir would give us a fair idea of the volume of flow in the river after the upstream utilisations are added to it". The Krishna Water Disputes Tribunal – II has also adopted the same and at page 275 of its Report, it is stated that "after considering the flow data at the terminal point viz.

Prakasham barrage, next important component to arrive at is upstream utilization".

781. From the information available at the web site of the Sardar Sarovar Narmada Nigam Limited, it is found that the total basin area of the river is 97,410 sq.km. and the catchment area upto the dam site is 88,000 sq.km. Thus, the area downstream of the Sardar Sarovar dam is 9,410 sq.km. i.e., about 9.7% of the total area of the basin. However, the exclusion of the area for the purpose of assessment of water availability of the Narmada basin was not an issue at all. The Issue No. 7 framed for determination by Narmada Water Disputes Tribunal as indicated at page 3 of the Volume I of the Report of the Tribunal is reproduced hereunder.

> "7. What is the utilisable quantum of waters of Narmada at Navagam dam site on the basis of 75 per cent or other dependability and how should this quantum be apportioned among the States of Gujarat, Maharashtra, Madhya Pradesh and Rajasthan?"

Therefore, the question of exclusion of an area for the purpose of assessment of water availability of the Narmada basin does not arise.

782. Shri Chetan Pandit has stated that the Hon'ble Cauvery Water Disputes Tribunal has allocated the yield of the Cauvery basin only up to an anicut known as the Lower Anicut. The area downstream of the Lower Anicut across Coleroon, is about 9.8% of the total catchment area of 81,155 sq.km. of the Cauvery basin. In this regard, the Tribunal notes that the assessment of yield of the Cauvery basin was made by the Cauvery Fact Finding Committee constituted by the Government of India on 12th June 1972, and the same was accepted by the Cauvery Water Disputes Tribunal. The Cauvery Fact Finding Committee has assessed the yield up to Grand Anicut. The relevant extract from page no. 72 of the Report of the Cauvery Fact Finding Committee are reproduced hereunder.

> "**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 Anict for the corresponding year have been added to arrive at the realisations 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 realisations at Upper Anicut. Thus the realization worked out would represent the yield from the Cauvery basin up to 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. …"

783. Shri Chetan Pandit has stated that the Hon'ble Godavari Water Disputes Tribunal has allotted the yield of the Godavari basin only upto the Dowleshwaram anicut, excluding an area of 3545 sq.km. The area of 3545 sq.km. is only1.1% of the total catchment area of 312812 sq.km. of the Godavari river. However, the point which is important is that, in case of Godavari, the issue of water availability was addressed in view of the several agreements among the party States. The Sub-issue No. 1 under Issue No. III reads as under.

> "(1) On what basis should the available waters be determined?"

The decision of the Godavari Water Disputes Tribunal on the Issue No. III at Para 135, page 46 of its Report, is reproduced hereunder.

> "The Agreements filed by the parties have apportioned the waters of the Godavari river between them.
>
> In the Agreement dated the 7th August, 1978 between the States of Maharashtra, Madhya Pradesh and Andhra Pradesh, the three States have agreed to set up a duly constituted Tripartite Inter-State Control Board for Inchampalli Project *inter-alia* for its operation and maintenance. Except as aforesaid the Agreements filed by the parties do not provide for setting up of any machinery by the Tribunal for making available and regulating the allocations of water to the States concerned or otherwise to implement the Agreement between the parties or the decision of the Tribunal. Issue No. III (8) is disposed of accordingly.
>
> No other question arises under Issue No. III in view of the Agreements between the parties and the Issue is disposed of accordingly."

784. From above, it is evident that the yields at terminal points have been assessed on consideration of various issues and facts and the same have been used for the purpose of apportionment of water among the party States. However, in all cases, it is clearly stated that the yield is at the terminal point,

and that in no case, the yield at such terminal point, is defined as yield from the basin. It is also noted by the Tribunal that in none of the cases, aspects related to intrusion of the saline water from the sea / ocean and its mixing with the fresh water and rendering it unfit for any human, has been cited as a reason for excluding any part of the basin for the purpose of assessment of yield. Thus, the statement of Shri Pandit that "when yield is estimated for the purpose of estimating the quantity of water available for use, it is standard practice to exclude this part of the catchment from the yield studies" is not based on fact and is factually incorrect.

785. The Tribunal finds that the yield of Drainage Basin has been defined in the IS:4410 (Part XI/Sec 2) – 1972 at para 2.66 as "Total volume or flow from a drainage basin for a long stipulated period of time, for example 'annual yield of a drainage basin' is mean annual runoff". Further, the term "yield of a river" has been clearly defined in the report of the Cauvery Water Disputes Tribunal. The very first sentence of Chapter – I of Volume III – Availability of Water, of the Report of the Cauvery Water Disputes Tribunal states that "The yield of a river system is the annual virgin flows at its terminal site". In the question No. 173,

Shri Chetan Pandit was also specifically asked whether he agreed with the above mentioned definition of yield as given in the Indian Standard Code or that included in the Report of the Cauvery Water Disputes Tribunal. In his reply, Shri Chetan Pandit did not specifically convey his disagreement with the definition of yield as given in the Indian Standard Code or that included in the Report of the Cauvery Water Disputes Tribunal but linked it to the outfall point on the river. The relevant extract from his reply is reproduced hereunder.

> "… In IS Codes they do not make a distinction between a tributary which meets a larger river at a specific point vis-à-vis a large river which outfalls into an ocean or sea. The river which outfalls into the sea/ocean would pass through a delta and estuarine phase, whereas a tributary has no delta, no estuary. Obviously, the definition of catchment for the purpose of allocation of utilizable yield of a river which is a tributary, for example the Yamuna, will have to be different from the definition for a river which may be small, but is an independent river out falling into a sea or an ocean. …"

786. Shri Subrai T. Nadkarni, AW5, who is examined on behalf of the State of Goa, has stated in reply to Q.No.19 by the learned Counsel of the State of Karnataka, that the small quantum of water available is mainly used for protective

irrigation. The Question No. 19 and the reply thereof are reproduced hereunder.

> "Q.No.19. Please refer to question No. 11, and your answer thereto. I show you the statement of list of projects completed and also proposed by the State of Goa in the area of 509 Sq. Km.
>
> (PER TRIBUNAL: The learned counsel for the State of Karnataka has handed over to the witness a statement containing "List of projects completed by Goa in the excluded Zone of 509 Sq. Km. utilising 3.305 TMC in Mahadayi basin". The statement is taken on record and is marked as MARK-KA/24.)
>
> If the water generated in the zone of 509 Sq. Km. is not utilisable, and cannot be treated to be a part of yield, then how did Goa plan these projects?
>
> Ans. I have gone through the list contained in the document MARK-KA/24, handed over to me, and I wish to state that many of the projects listed therein, either do not lie in the 509 Sq. Km. area, as shown in the list or some minor schemes like very small bandharas, ponds are included in the said 509 Sq. Km. zone, and I wish to state that the small quantum of water available is mainly used for protective irrigation.
>
> I may add that the projects listed at Sl. No.1, 2, 3, 5 and 7, all the lift irrigation schemes and all the water supply schemes, do not lie within the 509 Sq. Km. zone."

It becomes necessary for the Tribunal to examine the question as to what is ‘protective irrigation’. The dominant design practice in irrigation engineering is, to design irrigation systems, in such a manner that water supply covers the full crop water requirements, either completely by irrigation or in addition to rainfall. The ‘protective irrigation’ systems are designed and operated on the principle that available water in rivers or reservoirs, has to be spread thinly over a large area, in an equitable manner. The idea is to reach as many farmers as possible, and to protect them against crop failure and famine, which would regularly occur without irrigation in regions with low and erratic rainfall. The general aim of protective irrigation translates into specific technical, organizational and socio-economic characteristics. In technical sense, protective irrigation implies spreading water thinly into ‘light crops’ i.e. low water demanding, which are envisaged to be grown and water is rationed on the basis of available supplies. Thus, in water terms, it is characterized by high duties i.e. low unit water supplies and low design intensities. In protective irrigation schemes, crop water requirements of the full command area are not met, nor taken into account in the design of the scheme. Protective systems are completely supply oriented. The systems are

designed for continuous flow and automatic water distribution, implying low levels of management intensity. In an organizational sense, protective irrigation implies distributing limited amounts of water over a large number of people. To achieve this, a system of organizational arrangements has to be devised that makes farmers accept less water than is needed for the full growth of their crops, so that other farmers can also have water. In a socio-economic sense, protective irrigation means the maximization of returns per unit of water instead of unit of land and thereby maximizing total social benefits. From a national economic perspective, protective irrigation makes sense because it maximizes agricultural output given the limited availability of water, generates more employment and spreads the benefits over a large number of producers. Thus, for the purpose of assessment of water availability for meeting the consumptive demand, the 'protective irrigation' is, same as irrigation. Schemes developed in 509 sq.km., for utilizing the water generated over the area, which also forms part of the catchment of Mahadayi Basin, plays its own role in maximizing agricultural output of light crops and benefits thereof reach to large number of farmers. Therefore, once the water generated over a piece of land, say, in this case, 509 sq. km. of land, is utilized for any beneficial use,

including protective irrigation, such land cannot be excluded from the total catchment area of Mahadayi basin, while estimating yield of Mahadayi basin.

787. From above, it is clear that the yield of a river basin cannot be defined with reference to usability of water from the consideration of its productive use for human beings, animals or agriculture. Thus, the contention of the State of Goa that, for the purpose of estimation of water yield at different dependability, an area of 509 sq.km. or 1050 sq.km. (out of total catchment area of 2032 sq. km.) is required to be excluded, is not justified. The Tribunal is of the considered view that the water availability or yield of the Mahadayi basin must be assessed on the basis of total catchment area of the river basin, viz., 2032 sq.km. Thus, issue No. 24 is answered in negative, by the Tribunal.

788. The Tribunal finds that the methodology for assessment of water availability used by all the three party States, namely Goa, Karnataka and Maharashtra and that adopted by the Expert Witnesses appearing on behalf of them are broadly same, i.e. all have used linear regression equation to assess the water availability from average rainfall over the basin

computed with the help of rainfall data of few selected rain gauge stations. However, in view of the various deficiencies noticed in the data/data processing by them, it has become important for the Tribunal to have a critical review of the values of water availability reported by the three States, either through the Statement of Case of State of Goa and State of Maharashtra / Statement of Claims of State of Karnataka or Affidavits of the Expert Witnesses or through the answers / explanations given by their respective expert witnesses, during the course of Cross Examinations.

789. In the first instance, the water availability for the entire Mahadayi basin has been examined as under:

Water Availability Estimated by the State of Goa

790. Based upon suggestions of the State of Goa, the Issue No. 10 relating to the water availability in Mahadayi basin was framed for determination, which is reproduced hereunder.

> "10. Whether the State of Goa establishes that (a) the 75% and 50% dependable annual runoff in the entire Mandovi River Basin is 4110.79 M.cu.m (145.05 TMC)

and 4632.178 M.cu.m (163.45 TMC) respectively, (b) the 75% and 50% dependable annual yield is 3081.07 M.cu.m (108.72 TMC) and 3471.85 M.cu.m (122.51 TMC) respectively from the entire Mandovi River Basin considering the area of 1523 km^2 [(2032-509) km^2], and (c) the 75% and 50% dependable annual safe yield is 1986.61 M.cu.m (70.10 TMC) and 2238.58 M.cu.m (78.99 TMC) respectively from entire Mandovi River Basin considering the area of 982 km^2 [(2032-1050) km^2]."

The water availability of entire Mahadayi basin indicated in the Issue No. 10 is as under.

- Runoff over entire catchment area of 2032 sq.km. at 75% dependability = 145.05 tmc

- Runoff over entire catchment area of 2032 sq.km. at 50% dependability = 163.45 tmc

791. In the Table in Para 19 on page 8 of his Affidavit (Volume 191), Shri Chetan Pandit, Expert Witness of the State of Goa, has reported the results of his study. However while tendering his affidavit on 30.8.2016, Shri Chetan Pandit mentioned about a typing error and stated as under.

"… In the affidavit on page 8 at the bottom there is a table. In this table there is a typing error. The 75% dependable yield for an area of 2032 sq.km., is shown as

3777.3 MCM and 133.4 TMC respectively. This should read 4372.4 MCM and 154.4 TMC. These figures have been inadvertently typed in the next row. Correspondingly, the 50% dependable yield for an area of 1523 Sq. Kms. reads 4372.4 MCM and 154.4 TMC should instead read 3777.3 MCM and 133.4 TMC. An identical correction needs to be carried out in another instance of the same table at page 58 of the report, Table 34-A."

Yield reported by Shri Chetan Pandit, after incorporating the corrections suggested by him, is as under.

Yield		Mcum	tmc
Runoff over entire catchment. Area 2032 SqKm	50% Dependable	5039.8	178.0
	75% Dependable	4372.4	154.4
Usable Yield. Catchment Area 1523 SqKm	50% Dependable	3777.3	133.4
	75% Dependable	3277.2	115.7

792. However, during the course of cross examination, Shri Chetan Pandit, Expert Witness of the State of Goa in reply to question No. 154 put to him by the Tribunal on 5.10.2016 and replied by him on 6.10.2016, admitted that due to some software

errors found in the 2003 version of Microsoft Office, the values indicated in his Affidavit of evidence filed on 4.8.2016 (Volume 191) needed corrections, and accordingly, during reply to question No. 154, he informed on 6.10.2016 that the reassessed values of the water availability for the entire Mahadayi basin, with catchment area of 2032 sq.km were as under.

- Runoff over entire catchment area of 2032 sq.km. at 75% dependability = 151.47 tmc

- Runoff over entire catchment area of 2032 sq.km. at 50% dependability = 175.16 tmc

Water Availability Estimated by the State of Karnataka

793. The State of Karnataka, in its Statement of Claims (Volume 129), has referred to the water availability assessed by Central Water Commission and the following has been stated at Para 9.2, page 76, Volume 129.

> "… The total yield of Mahadayi upto the mouth of the river worked out in the CWC Report of 2003 is 6234

> Mcum (220 tmc) at 50% dependability and 5652 Mcum (199.60 tmc) at 75% dependability. …"

Accordingly, as per the suggestions of the State of Karnataka, the Issue No. 34 was framed for determination as under.

> "Whether the State of Karnataka establishes that the total available water for allocation amongst the basin States in the inter-State river Mahadayi and its valley is not less than 220 tmc at 50% dependability or 199.6 tmc at 75% dependability as estimated by the Central Water Commission in its reports of October 2001 and March 2003?"

794. As per Table-11, page 49 of the Report dated 12.9.2015 (Volume 166) of Prof. A. K. Gosain, Expert Witness of the State of Karnataka, the water availability of the Mahadayi basin is estimated as under.

Case I: Computation of annual yield series of Mahadayi basin for the period from 1928-29 to 2012-13 with regression equation used in CWC's Report of March 2003	Water availability at 75% dependability	=	204.24 tmc
	Water availability at 50% dependability	=	224.61 tmc

Case II: Computation of annual yield series of Mahadayi basin for the period from 1928-29 to 2012-13 using revised regression equation based on extended runoff data.	Water availability at 75% dependability	=	206.14 tmc
	Water availability at 50% dependability	=	223.20 tmc

795. As per Table-4, page 10 of the Report dated 9.5.2017 (Volume 198) of Prof. A. K. Gosain, Expert Witness of the State of Karnataka, the water availability of the Mahadayi basin is re-assessed as under.

Case I: Computation of annual yield series of Mahadayi basin by substituting the catchment rainfall (mm) for the monsoon period for the period from 1928-29 to 2000-01 in the best fit R-R relation	Water availability at 75% dependability	=	198.42 tmc
	Water availability at 50% dependability	=	215.59 tmc
Case II: Computation of annual yield series of Mahadayi basin by substituting the catchment rainfall (mm) for the monsoon period for the period from 1928-29 to 2012-13 in the best fit R-R relation	Water availability at 75% dependability	=	202.55 tmc
	Water availability at 50% dependability	=	216.89 tmc

796. Prof. A. K. Gosain, Expert Witness of the State of Karnataka on 18.5.2017 before the start of his cross examination, further stated that he had worked out the water yield by using the R-R relationship derived after incorporating the omitted rainfall and runoff data of 1979-80, and the re-computed values of the water availability of the Mahadayi basin were as under.

- Water availability at 75% dependability = 206.17 tmc
- Water availability at 50% dependability = 223.06 tmc

Water Availability Estimated by the State of Maharashtra

797. Issue No. 55 has been framed for determination in respect of the water availability on the suggestions of the State of Maharashtra. The Issue No. 55 is reproduced hereunder.

> "Whether the State of Maharashtra proves that the contribution of Maharashtra territories to the basin flow of Mahadayi river is 200.006 Mcum at 50% dependability and 171.891 Mcum at 75% dependability."

798. Specific values of water availability either at 75% dependability or at 50% dependability for the entire Mahadayi basin have not been indicated in the Statement of Case filed by the State of Maharashtra.

799. Shri S. N. Huddar, Expert Witness of the State of Maharashtra has, however, examined the water availability for the Mandovi (Mahadayi) basin assessed by the various Experts and reported by them in different documents, and mentioned that the specific yield revealed by CWC study is justified. In addition, he has proposed to account for the import of water from Tillari (Chapora) basin through Tillari Irrigation Project. He has mentioned in Para 4.6, page 21 of Affidavit filed on 15.9.2015 [Volume 163(a)] that taking into account this water import, he has assessed “the availability in Mandovi basin as 5913 Mcum at 75% dependability”. The water availability of 5913 Mcum at 75% dependability is equal to 208.73 tmc.

Highly Varying Estimates of Water Availability by Various Experts

800. The quantum of water availability assessed and included in different Reports varies considerably. The water availability at 75% dependability for the entire Mahadayi basin with catchment area of 2032 sq.km. as indicated in different Reports filed by the respective State Governments or by the Expert Witnesses are as under:

Sl. No.	Sources		Water Availability at 75% Dependability
1.	Affidavit of Shri S. N. Huddar, Expert Witness of the State of Maharashtra (Ref: Para 799 above)	:	208.73 tmc
2.	Statement of Prof. A. K. Gosain during cross examination (Ref: Para 796 above)	:	206.17 tmc
3.	Report of Prof. Gosain of September 2015 (Ref: Para 794 above) – Case II	:	206.14 tmc
4.	Report of Prof. Gosain of September 2015 (Ref: Para 794 above) – Case I	:	204.24 tmc
5.	Report of Prof. Gosain of May 2017 (Ref: Para 795 above) Case II	:	202.55 tmc

6.	Statement of Claims of the State of Karnataka (Ref: Para 793 above)	:	199.60 tmc
7.	Report of Prof. Gosain of May 2017 (Ref: Para 795 above) Case I	:	198.42 tmc
8.	Affidavit of Shri Chetan Pandit (Ref: Para 791 above)	:	154.40 tmc
9	Statement of Shri Chetan Pandit during cross examination (Ref: Para 792 above)	:	151.47 tmc
10.	Statement of Case of the State of Goa (Ref: Para 790 above)	:	145.05 tmc

801. The State of Maharashtra has not indicated the water availability for the Mahadayi basin as a whole, in its pleading. However, Shri S. N. Huddar, Expert Witness on behalf of the State of Maharashtra has mentioned the water availability for the entire Mahadayi river basin as 208.73 tmc at Para 6.0 on page 25 of his Affidavit filed on 15.9.2015 [Volume 163(a)]. In addition to above, Shri Subrai T. Nadkarni, Expert on behalf of the State of Goa has also undertaken sub-basin wise hydrological studies and included the result in his Report of November 2017 (Volume 208).

802. In view of highly varying values of water availability mentioned in different Reports, the Tribunal has decided to critically examine the following Reports.

- Report of Central Water Commission of 2003 (Volume 15)
- Reports of Prof. A. K. Gosain of September 2015 (Volume 66) and May 2017 (Volume 198 and Volume 198A)
- Report of Shri Chetan Pandit of August 2016 (Volume 191)
- Report of Shri S. N. Huddar of September 2015 [Volume 163(a)]
- Report of Shri Subrai T. Nadkarni of November 2017 (Volume 208)

Critical Examination of Report of Central Water Commission of 2003 (Volume 15)

803. As already mentioned earlier, the Tribunal has no hesitation in holding that the Central Water Commission Report of March, 2003 (Volume 15) cannot be said to be a Report of the CWC. The Report has been examined from the view point of its technical contents only. The Tribunal notices that the findings of the Report of Central Water Commission of 2003 (Volume 15) were adopted by the State of Karnataka and these findings

formed the basis for its claims in respect of water availability of entire Mahadayi basin. It is also noticed by the Tribunal that Prof. A. K. Gosain, Expert Witness of the State of Karnataka, has endorsed the Report of the CWC of 2003, (Volume 15) and that the Report of Prof Gosain of September 2015 (Volume 166) is based on the methodology adopted by CWC for preparation of its Report of 2003 with additional data for the period from 1998-99 to 2012-13. This is apparent from the averments made by Prof. Gosain at Para 6, page 5 of his Affidavit filed on 15.9.2015 (Volume 166) which is reproduced as under:

> "… The present study aims at assessing the annual gross yield of Mahadayi basin on 75% and 50% dependability basis taking into account the additional hydrological and meteorological data that has become available after the CWC study was conducted in 2003 and using the standard procedures and methodologies deployed by CWC."

804. The State of Goa, in its Statement of Case (Volume 131), has raised several objections against the Report of CWC of 2003 at Paras 179B to 179D(i). The State of Goa has also highlighted a number of deficiencies in respect of data processing and methodology adopted in the Report of CWC of 2003 at Paras 179I to 179M of its Statement of Case (Volume 131).

805. Accordingly, the Tribunal has critically examined the contents of the Report of the CWC of 2003 (Volume 15), keeping in view the available information from the Statement of Case of the State of Goa (Volume 131) and that from the Statement of Claims of the State of Karnataka (Volume 129) and other related documents to ascertain as to:

a. what prompted CWC to take up the Study and finalize the Report of 2003;
b. whether the objectives of the CWC Study have been achieved;
c. whether the objections raised by the State of Goa in respect of data and procedures adopted by CWC are valid; and
d. whether the findings of CWC Study of 2003 (Volume 15) can be relied upon?

806. From the averments made by the State of Goa at Para 87, page 117 of its Statement of Case (Volume 131) and the State of Karnataka at Para 2.19, page 22 of its Statement of Claims (Volume 129), it is apparent that the process of undertaking the hydrological study of Mahadayi basin was initiated during the first inter-State meeting held under the Chairmanship of Member

(WP&P), CWC, on 29.5.2001 which was, among others, attended by the Secretary, Government of Goa, Secretary, Government of Karnataka and Secretary, Government of Maharashtra. One of the decisions taken during the meeting was to set up the "Hydrological Study Group" comprising the Chief Engineer, Hydrology Studies Organization, CWC, representatives from the States of Goa, Karnataka and Maharashtra and a representative of National Water Development Agency (NWDA). It was decided that the Hydrology Study Group would submit its report in three months' time.

807. The first meeting of the Study Group under the chairmanship of Chief Engineer (Hydrology), CWC, New Delhi was held on 13.10.2001 at the Office of the Chief Engineer, WRD, Government of Goa, Panaji, Goa. In terms of the decision at the first Interstate meeting of 29.5.2001, it was agreed that the Interstate Study Group had to submit a Report. The Chief Engineer (Hydrology), CWC, who was the Chairman of the Study Group, did not even convene any meeting of the Interstate Study Group, much less or call for any Report. Rather, at this meeting, the Chief Engineer, CWC produced a Yield Study Report unilaterally prepared by its Hydrology Directorate, ignoring

entirely the previous decision of involving Interstate Study Group. The minutes of the first meeting of the Study Group held on 13.10.2001 were circulated vide letter dated 22.10.2001. After the receipt of the minutes of the first meeting of the Study Group, the Govt. of Goa had sent detailed comments on the unilateral study carried out by CWC vide letter dated 12.11.2001 addressed to Shri V. R. Sastry, Chief Engineer, HSO, CWC, New Delhi. A similar letter dated 13.11.2001 was also sent to Shri. S. B. Suri, Chief Engineer (HQ), NWDA, New Delhi**.** In response to the letter dated 13.11.2001, clarifications were received by the State of Goa from the NWDA vide their letter dated 4.1.2002**.** Further, the Government of Goa requested NWDA to supply the full and correct data vide letter dated 18.1.2002.

808. The second meeting of the Hydrological Study Group for the yield of Madei river basin was held on 11.1.2002 at Bengaluru, which was intimated by letter, dated 12.12.2001 enclosing agenda for the meeting**.** The notes were circulated by Goa in the second meeting of the Study Group at Bangalore**.** The following paragraphs give the outcome of the discussions which took place in the second meeting of the Hydrology Study Group.

i. Director, Hydrology (S) requested the members to identify the rain gauge stations, which the co-basin states propose to be considered in the study. During the discussions in the first meeting, Government of Goa was of the view to consider only IMD stations. Govt. of Goa now confirmed their view that all the stations for which data is available irrespective of the agency who is maintaining the station is to be used in the analysis. Other members also agreed for the same. While raising the issue of influencing area of each stations, Director, Hydrology (S) wanted to know if certain stations below some threshold influencing area could be neglected.

ii. While discussing about the authentication of hydro-meteorological data to be used in the study, Chief Engineer, Govt. of Goa, expressed the following concerns.

(a) The rainfall data for some years and some stations, which they have got directly from IMD, do not match with what has been used in the preliminary study by CWC.

(b) The discharge data at Ganjim is not consistent. The discharge varies significantly for the same gauge level.

iii. After discussing the approach to be applied to the study, it was decided that rainfall – runoff model at Ganjim can be

developed once the rainfall data and discharge data are reconciled and corrected, considering all the stations up to Ganjim.

iv. While discussing about the period for which the rainfall data is to be used for extending the rainfall-runoff model, CWC in its preliminary studies has proposed to consider the period from 1931 onwards as most of the rainfall stations were operative in this period, which give a more rational catchment rainfall value. Seventy years is sufficiently good length of series to finalize the yield studies. Government of Karnataka agreed to this proposition. However, Government of Goa insisted to consider the data for the entire period i.e., 1901 onwards irrespective of the number of stations and their period. After detailed discussion, no consensus among the participating states could be reached on the period of data to be used for developing the series. It was therefore decided that this would be discussed in the next meeting.

809. Before the Study Group could even complete the yield study, the CWC summoned the second Interstate meeting on 7.3.2002 vide letter dated 15.02.2002. However, from the

minutes of the meeting circulated vide letter dated 16.4.2002, it is evident that the meeting was actually held on 27.3.2002. The notes were circulated by Goa Team in the second inter-state meeting at New Delhi. The minutes of the second inter-state Meeting are indicated in para 36(xc) of Volume II.

810. An inter-State meeting was convened by the Union Minister of Water Resources on 20.12.2002. The meeting was attended by the Chief Minister of Goa, Minster of Major and Medium Irrigation from Karnataka among others. It was decided that the yield study should be completed by 31.3.2003, after reconciliation of the discrepancies by the officials of the Government of Goa and CWC.

811. In pursuance to the decision taken during the meeting taken by the Union Minister of Water Resources on 20.12.2002, the CWC, vide letter dated 6.3.2003 (Annex. III, page 16, Volume 15) requested the States of Goa, Karnataka and Maharashtra to depute the representatives of respective States to CWC. The CWC proposed to start the work on 10.3.2003 and informed the States that the analyses might take about 15 days.

812. CWC informed that the representatives of the NWDA and the States of Karnataka and Goa attended Central Water Commission, but the State of Maharashtra did not respond. However, CWC also reported that the representative of Goa initially attended the meeting but later on withdrew and conveyed his reservation on correctness of rainfall and discharge data and suggested for postponing the yield studies till apprehensions were allayed.

813. However, the study report titled "Study on Yield of Mahadayi Basin" was drafted in CWC in March 2003 by the Study Group consisting of members from NWDA and State of Karnataka only. Thereafter, the report was submitted to the Ministry of Water Resources by the Chairman, CWC on 10.4.2003. The Union Ministry of Water Resources, after examining the matter, directed CWC to convince Government of Goa about the data collection procedure in view of the restrictions placed by Ministry of Water Resources for supply of raw data; and to call further meeting of the engineers of the two States (i.e., Goa and Karnataka), to reach an agreement on the studies done by CWC. The record does not indicate that any steps were taken by the CWC pursuant to directions given by the Ministry of Water

Resources nor there is anything on record to show that any meeting of the engineers of the two States, was convened by the CWC or that any agreement was reached, regarding study done by CWC, between Goa and Karnataka. Thus, the studies carried out by CWC in March 2003 remained inconclusive and incomplete. In view of above, it is evident that the report titled "Study on Yield of Mahadayi River Basin" of the Central Water Commission (Volume 15) was never considered by the Hydrology Study Group. Further, there is nothing on record to establish that the said Study has been considered during the subsequent inter-State meetings. It is also evident that the Ministry of Water Resources has also not accepted or adopted the said Study. In view of what is stated above, the Tribunal is of the opinion that there is no CWC Report (2003) and Volume 15 produced by the State of Karnataka cannot be taken into consideration as the report of the Central Water Commission, prepared in the year 2003.

814. The Tribunal notes that there is nothing on record which mentions about objective of the preparation of the Report of CWC of 2003. It is noted that the only action on part of the Union Ministry of Water Resources was to issue the letter dated

30.4.2002 (Annexure- 24, pages 101-102 of Volume 11) to convey the in-principle clearance from water availability angle to the Government of Karnataka for diversion of 7.56 tmc from Madei basin to meet the drinking water needs of Hubli / Dharwad. Subsequently, the letter dated 30.4.2002 was kept in abeyance by the Union Ministry of Water Resources vide letter dated 19.9.2002 (Annexure-25, pages 103-104, Volume 11). The Tribunal notes that the specific action on part of the Union Ministry of Water Resources i.e., issuing the letter conveying the in-principle clearance and subsequently keeping the in-principle clearance in abeyance, was much before the drafting of the Report of CWC of 2003 and forwarding the same to the Ministry of Water Resources on 10.4.2003.

815. The Tribunal notices that, in this regard, following important points emerge.

a. The “Study on Yield of Mahadayi River basin” finalized by the Central Water Commission has not been formally considered by the “Hydrology Study Group”. There is nothing on record which establishes that the “Hydrology Study Group” has applied its mind on the “Study on Yield of

Mahadayi River basin" drafted by the Central Water Commission and adopted, affirmed, agreed to, concurred with, recognized or acknowledged the same.

b. There is nothing on record to establish that the said study has been considered during subsequent Inter-State meetings, either at the level of Member (WP&P), CWC or at the level of Union Minister of Water Resources.

c. There is nothing on record which establishes that the said study has been adopted by the Union Ministry of Water Resources for any purpose.

816. The Tribunal is of the firm view that neither the State of Karnataka nor the State of Maharashtra, is justified in treating such an inconclusive and incomplete report as that of CWC (2003) Report. Further, the Tribunal holds that different projections of water availability, made by the State of Karnataka and State of Maharashtra as well as by their respective Expert witnesses, on the basis of so called CWC (2003) report, which in fact, is not the report of CWC, in the eye of the law at all, are uncalled for and unwarranted and therefore, the same cannot be considered, by the Tribunal.

817. Four specific objections of the State of Goa, on the data used by CWC for the preparation of the Report and the methodology adopted by it, are at Paras 179B, 179C, 179D and 179D(i) of its Statement of Case (Volume 131). In addition, few other deficiencies have also been highlighted in paras 179I to 179M.

818. The Tribunal finds that the Objection 1 at Para 179B at pages 212 and 213 (Volume 131) relates to exclusion of rainfall data of Panaji Station from the year 1901 to 1927. However, it was noted that Shri Chetan Pandit, the Expert Witness of the State of Goa, himself has not used the data of Panjim Station from 1901 to 1927 in his study (Volume 191). As a matter of fact, Shri Chetan Pandit has used the data of various rain gauge stations including that of Panjim for the period from 1964 to 2005 only for the purpose of estimation of water availability. Therefore, this objection raised by State of Goa, has no substance.

819. It is noted by the Tribunal that the Objection 2 at Para 179C, pages 213 and 214 (Volume 131) pertains to use of runoff data based on discharge measurement at Ganjim Site by 'float

observation method'. It is, however, noted that Shri Pandit has himself used the same data i.e., discharge data observed by CWC using 'float observation method' after applying certain corrections, although on an erroneous assumption. This aspect has been discussed in detail while dealing with the Issue No. 6 framed for determination. Thus the objections to CWC (2003) report raised in Para 179C has also, no substance.

820. The objection 3 at Para 179D, pages 214 to 216 (Volume 131) raised by the State of Goa relates to non-exclusion of an area of 1050 sq.km. from the total catchment area of 2032 sq.km. of Mahadayi basin for the purpose of determination of 75% and 50% dependable yield. It is, however, noticed by the Tribunal that subsequently at Para 179N, page 222 (Volume 131), the State of Goa has mentioned that a Report of IIT, Bombay has assessed the catchment area to be excluded as 501 sq.km., and not 1050 sq.km as mentioned at Para 179D. The Tribunal notices that on the other hand, Shri Chetan Pandit, in his Report of August 2016 (Vol 191), has considered 509 sq.km. as the area to be deducted. This aspect of exclusion of an area of 509 sq.km. has already been discussed at paras 3 to 15 and the Tribunal is of the considered view that for the purpose of

assessment of water availability or yield of the Mahadayi basin, total catchment area of 2032 sq.km. should be taken. Therefore, the objection does not sustain.

821. The objection 4 at Para 179D (i) at page 217 (Volume 131) relates to errors in derivation of regression equation by CWC. In this regard, a similar question was put to Prof. A. K. Gosain, by the State of Goa, in respect of regression equation derived by Prof. Gosain by using the additional data. In reply to the question No. 187 put to Prof. Gosain by the learned Senior Counsel of the State of Goa on 17.5.2017, he replied as under:

> "While deriving the regression equation, it is always important to understand the other conditions also. In the question No. 181 posed to me yesterday, I was told that Goa had achieved a runoff equation as below:-
>
> Runoff = 0.625 * Rainfall + 1278.113
>
> When I used this equation to derive the Mahadayi yield, as per the procedure and data used in CWC (2003) Report, I got a yield of 238.69 TMC at 75% dependability and 273.38 TMC at 50% dependability, which is drastically different from the yield obtained by CWC (2003) Report. I believe Goa has ignored a very important line provided in CWC (2003) Report, at pages 9-10. I quote:-
>
> > 'Regression analysis has been carried out using the monsoon catchment rainfall and concurrent runoff and best fit R-R relation obtained, ignoring

> inconsistent data of monsoon rainfall / runoff points as per standard practice'.
>
> Therefore, if you do not use the proper information, while deriving the R-R relation, you are bound to get different equations. As far as my above referred equation is concerned, it has been derived by ignoring all the years with the runoff factor more than 1.0."

822. In view of above, the specific objection i.e., Objection 4 of the State of Goa does not sustain in its present form, However, the issue relating to ignoring specific data sets while deriving the rainfall runoff equation has been examined separately in subsequent Paras.

823. Even if, one assumes, for the sake of argument, that there is a CWC (2003) report, as contended by the State of Karnataka and State of Maharashtra, as well as by their respective Expert witnesses, there are serious deficiencies, drawbacks, anomalies, shortcoming, inconsistencies, in the data and processing of data, used in CWC (2003) Report, which are enumerated by the Tribunal as under.

a. The Central Water Commission, in its Report on "Consistency Analysis of Flow Data in Mahadayi Basin" (Vol

99) has concluded at Para 5.0, page 17 that 'the flow data of Ganjim G&D site appears to be consistent and homogeneous and reliable for any water availability analysis / estimate in basin'. However, it is found by the Tribunal that for the purpose of derivation of Rainfall-Runoff equation in its Report of 2003 (Volume 15), CWC chose to ignore the data of 9 years out of total length of data of 19 years, which were available at the time of preparation of the Report, as is apparent from "Note on Inconsistency in the Process of Exclusion of Data Used for Development of Rainfall Runoff Relations as Adopted in the Report (2003) of CWC and the Report of September 2015 of Prof. A. K. Gosain", prepared by the Tribunal and shown to Prof. Gosain as MARK-19. The Note is reproduced hereunder:

"On the basis of limited preliminary analysis (using trial and error approach) of data included in the studies carried out by CWC [Annexure-29 of the Statement of Claims on behalf of the State of Karnataka] and the information provided by Prof. A. K. Gosain vide Exhibit KAR/RW-1/7, the following position emerges.

Sl. No.	Year	Runoff factor	Information about exclusion of data in		Remarks
			CWC's 2003 Report using 19 years of data	Prof. Gosain's Report using 34 years of data	
1	2	3	4	5	6
1.	1980	1.35	Excluded	Excluded	
2.	1982	1.30	Excluded	Excluded	

3.	1988	1.11	Excluded	Excluded	
4.	2011	1.11	-	Excluded	Data for 2011 not used by CWC
5.	1984	1.09	Excluded	Excluded	
6.	1999	1.05	-	Excluded	Data for 1999 not used by CWC
7.	1990	1.02	Excluded	Excluded	
7.	1983	1.01	Excluded	Excluded	
8.	1995	0.98	Excluded	Not excluded	
9.	1981	0.97	Excluded	Not excluded	
10.	1996	0.61	Excluded	Not excluded	
11.	2006	0.58	-	Excluded	Data for 2006 not used by CWC

From above, it is apparent that CWC excluded data set of 9 years for the study to develop linear regression equations. It is noted that the data excluded by CWC inter-alia included the data for the years 1981, 1995 and 1996 but Prof. Gosain, Expert Witness for the State of Karnataka did not exclude the data for these years and considered data for these years in his study. It also appears that data for the year 2006 with runoff factor of 0.58 has been excluded by Prof. Gosain. Obviously, there are marked variations in the procedure followed by CWC and that by Prof. Gosain."

The reasons, for not considering data of 9 years out of 19 years and ignoring 9 years of data for development of Rainfall-Runoff equation, have not been fully explained by CWC in its Report of 2003.

b. The process of filling-in the missing monthly rainfall data with monthly normal values, stated as the 'method of Normals' is not in conformity with prescribed procedures in

various documents. The report titled “Hydro-meteorology Handbook: Precipitation and Climate (May 2014)” prepared under Indian Hydrology Project (MARK-18, which was shown to Prof. A. K. Gosain), prescribes three methods, namely (a) Arithmetic Average method, (b) Normal Ratio method, and (c) Distance Power method, for filling up the gap. Similarly, in the publication No. UM-1/98-99 titled “Procedure for Systematic Processing of Rainfall Data” of National Institute of Hydrology (MARK-10), which was shown to Prof. Gosain), two methods namely (a) Normal Ratio method, and (b) Distance Power method, have been described.

c. The Tribunal finds that there are obvious mistakes of serious nature in computations as is evident from Annex-XI on page 46 of the Report of CWC of 2003 (Volume 15). At page 46 of Report of CWC of 2003 (Volume 15), the gross monsoon yields from the year 1979-80 to 1997-98 are shown to be increasing every year by 1 Mcum, which is not correct as is evident from the values indicated in Annex X, page 45 of Volume 15. Similarly, the non-monsoon yield in the 3rd column of Annex XI is found to be increasing by 1

Mcum every year which is contrary to the values indicated in column 9 of Annex IX(a), page 42 of Volume 15. Shri A. K. Bajaj, Expert Witness of the State of Karnataka, in reply to question No. 105 (xi) put to him on 18.9.2017, by the learned Senior Counsel for the State of Goa, stated as under.

> "This point was answered by me sometimes back also and it was indicated at that time also that this is a typographical error that has crept in while copying / pasting data in the excel sheet from one data set to another."

The Tribunal finds that, such justifications, for obvious errors in the computations, which have a bearing on the final outcome, are not at all acceptable, to the Tribunal at all.

d. The checks for external consistency as prescribed in the "Guidelines for Preparation of Detailed Project Reports of Irrigation and the Multipurpose Projects issued by Government of India, Ministry of Water Resources, 2010 (MARK-5) and presence of trend in the data as prescribed in the "Guidelines for rainfall-runoff modelling – Towards best practice model application" published by eWater

Cooperative Research Centre of the Australian Government. (MARK-34) and illustrated in the "Comparison Table" prepared by the Tribunal (MARK-35) were not undertaken by CWC in its report of 2003, although these are part of prescribed procedures; and appropriate corrections to account for the trend, if significant, are necessary. Non consideration, of checks for external consistency, in fact, vitiates the CWC (2003) Report.

824. Thus even if one assumes for the sake of argument that there is a Report of CWC of the year 2003, the Tribunal finds that it is full of inconsistencies, discrepancies, drawbacks and not prepared in accordance with principles relating to hydrology. Therefore, the Tribunal is of the opinion that the same is not a reliable piece of evidence.

Critical Examination of Report of Prof. A. K. Gosain of September 2015 (Volume 166) and May 2017 (Volume 198 and Volume 198A)

825. During the course of cross examination of Prof. Gosain, Expert Witness of the State of Karnataka, several inconsistencies were noted in his analyses of the data and during

the development of the rainfall-runoff model by him. Following two major flaws, are noteworthy in his analyses.

a. Although it has been stated by CWC as well as by Prof. Gosain in his Reports that the discharge data, observed by CWC at Ganjim G&D site is consistent, data of considerable number of years are omitted for development of rainfall-runoff relation on the ground that, in such years, runoff factor is more than 1. It is also noted that reasons for such a situation, i.e., runoff factor being more than 1 in many years, are neither investigated nor explained in the concerned Report(s).

b. While developing the rainfall-runoff model, data sets of rainfall and runoff with runoff factor very close to 1 (say, 0.98, 0.97, 0.94 etc.) were, however, retained / utilized by him, without justifying the use of such data sets, in the analyses.

826. From the above, it is apparent that necessary checks were not performed on the input data used either by CWC or by Prof. Gosain, before attempting, the development of rainfall-

runoff model and applying the same, for assessing the water availability of Mahadayi basin.

827. It has also been noted that there are many inconsistencies in the rainfall data and in the processing of rainfall data by Prof. Gosain. Some of these major inconsistencies are as under:

a. Prof. A. K. Gosain has used rainfall data of ten rain gauge stations, namely, Valpoi, Ponda, Panjim, Mapuca, Sanguem, Khanapur, Kankumbi, Jamagaon, Amagaon and Castlerock in his analysis, wherein, values of rainfall of some of the rain gauge stations, appended to his two Reports i.e., Report of September 2015 (Volume 166) and Report of May 2017 (Volume 198 and Volume 198A) are very different for several years as is apparent from the following Table which is marked as from MARK-26.

COMPARISON OF RAINFALL DATA (in mm) IN REPORTS OF 2015 AND 2017						
Year	Valpoi			Ponda		
	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report
1979	3417	3640	7	2585	2736	6
1980	3934	4384	11	3376	3392	0
1981	4384	4661	6	4364	4364	0

1982	4661	4787	3	3933	3933	0
1983	4787	3957	-17	3526	3526	0
1984	3957	3648	-8	2423	2423	0
1985	3648	3104	-15	2968	2968	0
1986	3104	3465	12	1909	1909	0
1987	3465	3464	0	2933	2933	0
1988	3934	5065	29	3376	3610	7
1989	3753	3754	0	2951	2956	0
1990	4410	4410	0	3338	3339	0
1991	3560	3560	0	2726	2727	0
1992	3984	3984	0	3893	3893	0
1993	3934	5258	34	3339	3336	0
1994	3934	5974	52	3577	3477	-3
1995	3934	3786	-4	3396	3362	-1
1996	4217	3018	-28	3083	3093	0
1997	4891	3913	-20	3609	3612	0
1998	3404	3262	-4	3375	2978	-12
1999	4506	3605	-20	3540	3600	2
2000	4010	3208	-20	3290	3301	0
2001	3106	3106	0	2665	2665	0
2002	3409	3409	0	2575	2575	0
2003	3659	3659	0	3122	3122	0
2004	3152	3152	0	2527	2527	0
2005	4584	4584	0	3585	3585	0
2006	9148	7282	-20	3038	5178	70
2007	4085	4085	0	3765	3795	1
2008	6439	5021	-22	2938	3744	27
2009	3826	3826	0	3446	3446	0
2010	4943	4943	0	3909	3909	0
2011	5092	5092	0	4097	4097	0
2012	4156	4156	0	3033	3033	0
Average 1979-2012	4218	4124	-2	3241	3328	3

COMPARISON OF RAINFALL DATA (in mm) IN REPORTS OF 2015 AND 2017						
Year	Panjim			Mapuca		
	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report
1979	2299	1655	-28	2874	2148	-25
1980	2572	2572	0	2874	2677	-7
1981	3228	3228	0	3553	3553	0
1982	3020	3020	0	3395	3395	0
1983	3558	3558	0	4068	4068	0

1984	2575	2575	0	2621	2621	0
1985	2852	2852	0	3002	3002	0
1986	1722	1722	0	1952	1952	0
1987	2723	2723	0	2916	2916	0
1988	3083	3093	0	2874	3220	12
1989	2613	2613	0	2874	2720	-5
1990	2230	2230	0	2756	2756	0
1991	2409	2409	0	2089	2089	0
1992	2723	2723	0	2574	2574	0
1993	2464	2464	0	2340	2340	0
1994	2845	2845	0	3006	3007	0
1995	3507	3506	0	3404	3405	0
1996	2932	2932	0	3362	3363	0
1997	3286	3286	0	3607	3607	0
1998	3010	3010	0	2874	3134	9
1999	3334	3334	0	3612	3612	0
2000	2905	2905	0	3054	3054	0
2001	1955	1955	0	2013	2013	0
2002	2196	2196	0	2254	2254	0
2003	2682	2682	0	2581	2581	0
2004	1991	1991	0	1974	1974	0
2005	2356	2356	0	3150	3150	0
2006	4431	2507	-43	4759	2610	-45
2007	3244	2932	-10	3507	3507	0
2008	2675	2893	8	2730	3012	10
2009	2943	2662	-10	3105	3105	0
2010	3787	3787	0	3938	3938	0
2011	3011	3011	0	3502	3502	0
2012	2797	2797	0	2869	2869	0
Average 1979-2012	2822	2736	-3	3002	2933	-2

COMPARISON OF RAINFALL DATA (in mm) IN REPORTS OF 2015 AND 2017						
Year	Sanguem			Khanapur		
	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report
1979	3202	3202	0	1911	1838	-4
1980	3638	3678	1	1414	2146	52
1981	4460	4460	0	1973	1873	-5
1982	4183	4183	0	1435	1852	29
1983	3897	3897	0	1456	2033	40
1984	3085	3085	0	1724	1653	-4
1985	4052	4052	0	1320	1320	0
1986	2775	2775	0	1446	1446	0

1987	2797	2797	0	1169	1178	1
1988	4008	3156	-21	1610	1610	0
1989	3364	3196	-5	1333	1333	0
1990	3652	3450	-6	1577	1577	0
1991	3203	3024	-6	1857	1857	0
1992	4099	3622	-12	1906	1906	0
1993	3091	2882	-7	1957	1957	0
1994	3655	3454	-6	3044	3044	0
1995	3213	3024	-6	1283	1294	1
1996	3211	3784	18	2322	1564	-33
1997	3966	3838	-3	1356	2164	60
1998	3638	2932	-19	1463	1483	1
1999	4214	4214	0	2076	2076	0
2000	4463	4463	0	1417	1417	0
2001	3059	3059	0	1083	1083	0
2002	2637	2637	0	1143	1143	0
2003	3305	3305	0	1469	1190	-19
2004	2817	2817	0	1266	1508	19
2005	5459	3558	-35	2151	1527	-29
2006	6909	5162	-25	2056	1460	-29
2007	3192	3253	2	2654	1885	-29
2008	8533	4249	-50	1966	1966	0
2009	3932	3932	0	2819	2002	-29
2010	4596	4596	0	1984	1433	-28
2011	4384	4384	0	2044	2079	2
2012	3170	3170	0	1669	1188	-29
Average 1979-2012	3878	3567	-8	1746	1679	-4

COMPARISON OF RAINFALL DATA (in mm) IN REPORTS OF 2015 AND 2017						
Year	Kankumbi			Jamagaon		
	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report
1979	5495	4396	-20	4177	4177	0
1980	5170	6292	22	3008	4688	56
1981	6712	5824	-13	4353	4354	0
1982	3822	5505	44	2942	3301	12
1983	6539	5231	-20	3054	4231	39
1984	5812	4700	-19	2942	2713	-8
1985	5103	4118	-19	4052	2356	-42
1986	3951	3161	-20	3005	3004	0
1987	4207	3365	-20	2913	2445	-16
1988	5888	4702	-20	4181	4181	0
1989	5062	4418	-13	3592	3592	0
1990	6209	4967	-20	4472	4559	2

1991	7187	4393	-39	4426	4426	0
1992	6640	4803	-28	3830	3836	0
1993	6323	5327	-16	4602	4111	-11
1994	10205	6445	-37	8522	6064	-29
1995	5250	3945	-25	2299	2905	26
1996	7409	4140	-44	5378	3694	-31
1997	6650	6595	-1	4713	4676	-1
1998	5700	5700	0	3211	2264	-29
1999	6575	6576	0	3763	3803	1
2000	5382	5382	0	3181	3378	6
2001	4430	4430	0	2808	2808	0
2002	4579	4579	0	2669	2669	0
2003	5227	4549	-13	3494	3462	-1
2004	4504	5543	23	3010	3833	27
2005	6973	6973	0	5379	5379	0
2006	7414	7414	0	5700	5700	0
2007	6425	6425	0	5115	5115	0
2008	5362	5362	0	4307	4307	0
2009	5389	5389	0	3538	3538	0
2010	7062	6279	-11	4720	3985	-16
2011	7275	7363	1	4863	5046	4
2012	5938	5094	-14	3969	2971	-25
Average 1979-2012	5937	5276	-11	4006	3870	-3

COMPARISON OF RAINFALL DATA (in mm) IN REPORTS OF 2015 AND 2017						
Year	Amagaon			Castlerock		
	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report	As per Report of 2015	As per Report of 2017	Variation w.r.t 2015 Report
1979	4011	5395	35	2695	7734	187
1980	3511	5657	61	2232	6934	211
1981	4793	5278	10	3335	6319	89
1982	3077	6052	97	2036	6643	226
1983	4157	5518	33	2492	6675	168
1984	3332	6236	87	2300	5605	144
1985	3755	5438	45	1977	5144	160
1986	3755	4970	32	1931	5115	165
1987	2491	4383	76	2452	4723	93
1988	3755	6679	78	2317	6868	196
1989	3313	5065	53	1965	5181	164
1990	4397	6249	42	2816	7054	150
1991	4323	5981	38	2712	5907	118
1992	4536	5763	27	2850	5809	104

1993	4636	6678	44	3458	5949	72
1994	7107	9041	27	4835	8264	71
1995	2854	4873	71	2014	5149	156
1996	4590	5222	14	3258	5197	60
1997	5082	6447	27	3455	6273	82
1998	3734	7526	102	1708	4860	185
1999	3756	8638	130	3003	6769	125
2000	3935	5085	29	2338	5454	133
2001	5343	5343	0	5305	5305	0
2002	4823	4823	0	4860	4860	0
2003	3607	4738	31	4854	4854	0
2004	3108	6182	99	5848	5848	0
2005	8006	8006	0	7486	7486	0
2006	10489	10489	0	7380	7380	0
2007	7864	7864	0	5044	5044	0
2008	6216	6216	0	5883	5883	0
2009	6623	6623	0	5565	5565	0
2010	4873	10051	106	5330	5465	3
2011	5020	9502	89	6305	6931	10
2012	4098	5762	41	5087	5358	5
Average 1979-2012	4676	6405	37	3739	5988	60

b. The Tribunal finds that, in particular, the data of rain gauge station at Castlerock appended to different reports filed by the State of Karnataka, including the two reports of Prof. A. K. Gosain, viz., the Report of September 2015 (Volume 166) and the Report of May 2017 (Volume 198 and Volume 198A) have large variations, as is apparent from the following Table which is marked as MARK-27.

COMPARISON OF RAINFALL DATA OF CASTLEROCK (in mm) USED FOR ANALYSIS IN DIFFERENT REPORTS						
Year	Annex - V(xv), Page 32 of CWC Report of 2003 (Vol 15)	Annex - VI, Page 33 of CWC Report of 2003 (Vol. 15)	Data of Station maintained by IMD, Annexure - C (Colly), page 63 of Vol. 98 filed on 1.12.2014	Data of Station maintained by WRD, Karnataka, Annexure - D (Colly), page 69 of Vol. 98 filed	Annexure-IV, page 61 to 63 of Report of September 2015 of Prof. Gosain (Vol.166)	Annexure-IV, Pages 77 to 79 of Report of May 2017 of Prof. Gosain (Vol.198)

				on 1.12.2014		
1962				6732		
1963				3137		
1964	2553.4	1772	2553	6453	1772	6920
1965	1992.9	1251	1993	4107	1251	5401
1966	2578.0	1878	2578	3691	1878	7005
1967	210.0	2270	209	5869	2270	4554
1968	1932.4	692	1932	5994	692	5237
1969	2335.0	1610	2335	5920	1610	6328
1970	2491.5	1698	2492	6634	1698	6752
1971	1553.7	1551	1553	4907	1554	4211
1972	2103.9	1048	2104	4678	1048	5702
1973	2176.6	854	2177	5291	854	6359
1974	2026.9	1864	2028	13145	1864	5493
1975	2547.4	1257	2548	6119	1257	6903
1976	2036.1	2211	2036	4725	2211	5518
1977	1952.9	1629	1953	5968	1629	5292
1978	2736.6	2737	2736	7788	2737	7416
1979	2854.0	2695	2854	5713	2695	7734
1980		2232		6534	2232	6934
1981	3335.1	3335	6320	6275	3335	6319
1982		2036	6644	6641	2036	6643
1983	2492.3	2492	6675	6675	2492	6675
1984	2300.0	2300	5605	5605	2300	5605
1985	1976.7	1977	5144	5144	1977	5144
1986	1931.3	1931	5116	5116	1931	5115
1987		2452	4722	4722	2452	4723
1988	2316.7	2317	6869	6869	2317	6868
1989	1965.2	1965	5182	5181	1965	5181
1990	2815.7	2816	7055	7055	2816	7054
1991	2711.6	2712	5906	5917	2712	5907
1992	2849.6	2850	5810	5810	2850	5809
1993	2275.6	3458	5948	5948	3458	5949
1994	4160.3	4835	8265	8265	4835	8264
1995	1405.3	2014	5149	5149	2014	5149
1996	2300.6	3258	5198	5229	3258	5197
1997	2728.3	3455	6272	6182	3455	6273
1998	1920.5	1708	4861	4815	1708	4860
1999	2714.5	3003	6770	6787	3003	6769
2000	2337.6	2338	5454	5454	2338	5454
2001	2143.0		5305	5308	5305	5305
2002			4861	4862	4860	4860
2003			4854	4854	4854	4854
2004				5848	5848	5848
2005				7494	7486	7486
2006					7380	7380
2007					5044	5044

2008					5883	5883
2009					5565	5565
2010					5330	5465
2011					6305	6931
2012					5087	5358
Av. of all data	**2307**	**2230**	**4309**	**5923**	**3091**	**5973**
Av. of data upto 1979	**2130**	**1689**	**2130**	**5937**	**1689**	**6052**
Av. of data after 1980	**2457**	**2642**	**5825**	**5913**	**3771**	**5935**

c. At Para 3(ii) on page 21 of his Report of September 2015 (Volume 166), Prof. A. K. Gosain stated that rainfall data of rain gauge Stations in and around Mahadayi basin collected / supplied by IMD were used in the analysis. It is noted that restricting the choice of rain gauge stations whose data were collected / supplied by IMD is contrary to the decision taken during the second meeting of Hydrology Study Group held on 11.1.2002, which are reproduced hereunder.

> "…
> (i) Director, Hydrology (S) requested the members to identify the rain gauge stations, which the co-basin states propose to be considered in the study. During the discussions in the first meeting, Government of Goa was of the view to consider only IMD stations. Govt. of Goa now confirmed their view that all the stations for which data is available irrespective of the agency who is maintaining the station is to be used in the

> analysis. Other members also agreed for the same. While raising the issue of influencing area of each stations, Director, Hydrology (S) wanted to know if certain station below some threshold influencing area could be neglected.
> …
> (iii) After discussing the approach to be applied to the study, it was decided that rainfall – runoff model at Ganjim can be developed once the rainfall data and discharge data are reconciled and corrected, considering all the stations up to Ganjim.
> …"

The reasons for not adhering to the decisions taken by the Hydrology Study Group have not been indicated either in the CWC (2003) Report (Volume 15) or by Prof. Gosain in his Report of September 2015 (Volume 166)

d. Further, different procedures, namely (a) Arithmetic Average method, (b) Normal Ratio method, and (c) Distance Power method have been adopted for filling-in the missing rainfall data by Prof. A. K. Gosain in his Report of September 2015 (Volume 166) and in the Report of May 2017 (Volume 198 and Volume 198A), without clearly justifying the reasons for adopting different procedures.

e. Thiessen Polygon Method has been used for estimating the average rainfall over the entire basin or the basin up to Ganjim site. However, for estimating the average rainfall, over the catchment area up to the various project sites, in State of Karnataka, the rainfall of a rain gauge station or the mean of two or three rain gauge stations by 'Arithmetic Mean Method' has been used for estimating average rainfall over the catchment area up to the project sites, as is apparent from Table 1 on page 12, Table 5 on page 16, Table 9 on page 20 and Table 10 on page 21 of Additional Affidavit of Prof. A. K. Gosain filed on 15.11.2016 (Volume 193). It is noted by the Tribunal that the reasons for selecting specific rain gauge Station or Stations for estimating the average rainfall over the catchment up to the project sites have not been explained and / or offered by Prof. Gosain.

f. Similarly, the reason for using 'observed runoff' at Ganjim, has not been explained. This is more so, in view of the fact that Prof. Gosain has chosen to ignore runoff data of 9 years out of 34 years, observed at Ganjim for development of rainfall runoff equation. It is also observed that Prof. Gosain

in his Report of November 2016 filed on 15.11.2016 (Volume 193), has used the observed runoff data of Collem gauging site for estimation of water availability at 75% dependability for two project sites, namely, Katla-Palna dam and Diggi diversion. It is, however, noted that Prof. Gosain at Para 5.1.1.4 on page 29 of his Report of September 2015 (Volume 166), has concluded that "the test shows a mixed response to the consistency checks of the flow series of Collem, therefore the station has not been used further for any detailed assessment of the basin water yield". Prof. Gosain has not explained as to why he chose to use the data of Collem gauging site for estimation of water availability at 75% dependability for two project sites namely, Katla-Palna dam and Diggi diversion, when he had already decided not to use this data further.

828. In view of above mentioned drawbacks, inconsistencies etc., it is apparent that the data, the analysis of data and the results thereof, included in the Report of September 2015 of Prof. Gosain (Volume 166) and that of May 2017 (Volume 198 and 198A) cannot be accepted or relied upon by the Tribunal.

Critical Examination of Report of Shri Chetan Pandit of August 2016 (Volume 191)

829. It emerges from question No. 20 put to Shri Chetan Pandit, Expert Witness of the State of Goa, by the Tribunal that there are several instances of inconsistencies in the rainfall data used by him. The question No. 20 and answer thereof are reproduced hereunder.

> "Q. No. 20. As per the title of the Table-2, page 15 of the Additional Affidavit filed by you on 4.1.2017, the table contains "Annual Rainfall at Stations used in the present study [Taken from the Table 31, page 90, of Document 191]. On examination of the content of the Table 31, page 90 of the Document 191, it is found that it contains the monsoon rainfall of various rain gauge stations and not the annual rainfall and that the same has been shown as annual rainfall in the Table-2 of the Additional Affidavit. This needs to be corrected.
>
> The monsoon rainfall data of some of the rain gauge stations are included in other documents filed by the State of Goa, particularly in the "Report by the Panel of Experts" at Annexure 120 of the Document No. 31. Examination of the monsoon rainfall data provided in Annexure 12 of the Document No. 31 and that in Document No. 196 indicates that there are considerable variations in the monsoon rainfall in respect of some of

the years. A statement indicating the variation is enclosed. Some of the notable variations are as under:-

i. Data of Valpoi used by you for the year 1971 is about 62% less;
ii. Data of Valpoi used by you for the year 1972 is about 63% less;
iii. Data of Sanguem used by you for the year 1971 is about 67% less
iv. Data of Sanguem used by you for the year 1972 is about 63% less;
v. Data of Kankumbi used by you for the year 1964 is about 151% less;
vi. Data of Kankumbi used by you for the year 1965 is about 166% less;
vii. Data of Amagaon used by you for the year 1977 is about 42% less;
viii. There are considerable variations in almost all the years in case of Chapoli. Apparently, there is shift in the rainfall values by one year.

In this regard, please answer the following:-

a. What are the reasons for such variations in respect of the rainfall data included in the two documents filed by the State of Goa?

b. Don't you feel that reduction in the monsoon rainfall of such a high magnitude even in one or two years has potential of assessment of water availability on lower side and particularly in case of assessment of water availability at 75% dependability?

Ans. The title of the Table 2 on page 15, should be annual monsoon rainfall and not the annual rainfall. The word monsoon is omitted which is a typographical error.

a) As regards the variation in the rainfall data for certain stations, as used by me and in the "Report BY THE PANEL OF EXPERTS", the source of the data used by the Panel of Experts in 1999 study is not known to me. However, I have reasons to believe that there were some discrepancies in the data used by various agencies before 2003. If one refers to the CWC report of 2003, which is marked Annexure 29 (Vol. 15) (Exh. KAR/66), it will be seen that para 3 at page 3 says "The rainfall data used in the study by CWC is the data collected by NWDA from IMD. There are discrepancies in this data and the data collected by Goa from IMD independently". Further at the bottom of the same page, it says that a meeting was taken by the Hon'ble Minister of Water Resources, Government of India on 20th December 2002, and in this meeting, it was decided that the Government of Goa and CWC may make joint efforts to reconcile the discrepancies in the data and yield figures. On Page 4, the third paragraph says "…Therefore, after the Ministerial Level Meeting, it was decided by CWC to independently obtain authenticated rainfall data directly from IMD, Pune for carrying out the study".

Thus, it would be appreciated that discrepancies in the rainfall data prior to 2003 was a known fact, which is why a decision was taken to do the study again after obtaining data directly from the IMD Pune.

> I do not know whether the CWC in 2003 obtained the data directly from IMD, and if so what was that data. However, sometimes in 2014, the Government of Goa obtained the data directly from IMD Pune. The data used by me is based on this data supplied by the IMD, Pune, in 2014.
>
> b) If the data used is less than the correct data then, yes it will have an impact on the yield. However, it has not been established that the lesser data is the correct data. On the contrary the discrepancies in the data prior to 2003 was a known fact, and the IMD data, as used by me is the data supplied directly by the IMD in 2014."

830. The factual position, which emerges, from the above quoted answer is that, as regards, the variations, in the rainfall data, for certain years as used by Shri Pandit and also mentioned in the Report by the Panel of Experts, the source of data, obtained by the Panel of Experts, was not known to Shri Pandit.

831. A major and serious flaw in the procedure adopted by Shri Chetan Pandit, Expert Witness for the State of Goa, for estimation of water availability, that has been noticed by the Tribunal, relates to applying a correction factor of '0.84' (as mentioned at Para 17, page 57 of Volume 191) by Shri Chetan Pandit to the discharges observed by CWC at Ganjim site for the

period from 1979 to 2000, thereby reducing the quantum of observed runoff. This action on part of Shri Pandit was based on his assumption that the needed correction factor to convert 'surface velocity' to 'mean velocity' at the time of discharge observation by 'Float Method', was not applied by CWC while computing the daily discharges at site. However, his assumption was not based on the facts, since the 'surface velocity' was already converted into the 'mean velocity' by applying a correction factor of '0.89' by CWC, as is apparent from "Velocity Observation by Float dated 3.7.01 prepared by CWC at Site No. 25A, Ganjim" [MARK-15 (Colly)]. Hence the process of reducing the values of the annual runoff by Shri Pandit and using these reduced values of runoff for development of rainfall-runoff model is erroneous, faulty and unwarranted.

832. Obviously, the assessment of water availability of Mahadayi river basin, made by Shri Chetan Pandit, Expert Witness of the State of Goa, which is based on a model developed by him, using the runoff data modified, on the basis of erroneous assumption resulting into underestimation of runoff, cannot be considered, as reasonable and reliable. The assessment of water availability as projected by the State of Goa

and the one reported by the Expert Witness of the State of Goa in his Report, are apparently on lower side, and therefore, it is difficult by the Tribunal, to accept the same.

Examination of Report of Shri S. N. Huddar of September 2015 [Volume 163(a)]

833. The Report of Shri S. N. Huddar, Expert Witness of the State of Maharashtra, has for all practical purposes, endorsed the findings of the Report of CWC of 2003 (Volume 15) in respect of water availability for the entire Mahadayi basin with catchment area of 2032 sq.km.

834. At Para 4.2 on page 19 of his Affidavit dated 13.9.2015 [Volume 163(a)], Shri Huddar stated that he got the rainfall-runoff relationship derived by CWC checked from his team. In this regard, the learned Advocate General of the State of Goa asked Shri Huddar as to what all was checked by him and his team. The question No. 3 put to Shri Huddar and his reply are reproduced hereunder.

"Q.No.3. Please refer to Paragraph 4.2 on page 19 of your Affidavit dated 13th September 2015, (Vol 163a), wherein you have stated as under:-
"I have got the rainfall-runoff relationship derived by CWC, checked from my team. …"

Could you please state what all was checked by you and your team? More specifically, did you check the following:-

a) The selection of the rainfall stations used for computing weighted rainfall at Ganjim;
b) The selection of the rainfall stations used for computing weighted rainfall for entire catchment;
c) The drawing of Thiessen polygon at Ganjim;
d) The measurement of areas of Thiessen polygon at Ganjim;
e) The computation of Thiessen weights at Ganjim;
f) The drawing of Thiessen polygon for entire catchment;
g) The measurement of areas of Thiessen polygon for entire catchment;
h) The computation of Thiessen weights for entire catchment;
i) The adding of the daily rainfall data, from IMD's files, in order to obtain the monthly rainfall data;
j) The adding of the daily runoff data, from CWC's files, in order to obtain monthly runoff data;
k) The filling of the missing rainfall data;
l) The consistency checks applied to the rainfall data;
m) Any other checks applied to the rainfall data
n) The computation of the non-monsoon contribution;

o) The derivation of the regression equation;
p) The application of the regression equation to data prior to 1979, and, the preparation of estimated runoff series;
q) The determination of 75% dependable yield from the runoff series.

Could you please list, out of these, what all was checked by you and by your team?

Ans. I only checked, through the assistance of my team, the derivation of the regression equation and compared it with the equation arrived at by CWC (2003) Report, ignoring the data points for 1980 to 1984, 1988, 1990, 1995 and 1996. Before doing so, I had also checked the R-R equation without deleting the data points from 1979 to 1997 and compared both the equations so derived. In my Study annexed as Annexure 1 (Exh.MAH-MW/1/1) and I have described my findings in para 9.0 to para 12.0 (pages 32-34).

The paras (a) to (n) and (p), in the question were not checked by me and my team. Based on the monsoon rainfall figures from the CWC (2003) Report, for the years 1928 to 2000, from Annexure VIII, from CWC (2003) Report and for years 2001 to 2005 were taken from Annexure 3, the IISc Bangalore Study Document at Volume No. 86(a) and with R-R relation equation worked out the monsoon yield to which I added non-monsoon runoff at the percentage given in CWC (2003) Report and worked out the annual yield and compared with the CWC figures.

> My results for para (q) are mentioned at the end of proforma (c) to my Study at page 41."

835. From his reply, it is apparent that Shri Huddar has not examined the CWC (2003) Report properly. This is also evident from the reply of Shri Huddar to question No. 4 wherein he categorically stated as under.

> "I have not scrutinized CWC (2003) Report at Volume 15 in details. The only thing I looked in this Report is the estimated yield of 5652 Mcum at 75% dependability and considered it as a reasonable estimate."

From above, it is apparent that Shri Huddar has not examined the Report of CWC with due care and therefore his conclusion at Para 20 on page 36 of his Report cannot be considered as reliable.

836. Shri S. N. Huddar at Para 6.2, page 25 of his Affidavit [Volume 163(a)] has stated that "contribution to the Mandovi basin from Maharashtra's portion is of the order of 184 Mcum and 262 Mcum at 75% and average dependability respectively which may be considered for allocation purpose".

837. The procedure adopted by Shri Huddar for estimation of water availability of Mandovi (Mahadayi) basin, from Maharashtra's portion of the Mahadayi catchment appears to be broadly in order.

838. However, the Tribunal finds that, Shri Huddar has not taken up any independent study, for assessment of water availability of the entire Mahadayi basin. In reply to question No. 12, put to him by the Tribunal on 14.11.2017, Shri Huddar has stated as under.

> "Q.No.12. (At the commencement of this question, we have shown three documents to the witness, as follows:
>
> i. Relevant pages from the book titled "Introduction to Linear Regression Analysis (Third Edition) by Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining". The same is taken on record and is marked as MARK-31.
> ii. Relevant pages from the publication titled "Chapter A3 Statistical Methods in Water Resources by D.R.Helsel and R.M.Hirsch of Book4, Hydrologic Analysis and Interpretation" of the United States Geological Surveys (USGS). The same is taken on record and is marked as MARK-32.
> iii. Relevant pages from the publication titled "Training module #SWDP-37 – How to do hydrological data validation using regression" prepared under Hydrology Project by DHV

Consultant BV & Delft Hydraulics. The same is taken on record and is marked as MARK-33.)

We find that you have adopted a simple linear equation to represent the Rainfall-Runoff relation in respect of Mahadayi basin, and you have estimated the parameters of the simple linear equation i.e., 'slope' and 'intercept' by using a computer programme on linear regression. It is, however, not clear from your Report [Vol.163 (a)], whether you have examined the various assumptions related to linear regression and satisfied yourself about validity of these assumptions before proceeding ahead with development of simple linear equation for Mahadayi basin at Ganjim site. We also note that you have used the criteria of R^2 only for testing the model adequacy.

Relevant extract from the book titled "Introduction to Linear Regression Analysis (Third Edition) by Douglas C. Montgomery, Elizabeth A. Peck and G. Geoffrey Vining" (MARK-31) are reproduced hereunder:-

"The major assumptions that we have made thus far in our study of regression analysis are as follows:

1. The relationship between the response *y* and the regressors is linear, at least approximately.
2. The error term ε has zero mean.
3. The error term ε has constant variance σ^2.
4. The errors are uncorrelated.
5. The errors are normally distributed.

Taken together, assumptions 4 and 5 imply that the errors are independent random variables. Assumption 5 is required for hypothesis testing and interval estimation.

We should always consider the validity of these assumptions to be doubtful and conduct analyses to examine the adequacy of the model we have tentatively entertained. The types of model inadequacies discussed here have potentially serious consequences. Gross violations of the assumptions may yield an unstable model in the sense that a different sample could lead to a totally different model with opposite conclusions. We usually cannot detect departures from the underlying assumptions by examination of the standard summary statistics, such as the t or F statistics, or R^2. These are "global" model properties, and as such they do not ensure model adequacy."

Yet another important aspect relates to 'Validation of Regression Model'. In this regard, relevant extract from the above mentioned book are reproduced hereunder:-

"Regression models are used extensively for prediction or estimation, data description, parameter estimation, and control. Frequently the user of the regression model is a different individual from the model developer. Before the model is released to the user, some assessment of its validity should be made. We distinguish between model adequacy checking and model validation. Model adequacy checking includes residual analysis, testing for lack of fit, searching for high-leverage or overly influential observations, and

other internal analysis that investigate the fit of the regression model to the available data. Model validation, however, is directed towards determining if the model will function successfully in its intended operating environment.

Since the fit of the model to the available data forms the basis for many of the techniques used in the model development process (such as variable selection), it is tempting to conclude that a model that fits the data well will also be successful in the final application. This is not necessarily so. For example, a model may have been developed primarily for predicting new observations. There is no assurance that the equation that provides the best fit to existing data will be a successful predictor. Influential factors that were unknown during the model-building stage may significantly affect the new observations, rendering the predictions almost useless. Furthermore, the correlative structure between the repressors may differ in the model-building and prediction data. This may result in poor predictive performance for the model. Proper validation of a model developed to predict new observations should involve testing the model in that environment before it is released to the user."

These aspects are also highlighted in the "Chapter A3 – Statistical Methods in Water Resources by D.R. Helsel and R.M. Hirsch of Book 4, Hydrologic Analysis and Interpretation" of the United States Geological Surveys (USGS) (MARK-32) Detailed procedures are also described in the publication titled "Training module # SWDP-37 – How to do hydrological data validation using

regression" prepared under Hydrology Project by DHV Consultant BV & Delft Hydraulics. In particular, relevant extract from Para 9.3, page 228 of "Chapter A3 – Statistical Methods in Water Resources by D.R. Helsel and R.M. Hirsch of Book 4, Hydrologic Analysis and Interpretation" of the USGS (MARK-32) is reproduced hereunder: -

"**9.3 Building a Good Regression Model**

A common first step in performing regression is to plug the data into a statistics software package and evaluate the results using R^2. Values of R^2 close to 1 are often incorrectly deemed an indicator of a good model. This is a dangerous, blind reliance on the computer software. An R^2 near 1 can result from a poor regression model; lower R^2 models may often be preferable. Instead of the above, performing the following steps in order will generally lead to a good regression model. …"

Various steps i.e. steps 1, 2, 2a, 2b, 2c, 3, 3a, 3b, 3c, 3d, and 4 are described at pages 228 to 237 of the "Chapter A3 – Statistical Methods in Water Resources by D.R. Helsel and R.M. Hirsch of Book 4, Hydrologic Analysis and Interpretation" of the USGS.

In this regard, please answer the following:

a. Whether you undertook studies to satisfy yourself that a simple linear equation would be most appropriate rainfall-runoff model, particularly in view of various assumptions related to linear regression analysis, and validity of the same in case

of data related to rainfall and runoff up to Ganjim site of Mahadayi basin? If yes, please indicate the relevant pages of your Report where these aspects have been discussed. If no, why such important aspects were not considered by you?

b. Why did you rely upon R^2 value alone and did not carry out necessary investigations essentially required for finding the best fit equation?

c. Whether you undertook studies related to validation of the Regression Model? If yes, please indicate the relevant pages of your Report where these aspects have been discussed. If no, why such important analysis was not considered necessary?

Ans. The point-wise answers are as under:

a. While preparing my affidavit, my approach, as far as reliance by the State of Maharashtra on CWC (2003) Report is acceptable or otherwise and hence I have not gone into the detailed study to satisfy whether a simple linear equation is appropriate or otherwise. I had just used the data from CWC and checked the regression equation they have developed is in order or not. After deleting the inconsistent runoff factor figures, I verified the equation and since they were nearly the same, I concluded that Maharashtra's reliance is acceptable.

b. As stated to answer to (a) above, I have not investigated further details, but just to check the regression analysis.

c. No, I did not undertake studies related to validation of the regression model."

839. In view of above position, the recommendations of Shri S. N. Huddar for adopting the yield estimated by CWC in its Report of 2003 is found to be completely erroneous and cannot be accepted by the Tribunal.

840. From aforesaid Paras, it is apparent that neither the assessment of water availability by the State of Goa, which apparently is on lower side nor the assessment of water availability by the State of Karnataka which is on higher side nor the recommendations of the State of Maharashtra in respect of yield of Mahadayi river basin, can be considered to be valid and are not accepted by the Tribunal.

841. Therefore, it becomes necessary for the Tribunal to undertake independent study to arrive at a rational estimate of the water availability of the Mahadayi river basin.

842. As a first step, the Tribunal considers it necessary to undertake independent analysis of the data made available by the respective State Governments to satisfy about the consistency of the data or otherwise and decide whether such data could be used for independent analysis.

Examination of Report of Shri Subrai T. Nadkarni of November 2017 (Volume 208)

843. Shri Subrai T. Nadkarni, witness on behalf of the State of Goa, in his Report of November 2017 (Volume 208), has also included the results of his study on sub-basin wise water availability for various sub-basins, namely, Ragada, Khandepar, Kotrachi, Valvanti, Bicholim, Assnora, Surla, Siquerim, Kudnem and Madei stem. Shri Subrai T. Nadkarni has stated that the availability of water sub-basin wise has been extended based on the hydrology study done by Shri Chetan Pandit. He has further, stated that the present exercise is just a computation of the water availability sub-basin wise based on extension of hydrology study by Shri Chetan Pandit. The result of the study of Shri Subrai T. Nadkarni are summarized in Table 13 at page 65 of his Report of November 2017 (Volume 208).

844. Table on page 42 of the Report of November 2017 of Shri Nadkarni (Volume 208) indicates mean annual flows for various sub-basins. In Table 13 on page 65, the 75% dependable yield of various sub-basins are shown. The Tribunal notes that the values of mean annual flow and the values of 75% dependable yield are same of all the sub-basins. The values of mean annual flow and the values of 75% dependable yield cannot be the same. Obviously, there are some errors.

845. It is noted that in Table 13, Shri Nadkarni has also indicated the total water availability as 3283.3 Mcum (115.9 tmc). The Tribunal notes that the corresponding value of water availability indicated in the Report of Shri Chetan Pandit (Volume 191) is 3277.2 Mcum (115.7 tmc), which was subsequently modified by Shri Pandit as 3214.70 Mcum (113.5 tmc) during the course of reply to question No. 154. It is noted that Shri Nadkarni has not indicated as to why he considered it necessary to compute the water availability at 75% dependability for the total catchment by summing up the water availability at 75% dependability of various sub-basins. Shri Nadkarni has also not explained the reason for variation from the value arrived at by Shri Pandit. However, in reply to question No. 3, Shri Nadkarni

stated that he had carried out the arithmetic by adding up the 75% dependable figure to find overall excess / deficiency and that he agreed that the overall 75% dependability would be as evaluated by Shri Chetan Pandit, and he stood by the result of 113.5 tmc for the whole basin assessed by Shri Pandit. The question No. 3 and the reply of Shri Nadkarni are reproduced hereunder.

> "Q.No.3. In the Table at Para 30, pages 14-15 and in the Table 13, page 65 of your Affidavit dated 14.11.2017 (Vol. 208), you have indicated the sub-basin wise availability of water (in Mcum) at 75% dependability in the second column.
>
> It is noted that the total availability of water at 75% dependability has been shown as 3283.30 Mcum, which is equal to 115.9 tmc after conversion from Mcum to tmc.
>
> Why have you undertaken sub-basin wise assessment of water availability at 75% dependability and to sum up to arrive at a new yield figure for the Mahadayi basin?
>
> Ans. I had carried out the arithmetic by adding up the 75% dependable figure to find overall excess/deficiency. However, I agree that for the whole basin, the overall 75% dependability will be the effect of 13 Stations, as evaluated by Shri Chetan Pandit, and I stand by his result of 113.5 TMC for the whole basin.

I took up sub-basin study as I wanted to evaluate as to what would be the effect of availability and demands in each sub-basin."

846. In view of above, result obtained by Shri Nadkarni in respect of water availability from the catchment area of 1523 sq.km. at 75% dependability becomes redundant for all purposes.

Critical Examination of Consistency of Observed Discharge Data

847. The Tribunal notices that the Expert Witnesses of the State of Goa and the State of Karnataka have used the observed discharge data of CWC site at Ganjim. Although, Shri Chetan Pandit, the Expert Witness of the State of Goa has highlighted several deficiencies in the process of observation of data at Ganjim in paras 9(e), 9(f), 9(g),and 9(h) on pages 48-49 of his report (Volume 191), he has used the same data after applying a correction, based on his assumption that CWC did not apply the necessary correction for converting the 'surface velocity' measured through 'Float Observation Method' into the 'mean velocity'. The Tribunal notes that his assumption was not based

on facts. Further the method used for arriving at the 'correction factor' is not in accordance with the procedure prescribed at Para 5.2 of Bureau of Standards (BIS) Code "IS 3911:1994, Surface Floats – Functional Requirements" [MARK – MAH2 (Colly)] and at Para 7.2.5.1 and Para 7.2.5.2 of BIS Code "IS 1192:2013 – Hydrometry – Measurement of Liquid Flow in Open Channels using Current-meters or Floats" (MARK-14). The relevant paragraphs of "IS 3911:1994, Surface Floats – Functional Requirements" are reproduced hereunder.

> "5.2 In the selected reach, measurements shall be made at as near a stage as possible by current meter, preferably by the integration method according to IS 1192:1981, and the coefficient for obtaining the mean velocity in the vertical worked out for the float. In the absence of a more reliable figure a reduction coefficient of 0.85 may be adopted.
>
> NOTE – The reduction coefficient generally vary from 0.79 to 0.92. This reduction coefficient is not a constant even for a particular channel, since it varies with depth, slope, and relative roughness of the channel boundary. It may also be obtained from Von Karman's logarithmic velocity distribution law."

The relevant paragraphs of "IS 1192:2013 – Hydrometry – Measurement of Liquid Flow in Open Channels using Current-meters or Floats" are also reproduced hereunder.

"7.2.5.1 Method

The float velocity shall be determined by dividing the distance between the cross-sections by the time taken by the float to travel this distance. Several measurements of the float velocities shall be taken and the mean of these measurements shall be multiplied by the appropriate coefficient to obtain the mean velocity in the segment. The coefficient derived from current-meter measurements at the site at a stage as near as possible to that during the float measurement may be used for converting the float velocity to mean velocity.

7.2.5.2 Surface float

Where it is not possible to check the coefficient directly, it may be assumed for guidance that, in general, the coefficient of the surface float varies between 0.84 and 0.90 depending upon the shape of the velocity profile. The higher values are usually obtained when the bed is smooth, but values outside this range may occur under certain circumstances."

848. On the other hand, Prof. A. K. Gosain, the Expert Witness of the State of Karnataka has considered, the observed discharge data of CWC site at Ganjim as correct, but still he chose to ignore data of 9 years out of 34 years without undertaking detailed investigations as to why these data should be considered as inappropriate and should be brushed aside, for the purpose of

further analysis. Surprisingly, none of the Experts i.e., Shri Chetan Pandit or Prof. A. K. Gosain had made any effort to examine and use the discharge data observed by the three States namely, the State of Goa, the State of Karnataka and the State of Maharashtra.

849. With a view to independently examining whether the observed discharge data of CWC site at Ganjim can be considered as wholly reliable, the Tribunal has made an effort to compare the observed discharge data of CWC site at Ganjim with the data observed and filed by the respective States.

850. The various States have filed the observed discharge data, of the following sites.

a. Data observed by the State of Karnataka at Chapoli site for the years 1980 and 1983 to 1991 and that from 2000-01 to 2011-12
b. Data observed by the State of Maharashtra at Virdi site for the period from 1986-87 to 2004-05 and from 2006-07 to 2011-12

c. Data observed by the State of Goa at Daucond site for the period from 2010 to 2013
d. Data observed by the State of Goa at Khadki site for the period from 2010 to 2012
e. Data observed by the State of Goa at Kudchire site for the period from 2009 to 2013
f. Data observed by the State of Goa at Paikul site for the period from 2009 to 2013

851. However, the data observed by the State of Goa for the Gauging Stations, namely, Daucond, Khadki, Kudchire and Paikul are relatively of shorter duration of 3 to 5 years only.

852. It is further noted by the Tribunal that there are inconsistencies in the data reported by the State of Goa. Shri Chetan Pandit, Expert Witness of the State of Goa was asked about the inconsistencies in the data of the Stations maintained by the State of Goa. In reply to question No. 163 put to him, by the Tribunal, on 6.10.2016, Shri Chetan Pandit stated that the data was not reliable and that the observation procedure was yet to stabilize. Question No. 163 and the reply thereof are reproduced hereunder.

"Q-163: Information culled out from the data submitted by Central Water Commission (vide report titled "Consistency Analysis of Flow Data in Mahadayi Basin" filed on 1.12.2014) and that by the State of Goa (vide Exhibit 'B' of the report titled "Submission of the State of Goa in Compliance with Paragraph 4 of the Order dated 3.9.2014 passed by this Honourable Tribunal" filed on 22.12.2014) are presented hereunder.

Year	Annual runoff at Ganjim site of CWC (in mm)	Annual runoff at sites maintained by the State of Goa (in mm)	
		Khadki	Kudchire
2010-11	4327	4459	-
2011-12	5961	8361	-
2012-13	3941	6497	1952
2013-14	-	8348	2966

We note that there are wide variations in annual runoff (in terms of depth in mm) at different sites. In particular, the variations in the annual runoff (in mm) in respect of Khadki and Kudchire sites maintained by the State of Goa during the years 2012-13 and 2013-14 are on very high side. Obviously, such variations are not acceptable.

What are your comments?

Ans. I have not analysed the data at any station beyond 2005 and also I have not analysed the data at Khadki and Kudchire for any duration and therefore, I am not able to explain the variation at this point of time. I have been

given the data along with the question. I will analyse the same during the evening and report the outcome tomorrow."

853. On 7.10.2016, Shri Pandit stated further as under.

"I was asked to comment on the annual runoff for the years 2010-11 to 2013-14 as Khadki and Kudchire discharge observation sites maintained by the State of Goa. I have examined the same. The Khadki site is located on the main river Mahadayi approximately 7 KMs, upstream of the Ganjim site. There are no major diversion works between Khadki site and Ganjim site. Therefore, there is no logical reason for the flow at Khadki to be more than the flow at Ganjim. The flow at Khadki for the years referred above is not only more than the flow at Ganjim, but in 2011-12 and 2012-13, it is significantly more. Therefore, in my opinion, this data is not reliable.

The Kudchire site is located on river Bicholim which is a tributary of Mahadayi and meets the main river Mahadayi downstream of Ganjim site. Therefore, the flow observed at Kudchire cannot be compared to flow observed at Ganjim site. One way to form an opinion about the flow observed at Kudchire site is by comparing it with the rainfall in its catchment for the years concerned. This data is not readily available and, therefore, at this moment no opinion can be expressed about the reliability of data at this site.

I was informed by the WRD Goa Engineers that both these sites have been newly established under the

Hydrology Project and, perhaps in 2010 to 2014, the observation procedure was yet to stabilize."

(Emphasis supplied)

854. In view of above position, the data for the aforesaid gauging Stations filed by the State of Goa, have not been considered by the Tribunal for the purpose of comparison with the observed discharge data of CWC site at Ganjim.

855. The Tribunal also notices that the data of Chapoli site submitted by the State of Karnataka for the years 1980 and from 1983 to 1991, have been furnished by the State of Karnataka as "Annexure – B (Colly) – Observed Hydrological Data of Gauging at Kotni Dam Site" [Volume 98(a)]. Data are in the form of data sheets observed by site officials, with missing records of observations on considerable number of dates. The observed discharge data during the monsoon period of five months (i.e., 153 days of June to October) are found to be only for 5 days in 1980, 44 days in 1983, 85 days in 1984, 102 days in 1985, 93 days in 1986, 79 days in 1987, 74 days in 1988, 90 days in 1989, 91 days in 1990 and 118 days in 1991. Therefore, it is not considered appropriate, by the Tribunal to use such data even for the limited purpose of comparison by the Tribunal.

856. The annual runoff data of the following three sites are, however, examined and presented in Table-1.

Table-1: Comparison of Reported Observed Rainfall Data – Data of Ganjim, Khadki, Kudichire, Chapoli and Virdi in millimeters (mm) and Data of Daucond and Paikul in million cubic meters (Mcum)

Year	Runoff at CWC Site at Ganjim (CA = 880 sq.km.)	Khadki Site of State of Goa	Daucond Site of State of Goa	Kudchire Site of State of Goa	Paikul Site of State of Goa	Chapoli Site of State of Karnat-aka (CA = 124.4 sq.km.)	Virdi Site of State of Mahara-shtra (CA = 35.43 sq.km.)	Remarks
1	2	3	4	5	6	7	8	9
1979-80	3292							1. Data of CWC Site at Ganjim is taken from Vol.99. 2. Data of Goa Sites is taken from Vol. 101 3. Data for Chapoli Site of Karnataka is taken from Vol. 98. 4. Data for Virdi Site of Maharashtra is taken from Vol. 97 & 97(a) 5. The catchment areas up to Sites Khadki, Daucond, Kudchire and Paikul have not been made avaialble by the State of Goa. 6. The runoff at Sites Daucond and Paikul have not been indicated in mm by the State of Goa. Therefore, the runoff for these two sites are mentioned only in Mcum
1980-81	5022							
1981-82	4432							
1982-83	4789							
1983-84	4309							
1984-85	4020							
1985-86	3505							
1986-87	2901						1472	
1987-88	2543						1946	
1988-89	4680						3449	
1989-90	3143						2896	
1990-91	4567						2933	
1991-92	3749						2714	
1992-93	3768						7059	
1993-94	3750						2233	
1994-95	5362						5566	
1995-96	3342						2874	
1996-97	2900						2972	
1997-98	4227						3688	
1998- 99	3288						3413	
1999 -00	4457						2895	
2000-01	3627					2535	2331	
2001-02	2767					2149	3064	
2002-03	2674					2269	1899	
2003-04	2935					2240	2416	
2004-05	3028					2901	2370	
2005-06	4328					4640		
2006-07	4946					4746	4931	
2007-08	5649					4451	5174	
2008-09	4478					3474	4717	
2009-10	3433				321	3251	1647	
2010-11	4327	4459	1063		440	2639	3197	
2011-12	5961	8361	1043		772	3686	3435	
2012-13	3941	6497	1090	1952		2206		

2013-14		8348	1544	2966		3184		
Total	134141	27665		4918		63704	81291	
Average	3949	6916		2459		3034	3252	

The result of the analysis carried out by the Tribunal are summarized as under.

a. Average annual runoff at Ganjim (on the basis of 34 years of data i.e., from 1979-80 to 2013-14) : 3949 mm
b. Average annual runoff at Chapoli (on the basis of 14 years of data i.e., from 2000-01 to 2013-14) : 3034 mm
c. Average annual runoff at Virdi (on the basis of 25 years of data i.e., from 1986-87 to 2004-05 and from 2006-07 to 2011-12) : 3252 mm

857. The Tribunal finds that obviously, the runoff observed at Ganjim Site is, on relatively very high side. However, since the periods of observed data at the three Sites are different, the comparison must be termed as inappropriate. Therefore, the data of concurrent periods for the three Sites, as referred to above, were also compiled by the Tribunal. The annual runoff data of the three sites for the concurrent period are presented in Table-2.

Table-2: Comparison of Reported Observed Runoff Data at Different Sites (in mm) of Concurrent Period

Year	Runoff at CWC Site at Ganjim (CA = 880 sq.km.)	Chapoli Site of State of Karnataka (CA = 124.4 sq.km.)	Virdi Site of State of Maharashtra (CA = 35.43 sq.km.)
1	2	3	4
2000-01	3627	2535	2331
2001-02	2767	2149	3064
2002-03	2674	2269	1899
2003-04	2935	2240	2416
2004-05	3028	2901	2370
2006-07	4946	4746	4931
2007-08	5649	4451	5174
2008-09	4478	3474	4717
2009-10	3433	3251	1647
2010-11	4327	2639	3197
2011-12	5961	3686	3435
Total	43827	34341	35182
Average	3984	3122	3198

The results are summarized as under.

a.	Average annual runoff at Ganjim (on the basis of 11 years of data i.e., from 2000-01 to 2004-05 and 2006-07 to 2011-12)	:	3984 mm
b.	Average annual runoff at Chapoli (on the basis of 11 years of data i.e., from 2000-01 to 2004-05 and 2006-07 to 2011-12)	:	3122 mm
c.	Average annual runoff at Virdi (on the basis of 11 years of data i.e., from 2000-01 to 2004-05 and 2006-07 to 2011-12)	:	3198 mm

858. From the above, it is apparent that the average annual runoff at Ganjim Site, arrived at, on the basis of observed discharge data at the Hydrological Observation Station of CWC at Ganjim, is on higher side. This position is in contradiction with, the rainfall pattern, which is reported by the State of Goa as well that by the State of Karnataka as elaborated in the following Paras.

859. At Para 1.2, pages 1-2 of the Report titled filed as "Exhibit A to the Submissions of the State of Goa in compliance with Paragraph – 4 of the Order dated 03/09/2014 passed by this Tribunal (Water Yield Studies for Mandovi River Basin – a linear

regression approach)" [Exhibit GOA-148] [Volume 101(a)] the following has been stated.

> "… Goa has a tropical monsoon climate and the region is generally warm and humid. The temperature ranges from 20°C to 34°C. The humidity is high throughout the year. The state receives an average annual rainfall of about 3200 mm. The rainfall occurs mostly due to orographic frontal process, as a result of the orographic influence the rainfall increases progressively from the coast to the Western Ghats. …"

860. Prof. A. K. Gosain, Expert Witness of the State of Karnataka in his Report titled "The Yield Study of Mahadayi Basin" filed as Annexure – B to his Affidavit dated 12.9.2015 [Exhibit KAR-RW1/2] (Volume 166) has stated as under in Para 2, at page 18.

> "The basin receives major portion of its rainfall during the south west monsoon season. Over 90 percent of rainfall is received during four months of monsoon from June to September. However, there is a significant variability in the rainfall across the basin. The normal rainfall in the basin varies from 2950 mm near seashore to about 5400 mm in the upper reaches of the basin."

861. The Tribunal is of the considered view that from the aforesaid quoted paras, the discharge data observed at Hydrological Observation Station of CWC at Ganjim, cannot be relied upon.

862. It is noted by the Tribunal that neither the State of Goa nor the State of Maharashtra has raised any issue relating to inconsistency or non-reliability of the discharge data observed at Chapoli gauging site of the State of Karnataka. However, it is also observed that even the State of Karnataka has not used the discharge data observed at Chapoli. Further, the catchment area up to Chapoli site is only about 124.4 sq.km., which is relatively much lesser as compared to the total area of Mahadayi basin of 2032 sq.km., and therefore, the use of data at this site for development of Rainfall-Runoff model, to be used for assessment of water availability for the entire basin, is not considered appropriate and is accordingly not considered.

863. It is also noted by the Tribunal that the State of Goa and the State of Karnataka have not raised any issue about inconsistency or non-reliability of the discharge data observed at Virdi gauging site of the State of Maharashtra. However, the

catchment area up to this site, is still lower. The catchment area up to Virdi gauging site is only 35.43 sq.km. against the total catchment area of 2032 sq.km. of the entire Mahadayi basin river basin, and it is not safe to rely upon such discharge data, for the assessment of availability of water.

864. In view of above position, neither the observed discharge data at the Hydrological Observation Station of CWC at Ganjim nor the discharge data observed by the State of Goa at the four gauging Stations, namely Daucond, Khadki, Kudchire and Paikul nor the data observed by the State of Karnataka at Chapoli gauging Site nor the data observed by the State of Maharashtra at Virdi gauging Station, are found appropriate, by the Tribunal, for assessment of the water availability for the entire Mahadayi river basin or for development of a Rainfall-Runoff model to be used, for water availability assessment, for the entire Mahadayi river basin.

Critical Examination of Consistency of Rainfall Data

865. The issues relating to consistency of rainfall data have been discussed at length during the course of examination of the

issues raised for determination as well as during the examination of the Reports which have been filed by the State of Goa or by the State of Karnataka.

866. From perusal of the information provided in various documents filed by the party States, the Examinations-in-Chief and cross examinations of the Expert Witnesses of party States, on the subject of hydrology and water availability, some inconsistencies in the rainfall data and its processing, have been noticed by the Tribunal which are summarized as under.

a. Choices of different sets of rain gauge stations for assessment of average rainfall: 10 rain gauge stations, namely, Amagaon, Jamagaon, Kankumbi, Ponda, Valpoi, Sanguem, Gawali, Chapoli, Krishnapura, and Kotni dam have been selected by Shri Chetan Pandit, Expert Witness of Goa, for assessing the average rainfall over the catchment up to Ganjim site. On the other hand, Prof. A. K. Gosain, Expert Witness of Karnataka has selected only 7 rain gauge stations, namely, Amagaon, Jamagaon, Kankumbi, Ponda, Valpoi, Khanapur, and Castlerock for assessing the average rainfall over the catchment up to Ganjim site. Thus only five

rain gauge stations, namely, Amagaon, Jamagaon, Kankumbi, Ponda and Valpoi are found to be common in the two lists. For assessing the average rainfall of the entire Mahadayi basin, Prof. A. K. Gosain considered 12 influencing rain gauge stations (Ref: Para 7.3.2, page 41, Volume 166) for varying period from 1928-29 to 2012-13, whereas Shri Chetan Pandit has considered data from 13 rain gauge stations. Similarly, there are variations in the choice of rain gauge stations for assessing the average rainfall over the catchment area of different proposed project sites. This is apparent from the following Table.

Proposed project sites	**Rain gauge stations selected by Prof. Gosain (Vol. 193)**	**Rain gauge stations selected by Shri Pandit (Vol. 195)**
Bhandura dam	Chapoli, Gavali and Jamagaon	Jamagaon
Kotni dam site (independent catchment)	Jamagaon	Jamagaon, Chapoli, Gavali and Kotni
Irti pick-up dam (independent catchment)	Chapoli and Gavali	Chapoli, Gavali and Kotni
Katla-Palna diversion	Castle Rock	Sanguem
Diggi diversion	Castle Rock	Sanguem

Viranjole diversion	Castle Rock	Jamagaon, Valpoi and Krishnapura

b. Selection and use of varying length of rainfall data: Though the Tribunal has rejected CWC (2003) Report, as unreliable, it is noticed, just for the sake of mention that, the Report of CWC of 2003 (Volume 15), rainfall data of 70 years i.e., from 1928-29 to 1997-98, have been used. In the Report of Prof. A. K. Gosain of August 2015 (Volume 166), he has used the rainfall data of 85 years i.e., from 1928-29 to 2012-13, whereas Shri Chetan Pandit, in his Report of August 2016 (Volume 191) has used the rainfall data of only 42 years i.e., from the 1964 to 2005.

c. Variations in the values of rainfall at same rain gauge station as reported in two different documents filed by the same State: There are variations in the rainfall data of some years in respect of Rain Gauge stations at Valpoi, Sanguem, Kankumbi, Amagaon and Chapoli in two Reports filed by the State of Goa, i.e., the Report of the Panel of Experts (Annexure-120 in Volume 31) and the Report of Shri Chetan Pandit, Expert Witness of the State of Goa (Volume 196). The variations in the values of the rainfall data in two Reports are indicated in the following Tables.

Comparison of Monsoon Rainfall of Valpoi and Sanguem Raingauge Stations in Different Documents furnished by the State of Goa

Year	Valpoi			Sanguem		
	As per Table-2, Page 15, Vol.-196	As per Proforma 5.10, pages 75-78 of Report of Panel of Expert, Vol.II	Variation between Col. 2 and Col. 3 (in %)	As per Table-2, Page 15, Vol.-196	As per Proforma 5.5, pages 57-60 of Report of Panel of Expert, Vol.II	Variation between Col. 5 and Col. 6 (in %)
1	2	3	4	5	6	7
1964	4189.9	4202.0	-0.29	2552.9	2602.0	-1.92
1965	3598.1	3598.0	0.00	3440.1	3441.0	-0.03
1966	3726.0	3729.0	-0.08	2872.5	2973.0	-3.50
1967	4083.2	4015.0	1.67	2862.0	3461.0	-20.93
1968	4017.0	4017.0	0.00	3323.7	3321.0	0.08
1969	3984.3	3975.0	0.23	3737.3	3737.0	0.01
1970	4704.4	4707.0	-0.06	4168.0	4558.0	-9.36
1971	2321.4	3754.0	-61.71	2010.0	3348.0	-66.57
1972	1961.3	3191.0	-62.70	1698.2	2767.0	-62.94
1973	3820.5	3820.0	0.01	2857.4	2857.0	0.01
1974	4880.3	4363.0	10.60	3160.0	3736.0	-18.23
1975	4856.5	4857.0	-0.01	3762.0	3761.0	0.03
1976	3511.6	3582.0	-2.00	3040.7	4170.0	-37.14
1977	3962.8	4052.0	-2.25	3431.3	3785.0	-10.31
1978	4622.3	5088.0	-10.08	4002.3	4300.0	-7.44
1979	3644.6	3640.0	0.13	3418.5	3201.0	6.36
1980	5061.3	4308.0	14.88	4382.5	3678.0	16.08
1981	4384.0	4385.0	-0.02	4460.4	4460.0	0.01
1982	4661.3	4713.0	-1.11	4182.7	4183.0	-0.01
1983	4787.1	4190.0	12.47	3897.4	3900.0	-0.07
1984	3956.7	3807.0	3.78	3085.0	2785.0	9.72
1985	3648.3	3692.0	-1.20	4052.0	4051.0	0.02

Comparison of Monsoon Rainfall of Kankumbi and Amagaon Raingauge Stations in Different Documents furnished by the State of Goa

Year	Kankumbi			Amagaon		
	As per	As per	Variation	As per	As per	Variation

	Table-2, Page 15, Vol.-196	Proforma 5.14, page 91 of Report of Panel of Expert, Vol.II	between Col. 2 and Col. 3 (in %)	Table-2, Page 15, Vol.-196	Proforma 5.16, page 95 of Report of Panel of Expert, Vol.II	between Col. 5 and Col. 6 (in %)
1	2	3	4	5	6	7
1964	1964.0	4932.0	-151.12	2599.4	2599.0	0.02
1965	1943.1	5172.0	-166.17	2231.6	2231.0	0.03
1966	1394.5	1506.0	-8.00	1799.2	1800.0	-0.04
1967	3952.1	2264.0	42.71	3423.8	3095.0	9.60
1968	1953.7	1897.0	2.90	2057.4	2048.0	0.46
1969	1983.4	1967.0	0.83	2291.8	2294.0	-0.10
1970	2289.5	2287.0	0.11	2505.6	2504.0	0.06
1971	1815.9	1801.0	0.82	2222.4	2217.0	0.24
1972	1834.9	1692.0	7.79	1968.0	1968.0	0.00
1973	2044.2	2027.0	0.84	2203.3	2181.0	1.01
1974	2276.0	2251.0	1.10	2363.3	2364.0	-0.03
1975	4842.4	1854.0	61.71	2054.5	2055.0	-0.02
1976	4198.8	5602.0	-33.42	3637.6	3624.0	0.37
1977	5360.6	5432.0	-1.33	2385.9	3386.0	-41.92
1978	7172.3	7173.0	-0.01	2884.6	2881.0	0.12
1979	5495.2	5496.0	-0.01	2920.0	2922.0	-0.07
1980	7865.3	7797.0	0.87	3061.7	3323.0	-8.53
1981	7280.3	7280.0	0.00	2856.7	2837.0	0.69
1982	6881.8	6881.0	0.01	3275.7	3291.0	-0.47
1983	6538.6	6537.0	0.02	2986.7	2987.0	-0.01
1984	5874.6	5875.0	-0.01	4251.6	3375.0	20.62
1985	5147.3	5003.0	2.80	4509.9	2943.0	34.74

Comparison of Monsoon Rainfall of Chapoli Raingauge Station in Different Documents furnished by the State of Goa

Year	Chapoli Raingauge Station			Remarks
	As per Table-2, Page 15, Vol.-196	As per Proforma 5.19, page 101 of Report of Panel of Expert,	Variation between Col. 14 and Col. 15 (in %)	

		Vol.II		
1	2	3	4	5
1965	4375.0	1309.0	70.08	Apparently, there is shift in the rainfall values by one year.
1966	1309.0	610.0	53.40	
1967	610.0	3619.0	-493.28	
1968	3619.0	1335.0	63.11	
1969	1335.0	1601.0	-19.93	
1970	1601.0	1646.0	-2.81	
1971	1646.0	1034.0	37.18	
1972	1034.0	1322.0	-27.85	
1973	1322.0	1594.0	-20.57	
1974	1594.0	1587.0	0.44	
1975	1587.0	3123.0	-96.79	
1976	3123.0	4336.0	-38.84	
1977	4336.0	1625.0	62.52	
1978	1625.0	4547.0	-179.82	
1979	4547.0	4197.0	7.70	
1980	4197.0	5509.0	-31.26	
1981	5509.0	5691.0	-3.30	
1982	5691.0	7592.0	-33.40	
1983	7592.0	3902.0	48.60	
1984	4002.0	7312.0	-82.71	
1985	7312.0	5328.0	27.13	

Similarly, there are variations in the rainfall data reported in two different reports, namely Report of 2015 (Volume 166) and Report of 2017 (Volume 198) of Prof. A. K. Gosain, Expert Witness of the State of Karnataka as highlighted at Para 54(a) and Para 54(b).

d. Use of different methods of filling-in the missing data: Just for the sake of mention, it is stated that, Central Water Commission, in its Report of 2003, has used the 'Method of Normals', whereas Shri Chetan Pandit, Expert Witness of the Sate of Goa has used the 'Normal Ratio Method' and

Prof. A. K. Gosain, Expert Witness of the State of Karnataka has also used the 'Normal Ratio Method' for filling-in some of the missing data. However, it is noted that the procedure for filling the missing rainfall data has been described in the "Hydro-Meteorology Handbook: Precipitation and Climate" prepared under Indian Hydrology Project of Ministry of Water Resources, River Development and Ganga Rejuvenation (MARK-18), are as under.

"**Normal ratio** – applied if the average annual rainfall of the station under consideration differs from the average annual rainfall at the neighbouring stations by more than 10%. The erroneous or missing rainfall at the station under consideration is estimated as the weighted average of the data at the neighbouring stations. The rainfall at each of the neighbouring station is weighted by the ratio of the average annual rainfall at the station under consideration and average annual rainfall of the neighbouring station. The rainfall for the missing or the erroneous value at the station under consideration is estimated as:

$$P_{test} = \frac{1}{M}\left(\frac{Ntest}{Nbase1}P_{base1} + \frac{Ntest}{Nbase2}P_{base2} + \frac{Ntest}{Nbase3}P_{base3} + \cdots + \frac{Ntest}{Nbase.M}P_{base.M}\right)$$

Where, N_{test} = annual average rainfall at the station under consideration

$N_{base\ i}$ = annual average rainfall at the adjoining stations (for i = 1 to *M*)

A minimum of three neighbouring stations should generally be used for obtaining good estimates using the normal ratio method."

The document titled "Hydro-Meteorology Handbook: Precipitation and Climate" prepared under Indian Hydrology Project of Ministry of Water Resources, River Development and Ganga Rejuvenation was shown to Prof. A. K. Gosain and is marked as MARK-18.

In this regard, relevant extract from "Handbook of Applied Hydrology by Ven Te Chow" (which was also shown to Prof. A. K. Gosain and is marked as MARK-11) is also reproduced as under.

"**3. Interpolation of Rainfall Records.** Frequently, records of rainfall for a certain station are missing for a day or several days, especially for cooperative stations. In order not to lose valuable information, it is desirable to have techniques for estimating the amounts for such days in calculating monthly and annual totals. The U.S. Weather Bureau [22] uses two procedures for these estimations, both based on simultaneous records for three stations as close to and as evenly spaced around the station with missing records as possible: (1) if the normal annual precipitation at each of these stations is within 10 per cent of that for the station with missing records, a simple arithmetic average of the precipitation at the three stations is used for the estimated amount. (2) If the normal annual precipitation at any of the three stations differs from that of the station with missing

records by more than 10 per cent, the *normal-ratio method* is used. This method consists of weighting, by the ratios of the *normal-annual-precipitation* values,

$$P_x = \frac{1}{3}\left(\frac{Nx}{NA}P_A + \frac{Nx}{NB}P_B + \frac{Nx}{NC}P_C\right)$$

Where, *N* is the normal annual precipitation. It is readily seen that the second method is adaptable to regions where there is large orographic variation in the precipitation. The two procedures have been adapted to machine methods and are used routinely by the Weather Bureau."

It is observed that both the references suggest the use of data of at least three neighbouring Rain Gauge Stations.

It is observed that the prescribed procedure has not been followed.

e. <u>Use of different methods of computing average rainfall</u>: Thiessen Polygon method has been used for estimation of average rainfall over the entire catchment area of Mahadayi basin as also for the catchment area up to Ganjim site. However, for estimation of average rainfall over the catchment area of the most of the identified project sites, Arithmetic Mean method, has been used by the Expert Witnesses of the States of Goa and Karnataka.

f. Non-application of all required consistency checks: Checks for the presence of trend in the long term rainfall data series have also not been applied either by the Expert Witness of the State of Goa or by the Expert Witness of the State of Karnataka. Similarly, checks for external consistency have also not been applied by them.

867. In view of above, and particularly in view of variations in the values of the rainfall of a Station, in numerous cases in different Reports, it is not considered appropriate, by the Tribunal to use the rainfall data reported by the States in the Reports filed by them.

Assessment of Water Availability of Mahadayi Basin by the Tribunal using an Independent Approach

868. In view of highly varying values of the assessment of water availability of the Mahadayi basin as reported by the party States and the deficiencies noticed in the process of assessment, none of the assessments being acceptable, it has become necessary for the Tribunal, to make assessment of water availability of Mahadayi basin, independently.

869. The Tribunal has adopted the following approach.

Rainfall Data to be Used

870. Since the rainfall data reported and used in different Reports filed by the States of Goa and Karnataka and by their respective Expert Witnesses were not found acceptable, the Tribunal decided to use the "High Spatial Resolution (0.25°x0.25°) Long Period Daily Gridded Rainfall Data", which is processed by India Meteorological Department (IMD).

871. In this regard, it is noted that Prof. A. K. Gosain, has prepared a Report titled "Analysis to check the Consistency of Rainfall data in and around Mahadayi River Basin" which has been filed by the State of Karnataka along with "Further Response of the State of Karnataka to the Brief Note Handed over to the Hon'ble Tribunal at the Hearing on 11.02.2015 Read with Orders dated 03.9.2014 and 12.02.2015" (Volume 122). In the above said Report, following has been stated.

> "Recently, a new product of India Meteorological Department, in the form of high resolution gridded daily rainfall data (0.25°x0.25° resolution), derived using quality controlled station data (http://www.imd.gov.in/doc/nccraindata.pdf) has come into being which is supposed to be a much better product due to reanalysis, has been used here for consistency analysis. …"

872. It is further noted by the Tribunal that the annual / yearly rainfall data for eight Gridded Points namely (a) 73°45'E 15°30'N, (b) 73°45'E 15°45'N, (c) 74°E 15°15'N, (d) 74°E 15°30'N, (e) 74°E 15°45'N, (f) 74°15'E 15°15'N, (g) 74°15'E 15°30'N, and (h) 74°15'E 15°45'N for the period from 1979 to 2011, were included in the above said Report in Table 1 on page 15 of Volume 122.

873. With a view to independently examining and checking the annual rainfall data at different Gridded Points, included in the above said Report (Volume 122), the Tribunal requested the National Climate Centre, India Meteorological Department, Pune to supply the 'High Resolution (0.25°x0.25°) Daily Gridded Rainfall Data' vide letter No. 4/27/2015/MWDT/109/377 dated 17.9.2015.

874. India Meteorological Department supplied a CD of "daily gridded 0.25°x0.25° rainfall data (1901-2013)" vide its letter No. NCC/Product/6/2014/4362 dated 22.9.2015 to the Tribunal.

875. From the Report of the India meteorological Department, received along with the data, it is noted by the Tribunal that India Meteorological Department has computed values of the rainfall at the Grid Points, after taking into consideration, all the data in and around the Grid Points, with due consideration to all aspects. Relevant extract from the publication titled "Development and Analysis of a New High Spatial Resolution (0.25°x0.25°) Long Period (1901-2010) Daily Gridded Rainfall Data Set over India" of the National Climate Centre, India Meteorological Department are reproduced hereunder.

> "In this study, as a part of IMD's efforts to make use of all the available quality rain gauge data over the country to prepare a high resolution daily rainfall data set for various applications such as climate variability & climate change studies, validation of model rainfall at various scales, hydrological modelling, drought monitoring etc., development of a new daily gridded rainfall data set

over India at a spatial resolution 0.25° × 0.25° for 110 years (1901-2010) have been discussed. The data set was prepared using the daily rainfall data from all the rain gauge stations over the country available in the IMD archive. …"

876. In view of above features, Prof. A. K. Gosain, Expert Witness of the State of Karnataka was asked a question by the Tribunal on 13.7.2017. The Question No. 17 and the answer thereof are reproduced hereunder.

"Q.No.17. In your report titled "Analysis to Check the Consistency of Rainfall Data in and around Mahadayi River Basin" [Annexure A of "Further Response of the State of Karnataka to the Brief Note handed over to the Hon'ble Tribunal at the Hearing on 11.2.2015 (read with Orders dated 3.9.2014 and 12.2.2015)" – Vol. 122"] filed by the State of Karnataka on 15.4.2015, following has been stated: -

"Recently, a new product of India Meteorological Department, in the form of high resolution gridded daily rainfall data (0.25°x0.25° resolution), derived using quality controlled station data (http://www.imd.gov.in/doc/nccraindata.pdf) has come into being which is supposed to be a much better product due to reanalysis, has been used here for consistency analysis. Location of these grid points in and around the Mahadayi basin has been shown in Figure 2.

Therefore, under present situation, it is decided to use a recent product of India Meteorological Department, in the form of high resolution gridded daily rainfall data (0.25°x0.25° resolution), derived using quality controlled station data ….."

However, in the report titled "The Yield Study of Mahadayi Basin" submitted as Annexure-B of your Affidavit, you have not used the data contained in the new product of India Meteorological Department, in the form of high resolution gridded daily rainfall data which in your opinion is much better product.

Please explain the reasons for not using a much better product. Please also tell us whether the high resolution gridded daily rainfall data included in the new product of India Meteorological Department (which in your opinion is much better product) should be invariably used for development of rainfall runoff models and if not, the reasons therefor."

"Ans. I personally feel that the gridded daily rain fall data, as provided by the IMD, is more suitable for the end users, since it is a processed rain fall data, checked for most of the possible errors. However, in the present case, since it was a matter of difference of opinion between the parties, I did not want to bring in another parameter, as to the authenticity of the gridded data itself, since I know that it is an end product of interpolation, of the available actually observed rain fall, and transformed on to a uniform grid of 0.25° x 0.25° by IMD. Therefore, having started in that direction, and submitting one Report of consistency of the gridded

data, as given along with this question, I decided to use the actual rain gauge stations for my analysis."

877. Thus Prof. Gosain has asserted and informed the Tribunal that the gridded daily rain fall data, as provided by the IMD, is more suitable for the end users, since it is a processed rain fall data, checked for most of the possible errors.

878. From above, the Tribunal concludes that the daily gridded 0.25°x0.25° rainfall data of the India Meteorological Department can be safely considered alongwith other data relied upon by the party States for the assessment of the availability of water of Mahadayi basin. Further, use of this data would certainly lead to convergence, at least, in respect of rainfall data.

879. It is worth noticing that, despite full knowledge about the availability of such processed daily rainfall data by India Meteorological Department, none of the three States chose to use this data nor referred to in their respective written submissions.

880. In view of above, in order to facilitate the learned Senior Counsels of the party States, to examine the daily gridded

0.25°x0.25° rainfall data and offer their comments, a soft copy of the data as procured by the Tribunal from India Meteorological Department, was made available to them for their study. Learned Senior Counsels of the party States were directed to indicate as to: (a) why the daily gridded 0.25°x0.25° rainfall data of the India Meteorological Department has not been used by the State; (b) why the daily gridded 0.25°x0.25° rainfall data of the India Meteorological Department cannot be used for the assessment of yield of Mahadayi basin; and (c) whether it would be possible for the State to use the daily gridded 0.25°x0.25° rainfall data of the India Meteorological Department and re-assess the water availability before the conclusion of arguments by the learned Senior Counsel / learned Counsel of the party States i.e., before 22.2.2018.

881. In response, the State of Goa as well as the State of Karnataka have used the daily gridded 0.25°x0.25° rainfall data to: (a) develop the regression equations; and (b) re-assess the water availability. The regression equation developed by the State of Goa is “Runoff = 0.7904*Rainfall – 219.619” and produced the same before the Tribunal (Volume 237-D). The regression equation developed by the State of Karnataka is “Y =

0.981X – 269.2", where Y is runoff in mm and X is rainfall in mm (Volume 238A).

882. The State of Goa has, however, stated at page 11 of the "Para-wise Reply of the State of Goa to the Points Raised on 09.02.2018 by this Hon'ble Tribunal regrading Inconsistency in the Rainfall Data" (Volume 237D) as under.

> "Goa does not agree with Prof. Gosain that the grid data can be used to check the consistency of the station data. Dr. S Pai, is the Scientist F and Head, Climate Prediction, Climate Research Division, IMD. A paper by him and his colleague was included in the grid data handed over by this Hon'ble Tribunal. Goa wrote an email to Dr. Pai regarding use of this data. The query sent, and Dr. Pai's reply are enclosed. It is clear that if sufficiently long series of station data is available, and in Mahadayi it is thus available, then station data is the better option. Grid data is useful for situations where adequate station data is not available."

883. The Tribunal finds that the reply of Dr. S. Pai to the e-mail sent to him by Shri Chetan Pandit (which has been enclosed by the State of Goa), is as under.

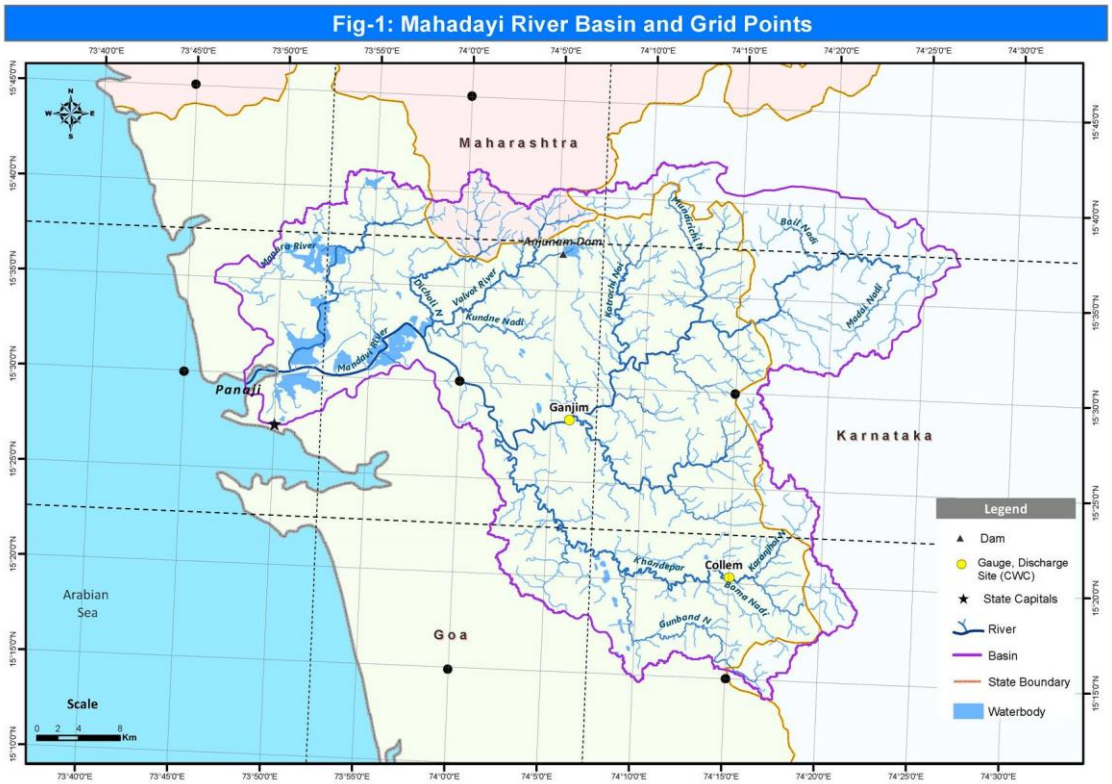
> "… If you have long times series of good quality stations data, this may better than gridded data. At the same time you can use both and compare the results for common period and if they match well you can use gridded data as the same is available from 1901 onwards."
>
> [Emphasis supplied]

884. What is worth noticing is that Shri Pai has made very specific reference to good quality station data. The main reason for the Tribunal for not accepting the data of various rain gauge stations included in different reports filed by the party States, is the inconsistencies noticed in the station data and not the length of the data. Obviously, the data with such inconsistencies cannot be regarded as "good quality stations data".

885. Accordingly, the Tribunal has decided to use the "High Spatial Resolution (0.25°x0.25°) Long Period Daily Gridded Rainfall Data" from IMD. The data supplied by IMD includes daily processed rainfall values at various Grid Points for the years from 1901 to 2013. After due examination, the Grid Points in and around the Mahadayi river basin were selected as the Grid Points which are located on west of the Sahayadri Hill Ranges are used for the assessment of the water availability of Mahadayi basin. In

view of orographic features, the Grid Points on the east of the Sahayadri Hill Ranges were not considered being in the rain shadow area.

886. Seven Grid Points i.e. (a) 74°E 15°15'N, (b) 74°15'E 15°15'N, (c) 73°45'E 15°30'N, (d) 74°E 15°30'N, (e) 74°15'E 15°30'N, (f) 73°45'E 15°45'N and (g) 74°E 15°45'N are thus selected. The location of the selected seven Grid Points, vis-à-vis, the catchment area of Mahadayi river basin are shown in Fig. 1.



Analysis of the Data to Assess the Average Annual Rainfall over the Basin

887. The daily rainfall values at the seven Grid Points are used by the Tribunal to compute the monthly values of the rainfall, which were further added to estimate the values of the annual rainfall for each year starting from year 1901-02 to 2012-13.

888. Annual average rainfall over the Mahadayi basin has been computed by using the Thiessen weight of the seven Grid Points and the annual average rainfall over the entire Mahadayi river basin with catchment area of 2032 sq.km. has, accordingly, been computed by the Tribunal and the annual values for 112 years from 1901-02 to 2012-13 are given in Table-3.

Table-3: Estimation of Average Annual Rainfall over Mahadayi River Basin

Year	Annual Rainfall (in mm) at Grid Points in Mahadayi Basin							Average Annual Rainfall (in mm) for Entire Mahadayi Basin (2032 sq.km.) - Using Thiessen Weights for Grid Points
	74°E 15°15'N (Thiessen Weight = 0.0317)	74°15'E 15°15'N (Thiessen Weight = 0.1470)	73°45'E 15°30'N (Thiessen Weight = 0.0566)	74°E 15°30'N (Thiessen Weight = 0.2704)	74°15'E 15°30'N (Thiessen Weight = 0.4218)	73°45'E 15°45'N (Thiessen Weight = 0.0043)	74°E 15°45'N (Thiessen Weight = 0.0682)	
1	2	3	4	5	6	7	8	9
1901-02	2356.9	2262.1	2544.2	3610.9	2409.0	3115.2	4085.6	2835.8

1902-03	3256.0	2218.7	3515.6	3188.4	1968.7	3749.9	3008.6	2542.2
1903-04	2491.3	1880.7	2612.7	2434.3	1682.0	3286.3	2630.1	2064.5
1904-05	2519.7	2057.9	2692.5	2475.1	1798.9	3106.1	2849.6	2170.5
1905-06	1572.7	1219.8	1572.1	1519.4	1053.3	1784.8	1674.4	1295.1
1906-07	2200.3	1757.6	2310.0	2126.6	1479.8	2770.6	2321.6	1828.3
1907-08	2450.2	2696.8	2270.1	2244.6	2120.9	2979.7	2952.4	2318.3
1908-09	2803.0	2244.8	2836.3	2660.4	1834.4	3611.3	3146.1	2302.6
1909-10	2161.5	1813.1	2261.2	2071.1	1536.6	3316.9	2757.1	1873.5
1910-11	2293.8	1823.1	2378.3	2179.0	1536.4	2833.3	2397.0	1888.2
1911-12	2006.2	1893.4	1996.4	1917.7	1552.4	2445.7	2307.6	1796.2
1912-13	2640.0	2509.1	2737.3	2616.4	2267.2	3643.5	3451.3	2522.3
1913-14	2314.3	1862.9	2385.9	2233.3	1502.8	2710.1	2367.4	1893.1
1914-15	3240.9	3151.6	3167.8	3114.6	2823.5	3840.0	3885.6	3060.0
1915-16	2308.7	1608.3	2619.7	2300.9	1434.5	2865.5	2518.2	1869.2
1916-17	3077.0	2076.8	3340.4	2918.0	1560.4	4075.6	3094.6	2267.7
1917-18	3428.9	2414.6	3573.4	3209.4	1800.7	4135.5	3323.2	2537.7
1918-19	1410.8	1154.8	1391.6	1331.1	880.4	2002.3	1659.8	1146.3
1919-20	2427.0	2080.1	2352.7	2272.0	1557.4	2938.7	2693.5	1983.5
1920-21	1918.9	1970.2	1763.4	1785.1	1524.2	2186.7	2256.0	1739.1
1921-22	2331.9	2093.1	2358.3	2211.7	1623.6	2968.7	2746.3	1998.0
1922-23	2585.0	2173.4	2732.2	2395.6	1552.4	3454.1	3015.1	2079.1
1923-24	2839.3	2910.9	2639.0	2632.2	2291.8	3219.6	3291.4	2584.0
1924-25	2636.9	2388.2	2669.1	2491.3	1945.0	3196.9	2939.8	2294.0
1925-26	2205.9	2168.8	2110.0	2052.4	1773.6	2730.6	2727.2	2009.0
1926-27	2304.4	2283.4	2201.3	2280.6	1979.5	3026.4	3106.5	2209.8
1927-28	2121.7	2309.6	1893.6	2051.0	1970.0	2853.0	2846.3	2105.9
1928-29	3885.2	3105.7	2873.3	3681.9	3032.3	3634.4	3163.3	3248.3
1929-30	3652.1	2940.9	3218.4	3626.1	2969.4	3206.9	3004.6	3181.9
1930-31	3392.0	2843.4	2619.4	3688.7	2903.4	2159.6	2950.5	3106.4
1931-32	5130.7	3825.2	3780.0	4984.8	3876.0	4214.9	4050.5	4216.1
1932-33	3894.9	3237.6	3471.7	4120.1	3283.2	3469.1	3634.5	3557.6
1933-34	4005.2	3368.5	2840.3	4315.1	3484.7	3412.9	3658.7	3683.7
1934-35	4013.3	3355.3	2794.5	3916.1	3379.3	3514.2	3256.7	3500.1
1935-36	3039.7	2403.6	2165.1	2868.9	2287.3	2527.6	2222.2	2475.2
1936-37	3627.1	2871.1	2563.8	3400.9	2702.2	3681.4	3068.1	2966.6
1937-38	3815.6	3031.4	2830.8	3592.1	2907.9	4277.2	3123.2	3156.0
1938-39	3783.4	3159.2	2293.9	3758.3	3027.1	3077.4	3105.4	3232.3
1939-40	3413.9	3069.3	2093.5	3622.6	3142.1	3452.2	3427.3	3231.4
1940-41	4356.4	3360.2	3005.5	3601.2	2925.5	3918.0	3290.6	3251.2
1941-42	2312.9	2477.4	1552.3	2472.2	2155.5	1748.9	2357.6	2271.3
1942-43	4741.7	3193.1	3769.7	3806.7	2846.0	3871.6	3435.0	3313.8
1943-44	3405.4	2616.0	2597.5	2957.4	2209.7	3123.4	2843.6	2578.6
1944-45	3051.6	2452.2	1970.3	2746.8	2257.9	2879.9	2753.2	2464.0
1945-46	4128.5	2854.3	3017.5	3973.7	2730.0	3531.8	3287.4	3186.6
1946-47	3900.0	3231.4	2621.2	3849.7	3061.0	3176.0	3588.4	3337.5
1947-48	4075.9	2796.2	2549.5	3831.7	2552.8	3186.8	2979.0	3014.3
1948-49	4342.6	3000.5	3317.0	4107.7	2791.4	3532.6	3455.1	3305.4
1949-50	2051.9	2094.4	2539.9	4291.9	2400.6	3147.9	3054.1	2911.6
1950-51	4612.3	3541.3	2582.5	5095.5	3516.6	3763.5	3964.7	3960.7
1951-52	4137.3	2621.7	2678.9	3453.5	2425.0	2513.7	2763.4	2824.1
1952-53	3245.8	2546.1	2113.4	3834.7	2697.0	3537.4	3327.6	3013.4
1953-54	4091.9	3517.6	3376.2	4668.5	3517.9	3970.2	4127.7	3882.7
1954-55	4264.9	3017.8	3471.2	5282.0	3285.4	4184.6	3963.2	3877.6
1955-56	4326.4	2695.7	3745.6	4492.6	2796.0	4284.9	3237.1	3378.8
1956-57	4101.2	3295.5	3126.4	4603.8	3249.5	3549.3	3635.3	3670.1
1957-58	3354.6	2745.9	2759.8	4633.3	3082.4	3628.8	3689.7	3486.4

1958-59	3994.9	3453.6	3463.6	4892.1	3422.3	4059.3	4049.2	3890.3
1959-60	4522.1	3682.5	3441.1	5770.1	3914.4	3808.5	4486.3	4413.1
1960-61	4166.1	3004.1	3275.5	4476.0	2886.6	3550.1	3265.5	3424.9
1961-62	4527.8	3736.3	4140.2	5753.4	3896.6	4308.2	4843.5	4475.3
1962-63	1000.9	2598.3	2444.8	800.3	1117.2	1719.9	959.2	1312.5
1963-64	2967.4	2338.2	2990.0	3821.7	2444.9	3891.3	3608.9	2934.5
1964-65	2919.6	2919.1	2927.7	3923.7	2434.9	4105.2	2701.1	2977.2
1965-66	3925.7	2952.4	3154.1	4028.7	2133.6	2975.9	2894.3	2936.5
1966-67	2679.9	2857.0	2339.5	3516.6	2231.2	2560.5	2093.3	2683.1
1967-68	2727.1	1954.0	2720.4	3990.5	1399.6	2741.2	3260.6	2431.2
1968-69	3915.8	2625.0	2509.9	3842.4	2005.8	2954.8	2470.8	2718.3
1969-70	4727.7	3080.4	2815.7	4000.8	2362.1	3438.3	2696.8	3038.9
1970-71	6057.6	3370.5	3233.0	4617.4	2284.6	3952.4	2982.4	3303.1
1971-72	1955.9	1654.6	2460.4	2112.1	1688.5	2523.8	1895.6	1867.9
1972-73	2010.0	2413.8	1752.2	1917.6	1724.0	2464.1	2002.9	1910.6
1973-74	3376.9	3497.3	3041.6	3772.9	2260.3	2985.2	2094.7	2922.6
1974-75	4318.0	3443.7	3215.4	3885.4	1925.8	3334.1	2078.0	2844.1
1975-76	4700.7	3087.7	3141.1	4835.9	2890.8	3817.1	3827.6	3585.1
1976-77	2332.5	2063.6	2747.9	2315.2	2062.2	2379.8	1930.8	2170.6
1977-78	2856.1	2191.0	3081.5	4315.7	2341.5	3942.5	4974.9	3097.9
1978-79	2559.0	3273.6	2685.2	5362.2	3101.9	3148.4	6133.4	3904.5
1979-80	2952.8	3170.4	2290.5	3838.0	3276.3	2561.1	4737.3	3443.1
1980-81	3233.4	3391.3	2606.0	6595.3	3812.8	2953.6	6789.8	4615.9
1981-82	4642.7	4270.0	3361.8	4788.6	4534.2	4134.4	5611.3	4573.0
1982-83	4186.6	5615.4	3099.6	4704.7	4129.3	3673.3	4981.4	4503.0
1983-84	4407.0	4052.9	3731.7	4846.3	3831.2	4391.5	4868.7	4224.1
1984-85	3510.1	4159.6	2586.1	3876.6	3501.7	3157.2	4329.7	3703.2
1985-86	3899.1	4518.4	2919.5	3640.4	2935.4	3547.1	3710.6	3443.9
1986-87	2795.4	3107.4	1805.9	3150.7	3314.2	1937.4	3206.9	3124.5
1987-88	2900.4	3319.0	2763.3	3548.9	2897.2	2889.5	3253.5	3152.2
1988-89	3748.1	2978.5	3054.0	5567.3	4616.4	3012.4	4619.8	4510.1
1989-90	3511.2	3400.4	2917.9	4106.1	3804.5	2858.2	4381.7	3802.5
1990-91	3750.8	4004.3	2434.1	4673.8	5070.5	2973.1	5006.6	4602.1
1991-92	3290.7	4258.0	2147.7	3696.1	4365.0	2562.1	4310.3	3997.4
1992-93	3844.1	4193.2	2742.7	4197.0	4247.0	3058.3	4659.7	4150.7
1993-94	3313.3	3775.6	2506.2	4607.5	4310.4	2851.5	5058.5	4223.1
1994-95	4068.1	6354.7	2920.8	5976.8	6270.1	3232.7	6444.4	5942.7
1995-96	3573.8	3242.0	3475.3	3671.2	3340.5	3557.9	3139.4	3417.7
1996-97	3296.3	4134.6	3103.4	3841.5	3725.8	3392.3	3401.5	3744.8
1997-98	4042.1	4684.9	3483.4	5026.6	5204.7	3665.7	5699.7	4973.0
1998-99	4866.8	4107.9	3285.3	4978.1	3241.6	3581.7	4603.0	3986.8
1999-00	4245.4	3854.6	3673.2	4772.6	4607.9	3755.7	5276.5	4519.2
2000-01	4424.4	3655.6	3347.6	4115.6	3762.8	3385.4	4233.4	3870.4
2001-02	3082.1	2771.0	2001.9	3192.2	3342.7	2469.3	3752.3	3158.0
2002-03	2788.4	2811.5	2189.5	3448.9	3225.2	2582.6	3858.7	3192.8
2003-04	3354.9	3212.2	2804.7	3644.5	4359.2	3176.0	3087.3	3785.7
2004-05	2803.4	3570.1	2044.2	3053.6	4865.7	2616.2	2077.4	3760.3
2005-06	3554.8	3880.6	3771.0	4751.7	4232.7	3317.8	4249.6	4270.9
2006-07	5917.5	3907.0	2620.3	6801.1	5300.4	2994.2	6072.4	5412.0
2007-08	3916.7	4134.8	3630.7	5062.1	5126.5	3560.1	5180.1	4837.2
2008-09	4832.6	3491.9	2829.9	4603.7	4310.5	2680.3	4172.8	4185.8
2009-10	3939.4	3936.5	3180.7	4219.4	4241.2	3728.2	4638.8	4145.8
2010-11	4072.2	2575.4	3744.7	4752.6	3093.5	4328.9	3421.9	3561.6
2011-12	4270.2	4429.9	3172.8	5016.8	4708.9	3989.1	3814.8	4586.2
2012-13	3442.1	3409.3	2864.0	4169.7	3733.6	3518.9	3093.4	3700.8
Average	**3399.8**	**3007.7**	**2785.3**	**3700.8**	**2900.2**	**3248.0**	**3477.3**	**3182.7**

Length of the Data to be used for Analysis

889. The Tribunal notices that varying length of data sets have been used in different Reports by the Experts for the purpose of development of Rainfall-Runoff model i.e., the linear regression equation and for generation of runoff series to be used for assessment of water availability, at different dependability, of the Mahadayi river basin.

890. Though the Tribunal has decided not to utilize the CWC Report of 2003, limited information in respect of length of data, used for analysis is mentioned, only for the purpose of examining the length of the data necessary for assessment of water availability. In the Report of CWC of 2003 (Volume 15), the rainfall and runoff data set of 10 years i.e., for the years 1979-80, 1985-86 to 1987-88, 1989-90, 1991-92 to 1994-95 and 1997-98, have been used for development of Rainfall-Runoff model and rainfall data of 70 years, (from 1928-29 to 1997-98) have been used for generation of runoff series to assess the water availability of the Mahadayi river basin at 75% dependability and 50% dependability.

891. In the Report of Prof. A. K. Gosain of August 2015 (Volume 166), the rainfall and runoff data set of 25 years i.e., for the years 1979-80, 1981-82, 1985-86 to 1987-88, 1889-90, 1991-92 to 1998-1999, 2000-01 to 2005-06, 2007-08 to 2009-10, and 2012-13, have been used for development of Rainfall-Runoff model and rainfall data of 85 years (from 1928-29 to 2012-13), have been used for generation of runoff series to assess the water availability of the Mahadayi river basin at 75% dependability and 50% dependability.

892. In the Report of Prof. A. K. Gosain of May 2017 (Volume 198 & 198A), the rainfall and runoff data set of 34 years (from 1979-80 to 2012-13) have been used for development of Rainfall-Runoff model and rainfall data of 85 years (from 1928-29 to 2012-13), have been used for generation of runoff series to assess the water availability of the Mahadayi river basin at 75% dependability and 50% dependability.

893. Shri Chetan Pandit, in his Report of August 2016 (Volume 191) has used the rainfall and runoff data set of 27 years (from 1979 to 2005) for development of Rainfall-Runoff model and rainfall data of 42 years (from the 1964 to 2005) have been

used for generation of runoff series to assess the water availability of the Mahadayi river basin at 75% dependability and 50% dependability.

894. Shri S. N. Huddar, Expert Witness of the State of Maharashtra in his Report of September 2015 [Volume 163(a)] has not used the rainfall data. Instead, he has used the runoff series derived on the basis of the observed discharge data at Virdi Gauging Station of the State of Maharashtra, for 25 years (from 1986 to 2004 and from 2005 to 2011) for assessment of (a) water availability at 75% dependability, (b) water availability at 50% dependability and (c) average annual water availability for the Maharashtra portion only.

895. Thus, the Experts have used different length of data (a) varying from 10 years to 34 years for development of Rainfall-Runoff model, and (b) varying from 25 years to 85 years for generation of runoff series to assess the water availability at different dependabilities.

896. The Tribunal has noticed that none of the Reports filed by the States have undertaken the studies in respect of

external consistency checks and that related to checking the presence of trend in the data series and applied the corrections to address the presence of trend, wherever necessary. In this regard, Shri S. N. Huddar, was asked question No. 13 regarding the trend analysis and need for applying corrections for trend by the Tribunal on 14.11.2017. The specific question and answer to the question by Shri Huddar are reproduced hereunder.

> "Q.No.13.
> …
> a. Why necessary investigations, particularly those related to trend analysis in the data, were not undertaken by you before development of Rainfall-Runoff Equation and accepting the same as correct?
> b. Keeping in view the presence of rising trend in the rainfall data, would it be appropriate to use the past data i.e., data for the period from 1928 to 1978 without applying necessary corrections for the same?
>
> Ans. Para wise reply is as under:
> (a). As already stated in answer to previous question, I have restricted my scope to checking of the equation developed by the CWC, and hence, no independent investigation was done by me.
> (b). At present Hydrologists use the past record to the extent, which is readily available. Of course, it would be desirable to use the data after applying necessary correction for the same."

897. The Tribunal finds that the “Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects” of the Government of India, Ministry of Water Resources published in 2010 provides for use of a maximum of 40 years of data for hydrological studies. The document “Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects” of the Government of India, Ministry of Water Resources published in 2010 was shown to both Shri Chetan Pandit as well as Prof. Gosain during their cross examination and is marked as MARK-5. Regarding the length of the data, specific question was also put to Prof. Gosain by the Tribunal. The question No. 33 and the reply thereof are reproduced hereunder.

> “Q.No.33. The Chapter II of the “Guidelines for Preparation of Detailed Project Report of Irrigation and Multipurpose Projects”, of the Ministry of Water Resources, already on record as MARK-5, and a copy of which has already been handed over to you, suggests the time unit and length of the data required for hydrological analysis. For a complex system, the minimum length of data required for simulation has been suggested as 40 years. We find that at the time of preparation of your Report, observed hydrological data of about 34 years were available. You have extended the series to about 85 years, from the year 1928 to 2012, by

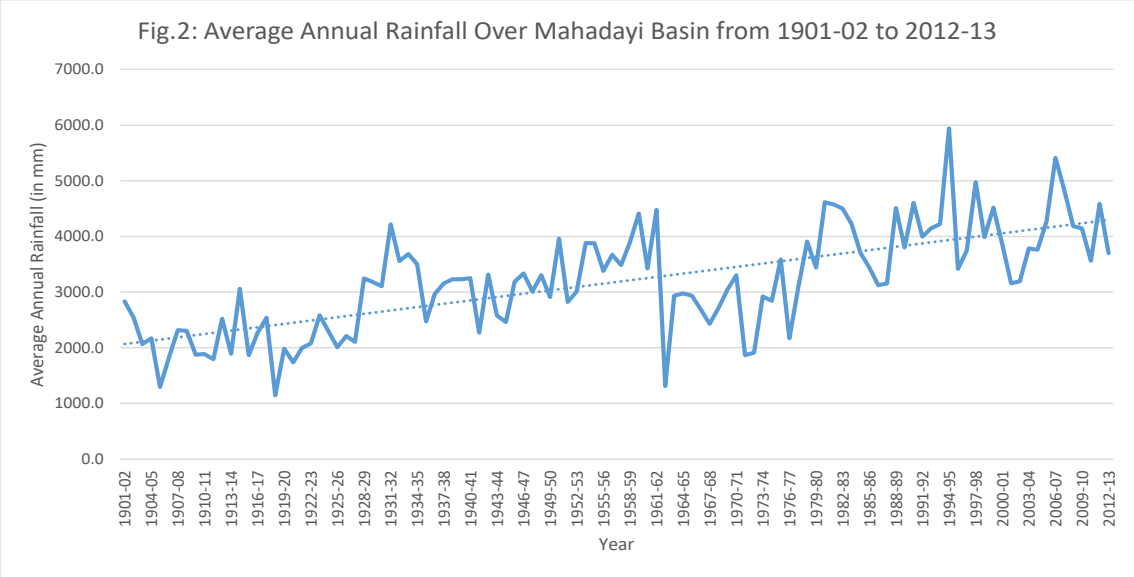
using long term rainfall data, and linear regression equation, developed for the purpose.

Why do you feel the need for extending the series for 85 years, and not restrict it only to about 40 years, which could be considered as adequate, as per the Guidelines?

Ans. In the document, MARK-5, made available to me, the 40 years recommended length of data is with respect to A4 type of projects. For type A3, the recommended length is 25 years. I would also like to refer to the document MARK-1, (Annex 2.4 on page A2.1-11, thereof), rainfall-runoff correlation method has been suggested even for short term data of 5 to 10 years, at para 2. Therefore, although the requirement of a data is associated with the type of the specific project in question, and that is the major emphasis of these manuals, the present study is more in terms of evaluating the yield of the basin, without referring to any specific project. For the purpose, a data length of around 30 years is more than reasonable, for developing reliable R-R equation."

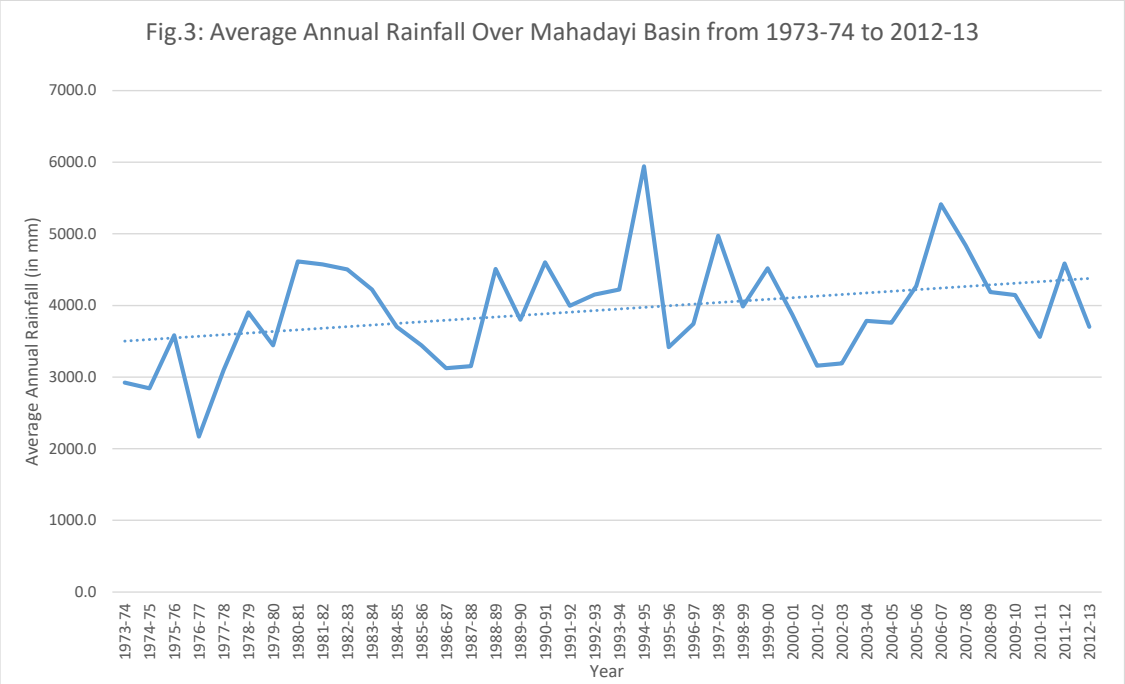
898. In view of above, the series of annual average rainfall values over the Mahadayi basin for 112 years (from 1901-02 to 2012-13) has been analyzed by the Tribunal to examine the presence of trend. The plot of the annual average rainfall of 112 years is shown in Fig.2 below, which clearly indicates a rising trend. Statistical tests were made by the Tribunal as per the

procedure laid down in "Chapter A3 – Statistical Methods in Water Resources by D.R. Helsel and R.M. Hirsch of Book 4, Hydrologic Analysis and Interpretation" (MARK-32) to ascertain whether the trend is significant or not. The value of '**t**' was found to be 10.22 which is considerably higher than the value of '$\mathbf{t_{crit}}$', i.e., 2.6. Thus the trend is significant.



899. In view of the provisions in the "Guidelines for Preparation of Detailed Project Reports of Irrigation and Multipurpose Projects" of the Government of India, Ministry of Water Resources published in 2010 (MARK-5), a series of 40 years of most recent available data of annual average rainfall over the Mahadayi river basin for the years from 1973-74 to 2012-13 has

been plotted to check the presence of trend, if any, and the same is shown in Fig.3 herein below. The Fig.3 also exhibits presence of rising trend, though with very mild slope. Statistical tests were made as per the procedure laid down in “Chapter A3 – Statistical Methods in Water Resources by D.R. Helsel and R.M. Hirsch of Book 4, Hydrologic Analysis and Interpretation” to ascertain whether the trend is significant or not. This document was shown to Shri S. N. Huddar, Expert Witness for the State of Maharashtra and the same has been marked as MARK-32 The value of ‘t’ was found to be 2.36 which is less than the value of ‘t_{crit}’, i.e., 2.6. Thus the trend is insignificant and hence, no correction is needed in the series of 40 years of recent available data of annual average rainfall over Mahadayi river basin as far as ‘trend’ is concerned.



900. In view of above position, the Tribunal has decided to use the most recent available data of 40 years (from 1973-74 to 2012-13) of the Annual Average Rainfall over the entire Mahadayi river Basin for generation of the runoff series for assessing the water availability. The daily rainfall data of the seven Grid Points and the average thereof, the computed monthly and annual rainfall data are being reproduced after para 923 of this Report.

Transforming the Annual Rainfall into Annual Runoff – Choice of Model

901. The Tribunal has observed that the model developed and used in different Reports filed by the States of Goa, Karnataka and Maharashtra and that by the Expert Witnesses are simple linear regression equation of the form "Runoff (R) = A x Rainfall (P) + B". Thus all the models are primarily of the same form. However, the values of the parameters 'A' and 'B' differ in view of the input values i.e., the values of rainfall and runoff used by the Experts for estimating these parameters.

902. Simple linear regression equations developed and used by the Experts in their respective Reports are summarized as under.

Sl. No.	**Report**	**Equation**
1.	Report of CWC of 2003 – Para 3.3, page 10, Vol. 15	R = 0.87891 x P – 49.6451
2.	Report of Shri S. N. Huddar of September 2015 – Para 12, page 34, Vol. 163(a)	R = 0.8791 x P – 50.106
3.	Report of Prof. A. K. Gosain	R = 0.7368 x P + 432.28

	of September 2015 – Para 7.4.2, page 43, Vol. 166	
4.	Report of Shri Chetan Pandit of August 2016 – page 57, Vol. 191	R = 0.689 x P – 115.454
5.	Report of Shri Chetan Pandit of August 2016 – Table 33, page 93, Vol. 191	R = 0.692967 x P – 168.195
6.	Report of Prof. A. K. Gosain of May 2017 – Para 3.4.1, page 6, Vol. 198	R = 0.749 x P + 214.2
7.	Equation developed by the State of Goa using the gridded rainfall data and submitted to the Tribunal during the arguments (Page 12, Vol. 237D)	R = 0.7904 x P – 219.619
8.	Equation developed by the State of Karnataka using the gridded rainfall data and submitted to the Tribunal during the arguments (Page 1, Vol. 238A)	R = 0.981 x P – 269.2

903. As already discussed in the preceding paras, the above mentioned linear regression equations have been derived by using the rainfall and runoff data. The data used by CWC as also

by Prof. Gosain and that by Shri Chetan Pandit are, however, not found reliable due to the reasons explained in earlier paragraphs. Shri S. N. Huddar has used the data of CWC, which is, in itself, not reliable. Therefore, none of the above equations can be considered as reliable and worth adopting for independent analysis and assessment of water availability. The Tribunal has, therefore, no option but to adopt an appropriate empirical formula.

904. A most commonly used empirical formula which is based on the data of Western Ghats is the Inglis and De Douza Formula, most commonly called as Inglis Formula. The Inglis Formula for Ghat area is: R = 0.85 x P – 305, where values of runoff (R) and precipitation (P) are in mm.

905. The Tribunal also notes that Inglis Formula is, in fact, included as one of the Rainfall-Runoff models developed for specific regions in India in the Report titled “Development of Hydrological Design Aids (Surface Water) under Hydrology Project II – State of the Art Report, July 2010” of the Government of India, Ministry of Water Resources, Central Water Commission

[MARK-1]. Relevant Extract from MARK-1 related to Inglis Formula are reproduced as under.

> "***Inglis and De Souza's Formula (1946)***
> Inglis and De Souza used data from 53 stream gauging sites in Western India. He studied catchments in western ghats and plains of Maharashtra, India and gave the following relationships.
> For ghat areas R = 0.85 P – 30.5
> ….
> Where R = runoff (cm)
> P = precipitation (cm)"

906. The State of Goa at Para 154B, page 159 of the Statement of Case of the State of Goa (Volume 131) has, adversely commented about the Inglis Formula that the same is "an empirical outdated and unrealistic formula". However, the Tribunal finds that the Inglis Formula is, in fact, a simple linear regression equation of the same form which has been derived and used by all the Expert Witnesses for Mahadayi river basin.

907. Shri Chetan Pandit was asked a specific question relating to estimation of water availability in the event of hydrological and hydro-meteorological data being either inadequate or not at all available. The relevant part of question

No. 153 put to Shri Pandit by the Tribunal on 5.10.2016 and his reply, are reproduced hereunder.

> "Q.No.153.
> …
> c) How will you proceed with the process of estimation of water availability at a specific point along a river for a basin or sub-basin in India when the available hydrological and hydro-meteorological data are not adequate?
> d) Is it possible to estimate the availability of water at a specific point along a river for a basin or sub-basin in India if requisite hydrological and hydro-meteorological data are not at all available? If yes, please tell us about commonly used procedures very briefly.
> Ans.
> c & d) If the inadequacy is so high that even the process of filling a few missing data does not serve the purpose, then the entire approach explained above will have to be changed. The extreme case of inadequate data is – no data. Many years ago a British Engineer by name Strange developed a Table, which is known as Strange's table which helps determine the water availability based on only a few parameters like the catchment area, mean annual rainfall etc. Such methods are called empirical methods. For other aspects of hydrologic analysis, viz., flood studies etc., there are other empirical formulae available viz., Inglis Formula, Nawab Sher Bahadur Jung Formula etc. These formulae may be used. But empirical formulae will give only a water availability figure without any attached dependability like 50%, 75% etc.

> CWC has also done some studies called "Regional Hydrologic Studies" where hydrology of an entire region is studied and this can be used. In short, compromises will have to be made and it will have to be kept in view that the outcome is less reliable."

908. Further, in his reply to the question No. 172, put to him by the Tribunal on 5.10.2016, Shri Chetan Pandit, inter-alia, has stated as under.

> "… The practice of hydrology continues with rather simple techniques like linear regression for monsoon or annual rainfall and runoff. …"

909. Similarly Prof. A. K. Gosain, in his reply to question No. 35, put to him by the Tribunal on 14.7.2017 mentioned about the use of Inglis Formula. The question No. 35 and the reply thereof by Prof. Gosain are as under.

> "Q.No.35. At Para 4, page 3 of the additional affidavit dated 15.11.2016 (Volume 193), you have mentioned that "the methods deployed by the respective departments to estimate the water yield have been variable since there is no unique approach that is universally used".

Please name the various departments and the methods deployed by each of them to estimate the water yield.

Ans. I do not have the record of which Department has used which method for estimating water yield, however, I can tell that the methods employed by the various Departments ranged from empirical relationships, such as Inglis Formula, and Rational method to approaches such as Area Proportion method."

910. The Tribunal also notices that the State of Goa has used the Inglis Formula for estimation of runoff from rainfall data in the detailed project reports (DPR) of at least 49 proposed projects in Mahadayi basin, namely, (i) Sonal – I [Volume 103(b)], (ii) Sonal [Volume 103(a)], (iii) Shelpi [Volume 103(d)], (iv) Bimbal – I [Volume 103(f)], (v) Ganjem [Volume 103(h)], (vi) Usgao [Volume 103(i)], (vii) Mandovi Nanoda [Volume 103(j)], (viii) Iverkhurd [Volume 103(k)], (ix) Golali [Volume 103(m)], (x) Thane [Volume 103(n)], (xi) Dongurwada [Volume 103(o)], (xii) Thane – I [Volume 103(p)], (xiii) Naneli – I [Volume 103(q)], (xiv) Pale [Volume 103(r)], (xv) Naneli – II [Volume 103(s)], (xvi) Zarme [Volume 103(t)], (xvii) Ragada – I [Volume 103(u)], (xviii) Ragada – II [Volume 103(v)], (xix) Nandran [Volume 103(w)], (xx) Avardo [Volume 103(x)], (xxi) Nandran – I [Volume 103(y)], (xxii) Jamboli [Volume 103(z)], (xxiii) Satpal [Volume 103(ab)], (xxiv) Fatiyagal

[Volume 103(ac)], (xxv) Ragada – III [Volume 103(ad)], (xxvi) Udalshem [Volume 103(ae)], (xxvii) Kumbharwada [Volume 103(af)], (xxviii) Shivde [Volume 103(ag)], (xxix) Paikul [Volume 103(ah)], (xxx) Melavali [Volume 103(ai)], (xxxi) Sonawali – I [Volume 103(aj)], (xxxii) Sonawali – II [Volume 103(ak)], (xxxiii) Mayda [Volume 103(al)], (xxxiv) Karanzol [Volume 103(am)], (xxxv) Khandepar [Volume 103(an)], (xxxvi) Ghatakwada [Volume 103(ao)], (xxxvii) Nayawada [Volume 103(ap)], (xxxviii) Dongurli [Volume 103(aq)], (xxxix) Kharamol [Volume 103(ar)], (xl) Kharamol – II [Volume 103(as)], (xli) Matujanwada [Volume 103(at)], (xlii) Kajumol [Volume 103(au)], (xliii) Suktoli [Volume 103(av)], (xliv) Tatodi [Volume 103(aw)], (xlv) Nirankal [Volume 103(ax)], (xlvi) Ponsule [Volume 103(ay)], (xlvii) Kodar [Volume 103(az)], (xlviii) Keri [Volume 103(aa)], and (xlix) Advalpal [Volume 103(bb)].

911. In view of above, the Tribunal decides to use Inglis Formula as a reasonable approach, particularly in view of the fact that the rainfall and the runoff data sets used by the State of Goa and that by the State of Karnataka cannot be relied upon.

Generation of Annual Runoff Series and Estimation of Water Availability for the Entire Basin

912. Using the Annual Average Rainfall of 40 years (i.e., from 1973-74 to 2012-13) as given in the Table-3, and adopting the Inglis Formula, annual runoff series of 40 years is generated for the Mahadayi river basin by the Tribunal and the same is shown in Table-4.

Table-4: Computation of Annual Runoff for Mahadayi River Basin

Year	Average Annual Rainfall (in mm) for Entire Mahadayi Basin (2032 sq.km.)	Annual Runoff (in mm) for Entire Mahadayi Basin (2032 sq.km.) - [(Rainfall in Col.2)*0.85 - 305]	Annual Runoff Series for Entire Mahadayi Basin [of Col.3] in Descending Order	Rank No.	Dependability
1	2	3	4	5	6
1973-74	2922.6	2179.2	4746.3	1.0	2.4
1974-75	2844.1	2112.5	4295.2	2.0	4.9
1975-76	3585.1	2742.3	3922.0	3.0	7.3
1976-77	2170.6	1540.0	3806.6	4.0	9.8
1977-78	3097.9	2328.2	3618.5	5.0	12.2
1978-79	3904.5	3013.8	3606.8	6.0	14.6
1979-80	3443.1	2621.7	3593.3	7.0	17.1
1980-81	4615.9	3618.5	3582.0	8.0	19.5
1981-82	4573.0	3582.0	3536.4	9.0	22.0
1982-83	4503.0	3522.6	3528.6	10.0	24.4
1983-84	4224.1	3285.5	3522.6	11.0	26.8
1984-85	3703.2	2842.7	3325.2	12.0	29.3
1985-86	3443.9	2622.3	3285.5	13.0	31.7
1986-87	3124.5	2350.9	3284.7	14.0	34.1
1987-88	3152.2	2374.4	3252.9	15.0	36.6
1988-89	4510.1	3528.6	3223.1	16.0	39.0
1989-90	3802.5	2927.1	3219.0	17.0	41.5
1990-91	4602.1	3606.8	3092.8	18.0	43.9
1991-92	3997.4	3092.8	3083.8	19.0	46.3
1992-93	4150.7	3223.1	3013.8	20.0	48.8
1993-94	4223.1	3284.7	2984.8	21.0	51.2
1994-95	5942.7	4746.3	2927.1	22.0	53.7
1995-96	3417.7	2600.0	2912.8	23.0	56.1
1996-97	3744.8	2878.1	2891.3	24.0	58.5

1997-98	4973.0	3922.0	2878.1	25.0	61.0
1998-99	3986.8	3083.8	2842.7	26.0	63.4
1999-00	4519.2	3536.4	2840.7	27.0	65.9
2000-01	3870.4	2984.8	2742.3	28.0	68.3
2001-02	3158.0	2379.3	2722.3	29.0	70.7
2002-03	3192.8	2408.9	2622.3	30.0	73.2
2003-04	3785.7	2912.8	2621.7	31.0	75.6
2004-05	3760.3	2891.3	2600.0	32.0	78.0
2005-06	4270.9	3325.2	2408.9	33.0	80.5
2006-07	5412.0	4295.2	2379.3	34.0	82.9
2007-08	4837.2	3806.6	2374.4	35.0	85.4
2008-09	4185.8	3252.9	2350.9	36.0	87.8
2009-10	4145.8	3219.0	2328.2	37.0	90.2
2010-11	3561.6	2722.3	2179.2	38.0	92.7
2011-12	4586.2	3593.3	2112.5	39.0	95.1
2012-13	3700.8	2840.7	1540.0	40.0	97.6
	3941.1	**3045.0**			

913. The Table-4 also indicates the dependability assigned to each of the values of annual runoff for 40 years by putting the same in descending order. From this Table, (i) the average annual water availability of Mahadayi river basin and (ii) the water availability at 75% dependability, are estimated by the Tribunal as under.

Description	**Water availability (in mm / Mcum / tmc)**
Average annual water availability of Mahadayi river basin (for entire catchment area of 2032 sq.km.)	3045.0 mm i.e., 6187.4 Mcum i.e., 218.41 tmc

Water availability of Mahadayi river basin (for entire catchment area of 2032 sq.km.) at 75% dependability	2621.8 mm i.e., 5327.5 Mcum i.e., 188.06 tmc

Assessment of Water Availability (a) For the Catchment Area of Mahadayi river basin in the State of Karnataka, (b) For the Catchment Area of Mahadayi river basin in the State of Maharashtra, and (c) For various project Sites in the States of Karnataka and Maharashtra

914. As in the case of entire Mahadayi river basin, the water availability has also been assessed for (a) the catchment area of Mahadayi river and its tributaries in the State of Karnataka, (b) the catchment area of tributaries of Mahadayi river basin in the State of Maharashtra, and (c) the catchment areas of the proposed project Sites in the States of Karnataka and Maharashtra by using the same approach viz., (i) using the rainfall values of recent 40 years (from 1973-74 to 2012-13) estimated by IMD at the concerned Grid Points, and (ii) applying Inglis Formula for generation of runoff series. For the proposed project sites in the territory of Karnataka and Maharashtra, water availability at 90% dependability has also been computed in addition to the

average annual water availability and water availability at 75% dependability.

915. The specific Grid Point (s), whose rainfall values are used by the Tribunal for the aforesaid purpose, are as under.

Sl. No.	Details of Catchment Area	Corresponding Grid Point (s)
1.	Catchment area of Mahadayi river and its tributaries in the State of Karnataka (for catchment area of 375 sq.km.)	Grid Points 74°15'E 15°15'N, 74°15'E 15°30'N and 74°E 15°45'N
2.	Catchment area of tributaries of Mahadayi river in the State of Maharashtra (for catchment area of 77 sq.km.)	Grid Point 74°E 15°30'N and 74°E 15°45'N
3.	Kalasa dam (including Haltara and Surla diversion) with catchment area of 25.50 sq.km.	Grid Point 74°15'E 15°30'N
4.	Bhandura dam with catchment area of 32.25 sq.km.	Grid Point 74°15'E 15°30'N
5.	Kotni dam (including Bhandura dam catchment and diversion of Irti, Bailnadi) with catchment area of 125.44 sq.km.	Grid Point 74°15'E 15°30'N
6.	Kotni dam site (independent	Grid Point 74°15'E

	catchment) with catchment area of 93.19 sq.km.	15°30'N
7.	Bailnadi with catchment area of 32.33 sq.km.	Grid Point 74°15'E 15°30'N
8.	Irti dam site with catchment area of 8.78 sq.km.	Grid Point 74°15'E 15°30'N
9.	Irti Pick-up dam (independent catchment) with catchment area of 9.91 sq.km.	Grid Point 74°15'E 15°30'N
10.	Katla-Palna diversion with catchment area of 22.50 sq.km.	Grid Point 74°15'E 15°15'N
11.	Diggi diversion with catchment area of 15.60 sq.km.	Grid Point 74°15'E 15°15'N
12.	Viranjole diversion with catchment area of 9.50 sq.km.	Grid Point 74°15'E 15°30'N
13.	Virdi Large Minor Irrigation Project of Maharashtra with catchment area of 8.25 sq.km.	Grid Point 74°E 15°45'N

916. The rainfall values related to (a) the catchment area of Mahadayi river and its tributaries in the State of Karnataka, and (b) the catchment area of tributaries of Mahadayi river basin in the State of Maharashtra have accordingly been computed and the same are shown in Table-5. The Table-5 also indicates the corresponding values of the runoff computed by using Inglis

Formula and the percentile dependability value associated with each value of the runoff.

Table-5: Annual Runoff from Catchment Areas of Mahadayi River Basin in Territory of Karnataka and Maharashtra

Year	Average rainfall over basin area in Karnataka - Weighted av. of rain at GP 74°15'E 15°15'N, 74°15'E 15°30'N & 74°E 15°45'N	Average rainfall over basin area in Maharashtra - Weighted av. of rain at GP 74°E 15°30'N & 74°E 15°45'N	Annual Runoff for basin area in Karnataka - [(Col.2)*0.85 - 305]	Annual Runoff for Basin Area in Maharashtra - [(Col.3)*0.85 - 305]	Annual Runoff Series of Karnataka Area (Col. 4) in Descending Order	Annual Runoff Series of Maharashtra Area (Col. 5) in Descending Order	Rank No.	Depend -ability
1	2	3	4	5	6	7	8	9
1973-74	2395.1	2279.3	1730.9	1632.4	5034.8	5448.1	1	2.4
1974-75	2096.6	2276.8	1477.1	1630.3	4078.7	5129.0	2	4.9
1975-76	2926.7	3938.5	2182.7	3042.7	4076.3	4924.7	3	7.3
1976-77	2060.4	1973.1	1446.3	1372.1	3959.6	4836.3	4	9.8
1977-78	2364.3	4902.4	1704.7	3862.0	3903.5	4476.8	5	12.2
1978-79	3166.4	6048.6	2386.5	4836.3	3673.1	4387.7	6	14.6
1979-80	3286.5	4638.4	2488.5	3637.6	3659.8	4132.9	7	17.1
1980-81	3810.7	6768.4	2934.1	5448.1	3549.2	4087.1	8	19.5
1981-82	4521.0	5520.8	3537.9	4387.7	3537.9	3952.6	9	22.0
1982-83	4307.0	4951.0	3356.0	3903.3	3464.4	3919.5	10	24.4
1983-84	3871.4	4866.2	2985.7	3831.3	3394.5	3903.3	11	26.8
1984-85	3587.1	4279.9	2744.1	3332.9	3356.0	3862.0	12	29.3
1985-86	3122.7	3702.9	2349.3	2842.4	3317.9	3831.3	13	31.7
1986-87	3289.6	3200.7	2491.2	2415.6	3305.1	3710.4	14	34.1
1987-88	2949.4	3286.0	2202.0	2488.1	3279.9	3642.6	15	36.6
1988-89	4434.6	4724.0	3464.4	3710.4	3276.3	3637.6	16	39.0
1989-90	3768.3	4351.4	2898.1	3393.7	3275.9	3612.5	17	41.5
1990-91	4951.2	4970.0	3903.5	3919.5	3259.8	3598.8	18	43.9
1991-92	4352.3	4242.7	3394.5	3301.3	2985.7	3393.7	19	46.3
1992-93	4247.2	4608.8	3305.1	3612.5	2934.1	3354.1	20	48.8
1993-94	4262.3	5008.9	3317.9	3952.6	2898.1	3332.9	21	51.2
1994-95	6282.1	6393.0	5034.8	5129.0	2896.4	3301.3	22	53.7
1995-96	3326.6	3197.9	2522.6	2413.2	2889.3	3282.4	23	56.1
1996-97	3766.3	3449.9	2896.4	2627.4	2829.8	3282.2	24	58.5
1997-98	5154.4	5625.7	4076.3	4476.8	2744.1	3050.0	25	61.0
1998-99	3358.2	4644.3	2549.5	3642.6	2549.5	3042.7	26	63.4
1999-00	4534.3	5221.1	3549.2	4132.9	2522.6	2936.6	27	65.9
2000-01	3758.0	4220.4	2889.3	3282.4	2491.2	2842.4	28	68.3
2001-02	3285.4	3690.7	2487.6	2832.1	2488.5	2832.1	29	70.7
2002-03	3188.8	3813.6	2405.5	2936.6	2487.6	2728.0	30	73.2

2003-04	4212.8	3148.6	3275.9	2371.3	2405.5	2627.4	31	75.6
2004-05	4680.1	2184.8	3673.1	1552.1	2386.5	2488.1	32	78.0
2005-06	4193.9	4304.8	3259.8	3354.1	2349.3	2425.0	33	80.5
2006-07	5157.3	6152.6	4078.7	4924.7	2279.8	2415.6	34	82.9
2007-08	5017.2	5167.1	3959.6	4087.1	2202.0	2413.2	35	85.4
2008-09	4217.6	4220.2	3279.9	3282.2	2182.7	2371.3	36	87.8
2009-10	4213.3	4592.7	3276.3	3598.8	1730.9	1632.4	37	90.2
2010-11	3040.9	3568.3	2279.8	2728.0	1704.7	1630.3	38	92.7
2011-12	4664.5	3947.0	3659.8	3050.0	1477.1	1552.1	39	95.1
2012-13	3688.0	3211.8	2829.8	2425.0	1446.3	1372.1	40	97.6
Average	**3837.8**	**4269.6**	**2957.1**	**3335.0**				

917. Table-6 shows the annual rainfall values of corresponding Grid Point(s) related to various identified projects in Mahadayi river basin in the State of Karnataka, the corresponding values of runoff computed by using Inglis Formula, and the percentile dependability value associated with each value of the computed runoff.

Table-6: Annual Runoff for Proposed Projects in Mahadayi River Basin in the State of Karnataka

Year	Average Annual Rainfall (in mm) for Projects at Kalasa, Bhandura, Kotni, Bailnadi, Irti & Viranjole (Grid Point 74°15'E 15°30'N)	Average Annual rainfall (in mm) for Projects at Katla-Palna & Diggi (Grid Point 74°15'E 15°15'N)	Annual Runoff for Projects at Kalasa, Bhandura, Kotni, Bailnadi, Irti and Viranjole - [(Col.2)*0.85 - 305]	Annual Runoff for Projects at Katla-Palna & Diggi - [(Col.3)* 0.85 - 305]	Annual Runoff for Projects at Kalasa, Bhandura, Kotni, Bailnadi, Irti & Viranjole in Descending Order	Annual Runoff (in mm) for Projects at Katla-Palna & Diggi in Descending Order	Rank No.	Depend -ability
1	2	3	4	5	6	7	8	9
1973-74	2260.3	3497.3	1616.3	2667.7	5024.6	5096.5	1	2.4
1974-75	1925.8	3443.7	1331.9	2622.1	4200.3	4468.1	2	4.9
1975-76	2890.8	3087.7	2152.2	2319.5	4119.0	3677.2	3	7.3
1976-77	2062.2	2063.6	1447.9	1449.1	4052.5	3535.6	4	9.8
1977-78	2341.5	2191.0	1685.3	1557.4	4004.9	3460.4	5	12.2
1978-79	3101.9	3273.6	2331.6	2477.6	3830.8	3324.5	6	14.6
1979-80	3276.3	3170.4	2479.9	2389.8	3697.6	3314.3	7	17.1
1980-81	3812.8	3391.3	2935.9	2577.6	3618.9	3259.2	8	19.5
1981-82	4534.2	4270.0	3549.1	3324.5	3611.7	3230.7	9	22.0
1982-83	4129.3	5615.4	3204.9	4468.1	3549.1	3209.6	10	24.4
1983-84	3831.2	4052.9	2951.5	3140.0	3405.3	3209.4	11	26.8
1984-85	3501.7	4159.6	2671.4	3230.7	3400.3	3186.7	12	29.3

1985-86	2935.4	4518.4	2190.1	3535.6	3358.9	3140.0	13	31.7
1986-87	3314.2	3107.4	2512.1	2336.3	3358.8	3098.7	14	34.1
1987-88	2897.2	3319.0	2157.6	2516.2	3305.0	3041.0	15	36.6
1988-89	4616.4	2978.5	3618.9	2226.7	3300.0	3016.0	16	39.0
1989-90	3804.5	3400.4	2928.8	2585.3	3292.8	2993.5	17	41.5
1990-91	5070.5	4004.3	4004.9	3098.7	3204.9	2971.4	18	43.9
1991-92	4365.0	4258.0	3405.3	3314.3	2951.5	2904.3	19	46.3
1992-93	4247.0	4193.2	3305.0	3259.2	2935.9	2802.3	20	48.8
1993-94	4310.4	3775.6	3358.8	2904.3	2928.8	2729.6	21	51.2
1994-95	6270.1	6354.7	5024.6	5096.5	2893.4	2667.7	22	53.7
1995-96	3340.5	3242.0	2534.4	2450.7	2868.6	2663.1	23	56.1
1996-97	3725.8	4134.6	2861.9	3209.4	2861.9	2622.1	24	58.5
1997-98	5204.7	4684.9	4119.0	3677.2	2671.4	2592.9	25	61.0
1998-99	3241.6	4107.9	2450.4	3186.7	2536.3	2585.3	26	63.4
1999-00	4607.9	3854.6	3611.7	2971.4	2534.4	2577.6	27	65.9
2000-01	3762.8	3655.6	2893.4	2802.3	2512.1	2516.2	28	68.3
2001-02	3342.7	2771.0	2536.3	2050.4	2479.9	2477.6	29	70.7
2002-03	3225.2	2811.5	2436.4	2084.8	2450.4	2450.7	30	73.2
2003-04	4359.2	3212.2	3400.3	2425.4	2436.4	2425.4	31	75.6
2004-05	4865.7	3570.1	3830.8	2729.6	2331.6	2389.8	32	78.0
2005-06	4232.7	3880.6	3292.8	2993.5	2324.5	2336.3	33	80.5
2006-07	5300.4	3907.0	4200.3	3016.0	2190.1	2319.5	34	82.9
2007-08	5126.5	4134.8	4052.5	3209.6	2157.6	2226.7	35	85.4
2008-09	4310.5	3491.9	3358.9	2663.1	2152.2	2084.8	36	87.8
2009-10	4241.2	3936.5	3300.0	3041.0	1685.3	2050.4	37	90.2
2010-11	3093.5	2575.4	2324.5	1884.1	1616.3	1884.1	38	92.7
2011-12	4708.9	4429.9	3697.6	3460.4	1447.9	1557.4	39	95.1
2012-13	3733.6	3409.3	2868.6	2592.9	1331.9	1449.1	40	97.6
Average	**3848.1**	**3698.4**	**2965.8**	**2838.6**				

918. The values of average annual water availability and the water availability at 75% dependability for (a) the catchment area of Mahadayi river and its tributaries in the State of Karnataka and (b) the catchment area of tributaries of Mahadayi river basin in the State of Maharashtra has been computed by the Tribunal as under.

Sl. No.	**Catchment in States of Karnataka / Maharashtra**	**Average annual water availability (in mm / Mcum / tmc)**	**Water availability at 75% dependability (in mm / Mcum / tmc)**
1.	Catchment area of	2957.1 mm	2426.0 mm

	Mahadayi river and its tributaries in the State of Karnataka (for catchment area of 375 sq.km.)	i.e., 1108.9 Mcum i.e., 39.14 tmc	i.e., 909.8 Mcum i.e., 32.11 tmc
2.	Catchment area of tributaries of Mahadayi river in the State of Maharashtra (for catchment area of 77 sq.km.)	3335.0 mm i.e., 256.8 Mcum i.e., 9.06 tmc	2652.5 mm i.e., 204.2 Mcum i.e., 7.21 tmc

919. Values of (a) average annual water availability, (b) water availability 75% dependability and (c) water availability at 90% dependability in respect of various proposed projects by the States of Karnataka and Maharashtra have been computed and the results are summarized as under.

Sl. No.	**Various proposed projects in the States of Karnataka and Maharashtra**	**Average annual water availability (in mm / Mcum / tmc)**	**Water availability at 75% dependability (in mm / Mcum / tmc)**	**Water availability at 90% dependability (in mm / Mcum / tmc)**
Proposed Projects in Karnataka				
1.	Proposed Kalasa dam site (including Haltara and Surla diversion) with	2965.8 mm i.e., 75.6 Mcum i.e., 2.67 tmc	2439.9 mm i.e., 62.2 Mcum i.e., 2.19 tmc	1724.2 mm i.e., 43.9 Mcum i.e., 1.55 tmc

	catchment area of 25.50 sq.km.			
2.	Proposed Bhandura dam site with catchment area of 32.25 sq.km.	2965.8 mm i.e., 95.6 Mcum i.e., 3.37 tmc	2439.9 mm i.e., 78.7 Mcum i.e., 2.77 tmc	1724.2 mm i.e., 55.6 Mcum i.e., 1.96 tmc
3.	Proposed Kotni dam site (independent catchment) with catchment area of 93.19 sq.km.	2965.8 mm i.e., 276.4 Mcum i.e., 9.76 tmc	2439.9 mm i.e., 227.4 Mcum i.e., 8.02 tmc	1724.2 mm i.e., 160.7 Mcum i.e., 5.67 tmc
4.	Proposed Kotni dam site (including Bhandura dam catchment and diversion of Irti, Bailnadi) with catchment area of 125.44 sq.km.	2965.8 mm i.e., 372.0 Mcum i.e., 13.13 tmc	2439.9 mm i.e., 306.1 Mcum i.e., 10.80 tmc	1724.2 mm i.e., 216.3 Mcum i.e., 7.63 tmc
5.	Proposed Bailnadi diversion site with catchment area of 32.33 sq.km.	2965.8 mm i.e., 95.9 Mcum i.e., 3.38 tmc	2439.9 mm i.e., 78.9 Mcum i.e., 2.78 tmc	1724.2 mm i.e., 55.7 Mcum i.e., 1.97 tmc
6.	Proposed Irti dam site with catchment area of 8.78 sq.km.	2965.8 mm i.e., 26.0 Mcum i.e., 0.92 tmc	2439.9 mm i.e., 21.4 Mcum i.e., 0.76 tmc	1724.2 mm i.e., 15.1 Mcum i.e., 0.53 tmc
7.	Proposed Irti Pick-up dam site (independent catchment) with catchment area of 9.91 sq.km.	2965.8 mm i.e., 29.4 Mcum i.e., 1.04 tmc	2439.9 mm i.e., 24.2 Mcum i.e., 0.85 tmc	1724.2 mm i.e., 17.1 Mcum i.e., 0.60 tmc
8.	Proposed Katla-Palna diversion scheme with catchment area of 22.50 sq.km.	2838.6 mm i.e., 63.9 Mcum i.e., 2.25 tmc	2431.7 mm i.e., 54.7 Mcum i.e., 1.93 tmc	2053.3 mm i.e., 46.2 Mcum i.e., 1.63 tmc

9.	Proposed Diggi diversion scheme with catchment area of 15.60 sq.km.	2838.6 mm i.e., 44.3 Mcum i.e., 1.56 tmc	2431.7 mm i.e., 37.9 Mcum i.e., 1.34 tmc	2053.3 mm i.e., 32.0 Mcum i.e., 1.13 tmc
10.	Proposed Viranjole diversion scheme with catchment area of 9.50 sq.km.	2965.8 mm i.e., 28.2 Mcum i.e., 0.99 tmc	2439.9 mm i.e., 23.2 Mcum i.e., 0.82 tmc	1724.2 mm i.e., 16.4 Mcum i.e., 0.58 tmc
Proposed Project in Maharashtra				
11.	Virdi Large Minor Irrigation Project of Maharashtra on Kattica Nalla with total catchment area of 8.25 sq.km.	3324.1 mm i.e., 27.4 Mcum i.e., 0.97 tmc	2590.6 mm i.e., 21.37 Mcum i.e., 0.75 tmc	1545.8 mm i.e., 12.75 Mcum i.e., 0.45 tmc

920. It may be noted that the average annual runoff of 3034 mm based on the observed data by the State of Karnataka at Chapoli gauging site reasonably matches with the assessed runoff of 2966 mm found by the Tribunal for the catchment area of Mahadayi river and its tributaries in the State of Karnataka (for catchment area of 375 sq.km.). Similarly the runoff of 3324.1 mm assessed by the Tribunal for the catchment area of tributaries of Mahadayi river in the State of Maharashtra (for catchment area of 77 sq.km.) matches reasonably with the average annual runoff of 3252 mm estimated on the basis of observed data at the Virdi gauging site of the State of Maharashtra.

921. The results of independent study have also been compared in respect of the runoff factor, with the runoff factor indicated in Table 33, page 93 of the “Affidavit of Examination-in-Chief of Shri Chetan Pandit” (Volume 191) in respect of the observed runoff data at Ganjim for the years 2001 to 2005, which is considered as correct one, by Shri Pandit and used for his analysis. The runoff factors indicated in Table 33, page 93, Volume 191 by Shri Pandit for the years 2001, 2002, 2003, 2004 and 2005 are 0.7379, 0.6837, 0.7438, 0.8868 and 0.7770 respectively. The average of these five values of runoff factors has been computed by the Tribunal as 0.7658. The average runoff factor in respect of the 40 years of runoff series (for the period from 1973-74 to 2012-13) has also been assessed by the Tribunal using the average annual rainfall value of 3941.1 mm and the average annual runoff value of 3045.0 mm as mentioned in the Table-4. The runoff factor works out to be 0.77 (=3045.0/3941.1), which is quite comparable with the average of the runoff factors of the aforesaid five years adopted by Shri Pandit.

922. A comparison of the water availability as reported by the party States and as assessed by the Tribunal has been made and summarized hereunder.

I. Water availability for entire Mahadayi basin (catchment area of 2032 sq.km.) at 75% dependability

a. As per report filed by the State of Karnataka = 198.42 to 206.17 tmc
b. As per report filed by the State of Goa = 151.47 to 154.4 tmc
c. As per report filed by the State of Maharashtra = 208.73 tmc
d. As assessed by the TRIBUNAL = 188.06 tmc

II. Water availability for catchment area of 375 sq.km. of Mahadayi basin in Karnataka at 75% dependability

a. As per report filed by the State of Karnataka = 44.15 tmc
b. As assessed by the TRIBUNAL = 32.11 tmc

III. Water availability for catchment area of 77 sq.km. of Mahadayi basin in Maharashtra at 75% dependability

a. As per report filed by the State of Maharashtra = 6.25 to 7.48 tmc

b. As assessed by the TRIBUNAL = 7.21 tmc

IV. Water availability at 75% dependability (in tmc) in respect of various proposed project sites on Mahadayi or its tributaries in Karnataka

Sl. No.	**Project site**	**As assessed by Karnataka**	**As assessed by Goa**	**As assessed by the TRIBUNAL**
1.	Proposed Kalasa dam site (including Haltara and Surla diversion) with catchment area of 25.50 sq.km.	3.8 tmc	1.98 tmc	2.19 tmc
2.	Proposed Bhandura dam site with catchment area of 32.25 sq.km.	3.7 tmc	1.50 tmc	2.77 tmc
3.	Proposed Kotni dam site (independent catchment) with catchment area of 93.19 sq.km.	10.6 tmc	6.59 tmc	8.02 tmc

4.	Proposed Kotni dam site (including Bhandura dam catchment and diversion of Irti, Bailnadi) with catchment area of 125.44 sq.km.	19.4 tmc	-	10.80 tmc
5.	Proposed Bailnadi diversion site with catchment area of 32.33 sq.km.	3.7 tmc	1.77 tmc	2.78 tmc
6.	Proposed Irti dam site with catchment area of 8.78 sq.km.	0.9 tmc	0.4 tmc	0.76 tmc
7.	Proposed Irti Pick-up dam site (independent catchment) with catchment area of 9.91 sq.km.	1.2 tmc	0.81 tmc	0.85 tmc
8.	Proposed Katla-Palna diversion scheme with catchment area of 22.50 sq.km.	2.5 tmc	1.52 tmc	1.93 tmc
9.	Proposed Diggi diversion scheme with catchment area of 15.60 sq.km.	1.8 tmc	1.05 tmc	1.34 tmc

10.	Proposed Viranjole diversion scheme with catchment area of 9.50 sq.km.	0.8 tmc	0.73 tmc	0.82 tmc

V. Water availability in respect of proposed project site on Kattica Nalla, a tributary of Mahadayi in Maharashtra

a. As per report filed by the State of Maharashtra = 0.80 tmc
b. As assessed by the Tribunal = 0.75 tmc

923. In view of the above, the water availability assessed by the Tribunal and indicated in the aforesaid Para 913, Para 918, and Para 919 are adopted by the Tribunal for further examination of the claims of the three party States.

MONTHLY RAINFALL DATA

FOR THE PERIOD

FROM JUNE 1901 TO MAY 2013

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1901-02							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1044.1	494.9	1428.1	1024.6	557.2	1329	1001
July	674	888	611.5	1267.3	817.3	963.2	1534.5
August	475	633.3	360.8	1001.8	787.1	574.1	1131.2
September	79.9	68.1	107	162.1	69.5	155.1	200.3
October	42.3	83.8	19.6	88.1	69.9	32.1	104.5
November	14.8	19	8.1	22.9	15.8	19	27.9
December	3.9	1.1	1.1	16.3	6.7	0.2	22.1
January	0	0.1	0	0	0	0	0
February	0	0	0	0	0	0	0
March	3.8	12.5	0	0.2	6.1	0.6	2
April	4.8	17.2	0.3	4.3	14.5	4.8	12.9
May	14.3	44.1	7.7	23.3	64.9	37.1	49.2
Total	2356.9	2262.1	2544.2	3610.9	2409	3115.2	4085.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1902-03							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	783.4	329.5	911	800	277.5	779.4	638.4
July	1090.9	830.8	1119.3	1072.3	785.3	1316.1	1073.7
August	322.2	197.4	344.5	315.9	163.2	432.2	344.3
September	577.5	316.2	674.7	531.4	198.1	634.3	422.3
October	104.1	168.4	66.3	89.7	159.1	106.8	146.2
November	81.2	38.6	112.9	87.8	43.4	125.5	77.2
December	97.5	172	73.8	105.7	201.2	73.5	118.5
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	2.5	0	1.1	4.7	0	5.1
May	199.2	163.3	213.1	184.5	136.2	282.1	182.9
Total	3256	2218.7	3515.6	3188.4	1968.7	3749.9	3008.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1903-04							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	536.7	176.9	624.4	540.1	168.4	705.8	397.2
July	1086.8	1092.5	1038.3	1036.1	933.2	1544.2	1455.8
August	510.1	301.3	585.3	472.8	237.5	647.8	441.2
September	203.5	122.1	222.9	199.5	100.8	232.3	146.6
October	54.8	33.2	63.6	77	60.7	94.5	91.8
November	27.4	18	31.3	31.8	27.4	27	16.4
December	3.5	3.6	4	4.6	2.2	4.8	9.9
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0.1	3.4	0	3.8	3.4	0	21.9
April	29.3	36.2	19.8	32.7	47	8.6	12.8
May	39.1	93.5	23.1	35.9	101.4	21.3	36.5
Total	2491.3	1880.7	2612.7	2434.3	1682	3286.3	2630.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1904-05							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1091.4	768.3	1191.8	1083.7	669.1	1385	1260.4
July	889.1	725.2	943.5	848.6	571.2	1061.3	928.5
August	241	349.2	205.9	227.2	324.1	323	376
September	197	88.3	254.2	209.4	87.3	207.7	171.5
October	62.8	65.6	65.1	63.9	70.4	112.2	56.4
November	0	0.3	0	0	0	0	0
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0.6	0	0
April	4.5	20.2	2.1	8.8	29.6	0.7	12.4
May	33.9	40.8	29.9	33.5	46.6	16.2	44.4
Total	2519.7	2057.9	2692.5	2475.1	1798.9	3106.1	2849.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1905-06							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	606.4	157	703.6	593.6	127.1	562.4	284.8
July	380	604.2	289.1	379.9	531	556.5	766.1
August	276.7	189.7	244.5	261.3	150.8	348.5	351.8
September	128.7	67.1	164	123.4	42.1	176.8	126
October	131.1	111.4	127.5	107.6	86.3	114.9	86.9
November	24.9	63.9	8	13.6	50.2	5.4	9.7
December	0	0	0	0	0	0	0
January	8.2	10.7	9.5	14.8	21	6.8	26.2
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	1.2	0	0.6	4.1	0	0.2
May	16.7	14.6	25.9	24.6	40.7	13.5	22.7
Total	1572.7	1219.8	1572.1	1519.4	1053.3	1784.8	1674.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1906-07							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	600.2	334	680.6	587	269.7	628.2	443.1
July	912.2	742	951.6	867.1	594.6	1234.1	1000.6
August	342.8	262.3	354	347.9	223.3	585.1	459.9
September	155.9	111.8	163.4	152	114.6	189	164.5
October	81.7	133.8	68.2	71.7	125.3	71.3	58.2
November	5.3	7.1	7.8	12.9	16.4	25.5	47.4
December	16.4	37.5	7.6	10.5	24.8	2.3	21.3
January	9.2	3.7	15.1	9.1	3.6	6.4	5.3
February	0	0	0	0	0	0	0
March	0	1	0	0.6	0.5	0	3.8
April	74.8	116.4	61.7	66.1	97.9	28.7	114.4
May	1.8	8	0	1.7	9.1	0	3.1
Total	2200.3	1757.6	2310	2126.6	1479.8	2770.6	2321.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1907-08							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	688.7	382.9	760.2	641.5	250.7	777.9	508.1
July	852.2	781.7	824.4	782.3	583.7	1122.3	972.7
August	654.5	1109.6	500.2	606.5	919.5	812.2	1146.6
September	178.1	234.3	167.2	180.8	239.6	229.6	258.5
October	24.8	48.2	10.8	12.9	24.6	26.8	25.2
November	14.3	28.8	2.8	7.7	28.8	3.7	6.8
December	1.2	1.3	1.3	0.7	0.7	1.3	0.3
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0.9	0	0.6	1.5	0	3.2
April	25.4	76.3	0	6.3	45	4.7	15.9
May	11	32.8	3.2	5.3	26.8	1.2	15.1
Total	2450.2	2696.8	2270.1	2244.6	2120.9	2979.7	2952.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1908-09							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	557	248.4	604.5	531.5	227.8	670.3	424.6
July	1557.5	1360.9	1546.9	1465.8	1057.8	1970.1	1816.1
August	473.3	477.7	463.1	443.2	401.3	698.9	675.2
September	156.8	53.2	191.7	163.1	50.8	175.4	121.8
October	25.7	48.4	17.2	23	34.3	76.3	77.6
November	0.1	1.5	0	0.5	3	0	1.2
December	0	0	0	0	0	0	0
January	0	1.5	0	1.6	5.4	0.2	0.6
February	0	0	0	0	0	0	0
March	1	6	0	0.7	5.5	0	0.4
April	7.3	20.6	0.1	0.2	8.1	0	0
May	24.3	26.6	12.8	30.8	40.4	20.1	28.6
Total	2803	2244.8	2836.3	2660.4	1834.4	3611.3	3146.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1909-10							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	676.5	360.7	776	620.4	275.3	1038	665.5
July	1027.8	1119.8	991.9	976.9	921.5	1490.2	1443.8
August	199.2	128.9	223.7	195.1	91	383.3	241.2
September	211.4	93.9	231.4	189	69.7	349.6	188
October	17	68	11.8	47.8	118.7	41.7	133.3
November	11.6	21.2	2.6	13.7	28.9	5.8	36.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	2.6	4.7	2.3	2.1	4.1	1	0.7
April	0	0	0	0	1.8	0	0
May	15.4	15.9	21.5	26.1	25.6	7.3	47.8
Total	2161.5	1813.1	2261.2	2071.1	1536.6	3316.9	2757.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1910-11							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	976.8	404.4	1111.4	958.6	344	1098.4	728.6
July	444.6	442.7	436.4	392.9	336.5	555.5	536.7
August	320.2	527.5	228.1	314.8	481.4	516.1	648.3
September	343.2	241.6	370.4	312	171.2	462.1	305.4
October	58.9	137.9	27.8	46	118.1	65.9	94
November	55.8	18.4	69.6	55.5	15.2	81.4	42.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0.2	2.8	0.2	1.2	3.8	0	0.3
May	94.1	47.8	134.4	98	66.2	53.9	41.6
Total	2293.8	1823.1	2378.3	2179	1536.4	2833.3	2397

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1911-12							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	557	407.8	615.3	589.1	375.3	729.4	650.9
July	729.4	647.2	722.6	637.8	458.3	901.7	648.5
August	415.1	448.4	385.3	381.9	353	488.1	561.8
September	101.9	64.8	112	99.7	47.7	173.8	129.7
October	51	125.8	24	52.4	119.6	81	143.3
November	50.4	19.7	47.6	45.8	12.5	31.2	24.4
December	9.3	32.5	0.1	10.6	33.3	3.9	33.3
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	41.5	79.6	40.1	45.8	82.9	13.1	60.8
May	50.6	67.6	49.4	54.6	69.8	23.5	54.9
Total	2006.2	1893.4	1996.4	1917.7	1552.4	2445.7	2307.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1912-13							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	846.9	319.1	1089.9	846.8	223.8	1263.4	708.4
July	1065.3	1235.2	990.3	1061.6	1133.5	1469.3	1678.8
August	460.8	598.3	418.1	449.3	522.1	609	722.6
September	92.7	112.9	85.3	92.1	131.9	129.1	122.2
October	70.6	126.2	56.2	69.4	123.6	93.5	125.6
November	51.9	39.5	59.8	47.4	31.8	61.7	55.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0.2	0	0	0.1	0	0
March	2.6	7.3	0	0	2.9	0	0
April	5.5	13.1	3.6	4.2	14.2	1.2	6.8
May	43.7	57.3	34.1	45.6	83.3	16.3	31.1
Total	2640	2509.1	2737.3	2616.4	2267.2	3643.5	3451.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1913-14							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	743.6	494.5	838.5	750	430.8	907.2	753.2
July	890.4	725.1	874.5	837.3	528.9	1110.5	913.4
August	289.1	372.7	258.1	284.2	322.1	387	479.2
September	159.7	105.9	180.3	153.3	83.8	167.7	111.7
October	214.4	119.8	226.1	193.3	93.4	126.6	77.6
November	0.5	2.6	0.2	1.3	7.9	8.4	3.3
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	11.9	30.8	5.4	8.1	27.6	2.1	10.7
May	4.7	11.5	2.8	5.8	8.3	0.6	18.3
Total	2314.3	1862.9	2385.9	2233.3	1502.8	2710.1	2367.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1914-15							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	719.1	312	866.8	691.5	224.4	812	519.8
July	1202.2	1574.3	955.8	1104.8	1327.5	1260.9	1751.5
August	823.9	754.6	889.6	871.8	841.7	1139	1081
September	341.8	243.5	371.7	334.9	188	484.2	369.3
October	34.5	29	39.2	33.9	39.2	65.5	37.1
November	31.3	64.8	9.4	15	48	14.9	15.8
December	18.8	13.9	10	19.9	29.5	23.3	35.3
January	0.2	0.6	0	0	4.3	0	0
February	0	0	0	0	0	0	0
March	1.9	2.4	2	4.2	6.8	0.4	2.8
April	37.7	97.6	10.8	20.7	69.8	14.1	27.2
May	29.5	58.9	12.5	17.9	44.3	25.7	45.8
Total	3240.9	3151.6	3167.8	3114.6	2823.5	3840	3885.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1915-16							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	827	460.3	928.7	815.6	354.2	1004.7	803
July	620	463.8	736.9	636.2	428	861.6	801.8
August	368.5	282.9	449.1	366.5	237.1	388.6	418.3
September	295.2	162.1	310.7	289	167.5	393.1	285.2
October	95.9	91.2	92.2	90.3	76.7	120.7	107.6
November	18.8	40.7	5.9	17.8	39	9.4	18.3
December	1.2	5.5	0	2.2	11.2	0	1.6
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	1	0	0.4	1.9	0	0.2
April	15.4	45.9	6.4	16.2	44.4	1.7	21
May	66.7	54.9	89.8	66.7	74.5	85.7	61.2
Total	2308.7	1608.3	2619.7	2300.9	1434.5	2865.5	2518.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1916-17							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	963.7	607.6	1071.9	901.8	394.6	1343.7	953.3
July	687.7	315.1	772.7	682.6	233	825.3	554.6
August	445.6	489.5	416	420.1	377.7	824.3	748.6
September	639	171.3	813.6	621.4	135.6	727.8	437
October	140.7	213.3	112.2	116.3	175.2	165	152.3
November	139.7	209.7	102.2	119.4	183.6	150.9	206.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	30.6	25.5	28.7	28.8	19.9	20.2	21.6
March	3.8	7.6	2	6.4	11.1	0	6.7
April	10.7	35.9	0	4.4	28.3	2.3	7.3
May	15.5	1.3	21.1	16.8	1.4	16.1	6.4
Total	3077	2076.8	3340.4	2918	1560.4	4075.6	3094.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1917-18							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	706.9	483.7	726.6	691.9	401.8	1014.6	927.7
July	583.4	466.4	553.1	527	324.2	761	631.5
August	538.9	278.6	652.2	527.2	224.6	750.3	546
September	570.9	622.5	498.9	457.3	392.5	512.9	447.3
October	285.8	284.7	275.9	253.6	226.5	349.4	291.9
November	101.5	90.7	96.6	111.2	78.4	82.8	133.7
December	0	0	0	0	0	0	0
January	0	0.6	0	2	4.9	0	12
February	0	0	0	0	0	0	0
March	0.1	2.6	0	0	1.5	0	0
April	7.3	27.3	1.1	3.3	20.5	0.4	10.6
May	634.1	157.5	769	635.9	125.8	664.1	322.5
Total	3428.9	2414.6	3573.4	3209.4	1800.7	4135.5	3323.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1918-19							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	341.6	163.5	382.7	326.6	114.5	472.8	291.6
July	366	188.4	390.2	367.2	140	547.4	433.5
August	381.9	414.8	359.2	351.7	294.5	621.2	615
September	159.5	89.1	166.2	162.8	73.7	170.8	112.5
October	22.5	67.4	1.5	9.8	36.6	27.1	47.6
November	96.3	122.8	84.2	88.6	122.4	149.3	114.6
December	0.6	2.8	0	1	2.5	0	4
January	0	0	0	0	0	0	0
February	0	0	0	0	0.3	0	0
March	0	0	0	0.1	0	0	0
April	2.4	8.4	0	1.5	10.5	0	2.3
May	40	97.6	7.6	21.8	85.4	13.7	38.7
Total	1410.8	1154.8	1391.6	1331.1	880.4	2002.3	1659.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1919-20							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	614.2	489.3	605.2	591.5	371.3	728.8	604.5
July	813.4	656.4	817.9	728.1	432.2	1074.1	918.3
August	488.8	382.5	477.6	471.3	268.5	618	594.8
September	162.9	124.5	150.6	169	133.5	193	235.3
October	144.2	155.3	145.5	130	117.5	215	194
November	69.9	130.5	40.9	47.2	94	55.4	67.4
December	39.7	8	52.2	45.6	10.1	28	19.7
January	2.2	6.7	0	0.4	3.9	0	0.1
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0.6
April	70.2	89.2	47	61	73.8	18.9	34.4
May	21.5	37.7	15.8	27.9	52.6	7.5	24.4
Total	2427	2080.1	2352.7	2272	1557.4	2938.7	2693.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1920-21							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	551	392	555.2	523.5	270.1	556.6	609
July	785	1051.5	637.5	699.5	765.2	813.3	1012
August	332.8	259	321	309.9	186.1	504.5	359.7
September	160.8	93.5	189.4	168	100	172.2	126.1
October	57	94.3	41.8	58.9	122.6	109.5	111.6
November	1.5	4.9	2.2	6.2	12.8	24.4	16.7
December	0	0	0	0	0	0	0
January	0	0.1	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0.2	5.2	0	0	6.3	0	0
April	30.6	69.7	16.3	18.9	60.8	6.2	20.9
May	0	0	0	0.2	0.3	0	0
Total	1918.9	1970.2	1763.4	1785.1	1524.2	2186.7	2256

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1921-22							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	617.3	282.8	765.2	652.2	258.6	943.3	673.9
July	792.4	777	755.3	723	564.8	817.9	863
August	438.4	494.9	394.8	403	376.9	689	669.4
September	254	167.2	280.8	236.9	109.3	343.9	233
October	112.1	177	72.8	81	123.2	90.6	108.9
November	63.4	121.8	49.8	63.1	126.6	37.9	79.4
December	0	0	0	0	0	0	0
January	0	1.6	0	8.7	7	0	46.6
February	0	3.6	0	0	5.1	0	0
March	0	0	0	0	0	0	0
April	20.1	41.5	11	15.7	31	12	34.5
May	34.2	25.7	28.6	28.1	21.1	34.1	37.6
Total	2331.9	2093.1	2358.3	2211.7	1623.6	2968.7	2746.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1922-23							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	828.9	366.2	999.5	819.2	271.3	947	719.2
July	1051.4	1045	1022.6	917.1	682.7	1489.4	1267.3
August	343.8	383.5	328.5	309.3	258.5	496.5	514.6
September	161.5	128.3	160.7	136.3	76	180.9	168.2
October	33.3	79.3	12	18.6	60.2	37.9	51.8
November	123.6	30.7	189.6	145.8	57.6	266.5	179.3
December	0	0	0	0	0	0	0
January	0	0	0	0.3	0	0	1.8
February	0	0	0	0	0.3	0	0
March	12.1	59.7	0	15.6	63.7	1.5	59.6
April	4	21.7	0	5	23.9	2.3	11.9
May	26.4	59	19.3	28.4	58.2	32.1	41.4
Total	2585	2173.4	2732.2	2395.6	1552.4	3454.1	3015.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1923-24							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	422.2	227.3	468.3	387.6	134.2	426.8	279.8
July	1510.8	1625.9	1408.2	1429.3	1279.1	1774.7	1936.2
August	610.2	909.3	442.5	505.8	713	641.8	781.3
September	269.6	85.8	302.9	271.3	83	353.2	178.9
October	6.6	5	15.8	13.8	17	22.7	17.3
November	0.5	1	1.1	0.6	0.6	0.4	0.2
December	1.6	4.6	0	0.6	1.8	0	4.1
January	0	0.3	0	0.3	1.2	0	0.1
February	0	0	0	0	0	0	0
March	5.9	18.7	0	2.1	12.9	0	11.6
April	11.9	31	0.2	19.1	41	0	71.3
May	0	2	0	1.7	8	0	10.6
Total	2839.3	2910.9	2639	2632.2	2291.8	3219.6	3291.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1924-25							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	752.9	238.3	905.5	742.2	191.1	922.7	588.8
July	1160.8	1359.8	1043.4	1103.3	1110.6	1299.5	1518.2
August	304.2	354.4	283	289	317.1	443.9	467
September	192.7	218	193.4	155.3	144.5	313.4	201.9
October	34.5	73.5	15	18.3	47.3	35.9	47.2
November	11.8	21.6	3.4	5.2	15	1.5	5.8
December	0	0.4	0	0	0.4	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	1.3	5.8	0.1	1.5	6.7	8.1	6.5
April	32.5	26.4	51.1	34.4	36	16.1	15.9
May	146.2	90	174.2	142.1	76.3	155.8	88.5
Total	2636.9	2388.2	2669.1	2491.3	1945	3196.9	2939.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1925-26							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	819.9	615.2	816.3	752.9	463.1	936.2	790
July	711.2	987.5	580.5	660.9	851	871.5	1067.1
August	495.5	341.5	536.9	455.6	222.3	614	574
September	71.5	55	87.6	76.4	51.2	122.1	125.6
October	74.4	133.3	47.2	73	136.6	128.3	126.2
November	18.4	9.9	27.5	17.2	12.4	33.8	14.3
December	6.6	20.5	1	5.5	18.2	0	10.2
January	6.3	0	10.8	7.9	2	24.1	14.4
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	2.1	5.9	2.2	3	16.8	0.6	5.4
Total	2205.9	2168.8	2110	2052.4	1773.6	2730.6	2727.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1926-27							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	498.5	151.4	570.9	496.1	137.4	541.2	356.4
July	746.9	894.4	705.9	794.1	845.8	1038.3	1262.3
August	760.2	978.5	617.4	692.6	745.6	1052.5	1173.6
September	232.5	143.6	260.9	228.9	127.1	311	184
October	22.4	36.7	16.4	32.5	48.1	61.5	80.6
November	0.2	0	0	0	0	4.1	1.7
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0.1	0	0.2	0.9
April	11.9	36.4	0.4	3.5	22.7	0.1	15.6
May	31.8	42.4	29.4	32.8	52.8	17.5	31.4
Total	2304.4	2283.4	2201.3	2280.6	1979.5	3026.4	3106.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1927-28							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	437.7	344.6	402.2	428.6	325.8	731.1	495.6
July	976.4	1264.7	821.5	903.8	1037.9	1149.7	1409.4
August	301.9	329.2	280.2	278.5	265.7	471.4	459.6
September	217.2	163.8	213.8	219.7	183.7	238.7	228.2
October	85.6	48.6	90.6	82.5	31.1	158.8	80.3
November	89.5	67.7	79.9	75.9	42.8	102.5	84.6
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	2.4	20.3	1.7	0.9	6.2	0.3	1.3
March	0.7	2.2	0	20	17	0	41.2
April	4.5	58.3	3.4	16.2	48.7	0.5	36.8
May	5.8	10.2	0.3	24.9	11.1	0	9.3
Total	2121.7	2309.6	1893.6	2051	1970	2853	2846.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1928-29							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	663.2	561.5	696.7	530.6	513.4	1000	576.2
July	1207.3	1235.3	896	1341.9	1180.1	1266.4	1181.9
August	1031	798	729.6	1122.5	815.8	935.3	878.2
September	473	159.4	100.4	263.5	171	130.5	128.7
October	263.3	201.2	398	256.4	213.3	270	210.9
November	91	10.2	11.7	31.8	5	4.8	6.2
December	8.4	7.1	0	1	9.9	0	0.1
January	4.8	5.2	0.5	7.1	7.4	0.7	8.1
February	0	2.8	0	0	0.3	0	0
March	9.7	9.6	1.5	6.3	11	1.1	32.5
April	83.4	98.8	19.5	62.7	73.5	3.4	115.2
May	50.1	16.6	19.4	58.1	31.6	22.2	25.3
Total	3885.2	3105.7	2873.3	3681.9	3032.3	3634.4	3163.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1929-30							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	973.1	760.9	1348	1214.5	931.7	1282.7	971.7
July	1112.3	969.3	762.6	1140.3	933.2	928.5	1049.6
August	770.6	566.4	503.8	797.8	579.2	568.6	620.2
September	360.1	269.9	226.1	235.7	215.2	181.4	177.8
October	318.2	217	295.3	174.8	201.4	208.4	122.8
November	70.7	65.1	54.7	27.3	35.9	27.5	22
December	13.7	1.1	1.5	2.2	0	0.3	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	15	0	0	3	0	3.1
May	33.4	76.2	26.4	33.5	69.8	9.5	37.4
Total	3652.1	2940.9	3218.4	3626.1	2969.4	3206.9	3004.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1930-31							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	987.9	755.1	1179.1	1273.2	928.2	1015.8	991
July	887.7	887.4	476.9	1067.7	866	311.4	866.5
August	551.3	475.3	323.5	585.1	443.8	290.6	500.2
September	536.1	351.4	428.7	425.4	339.3	256.4	253.1
October	340.9	243.4	165.7	241.9	237.4	254	243.4
November	66.5	17.5	27.2	52.5	20	13.2	21
December	4.7	25.4	0.5	5.3	14	2.1	4.6
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0.2	0.1	0	0	1.7	0	0
April	5	51.1	11.1	3.4	28.5	10.3	28
May	11.7	36.7	6.7	34.2	24.5	5.8	42.7
Total	3392	2843.4	2619.4	3688.7	2903.4	2159.6	2950.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1931-32							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	510.3	272.3	843	527.9	354.4	531.6	376
July	1667.6	1341.2	1591.1	1955	1454.9	2129.5	1695.8
August	1701.9	1412.8	715.4	1464.1	1249.1	836.7	1160.2
September	570.2	279.7	169.7	370.3	243.3	147.6	211.1
October	374.3	264.6	284.1	464.3	359.9	355.9	358.5
November	174.5	81.1	61.8	111.1	86.2	84.5	89.7
December	52	42	37.3	34.4	33.8	29.3	31.3
January	13.6	1.4	1.2	2.7	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0.8	47.4	0	2.1	10.7	1.8	41.5
May	65.5	82.7	76.4	52.9	83.7	98	86.4
Total	5130.7	3825.2	3780	4984.8	3876	4214.9	4050.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1932-33							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	565.9	349.2	752.7	568.1	396.8	570.8	348.4
July	1202.4	1282.5	1034.6	1372.1	1263.1	1373.7	1515
August	881.9	671.2	401.3	792.2	665.4	485	695.1
September	542.5	411.1	438.8	623.5	442.8	513	507
October	279.3	220.3	247.4	336.6	216.7	224.7	252.5
November	173.5	141	53.6	114.2	89.2	51.8	86.3
December	38.5	2.9	2.8	6.1	1.1	10.7	1.5
January	0	0	0	0	0	0	0
February	0	0	1.7	0	0.2	1.1	0
March	0	3	0	0	6.2	0	8.9
April	48.7	13.2	113.4	18.4	25	39.5	20.2
May	162.2	143.2	425.4	288.9	176.7	198.8	199.6
Total	3894.9	3237.6	3471.7	4120.1	3283.2	3469.1	3634.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1933-34							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1027.8	844.8	1024.6	1475.9	1036.3	1119.2	1041.2
July	1318	1149.7	1040.1	1358.9	1122.5	1155.1	1238.4
August	717.3	648.8	323	511.3	531.4	515	558
September	516.8	364.5	219.9	512.4	403.5	235.6	359.3
October	245.1	232	158.8	318.9	268.9	332.1	344.9
November	131.1	66.1	53.5	95.5	65.7	33.8	64.3
December	28.9	30.9	16	23.5	16.9	16.5	13.6
January	2.6	0.2	0.2	1.7	0.4	0.5	0.7
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	7.7
April	16.9	14.4	0.2	11.4	29.5	0	13.1
May	0.7	17.1	4	5.6	9.6	5.1	17.5
Total	4005.2	3368.5	2840.3	4315.1	3484.7	3412.9	3658.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1934-35							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	889.5	782.3	1184	1312.2	954.7	1344.3	1036.6
July	1286.9	1111.2	599.8	967	1023.2	892.1	930.5
August	926.8	943.3	629.3	1049.3	897.2	862.6	905.8
September	569.7	312.1	278.7	413.3	309.6	348.7	233.9
October	269.1	146.8	71.2	134.9	150.9	41.9	97.5
November	53.6	50.1	29	35.6	39.8	24.6	48.5
December	15	1.6	1.3	2.9	0	0	0
January	0	5	0	0	0.5	0	0
February	2	0.2	0.5	0.4	0	0	0
March	0	0	0	0	0	0	0
April	0.7	1.5	0.7	0	2.5	0	0
May	0	1.2	0	0.5	0.9	0	3.9
Total	4013.3	3355.3	2794.5	3916.1	3379.3	3514.2	3256.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1935-36							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	507.6	323.5	752	615	397.6	824.2	456.2
July	1074.8	1012.4	679.1	1120.8	960.2	938	981.6
August	669.9	438.6	305.4	440.2	360.9	311.9	286.8
September	415.7	342.4	238.1	393.1	303.9	320.4	281.9
October	203.4	167.5	73	137.4	129.1	66	95.7
November	31.4	15.8	9.3	32.8	17.1	21.8	31
December	12.2	1.2	1	2.3	0	0	0.8
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0.9	1.7	0	0	0.8	0	0
April	4.2	14.8	0	0.8	4.9	0	1
May	119.6	85.7	107.2	126.5	112.8	45.3	87.2
Total	3039.7	2403.6	2165.1	2868.9	2287.3	2527.6	2222.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1936-37							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1058.6	844.7	916.2	998.5	867.7	1171.6	967.1
July	1252.2	939.6	777.6	1241	876.3	924.4	927.5
August	546.6	555	320	617.6	512.9	508.8	574
September	256.5	241.5	161.4	268	222.7	148.8	211.9
October	243.4	97.5	125.4	116.1	73.8	140.2	147.1
November	115.9	89	91.7	45.4	54	95.7	67.8
December	7.9	0	3.4	7.3	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0.3	0	0	0	0	0
April	129.9	102.4	158.8	94.5	94.3	691.6	172.7
May	16.1	1.1	9.3	12.5	0.5	0.3	0
Total	3627.1	2871.1	2563.8	3400.9	2702.2	3681.4	3068.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1937-38							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	762.3	571.4	856.2	713.3	564.4	914.5	636.4
July	1935.6	1542.3	1208	1633	1363.9	2300.3	1520.3
August	454.3	311.1	216.5	504.3	311.1	494.6	344.4
September	286.5	233	216	291.8	273.9	206	201.1
October	275.1	217.5	234.5	353.5	293.2	294.4	316.8
November	16.3	0.7	7.1	36.5	7.5	0.3	8.4
December	0.9	3.3	0.4	0.8	3.2	0	1.3
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	6.5	66.6	1.5	1	29	7.4	43.5
April	3.1	32.4	1.1	8.7	14.7	3.4	17.3
May	75	53.1	89.5	49.2	47	56.3	33.7
Total	3815.6	3031.4	2830.8	3592.1	2907.9	4277.2	3123.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1938-39							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1114	1029.9	628.6	1061.3	958.1	1032	1011.4
July	1345.8	1102.8	612.8	1296.3	1035.7	952.9	1040.7
August	690.9	526.6	510.9	742.1	541	504.3	513.2
September	415.1	304.9	352.3	370	296.6	388.1	295.5
October	176.1	149.3	165	263.9	170.8	194	221.1
November	34	22	20.4	12.7	9	2.2	8.5
December	0.6	0	0.3	0.6	0	0	3.3
January	0.6	0	0.3	0.6	0	0	0
February	0	0	0	0	0	0	0
March	0	12.7	0	0.3	3.6	0	5.6
April	5.8	10.8	2.9	10.2	6.6	3.8	6.1
May	0.5	0.2	0.4	0.3	5.7	0.1	0
Total	3783.4	3159.2	2293.9	3758.3	3027.1	3077.4	3105.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1939-40							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	906.4	699.3	587.7	930.6	792.3	957.9	830.2
July	884.1	829.1	666.3	964.6	834.1	1060.8	1047
August	1012.4	1016.6	583.6	1278.4	1083.7	1139.5	1203.4
September	286.9	178.9	106.6	193.2	178	140	133.7
October	239	213.5	118.8	157.3	157.2	112.7	116.9
November	52.3	39.5	24.3	26.1	32	13.2	17.7
December	0.2	0	0	0.2	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0.1	0	0	8.2	1.2
March	0	1.7	0	0	0.2	0	0
April	2.1	20.7	0.2	18.5	13.2	0.7	27.7
May	30.5	70	5.9	53.7	51.4	19.2	49.5
Total	3413.9	3069.3	2093.5	3622.6	3142.1	3452.2	3427.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1940-41							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	631.4	514	641.4	499.5	504.6	717.1	574.2
July	1598.1	1255.9	929.4	1415.1	1112.1	1339.8	1275.7
August	1600.2	1187.2	1123.9	1266.6	978.4	1483.9	1085.4
September	239.4	118.6	104.6	245.7	118.2	162.5	147.5
October	120.5	110.8	110.6	82	101	143.8	113.2
November	91.1	46.8	55.2	54.5	39.9	22.3	39.7
December	3	0.3	1.2	2.7	0	0	0
January	15.2	9	19.2	24.2	13.8	23.8	24
February	0.5	0.4	0.2	2.4	4	0.7	1
March	0	26.9	0	0	13.9	0	0
April	3.2	18.8	1.4	2.2	7.8	2.6	3.8
May	53.8	71.5	18.4	6.3	31.8	21.5	26.1
Total	4356.4	3360.2	3005.5	3601.2	2925.5	3918	3290.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1941-42							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1007.6	750	871	935.4	581.1	804.2	754.8
July	519.2	870.5	239.8	596.5	843.4	416.6	883.6
August	440	456.9	247.8	550.8	381.4	267.6	441.9
September	215	113.5	127.5	183.7	114.3	160.4	112.3
October	63.4	109.2	28	160.6	148.3	67.2	115.3
November	4.7	1.5	0	0	0.4	0	0
December	25.4	104.7	16.4	18.7	40.1	23.5	18.8
January	0	0	0	0	0	0	0
February	0	2.7	0	0	0.5	0	0
March	0	4.6	0	0	0.9	0	0
April	19.9	20.7	21.4	13.3	12.6	8.1	20.9
May	17.7	43.1	0.4	13.2	32.5	1.3	10
Total	2312.9	2477.4	1552.3	2472.2	2155.5	1748.9	2357.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1942-43							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1625.3	773.2	1396.1	931.9	603.2	1349.4	723
July	1594.2	1292	977.9	1508.3	1257.2	1265.1	1557.6
August	742.8	503.2	659.1	650.4	426.5	554.3	563.9
September	248.9	158.8	236.7	246.1	166.3	241.8	169.7
October	109.8	98.3	71.3	112.1	55.5	93.1	88.9
November	3.2	2.2	7.5	0.1	2.5	1.9	10
December	3.7	14.9	0	47	22.9	1.9	29.6
January	2.9	1.5	22.1	11.1	3.9	1.1	7
February	0	0	0	0	0	0	0
March	0	0	0	0	4.6	0	12.2
April	0.3	25.7	0.9	0	13.5	0	1.3
May	410.6	323.3	398.1	299.7	289.9	363	271.8
Total	4741.7	3193.1	3769.7	3806.7	2846	3871.6	3435

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1943-44							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1017.3	470.9	909.4	839.3	427.3	956.5	580.7
July	1166.3	1203.9	840.9	1192.6	1030.2	1047.5	1347.1
August	289.9	206.4	214.8	334.5	209.2	311	307.2
September	452.2	272.1	361.6	391.4	237.7	485.9	318.4
October	358	296.1	129.2	115.5	191.1	204.7	196.6
November	91.1	123.9	81.6	49.5	72.8	58.8	36.6
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0.2	0	0	0	0	0
March	0	0.2	0.7	0	0	0	1
April	0.5	20.2	0.4	0	4.3	0.3	0
May	30.1	22.1	58.9	34.6	37.1	58.7	56
Total	3405.4	2616	2597.5	2957.4	2209.7	3123.4	2843.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1944-45							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	879.5	448.1	640.7	787.2	423.8	800.7	571.6
July	1332.5	1278.3	893.2	1204.3	1117.4	1373.9	1401.2
August	528.9	415.6	248.2	380.4	327.1	457.1	422.1
September	61.6	49.8	41.4	66.5	117.9	59.1	65.5
October	210.8	176.7	134.5	202.8	178	159.7	182
November	30.5	54.4	9.5	98.4	57.6	20.2	98
December	0	0	0	0	0	0	0
January	0	0.4	0.7	1.9	0.8	7.9	4.5
February	0	0	0	0	0	0	0
March	0	0.2	0	0	0	0	0
April	4.5	6.8	1.9	0.4	11.6	0.1	0
May	3.3	21.9	0.2	4.9	23.7	1.2	8.3
Total	3051.6	2452.2	1970.3	2746.8	2257.9	2879.9	2753.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1945-46							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	943.8	494	848.7	952.5	529.4	946.1	679.5
July	1964.7	1452.2	1292.8	1740.4	1246.6	1543	1523.6
August	578.7	393.4	386.5	773.4	538.8	507.9	629.7
September	537.2	279.1	314.4	375.1	240.6	352.8	293.2
October	26.3	35.7	36.7	55.7	40.9	73.3	57.1
November	25.1	19.5	24.1	9.7	22.9	4.4	8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	14.7	91	14.5	29.3	51.4	39.8	30.5
May	38	89.4	99.8	37.6	59.4	64.5	65.8
Total	4128.5	2854.3	3017.5	3973.7	2730	3531.8	3287.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1946-47							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1396.4	861.2	1176	1042.9	694.3	1241.5	811.3
July	1100.7	1175.3	497	1177	1079.1	780.2	1147
August	865.6	838.6	512.2	1105.3	809.8	719.7	1085.1
September	222.6	142.1	175.1	351.9	239.3	172.3	231.4
October	95.8	58.1	30.8	42.2	50.1	26.2	81.8
November	170.1	124.8	160.6	94.4	120.5	151.1	126.8
December	8.1	2.3	9.7	0.3	1.8	6.2	3.6
January	0	0	0	0	0	0.8	0.1
February	0	0	0	0	0	0	0
March	3.5	2.9	0.5	0	9.2	2.8	17.7
April	33.5	19.5	47.2	24.2	39.9	50.2	50.8
May	3.7	6.6	12.1	11.5	17	25	32.8
Total	3900	3231.4	2621.2	3849.7	3061	3176	3588.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1947-48							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	758.3	405.8	718.6	810.7	407	788	474
July	1543.8	1151.8	881.4	1357.6	953.4	1255.9	1197
August	1212.4	766	704.1	1118.1	703.3	832.1	814.4
September	470	354.7	213.1	430.9	344.3	259.1	324.9
October	76.9	57.8	13.1	85.4	53	14.9	60.2
November	1.5	8.1	0	0.2	8.4	8	3.3
December	0	1.6	0.2	0	0.3	0.3	19.9
January	3	0.8	2.4	2.9	1.1	5.9	2.6
February	0	0	0	0	0	0	0
March	0	14.5	0	0	2.8	0	30.9
April	4.6	22.1	4.5	0.3	20.5	5.8	14.2
May	5.4	13	12.1	25.6	58.7	16.8	37.6
Total	4075.9	2796.2	2549.5	3831.7	2552.8	3186.8	2979

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1948-49							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	980	561.8	909.6	880.8	547.7	916.1	746.2
July	1560.7	924.7	950.2	1229	832.8	1309.5	1070.5
August	919.1	752.6	650.7	904	645.8	403.4	717.5
September	410.9	224	451.6	484.5	273.7	429.2	333.4
October	222	196.2	48	161.4	134.3	76.2	108.4
November	176	122	98.9	203.3	152.1	74.7	145.6
December	0	0	0	0	1	0	6.4
January	3.6	0.7	0.6	1.1	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	2.6
April	7.7	46	0.5	11	43	3.9	44.3
May	62.6	172.5	206.9	232.6	161	319.6	280.2
Total	4342.6	3000.5	3317	4107.7	2791.4	3532.6	3455.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1949-50							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	142.1	172.5	533.7	790.3	353.7	706.1	535
July	327.6	714.9	984.2	1778.7	950.4	1267.6	1306.3
August	612.2	472.4	352.7	810.7	500.5	501.6	553.5
September	553.9	327.5	481.2	539.9	300.2	493	395
October	242.1	256.3	112.2	301.4	212.5	80.7	205.5
November	21.5	45.5	38.8	28.1	25.4	48.3	23.7
December	0	0.4	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	2.6	0	0	0.5	0	0
April	1.1	7.8	0.2	7.1	6.1	0	7.7
May	151.4	94.5	36.9	35.7	51.3	50.6	27.4
Total	2051.9	2094.4	2539.9	4291.9	2400.6	3147.9	3054.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1950-51							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	798.6	436.5	484.9	700.7	390.7	690.1	448.5
July	1880.9	1636.4	1045.7	2076.7	1562.2	1546.5	1834.8
August	524.5	542.3	308.5	928.1	606.4	469.7	654
September	1107.2	628.6	578.1	904.9	555.3	855.8	610.2
October	151.1	137.9	42.7	191.5	228.7	120.9	240
November	46.7	64.7	22.8	71.8	49.2	41.2	52.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	3.5	7.1	25.5	59.6	26.9	6.7	25.3
May	99.8	87.8	74.3	162.2	97.2	32.6	99.8
Total	4612.3	3541.3	2582.5	5095.5	3516.6	3763.5	3964.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1951-52							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1429.3	799.6	819.5	960	660.2	636.8	773.9
July	1480.9	885.6	1138.2	1017.7	737.9	1030.7	838.2
August	537.9	486.1	214	655.5	471.6	362.4	569
September	219.8	159.9	167.3	296.6	177.2	148.4	195.1
October	247.7	171.5	184.9	237.4	196.1	258.5	215.5
November	67.9	40.1	71.2	166.8	78.7	19.1	88.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	8.9	21.8	4.9	0	32	9.5	36.2
May	144.9	57.1	78.9	119.5	71.3	48.3	47.4
Total	4137.3	2621.7	2678.9	3453.5	2425	2513.7	2763.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1952-53							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1019.4	587.1	794.6	806.8	509.6	1063.8	690.2
July	1201.6	1017.1	597	1469.7	1078.8	1333	1308.3
August	728.1	652.1	349.9	1231.4	757.4	701.5	972.8
September	48.2	32.6	61.9	81.3	52	49.4	54
October	193.1	140.7	271.6	213.2	204.8	369.2	226.4
November	0	0	0	0	0	0	0
December	14	20.4	3.8	0.6	8.8	5.2	3.5
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0.5	0	0	0	0
April	41.4	94	32.9	31.7	85.2	15.2	72.4
May	0	2.1	1.2	0	0.4	0.1	0
Total	3245.8	2546.1	2113.4	3834.7	2697	3537.4	3327.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1953-54							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	945.8	780.5	877.5	1243.4	849.6	1076.1	1169.1
July	1689.3	1263.9	1709.5	1712.6	1214.2	1730.4	1455.7
August	738.3	858.5	365.6	923.2	813.7	619.2	884.8
September	236.3	135.9	140.1	398.6	203.7	161.6	219.5
October	418.1	375.2	242.3	379.6	340.6	362.7	372
November	6.8	2.4	0.5	0	0.7	0	0
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	22.6	22.8	10.8	0.3	29.5	8.4	11.6
April	25.5	59.6	23.9	0.6	27.2	9.4	8.1
May	9.2	18.8	6	10.2	38.7	2.4	6.9
Total	4091.9	3517.6	3376.2	4668.5	3517.9	3970.2	4127.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1954-55							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	858.9	507.3	807	925	493.1	1041.3	639.5
July	1603.4	1163.2	1494.4	2242.6	1372.9	1627.8	1686.9
August	806	599.1	579.8	964.9	661.3	962.2	831.3
September	529.2	361.9	439.8	702.1	381.1	469.2	475.4
October	150.6	150.8	51	223.2	158.7	34.2	123.3
November	0	0	0	0	0	0	0
December	0	0	9.7	0	1.2	4	0
January	0.6	0.5	2.4	0.2	0	0	0
February	0	0	0	0	0	0	0
March	0	3.8	0	20.8	9.7	0	36.9
April	20.2	39.4	22.2	57.2	44.8	8.7	39.6
May	296	191.8	64.9	146	162.6	37.2	130.3
Total	4264.9	3017.8	3471.2	5282	3285.4	4184.6	3963.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1955-56							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	959.8	507.5	989.8	788	550.7	980	632.5
July	964	501.4	1050.6	1012.5	571.1	1158.3	703.3
August	1060.3	749.3	722.9	1146.1	649.9	943.5	745.8
September	396.2	337.5	291.4	554.2	374.4	458.9	442.9
October	493.7	328.9	303.4	712.9	454.3	411.2	494
November	69.4	24.8	7.9	17.7	14.3	2.3	12.5
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	1.7	10.6	2	0.2	6	0.4	5.9
March	0	0	0	0	0	0	4.3
April	29.5	35.5	25	10.2	28.3	8.9	13
May	351.8	200.2	352.6	250.8	147	321.4	182.9
Total	4326.4	2695.7	3745.6	4492.6	2796	4284.9	3237.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1956-57							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1124.6	768.9	1113.8	1063.7	718.2	1028.2	741.1
July	1644.2	1351.1	1155.7	1856.1	1270.3	1424.2	1504.8
August	491.3	528.8	347.8	902.8	595	562.4	743.2
September	333	195.3	336	349	202.1	311.9	229.2
October	244	213.3	122.2	325.4	297.4	147.8	249.3
November	197.4	114.3	37.6	70.2	74.2	56.7	102.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	1.8	0	0	2.6	0	0.3
April	12.3	17.8	0.3	0.3	11.7	0.4	15.8
May	54.4	104.2	13	36.3	78	17.7	48.8
Total	4101.2	3295.5	3126.4	4603.8	3249.5	3549.3	3635.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1957-58							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	616.1	391.7	646.1	777.7	495.4	830.8	605.8
July	1284.4	1049.7	985.3	1697.8	1053.5	1233.7	1312.3
August	869.1	699.9	633.3	1293.9	823.1	1027	1026.2
September	156.2	94.9	133.3	245.7	134.8	218.1	180.9
October	167.2	175	133.2	252.6	269.2	166.6	256.1
November	102	90.8	78.3	130.6	101.5	65	82.1
December	0	0	0	0	0	0	0
January	0	0.7	0.5	0	0.1	0	0
February	0	0	0	0	0	0	0
March	0	1.1	0	1.9	7.4	0	4.5
April	3.1	28.6	11.1	12.1	22.5	7.9	47.4
May	156.5	213.5	138.7	221	174.9	79.7	174.4
Total	3354.6	2745.9	2759.8	4633.3	3082.4	3628.8	3689.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1958-59							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1139.6	721.4	1022	1237.4	719	1097	841.7
July	1304	1597.4	815	1689.6	1557.5	1136.1	1829.9
August	926.3	618	1171.5	1179.2	623	1282.8	825.9
September	327.7	173.1	261.2	364.5	192.2	292.6	219.4
October	123.8	114.4	105	167.6	133.5	115.3	117.1
November	55.8	31.8	16.9	126.6	63.6	26.5	70.2
December	0	0.9	0	0	0.2	0	2.9
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	8.4	33.7	1.1	7.5	37	5.9	35.8
May	109.3	162.9	70.9	119.7	96.3	103.1	106.3
Total	3994.9	3453.6	3463.6	4892.1	3422.3	4059.3	4049.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1959-60							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1211.7	651.6	1263.2	1480.4	890.6	1216.3	963.8
July	1593.8	1694.6	1139.2	2209.1	1705	1370.2	1927.6
August	895.6	687.1	478	1022.2	667.4	599.8	797.6
September	512	371.3	279.8	686.7	401.3	304.6	411.6
October	59.5	48.2	46.1	85.6	54.9	52.5	68.2
November	79.7	51.9	24.4	29.3	30.7	51.3	87.4
December	0.4	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	5.4	0	0	1.1	0	0
April	0.1	9.5	0	9.7	5	0.9	9.4
May	169.3	162.9	210.4	247.1	158.4	212.9	220.7
Total	4522.1	3682.5	3441.1	5770.1	3914.4	3808.5	4486.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1960-61							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	936.4	574.7	815.5	1086	631.8	1037.2	718
July	1430.6	1003.2	840.7	1325.6	889.2	1105.7	1080
August	661.2	558.4	413.8	874.2	555.8	583.4	681.3
September	311	243.2	373.7	378.1	248.2	354	241.2
October	119.2	86.4	55.9	171.1	92.2	64.9	98.8
November	36.4	36.7	38.1	21.1	20.8	45.3	25
December	0	0	0	0	3.6	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0.7	0	0	0	0	0
April	20.1	21.4	15.5	2.5	11.4	4.9	12.8
May	651.2	479.4	722.3	617.4	433.6	354.7	408.4
Total	4166.1	3004.1	3275.5	4476	2886.6	3550.1	3265.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1961-62							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1137.6	426.2	1072.9	983.4	457.1	1141.6	664.4
July	1613.3	1630.4	1333.9	2166.1	1806.9	1416.9	2107.9
August	731.3	703.6	609.4	1353	805.9	773.1	1114.2
September	639.1	348.2	486.5	824	427.2	699.8	615.2
October	156.4	122.1	135.8	153.5	143.9	111.9	122.6
November	3.2	43	10.3	4.9	12.8	14.6	28.9
December	0	0	0	0	0	0	0
January	50.2	13.1	173.5	65.6	21.2	48	28.9
February	105.2	89.2	115.4	68	43	28.5	32.2
March	28.2	20.2	57.2	95.6	32.1	18.4	46.1
April	38.3	104.5	32.9	22.7	62.3	17.2	13.1
May	25	235.8	112.4	16.6	84.2	38.2	70
Total	4527.8	3736.3	4140.2	5753.4	3896.6	4308.2	4843.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1962-63							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	76.1	40.3	7.2	173.8	120.8	29.7	113.9
July	230.3	496.9	518.5	53.3	128.7	464.2	275.6
August	355	1292.5	1033.3	83.5	418.8	476.6	95.7
September	156.6	289.4	414.6	321.6	164	334.6	181.7
October	32.8	298.4	148	6.5	134.6	127.5	71.1
November	30.7	25.3	12.3	12.8	11.8	27.3	15.8
December	109.9	59	204.1	90.5	55.3	222.8	102.9
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	12.4
March	0	4.6	1.2	0	3.1	0.3	16.5
April	1.9	36.9	0.5	14.1	23.4	0.1	20.7
May	7.6	55	105.1	44.2	56.7	36.8	52.9
Total	1000.9	2598.3	2444.8	800.3	1117.2	1719.9	959.2

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1963-64							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	650	321.1	850	890.6	415.7	1020.2	807.3
July	834.6	732.2	704	897.8	747.9	926.3	943.6
August	1206.4	950.4	1112.6	1457.2	945.2	1360.5	1264.4
September	157.3	133.3	140.7	232.9	125.5	300.8	271.8
October	111.5	178	168.4	335.5	199.2	261.7	308.1
November	6.6	5.8	13	3.6	2.6	21.8	8.7
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	16.6	0	0	6.8	0	0
April	0	0.8	0	0	0.6	0	0
May	1	0	1.3	4.1	1.4	0	5
Total	2967.4	2338.2	2990	3821.7	2444.9	3891.3	3608.9

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1964-65							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	630.1	495.9	768.7	832.2	378.9	1050.6	467
July	565.9	802.3	883.8	1064.3	541.6	1360	684.7
August	1018.9	1050.6	745.6	1195.9	868.2	1140.8	1063.3
September	473.8	335.2	268.4	410.3	379.7	288.6	220.1
October	199	170.2	223.7	352.3	177.9	229.4	147.8
November	29.2	43.3	18.5	68.5	56.3	23.4	63.4
December	2.7	1.3	2	0.2	0.7	0.8	3.7
January	0	0.7	2.1	0	0.6	0.9	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	7
April	0	11	14.9	0	22.8	10.7	31
May	0	8.6	0	0	8.2	0	13.1
Total	2919.6	2919.1	2927.7	3923.7	2434.9	4105.2	2701.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1965-66							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1141.7	552	981.1	872.4	275.3	1002.9	545.6
July	1227	1376.3	966.9	1633	1018	1062.8	1362.5
August	673.9	387.2	411.3	532.1	198.7	397	328.9
September	265.4	202.8	252	305.4	132.4	156	127.6
October	14	53.7	3	33.9	25.8	4.3	17
November	2	3.2	1.4	17.7	3.6	3.4	6.4
December	202.4	70	270.4	152.5	52.1	262.6	149.4
January	0	0	0	0	0	0	0
February	0	0	0.6	0	0	0	0
March	0	0	0	0	0	0	6.2
April	3.3	18.6	1.1	0.3	14.1	0	3.1
May	396	288.6	266.3	481.4	413.6	86.9	347.6
Total	3925.7	2952.4	3154.1	4028.7	2133.6	2975.9	2894.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1966-67							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	444.6	324.5	551.4	518.4	207.4	406.3	220.9
July	1124.4	1457.3	1001.5	1657.2	1006.3	1223.7	977.6
August	314.3	269.5	150.2	295.3	223.5	236.1	244.1
September	454.3	415.2	328.1	588.5	403.8	394.7	301.4
October	221.1	145	67.1	91.6	96.1	58.6	51.1
November	103.6	216.1	205.3	330	266.2	211.1	226.3
December	1.6	20.6	3.7	31.8	14.8	0.3	18.3
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	10.3	0	0
April	1.3	4.6	1.2	2.4	0.7	1.7	22.4
May	14.7	4.2	31	1.4	2.1	28	31.2
Total	2679.9	2857	2339.5	3516.6	2231.2	2560.5	2093.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1967-68							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	668.6	289.8	827.7	818.8	225	859.9	530.3
July	1138.2	863.5	1112.9	1576.5	597	1139.1	1392.4
August	414.7	477.4	322.5	733.9	306.9	343.2	659.8
September	297.5	129.3	275.3	556.9	137.7	294	351.7
October	114.9	67	119	225.4	72	93.2	155.2
November	1.1	0.3	6.1	3.5	1	5.1	27.1
December	0.3	12.2	0.2	0	9.1	1.6	27.7
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	1
April	83	103.2	45	26.7	31.4	0.4	90.8
May	8.8	11.3	11.7	48.8	19.5	4.7	24.6
Total	2727.1	1954	2720.4	3990.5	1399.6	2741.2	3260.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1968-69							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1127.2	521.9	709.7	854.5	259.2	969.9	557.1
July	1818.9	1201.4	1263.2	1876.7	841.9	1385	1063.4
August	309.9	469.3	161.1	452.6	564.5	203.9	475.7
September	287.6	194.7	77.7	212.2	102.8	149.8	109.1
October	331.4	201	275.1	362.8	131.4	212.1	147
November	6.5	21.4	11.5	24.6	39.6	4.8	32.4
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0.6	0.9	5.6	31.9	27.1	17	41.5
May	33.7	14.4	6	27.1	39.3	12.3	44.6
Total	3915.8	2625	2509.9	3842.4	2005.8	2954.8	2470.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1969-70							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	801.8	378.7	883.5	681.4	229.4	873.5	334.2
July	2002.8	1297	864	1633.4	1123.5	1220	1241.5
August	688.8	709.2	217.4	836.6	587.1	405.5	590.7
September	728.3	338.8	537.1	474.9	163.6	582.1	233.5
October	174.4	113.1	50.4	104.3	73	107.8	69.6
November	72.2	32.2	50.4	28.8	43	15.5	11.8
December	12.5	9.9	0.4	2.3	5.5	2.5	13.3
January	0	0	0	0.1	0.4	0	0.9
February	0.3	0	0	0.2	0.8	0	1.7
March	0.3	0	0	0.8	2.4	0	5.4
April	6.1	30.4	2.6	44.6	34.4	0	79.1
May	240.2	171.1	209.9	193.4	99	231.4	115.1
Total	4727.7	3080.4	2815.7	4000.8	2362.1	3438.3	2696.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1970-71							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1959.7	566.9	828.5	974.4	223.9	1028.9	489.8
July	1909.8	1317.4	894.1	1763.2	959.5	1209.7	1223.8
August	1628	1071.7	1080	1265.5	750.4	1219.7	944.6
September	325.2	213.9	238.6	282.9	161.4	278.2	189.9
October	51.3	149.1	40	143.5	129.4	141.4	102.6
November	26.9	15.4	0.3	13.1	7.3	0	1.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	1.8	11.1	2.2	3.3	7.6	4.1	4.7
May	154.9	25	149.3	171.5	45.1	70.4	25.9
Total	6057.6	3370.5	3233	4617.4	2284.6	3952.4	2982.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1971-72							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	712.2	560.6	1116.1	696.2	573.3	1079.4	686.1
July	675.1	524.7	733.8	603.5	547.6	709.4	548.8
August	386.3	290.6	310.6	332.1	309.5	365.5	313.7
September	120.4	245.7	225.2	332.1	166.6	310.7	160.1
October	21.7	18.8	11.3	51.6	25.1	39.4	16.2
November	4	3.7	9.7	33.6	15.7	0	13.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0.2	0	0	0
March	0	0	0	0	0	0	0
April	0.9	1.2	3.3	3.6	11.9	1.1	45
May	35.3	9.3	50.4	59.2	38.8	18.3	112.6
Total	1955.9	1654.6	2460.4	2112.1	1688.5	2523.8	1895.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1972-73							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	544.1	626.2	771.4	422.1	345.1	805.1	374.2
July	874.2	1116.8	546.7	858.2	827.5	938.7	926.7
August	394.5	349.6	313	353	241.8	487	371.1
September	128.7	166.1	78.2	199.1	167.3	160.5	212.5
October	54.4	116.6	18.4	44.6	69.7	31.8	37.4
November	1.1	1.2	2.1	2.9	10.9	19.9	22.7
December	0	0	0	0	0	0	3.4
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0.9
April	0	0	0	0	8.3	0	5.5
May	13	37.3	22.4	37.7	53.4	21.1	48.5
Total	2010	2413.8	1752.2	1917.6	1724	2464.1	2002.9

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1973-74							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	820.2	753.7	830.3	933	469.9	687	445.4
July	849.6	1171.7	879.6	1144.5	826.9	948.2	763.9
August	1219.2	1043.8	864.5	1059.2	563.2	931.2	515
September	228.3	278.6	121.3	216.1	89	130.7	115.1
October	121	90.9	186.6	250.5	132.9	151.4	107.7
November	6.9	6.9	16.2	34.1	14.4	2.7	20.7
December	0	0	4.4	0	0	5.8	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	1	0	0
April	8.4	17.9	2.9	9.1	20.3	4.5	50.6
May	123.3	133.8	135.8	126.4	142.7	123.7	76.3
Total	3376.9	3497.3	3041.6	3772.9	2260.3	2985.2	2094.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1974-75							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	420.4	429.2	836.6	394.9	187.5	727	346.3
July	1757	1397.8	1130.5	1561.1	795.7	1350.2	768.6
August	1259.6	980.5	527.6	1099.8	578.1	702	624.5
September	320.2	349.2	374.1	510.5	183.5	424.6	196.5
October	530.9	216.4	322.4	272.4	129.7	123.2	118
November	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0.2	0	0	0	0
April	13.7	16.9	5	10.4	17.7	0	3.4
May	16.2	53.7	19	36.3	33.6	7.1	20.7
Total	4318	3443.7	3215.4	3885.4	1925.8	3334.1	2078

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1975-76							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1267.4	859.3	757.3	1202	822.7	1046.5	1085.1
July	1248.4	841	969.5	1447.5	779.6	1168.1	1095.4
August	1046.3	732.4	632.8	891.7	672.2	715.8	759.8
September	934.1	462.8	514.4	858.3	382.2	538.9	553.7
October	132.4	130.2	234.3	306.9	145.6	319.6	221.9
November	65.7	58.4	19.1	120.4	54	9.9	66.6
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	2.2	0	8.8	4	10.9	7.7	31.5
April	0.7	3.6	0.5	0.6	23.6	7.7	11.5
May	3.5	0	4.4	4.5	0	2.9	2.1
Total	4700.7	3087.7	3141.1	4835.9	2890.8	3817.1	3827.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1976-77							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	367.8	207.6	692.4	498.6	383.1	571.2	432.8
July	990.8	933.9	1058.7	1045.7	851.9	916.2	826.1
August	573.5	612.4	521.2	262	387.5	521.1	161.1
September	261.1	247.2	259.6	213.6	191.2	193.6	192.5
October	22.4	36.7	19.2	31.1	96.2	54	39.4
November	74.8	11.6	136.8	123.7	44	101.9	94.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0.9	0	0	4.5	0	0
March	7.5	0.8	2.1	21.9	9.2	0.6	33.1
April	0	4.1	0.4	58.9	42.8	0.6	78.5
May	34.6	8.4	57.5	59.7	51.8	20.6	72.5
Total	2332.5	2063.6	2747.9	2315.2	2062.2	2379.8	1930.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1977-78							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	526.5	375.7	776	933.3	383.8	931.8	1200.4
July	1270.8	901.4	1254.1	1776	992.3	1721.6	2045.8
August	441.1	376.7	379	797.2	481.8	579.7	932.9
September	328.3	332.4	260.8	465.5	249.5	342.9	512.7
October	76.4	68.6	86.2	96.7	69.8	95.6	109.2
November	93.1	124.3	98.1	46.1	95.8	99.9	47.1
December	0.6	0	0.8	0.6	0	0.3	0
January	0	0	0	0	0	0	0
February	0	0	0	0	1.3	0	0
March	0	0	0	0	0	0	0
April	11.1	4.4	20.3	20.9	21	14.8	56.5
May	108.2	7.5	206.2	179.4	46.2	155.9	70.3
Total	2856.1	2191	3081.5	4315.7	2341.5	3942.5	4974.9

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1978-79							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	937.1	824.6	1088.2	1722.8	933.6	1115.6	1893.1
July	691.1	1246	947.8	1591.6	901.1	1057.7	1806.8
August	721.2	1020.9	385.8	1503.8	939.1	553	1754.3
September	150.5	108.8	192.3	118.5	123.9	334.2	116.7
October	45	49.4	51.1	385.7	83.8	67.5	504.3
November	14.1	23.8	19.7	37.3	62.4	17.8	40.9
December	0	0.1	0	0	0.4	0.7	5.7
January	0	0	0	2.2	17.1	0	3.3
February	0	0	0	0.2	1.5	0	0
March	0	0	0.3	0.1	0	0.1	0
April	0	0	0	0	0.6	0	0
May	0	0	0	0	38.4	1.8	8.3
Total	2559	3273.6	2685.2	5362.2	3101.9	3148.4	6133.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1979-80							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	484.7	628.1	725.9	875.8	537	671	986.8
July	1339.8	828.4	701.8	1188.2	726.1	881.1	1327
August	783	1251.4	466.1	1075	1326.1	534.8	1564.4
September	183.2	350.9	201.1	342.1	355.4	255.7	422.9
October	93.3	80	58.2	118.8	77.2	100.8	130.7
November	51.2	15.7	94.7	196.4	160.5	78.3	199.8
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	8.5	10.2	21.3	21.5	63.2	22.5	63.7
May	9.1	5.7	21.4	20.2	30.8	16.9	42
Total	2952.8	3170.4	2290.5	3838	3276.3	2561.1	4737.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1980-81							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1054.3	995.7	1021.2	1761.3	1032.3	1091.2	1718.2
July	920.6	1220.7	574.5	2293.4	1330.2	799.5	2436.7
August	963.2	934.2	794	1950.7	1097	795.5	1990.3
September	155.8	195.5	99.9	370.6	193.8	146.5	393.1
October	28.1	25.8	3.7	84	12	42.4	91.8
November	45.6	9.7	72.1	71.6	54.5	36.8	25
December	14.4	0.8	26.4	20.1	11.1	33.7	11
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	1.4
April	0.2	0	0.3	2.7	3.2	0	48.9
May	51.2	8.9	13.9	40.9	78.7	8	73.4
Total	3233.4	3391.3	2606	6595.3	3812.8	2953.6	6789.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1981-82							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1565.8	290.1	1260.5	1239.4	758.8	1367.5	919.9
July	1349.1	1122.2	1002.1	1391.4	1589.8	1339.5	2044.6
August	1149.6	1939.1	747.8	1221.9	1606	846.4	1930.6
September	354.9	618.6	274.8	588.5	433	481	452.9
October	102.3	280.9	33.9	62.7	70.5	70.7	76.1
November	37.8	9	3.8	115.2	26.1	4.7	10.3
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0.8	0	1.1
May	83.2	10.1	38.9	169.5	49.2	24.6	175.8
Total	4642.7	4270	3361.8	4788.6	4534.2	4134.4	5611.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1982-83							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	982.5	1008.5	1005.7	970.6	559.4	1031.3	848.1
July	1369.6	1976.6	988.6	1565.5	1701.6	1127.3	1811.1
August	1451.3	2160	869.5	1799.7	1615.2	1181.4	1914.2
September	232.4	231.8	157.5	228.2	165.6	213.9	163
October	78.7	188	31.8	65	56.6	80	164
November	72.1	35	39.7	66.6	10	39.4	49
December	0	15.5	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	0	0	6.8	9.1	20.9	0	32
Total	4186.6	5615.4	3099.6	4704.7	4129.3	3673.3	4981.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1983-84							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	737.2	900.9	648.1	1132	1008.4	757.7	1312.5
July	1204.4	1129.6	1024.3	1424.1	1234.6	1363.7	1416.7
August	1623.3	1365.8	1168	1418.9	1016.6	1340.9	1391.3
September	679.9	518.7	744.7	737.4	455.6	795.1	545.8
October	87.5	136.5	109.8	91.6	104.2	64.4	95.2
November	40.7	1.4	11.5	17	7.6	49.8	56.3
December	32.5	0	14.9	19.3	0.6	2	2.4
January	0	0	0.2	0	0	0	0
February	0	0	2.1	0	0	0.2	6.2
March	0	0	0.1	0	1.1	1.7	7.5
April	1.5	0	4.9	4.4	0.8	6.9	20.4
May	0	0	3.1	1.6	1.7	9.1	14.4
Total	4407	4052.9	3731.7	4846.3	3831.2	4391.5	4868.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1984-85							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	962.6	997.1	976.1	1109	849.4	949	1237.1
July	1340.6	1769.6	798.6	1514.7	1516.7	1062.3	1759
August	643.6	939.3	405.7	655.1	740.6	496.5	856.1
September	264.8	318	201.9	310.4	225.5	334.3	239
October	135.5	135.6	154.1	279.8	144.9	285.2	151.8
November	64.9	0	8.8	0.2	0	3.3	5.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	2.6
February	0	0	0	0	0	0	0
March	0	0	0.2	0	0.2	0.1	12.5
April	0	0	7.6	0.2	8.5	0.7	17.2
May	98.1	0	33.1	7.2	15.9	25.8	49.3
Total	3510.1	4159.6	2586.1	3876.6	3501.7	3157.2	4329.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1985-86							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1560.8	1289.2	1333.5	1375.9	806.6	1322.2	1041.4
July	1094.3	1104.9	550.2	860.5	832.3	924.8	1121
August	674.3	1771	590.4	880.5	888.8	755.3	1021.6
September	101.4	89.1	94.2	159.4	138	73.5	190.9
October	464.9	264.2	345.3	354.4	269.7	458.6	318.9
November	0.3	0	4.6	7.7	0	0.4	1.5
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0	0	0.9	0	0	3.3	3.8
May	3.1	0	0.4	2	0	9	11.5
Total	3899.1	4518.4	2919.5	3640.4	2935.4	3547.1	3710.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1986-87							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	837.2	751.4	656.9	983.2	1042.2	693.5	1083.6
July	815.4	799.9	467.6	814.1	1003.3	621.8	1034
August	926.9	1290.3	534.6	938.4	1118.3	446.8	720.7
September	118.7	115	27.7	177.4	85.4	47.4	174.3
October	6.3	150.8	20.5	37.8	22.4	8	55
November	71.1	0	90.2	126.5	6	114.8	62.6
December	0	0	0	0	0	0.1	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0.8
March	0	0	0	0	0	0	1.6
April	5.1	0	0	0	3.9	0	3.2
May	14.7	0	8.4	73.3	32.7	5	71.1
Total	2795.4	3107.4	1805.9	3150.7	3314.2	1937.4	3206.9

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1987-88							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	775.5	670.5	1120.7	957.9	593.3	1229.9	591.8
July	876.8	1163.2	626.8	996.5	1089.9	556.1	1255.9
August	771.3	1084.1	637.6	924.2	772.3	726.8	780.5
September	154.4	196.1	154.8	322.5	234.1	109.7	265
October	277.6	178.9	187.6	309.8	177.7	219.3	271.9
November	14.6	12.6	19.7	27.8	29.9	29.1	32.3
December	3.5	0	4.7	1.5	0	1.8	16.3
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	6.4	4.6	10.5	0	0	7	15.4
May	20.3	9	0.9	8.7	0	9.8	24.4
Total	2900.4	3319	2763.3	3548.9	2897.2	2889.5	3253.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1988-89							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	516.8	318.2	591	734.4	661.6	599	643.2
July	1624	1242.6	1173.8	2437	2096.5	1081.8	1921.8
August	1035.5	1038.8	821.3	1493	1086.8	656.9	1190
September	485.5	305.8	393.9	810.4	643.2	605.5	710.5
October	78.9	7.5	52.6	44.4	70.7	35.7	65.5
November	0	0	0	0	0	0	0
December	0	1.1	0	4.6	5.6	6.7	7.2
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	4.4	1.7	8.3	3.5	3.2	18.6
April	0.5	22.6	1.9	1.7	5.7	0.7	14.8
May	6.9	37.5	17.8	33.5	42.8	22.9	48.2
Total	3748.1	2978.5	3054	5567.3	4616.4	3012.4	4619.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1989-90							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1172	1113.7	707	1373.4	1211.1	860.9	1373.8
July	902.8	1129.6	741	1118.9	1316.8	777.9	1362.3
August	797.5	807.2	674.2	845.4	816.4	470.5	874.4
September	264.9	193.5	312.2	419.9	225.1	320.4	260.2
October	60.8	19.7	83.3	74.6	31.9	91.2	349.2
November	30.8	12.1	0.1	0.7	15.4	2.1	0.6
December	0	7.4	0.1	0	0.6	0	0
January	0	0	0.1	0	0	0.2	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0.1	0.3	0	0.1	2.7	1.4	3.9
May	282.3	116.9	399.9	273.1	184.5	333.6	157.3
Total	3511.2	3400.4	2917.9	4106.1	3804.5	2858.2	4381.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1990-91							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1072.7	730.5	768.1	1135.9	1093.6	908.8	833.2
July	900.3	1083.4	587.5	1427.8	1775.1	850.7	1838.4
August	975.8	1560.8	679	1224.9	1407.6	770.1	1529.8
September	376.8	352.9	227.7	502.6	446.1	267.1	407.4
October	284.8	130.2	85.2	219.8	192.3	94.6	176.1
November	29.2	27.7	38.1	71.8	33.4	25	33
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	33.2	59.7	16.9	38.2	56.3	19.7	84.7
May	78	59.1	31.6	52.8	66.1	37.1	104
Total	3750.8	4004.3	2434.1	4673.8	5070.5	2973.1	5006.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1991-92							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	672.4	963.5	490.2	837.4	978.5	620.7	779.6
July	1611	1594.6	1134.1	1627.2	1986.6	1316.4	2057.1
August	831.5	1400.8	433.5	986.6	1216.7	520.1	1156.3
September	81.9	204.3	52.4	131.3	81.4	34.3	183.4
October	63.4	16.4	12.7	68.4	45.3	23.9	76.2
November	3.2	19.7	8.4	6.9	6.5	2.4	0.1
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	2.4	19.4	0	2.6	4	0	20.6
May	24.9	39.3	16.4	35.7	46	44.3	37
Total	3290.7	4258	2147.7	3696.1	4365	2562.1	4310.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1992-93							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1115.4	934.1	1002.2	1133.8	699.3	993.9	962.6
July	1135.1	1404.1	736	1304.5	1452.1	829.6	1510.4
August	1163.1	1348.9	711	1194.8	1444.7	814	1486.4
September	251.7	310.5	165.2	329.3	405.2	212.6	330.3
October	97.5	110.2	66.5	201.9	164.9	108.6	209.6
November	24.1	41.4	2.5	21.4	19.4	22	64.5
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0.1	3.7
April	0.5	10.5	0	0	11.8	0.3	10.6
May	56.7	33.5	59.3	11.3	49.6	77.2	81.6
Total	3844.1	4193.2	2742.7	4197	4247	3058.3	4659.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1993-94							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	596.5	781.9	473.2	1014.7	770.8	537.8	1307.4
July	1448.9	1509.3	1215.7	1822.9	1822.1	1162.8	1687.5
August	646.4	931.7	346.9	960.5	1146.4	511.2	1168.3
September	251.8	241.2	212.2	409.8	301.8	308.1	450.4
October	301.3	206.4	191.3	306.8	127.2	291.6	311
November	15.9	20.9	4	26.5	35	12.2	38.1
December	24.1	38.8	11.5	23.5	24.9	14.9	12.3
January	0	3.7	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0.3	3.4	0	0	3.9	0	0
April	9.9	30.5	15.9	19.7	72	5.7	73.7
May	18.2	7.8	35.5	23.1	6.3	7.2	9.8
Total	3313.3	3775.6	2506.2	4607.5	4310.4	2851.5	5058.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1994-95							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1028.9	1367.5	836.5	1423.3	1442.1	975	1476.5
July	1448.2	2482.3	935.3	2284.5	2524.8	1060.9	2529.5
August	950.1	1601	614.4	1422.9	1440.3	606.4	1460.4
September	266.9	578.4	212.5	505.6	591.7	249.7	564
October	274	280.7	265.2	195.1	202.3	312.7	233.3
November	0	1.3	1.8	0.5	0	1.2	0
December	0	1.5	0	0	0	0	0
January	11.9	3.6	12.9	12.6	6.2	3.8	21.8
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0.8
April	15.8	18.8	2	29.9	2.7	0.6	67.5
May	72.3	19.6	40.2	102.4	60	22.4	90.6
Total	4068.1	6354.7	2920.8	5976.8	6270.1	3232.7	6444.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1995-96							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	649.8	493.9	779.2	557.6	344.4	644.6	318.9
July	1509.9	1480.2	1457.7	1708.9	1505	1435.1	1383.1
August	761.4	742.2	767.3	796.2	774.9	878.9	683.7
September	220.5	351.2	210.5	370.9	466.9	309.6	495
October	368.1	156.8	253.3	208.2	224.7	276.2	151.1
November	45.8	4.7	6.4	23.3	12.6	10.8	77
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0.1	0	0	0	0	0
March	0	0	0	0	0	0	0
April	4.3	1.1	0.4	3.4	5.8	0	10.2
May	14	11.8	0.5	2.7	6.2	2.7	20.4
Total	3573.8	3242	3475.3	3671.2	3340.5	3557.9	3139.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1996-97							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	944.2	1012.2	1109.9	1014.2	783.7	1164.3	840.7
July	1218.7	1542.3	1199	1308.5	1439.5	1252.7	1197.2
August	524.3	903.1	358.1	663	705.7	447.9	766.2
September	312.2	280.1	191.6	378.6	331.7	203.1	248.9
October	264.5	359.3	223.8	419	414.5	313	290.4
November	0	2.5	8.7	16.7	0	5	0
December	13.5	24.3	4.6	7	0	1.4	0.4
January	0.7	0	7.7	4.2	0.7	4.9	6.6
February	0	0	0	0	0	0	0
March	9.5	10.8	0	9.5	25.6	0	9.2
April	8.7	0	0	5.8	21.9	0	20.9
May	0	0	0	15	2.5	0	21
Total	3296.3	4134.6	3103.4	3841.5	3725.8	3392.3	3401.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1997-98							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1013	894.6	1090.3	1358.1	1166.9	1104.6	1403.2
July	1461.8	1563.6	1176.7	1505.9	1686.6	1166.3	1962.9
August	1207.5	1547.1	900.3	1710.9	2020	1080.2	1842.7
September	50.1	168.2	67.1	81.9	169	104.7	86.6
October	93.8	163.9	46.4	105.9	54.2	24.4	119.8
November	70.6	195	68.3	143.6	22.3	83.5	161.3
December	53	59.8	68	73.2	32.9	88.5	57.7
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	6.6	30	0	0.4	1.1	0	0
May	85.7	62.7	66.3	46.7	51.7	13.5	65.5
Total	4042.1	4684.9	3483.4	5026.6	5204.7	3665.7	5699.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1998-99							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	949.3	904.6	1024.8	989.3	728.2	1018.4	875.9
July	1700.2	1159.7	773.6	1669.9	1163.4	1066.7	1432.8
August	1048.9	911.7	516.3	1052.6	716.4	603.1	1019
September	490.9	587.8	436.1	588.3	334	406.4	571.2
October	351.5	317.1	172.2	372.5	187.6	317.4	353.4
November	69	38.9	44.7	79.4	46.5	69.4	99.1
December	0	0	0.5	0	0.3	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0.6	1.5
March	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0
May	257	188.1	317.1	226.1	65.2	99.7	250.1
Total	4866.8	4107.9	3285.3	4978.1	3241.6	3581.7	4603

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 1999-2000							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1383.2	966.2	1595.8	1325.1	937.2	1581.1	1139
July	1654	1771.1	1195.3	2070.5	2314.4	1328.3	2449.7
August	401.2	593.4	202.1	512.2	678.8	262.6	752.9
September	282.1	180.3	200.6	333.6	340.2	204.9	289.3
October	298	210	175	257	188.4	151.4	374.1
November	3.9	0	3.1	22.8	0.4	3.9	14.6
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0.4	1.1
February	0	0	0	0	0	0	0
March	0	0	0	0.2	0.4	0	3.1
April	9.4	15.9	10.1	9.6	28.9	11	19
May	213.6	117.7	291.2	241.6	119.2	212.1	233.7
Total	4245.4	3854.6	3673.2	4772.6	4607.9	3755.7	5276.5

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2000-01							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1401.3	881.6	1115.1	1291.6	722.8	1119.8	818.1
July	1582.3	1269.7	1338.1	1412.3	1514	1241.2	1573.6
August	805.6	928.3	532	950.9	965.1	690.2	1007
September	240.7	348.8	103.7	248.3	329.9	129.5	394.9
October	207.4	159.5	69.8	101.9	100.2	104	266.8
November	8.4	0	2.6	4.9	1.3	0.2	37.1
December	0	0	0.3	0	0	0	0
January	1.7	0	8.9	2.3	0	0.6	17.5
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	13.4	13.2	6	19.2	46.6	2	30.4
May	163.6	54.5	171.1	84.2	82.9	97.9	88
Total	4424.4	3655.6	3347.6	4115.6	3762.8	3385.4	4233.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2001-02							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	963.5	811.2	518.5	781.4	717	564.2	881.3
July	1133.3	959.5	839.2	1168.3	1251.3	1070.3	1378.8
August	655.9	804.8	393.4	850.4	1113	486.5	1108.5
September	98.7	84.6	101.7	164.4	155.8	154.5	190.6
October	140.6	48.3	83.4	163.3	48.9	173.4	91.5
November	6.1	0	11.4	29.6	8	7.9	24.6
December	0	1.6	0	1.1	9.7	0	15.9
January	0	0	0	0	1.1	0	0
February	0	0	0	0.2	0	0	3.3
March	0	0	0	0	0	0	0
April	12.5	16.3	1	9.1	14.7	0	9.8
May	71.5	44.7	53.3	24.4	23.2	12.5	48
Total	3082.1	2771	2001.9	3192.2	3342.7	2469.3	3752.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2002-03							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1039.5	761.5	1095.7	1064	820.4	998.9	1043.9
July	702.7	752.6	306	712.6	815.8	452.9	950.7
August	677.6	941.1	569	1043.1	1228.9	822.4	1383.9
September	148.4	180.2	125	203.8	181.2	162	189.3
October	216.8	139	90.6	379.7	136.6	145.4	249.9
November	0	0	0	0	0	0	0.5
December	0	0	0	0	0	0	0
January	0.4	0.4	0.7	0	2.5	0	0
February	0	0	0	0	0	0	0
March	1	3	0.6	22.3	8.7	0	10.7
April	1.5	32.2	1.9	23.4	28.6	1	28.4
May	0.5	1.5	0	0	2.5	0	1.4
Total	2788.4	2811.5	2189.5	3448.9	3225.2	2582.6	3858.7

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2003-04							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1053.9	1016.1	895	1153.9	1303.3	934.6	1036.8
July	983.3	936.2	1093.2	1312.8	1388.1	1165.1	956.3
August	689.4	721.1	410.2	797.7	939.1	659.1	665.3
September	340.7	246.7	191.9	226	420.2	229.3	179.2
October	143.8	118.2	51.2	116.4	122.2	82.8	103.6
November	16.4	4.2	7.6	10	4.7	1.4	13.3
December	0	0	0	0	0	0	0
January	0	0	0	0	0.3	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	0.6	2.1	0	0	7.5	1.8	23.5
May	126.8	167.6	155.6	27.7	173.8	101.9	109.3
Total	3354.9	3212.2	2804.7	3644.5	4359.2	3176	3087.3

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2004-05							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	736.1	917.2	623.1	808	1129.7	855.8	651
July	882.6	979.6	626.4	975.9	1475.9	788.7	467.9
August	853.9	1465	474.9	870.7	1961.9	660.9	693.1
September	195.2	119.2	138.9	293.5	187.6	159.9	187.4
October	70.2	49.6	79.2	57.8	59.3	51.6	22.6
November	24.4	2	23.2	2.2	8.6	34.2	0
December	0	0	0	0	0	0	0
January	0	0	0.9	0	0	2	0.5
February	0	0	1.3	0	0	1.4	0.2
March	0	0	0	0	0	0	0
April	1.7	4.4	32.9	25.8	16.1	19.8	25.4
May	39.3	33.1	43.4	19.7	26.6	41.9	29.3
Total	2803.4	3570.1	2044.2	3053.6	4865.7	2616.2	2077.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2005-06							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	852.1	919.4	827.5	1072	950	830.4	953.1
July	1232.5	1314.9	1134	1677.5	1509	1113	1485.8
August	532.5	588	407.7	687.2	628.2	379.6	580.1
September	539.2	583.8	612.2	858.5	729.1	581.7	750.5
October	221	229.9	121.8	205.4	213	131.6	179.8
November	0.9	1.4	0	0	0.5	0	0
December	0	0	0.1	0	0	1	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	7.9	0	26.1	32	7.2	4.6	49.7
April	0	0	0.5	3.3	3.2	8.5	8.2
May	168.7	243.2	641.1	215.8	192.5	267.4	242.4
Total	3554.8	3880.6	3771	4751.7	4232.7	3317.8	4249.6

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2006-07							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1018	575	712.2	1251.8	831.2	670.1	1228.7
July	2061.8	1474.1	369.7	2704.7	2212.9	827.7	2275.8
August	1954.7	1194.1	582.8	1973.9	1610.4	632.1	1678.1
September	654.9	389.7	396.3	535.4	399.6	561.5	529.6
October	156.7	210.9	436.1	190.5	188.6	222.9	188.7
November	0	0	29.8	73.4	10.4	13.5	105
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0.7
March	0	0	0	0	0	0	0
April	27	49.1	0.2	5.8	39	0	31.3
May	44.4	14.1	93.2	65.6	8.3	66.4	34.5
Total	5917.5	3907	2620.3	6801.1	5300.4	2994.2	6072.4

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2007-08							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	928.4	774.7	1070.2	1118.9	824.4	946.6	1203.4
July	920.8	1111.6	697.9	1139.3	1600.7	738.1	1632.9
August	1157.4	1475.2	890.6	1530.3	1652.3	949.1	1349.9
September	679.9	675.5	742.2	678.3	849.6	716.4	726.4
October	156.4	62.9	94.4	274.3	30.2	74.9	29.8
November	25.8	0	63.4	84.6	12.1	56.4	0
December	0.9	0	0.8	1.9	0	0	0
January	0	0	0	0.4	6.5	0	0
February	5.5	4.6	0.2	13.7	9	0	4.8
March	39.5	24.4	45.5	177.3	127.3	55.5	163.7
April	1.1	2.2	15	23.2	12.2	6.3	27.1
May	1	3.7	10.5	19.9	2.2	16.8	42.1
Total	3916.7	4134.8	3630.7	5062.1	5126.5	3560.1	5180.1

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2008-09							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1112.1	811.1	797.7	1194.7	908.6	702.9	1119.9
July	1301	760	574.9	969.6	979	514.5	915.5
August	1713	1278.3	872.2	1576.6	1542.4	819.7	1389.1
September	605.9	434.4	552.7	751.2	538.5	446.5	542.2
October	49.3	120.8	3.1	25.2	32.7	59.8	73.6
November	5.2	14.7	5.7	2.3	28.8	19	25.4
December	0.2	0.4	7.1	16.7	195.2	0.6	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	12.5	13.2	0.9	30.1	17.7	18.5	44.2
April	17.9	13.6	0.6	20.9	30.5	11.3	19.8
May	15.5	45.4	15	16.4	37.1	87.5	43.1
Total	4832.6	3491.9	2829.9	4603.7	4310.5	2680.3	4172.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2009-10							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	600.6	494.8	715.1	573.6	428.5	634.7	364.4
July	1796.7	1895.7	1186.2	2110.9	2176.3	1609.3	2656.2
August	468.7	515.5	276.1	549.3	702.3	372.6	645.1
September	580.5	584.7	380.4	534.6	598.2	360.9	545.1
October	319.9	240.6	388.9	237.5	210.7	559.8	303.5
November	93.7	103	153.8	132.1	49.5	133.7	71.1
December	12	12.9	0.2	0	2.9	0	0.2
January	15.7	53.9	6.3	5.7	33.2	0.7	2.2
February	0	0	0	0	0	0	0
March	0	3.4	0	0	2.5	0	0
April	7.5	26.5	1.1	9.1	24.7	1.4	2.4
May	44.1	5.5	72.6	66.6	12.4	55.1	48.6
Total	3939.4	3936.5	3180.7	4219.4	4241.2	3728.2	4638.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2010-11							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	796.8	366.4	935.3	824.9	478.6	1028.8	596.3
July	1246.1	902	1197.9	1379.4	1009.2	1542.9	1171.7
August	860.3	516	708.6	1191.4	653.4	781.9	733
September	665.4	471.2	464.7	653.6	602.2	488.1	447
October	288.7	121.5	268.8	408	177	278.4	297
November	183.9	175.8	134.5	269.5	148.7	161.6	163.8
December	8.7	3.5	7.5	1.8	0.4	1.7	0.5
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	18.2	14.1	20.7	10.8	12.7	33.3	7.1
May	4.1	4.9	6.7	13.2	11.3	12.2	5.5
Total	4072.2	2575.4	3744.7	4752.6	3093.5	4328.9	3421.9

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2011-12							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1309.9	1309.3	862.2	1503.3	1405.3	1226.8	1085.4
July	1437.3	1360.6	1013.8	1371.9	1363.5	1144.3	1065.4
August	894.6	992.3	787.6	1137.8	1060.2	940.7	917.1
September	439.8	543.2	451.5	769.8	659.4	591.4	572.7
October	111.7	156	48.1	210.8	179.3	69.5	153.8
November	66.1	60.2	9.4	20.8	36.1	15.5	9
December	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0
April	10.8	8	0.2	0.2	3.8	0.9	9.5
May	0	0.3	0	2.2	1.3	0	1.9
Total	4270.2	4429.9	3172.8	5016.8	4708.9	3989.1	3814.8

MONTHLY RAINFALL (in mm) AT DIFFERENT GRID POINTS FOR THE YEAR 2012-13							
Month	**Grid Points**						
	74°E 15°15'N	74°15'E 15°15'N	73°45'E 15°30'N	74°E 15°30'N	74°15'E 15°30'N	73°45'E 15°45'N	74°E 15°45'N
June	1115.8	942.7	1142.6	907.5	942.1	1233.2	580.6
July	980.4	988.3	642.5	1344.8	1160.2	943.8	1047.8
August	839.3	932.2	651.1	1132.2	1022.3	792.1	902.3
September	245.8	313.1	239.8	503.8	397.8	324.5	373.7
October	115.6	130	101.3	170.6	142.3	131.3	131.5
November	38.5	42.7	11.4	12.7	24.9	7.9	8.2
December	0	0	0	0	0.3	0	0
January	0	0	0	0	0	0	0
February	13.4	9.7	2	33.2	5.1	26.6	17.8
March	0	0	0	0	0.4	0	0.2
April	0	15.2	0	0	3.5	0	0.6
May	93.3	35.4	73.3	64.9	34.7	59.5	30.7
Total	3442.1	3409.3	2864	4169.7	3733.6	3518.9	3093.4