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Government of West Bengal  
Irrigation and Waterways Department

Preliminary Report of the  
West Bengal Flood Enquiry  
Committee, 1959

Volume I  
(Report)  
Calcutta, June 1960

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# **Preliminary Report of the West Bengal Flood Enquiry Committee, 1959.**

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## NOTE

“References will be found in the Report to numerous Appendices, Annexures, memoranda, which have not been printed.”

# CHAPTER-1

## INTRODUCTORY

1.1. In 1959 there had been two periods of heavy rainfall over a wide area covering both the upper and lower Valleys of all the rivers in Central, Western and Southern districts of West Bengal. The first storm period occurred in the second week of September when the rivers become swollen with high floods and large areas of land were inundated. Before complete drainage could be effected the second and severer storm came towards the end of the month lasting from 30th September to the 3rd October. This was caused by a cyclonic storm and resulted in a very heavy rainfall in the Bihar plateau as well as in the ten districts of Gangetic West Bengal, namely, Bankura, Birbhum, Burdwan, Hooghly, Howrah, Midnapore, Murshidabad, Nadia, Purulia and 24-Parganas. The total rainfall for the period over these districts of Gangetic West Bengal averaged 9.95".

1.2. The special characteristics of this second flood were its severity, high levels attained by rivers, slow drainage from the land and the equally slow recession of rivers. Extensive damage was caused to crops, homestead lands, and other properties in that part of the State.

1.3. The flood affected areas were inspected by the Prime Minister of India, the Chief Minister of West Bengal, the Union Ministers for Irrigation and Power and for Law, the Minister-in-Charge, Irrigation and Waterways Department of West Bengal, other State Ministers, the Deputy Union Minister for Irrigation and Power and others.

1.4. In a conference held in the room of the Chief Minister, West Bengal on 22.10.59 it was decided to appoint a broad based Committee of experts to enquire

into the causes of the floods and to formulate measures for preventing such floods in future. The Government of West Bengal, Irrigation and Waterways Department by their Resolution No. 37/I dated the 26th December, 1959 (Appendix I, Vol. II) accordingly appointed the West Bengal Flood Enquiry Committee, 1959. The following Members constituted the Committee :

**Chairman**

1. Sardar Man Singh. I.S.E. (Rtd.).

**Members**

2. The Chief Engineer, Floods, Central Water and Power Commission, (Shri P. R. Ahuja).
3. The Chief Engineer, Irrigation, North Bihar, Government of Bihar (Shri P. R. Guha).
4. The Chief Engineer, Kosi Project, Government Bihar (Shri D. Mookerjea).
5. The Chief Engineer, Eastern Railway (Shri S. N. Wadhwa).
6. The Regional Director of Meteorological Department at Calcutta (Dr. S. N. Sen).
7. The Chief Engineer, South Eastern Railway (Shri V. Venkatramaya).
8. The Chief Engineer, Irrigation, Government of Bihar (Shri H. K. Nivas, I.S.E.).
9. The Chief Engineer, (Civil), Damodar Valley Corporation (Shri B. Parthasarathy).
10. The Chief Engineer, Corporation of Calcutta (Shri A. K. Sen).
11. The Chief Engineer, Development (Roads) Department, West Bengal (Shri R. C. Roy).
12. The Chief Engineer, Works and Buildings Department, West Bengal (Shri J. K. Banerjee).

13. The Chief Engineer, West Bengal, Irrigation and Waterways Directorate (Shri A. L. Das, I.S.E.).
14. The Director, River Research Institute, West Bengal (Shri B. Maitra).
15. Dr. N. K. Bose, Special Officer, Irrigation and Waterways Department, (West Bengal).
16. The Conservator General of Forests, West Bengal, (Shri V. S. Rao, I.F.S.).
17. Member-Secretary  
The Chief Engineer, Floods, West Bengal.  
(Shri I. B. De, I.S.E. (Rtd.):

The terms of reference of the Committee were :

(a) to enquire into and determine the cause of the 1959 floods in the districts of (i) Midnapore, (ii) Howrah, (iii) Hooghly, (iv) Burdwan, (v) Birbhum, (vi) Bankura, (vii) Purulia, (viii) Nadia, (ix) Murshidabad and (x) 24-Parganas ;

(b) to make an assessment of the effects of the floods ;

(c) to ascertain if the intensity of the flood in the river valley areas could have been reduced by proper regulation of releases from the dams ;

(d) to suggest remedial measures for the purpose of preventing recurrence of such floods in future ;

(e) to indicate broadly in order of priority schemes for flood control and flood protection-river-wise, basin-wise, or area-wise as the case may be.

1.5. The Committee was to have its headquarters in Calcutta and was to begin to function immediately.

1.6. The Chairman, Sardar Man Singh, I. S. E. (Rtd.) took over his duties on the 31st December, 1959 afternoon. His appointment on a whole time basis was for a term of four months (i. e. upto 30th April, 1960)

until the preparation of the preliminary report. This period was later extended by a month (i. e. upto 31st May, 1960). Thereafter, he will continue to work on a part time basis upto the 31st December, 1960 or later until the final report is submitted.

1.7. The following changes have taken place in the personnel of the Committee since its inception :

(a) Shri S. N. Wadhwa, Chief Engineer, Eastern Railway went over to the South Eastern Railway from the 28th January, 1960 and continued to remain a Member of the Committee. Later, upon his taking over as a General Manager of that Railway, his successor, Shri D. N. Chopra, became a Member of the Committee from 1st April, 1960.

(b) Shri S. N. Wadhwa's successor on the Eastern Railway was Shri U. G. K. Rao, who has been a Member ever since.

(c) Shri P. B. Sarkar succeeded Shri R. C. Roy as Chief Engineer, Development (Roads) Department and has been a Member since the latter's retirement on 31.1.60.

(d) During the period Shri V. S. Rao, Conservator General of Forests, West Bengal was on leave from 28.2.60 to 18.4.60 Shri Kanak Lahiri was a Member in his place Shri Kanak Lahiri again became a Member, when Shri V. S. Rao left West Bengal to take over charge as Inspector General of Forests, Government of India from 11.5.60.

(e) Shri Ripudaman Singh, I. S.E. came in place of Shri I. B. De, I. S. E. (Rtd.), upon the latter's retirement as Chief Engineer, Flood Control on the 29th February, 1960 afternoon.

(f) Shri H. K. Nivas, Chief Engineer, Irrigation, Bihar retired from 9.5.60 and he ceased to be a Member.

1.8. Shri S. Gupta, I. S.E. was appointed as wholetime Member-Secretary from 1st March, 1960 to the 30th June, 1960.



## CHAPTER—2

### **Meetings and tours of inspections by the Committee**

2.1. The first meeting of the Committee was held in the Writers' Buildings, Calcutta on the 27th and 28th January, 1960. It was attended by 16 out of 17 members. Besides the members, the Superintending Engineers of the Western, Eastern, Greater Calcutta Drainage and Flood Control Circles also attended by invitation.

2.2. The Minister-in-charge of Irrigation and Waterways Deptt., West Bengal inaugurated the proceedings of the meeting and Shri Bimal Chandra Sinha, Minister-in-Charge of Land and Land Revenue Department and the Secretary to the Government of West Bengal, Irrigation and Waterways Department were also present. In his inaugural address the Minister referred to the havoc caused by the floods of 1956, and 1959 the complexity of the flood problems and the imperative need of finding proper solutions for the same as soon as possible. Schemes with the respective priorities were desired.

2.3. After the address the Committee settled the procedural matters and the manner in which the work was to be done. It was felt that it would be impossible for the Committee to complete its task within the time desired if a whole time Secretary was not appointed. Accordingly, it was decided to approach the Government to appoint a whole time Secretary of a Chief Engineer's rank as soon as possible in order to facilitate the work being done speedily.

2.4. It was decided to visit some important places in the flood affected areas. A tentative programme of visits was drawn up. The visits were given as wide a publicity as possible so that besides the irrigation officers in charge of the area the public in general could meet the members of the Committee and give them the benefit of their experience as to the extent and manner of flooding

in the localities and the effects of the floods and suggestions, if any, for preventing or controlling such occurrences in future. Memoranda on these points were also invited from the public in general, to be sent to the Committee by the 29th of February, 1960. This date was later extended and these have been coming in right upto the time of submission of this preliminary report.

2.5. It was decided to hold meetings of the Committee once every month in order to study the information and the data collected during visits, inspections and from other sources. The next meeting was accordingly fixed for the 22nd February, 1960 at Maithon.

#### 2.6. The first tour.

2.6.1. The first tour covered Panskura, Mahishghata (Daspur), Gopiganj, Ghatal, Midnapur and Tamluk, and was undertaken from the 10th to 12th February, 1960.

2.6.2. The local people drew the attention of the members of the Committee to the condition of the Durbachati and Palaspai Khals which were silted up and were, therefore, unable to drain the area efficiently. The Palaspai Khal was re-excavated in the previous year under Test Relief, but as the spoil was dumped within the channel section it had flown back into the khal.

2.6.3 At the site of the cut in the Chetua Circuit Embankment at Mahishghata (Daspur) the extent of damage was seen. There was a large gathering who explained their problems of floods and drainage and also gave their suggestions for the improvement of the situation. They referred to soil erosion which had followed in the wake of deforestation and the siltation of the Silabati, the Rupnarain and all outfall rivers, as being the causes of the floods and wanted action in respect of them.

2.6.4. At Gopiganj too there was a meeting with local gentlemen and their problems were discussed.

They placed the same reasons for the floods and suggested the same remedies as the gentlemen at Mahishghata had done.

2.6.5. At Ghatal a larger gathering met the Committee. The Main point stressed here was the question of restoration of the abandoned Ghatal Circuit Embankment and the maintenance of the embankment along the Silabati River at Ghatal.

2.6.6. At Midnapore discussions were held with representatives of various organisations. The Collector of the district also joined the discussions. The problems of the whole of the Midnapore District were discussed as also the many suggestions that were put forward by those present and in the various memoranda submitted. The deterioration of the Kangsabati, deforestation, weak Ex-Zamindari embankments and obstructed drainage were mentioned and steps to remedy them were suggested.

2.6.7. The Tamluk meeting was also largely attended. The flood problems of the Tamluk area and its rivers, khals and basins were discussed as also the suggestions for controlling them. The silting of the Kangsabati and of open tidal channels together with the deterioration of the Rupnarain, Hooghly and the Haldi were stressed and their improvement desired.

## 2.7. The second tour.

2.7.1. During the second tour, inspections and meetings were held at Mangalkote, Burdwan and Raina on the 18th and 19th February, 1960.

2.7.2. S. D. O. Sadar, a couple of other local officials and a large number of people of the locality met the committee at Mangalkote and described their problems, which were attributed to the Railway Embankment, soil erosion, D. V. C. Canals and the meandering of rivers.

A number of memoranda giving details were submitted. River Ajoy in the vicinity was inspected.

2.7.3. At the meeting in Burdwan Circuit House, local gentlemen, representatives of various political parties and some officers presented memoranda. They stated the extent of damage from breaches in Embankments along the rivers in the district and alleged that insufficient storage capacity and wrong operation of the D. V. C. reservoirs were the main causes of the disastrous floods.

2.7.4. At Raina, the gathering was the largest in the district. The Collector also met the members of the Committee. A number of memoranda were received. Closure of the "hanas" in the right bank of the Damodar and silt-clearance of the Dev, Kati and other khals were asked for. Obstruction of drainage by the Bankura Damodar River Railway Embankment and breaches in the D. V. C. canal banks were reported to have considerably aggravated conditions which were already difficult on account of sudden heavy releases from D. V. C. reservoirs when the flow in the river was already high.

2.7.5. Members of the Committee reached Maithon on the 19th evening. On the 20th they split into groups visiting the Tilaiya, Konar, Bokharo and Panchet Hill sites in the valley and a proposed dam site on the Ajoy near the 59th mile of the Barakar-Jamtara Road.

## 2.8. The second meeting.

2.8.1. The second meeting of the Committee was held at Maithon from the afternoon of the 21st February, 1960. Thirteen out of seventeen members were present. In addition a representative of the Chief Engineer (Civil) D. V. C., a member, who was on leave also attended. The Manager, Reservoir Operation, D. V. C. and the Superintending Engineer, Flood Control Circle attended by invitation.

2.8.2. The Committee considered the communications from some members calling for comprehensive information relating to the reservoirs at the time of the 1959 floods. The Manager, Reservoir Operation, D.V.C., gave brief outlines and promised to send detailed notes on the questions raised.

2.8.3. In studying the data collected so far it was found that contour survey of the entire flood affected area was not available nor some very important hydrological data. It was, therefore, decided to request Government to arrange for aerial contour survey at one foot intervals as early as possible. The specific areas would be found by Chief Engineer, Floods and Flood Control, Chief Engineer, Irrigation and Waterways Directorate and Dr. N. K. Bose after checking up the areas for which surveys were already available. It was also decided that gauge, discharge and silt observations and cross section at certain key points should also be recommended to be taken up from the 1st June, 1960. The Chief Engineers, Irrigation and Floods and Flood Control, West Bengal and the Director, River Research Institute, West Bengal, would prepare the list showing these points and the kind of observations to be commenced at each.

2.8.4. On the 22nd February morning the proposal initiated by Shri K. K. Framji, Chief Engineer and Joint Secretary, Ministry of Irrigation and Power, Government of India, for the lowering of the bed of the Bhagirathi in a width of 200' to a grade of 1 in 20,000 with the bed level of Biswanathpur head of R. L. 40 was discussed and considered. Shri K. K. Framji joined the discussions by invitation.

2.8.5. The Chairman, Member-Secretary and other members, available in Calcutta were authorised to meet, discuss and obtain information in respect of matters relating to the Committee's work from persons interested in flood

problems, representatives of connected departments and bodies whose views would be useful. Gists of such discussions and informations obtained were to be circulated among all members of the Committee.

## 2.9. The Third tour

2.9.1. The third tour of the Committee was to the Azimganj Nabadwip area on the 5th and 6th March, 1960. The Members inspected the Railway Embankment from Azimganj to Nabadwip by railway trolley with special reference to the bridge openings in the section. The Bridge Engineer and the Divisional Engineer of that section of the Eastern Railway accompanied. The flood affected areas of 1959 in the locality were seen. The party inspected in particular the Uttarasan and Babla Bridges and the bridge for the Babla spill. Abnormal heading of the flood waters at these waterways had been recorded.

2.9.2. At Nabadwip they met the Collector and other officers of Nadia district and a large number of local people representing the Municipal Committee, the District Board, various political parties as well as other persons interested in the flood problem of the township. The town had been very badly flooded, water reaching in some cases as high as the first floor of the buildings. The causes of the floods were stated to have been the high level of the Bhagirathi augmented by discharges from the western tributaries. Most of the people wanted a circuit embankment with provision for pumping out the drainage water from the enclosed area. They also stressed the need for the Ganga Barrage which was expected to improve the condition of the Bhagirathi. The Chairman of the Municipality promised to send maps and data. A number of memoranda were received at the meeting.

## 2.10. The fourth tour.

2.10.1. The fourth tour of the Committee was made in the Kharagpur-Digha-Contai area on 11th and 12th

March, 1960. The drainage channels between Digha and Contai to the sea were seen. A meeting was held at Contai. Some 75 persons attended. Seven memoranda were submitted. The flood and drainage problems of Midnapur with particular reference to the Contai Sub-division were discussed. The remedies suggested covered the improvement of rivers and drainage channels, the construction of new sluices and khals and maintenance and improvement of embankments. The people recommended that all drainage channels should be taken over by the Irrigation and Waterways Department and no fishing should be allowed.

## 2.11. The Extraordinary Meeting.

2.11.1. An extra-ordinary meeting of the Committee was held in Calcutta on the 16th March, 1960 to further consider the proposal for making a pilot cut along the bed of the Bhagirathi. Representatives of Commissioners for the Port of Calcutta and Shri K. K. Framji attended by invitation. It was decided to recommend the scheme provided it was suitably modified to fit into and phased in the construction of the Ganga Barrage Project as was provided therein. The resolution was communicated to the Secretary, West Bengal Flood Control Board, in the Chairman's letter No. 116 of 16.3.60 (Appendix II, Vol. II).

## 2. 12. The fifth tour.

2.12.1. The fifth tour of the Committee covered Suri, Messanjore, Kandi, Berhampore, Biswanathpur and the Lalkhandiar and Daffarpur shoals in the Bhagirathi between the 20th and the 23rd March, 1960. The first meeting was held at Suri. Nearly 50 persons came. Five memoranda and one filled in questionnaire form were received. The complex nature of the floods was stressed by one of the spokesmen. A complete contour survey of the country, including the rivers and channels, was suggested. The improvement of all the rivers inclu-

ding the Bhagirathi, sufficient openings in the Railway line in the Hijole area, proper maintenance of all embankments, construction of more dams and the taking up of interim short term measures were suggested.

2.12.2 On the 21st March, 1960, the Committee examined the records of the October, 1959 reservoir operation and other data at Messanjore.

2.12.3. At the meeting at Kandi on the 21st March, 1960, about 150 people were present. Nineteen memoranda and a copy each of the two local newspapers were received. The serious nature of the floods in Kandi was emphasised by all the speakers. They blamed the heavy rains, the Canada Dam releases, the insufficiency of railway openings, the reclamation of the Hijole and other beels, the construction of marginal embankments and the silting up of rivers for the catastrophe.

2.12.4. Remedies in respect of all these problems were wanted. More openings under the Railway line, if possible, its diversion, more drainage cuts, more embankments, deepening of rivers particularly the Bhagirathi, the Ganga Barrage, efficient flood-control dams and interim short-term measures were among the demands. The members of the Committee were shown an area where sand had been deposited on the fields by the overflow from the Mayurakshi river, through a breach in the Embankment.

2.12.5. On the 23rd March, 1960, the members went to Biswanathpur and inspected the off-take of the Bhagirathi and the Ganga river in the vicinity in a launch and the river bank, upstream and downstream of the off-take. They met local officials and a few non-official gentlemen. Later they inspected the Lalkhandiar and Daffarpur shoals in the Bhagirathi River and returned to Berhampur in the evening when a meeting was held there. Some 30 persons attended. Nine memoranda



and two filled-in-questionnaire forms were received. It was acknowledged by one of the speakers that the Mayurakshi Dam was not for flood control. He also stated that no action had been taken by the Government on the recommendation of the 1956 Flood Enquiry Committee. The reclamation of the Hijole was one of the alleged causes of the floods. The Biswanathpur cut, the insufficiency in the railway openings in the Hijole area, and silting up of rivers, absence of waterways in the National Highway No. 34 and the release of water from Mayurakshi reservoir were the causes of the floods. If the causes were remedied, the Ganga Barrage built and a few drainage cuts made, the problems could be solved.

## 2. 13. The Sixth Tour.

2. 13. 1. The Sixth tour of the Committee was to the Falta area on the 27th March, 1960. The members of the committee were accompanied by officers of the Commissioners for the Part of Calcutta. The char reclamation operations above the outfall of the Damodar, the outfalls of the Damodar, and the Rupnarain and the cutting of the Falta bank of Hooghly at Nainan were inspected. The works were being carried out by the Commissioners for the Port of Calcutta. No member of the public attended here. Representations had been received for the silt clearance of the Kantakhali and Balarampur khals. Some of the areas sought to be benefited from these were seen during the Journey.

## 2. 14. The Seventh Tour.

2. 14. 1. The Committee undertook its seventh tour on the 28th March, 1960, to the Khardah area. During the journey the condition of the drainage channels along side the roads was seen. The Khardah beel area was inspected. The meeting later in Khardah Municipal office was attended by a large number of people. Collector, 24-Parganas, S. D. O., Barrackpore and other local officials took part

in the discussions. Quite a number of memoranda were presented. The main demands were for the re-excavation of the Khardah Khal, a sluice at its outfall into the Hooghly, increase of ventages of waterways and improvement of the drains alongside the Barrackpore Trunk Road and providing wider culverts on the side roads coming into the Trunk Road.

2. 14. 2. Some of the members also inspected the Khardah Khal outfall, the erosion of the Khardah Bank by the Hooghly and the protective works undertaken by the Irrigation and Waterways Department, West Bengal, which were in progress.

#### 2. 15. The Third Meeting.

2. 15. 1. On the 28th March afternoon the 3rd meeting of the Committee took place in the Committee's office at P-5, C. I. T. Scheme No. LV Calcutta-14.

2. 15. 2. The information which had been called for from the D. V. C. was placed before the meeting. Detailed discussions were held over until the next meeting, by when the papers submitted would be studied by the Members.

2. 15. 3. The concrete proposals for additional hydrological observations on the various rivers were considered and it was decided to recommend their commencement from 1st June, 1960. This was done in Chairman's letter no. 332 dated 18.4.1960. (Appendix III.....Vol. II).

2. 15. 4. Para 6 of Government Resolution No. 37-I dated 26.12.59 was interpreted to mean that interim recommendations could be made to the West Bengal Flood Control Board even before the submission of the Preliminary and/or the Final Reports.

2. 15. 5. It was also decided to discuss with the officers of the Irrigation and Waterways Directorate the suggestions made by the public in discussions, during tours of inspection and in the various memoranda. If any schemes

had been worked out it was decided to obtain the details to facilitate discussions at the next meeting proposed to be held towards the beginning of May, 1960,

## 2. 16. The Eighth Tour.

2.16. 1. The eighth tour was undertaken in the Champadanga-Khanakul area on the 5th April, 1960. The members of the Committee saw the irrigation and drainage areas upto Champadanga, the Amta Channel and the Damodar River at the site of the new bridge at Champadanga, the flood-affected areas in the Trans-Damodar area including the damaged roads and the flood and spill channels (namely, the Harina Khola, Mundeswari, the Aurora among others). Public meetings were held at Champadanga and Khanakul.

2. 16. 2. The Champadanga meeting was attended by approximately 30 persons. The Additional Collector, Hooghly District, and local officials also attended. Five memoranda and a note with a statistical table sent by the District Mrgistrate, Hooghly, were received.

2. 16. 3. The main complaints related to flooding from the Kunti cut of the D. V. C. and the drainage congestion in the channels in Hooghly District. The latter were stated to have been aggravated by water from the D. V. C. canals by breaches, tail discharge and/or overtopping.

2. 16. 4. The remedies suggested were silt clearance of drainage channels, maintenance of the embankments, rectification of the D. V. C. canal system.

2. 16. 5. The attendance at Khanakul numbered about 25 persons. Two memoranda and a sketch were received.

2. 16. 6. The main suggestions were the removal of bunds, more waterways in the State roads, improvement of the rivers and the drainage channels. Spill, as such, was not objected to. Quick drainage was the chief requirement.

## 2. 17. The Ninth Tour.

2, 17. 1. The Committee undertook the ninth tour on the 6th April. They traversed the area between Howrah-Champadanga-Arambagh and across the Darakeswar to Bankura and Purulia.

2. 17. 2. At Arambagh some 50 persons met the Committee including the S. D. O. and some Block Development Officers. Two memoranda were received. The main suggestions were for the improvement of the major rivers, Damodar, Lower Damodar, Rupnarain, Mundeshwari, Darakeswar and other drainage channels, all of which were incapable of carrying even normal flood discharges. It was particularly mentioned that spill from Darakeswar was very harmful as it invariably brought coarse sand with it which affected the fertility of the soil adversely. Damodar spill on the contrary brought fertility. Only the water should not stagnate on the fields. Sufficient waterways at the Damodar Bridge at Champadanga in the Arambagh and other roads, a few embankments and some regulators were wanted. Flood disposal and not flood prevention was desired.

2. 17. 3. The Bankura meeting on the morning of 7th April was attended by about 20 persons. One memorandum and a note from the Collector were received.

2. 17. 4. The flooding, it was suggested, had been along the Damodar and the Sali rivers and from breaches in the D. V. C. Embankments. Canal structures on the canal were said to be defective. The rainfall had been heavy, the numerous tanks in the district had no spillways with the result that the bunds burst. The land had been overflowed and soil eroded. On these accounts the flooding in the lower regions was intensified.

2. 17. 5. On the evening of the same day the Committee met some 15 persons at the Purulia Circuit House. It was learnt there that for the Panchet Hill reservoir land had been acquired upto R. L. 425 only and homestead upto R. L. 435. During 1959 flood water level went upto R.

L. 436, though the top of the gates was at R. L. 445. On account of the reservoir level having gone above the acquisition levels, there had been flooding of unacquired lands. The D. V. C. it was said, were now thinking of acquiring all lands upto R. L. 445 and hcmesteads upto R. L. 450.

2. 17. 6. It was urged that the steep slope of the District, its heavy rains, and high run-off were causing floods in the lower districts. Check-dams, soil conservation and afforestation would be the means for checking the floods. The water conserved in small tanks in the upper catchment would be very useful there and help in controlling floods in the lower areas.

#### 2.18. Tenth Tour.

2.18.1. The tenth tour was undertaken on the 9th April, 1960. It was to Amta. Some 200 persons (excluding a procession demanding bunds) attended. Ten memoranda were received. Improvement of the major and minor rivers, the construction of the Ganga Barrage, proper regulation of Damodar Dams, quick drainage of flood waters, proper waterways in rail and road bridges, particularly on the Damodar, stoppage of construction of boro bunds and leasing and reclamation of beds of rivers and catering for proper drainage of the area, were the requirements pressed for by the local representatives.

#### 2.19. The Eleventh Tour.

2.19.1 Inspection of the Bashirhat area comprised the eleventh tour of the Committee en-route the flooded areas in the Arbelia-Bashirhat area were seen. About 50 persons including the S.D.O. and some other local officials attended and ten memoranda and a sketch map were submitted.

2.19.2. The people wanted the improvement of the Sunderbans areas including the river Ichamati and the improvement of the sluices in the Circuit Embankments,

their proper maintenance and that of the drainage channels. They wanted the execution of schemes for the Sealdah Gong, Beel Pakuria, Dantbhanga areas. They were hoping to get flushing water from the Hooghly after construction of the Ganga Barrage for the Sunderbans Rivers.

## 2.20. The Twelfth Tour.

2.20.1. The twelfth tour was undertaken on the 12th April, 1960 to the Canning area. The Beels and flooded areas en-route were seen. At Canning about 75 persons met the members and one memorandum was submitted.

2.20.2. The main demand was for the proper maintenance of the Sunderbans embankments and their sluices. The people wanted more sluices in the Piali-Matla region both on the Piali and the Matla and repairs to sluices on the Piali. They wanted control of flooding from the Calcutta Corporation's storm water channel and also branch channel leading drainage to this channel. Some new channels were also necessary. According to them the raising of the Prafulla Sen Road to become an embankment and a spoil bank on the right bank of the Channel leading to the Dabu sluice was necessary. They also wanted the proper execution of the second phase of the Arapanch Scheme and the prevention of encroachments on the beds of the Piali River.

## 2.21. The Fourth Meeting.

2.21.1 The 4th meeting of the Committee was held in Calcutta on the 3rd and 4th May, 1960. It was decided to recommend the scheme for the drainage of the Tollygunj-Panchannagram to the Secretary, West Bengal Flood Control Board, with the suggestion that the possibility of cuts in the Panchannagram Taccavi Embankment must be guarded against.

2.21.2. The operation of the D. V. C. reservoir and the 1959 floods was discussed in detail by the Member

with Shri N. S. Iyengar, Manager, Reservoir Operation, D. V. C., who attended by invitation.

2.21.3. Finally the Committee decided upon the outline of the preliminary report.

## 2.22. The 5th Meeting

2.22.1. The 5th meeting was held in Calcutta from 23rd to the 24th May, 1960. The draft report was then examined and three chapters were approved.

## 2.23. The 6th Meeting.

2.23.1. The 6th meeting was held in Calcutta from 24.6.60 to 26.6.60 when the report including the priorities for the different schemes were finalised.

2.24. The Committee thus held 21 meetings with the people of localities which they visited and that had a vivid description of the catastrophe which befell the State from the affected people themselves who also gave their suggestions for dealing with the vexed problems. 141 memoranda were received during these meetings, the total being 79. The remainders were received by post or by hand in the office.

2.25. These general discussions were supplemented by discussions with technical persons, representatives of organisations and others. Chief among these were :

(a) Shri Kapil Bhattacharjee, Civil Engineer, (b) Shri V. S. C. Banerjee, I.A.S., District Magistrate, Berhampore, (c) Prof, Dr. S. P. Chatterjee, Director, National Atlas Organisation and head of the Department of the Geography of the University of Calcutta and Shri Kanan Gopal Bagchi of the University of Calcutta, (d) Shri Tridib Chaudhuri, M.P., (e) Representatives of the Communist Party of India, (f) Representatives of the Ramnagar Cane and Sugar Co. Ltd., Plassey, Nadia, (g) Shri D. P.

Chatterjee, Superintending Engineer, Mayurakshi Canal Circle, (h) Members of the Standing Borough Committee No. 16 of the Calcutta Corporation of the Tollygunge area, (i) Shri S. A. P. Swamy, (j) Shri J. Bakshi, Ex-I.S.E., (k) Shri S. R. Ghosh, Deputy Chief Engineer, Barrage and Irrigation, D.V.C., (l) Shri S. P. Sarathy of the Commissioners for the Port of Calcutta, (m) Shri N. K. Ghose, Superintending Engineer, Damodar Irrigation Circle and his Executive Engineers, (n) Shri R. B. Chakravorty, Chief Project Engineer, Kangasbati Project, (o) Shri N. Siddhanta, Superintending Engineer, Western Circle and his Executive Engineers, (p) Shri S. Dutt, Superintending Engineer, Eastern Circle and his Executive Engineers, (q) Shri K. L. De, Executive Engineer, Drainage, Corporation of Calcutta, (r) Superintending Engineers and other officers of the Development (Roads) Department, West Bengal, (s) Shri N. S. Iyengar, Manager, Reservoir Operations, D.V.C. (t) Officers of the Eastern and South Eastern Railways, (u) Shri B. N. Banerjee, Joint Director of Agriculture Engineering, West Bangal.

2.26. The memoranda and their abstracts are given from pages 1 to 1444 of Volume III.

2.27 The records of the discussions with the gentlemen in the foregoing paragraph will be found in Annexures IV to XXXII of Volume II of the report.



## CHAPTER 3.

Causes of 1959 floods and assessment of effects of these floods.

3.1. The primary cause of floods is heavy precipitation of rain. In the hilly catchment where the slopes are steep, the run-off is carried away by rivers draining the area comparatively quickly, and little or no ill effects are felt if, however, the drained area also is bare, sheet erosion takes place which goes on getting worse with the passage of time. The run-off collects in rivulets where its eroding and transporting process gets increased and gullies get formed which in turn induce further aggravation of erosion. Thus, the load of eroded material to be carried by the rivers tends to go on increasing. When such streams debouch on to the plains lower down where the slopes are much flatter they unload their sediment charge, silt up their original channels and, floods and sediment are forced on to the adjoining areas causing a lot of damage and distress. Not unoften the process of unloading entirely dams up the channel so that the river breaks out into a new course laying waste further areas. Construction of marginal embankments along the rivers is taken recourse to. These serve the purpose of preventing floods for the time being but tend to create more problems later. Behind the embankments vested interests grow up encroaching into the flood plain of the river. On account of further aggradation of the river bed or unusual heavy rainfall or both, the embankments fail and the havoc caused is catastrophic.

3.2. In the Gangetic West Bengal, almost all the rivers answer to the pattern described in the foregoing paragraph. The floods in the area are further accentuated by the deplorable condition of the drainage channels which delays recession and prolongs submersion. The obvious remedies would appear to be to control erosion in the upper catchments of the rivers and improve the

drainage channels. But unfortunately these have not received the amount of attention they deserve. The catchments of the rivers like the Mayurakshi, the Ajoy, the Damoder, the Kangsabati etc. are in bad state of denudation. The courses of the rivers are short, the gradients steep and the effects of heavy precipitation are more immediate and disastrous. Soil and water conservation measures in these catchments are a matter of the utmost urgency. Equally urgent is the necessity of improving the drainage conditions lower down.

3. 3. The catchments of these rivers can be divided into forested regions and cultivated areas. In the latter, wherever paddy fields exist they obstruct and retain some water on account of existence of 'ails' (field bounds) but there is also a lot of dry cultivation without bunding and terracing. This has led to serious erosion of the soil, even ravine formation, and to eventual abandonment.

3. 4. The problems in West Bengal have one other very important complication and that is that the lower portions of the drainage outlets are all tidal. These are, all, for reasons which will be described in a latter chapter in the process of deterioration. Their comparatively low discharging capacities get a further set-back from tidal lockage so that drainage is slow and submergence of flooded areas gets prolonged.

3. 5. The 1959 floods were caused by a combination of these various factors described below.

- (a) Heavy and concentrated rainfall,
- (b) Lack of adequate soil-cover in the catchments of all the rivers,
- (c) Badly deteriorated condition of the Bhagirathi-Hooghly, Rupnarain and lower reaches of their tributaries and other drainage channels,
- (d) Releases from the Mayurakshi and Damodar Valley Reservoirs,
- (e) Encroachments in the Food plains of the rivers and,

(f) High tide levels in the Hooghly and the Rupnarain. These are further discussed in the following paragraphs :  
3. 5. 1. Rainfall.

3. 5. 1. 1. The sixty year mean monthly rainfall in the Gangetic West Bengal and in the Damodar Valley, within which the ten affected districts of the State lie, are 7" to 9" in September and 3" to 5" in October. Monsoon normally withdraws from this area in the second week of October. Thus, rainfall in September and in the early part of October is due to active south-west monsoon conditions, while in the latter part of October it is usually the result of post-monsoon thundershowers. On an average, there are 9 to 13 rainy days in September and 3 to 6 in October in this area. Floods occur as a result of a few consecutive days of heavy concentrated rainfall. Such rainfall in September-October is associated with active monsoon conditions generally caused by the passage of a depression or cyclonic storm from the Bay of Bengal. Rainfall in the coastal districts often commences while the storm is 2 to 3 hundred miles away from the coast and continues till it passes inland. As the storm approaches and crosses the coast very heavy rainfall occurs over the coastal area and with the movement of the storm, the rainbelt gradually extends into the interior. The average rate of movement of the depressions and storms is 200-250 miles a day but they may move slower or faster. The slow-moving storms cause more prolonged heavy rains.

3. 5. 1. 2. During September and October, 1959 the districts of Gangetic West Bengal (viz. Bankura, Birbhum, Burdwan, Hooghly, Howrah, Midnapore, Murshidabad, Nadia, Purulia and 24-Parganas) and the Bihar Plateau experienced two successive periods of heavy rain, first, from the 8th to the 12th September and second, from the 30th September to the 3rd October. The latter spell of heavy rain associated with a cyclonic storm led to intensive flooding all over the area, when rivers like the Mayu-

rakshi, Ajoy, Damodar, Rupnarain, Silai, Kasai, Kalighai, Subarnarekha rose very high. The Ganga and its effluents, the Bhagirathi, the Jalangi, the Churni and the Ichamati, also were simultaneously in flood. The spring tides too occurred at this time and thus aggravated the flooding and delayed drainage.

3. 5. 1. 3. During the first period from the 8th to the 12th September there had been widespread rain over the Gangetic West Bengal and the Bihar Plateau. This earlier period of rain had left some saturation of the soil and filled up 'beels' and low pockets. These factors had apparently contributed to a speedier run off and more flooding as a result of the latter storm from the 30th September to 3rd October.

3. 5. 1. 4. The daily average rainfall during the first period for the affected districts is given in the table below :

Table - I.

Statement of the average daily rainfall in inches in the flood, affected districts of West Bengal for the period 8. 9. 59. to 12. 9. 59.

Districts	8/9	9/9	10/9	11/9	12/9	Total.
Bankura (13)	1.78	1.99	1.89	1.29	0.97	7.92
Birbhum (5)	1.16	1.27	1.43	0.54	0.36	4.76
Burdwan (8)	0.97	2.28	2.43	1.89	1.45	9.02
Hooghly (6)	0.67	3.13	3.57	2.20	1.89	11.46
Howrah (1)	*	2.14	3.75	1.85	0.65	—
Midnapore (19)	0.57	2.01	2.30	1.76	0.96	7.60
Murshidabad (5)	0.75	0.96	1.11	1.71	1.02	5.55
Nadia (2)	0.15	2.45	2.25	2.07	1.06	7.98
Purulia (8)	1.30	1.16	1.09	1.19	0.85	5.59
24-Parganas (9)	0.31	2.66	3.68	2.95	1.27	10.87

\* Data not available.

N. B. Figures within brackets against district names indicate the number of rain-gauge stations data of which have been taken into account for working out the district averages.

3. 5. 1. 5. It will be noticed that districts of 24 Parganas, Hooghly and Burdwan received comparatively more rain in the 5 day period of the storm. From the 13th September the rainfall decreased gradually and little or no rain fell in the area in the following fortnight. The upper catchment of the Damodar had received only light to moderate rain during this period.

3. 5. 1. 6. The second spell of heavy rain from the 30th September to the 3rd October was associated as already stated with a severe cyclonic storm which developed from an earlier depression formed in the East central Bay of Bengal. It remained practically stationary near the head of the Bay about 140 miles south of Calcutta from the evening of 29th September till the morning of the 30th September and intensified into a severe storm. It then started to move northwestwards and crossed the West Bengal-North Orissa coast between Contai and Balasore in the early morning of the 1st October. After entering inland, the cyclonic storm weakened into a depression, which was near Chaibasa on the morning of the 1st October and near Ranchi on the 2nd morning. By the 3rd October, the depression weakened further into a low pressure area extending from the Bihar Plateau to Gangetic West Bengal. The track of the cyclonic storm is shown in plate - in Volume II.

3. 5. 1. 7. There had been light to moderate rain at some places in the Gangetic West Bengal from the 27th to the 29th September, when the depression was moving towards the West Bengal-North Orissa coast. With the intensification of the depression into a severe cyclone heavy rainfall started in the Gangetic West Bengal including the lower Damodar basin on the 30th September - 1st October. Then the region of heavy rainfall shifted to the upper basin of the Damodar on the 1st and 2nd October. The main period of heavy rain in the districts of Gangetic

West Bengal was from the 30th September to the 3rd October. The daily average rainfall for the districts during the period is shown in table below :

Table - II.

Statement of the average daily rainfall in inches in the flood-affected districts of West Bengal for the period 30. 9. 50 to 3. 10. 59.

Districts	30/9	1/10	2/10	3/10	Total
Bankura (14)	2.11	2.77	1.99	1.08	7.95
Birbhum (5)	1.07	2.41	3.57	1.07	8.12
Burdwan (9)	1.05	4.34	2.46	1.26	9.11
Hooghly (6)	5.18	3.63	1.18	0.79	10.78
Howrah (1)	0.84	8.06	0.76	0.35	10.01
Midnapore (20)	2.62	3.46	0.70	0.77	7.55
Murshidabad (5)	1.65	3.62	3.83	5.48	14.58
Nadia (2)	1.65	5.06	5.28	1.06	13.05
Purulia (8)	2.22	2.51	1.83	0.05	6.61
24-Parganas (10)	3.94	5.65	1.43	0.71	11.73

N.B.—Figures within brackets against district names indicate the number of rain gauge stations data of which have been taken into account for working out the district averages.

3. 5. 1. 8. During this 4 day period the total average of 10" to 15" of rain fell in the districts of 24 Parganas, Howrah, Hooghly, Nadia, and Murshidabad and 7" to 9" in the remaining districts of West Bengal. The heavy rain in the coastal areas, Midnapore, 24 Parganas, Hooghly and Howrah occurred mostly during the 2 day period of the 30th September and the 1st October, decreasing thereafter. The inland districts, Burdwan, Birbhum, Nadia and Murshidabad recorded the main spell of heavy rains, a day later, that is, during the two day period of the 1st and 2nd October. In the Murshidabad district, however there was another day of heavy rain on the 3rd October.

In other districts, there was an appreciable decrease of rain by the 3rd October.

3. 5. 1. 9. In Table III below the rainfall during some of the major floods of the last 60 years (including the October 1959 floods) have been compared. Districts of 24-Parganas, Nadia and Murshidabad recorded very heavy rainfall of the order of 12" - 15" during 30th September - 3rd October, 1959 as against 10" - 12" during a similar 4 day period in September flood, 1956. The districts of Birbhum, Burdwan and Hooghly, however, recorded more rain during September 1956 flood than in October, 1959.

TABLE—III

Statement showing districtwise average rainfall in ten districts of West Bengal during some of the flood periods.

Name of Districts	1905	1916	1917	1939	1943	1956	1959	1959
	July 27th-29th	September 21st-23rd	July/Aug. 30th-1st	August 1st-4th	July 15th-17th	September 23rd-26th	September 8th-12th	Sept. & Oct. 30th-3rd
Bankura ...	9.10	7.10	4.35	9.74	5.48	8.03	7.92	7.95
Birbhum ...	6.29	6.13	4.60	4.98	9.81	13.74	4.76	8.12
Burdwan ...	11.01	6.28	4.94	7.43	10.03	15.58	9.02	9.11
Hooghly ...	13.81	5.85	1.81	11.25	4.35	11.77	11.46	10.78
Howrah ...	14.58	5.89	1.31	9.09	3.82	*8.73	—	*10.01
Midnapur ...	7.56	4.13	2.23	6.73	1.25	6.11	7.60	7.55
Murshidabad ...	4.72	4.03	2.12	9.28	4.26	10.22	5.55	14.58
Nadia ...	8.97	4.45	2.19	11.04	3.66	11.65	7.98	13.05
Purulia (West Bengal)	3.48	3.79	5.27	7.20	4.93	4.71	5.59	6.61
24-Parganas ...	10.27	5.54	1.96	8.86	3.03	10.09	10.87	11.73

\* Based on data of only one State rain gauge station.



3. 5. 1. 10. Rainfall in Damodar catchments and comparison with earlier flood periods.

3. 5. 1. 10. 1. Daily averages of rainfall over the Damodar and Barakar catchments and in the lower valley have been worked out for the period 30th September to 2nd October, 1959. These data are given in Table IV. Isohyetal maps showing the distribution of actual daily rainfall over the Damodar Valley area during this period as prepared by the Meteorological Office were also studied by the Committee.

TABLE—IV

Averages of daily rainfall over Barakar Catchment, Damodar Catchment and Lower Valley during the period 30. 9. 59. to 2. 10. 59.

Barakar Catchment (10)	Dates	Averages (inches)
	30/9	0.12
	1/10	1.91
	2/10	5.54
Damodar Catchment (33)	30/9	0.74
	1/10	1.92
	2/10	3.67
Lower Valley (16)	30/9	0.83
	1/10	4.55
	2/10	3.32

N.B. Figures within brackets against catchment names indicate the number of raingauge stations data of which have been taken into account for working out the catchment averages.

3. 5. 1. 10. 2. The total average rainfall for the 3-day period 30th September to 2nd October over the upper catchment (above Raniganj) and the lower valley (below Raniganj) have also been computed as shown in Table V

along with similar comparative value of average rainfall associated with storm periods of the past 60 years. The past data for the earlier storm up to 1943 have been reproduced from a published memoir by V. Satakopan of the India Meteorological Department.

3. 5. 1. 10. 3. It may be seen that the lower valley of the river Damodar (below Raniganj) received a total rainfall of 8.61 inches during the 3-day period from 30th September-2nd October (i.e. 2".87 per day). In September, 1956, the same area received still heavier rainfall of 12".92 during 4-day period 24th-27th September (i.e. 3". 23 per day). Rainfall in the upper catchment (above Raniganj) was, however, heavier in 1959 flood (6".83) than in 1956 (3".57).

TABLE—V

Statement showing accumulated average rainfall on occasion of heavy precipitation over the Damodar Catchments (upper and lower).

Year	Month	Dates	Duration of spell in days.	Total of daily average rainfall inches during period indicated under Col 4.	
				Upper catchment (above Raniganj)	Lower catchment (below Raniganj)
1	2	3	4	5	6
1897	July	... 12-15	4	8.15	7.76
1898	June	... 17-19	3	7.85	10.99
1900	September	20-22	3	5.51	7.08
1908	July	... 6-10	5	5.64	7.11
1913	August	... 6-10	5	11.85	5.33
1916	September	... 22-23	2	5.99	5.55
1917	October	... 5-7	3	5.56	5.31
1924	June	... 20-21	2	3.49	6.24
1928	June	... 13-19	7	10.10	10.29
1935	August	... 11-13	3	9.21	3.33
1939	August	... 1-4	4	5.28	7.73
1941	October	... 8-10	3	6.90	6.40
1943	July	... 15-17	3	8.40	6.98
1956	September	... 24-27	4	3.57	12.92
1958	September	... 15-16	2	6.83	1.42
1959	September	... 8-13	6	5.90	10.93
1959	September to October	... 30-2	3	6.83	8.61

3. 5. 1. 11. The heavy rainfall (30th September to 3rd October) spread over almost the entire area, following the earlier spell of slightly lower intensity, led to almost all the rivers in the region swelling above their banks and inundating the areas on both sides except where protective embankments existed and were not breached. Danger levels fixed were exceeded to varying extents at almost all the important places

3.5.2.: Lack of adequate soil cover in the catchments of the rivers.

3. 5. 2. 1. Total or partial lack of soil cover in the catchment of a river leads to soil erosion and increased run-off. The factors that influence erosion are :

1. The amount and intensity of rainfall.
2. The type and condition of the vegetative cover.
3. The nature and properties of the soil.
4. The slope of the land.
5. The land-use pattern.

It is not possible to exercise any control whatsoever on the first and the fourth of the factors stated above.

3. 5. 2. 2. Role of vegetative cover.

The vegetative cover helps water and soil conservation in the following ways :

1. It protects the soil from the beating and dispersing action of the raindrops by breaking their velocity. A closed canopy of trees with dense undergrowth will allow the raindrops merely to trickle down harmlessly to the soil.

2. The roots help in binding the soil particles together and in building a better structure.

3. The roots help in opening the soil and thereby aid in increasing water absorption and in reducing run-off.

4. Vegetation provides a mechanical obstruction to flowing water thus reducing its velocity and soil-carrying capacity. The reduced velocity also aids absorption by the soil.

5. The floor of a well-managed forest is covered with a thick layer of leaf litter in the various stages of decomposition underlain by a layer of humus which imparts to the soil below the property of holding a large amount of water.

### 3. 5. 2. 3. Description of catchment areas :

3. 5. 2. 3. 1. The D.V.C. have made certain studies on the catchment areas of the Damodar and its tributaries. It is learnt that of the catchment area of over 9,240 sq. miles 1,865 sq. miles of lower catchment is in West Bengal. The rest, forming the upper catchment, is in the State of Bihar. The upper catchment areas of the Mayurakshi and the Ajoy are again in Bihar but the major portion of the upper catchment of the Darakeswar, the Kangsabati and the Silabati are in this State.

3. 5. 2. 3. 2. The topography to the catchment of all these rivers are fairly similar, being hilly in upper areas and undulating in the lower region. The altitudinal range is from 350 to 4,480 ft. The soil is sandy loam over major part of the upper catchment but in the lower catchment it is more lateritic. In general, the soil all over is poor in organic content which is as low as 0.09 per cent.

The land use pattern again is fairly similar in all the catchment areas. In the lower catchment area practically all land has been bared of vegetative cover. Good cultivations are in the valleys and pockets where the slope is gentle. Elsewhere the land is lying as either current fallow or waste. The land use pattern of the upper Damodar Valley is reproduced below :

This relates to the year 1952-53 for which data are available,

## Land-use data for Upper Damodar Valley for 1952-53

Civil Districts.	Area within Damodar Valley (Sq. miles)	Area under [crops excluding current fallows (Acres)	Forest area Acres Percentage of	Waste Land		Area occupied by houses, tanks but not rivers and reservoirs, Percentage of 2
				Culturable Acres Percentage of 2	Unculturable Acres Percentage of 2	
I	2	3	4	5	6	7
Hazaribagh ...	4,816	8,08,855	12,73,340 41.31	2,25,695 7.32	11,4,943 3.73	3.21
Purulia ...	531	1,45,739	31,406 9.24	44,677 13.15	9,909 2.92	11.79
Dhanbad ...	1,111	1,36,956	68,537 9.64	1,13,290 15.93	63,461 8.93	12.37
Ranchi ...	385	1,29,537	46,880 20.29	11,878 5.14	10,291 4.45	5.43
Palamau ...	310	63,211	1,46,624 73.90	5,178 2.61	4,571 2.30	2.11
Santhal Parganas	222	4,30,308	4,925 3.47	18,702 13.18	702 .50	6.77
<hr/>						
	7,375	17,14,606	15,71,712* 33.44	4,19,438 8.92	2,03,877 4.33	5.40
<hr/>						

\* 2,455.8 Square miles.

Source of information—Shri V. S. Rao, Conservator General of Forests, West Bengal.

3.5.2.3.4. The data furnished above show that—

- (a) the Forests form about 34 per cent. of the total land surface of the upper valley.
- (b) about 318 sq. miles (2,03,877 acres) or waste land (the ownership of most of the lands has already vested in Govt.) is now primarily used as inferior grazing ground, liable to constant erosion.

(c) about 655 sq. miles (4,19,438 acres) form culturable waste. Unless these areas are properly managed, they only aid the process of erosion.

3.5.2.3.5. The forest area in Santhal Parganas is about 30 per cent. of the total land area, in the Darakeswar-Kangsabati-Silai catchment, out of a total land surface of 2,700 sq. miles, about 520 sq. miles or about 19% are under forest. The forests area in the lower catchment areas is insignificant.

3.5.2.3.6. The forests in the catchment areas had been under maltreatment for decades and diminishing in extent. The following table shows what had been the extent of disforestation during last 100 years in these catchment areas :

District	Present extent of forest (sq. miles)	Present extent of idle land (sq. miles)	Former extent of forest about a century ago. (sq. miles)
1	2	3	4
Bankura ...	400	500	1,000
Midnapur ...	625	115	900
Purulia ...	330	470	420
Birbhum ...	50	20	300
Burdwan ...	100	15	200

Source of information—Shri V. S. Rao. Conservator General of Forests, West Bengal,

3.5.2.4, It is necessary to comment on the extent of present forest cover, The National Forest Policy of 1952, as laid down by the Government of India notification No. 13-1/52-F., dated 12.5.52, prescribes a forest cover of an average of 33 per cent. for the country but 60 per cent. in mountainous region and 20 per cent. in the plains. The present forest cover in the upper catchment area falls short of the target laid down in the National Forest Policy. The area so covered in the lower catchment area is far less.

3.5.2.5. The disforestation had been gradual over many decades under private ownership. All these forests were subjected to repeated cuttings thereby decreasing the density

or vegetative growth, overgrazing by village cattle whose uncontrolled population is constantly on the increase, and by recurring annual fires caused by the graziers as well as the tribal people in pursuance of their habits of the annual hunts. During the period of laissez-fair (approximately last hundred years) considerable areas were disforested in an attempt to bring the land under agriculture, The present extent of highlands lying waste is the result of such ventures, The cumulative effects of these maltreatments caused increasing soil loss and surface run-off. It will bear stress here that the adverse effects of these maltreatments are not felt so much immediately as increasingly afterwards.

3.5.2.6. A well-managed and well-maintained forest cover is the best remedy for prevention of soil erosion and excessive run-off. In India, Forest Influence Stations are not functioning for long to give adequate comparable data. The following figures obtained from the Soil Conservation Research Station of the U.S.A. would give useful information.

Slope per cent.	Drainage area acres.	Annual Rainfall in	Period years.	Cover	Average annual soil loss, tons per acre.	Water loss per cent. precipitation.
1	2	3	4	5	6	7
7.5	7.94	42.23	9	Woods	0.06	1.2
12.5	(0.01					
	(0.01	40.95	9	(Woods	0.05	0.3
				(Woods	0.36	2.6
				(burns		
4.8	5.62	28.68		Woods	0.15	3.07
5.6	2.50	26.81		(Grass	0.03	1.2
5.17	0.01)			(Pasture		
5.17	0.01)	30	9	Woods	0.01	0.1
		approx		(Woods	0.13	4.4
				(burned		
7.7	0.01)			(Grass	0.02	1.0

7	2	3	4	5	6	7
10.0	0.01)	46.61	10	(Woods	0.002	0.06
				(Woods	8.68	11.5
				(burned		
				(Grass	0.31	1.9
12.0	(2.23)	37.91		Woods	0.01	3.2
	(2.55)	)		Cultivated	17.18	20.6
	( )	)		Grass	0.1	13.8
	(3.57)	)		Pasture		
		38.02	9	Grass	0.028	5.42
	(0.01					

3.5.2.7. In this context the following information available from experiments carried in Malaya is revealing. Measurements were taken on sediment both carried in suspension and travelling along the bed of each of three main rivers. The results obtained were as follows :

Catchment area	S. Bertam	S. Telom
Square miles	28	30
Jungle	64%	94%
Type of Vegetation		
Tea	21%	5%
Vegetable cultivation	7%	1%
Open land	8%	—
Soil Erosion		
lb. per year	$4^1 \times 10^6$	$9 \times 10^6$
lb. /acre/year	2,300	470

3.5.2.7.1. By comparing the quantity of sediment in the Telom (94% jungle) with that in the Bertam (64% jungle) the increase in soil erosion caused by jungle clearance is clearly seen. It may be noted that the jungle cover in the State is not more than about 13%.



3.5.2.7.2. The comparative average amounts of soil erosion for different types of vegetation in the Malayan region referred to above are approximately as follows, although the erosion is naturally much worse on very steep slopes than on comparatively flat ground :

Jungle	...	300/lb./acre/year
Tea	...	6,000/lb./acre/year
Vegetation cultivation		9,000/lb /acre/year

3.5.2.8. It may be noted that the terrain referred to is a table land with relatively level valleys. Where the country is made of sharp ridges and steep valleys as in the catchments of West Bengal Rivers figures for erosion on cleared areas would be very much higher, and the products of erosion would reach the low lands in greater quantity and in a much shorter time. Because of maltreatment, the effectiveness of the forest cover is much less under the prevailing conditions, thereby affecting the silt load of the rivers.

3.5.2.9. The Director of Soil Conservation, D.V.C. has quoted the following figures of soil loss and run-off obtained from his Experimental Stations in forested catchment areas that are subjected to indiscriminate exploitation at the time of study :

Site	Acreage	Slope	Soil loss in lbs. per acre		Percentage run-off	
			1953	1954	1953	1954
1	35	6.15%	4892	4402	17.1	21.4
2	115	1.83%	6783	2532	37.3	35.7

3.5.2.10. The following figures of silt data have been quoted by the D.V.C. Planning Engineer :

River and silt reading site	Catchment area (sq. miles)	% of forest area in the catchment.	Observed average maximum concentration gm litre.	Annual 1000 tons.	Load Ac. ft.	Annual load in A. C. ft. per 100 sq. miles.
Barakar, Barhi	280	40.40	7.61	314	215	77
Konar, Konar	385	37.73	4.16	298	204	53

3.5.2.11. In addition to the maltreated forest cover in the catchment area, overgrazing considerably increases soil erosion and surface run-off. The hazards of overgrazing have been amply demonstrated in the experiments carried out at Deochanda by the D.V.C. authorities. The following table shows that soil loss increase in grazing intensity and that the overgrazed area loses over three times the soil that is lost from a properly grazed area.

**Grass land on 2% slope. ( Run-off Plot studies  
Size of the plot 50' x 10' )**

**Soil loss in pounds per acre.                      Percentage Run-off**

Treatment Year	Untouched fallow	Properly grazed fallow.	Over-grazed fallow.	Untouched fallow	Properly grazed fallow.	Over grazed fallow.
1954	550	—	2478	7.1	—	20.2
1955	295	487	3778	8.9	15.8	15.8
1956	716	1041	2667	15.6	28.9	29.5
1957	138	569	465	11.0	24.3	31.7
1958	286	636	1204	10.9	28.9	45.8
Mean	357	683	2110	10.5	19.6	28.6

3.5.2.12. Surface run-off as well as soil loss have also been studied both in the D.V.C. area and Santiniketan on lands under different crops of agriculture. The data is reproduced below from which it would be seen that both run-off and soil loss vary greatly with different agricultural crops ;

(i) Deochanda Experimental Station

Percentage run-off and soil loss during Monsoon of 1954, 1955 and 1956.

Treat- ment.	Monsoon					
	1954		1955		1956	
	Percentage run-off	Soil loss in lb./acre	Percentage run-off	Soil loss in lb./ acre	Percentage run-off	Soil loss in lb. / acre
Gora Paddy	8.4	1473	14.2	4046	19.0	1960
Gora Paddy and arhar.	9.4	1632	17.3	5616	26.0	2161
Maize	4.7	1314	9.6	5087	4.8	2374
Maize and arhar.	5.0	1325	11.8	4631	3.0	880
Maize and arhar	Not	Not	13.3	4475	3.8	1381
(maize stubble mulch.)	recorded	recorded				
Maize and urid (seed)	3.7	1215	12.7	5881	2.7	1025
Maize and urid (green manure).	3.3	835	13.5	5293	2.9	1579
Untouched fallow	7.1	550	8.9	295	15.6	717
Properly grazed fallow	Not recorded	Not recorded	15.8	487	28.9	1042
Overgrazed fallow	20.2	2478	15.8	3748	30.7	2562



Where, under above form of intermittent cultivation, wrong tillage practice is adopted, the effect of run-off and soil loss is very significant. The results from a comparative study, reproduced below, will clearly substantiate this point :

Cropping system	Soil loss in lbs./acre			Percentage run-off (against rainfall)			Remarks
	1957	1958	1959	1957	1958	1959	
Maize sown and down.	14600	21954	19512	43.3	45.3	39.0	Local Practice
Maize sown on contour and intercropped with arhar.	2485	7385	10255	17.1	25.7	16.0	Improved practice.

3.5.2.14. As explained before, sheet and finger erosion ultimately end in gully formation. The other factor that aggravates such formation is the bullock carts that play over the undulating 'danga' lands without a path or roadway. During the dry months the soil remains friable and the bullock cart wheels break the surface to form tracks that become the channels during surface run-off. Once gullies are formed, the soil loss every year alarmingly increases in quantity. Experiments conducted on the rate of advance of gully banks in Santiniketan showed that in five years, without any added interference, the gullies extended backward by nearly 5 ft.

3.5.2.15. The extent of the influences has been shown in the analyses above. Their nature affecting the flood problem are briefly summarised below :

- (1) Inadequate forest cover in the catchment areas.
- (2) Ineffectiveness of the existing forest cover.
- (3) Overgrazing and other maltreatment of waste land.
- (4) Incorrect tillage practice and crop pattern.
- (5) Improper land use.

3.5.2.16. The water absorbing capacity of the soil deteriorates with the result that the run-off is much greater and tends to swell the volume of water in the river. The forest areas in these catchments are few and in a degraded condition. They are subject to many malpractices such as frequent cropping, grazing and continual removal of leaves, dry sticks, branches, interior trees etc., which it is very necessary to preserve on the forest floor to produce humus and give the soil a porous, sponge-like, water absorbent and water retentive texture. The frequent cutting and thinning out of the forest lets in the hot sun to the forest floor, the open grazing by cattle hardens the surface and kills seedlings. Consequently the entire forest area on the hills and sloping ground is subject to sheet erosion, with gullies and ravines developing along the margin. The siltation of the bed of a stream is caused by sediment washed into it all along its course. Though the mountainous region forming the upper catchment contributes the greater part of the sediment load there are significant additions in the lower reaches as well, especially when the stream passes through large areas of undulating land, such as are to be found in the western districts of this State viz. Purulia, Bankura, Birbhum, Burdwan and Midnapur. Vast forests which once occupied this rolling country acted as effective agents for retarding the force of rain water, encouraging insoak into the ground and preventing soil wash into the rivers. They also built up great underground

reservoirs of water, which filled the wells in the neighbourhood and formed the sources of springs, thus greatly benefiting the population and their agriculture. The table in page 33 shows approximately the present extent of forest, the present extent of idle land and the former extent of forest (about a century ago) in these five districts :

3.5.2.17. The loss of over 1,000 sq. miles of forest from the tract within a century and the continual short erosion from over 1,100 sq. miles of idle land must surely be having a very serious effect on the water-regime and the sediment burden of rivers. Besides, it may be noted that even the existing forests contain numerous blanks. Such forests are not effective water and soil conserving agents.

### 3.5.3. Releases from the Reservoirs.

3.5.3.1. In the month of September the Mayurakshi Dam held up almost all the run-off from its catchment and thus gave some relief to the lower valley. Towards the end of the month on account of heavy precipitation over the whole of the catchment the reservoir got filled up to the top of the gates with the result that the entire inflow had to be let down into the river causing a rise in the water levels in the lower valley.

3.5.3.2. In the case of the Panchet Hill and Maithon Reservoirs in the Damodar Valley the Reservoir levels which were ready above the prescribed monsoon storage levels rose very rapidly on the night of 1st October and over 2,00,000 cusecs were let down from each of the reservoirs during certain hours of the night between the 1st and 2nd October, 1959, the combined outflow not exceeding 2,88,000 at any stage. This added to the swelling up the Damodar and other rivers in the deltaic area which were already in high floods owing to heavy rainfall in the plains as well.

### 3.5.4. Encroachments in the flood plains of the rivers.

3.5.4.1. Along almost all the rivers in the deltaic West Bengal embankments have been constructed in order to save the neighbouring countryside from inundation from the spills of rivers. These by themselves have constricted the river sections which in consequence of deposition of sediment tend to become less and less capable of carrying the discharges flowing into them from the upper reaches. In addition, behind the protection given by the embankments, vested interests have grown up and to safeguard these, certain embankments have had to be continuously raised and strengthened. But when they breach the flood havoc becomes greater. A large number of breaches in almost all kinds of embankments occurred during the 1959 floods.

### 3.5.5. High tide levels in the Hooghly and the Rupnarain.

3.5.5.1. Unfortunately the heavy rains from the 30th September to 2nd October synchronised with high spring tides in the main drainage channels of the deltaic West Bengal, namely, the Hooghly and the Rupnarain. This led to backing up the rivers and khals which discharged into them and retarded the drainage of inundated lands.

## 3.6. Effects of floods.

Flood-affected area has been divided regionwise and the extent and amount of flooding in each is described below :

### Region I—East of the Bhagirathi River.

#### 3.6.1. Murshidabad District :

3.6.1.1. The flooded area comprised of an area of about 168 sq. miles to the north of Berhampur-Jalangi road. This is bounded by Berhampur-Lalbag. Road on



the West. River Padma on the east and the Ganges embankment, Akhriganj-Katlamari Road, and Krishnagar Debipur Jalangi Road on the North stretching up to about  $1\frac{1}{2}$  miles below Akhriganj. This area lies within the local catchments of the Bhairab, the Chotto Bhairab and the Sialmari Rivers. The flooding here was more due to the Mid-September rainfall when the river Ganga and its effluents, the Bhagirathi, the Bhairab, the Chotto Bhairab, were running high making it difficult for the rain water to drain. The Bhairab at Akhriganj remained high throughout the period from the 20th August to the beginning of October.

3.6.1.2. The flooded area below the Berhampur-Jalangi Road measured 308 sq. miles and is bounded by Beldanga-Berhampur Railway line on the west, the Jalangi river on the east and the District boundary of Nadia on the south. This area is commonly known as the "Kalantar" area and lies within the lower local catchments of the Chotto Bhairab, the Bhairab and the Jalangi rivers. The depth of water standing on this area was on the average 6 ft. the maximum being in the neighbourhood of 14ft. in the lowest pocket. Heavy rains during mid-September and early October could not be drained out on account of the rivers round the area remaining in high floods. In normal years also the drainage is slow owing to the deteriorated conditions of the drainage channels.

3.6.1.3. The total number of houses damaged in this part of the district and the parts flooded lying on the right bank of the Bhagirathi was reported to be a little over 90,000.

### 3.6.2. Nadia District :

3.6.2.1 An area of 800 sq. miles bounded by the Murshidabad District boundary on the north, the Bhagirathi-

Hooghly river on the west, the Jalangi river and the Ranaghat-Bagula Railway line in the east stretching up to about Kanchrapara on the south, was flooded. This area is mainly drained by the Jalangi and the Churni Rivers which remained high from the end of August to the middle of October 1959. The drainage congestion lasted for nearly a month and a half during which time considerable damage took place to the crops, village homesteads, roads and Railway structures. These latter were the narrow guage railway line between Krishnagar and Nabadwip Ghat, Karimpur Road, all ex-zamindary embankments in the district of Nadia, Hansdanga sluice, a culvert of Betai-Lalbazar Road, Jalkar Jalmahal sluice, Kuturia sluice on Jagatkhali Embankment, 4 Nos. spurs at Kalna etc.

3.6.2.2. A flood occurred towards the end of August due to the Ganga and its effluents being in spate. In this area the following gauges were observed :

Gauge Station	River	Gauge Readings	Danger level
Swarup Ganj	Jalangi	30.85 (24.8.59)	29.20
Kalna (Hanspukur)	Hooghly	23.25 (23.8.59)	26.55
Hanskhali	Churni	25.05 24.8.59	26.20

3.6.2.3. The table below shows how the rivers shot up during the first spell of rains in mid-September.

Gauge Stations	River	Gauge levels recorded before this precipitation with date	Maxm. gauge reading during the period with date.
Swarup Ganj	Jalangi	24.85 (8.9.59)	31.40 (17.9.59)

Gauge Stations	River	Gauge levels recorded before this precipitation with date.	Maxm. gauge regarding during the period with date.
Kalna (Hanspukur)	Hoogly	17.975 (9.9.59)	24.75 (17.9.59)
Hanskhali	Churni	19.75 (8.9.59)	25.20 (18.9.59)

3.6.2.4. Levels once again began to fall at a slow pace and continued to do so till the end of the month when the second spell of heavy rains again caused higher and rapid rise in the rivers with the result that they spilled their banks overtopping all embankments and roads and submerging additional tracts of land. The gauge readings were as in the table below also show the time taken for final recession :

Gauge Station	River	Gauge readings before the period of last storm with date.	Maxm. gauge reading during the period with date.	Danger level.
1	2	3	4	5
(i) Swarupganj	Jalangi	26.18 (30.9.59)	35.78 (8.10.59)	29.20
(ii) Kalna (Hanspukur)	Hooghly	19.375 (30.9.59)	29.40 (3.10.59)	26.55
(iii) Hanskhali	Churni	20.95 (30.9.59)	30.25 (14.10.59)	26.20

Time taken by the guage to go below the danger level.

Rate of fall per day

	6	7
(i)	13 days	0.51 ft.
(ii)	7 days	0.41 ft.
(iii)	13 days	0.31 ft.

3.6.2.5. The danger levels were exceeded in the river Jalangi at Swarupganj thrice and the Hooghly at Kalna (Hanspukur) and the Churni at Hanskhali once. The inundation of the area was to the extent of 5'-0." to about 12'-0." in the lower pockets.

3.6.2.6. In this district 29 human lives were lost in addition to about 1,00,000 houses damaged.

### 3.6.3. District 24 Parganas.

3.6.3.1. The total flooded area in this district was about 941 sq. miles. The major basins affected were :

- (i) The Mograhat Basin 286 sq. miles.
- (ii) The Falta Basin 232 sq. miles.
- (iii) Habra Basin 68 sq. miles.
- (iv) Basirhat Basin 68 sq. miles.

The rest was composed of smaller areas, of Barrackpur, Dum Dum, Behala and numerous pockets in the Sunderbans.

3.6.3.2. In the Mograhat Basin the depth of water in the low pockets was between 4' to 9'. In the Falta Basin the depth in the low pockets varied from 1' to 5' while in the Habra Basin the depth varied from 1'-0" to 4'-0."

3.6.3.3. In the Basirhat basin the Arbelia low pocket is about 62 sq. miles. The Calcutta-Hasnabad-Taki Road was under water in this area to the extent of about 5 ft. It remained under water for more than 20 days and was severely damaged. Relief work had to be undertaken on an extensive scale and population had to be shifted to safer places the huts having been damaged considerably.

3.6.3.4. There was considerable damage to crops in the entire area as also homesteads. Majority of these were in Habra and Basirhat basins. Houses damaged or destroyed were over 60,000, cattle lost over 3,000 and 14 human lives were also lost.

3.6.3.5. The level in the river Ichamati ruled high during the period and also in the other rivers which surround and run through the basins. Both the channels through which the various basins discharge drainage and, into which it ultimately falls, are badly silted up so that water stagnates in the basins for long periods.

### 3.6.4. CALCUTTA MUNICIPAL AREA

3.6.4.1. Out of 37.00 sq. miles of the Calcutta Municipal area, about 17.00 sq. miles is still unsewered. The unsewered areas are: Cossipore-Chitpore (3.30 sq. miles), portion of Manicktola (2.14 sq. miles) and Tollygunge (7.44 sq. miles). Besides the above, there are unsewered pockets. (Topsia and Tangra measuring 2.53 sq. miles and a part of Port area measuring 1.40 sq. miles) within the frame work of the existing sewerage which have yet to be sewered. These pockets thus aggregate to another 3.93 sq. miles. A map showing these areas is appended.

3.6.4.2 Arrangements for drainage of the area are described in the extract memorandum in Appendix XXVIII Vol. II.

3.6.4.3. The general causes of flood in September and October, 1959 were :

(i) heavy precipitation of rains with a higher intensity than the drainage system is designed for.

(ii) Higher run-off coefficient induced by almost continuous showers over a long period prior to flooding, which had saturated the soil and reduced the storage capacity of the area in tanks and low lands to almost nil.

(iii) Erection of unauthorised huts and buildings in low-lying areas, sometimes on the actual lines of drainage.

(iv) High levels maintained by the rivers Kulti and Hooghly in the months of August and September, which had increased the tide-lock period, during which the outfall sluices could not be effectively operated for proper drainage.

(v) Entry into the Storm Water Channel leading to the River Kulti of vast quantity of additional storm water from the adjoining areas which were inundated, before the storm water from the city could be effectively discharged into the channel.

(vi) Increase in the flood period of the city due to river water from Hooghly and the Tolly's Nullah overtopping their banks at several places and finding its way into the city.

#### 3.6.4.4. Affected areas and the extent of flooding.

##### 3.6.4.4.1. Sewered areas :

The precipitation was far in excess of the capacity of of the sewer system. This, coupled with inadequate pumping capacities of the pumping stations and the existence of a large amount of deposit of solid matter in the system, resulted in delayed evacuation of the flood water from the sewered portions of the city. The low-lying areas which were inundated caused much inconvenience to pedestrian traffic and in some cases, interrupted the vehicular traffic as well. Accumulation of water over the streets in these areas varied from 1'-0" to 2'-0".

#### 3.6.4.4.2. Cossipore-Chitpore area :

Major portion of this area drains into the Bagjola Canal. The drainage was affected, though to a comparatively small extent, on account of the persisting high levels obtaining in this canal. Depth of flood water over the area ranged from 4" to 1'-6."

#### 3.6.4.4.3. Manicktola area :

The four storm-water overflows into the New Cut Canal could not function during the peak flood period as high level persisted in that canal. On the contrary, the canal water overtopped the overflow spills and entered the area, thus aggravating the situation. Depth of accumulated water ranged from 3" to 1'-3" while in low-lying bustees, the depth went upto 2'-0"

#### 3.6.4.4.4. Tollygunge area :

The whole of Tollygunge area drains gravitationally, the major portion into the Panchannagram Swamp, whose only drainage outlet is through a sluice of three vents (each 5' x 4') at Chowbhaga on the Suburban Storm Water Channel. The remaining portion abutting on Tolly's Nullah, drains into this channel. The drainage was very much handicapped because of the following factors :

- (1) Progressive reduction in the reservoir capacity of the Swamp.
- (2) Silting of the carried channels.
- (3) Obstruction placed in the Swamp by fishery bunds and bunds put up for reclamation.
- (4) Influx of enormous quantity of flood water into the Swamp from the Southern Salt Lake area on the east of the Panchannagram embankment by overflow in the low portions of the embankment and through many surreptitious cuts, leaky sluices and "Ghogs."

- (5) The high levels maintained in the Storm Water Channel at Chowbhaga owing to extraneous discharges finding their way into the channel.
- (6) Drainage from the portion abutting on Tolly's Nullah, suffered badly from high tide level in the Tolly's Nullah. The Tolly's Nullah overtopped its embankment and the spill entered the low-lying pockets at different places aggravating the flood conditions.

Depth of accumulated water on the streets ranged from 6" to 3'-0" but in low-lying pockets and on the eastern fringe areas, the intensity of flooding was much more, the depth in worst affected areas having been as much as 4'-6".

#### 3.6.4.4.5. Unsewered pockets including Topsia and Tangra.

Inadequate drainage arrangements and deficiency in pumping capacity of the pumping stations in Topsia and Tangra areas were the primary causes. In these areas depth of accumulated water on the streets ranged from 3" to 3'-0" while in low-lying pockets, the depth of flood water went up to 4'-6". In some of these low areas water stagnated for months.

### Region II : West of the Bhagirathi River.

#### 3.6.5. Bagmari, Bansloi, Pagla Basins.

3.6.5.1. The flooded area measures 72 sq. miles and extends up to about 1½ miles north of Dhulian Bounded by the boundary of Santnal Parganas on the west, Bandel-Barharwa Loop Line on the east and up to Raghunathganj on the south. The average depth of water cover the fields was as much as 8'-0". Floods in this area are a normal



feature. As early as mid August when the levels in the Ganga and the Bhagirathi rise high the drainage becomes congested. The outfalls of the three rivers get silted up on account of backflow from the Ganga and the Bhagirathi so that drainage later is also a slow process.

### 3.6.6. Kandi Area :

3.6.6.1. This is a low area measuring a little over 600 sq. miles. About 340 sq. miles lie in the District of Murshidabad and the rest in the contiguous district of Birbhum. The area suffers from inundation without fail every year, the intensity depending on the amount of precipitation of rain in the area, the volume of water brought down by the Mayurakshi, the Dwarka and the Brahmani on the north and the Kula, the combined stream of the Bakreswar and Kopai on the South. The area is ultimately drained by the Babla and its branches into the Bhagirathi. These are silted up and quite insufficient to cope with the heavy amount of water which pours into the area.

3.6.6.2. There are a fairly large number of beels aggregating to about 50 sq. miles in area which serve as detention reservoirs till the higher cultivated areas have been drained by the Babla. Most of these beels have been reclaimed for cultivation by putting up 'Gherbunds'. The process has been considerably accelerated since the "Grow More Food" campaign and the influx of refugees from East Pakistan started. The position, therefore, has become one of grave import as the cultivated areas even normally on this account, remain submerged for long periods causing considerable damage to the standing crops. When the Bhagirathi rises high, congestion gets further prolonged and the submersion is deeper.

3.6.6.3. During August to October, 1959, the area experienced three successive heavy downpours together

with extraordinary high run-off from the rivers mentioned above. During the floods which occurred in the last week of August, the Mayurakshi rose to R.L. 76.68 at Panchthupi. The Dwarka at Ranagram rose to R.L. 61.3. The entire Hijole, the biggest 'beel' in the area, was completely inundated and breaches occurred in the marginal bunds of the river Dwarka. The next flood occurred in the 2nd week of September and the Panchthupi gauge rose up to R.L. 78.70. The Ranagram gauge was only at R.L. 60.10. The Mayurakshi having been very high broke through the embankments on both its banks—on the right at Maliandi, Baidyanathpur, Godda and on the left bank at Talbona, Senai, Jhibra and Panchthupi. The last flood occurred on the 2nd October, 1959 as a result of much heavier downpour over almost the entire catchment which at Kandi measures nearly 4000 sq. miles. The Mayurakshi rose to R.L. 83.00 at Panchthupi, Kula at Talgram to R.L. 77.64, Bele at Andulia to R.L. 61.42, Dwarka at Ranagram to R.L. 64.00, Babla at Tenya to R.L. 56.42 and Kana Mor at Kandi to R.L. 65.20. For the short period of three years that gauge readings at these places are available these levels are the highest. Actually the reports were that such high levels in the rivers had not been known in the living memory. With the rivers so high, the discharges through the breaches moved the bed material-sand-on to the cultivated fields which would render them useless for a number of years.

3.6.6.4. Waterways provided in the section of the Bandel Barharwa loop of the Eastern Railway between miles 104 and 113 under conditions of flow mentioned above, caused high affluxes during the 1959 October floods. At Babla bridge it was as much as 6'-0"

3.6.6.5. The Kandi-Panchthupi Road breached at 36 places and the Kandi-Salar Road at two places. Crops over a large area were totally destroyed. Large number of villages were marooned and total number of persons affected

was over three lacs. In the Birbhum part of the area, 17 human lives, 160 cattle were lost and over 26,000 houses were damaged.

### 3.6.7. Region III—Burdwan area (excluding the Trans-Damodar area).

3.6.7.1. The total area affected in this part of the District aggregated to nearly 400 sq. miles. The table below gives the levels which were attained by the rivers in this area at the gauging Stations :

Name of river	Name of Stn.	Danger level. (P.W.D. datum).	Dt. on which W. L. crossed D.L.	Maxm. W.L. (P.W.D. datum).	Date	Date on which level dropped below D.L
Ajoy	Satkahania	174.01	1.10.59	180.01	2.10.59	3.10.59.
Bhagirathi	Katwa	46.50	3.10.59	50.10	5.10.59	13.10.59.
Damodar	Edilpur	109.01	2.10.59	110.28	3.10.59	3.10.59.

It will be noticed that the Danger levels were exceeded considerably at all stations where the rivers were gauged.

### 3.6.7.2. The Katwa-Purbasthali-Kalna area.

A small area contiguous to the river Bhagirathi in this region was inundated on account of heavy down-pour coupled with high levels maintained by the River Bhagirathi which was already in high floods and to which a very large volume of water was added by the River Ajoy. The gauge at Katwa on the Ajoy shot upon R. L. 53.40 on 4. 10. 59 as against the highest level previously attained in 1956, which was R. L. 53.18. Several breaches took place in the Ex-Zamindary Embankment on the right of the Bhagirathi.

### 3.6.7.3. Town of Nabadwip.

The town of Nabadwip suffered the most in this region. Water was noticed to have reached up to the 1st floor of houses in the low parts of the township. Owing to pressure of population homesteads have been built in areas not suitable for the purpose : Even the fore-shore of the river has been encroached. The distress of the people was very great as all the essential municipal services had to remain suspended till the water drained away from the township.

#### 3.6.7.4. Ajoy Embankment.

Ex-Zamindary embankments along the river Ajoy were damaged at a number of places.

#### 3.6.7.5. D. V. C. Canals.

3.6.7.5.1. A large number of breaches occurred in the D.V.C. canals. The main causes were—

- (1) Unauthorised cuts made in the higher reaches.
- (2) Slips in the banks of the canals.

Flooding in the lower areas was accentuated by these and inadequate provision of the escapes.

3.6.7.5.2. A number of canal structures were also damaged but these were mostly confined to inlets. In the case of Drainage channels, the channels themselves are capacious enough to carry the drainage discharge, but the structures in certain cases were comparatively inadequate.

3.6.7.5.3 Tail-ends of the irrigation canals generally outfall in the drainage channels. Most of these drainage channels are themselves silted up and unable to serve their own basins. Since they have to take in the tail water from irrigation canals also, the drainage cogestion was increased.

3.6.7.5.4. A list of breaches and inlets in the canal banks and escapes in the Barrage and Irrigation canal system of the D. V. C. supplied by the D.V.C. Authorities is at Appendix XXIX, Volume II.

3.6.7.5.5. The Sahibganj Loop Line of the Eastern Railway near the crossing of the D. V. C. canal just above Bhedia was also breached which resulted in suspension of the railway traffic for a number of days,

3.6.7.5.6. 10 human lives were lost, 292 cattle were missing and over 16,000 homesteads were damaged. Crops over a very large area were damaged or destroyed.

### 3.6.8. Region IV—Howrah-Hooghly area.

3.6.8.1. The flooded area in this region was about 440 sq. miles of which 190 sq. miles are in Hooghly district and the rest in the Howrah district. The Damodar River at Amta in this region rose to a level of R. L. 24.75 on the 5th October exceeding the danger level by 4.75 ft. Recession took 10 days to complete.

3.6.8.2. The area has many low beels and pockets and a large number of moribund inefficient drainage channels. The heavy rainfall in the area itself together with very heavy run-off from the higher to the lower lands, considerably augmented by flow through the breach in the Kunti cut of the D. V. C. and tide lockage of the drainage were the main causes of heavy floods in this area. The modification to the Railway bridge not having been taken up the temporary protection and the structure also caused some restriction in the waterway. The Damodar Embankment in the Howrah district was overtopped in several places and a breach also occurred in the lower reach near Maheshrekha on the 5th. October, 1959. Breaches also occurred in the Khalna Circuit Embankment. The ex-Zamindary embankments were breached at a large number of places. A large number of houses was damaged in this area. Crops over a large area suffered.

3.6.8.3. There were other highly objectionable contributory causes, such as promiscuous reclamation of low lands, cultivation and construction of fishery bunds in the

drainage channels and throwing up of embankments across them for 'Boro' irrigation.

### Region V—Trans-Damodar Area.

#### 3.6.9. Raina-Khandaghosh area.

3.6.9.1. The area flooded in this part was about 150 sq. miles and lies on the right bank of the Damodar close to the border of the Bankura District. Heavy local rainfall coupled with high run-off from the contiguous high lands over the fields and through drainage channels together with the spill from the Damodar river over its right bank and through the "Hanas" were the main causes of floods. Tail discharges from the D.V.C. Canals coupled with the discharge brought by the channels themselves on account of cuts and breaches in their banks aggravated the situation. In the right bank canal system also the number of escapes is inadequate so that drainage from the upper area tends to flow into the lower. The main drainage khals, Dev and Kanti, having silted up are unable to drain flood waters quickly.

#### 3.6.10. Lower Trans-Damodar Area—Pursura, Khanakul and Arambagh.

3.6.10.1. The area is traversed by the Damodar, the Mundeswari and the Darakeswar and their tributaries. On account of the channels not being able to accommodate the quantity of water flowing into them they spill over the entire area between the Damodar and the Darakeswar which measures approximately 475 sq. miles. The Champadanga-Arambagh Road built on a fairly high embankment cuts right across the drainage of this area and sufficient waterways do not appear to have been provided in it. The result was that during 1956 and 1959 floods several breaches took place in the road embankment. But the worse effect was the heading up the drainage and increasing the depth of inundation on the upper side of the road.

3.6.10.2. The congestion in this area lasted for nearly two weeks with the result that the crops which were almost mature were completely destroyed over a very extensive area. In order to make up for the heavy loss an attempt was made to put up a long bund of a very heavy section across the Mundeswari, the main lower channel of the Damodar in order to raise the water level in the channel to irrigate 'boro' crop in an extensive area below the bund. The attempt to close the bund failed. But heavy remnants that will remain in the channel are bound to rise the water levels during the coming monsoons and do extensive damage to the areas above as well as the river channel itself. The construction of such bunds cannot be condemned too strongly.

#### Region VI—Midnapur District.

##### 3.6.11. The Daspur area.

3.6.11 This area comprises of two parts which were protected by Circuit Embankments. The embankment round the Ghatal area on the north of the Silabati River measuring 4 sq. miles was abandoned some years ago. This area now gets flooded every year and the drainage is very slow. It is affected by spills from the old Kangsabat, the Silabati and the lower portion of the Darakeswar. On the south of the Silabati river the area of 72 sq. miles is protected by the Chetua Circuit Embankment. Due to flooding on account of the heavy downpour of rain an attempt was made to drain the area through a cut at Daspur into the Palaspai Khal. But the high levels which followed in this Khal and the Rupnarain made the cut a source of flooding a large part of the area. The cut got enlarged to a very extensive length and a lot of damage took place in the area inundated measuring about 40 sq. miles.

3.6.11.2. The main cause of trouble in this area is the difficulty of draining it by gravitation into the

Rupnarain which is tidal and has got considerably silted up. The crop in the flooded area was entirely destroyed and over 2,000 houses were damaged.

### 3.6.12. The rest of the Midnapore District.

3.6.12.1. The approximate area flooded in the various thanas of the rest of the district aggregated about 233.4 sq. miles. Rivers Kaliaghari and Kangsabati were 2.25 and 5.10 ft. higher than the danger levels at Amgachia and Midnapore respectively on the 2nd October, 1959. Floods were caused by heavy downpour of rain and spill from the numerous khals and rivers spread over the area which are congested and unable to drain off the area efficiently. Five breaches occurred in the embankments of Dehaty Channel. Minor breaches also occurred in the embankments along Sankarara, Soadighi and Ganga-khali khals. The ex-Zamindari embankments were breached at several places.

3.6.12.2. Five human lives were lost, 10,000 houses were destroyed or damaged. Crops over 50,000 acres were partially or wholly lost.

### 3.6.13. Region VII—The upper areas in the Purulia and Bankura Districts.

3.6.13.1. In the Purulia district a small area along the right bank of the Damodar was inundated on account of reservoir at Panchet Hill filling up to a height up to which the D.V.C. had not acquired the area.

3.6.13.2. In the Bankura district the Sonamukhi thana was inundated by the Sali River.

3.7. The statistical report of floods in 1959 published by the Food, Relief and Supplies Department of Government of West Bengal soon after the occurrence of the floods, gives in detail figures of extensive damage suffered during



the floods from August to October. According to this statement crops valued at Rs. 31,59,00,000 were destroyed and the value of houses damaged was Rs. 7,22,00,000. Thus the total loss on these account was about Rs. 39 crores. This does not include the value of lost cattle which were over 8,000 heads.

3.8. The Communist Party of India in their Memorandum have estimated the loss at Rs. 100 crore. Whichever figure is correct, there is no doubt that the damage done by the floods of 1959 was enormous and far exceeded the damage by any other floods since 1950 (Vide Table in Report of the High Level Committee on Floods Vol. II).

A map of the flooded areas is in Vol II.

N.B. : (1) The description and extent of flooding in the several regions and areas have been taken from the official reports of the Irrigation and Waterways Directorate, West Bengal.

(2) The figures of loss of human lives, cattle and houses have been obtained from Food, Relief and Supplies Department, West Bengal.

## CHAPTER—4

### REGULATION OF RELEASES FROM THE DAMS

#### 4.1. THE MAYURAKSHI DAM

4.1.1. The reservoir behind this Dam is meant exclusively for irrigating an area of 600,000 acres. There is no reserve for flood moderation. The original idea was to take the top of the gates to a level of R. L. 412 but actually the dam built is of a lower height and the top of the gates now is at R. L. 398 i. e. 14' lower. When the water level in the reservoir rose to this level on the 1st October the gates had to be opened in order to prevent the level of the reservoir rising higher and flooding the unacquired area round the periphery of the lake. This was done and the effect was that all the inflow into the reservoir started being let down into the river below. At this stage the condition in the river, therefore, became as if there were no dam or reservoir on it. The flooding in the lower area which occurred as a consequence of this was what would have happened even if there were no dam. On the contrary calculations made by both the Superintending Engineer, Mayurakshi Canal Circle and the Director, River Research Institute, West Bengal (vide annexures XXX and XXXI Vol. II) show that the outflow was actually less than the inflow into the reservoir. This was possible because of the water spread in the lake. Although the total volume of water flowing into the lower area would not reduce the rate of flow was somewhat moderated.

4.1.2. There was one other effect of the reservoir in this catchment. It was that the earlier floods in the area which started from the end of August were considerably moderated as all the inflow continued to be stored up to 15.9.59 in the reservoir.

4.1.3. The common belief, however, is that the releases from the reservoir aggravated the flood situation. One reason for this belief is that claims are said to have been made that the reservoir would protect the area from floods. Certain Government publications and statements made by responsible officers were quoted in support of this (vide Volume II). The Committee are of the opinion, that the Government should make a categorical statement saying that the Mayurakshi Dam has no flood control provision.

4.1.4. The Committee also went into the question as to whether a portion of the reservoir capacity could be set apart for absorption of floods. It was found that if the reservoir filled up to R. L. 398 only then the July requirements of irrigation in the commanded area could be met in lean years when rains failed in the months of June and July which happens often. In both the years 1957 and 1958 this phenomenon was experienced. There is, therefore, no possibility of allocating any portion of the reservoir to flood control unless irrigation is sacrificed for a proportionate portion of the commanded area. The Committee does not recommend this being done.

4.1.5. The Committee have, therefore, come to the conclusion that releases from this reservoir could not be avoided and that these releases did not aggravate flood conditions in the lower areas which were all inherent consequence of heavy downpours of rain over the entire catchment which near Kandi measures nearly 4,000 sq. miles. The only drawback was that the run-off from the comparatively small area of about 700 sq. miles, which is intercepted by the dam, started flooding into the area rather suddenly.

## 4.2. The Damodar Reservoir.

4.2.1. The lower reservoirs were primarily constructed for controlling floods. Additional uses of the waters stored

in the reservoirs were to cater to the needs of irrigation in an area of a little less than one million acres and use the discharges for producing electric power. In the first stage of development four dams have been built in the upper valley. Later some more were to be added in order to ensure safety against a design flood of one million cusecs at Rondia instead of a peak flood of the order of 6,50,000 cusecs actually recorded in a number of years. The upper dams at Konar and Tilaiya have very small reservoirs behind them and although small capacities have been earmarked for flood control therein their moderating effect on floods at Durgapur is negligible. The lower two dams are at Maithon on the Barakar and Panchet Hill on the Damodar. In the reservoirs behind them the original project provisions for flood reserves were from R.L. 456 to R.L. 500 and R.L. 410 to R.L. 445 respectively up to the middle of August when most of the worst floods were known to have occurred. From middle of August to middle of October, the reserves were to be cut down to R.L. 480—R.L. 500 in the case of Maithon and to R.L. 425—R.L. 445 in the case of Panchet Hill. On further studies Mr. Hazra, one of the Consultants of the D.V.C., recommended uniform flood reserves in both the reservoirs right up to the middle of October. The levels recommended by him were R.L. 460 to R.L. 500 in the case of Maithon and R.L. 410 to R.L. 445 in the case of Panchet Hill. This recommendation was examined by the technical representatives of the participating Governments in June, 1951. They found that the storage up to R.L. 460 and R.L. 410 in the 2 reservoirs would not be sufficient for Kharif Irrigation in the command area below. They, therefore, suggested that the level in the Maithon reservoir should be raised to R.L. 480 and the height of the Dam increased by 25 so that the top of the gates could be at R.L. 525. This, it was calculated, would cost about Rs. 4.50 crore more and involve a great deal of difficulty in rehabilitating the displaced population from the extra area which would be submerged. From the data

worked out by the D.V.C. authorities it was found that a flood with a peak of 7,00,000 cusecs could be moderated to about 2,50,000 cusecs with pool levels of R.L. 480 in Maithon and R.L. 410 in Panchet Hill and at the same time provided sufficient water for irrigation and other uses. The height of Maithon Dam with top of the gates at R.L. 500 was, therefore, accepted by the technical representatives of the participating Governments (vide their report dated 19th September, 1951. Appendix XXXII Vol. II).

These reserves have been curtailed by limiting the levels to which the reservoirs can be filled. In the case of Maithon land and homesteads have been acquired in the reservoir area up to R.L. 945 reducing the flood reserve by 1,24,000 acre ft. (between R.L. 495 and R.L. 500). In the case of Panchet Hill the Complete acquisition is up to R.L. 425 and homesteads alone have been acquired between R.L. 425 and R.L. 435. The loss in flood reserve here amounts to 340,000 acre ft. ( between R.L. 435 and R.L. 445 ). Thus the total reduction amounts to 464,000 acre ft. out of the total reserve of 1,320,000 acre ft. a reduction of 35%.

4.2.3. From about the first week of September 1959 there was a further encroachment into the reserves at both places and at the time when floods due to heavy precipitation occurred on the 1st October, 1959, the level at Maithon reservoir at 6 A M. was 4' above R.L. 480 while in the Panchet Hill it was 5' above R.L. 410. This constituted about 12% (163,000 acre ft.) further reduction in the approved reserves. The D.V.C. have claimed that these encroachments were for the purpose of sending down flushing doses to the river below. This explanation is very difficult to understand. In the first place, the encroachments continued for almost the whole month right up to the 30th September when they were caught by heavy floods and secondly, it is clear that the intention was to conserve water for generation of power as the Chief Electrical Engineer, on the 19th September, asked

the levels to be kept up provided the Manager, Reservoir Operation, agreed.

4.2.4. On the 1st October at 6 a.m. when the floods came there was thus only 53% reserves available to absorb them i.e. out of a total reserve of 1.32 million acre feet which should have been available only 694,000 acre ft. was to be used to moderate them. At 9.20 P.M. a message was received at Maithon from the Executive Engineer (D.V.C.), Durgapur, that the discharge at Durgapur was 1,36,000 cusecs. Banka was overflowing its banks and it was raining in the entire area. He suggested that the discharge from the dams should be reduced immediately, and if due to any reason the flow is increased he should be informed. At 9.40 P.M. another message came from the Superintending Engineer (Barrage and Canals), Burdwan, saying that due to heavy rainfall in the lower valley the discharge into the river from the dams should be reduced to 40,000 cusecs with immediate effect. He further said that the discharge at Durgapur at the time was about 1,00,000. The Chief Engineer, Irrigation and Waterways Directorate, West Bengal, however, advised the Chief Engineer, (Civil), D.V.C., at about 4/45 P.M. the same day that the discharge at Durgapur need not be less than 2,50,000 cusecs. The outflows from the two reservoirs from 30th September onwards are shown in the annexure XXXIII Volume II. On the 30th September release from Maithon was of the order of 4,000 cusecs and the reservoir level remained at about R.L. 483.81. From Panchet Hill the outflow was 10,500 cusecs and the reservoir level maintained itself round about R.L. 415.30. On the 1st October till about 3 P.M. the releases continued to be at about the same rate from both the reservoirs. From this hour onwards the releases were increased, and between 3 P.M. and 6 P.M. at Maithon, it was 8,800 cusecs while from Panchet Hill it was 32,700 cusecs. The levels in both the reservoirs went on rising and at Maithon it rose to R.L. 497.80 at 3 P.M. on 2nd October. The rise between 12 midnight

and 3 A.M. on 2. 10. 59. was nearly 2 and again between 6 A.M. and 9 A.M. on 2. 10. 59. it was another 2 ft. The releases meanwhile had been stepped up, the maximum being between 12 noon and 3 P.M. and was 2,14,000 cusecs. At Panchet Hill the rise was recorded to have been almost 4 between 9 P.M. on 1. 10. 59. and 12 midnight. There was another rapid rise of over 3 ft. between 6 A.M. and 9 A.M. on 2. 10. 59. The releases were increased progressively and the maximum discharge of 2,10,000 cusecs was let out between 12 midnight and 3 A.M. on 2. 10. 59. The maximum reservoir level reached R.L. 435,95 at midnight on 2-3. 10. 59. The maximum discharge from the 2 reservoirs together was 2,88,000 cusecs between 3 P.M. and 6 P.M. on 2. 10. 59. The maximum discharge computed at Durgapur was 3,50,000 cusecs on the night of 2nd October, 1959.

4.2.5. With the situation with which the reservoir operation authorities were faced particularly from the rapid rise in both the reservoirs the releases made from them were a great deal less than those indicated by Rule curves in order to avoid aggravating conditions lower down. The catchment below the dams was experiencing a very heavy downpour and was itself contributing a very heavy run-off to the river. The maximum computed was 1,36,000 cusecs as Durgapur based on three-hourly rainfall data. Even with these releases the levels in both the reservoirs went above acquisition levels.

4.2.6. On the basis of the levels recorded at the Dams it was calculated that a flood with a peak of 8,10,000 cusecs would have occurred at Durgapur if the dams were not there. Of this nearly 6,90,000 cusecs would be contributed by the catchment above the two dams. The gauge at Panchet Hill Dam being an open one could have been influenced by wave-wash produced by the storm. Also it was reported that the gauge of Sindri near the top-end of the reservoir was consistently lower than the readings at the dam. No acceptable explanation

for this phenomenon has been found. Dr. N. K. Bose has tried to check up these figures by using the actual rainfall and unit hydrograph method and has come to the figure of 4,20,000 cusecs at Durgapur. He does not, however, claim that his computation can be taken as absolutely correct, but similar calculations carried out by him show agreement with 1913 and 1935 peaks of the floods. This matter, therefore, requires further closer examination.

4.2.7. Prior to 1959, the Meteorological Office at Calcutta was issuing daily rainfall forecast to the Manager, Reservoir Operation, and certain other D.V.C. officials during each monsoon season. Forecasts covered a period of 24 hours and indicated in descriptive terms the intensity and spatial distribution of rainfall in the three sub-catchments of the Damodar Valley Corporation area (Barakar, Damodar and Lower Valley), together with an outlook for subsequent 24 hours giving a general indication of the increase or decrease of rainfall on the second day. The actual rainfall reports recorded during the past 24 hours at raingauge stations situated in different parts of the catchments were also transmitted to the engineers along with the forecasts.

4. 2. 8. In accordance with the recommendation of the D. V. C. Meteorological Advisory Committee a new system of quantitative rainfall forecast in respect of three sub-catchments was introduced from the 1st August, 1959. These quantitative forecasts gave anticipated total catch of rain water in the different sub-catchments. The daily weather bulletin contains (i) actual rainfall report, (ii) quantitative forecast for 24 hours and (iii) outlook in general terms for subsequent 24 hours. It was on the 28th September, 1959 when the depression in the Bay of Bengal (which intensified into a cyclone) was more than 400 miles away from the central region of the Damodar Valley area, the first indication of a break in the previous spell of little or no rainfall in all the three catchments was indicated in the



weather outlook. Weather forecasts in the subsequent days, i.e. 29th September, 30th September and 1st October, indicated an increasing tempo of rainfall. The quantitative forecasts of rainfall in the 3 sub-catchments issued this period were verified with the during actual rainfall reports and the accuracy of the forecasts was found to be fairly satisfactory.

4. 2. 9. According to the D.V.C. engineers they could use the rainfall forecasts only in a qualitative way as a general indication of rainfall during the next two days. Even though the quantitative rainfall forecasts for 24 hours and the general outlook for subsequent 24 hours turned out to be accurate, they could not convert same into flood discharge forecasts for purposes of reservoir operation for the simple reason that no flood forecasting unit exists in the Reservoir Operation Organisation.

4. 2. 10. The Committee are of the opinion that regulation of releases, in the circumstances in which the management found itself, could not be otherwise than what it was. If the flood reserves in the reservoir had not been encroached upon and the upper limits had not been cut down, with the restraint and caution exercised the management could have further reduced the releases and intensity of floods in the plain below would have been less.

## CHAPTER 5-

### **Remedial measure for the purpose of preventing recurrence of floods**

5.1. Total prevention of floods is neither possible nor desirable, for, moderate floods have more beneficial effects than harmful. By bringing fine silt to the area inundated they rejuvenate the soil and by flushing drainage channels help to maintain them in regime and prevent them from becoming a source of insanitation. The benefits of bumper crops after the floods, improvement of the sanitary condition of the localities flooded and improvement in the drainage in many a case far outweigh the losses suffered. But heavy floods such as those of years 1956 and 1959 which caused widespread havoc and distress in an extensive area and occurred in such quick succession cannot be suffered with equanimity. Measures for preventing them or at least moderating their intensity become imperative. Broad outlines of how to achieve this purpose are laid down in the following paragraphs.

5.2. Before dealing with the problem it is necessary to bring out the fact that certain very essential data required for preparation of the schemes are not available. This handicaps the Committee in some cases in even suggesting the broad outlines of remedial measures. These are hydrological data of some very important problem rivers and topographical surveys of some of the flood affected areas. Collection of complete hydrological data is very essential if a close watch is to be maintained on the conditions of the rivers passing through the Gangetic West Bengal. It is only then that ameliorative schemes can be designed after signs of deteriorations are detected. Most of these have been recommended to be collected by various Committees appointed in the past by Governments of

India and of West Bengal to enquire into the condition of rivers in floods. The Committee cannot stress too strongly immediate arrangements being made for collection of the data. The data required have been listed in the letter addressed by the Chairman to the Secretary, West Bengal Flood Control Board, vide his letter no. 332 dated 18.4.50. The Committee hopes that the collection of these data will commence from the date recommended. Similarly aerial surveys with 1' contour intervals of the areas indicated must be taken up in the coming cold weather.

5.3. Another general recommendation which will be applicable to all river basins is the control of construction of embankments along and across the rivers and drainage channels. It is recognised that pressure of population has in the past necessitated construction of marginal embankments in order to make it possible for the flood plains of rivers being reclaimed for habitation. But the evil effects of these were recognised fairly early and a legislation was passed to arrest their haphazard construction. Unfortunately the existing legal powers have been ineffective either because they are not used or because they do not give sufficient power to the authorities. The Committee recommend that these laws be re-examined and if necessary altered to enable the promiscuous and haphazard construction of bunds, bandars etc. being effectively stopped. They do untold damage to the rivers and drainage channels. That they do so is accepted on all hands. The Committee were assured during its various tours of inspections that people were quite conscious of the evil effects of these and individuals or groups of individuals who indulge in putting up these must be prevented from doing so.

5.4. At present some embankments, mostly the ex-Zamindary bunds, are looked after by the Revenue Department. Similarly in case of some sluice channels,

although the sluices are maintained by Irrigation and Waterways Directorate, channels are looked after by the Revenue Officers. This, the Committee are of opinion, is not a very healthy arrangement. All embankments, sluices in them, drainage channels etc. should be in charge of the Irrigation and Waterways Directorate which is the appropriate and expert agency of the State Government. Some of the embankments which breach frequently may not be necessary. The question as to whether such and other embankments which do positive harm to the channels and the countryside should be abandoned, should be examined by the Officers of the Irrigation and Waterways Directorate.

5.5. Precipitation of heavy and concentrated rain cannot be controlled. Human ingenuity has not yet found the way to do it. The only alternative is to try to get rid of the water in flood plains as quickly as possible.

Similarly the tide-levels do not offer themselves to any control. Ameliorative measures have, therefore, to be designed on these premises.

Taking up the remedies river basin wise :-

#### 5.6. (1) The Bhagirathi-Hooghly Basin.

5.6.1. After the avulsion of Ganga to the Padma and abandonment of its course along the Bhagirathi-Hooghly in the 17th Century, the Bhagirathi has been progressively deteriorating. Until about the beginning of this century it used to get varying discharge and maintain a permanent connection with the Ganga. Sufficient drafts were available throughout the year to enable small vessels to navigate in it and get to and from the Ganga. Now the connection has become limited to the monsoon period of July-October. The upland water ceases to flow into the river from about the end of October and continuous to do so right up to the end of June. The channel has

considerably deteriorated, both in width and depth in consequence. The bed level all along is progressively rising. Even so, it is the main artery of drainage of the entire Gangetic West Bengal so that unless the deterioration is arrested and that, soon, and measures taken to improve the river, flood congestion in the State cannot be removed.

5.6.2. The lower portion of the Bhagirathi is called the Hooghly on which the Port of Calcutta is situated. The Port handles 40 to 45 per cent of the entire trade of the country. It is the very expensive river conservancy works which have prevented the river from completely drying out, the fate, which has overtaken so many rivers of similar nature in the old estuary of the Ganga in these parts. The works, dredging, training and constant surveys tend to become more and more expensive. And yet desired drafts cannot be obtained. The City of Calcutta with a population of over 40 lakhs depends on this river for its domestic water supply as do many other smaller townships all along the river. In Calcutta, owing to rapid deterioration of the river, the water tends to become more and more saline.

5.6.3. The improvement of this river is therefore of vital importance. The chief remedy is to restore the head water supplies by constructing a barrage across the Ganga and the ancillary works.

5.6.4. Along with the construction of the barrage it will be necessary to improve the Bhagirathi at places. A Pilot scheme has been prepared by Shri K. K. Framji, Chief Engineer, and Joint Secretary to the Government of India, Ministry of Irrigation and Power which was examined by the Committee. The proposal was to undertake the work before the monsoons of this year. But the Committee recommended its linkup with the construction of the Ganga Barrage after suitable modification.

5.6.5. A lot of encroachment in the form of cultivation and reclamation of the foreshore and berm in the river section which is harmful for its régime has taken place and continues to do so. This should be prevented if necessary by legislation. The Nabadwip town has extended to the foreshore land and the suffering during the last floods was acute. The Municipal Committee have submitted a detailed plan showing how the township gets inundated. A detailed survey should be made to explore the possibilities of protection of the town by closing the gaps and strengthening the section of the embankments already existing round the town and constructing sluices and installing pumps.

5.6.6. Lower down in the Hooghly a lot of encroachment in the shape of protruding jetties, unauthorised construction and disposal of industrial wastes takes place. This tendency is continuing. This must be prevented.

5.6.7. In the Port limits the use of the river as a navigable channel is only possible, by heavy dredging of shoals and bars which reform continuously. Nearly 188,000,000 Cft. of material is shifted annually at a cost of over Rs. 50 lacs. But the material is dumped within the river channel. If this could be deposited outside, the régime of the river would improve as also its capacity as drainage channel. The Commissioners for the Port of Calcutta are understood to be already considering a change in the method of dredging.

5.6.8. The proper conservancy of the river at present is entirely dependent on the tidal influx. No schemes which might result in reduction of this should be permitted or undertaken. There is a great deal of demand from the low lying areas in Howrah and Midnapur districts for sluices at the mouths of drainage channels in order to

prevent salt water entering the area during high tides. This, in the view of the Committee should be resisted. The drainage channels can be judiciously embanked to prevent inundation by salt water and at the same time ensure that the quantity of tidal water is not appreciably less than what it is at present. Neighbouring low areas lying near these channels should not be reclaimed for cultivation but should remain open to spill.

5.6.9. In the affected areas within the basin of this river the most important need is improvement of the drainage channels. With the experience which has been gained from the floods of 1956 and 1959, the Committee is of the opinion that the drainage index for design of drainage schemes should not be less than  $3/4$  inch per day. In smaller and coastal areas the index on the contrary should be higher.

5.6.10. Remedies for particular affected areas in this basin are now dealt with in the order in which they have been listed in Chapter III.

#### Region I—East of Bhagirathi River.

##### 5.7. Murshidabad and Nadia Districts.

5.7.1. The improvement of the local drainage channels would go a long way in solving flood problems of this area. Surveys and investigations to do this should be undertaken as soon as possible. This tract includes a number of extensive bills which need flood flushing for their improvement. It is further recommended that the flood flushing scheme contemplated from the Bhagirathi preferably with a control at the head of the proposed main channel should be taken up.

##### 5.8. 24-Parganas.

5.8.1. In this area the following schemes which are ready should be taken up immediately for execution.

- (i) Khardaha Khal scheme.
- (ii) Sealdah gong scheme.

- (iii) Bil Pakuria Scheme.
- (iv) The Kantakhali Balarampore Khal scheme
- (v) The Dantbhanga scheme.

5.8.2. The other schemes which the Committee consider necessary for solving the flood problems of this region are:

- (i) Sankdah Khal Scheme.
- (ii) Resecting of :—
  - (a) Churial Khal,
  - (b) Sastitala Khal,
  - (c) Keorapukur Khal and
  - (d) The inner channels leading to the Diamond Harbour sluice namely the Usti-Nainan outfall channel and the Diamond Harbour creek and diversion channel to the Diamond Harbour sluice. The side khals e.g. Hōtar, Surjipur, Katakhal, Joynagar, Dhanpota, Mogra, Sangrampur and Hatuganj khals too will need silt clearance at the same time. The vantage of the Diamond Harbour sluice may be examined to see if any increased is necessary. The redistribution of the drainage areas among the above mentioned drainage channels, which has become necessary on account of silting of the Piali River should be made, and drainage position improved.

(iii) The drainage from the area under phase II of the Sonarpur-Arapanch Scheme should be ensured,

(iv) The Sunderbans Embankments and their sluices should be maintained in an efficient condition to withstand both the monsoon floods and the dry season high tides.

5.8.3. The low, waterlogged "badas" within the circuit embankments, which had been prematurely reclaimed should be thrown open in a cycle to tidal reclamation after



settling the inhabitants in other places. Resettlement of them may be undertaken when the lands have been suitably raised. These measures should go on progressively until all the problem areas have been dealt with.

5.8.4. The rivers of the Sunderbans have all deteriorated considerably and the tidal levels have risen on account of :

(a) The reduction of the areas under forest and their subsequent reclamation with embankments.

(b) The cutting of head waters owing to deterioration of the affluents of the Ganga as well as their connections with the rivers of the Sunderbans.

Further deforestation in this area should be put a stop to and flood flushing schemes, one of the important feature of which is the improvement of the drainage channels of the areas, should be taken up for surveys and investigations with a view also to restoring somehead waters to the decayed and dying rivers in this area.

## 5.9. Calcutta area.

### 5.9.1. Sewered Areas :

The pumping capacities of the Drainage Pumping Stations are to be increased as well as replacement of the existing over-aged pumping plants are necessary.

Adequate steps should be taken for ensuring proper and regular desilting of the sewers. There has been a considerable lag in this work on account reasons. Suitable mechanical appliances should be introduced in addition to manual method to clear them as quickly as practicable.

### 5.9.2. Cossipore-Chitpore Area :

Sewerage scheme for this area should be implemented immediately.

### 16.5.9.3. Manicktola Area :

The remaining unsewered portion of Manicktola area should be sewerred immediately.

### 16.5.9.4. (iv) Tollygunge Area

Tollygunge-Panchannogram-Boinchitola Drainage Scheme, prepared by the Greater Calcutta Master Plan Technical Committee, at an estimated cost of Rs. 29.25 lakhs, should be implemented immediately. In view of its extreme urgency, the Committee have made special recommendation in a separate resolution on 3.5.60. The Committee feels that in order to get the full benefit of the said scheme, the scheme for effective drainage of the Southern Salt Lake area of 14 sq. miles should also be taken up early so that the influx of enormous quantity of storm water of this area does not find its way into the Tollygunge-Panchannogram basin. Pending implementation of the drainage scheme for Southern Salt Lake area, it is imperative that the Panchannogram, embankment, separating the two drainage basins, should be strenghtened and properly maintained. During the rainy season, this embankment should be kept under vigilant watch and proper measures should be taken to guard against surreptitious cuts being made.

Tolly's Nullah is the only outlet for a portion of the Tollygunge area. The condition of this Nullah should be improved.

As for the internal drainage of this area, the sewerage scheme should be taken up as soon as the Tollygunge-Panchannogram-Boinchitola Drainage Scheme is implemented. During the interim period, the existing surface drains should be improved by remodelling, desilting and removal of encroachments.

### 5.9.5. Unsevered Packets : including Topsia and Tangra :

Sewering of these areas are long overdue and should be taken up without further delay.

### 5.9.6. Storm Water Channel

5.9.6.1. The Committee is of opinion that the Storm Water Channel, from the city limit to the River Kulti, should be utilised exclusively for the drainage of the area for which it was designed. No additional area should be drained through this channel without enlarging its capacity. Until this is done the Committee recommends that the City's drainage should be given the first priority. Only after the City's drainage has passed through, the rural drainage should be allowed to make use of the channel. Necessary arrangement should be made to ensure that this plan is adhered to.

5.9.6.2. It is understood that the proposed area of 4 sq. miles to be reclaimed from the Northern Salt Lake area for extension of city and the remaining 14 sq. miles for Agricultural purposes as 'polder' will also be drained into this channel. Enlarging its capacity is, therefore, absolutely necessary. This is stated to be a difficult proposition on account of valuable assets lying along side. Other alternative such as combining the dry weather channel or installing pumps at the outfall should be investigated.

### 5.9.7. Area on the West of Tolly's Nullah :

The Committee is of opinion that adequate drainage from the portion of the city, on the West of Tolly's Nullah, can be effectively diverted into the River Hooghly. It is recommended that investigations in this regard should be taken up for accommodation of this drainage in the Manikhali or other khals for ultimate drainage into the Hooghly.

### 5.9.8. River Kulti :

The River Kulti-life line of drainage for the city of Calcutta, and vast rural tract has developed symptoms of progressive deterioration. The Committee feels that immediate action is called for to improve its condition by augmenting its head-water supply. It is learnt that detailed field investigations and model studies had been carried out by the River Research Institute, West Bengal for this purpose. On the basis of model studies and investigations two schemes have been recommended to be taken up immediately.

(1) Resuscitation of the Nowi and the Sunthi. The capacities of both the channels should be, gradually increased to accommodate the designed discharges viz. 2100 cusecs in the Nowi and 2300 cusecs in the Sunthi.

(2) Resuscitation of Sealdahgong to introduce drainage of 5300 cusecs.

The Committee understands that the schemes are also ready and therefore recommend their implementation at an early date with necessary modifications regarding the drainage index which should be  $3/4'$  per day.

### 5.10. Region II. West of the Bhagirathi.

5.10.1. The catchments of the rivers like the Bagmari, Bansloi, Pagla, the Mayurakshi system, the Ajoy, the Damodar, the Darkeswar, the Silabati, the Kangsabati, the Kaliaghari and the Rasulpur, which rise in the west and flow to the east to fall into the Bhagirathi Hooghly except the Bagmari which falls into the Ganga, are in bad state of deforestation and denudation. The courses of those rivers are short, the gradients steep and the effects of heavy precipitation immediate and severe. Soil and water conservation measures in these catchments are a matter of utmost urgency.

5.10.2. The water-absorbing capacity of the soils of properly maintained forests is great. Dense, well managed forests (wherefrom fire and cattle are strictly excluded and where no concessions are given) reduce the sediment load of the run-off. Since sediment must add to the volume considerably, its absence must naturally diminish the volume considerably.

5.10.3. When forests occur over a significant part of the catchment the upper catchment (in the hills), the middle reaches (in undulating and sloping country) and even in the lower reaches or flat land (no doubt, to a smaller extent and in the shape of shelter-belts, farm forest blocks etc.)—the resultant flood control effect is great.

5.10.4. It is, therefore, recommended that :

(a) The upper catchment of the western rivers be protected from further denudation.

(b) The existing forests be protected and managed in accordance with strict silvicultural principles and soil and water-conserving measures be introduced.

(c) Outside the forest area, all cultivation is to be done on properly terraced land.

(d) Afforestation of all idle land be done.

(e) Instead of the open coppice, a many-tiered forest be built up.

(f) Afforestation of sloping idle land be greatly intensified.

(g) Soil conservation measures be taken.

A regular land-use planning survey is necessary and should be undertaken. The work is of a long-term nature, but its early implementation will be a measure helpful in the reduction of floods in future.

The table below gives an idea of the work already done. It covers an area of only 40 sq. miles. This is very small indeed. The pace must be considerably increased. In the Third Five-Year Plan also the target is small as revealed by this table.

**Table—1**  
**Progress of afforestation and soil conservation**  
**in the catchment areas of different rivers**  
**of Southern Bengal.**

	Kangsabati Acres	Darakeswar Acres	Keleghai Acres	Mayurakshi Acres	Damodar Acres	Ajoy Acres	Total Acres
Areas already afforested or improved under soil conservation Scheme (approx.)	11,400	2,600	800	1,500	4,500	4,200	25,000
Areas proposed to be taken up in the Third Five-Year Plan for soil conservation or afforestation (approx).	48,000	20,000	2,000	5,000	18,000	5,000	98,000

5.10.5. It is emphasised that the work should be accelerated considerably so that the whole of the catchment is completely treated within the next few decades. The cost will assuredly be great but the returns will be more than adequate. While scientific land uses by contour bunding, terracing, pasture development etc. begin to pay almost immediately afforestation will need about 20 years before giving returns. This, therefore, has to be a long-term investment.

### 5.11. Bagmari, Bansloi and Pagla Basins.

These rivers are at some distance below the selected site of the Barrage across the Ganga. A link canal, suitable for navigation, will form part of the project. That channel is likely to cross all the three streams. Provision for the disposal of the flood and drainage from these rivers is expected to be made in the project for the link channel.

### 5.12. Kandi Area.

5.12.1. The rivers that drain into this low area of 600 sq. miles are the Mayurakshi with its tributaries, namely, the Bakreswar, the Kopai and the Dwarka with its tributaries, the Brahmani and the Gambhira. The Mayurakshi is the main river of this system of rivers. The Mayurakshi Dam and the Tilpara Barrage of the Mayurakshi Reservoir Project have been built across it. The Brahmani, Dwarka, Bakreswar and Kopai rivers also have barrages across them as part of that Project.

5.12.2. These rivers in their lower reaches, as they approach the Kandi beels, are extensively embanked. The embankments have encroached upon the channels of the rivers. Boro bunds are put across them in the dry season and cultivation is extending into them.

5.12.3. The ideal solution of flood problem of this area would be to throw open the low-lying areas which had been serving as detention basins in the past to inundation. But since a very large part of such areas has already been reclaimed for cultivation it may not be possible to do so. But it is imperative to ensure that no further encroachments take place.

5.12.4. In addition to catchment control it is recommended that—

(i) A thorough examination be made of all these embankments to decide which of them must be maintained

or alternatively, retired so that the flood waters may be contained within them.

(ii) The construction of new embankments, boro bunds or any obstructions and also extension of cultivation into the channels of the rivers should be stopped.

(iii) The outfalls of the rivers into the Kandi beels should be improved.

(iv) In order to drain out the water from the 'beel' areas investigations for the following should be taken up.

(a) Improving the outfall channels, such as, the Jibanti, Banki, Jhumjhumkhali, the Uttarasan and the Babla.

(b) Additional drainage outlets from the beels to the Bhagirathi River. These outlets should cross the Eastern Railway. Line between Tenya and Chowrigacha stations through new bridges and the channels should be embanked on both sides from below the Railway line to the Bhagirathi.

(c) The requirement and extent of further additional waterways in the section of the railway line.

(d) The desirability of removing some of the gher (circuit) embankments in the Hijole Beel.

(e) Constructing escapes in all the ghers, decided to be retained, so that water in excess of 2 feet inside the circuits may drain into the improved drainage channels outside the ghers.

(f) Wherever habitation have got set up in low areas they should be either raised or moved to higher areas.

5.12.5. In view of the practical limitations of implementing the ideal solution the steps as per (d) and (e) above are recommended.



### 5.13. The Katwa-Purbasthali-Kalna area.

The flood problems of this area will be solved by the improvement of the Bhagirathi River and the control of the Ajoy river, for which steps have been recommended.

Region III—Burdwan area (excluding the Trans-Damodar area)

### 5.14. Ajoy Basin.

5.14.1. In the Ajoy catchment in West Bengal the areas already afforested or improved under soil conservation schemes is approximately 4,200 acres or 6.2 sq. miles. The area proposed to be so treated in the Third Five-Year Plan period is approximately 5,000 acres or 7.5 sq. miles.

(i) The first step should be afforestation and soil conservation in the rest of its upper catchment and the undertaking of scientific land uses in the middle catchment.

(ii) Investigations should be taken up for flood control reservoir in the basin. Such a project is essential for improving the Ajoy River itself and also for improving the Bhagirathi near the confluence of the two rivers.

It is learnt that the Bihar Government have in view some irrigation schemes involving storage of water behind dams on the tributaries of the Ajoy, with a pick-up weir across the river. It is desirable to investigate whether the proposed schemes of irrigation in Bihar and flood control in Bengal can be combined so that a single dual purpose project is evolved. West Bengal Government should make an approach to Bihar Government. on this subject.

(iii) Whether the ex-zamindari embankments on the two banks of the Ajoy should be raised and improved in their entirety or in portions should be investigated along with the investigations for the reservoirs in the river basin.

### 5.15. Kunur River.

(i) The upper catchment of this river should be afforested and soil conservation and scientific land uses undertaken vigorously in the middle.

(ii) Investigation should be taken up for the improvement of the Kunur. But until Ajoy floods are controlled channel clearance of the Kunur will not be effective.

(iii) The adequacy of the waterways in the Sahibganj Loop Line of the Eastern Railway near the D.V.C. Canal crossing just above Bhedia should be examined.

### 5.16. Banka and the Khari.

(i) The upper and middle catchments of these two rivers should be treated in the same manner as those of the Ajoy and the Kunur.

(ii) Investigations should be taken up for resectioning the two rivers so that they may be able to carry the run-off from the catchments to the Bhagirathi. It should also be investigated if flushing water during floods cannot be let into these two drainage channels from the Damodar maintaining them in regime and improving sanitation of the areas through which they run.

### 5.17. D.V.C. Canals.

(i) Additional escapes should be constructed as and where necessary in the canals to dispose of all the discharge coming into them from the inlets.

(ii) The canal structures should be examined and those that may be found to be insufficient to pass additional drainage discharges should be enlarged.

(iii) Steps should be taken to dispose of tail discharge through the drainage channels such as the Purana, Rajapur, Dankuni khals etc. Investigations should be taken up for their resectioning and for alternative channels, where necessary.

### 5.18. Region IV—Howrah-Hooghly Area.

(i) The banks of the Kunti Cut should be strengthened. Any surplus discharge should go into the Kunti and the Saraswati, which should be adequately improved.

(ii) The existing Government or ex-zamindari embankments should be raised and strengthened sufficiently, wherever necessary.

(iii) Reclamation of low lands for cultivation, construction of fishery, 'boro' irrigation or other bunds steeping of jute in the drainage channels should be prevented.

### 5.19. Region V—The Damodar Basin.

5.19.1. The long-term measures of soil conservation which is to contribute substantially to the flood control by absorbing a large proportion of precipitation and retarding the run-off does not appear to have been given the importance it deserves. According to the Director, Soil Conservation, D.V.C., (vide appendix XXXIV Vol. II), out of the total catchment of 7,200 sq. miles up to date only 1,559 sq. miles have been surveyed for soil conservation. Actually works appear to have been done on about 31 sq. miles of which 7,514 acres have been afforested and 4,900 acres have been protected by 305 conservation structures and in the rest demonstrations have been carried out and soil conservation method of cultivation introduced in collaboration with the farmers owning the lands. Perhaps there are inherent difficulties in achieving better targets. But a far greater effort needs to be made if tangible results are to be expected within foreseeable time. The problem of soil erosion in the area must be a headache for the Government of Bihar and sediment load brought into the reservoirs are a matter of anxiety to all the participating Governments. The Committee, therefore, recommends that D.V.C. authorities should be requested to go ahead with the soil conservation in the upper valley of the river at a much faster speed than has been achieved so far.

5.19.2. Next in importance is that the entire flood reserves as envisaged while framing the project must be made available and kept inviolate for accommodation of the floods and for this purpose homesteads at least should be acquired up to the upper limits of submersion.

5.19.3. No encroachment into the flood reserve should be permitted till after the 15th October. Flushing doses during monsoon periods for the conservancy of the lower river are necessary. They should preferably be given during the earlier part of monsoon when the deficit caused by them can be made up with certainty. The doses should be given by drawing down the reservoir below the lower level of the flood reserves. They should, of course, be sent down only when there is little or no rainfall in the lower valley and should be as frequent as possible.

5.19.4. The present rule curves for releases give rather high discharges as they are based on recession taken place according to the "design flood" peak. Probably no hard fast rules will be available to revise them. Use of actual hydrographs from 1913 to 1959 might indicate the manner. The adequacy of flood reserves, with a view to routing the known floods to a limit of 2,50,000 cusecs at Durgapur should be examined. As the contribution from the uncontrolled catchment at Durgapur cannot always be correctly assessed, it will be desirable to fix the limit of outflow from the two reservoirs.

These studies, the Committee suggests, should be undertaken jointly by the D.V.C. with the representatives of the participating Governments.

5.19.5. It is further recommended that :

- (i) A Flood Forecasting Unit be set up to assist the Reservoir control organisation.

(ii) The quantitative rainfall forecasts are given in terms of ranges (i) less than 1", (ii) 1' to 2" (iii) 2" to 3" and (iv) above 3". The D.V.C. engineers expressed that the forecasts would be more useful if they could be supplied for closer ranges of rainfall, as for example, 1" to 2" may be replaced by 1" to 1½" and 1½" to 2" and so on. It is obvious that with closer ranges of rainfall accuracy of forecasts will be somewhat less. However, it is recommended that advisability of reducing the ranges of rainfall in the forecasts should be examined by the Meteorological Advisory Committee.

(iii) A wireless link should be set up for inter connecting the Meteorological Office in Calcutta, Durgapur, Maithon and other key points in the upper and lower valleys, for quick transmission to the Reservoir Operation Control Office of weather forecast bulletins and reports of actual rainfall and river conditions at those key points for storms during the whole of the monsoon season.

5.19.6. With the change in the storage levels of the reservoirs, if any as may be found necessary after examination, the present scope of the Damodar Valley Project may be affected. This will need careful examination.

#### Region VI—Trans-Damodar Area.

##### 5.20. Raina-Khandaghosh Area.

(i) Closing of hanas on the right bank will serve hardly any useful purpose as with the bank built up of friable material they will reform in the neighbourhood. Moderate inundation through them is generally beneficial. Only when they carry sand to the fields they are harmful. To remedy this the discharge through them should be controlled by constructing suitable structures.

(ii) Investigations should be made for improving the Dev and Kanti khals to drain away the water coming into them, including the tail discharges from the D.V.C. right bank canal system.

5.21. Lower Trans-Damodar area.  
Pursura-Khanakul-Arambagh.

(i) Investigations should be taken up immediately for improving the Damodar (Amta Mundeswari system) the Hurhura khal and the Aurora Khal so that they may accommodate the normal flood water that flows into them.

(ii) In the Darakeswar catchment 2,600 acres (roughly 4 sq. miles) of land has so far been afforested or improved by soil conservation and the programme for the Third Five-Year Plan period is 20,000 acres (roughly 31 sq. miles). The major portion of the upper catchment should be afforested and in the lower catchment other land uses should be modified for soil conservation. Similar measures should be undertaken in the Kangsabati and Silabati catchments too.

(iii) Investigations should be undertaken for the construction of a dam (at Suknibasa ghat or elsewhere) for checking the movement of sand and for supplying water for flushing the river.

(iv) Investigations should be undertaken for the improvement of the Rupnarayan river so that it may carry away the drainage from the Trans-Damodar and other area. The model experiments, that are being taken up for the improvement of the Rupnarayan river for navigation, it is recommended, should be extended to include the problems of the drainage of the Trans-Damodar area and the improvement of the Rupnarayan for drainage over and above the requirement for navigation as well as its effect on the navigability of the Hooghly below Geonkhali and a little above dredging has been suggested by some, while others have advocated training works. The efficiency of either, separately and in conjunction, should be considered in the model.

(v) Investigation should be taken up for exploring the possibility of ensuring regulated supplies in the lower

portions of the Darakeswar, Silabati and the Kangsabati (Durbachati) rivers.

(vi) Sufficient waterways should be provided in the Pursura-Arambagh and the Khanakul roads so that the flood water may not be obstructed and headed up.

### Region VII—Midnapore District

#### 5.22. Daspur area.

(i) The abandoned Ghatal circuit should not be restored.

(ii) The recommendations, that have been made in respect of the improvement of the Darakeswar, Silabati, Kangsabati (Durbachatty) with Region V (b) Lower Trans-Damodar Area (Pursura Khanakul and Arambagh) will serve the Daspur area too.

(iii) Investigations for the improvement of the Palaspai Khal and the inner khals of the Chetua Circuit and for determining the adequacy of the sluices including the one at Mahishghata should be undertaken.

#### 5.23. The rest of the Midnapur District.

(i) The afforestation and soil conservation done and proposed to be done in the Third Five Year Plan in the Kangsabati and Kaliaghai catchments are as follows :

	Kangsabati (acres)	Kaliaghai (acres)
(a) Area afforested or improved by soil conservation Schemes (approx)	11,400 (18 sq. miles roughly)	800 (1.25 sq. miles)
(b) Area proposed to be taken up in the Third Plan Period for afforestation or soil conservation (approx).	48,000 (75 sq. miles roughly)	2000 (3 sq. miles roughly)

It is recommended that the major portion of the upper catchment of these rivers should be afforested and in the lower catchment proper land-uses should be planned for soil conservation. The catchments of the Rasulpur and Subarnarekha also should be similarly treated.

(ii) Investigations for ensuring adequate regulated supplies to the Kangsabati, Kaliaghai, and the Rasulpur Rivers should be undertaken.

(iii) Investigations should be undertaken for the improvement of the Hooghli the Haldi, the Kaliaghai, the Kangsabati and the Rasulpur.

(iv) It is recommended that all Government Embankments should be at standard crest levels and with adequate sections.

(v) Generally no sluices should be built across the open tidal channels. Their marginal embankments should be made adequate and low areas kept open to spill.

(vi) The tex-zamindari embankments should be examined and those decided to be retained should be maintained up to standard.

(vii) All encroachments, cultivations and obstruction in rivers and drainage and other channels should be rigidly prevented.

(viii) All embankments, sluices, drainage channels and rivers should be under the administration of one agency, preferably the Irrigation and Waterways Department.

(ix) The problems of the drainage of the basins, which are inter-connected are very complex. It is therefore recommended that they should be the subject matter of detailed investigation separately.



5.24. Region VIII-Upper areas in the Purulia and Bankura Districts.

(i) Afforestation and soil conservation measures should be undertaken in both districts.

(ii) Investigations should be made for providing escapes in the tanks, all bunds of the fields and for small check dams in the streams and channels in both districts. Similar investigations may also be made in the undulating areas of Midnapur, Burdwan, Birbhum and Murshidabad districts.

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## CHAPTER 6

### Summary of Recommendations and Priorities.

6.1. Recommendations—The Committee has had the benefit of the views of the local people, the representatives of various political and social organisations and persons, having special knowledge in the field of enquiry, including officers of the Irrigation and Waterways, Roads, Agriculture, Health and Forest Directorates of the Government of West Bengal, Corporation of Calcutta, Commissioners for the Port of Calcutta, Railways, Meteorological Department and Damodar Valley Corporation. It has received and considered numerous memoranda, embodying the firsthand experience, thoughts and suggestions of many people, in respect of the floods of last year. The results of these studies and deliberations are embodied in the preceding chapters. They are summarised below :

#### 6.1.1. Causes of floods.

6.1.1.1. The floods of 1959 were primarily caused by the heavy and almost continuous rainfall during mid-September and beginning of October, 1959 synchronising with a flood in the Ganga and its affluents including the Bhagirathi, and high spring tides towards the end of September and beginning of October when the precipitation of rainfall was almost the heaviest, in all the channels which finally drain away the flood waters.

6.1.1.2. Promiscuous erection of embankments, 'Boro' irrigation and fishing bunds, encroachments in the river sections by cultivation, bunds construction of homesteads etc. have caused considerable deterioration of the drainage channels so that they have ceased to function efficiently. This resulted in the damage being more extensive and the period of floods prolonging.

6.1.1.3. The releases from the D. V. C. and Mayurakshi Reservoirs also contributed to the intensity of flooding.

6.1.1.4. Insufficient waterway for the passage of flood waters in some of the road and railway embankments also was a contributory factor.

## 6.1.2. Assessment of effects of flood.

6.1.2.1. Large areas were submerged to varying extents. Drainage was slow. Crops over extensive areas and large number of houses were destroyed or damaged. Cattle and some human lives were also lost and rail, road and other communications were damaged.

In terms of money the extent of the total loss has been variously assessed and it was colossal.

6.1.3. Possibility of reduction of flood intensity by storage release.

6.1.3.1. Release of water from the Mayurakshi Reservoir when it got filled up to the top of the spillway gates added to the intensity of floods in the lower area. This, however, could not be helped as the Mayurakshi Reservoir has no flood reserve. However, but for the existence of the Mayurakshi Dam the flooding would have been more severe. The reservoir till it became full prevented all flood water from flowing into the lower area and when it did get filled moderated the flow to some extent. In the case of D.V.C. reservoir further reduction in the flood discharges would have been possible if the entire flood reserve as designed has been available for flood absorption.

6.1.4. The important remedial measures recommended are :

6.1.4.1. Afforestation and other soil conservation measures including scientific land uses in the catchments of

all rivers. The pace of this work must be considerably speeded up by the authorities concerned.

6.1.4.2. Restoration and regulation of Headwater supplies flood flushing and the improvement of the channels of all the important rivers, which have considerably deteriorated. Construction of the barrage across the Ganga and its ancillary works is the most important proposal in this connection and should be taken up without any avoidable delay.

6.1.4.3. Examination of the embankments along the Mayurakshi with a view to place them sufficiently apart and resectioning them to pass the maximum flood as well as the improvement of the drainage outfalls from the Kandi Beels.

6.1.4.4. Improvement of drainage channels of the Trans-Damodar area and provision of adequate waterways in the roads.

6.1.4.5. Examination of the necessity of ex-zamindary and Gher Embankments and the removal of the unnecessary and harmful ones.

6.1.4.6. The maintenance of all necessary embankments up to standard and placing their administration including that of sluices and channels under one authority, preferably, the Irrigation and Waterways Department.

6.1.4.7. In general the tidal channels are to be kept open, and adjoining low lands to be thrown open to spill.

6.1.5. Regarding priorities general principles recommended are :

1. Long-term remedy of soil conservation in the hilly and middle catchments of all rivers should have the highest priority. Work on measures must be intensified and speeded up.

2. The schemes for execution and investigations should be spread over, as evenly as possible, in the affected areas, as they all suffered distress to varying extents. The ready or almost ready schemes will naturally have first preference and their priorities should be broadly in the following order :

- (a) Works designed to improve the regimes of rivers.
- (b) Protection of townships.
- (c) Protection of homesteads and villages.
- (d) Protection of agricultural properties.

The priorities for investigation and execution of new schemes should also be on the same principles.

3. The legal and administrative measures recommended require immediate implementation.

6.2. These are the measures that it has been possible to recommend in the preliminary report. It will be possible to make more specific proposals in the final report. Early implementation of the suggested works is recommended by the Committee. The investigations now recommended which are only preliminary to work with, should be started in the different areas simultaneously as expeditiously as possible.

6.3. In conclusion the Committee expresses its thanks to all persons, both official and non-officials, representatives of the various organisations, whose help has been so readily available for the expeditious conclusion of this first stage of the Committee's work. The Committee also acknowledges the benefit derived from the information available in the various technical reports placed at its disposal.

Sd/ A. K. Sen  
Chief Engineer, Corporation  
of Calcutta.

Sd/- P. B. Sarkar,  
Chief Engineer, Development  
(Roads) Department,  
West Bengal.

Sd/- J. K. Banerjee.  
Chief Engineer,  
Works and Buildings Depart-  
ment, West Bengal.

Sd/- A. L. Das,  
Chief Engineer, West Bengal,  
Irrigation.

Sd/- B. Maitra,  
Director, River Research  
Institute, West Bengal.

Sd/- N. K. Bose,  
Special Officer, Irrigation and  
Waterways Deptt.  
West Bengal.

Sd/- K. L. Lahiri,  
Conservator-General of  
Forests, West Bengal.

Sd/- Ripudaman Singh,  
Chief Engineer, Floods and  
Flood Control, West Bengal.

Sd/- Man Singh,  
Chairman, West Bengal  
Flood Enquiry Committee,  
1959.

Sd/- P. R. Ahuja,  
Chief Engineer, Floods  
Central Water and Power  
Commission,

Sd/- P. R. Guha,  
Chief Engineer, Irrigation,  
Bihar.

Sd/- D. Mookerjea,  
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Deptt., Bihar.

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gical Deptt., Calcutta.

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