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REPORT ON
DEVELOPMENT OF CHRONICALLY FLOOD
AFFECTED AREAS

NATIONAL COMMITTEE
ON
THE DEVELOPMENT OF BACKWARD AREAS

PLANNING COMMISSION
GOVERNMENT OF INDIA
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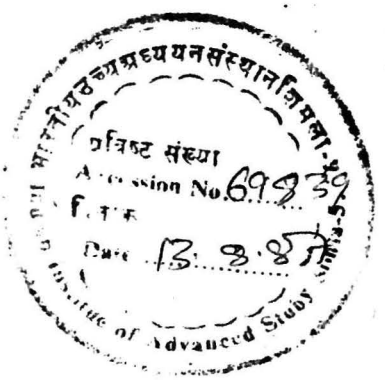

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REPORT ON
DEVELOPMENT OF CHRONICALLY FLOOD AFFECTED AREAS

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I. INTRODUCTION

1. Chronically flood affected areas should be treated as backward areas, and special measures instituted for dealing with their problems, and promoting their economic development.

(Para 1.1)

2. It is necessary to identify the ameliorating steps necessary for the development of the affected areas where damage is caused by natural havoc and is in the flood plains where neither any embankment exists nor are provided in the Master Plan. This is where nature's direct havoc on the economy is felt and this havoc, if chronic, creates the problems of backwardness.

(Para 1.11)

II. IDENTIFICATION OF CHRONICALLY FLOOD AFFCTED AREAS AND STRATEGY TOWARDS DEVELOPMENT

3. The following criteria should be used for identification of the chronically flood prone areas:

(i) flood frequency of at least once in three years,

(ii) flood duration of at least 7 days period at a stretch,

(iii) flood depth of more than the standing paddy at that time, and

(iv) flash floods with strong current liable to uproot plants even if the duration is less than 7 days.

(Para 2.4)

4. In all flood plains, one single Department must be designated as the Department to maintain sufficient hydraulic data. It is only this data which would enable a demarcation of the chonically flood affected areas and the nature and the change in such areas over time.

(Para 2.5)

5. In all the blocks affected by floods, the exercise to refine the identification of chronically flood affected areas requiring amelioration may be done within the next two years so that a realistic and satisfactory ameliorative programme can be introduced.

(Para 2.8)

6. Unlike the demarcation area of a block which the committee has deemed useful for planning in its reports already submitted, the area considered appropriate for the present report, for obvious reasons, is a water basin or sub-basin.

(Para 2.9)

7. Measures to mitigate flood losses need to be part of a comprehensive scheme where in modification of floods, reduced damage susceptibilities of infrastructure and property are looked at an integrated fashion.

(Para 2.15)

8. For developmental purposes it should not be difficult for a project approach to be implemented covering part areas of the blocks so long as they fall in a basin or sub-basin.

(Para 2.16)

9. Crop damage is one of the worst damages caused in floods. An appropriate cropping strategy and other steps have therefore to be adopted in these areas. The obvious pathways would be to popularise suitable flood escaping or flood tolerant cropping system or intensive crop production with irrigation in the flood free months there. The Committee considers that maximum utilisation of the water resources available in these areas and introduction of suitable cropping strategies would be the most important steps for the development of these areas.

(Para 2.17)

10. Regarding the damage caused to houses, property and infrastructure, strengthening of house structure, raising the level of whole villages or providing ring bunds around villages have been considered as possible alternatives. Each of these alternatives has positive and negative aspects; yet the fact remains that something has got to be done to provide protection to the human settlement.

(Para 2.18)

11. The committee would also like to emphasise the importance of pre-disaster preparedness measures since they can change a major disaster into a minor one and mitigate the suffering of those likely to be affected.

(Para 2.19)

12. The Meteorological Department is reported to have drawn up a comprehensive scheme for improving meteorological telecommunication net work for collection of data and its prompt dissemination to the appropriate quarters. The Committee would suggest early decision on these proposals.

(Para 2.24)

13. The Central Flood Forecasting Organisation is maintaining a net-work of observation stations where gauges have been installed to record river flows, sediment discharge etc. The Rashtriya Barh Ayog

have pointed out that there is need for complete review and preparation of a comprehensive plan with a view to bring the network to standards laid down by W.M.O. The net work should come into operation within 5 years. Similar action is necessary in respect of gauges maintained by the Irrigation Department of the States.

(Paras 2.26 & 2.27)

14. There are wide gaps in the hydrological data. No regular information has been maintained about the behaviour of the rivers. The river beds of some of the rivers are reported to have gone up due to reduced velocity of the flood and consequent accumulation of sand. This needs to be verified in the field.

(Para 2.28)

15. The Rashtriya Barh Ayog has referred to the new technologies developed for collection, transmission, storage and retrieval of basic data. While we may not be able to modernise completely collection, transmission, processing and storage of data, a minimum programme should be taken up for meeting the essential requirement of flood forecasting.

(Para 2.29)

16. The present restriction on use of margin money on disaster preparedness measures should be reviewed. Funds need to be provided.

(Para 2.34)

17. The Committee has already recommended a sub-plan approach for allocation of plan funds in respect of the backward areas. It has also dealth with extensively about the allocation of financial resources etc. The Sub-Plan approach would equally be applicable to the chronically flood affected areas identified by the States in accordance with the criteria recommended by the committee. The Committee has recommended a special grant of Rs. 5 lakhs per block, on a phased basis, to take care of certain special items like surveys, investigation etc. As in the case of chronically flood affected areas, a block would not be the unit for identification, but a basin or a sub-basin, the allocation may be on an area basis. A suitable formula would have to be devised so that this additional allocation is also available in respect of the chronically flood affected areas.

(Para 2.36)

III. CROPPING STRATEGY

18. Adequate research support needs to be provided to solve 'Diara' land problems. Suitable research projects should be taken up on crop and varietal improvement, efficient methods of village for timely operations, efficient use of irrigation water, pests and disease management etc. Organised marketing system to pick up the farm produce from the producers and fetch remunerative prices will go a long way to promote this cropping strategy.

(Para 3.4)

19. Given such facilities, and subject to local requirements, the general cropping pattern for the chronically flood prone areas of U.P. should be (a) intensive 'Rabi' cropping after recession of flood water with irrigation and raising crops with improved varieties of wheat, potato, peas and mustard; (b) after 'Rabi' irrigated summer cropping (Zaid) be practised, using suitable short duration varieties of summer maize, mung or paddy so as to harvest the crops before rains; and (c) 'Kharif' cropping when taken up, mostly flood tolerant paddy varieties like Madhukar, Chakia—59 etc., may be adopted.

(Para 3.5)

20. The 'Diara' land in Bihar constitutes the most flood affected areas of the State. Diara lands of Bihar are similar in character to those for eastern Uttar Pradesh. The various practices in the 'Diara' land can be applied to other chronically flood affected areas wherever suitable.

(Para 3.6 & 3.7)

21. Access to irrigation water is essential for promoting intensive crop production programmes during flood free months in chronically flood prone areas of Bihar. Adequate research support as advocated for 'Diara' lands in Uttar Pradesh holds good for Bihar.

(Para 3.7)

22. Flood incidence has been observed to be worst near the confluence of rivers in Assam. These areas which are chronically flood prone may continue to lack adequate flood protection for long years to come. Hence there is an urgent need for restructuring the cropping programme to minimise crop damage and loss of production.

(Para 3.8)

23. In Assam Valley worst floods are experienced in the months of July and August, although in some years floods have been reported in early June or in end of September. In general, however, the cropping has to be restructured to avoid the months of July and August.

(Para 3.9)

24. Recognising the flooding, pattern occurring in the riverine areas, the appropriate cropping strategy would be to raise early 'Ahu' paddy from February to June, followed by late transplanted 'Sali' paddy from September to December. However, farmers' acceptance of this strategy hinges on the availability of irrigation water for early planting of Ahu and for saving the 'Sali' paddy from moisture stress in the valley for year round surface flow irrigation due to topography, the ground water resources appear to be abundant. It is indeed, reported, that in most parts of the valley, ground water is available within a few metres of the surface and offers great scope for exploitation at fairly low cost. The Committee advocates that steps should be taken to popularise an irrigated cropping programme of early 'Ahu' paddy or jute, in the pre-flood season, followed by late 'Sali'

paddy or 'Rabi' wheat, mustard or pulses in the post-flood season. The State's efforts in the direction needs to be intensified using available high yielding varieties and technology.

(Para 3.11)

25. In the low lying deep water areas, farmers raise crop mixtures of 'Ahu' and 'Bao' paddy. For 'Bao' paddy varieties like 'Kekola Bao', 'Negheri Bao' etc. are recommended, Nevertheless, the modern technology of paddy cultivation has not yet benefited the deep water paddy culture and there is no breakthrough yet in deep water paddy cultivation. More intensive research has to be undertaken on deep water paddy.

(Para 3.12)

26. An alternate pathway to improve production from such land would warrant systematic development of deeper areas as organised water bodies for aquculture and use the same as a supplementary irrigation source for intensifying crop production in the remaining peripheral areas when properly drained. Recognising its merit, the committee considers it would be worth-while to test the economic viability of this concept by undertaking a few operational pilot projects in the State before its large scale adoption.

(Para 3.13)

27. The Committee endorses the contigent crop plans and alternate cropping pattern envisaged by the Government of West Bengal.

(Para 3.15)

28. In general, agriculture in Orissa, means raising of paddy. The October-January sown crop of paddy, though covers only upto 5 per cent of the State's paddy area, is practically free from flood and performs best. The season is comparatively cloudless and favours increased photo-synthetic efficiency from November onwards. All efforts should be made to expand paddy area in the October-January season. The Committee advocates this strategy in the flood prone coastal area of Orissa.

(Para 3.18)

29. The success of such a strategy depends on the availability of irrigation water. The Committee, therefore, reiterates its recommendations that immediate steps should be taken to increase irrigation facilities in the flood prone areas.

(Para 3.19)

30. Intensive research, carried out in the country by the scientists of the Central Rice Research Institute, Cuttack, Agricultural Universities etc. and elsewhere on paddy, now offers newer varieties and technology suitable for flood prone areas. Photosensitive high yielding varieties like CR—1009, CR—1011, CR—1018, Pankaj and Jagnath can successfully be grown in rainfed, shallow and intermediate waterlogged areas (15-50 cm water depth). For recurrent flood areas, flood resistant varieties like FRG-7, FRG-8, BR-13, BR-14, FR-13A and FR-43B are recommended. Where semi-deep (50-100 cm) flood water conditions are experienced, rice varieties like CR-1030, CR-260-30, CR-260-31 etc. would be the suitable varieties. Floating rice varieties like Jaisuria, CNDW 332, 327, 326 and 325 have shown great ecological adaptability and are recommended for deep water areas.

(Para 3.20)

31. The Committee advocates the restructuring of the cropping, which can escape or tolerate flood damage in the flood prone areas. For popularising such a cropping strategy, it is reiterated that steps should be taken to make available irrigation facilities in such areas.

(Para 3.21)

32. Due to management difficulties, deep water paddy produces low grain yields, ranging from 0.5 to 1 tonne per hectare. Suitable varieties are to be evolved to tolerate long periods of complete submergence. Nevertheless there appears no breakthrough in deep water paddy cultivation. In view of the importance of deep water paddy, in the flood prone areas and the formidable problems faced for attaining any breakthrough in its production, the Committee strongly advocates intensification of scientific research on deep water paddy on priority basis.

(Para 3.22)

IV. IRRIGATION STRATEGY

33. A strategy to retain some water in the natural depressions for providing lift irrigation during the later part of the rabi season and during hot weather season should be considered.

(Para 4.6)

34. It should be possible to carry canal water for irrigating lands rendered flood-free during Rabi and summer seasons if there is any major, medium or minor surface irrigation scheme operating in the relatively higher areas in the neighbourhood. The distribution arrangements can be made from the nearest canal water course either through portable pipes or through underground pipe system which may remain undisturbed during the floods. Such irrigation will provide gravity flow to the areas rendered free from floods for Rabi and hot weather crops in and around natural depressions. Drip irrigation and sprinkler irrigation may be tried to secure economy in water use.

(Para 4.6)

35. Wells could be sunk in the areas. They would be normally covered during the period of submergence and can be used for irrigation purposes with manual or animal operated devices as well as with portable pump sets to lift water from the wells in the floodfree season after the monsoon.

(Para 4.7)

36. In West Bengal many channels keep on flowing after the monsoon season even after the lands are

rendered flood free. To raise boro paddy or wheat the farmers are used to put up kucha bunds across the flowing channels to impound water and lift the same for irrigating the areas. The system is very crude and adversely affects the regimes of the natural streams or the drainage channels. Instead of putting up temporary earthen bunds, if a systematic programme of construction of sluices with gates are drawn up and construction undertaken, perhaps the purpose will be better achieved and during the monsoon season the gates can be kept opened to allow flood water to pass freely.

(Para 4.8)

37. A system of lifting water during the Rabi and summer season is already in vogue in some parts of the Assam State. This programme should be accelerated.

(Para 4.9)

38. So far as areas subjected to flash floods are concerned, the samé strategy of tube wells, wells and river lifts can be considered with similar portable arrangements for pumps, motors and distribution system for providing irrigation during Rabi and hot-weather seasons. In such areas it is most advisable not to try any crops during flood periods.

(Para 4.12)

V. MEASURES TO MITIGATE FLOOD DAMAGES

39. It is fully realised that absolute immunity from flood damage is not physically possible even in the distant future because of unpredictability of several natural forces which might cause an unprecedented situation.

(Para 5.1)

40. The full potential of the Landsat Imagery be utilised to know precise details about the behaviour of various upper reaches in the country.

(Para 5.8)

41. The moderation of run-off would directly help the chronically flood affected areas. For reduction of run-off, the committee would recommend (i) prohibition of production in the hilly catchments; (ii) constructon of flood detention reservoirs; (iii) contour bunding in hilly catchments; (iv) small check dams on the tributaries to delay run-off to point of concentration; and (v) elaborate arrangement for flood fighting arrangements at vulnerable points with adequate support of flood forecasting and warning thereof.

(Para 5.11)

42. A number of smaller flood retention reservoirs of suitable capacity should be constructed on or near each river, by excavation if necessary. This will serve to regulate the ferocity of flash floods down-stream of these reservoirs. The retained flood waters in various reservoirs can provide ample water supply during the dry season.

(Para 5.13)

43. The upper reaches management can be most effective on a watershed management basis. However, at times a judicious choice between conflicting alternatives has to be made.

(Para 5.14)

44. Any individualistic attemps at soil conservation measures may not yield the effective results. The whole watershed needs tackling in totality by the Governments and the individual farmers should be made to work within the prescribed norms. In consonance with the overall objectives, any financial needs of the individual farmers should be satisfactorily backed by governmental agencies.

(Para 5.15)

45. Embankment construction has been one of the age old method of reducing flooding. The Committee agree that the object of remedial measures of the protection of a chronically flood affected area should be to train the rivers on their way to the sea by constructing protective embankments, judicious dredging, flood escapes etc. One of the main reasons attributed to such frequent breaches has been found to be inadequate maintenance. The Committee endorses the Seventh Finance Commission recommendations on the subject.

(Para 5.17)

46. The importance of preparing a comprehensive plan of action assumes greater strength in the context of drainage management. The Committee would like to emphasise involvement of all the concerned authorities/agencies which would be responsible for sanctioned construction works in the flood plain areas.

(Para 5.18)

47. The maintenance of drainage by dredging and utilisation of the material thus dredged for filling up the hollow areas on the other side of the embankments is a possibility. The maintenance of major/medium drainages wherever maintained by Revenue Department, must be taken over by the Irrigation Department.

(Para 5.19)

48. The Committee, while endorsing the comprehensive treatment of the subject of drainages by the Rashtriya Barh Ayog would like to re-emphasise and recommend the following measures:—

(i) There is need for closer coordination amongst concerned agencies like the Railways, National Highways, State Irrigation/Flood Control Departments so as to ensure that structures like bridges, roads, railways etc. do not aggravate flood problems.

(ii) Prior consultation by National Highway authorities, State P.W.D.s and Railways with the State Irrigation/Flood Control Departments should be made obligatory. To facilitate an expeditious check, the Government of India should evolve guidelines/checklist for the purpose of vetting of waterways by the State Irrigation/Flood Control Departments.

(iii) It should be mandatory that assessment of adequacy of existing waterways should be made

by the State Committee of Engineers or some other Technical Board and the waterways for bridges to be constructed in the future should be vetted by the State Irrigation/Flood Control Department.

(iv) The Standing Committee for settling disputes on waterways and sharing of costs, headed by the Chairman, Central Water Commission, should be vested with statutory powers for implementation of its decisions.

(v) The State should undertake legislation to prevent unauthorised river bed cultivation and encroachments into drains etc. and where such laws already exist, the enforcement agencies should be strengthened. Cultivation of crops like water-melons, vegetables, etc. in river beds and berms, may however, be allowed with caution. The practice of cultivation in the abandoned beds of Dhars and which discharge into main rivers should be stopped.

(vi) Where suitable legislation with a penal clause for unauthorised crossings over drains has not been enacted, the same should be done and enforced.

(Para 5.20)

49. Flood relief channels should be constructed at suitable points to drain excess of flood water to remote artificial lakes; these should also be provided towards the downstreams and of enlarged channels to carry away surplus water to other artificial lakes. The flood relief channels can be used as feeders for minor irrigation canals.

(Para 5.20)

50. A complete review of the operation of the systems of sluices for drawing up a necessary operational manual for the same is necessary.

(Para 5.23)

51. The paucity of data on river bed behaviours inhibits in making any objective idea about the problem of sand casting. Studies should be undertaken whereby assessment of the problem in the right perspective can be had.

(Para 5.25)

52. The problem of sand casting, beyond a limit, is quite harmful for the crop growth. The Committee would recommend the initiation of scientific studies on the subject so that suitable crop planning can be devised.

(Para 5.26)

53. Rural houses, facing flood fury, are generally made of materials which cannot withstand a high degree of stresses and strains. In the event of raising pucca structures the damage susceptibility can be considerably reduced. Such a scheme should be supported in areas where alternatives are not found to be feasible. In case of its adoption strict enforcement would be desirable as otherwise additional numbers in the hope of receiving doles for contruction may get settled in affected areas.

(Para 5.29)

54. Raising of villages as a whole offers another alternative to mitigate the hardships of human settlements. Without liberal support from public funds the proposition can rarely succeed. In case of raising of villages, roads should not be raised correspondingly so as to avoid any interference with drainage aspects. The roads may be allowed to get submerged during floods. Availability of country boats in sufficient numbers would be able to solve the problems of the chronically flood affected areas during that spell.

(Para 5.31)

55. Construction of ring bunds around the villages or human settlements in another way which has been experimented at certain places. Such a scheme may be supported in the event of cost-benefit favouring the same in comparison to other alternatives.

(Para 5.32)

56. Structural changes and land elevation wherever undertaken by individuals or groups, should be encouraged and suitable monetary and other assistance be provided keeping in view the overall policy objectives.

(Para 5.33)

57. Strict regulation of land use in the chronically flood affected areas is necessary.

(Para 5.34)

58. The Planning Commission already provided for soil conservation and afforestation measures in the upper catchment of flood prone rivers. This programme will require to be implemented on sub-watershed basins after identifying the critically affected ones. Effective implementation of this programme will require building of inter-disciplinary teams for each of the basins. The pace of the programme will have to be accelerated along with effective measures to prevent deterioration of new areas. The Committee would recommend special efforts in this direction.

(Para 5.34)

59. Disaster relief, while warding off, the immediate distress, encourages certain attitudes which need to be deplored. There is a tendency to consider relief measures as a right. This in turn tends to remove the incentive to avoid future flood losses and encourages persistent human occupancy of the flood plain.

(Para 5.35)

60. Effective steps should be taken to train and organise local volunteers in fighting flood hazards due to threatened breaches in embankments and also to utilise effective steps to plug the breaches as and when the same occur.

(Para 5.36)

61. The Committee feels that there should be a law to ensure that any building that is constructed in such areas should provide for a plinth above the normal flood level.

(Para 5.37)

1. INTRODUCTION

1.1 Floods constitute one of the most serious environmental hazards and the problems of flood control, and the measures to be taken for relieving the distress of the flood affected population have been engaging the attention of Government and the planners for a considerable length of time. There are, nevertheless, substantial areas which suffer from heavy floods at frequent intervals resulting in serious crop losses, damage to houses, roads and other physical infrastructure, institutional properties, and dislocation of normal economic activity in the area from time to time. The economic growth of such areas has been and continuance to be impeded generally due to frequency of heavy floods, and special measures are, therefore, necessary for promoting their economic development. The National Committee has accordingly decided that chronically flood affected areas should also be treated thereafter as backward areas, and special measures instituted for dealing with their problems, and promoting their economic development.

1.2 The Rashtriya Barh Ayog (1980) has examined at considerable length the various factors that cause heavy floods in different river basins and deltas, and indicated the measures that need be taken for affording such flood protection as may be feasible in such areas. They have in particular recommended the measures to be taken for moderating the intensity of floods and reducing flood damage. The Rashtriya Barh Ayog has listed five States which need urgent help and attention for the purpose of flood control. These are Assam, Bihar, Orissa, Uttar Pradesh and West Bengal.

1.3 In Assam, there are two distinct physiographical regions viz., the Bramaputra Valley and the Barak Valley. The major problems that we are confronted with in the Bramaputra Valley are:—

(i) over bank spilling from the Bramaputra and its major tributaries;

(ii) drainage congestion; and

(iii) erosion and silting in various areas.

In Barak Valley, the main problem is inundation from river spills and drainage congestion.

1.4 In Bihar, floods occur frequently over large areas in North Bihar, and also along the flood plains of the Ganga at Places in South Bihar. The main contributory factors are:

(i) spillage in the snow fed rivers in North Bihar coming from the mountaineous regions; and

(ii) heavy silting and tendency of some of these rivers to frequent breaches and avulsions.

There is also blockage in the tributaries of Ganga on both the north bank and south bank when the Ganga itself is in high floods, besides drainage congestion in depressions and low-lying flood areas.

1.5 In Orissa, floods, occur mainly in the deltas of the more important rivers viz., the Mahanadi, the Baitarni, the Brahmani and the Subarnarekha. Some of the existing test relief embankments which are rather low and were constructed without due regard to engineering specifications often breach, and cause heavy damage. Bank erosion and sand casting also arise in some areas from time to time.

1.6 In Uttar Pradesh, major floods are caused by various over spillage in rivers like the Ghagra, the Rapti and the Gandak coming from high mountaineous regions of Nepal. There are also high floods in the Ganga and Yamuna from time to time.

1.7 In West Bengal, heavy floods have been caused in recent years in the Mahananda basin in North Bengal through over-spillage of the banks, breach in embankments, and change in the course of some channels. In Central Bengal, also serious floods have occurred in recent years due to the over-spillage of the Mahananda and, more or less, simultaneous high floods in Ganga. In the South Bengal region, heavy floods have occurred in recent years due to drainage congestion on account of deterioration in the regime of main rivers like the Saraswati, the Damodar, the Kana Damodar, the Kana Nadi, Roopnarayan, the Dwarakeshwar, the Silabati and Kargsabati. The situation is aggravated during periods when there is also blockage of inland drainage due to sea tides and cyclonic storms.

1.8 Traditionally, where the arable lands are liable to floods, people have tried to protect themselves from the inundation and possible damage by building embankments to keep off the flood waters. Construction of embankment has been going on in the river basins for centuries. Many states have passed legislation to control the intrusions and obstructions in the flood plains so as to maintain the drainage system most effectively and prevent blocking the flood to the detriment of the general population. After, freedom, many of these legislative controls appear to have been overlooked and embankment construction has generally been in haphazard manner.

1.9 Because of the haphazard construction of embankments and non-maintenance of key embankments the experience has been a continuous breaching of embankments which were supposed to protect large areas. Thanks to these breaches, the damage in the 'protected' areas is much more substantial than what it could have been had the areas not been protected.

1.10 The National Committee has carefully considered the objective criterion to be laid down for the demarcation of chronically flood affected areas. The franchise of the Committee is not only to identify the areas of backwardness but also to suggest remedies for improving the productivity and economics of these backward areas. Embankment breaches and consequent damages are, in most cases, man-made. By and

large, the remedy has to be sought only in people disciplining themselves to ensure that technical advice in these matters is obeyed meticulously and legislative controls imposed by the legislatures are faithfully observed.

1.11 The National Committee has, therefore, decided that it should not address itself to areas where damages are caused by human action referred to in para 1.10. It is confining itself only to the ameliorating steps necessary for the development of the affected areas where damage is caused by natural havoc and is in the flood plains where neither any embankment exists nor are provided in the Master Plan. This is where nature's direct havoc on the economy is felt. Again it is this havoc, which, if chronic, creates the problem of backwardness. The aim of the Committee, therefore, is to deal with such unprotected areas where natural havoc is chronic and suggest ameliorating measures.

1.12 Although a number of Committees and Commissions have been appointed to deal with the flood control measures, no proper attempt has so far been made to identify the areas which are unprotected from chronic havoc and to consider steps for ameliorating the problems in those areas. The National Committee has, therefore, decided to submit a separate report about the developmental problems and the approach in these areas as their problem and remedies have to be highly location specific and different from the normal developmental programmes.

1.13 At the outset, the Committee would hasten to add that it has greatly been handicapped by lack of basic data. The Committee is, however, grateful to the State Governments particularly West Bengal, Uttar Pradesh, Orissa and Bihar, which extended their whole-hearted support in giving whatever information was available with them. The Committee would particularly like to thank Shri S. K. Banerji, formerly Adviser, Planning Commission and now Member of the State Planning Board in Bihar, who was also one time Chairman of the Ganges Flood Commission for giving valuable assistance to the Committee in drafting its report. The Committee has also benefited by the advice of several experts in the field particularly those in Central Water Commission, Ministry of Agriculture etc.

1.14 In the following chapters, the Committee has attempted to deal with the criteria for identification of chronically flood affected areas, strategy of development and suggested specific lines of action for development of cropping patterns and irrigation which, by far, are the most important requirement for the development in these areas and also deal with the steps necessary for mitigating the flood damage and providing shelter to the human settlements.

2. IDENTIFICATION OF CHRONICALLY FLOOD AFFECTED AREAS AND STRATEGY TOWARDS DEVELOPMENT

At the outset, the National Committee would like to define the objective criteria for the demarcation of the chronically flood affected areas.

2.2 Within the flood plains, not all areas where the flood reaches at any time are really damaged. Damage is of two kinds: (i) crop damage; and (ii) damage to houses, cattle, infrastructure and other property. Crop damage can occur if the crop selected by the farmer is susceptible to water logging. People have adjusted themselves to the nature of the environment in areas which are flooded, by mainly growing paddy in these areas. By sheer experience they have also evolved methods to grow the right type of paddy which normally would escape flood damage by complete submersion. The paddy plant can survive even if the flood flows over the crop for 7 days at a stretch. Only where the current is strong and uproots the plants, real damage can occur where the flood is less than 7 days. These areas are marginal. House and cattle damage can occur where the habitations are low and the force of the current erodes foundations and where habitations have been located in areas where flood flows can be at high speed. Owing to lack of habitable areas and the pressure of population many spots unsuitable in the flood plain have been made into human habitations. This will be in areas which are generally flooded to some depth chronically. Normally it will be found that areas that may be flooded to cause crop damage of a severe nature to the paddy cultivation will also be the areas where house damage and cattle damage occur. The Committee, therefore, is of the view that if the problem of crop damage and the area involved is identified, the other problem areas will automatically be identified to a large extent.

2.3 Living in the flood plains the housholder must be insuring himself against periodic floods. Only if the frequency of floods is more than tolerable, he is at a disadvantage. The Committee, therefore, considers that a chronically flood affected area should be defined as one where the flood frequency is at least once in three years. At the same time, not all these areas will be liable to crop or house damage unless the level of the water in that area leads to crop damage and the force of the water leads to house damage.

2.4 The above criteria of once in three years flooding would have to be further refined taking into account the flood duration at a stretch, flood depth, flash floods, etc. The Committee would recommend the following criteria for identification of the chronically flood prone areas:—

(i) flood frequency of at least once in three years,

(ii) flood duration of at least 7 days period at a stretch.

(iii) flood depth of more than the standing paddy at that time, and

(iv) flash floods with strong current liable to uproot plants even if the duration is less than 7 days.

2.5 The Committee is cognisant of the fact that the above exercise can be undertaken only if certain basic data is available. The Rashtriya Barh Ayog tried to collect figures of the flood fluctuation within a year in various flood plains but the relevant data was not available. The Committee would strongly recommend that in all flood plains, one single Department must be designated as the Department to maintain sufficient hydraulic data. It is only this data which would enable a demarcation of the chronic flood affected areas and the nature and the change in such areas over time.

2.6 The Committee tried to get some data, on the above approach, from the Ganga Commission and the States about some blocks, which are impressionistically considered to be chronic flood affected blocks. It has not been possible to get much information from existing records on this subject. As a result, some detailed work was done on the Kandi block in West Bengal which is supposed to be a chronically flood affected block and the result of the investigations are as under:—

Kandi Block

Year	Extent of flooding (acres)	Duration of flooding (days)	Population affected	Cropped area damaged (acres)	No. of houses damaged
1	2	3	4	5	6
1977	24,900	3	60,000	18,000	285
1978	50,000	20	1,10,000	33,000	16,000
1979	Nil				
1980	5,800	5	10,000	4,400	230

During 1978 the flood level was above R.L. 53.8 (maximum R.L. 57.3) for 12 days, above R.L. 48.8 for 20 days and above R.L. 46.3 for 84 days. During 1977 the flood level was above R.L. 48.8 for 6 days and above R.L. 46.3 for 23 days; statistics of 1978 reveal that the flood level was above R.L. 46.3 for 8 days.

2.7 The above shows that the area affected in three of the years was by a flood duration of less than 7 days. Crop damage, if any, could not have been severe unless the wrong crop had been selected or it was in the river flow. These data are not available. In only one year the duration of the flood lasted for 20 days but here again there is no distinction of the area which should normally have had damage because of water stagnation beyond 7 days. This block turns out to be a chronic flood affected block on the criterion of flood patterns in these three years. The area that will have to receive ameliorative action may be found to be reasonably small. The Committee wants to emphasise that a general cry of flood damage and non-identification of the reasons for the damage and the area actually damaged will only lead to wrong methods for amelioration.

2.8 Steps will have to be taken to identify such areas before ameliorative action can really be started. The Committee recommends that in all the blocks affected by floods, this exercise to refine the identification of chronic flood affected areas requiring amelioration may be done within the next two years so that a realistic and satisfactory ameliorative programme can be introduced. What is required is preparation of a relief map of the area in the village plan annually giving the various contours affected by flood waters during the period demarcating the areas which were flooded more than 7 days at a stretch and within these areas where the depth of water was for 7 days at a stretch higher than the level of the traditional paddy crop grown in the area. Thus, the relief maps will have to give three contours for each season. We recommend that this exercise should now be done for every year so that the nation gets a correct idea of what area are susceptible to damage in present circumstances and needs out attention. The fact that 40 million hectares are liable to floods in a year is of no relevance for the problem of development of areas which are chronic flood affected. The Committee has no hesitation in saying that the actual area requiring attention will be much smaller than the actual area liable to flood. Ameliorative measures can be purposeful and relevant to the problem only when the demarcation of such areas is technically correct and sound. Annexure 2.1 reveals the extent of flood damages in the country as a whole. The main point of interest here is that crop area damaged is much less than the total flood affected area. The chronically flood affected area would naturally be much less than the crop area damaged because the latter includes crop damage due to enbankment breaches. Annexures 2.2 to 2.4 indicate the frequency and extent of flooding data obtained from the States of Orissa, Uttar Pradesh and West Bengal.

2.9 Unlike the demarcation area of a block which the Committee has deemed useful for planning in its reports already submitted, the area considered appropriate for the present report, for obvious reasons, is a water basin or sub-basin.

2.10 Heavy floods thoroughly upset the economy of chronically flood affected areas. Year after year, our country suffers from incalculable losses of human life, property, livestock and farm produce. Flood plain occupancy depicts an inherent major dilema. Whilst providing attractive locations for various human activities on account of the rich alluvial soils, the flood plain occupancy can prove very costly and disastrous in times of chronic floods and may exact a heavy toll of property damage, income loss of life as well. Inspite of these hazards caused, there has been no halt to the new settlements in the flood plains and rather mushrooming of settlements in the hitherto uninhabited area is often seen. The growing pressure of population on land and its contribution to enlarging the extent of damage has been compounded by the growing spread and intensity of floods themselves. The latter, in turn, has been the result of several factors. the most important of them being the deterioration of river channels. Their beds raised by increasing silt deposition, they are unable to carry the heavy monsoon flow which spills over their banks.

2.11 There has been an increasing awareness that absolute control and protection against floods can be seldom achieved. Complete protection against floods, though technically feasible, may not be economically justifiable or possible. Each flood control measure, be it a dike or flood wall or reservoir, has a limited effectiveness.

2.12 A changing perspective on flood loss prevention and management is a prerequisite for dealing with chronic flood affected areas. Attention has, of late, been focussed on several aspects; there are, however, quite a few more which need urgent or added attention. The problem needs priority attention, and has to be dealt with on a continuous basis rather than ad-hoc, and must be viewed in a comprehensive fashion. Traditional crisis—provoked approach deserves to be replaced by flood management approach and needs to be seen as a part and parcel of the social and economic developmental plans. In general the interest in floods has been following a pattern of short busts of feverish activity following a flood event, and the normal action had been to clear up the debris and ease the sufferings of the victims, followed up by setting up of enquiry committee and then the whole affair folding up with passage of time.

2.13 For reducing the flood damages effectively a number of measures are possible. No single measure may provide the right answer and as such adoption of a combination of measures becomes desirable. Tampering with nature on a macro scale is always fraught with risk and care must be taken not to disturb the natural regime of rivers. The mounting magnitude of flood damage is a pointer to the fact that either the measures adopted thus far had been out of tune or rather insufficient or incommensurate with the needs. This necessitates a fresh look for a deeper probe at the problem.

2.14 The Committee considers that the development of the chronic flood affected areas has to be looked at as a whole and the approach would require a comprehensive and integrated development. While modification of floods, reduction in damage susceptibilities of infrastructure and property etc. are no doubt important components of an integrated approach, the

development problems has also to take into account the steps necessary for exploitation of the potential available and the problems of human settlements. The engineering and other aspects of flooding like content of upper reaches control, embankments, maintenance, drainage control, control of sanding/silting, sand casting etc. are, by and large, engineering problems and have been dealt with at length, in the Rashtriya Barh Ayog report. We in this Chapter are trying to deal with the developmental problems and touch upon, the engineering problems like embankments to the extent they affected the development problems.

2.15 The Committee considers that the measures to mitigate flood losses need to be part of a comprehensive scheme wherein modifications of floods, reduced damage susceptibilities of infrastructure and property are looked at in an integrated fashion. These have been viewed so far in the content of upper reaches control, embankment, maintenance, drainage management and control of sanding/silting, alongwith the measures to deal with sand casting. The problems of human settlements would also deserve rightful attention. The engineering and other aspects of flooding as already noted have been dealt with at length in the report of the Rashtriya Barh Ayog. The relevant recommendations of the Rashtriya Barh Ayog have broadly been endorsed and wherever necessary modifications and additional recommendations have been highlighted in a separate Chapter.

2.16 Before undertaking any development profile for the area identified as chronically flood affected in accordance with the criteria indicated by us earlier in this Chapter, it would be necessary to draw a Master Plan based on proper surveys and investigations for the basin and sub-basin affected. The Committee has recommended earlier the concept of an Integrated Project Development Authority in its report on "Organisation of Administrative and Financial Structures for Backward Area Development". The Committee would suggest that in the case of chronically flood affected areas, the project approach should be based on a basin or sub-basin approach. It is quite likely that some of the sub-basins or basins may not cover the whole block and only a part of the block may be covered. The Committee feels that for developmental purposes it should not be difficult for a project approach to be implemented covering part area of the blocks so long as they fall within a basin or sub-basin. Detailed surveys and preparation of contour maps for the development of the areas identified require first priority. Such maps would help not only for formulating of developmental plans but also in forecasting more accurately the areas likely to be affected by floods thereby avoiding unnecessary evacuation from areas not likely to be affected.

2.17 The Committee has already pointed out that most of the chronically flood affected areas lie in the five States of Uttar Pradesh, Bihar, Assam, West Bengal and Orissa. The crop damage is one of the worst damages caused in floods. For instance, during 1976-78 block years, the crop area affected by floods aggregates on an averge to 41.05 lakh hectares annually for these States. Such magnitude of flood damage to cropped area in these areas keep the conditions of local farmers backward and unstable. An appropriate cropping strategy and other steps have therefore to be adopted in these areas. The obvious pathways would be to popularise suitable flood escaping or flood tolerant cropping system or intensive crop production with irrigation in the flood free months there. The Committee considers that maximum utilisation of the water resources available in these areas and introduction of suitable cropping strategies would be the most important steps for the development of these areas. These are dealt with in greater detail in relevant chapters.

2.18 The next in importance is the damage caused to houses, property and infrastructure. The chronically flood affected areas are often densely populated. Flood extract a heavy toll year after year in respect of damaged and swept away houses. According to the information collected by the Rashtriya Barh Ayog, on an average, 9.25 lakh houses were damaged each year during the last 25 years. Quite a few alternatives have been considered for minimising the damage to the houses It will not be socially possible to shift large number of people to higher grounds. Strengthening of house structures, raising the level of whole villages or providing ring bunds around villages have been considered as possible alternatives. Each of these alternatives has positive and negative aspects; yet the fact remains that something has got to be done to provide protection to the human settlement. The Committee has dealt with this matter in all its aspects in a separate Chapter.

2.19 The Committee would also like to emphasise the importance of pre-disaster preparedness measures since they can change a major disaster into a minor one and mitigate the suffering of those likely to be affected. Disaster preparedness involves a long chain action beginning with forecasting, issue of timely warning, reaching the warning to the persons concerned in time, advance preparation of contingent plans in respect of precautionary measures for safety and security of lives and property, education and training of the people in the vulnerable areas in various aspects relating to prevention and protection, stockpiling of supplies, organisational arrangements for disaster management and earmarking of necessary funds.

2.20 Timely issue of warning about the occurrence of floods and their nature and intensity is basic for disaster preparedness since it will enable people in the vulnerable areas to move to safer places with their moveable property where this is considered necessary or take adequate precautions where evacuation is not necessary. Concentration of rainfall during the rainy season in a few spells of heavy rain is the direct cause of floods. Most of the floods occur during the monsoon and are also assoicated with tropical storms and depressions. Location and monitoring the progress of depression and storms, predicting their future behaviour, and supply or reliable rainfall data has been among the major tasks of the Indian Meteorological Department.

2.21 Cloud pictures are transmitted twice a day by the polar orbiting Satellites and these are received by 7 automatic transmission receiving stations of the Meteorological Department. These pictures do not, however, reveal the nature and strength of the depres-

sion and its other parameters. The special Weather Satellite transmits very high resolution pictures. Special terminals are being set up by the I.M.D., N.R.S.A. and I.S.R.O. for receiving these pictures I.M.D. is proposing to acquire some specialised aircraft to penetrate through the eye of the cyclones and make actual in-situ observation of wind, temperature and pressure between the cyclone-fields and provide the basis for ground truthing of the Satellite data. When the Gas-stationary Satellite starts transmitting data it will be possible to have observations once in two hours.

2.22 Radars which can detect and tract the course of the depressions and cyclones within a distance of 400 Kms. have been set up at Calcutta, Paradeep, Vizag, Madras and Karaikal in the East-coast and Calicut, Bombay and Goa in the West Coast. One more Radar is being set up at Musulipatnam. The Meteorological Department is also maintaining 32 Observatories manned by Departmental staff and 31 manned by extra departmental employees along the coastal belt of India. These Observatories take 6 observations a day about rainfall and wind at fixed Departmental Observatories equipped with self-recording instruments. In some inaccessible areas automatic recorders with radio communication equipments have been set up. The Meteorological Department also maintains 30 Pilot Balloon Observatories for taking upper wind observations, atmospheric pressure, temperature, humidity etc. The weather data collected by the Meteorological Department is made available to the Central Flood Forecasting Organisation of the Central Water Commission.

2.23 There are many improvements that need to be carried out urgently to improve the efficiency of the Meteorological services. These include:—

(i) Conversion of part-time observatories into full-time ones with self-recording instruments;

(ii) Conversion of selected Pilot Balloon Observatories into Radio Wind Stations;

(iii) Augmenting the Radar Stations;

(iv) Provision of effective communication links between Radar Stations and Meteorological Centres;

(v) Modernising the Radar stations and providing them with equipments to transmit the pictures to the concerned cyclone warning centres; and

(vi) Expediting the acquisition of air-crafts for cyclone reconnaissance.

2.24 The Meteorological Department is reported to have drawn up a comprehensive scheme for this and other immediate requirements for improving meteorological telecommunication net-work for collection of data and its prompt dissemination to the appropriate quarters. The Committee would suggest early decision to these proposals.

2.25 Rainfall data is crucial for flood forecasting. The Rashtriya Barh Ayog has reported that as on 31-3-1979 there were 1092 ordinary and 614 self-recording rain-gauge stations maintained by the Meteorological Department. The State Governments and other organisations maintain 3791 ordinary rain-gauge stations. The Rashtriya Barh Ayog has emphasised the need for designing self-recording rain-gauge net-work for flood forecasting with a view to ensure adequate coverage of the catchment of the upper and lower reaches of the important rivers. The present position regarding maintenance of rain gauges by the agencies of State Governments, recording of rainfall, transmission of data etc., need to be streamlined. The work is not always taken seriously by staff who get only a very small honorarium for doing this work. Rainfall data should be scrutinised and published since it is a valuable record. It is of utmost importance that the flood forecasting stations are enabled to get rainfall data relating to the catchment of the rivers as well as their lower reaches without delay during the flood season.

2.26 The Central Flood Forecasting Organisation is maintaining a net-work of observation stations where gauges have been installed to record river flows, sediment discharge etc. The Rashtriya Barh Ayog have pointed out that there is need for complete review and preparation of a comprehensive plan with a view to bring the net-work to standards laid down by W.M.O. (World Meteorological Organisation). The net-work should come into operation within 5 years. This is very important recommendation and its implementation will improve flood forecasting.

2.27 Similar action is necessary in respect of gauges maintained by the Irrigation Departments of the states.

2.28 There are wide gaps in the hydrological data. No regular information has been maintained about the behaviour of the rivers. The river beds of some of the rivers are reported to have gone up due to reduced velocity of the flood and consequent accumulation of sand. This needs to be verified in the field. A study on the Mahanadi on para 5.24 of Chapter 5 shows how impression can be wrong. Without basic hydrological data flood control works cannot be planned properly.

2.29 The Rashtriya Barh Ayog has referred to the new technologies developed for collection, transmissions, storage and retrieval of basic data. These include use of automatic recording instruments—(like Radio Reporting Rain-gauge Instruments, automatic water level recorders etc.), Radar (for measurement of rainfall, stream velocity and soil moisture), aerial photography, remote sensing and use of computers. While we may not be able to modernise completely collection, transmissions, processing and storage of data, a minimum programme should be taken up for meeting the essential requirement of flood forecasting.

2.30 Government of India had introduced centrally sponsored schemes providing for 100 per cent grant for soil survey, topographical survey etc., under Command Area Development Programme. It is essential that surveys and data collection schemes relating to flood forecasting and flood control are fully financed by Government of India and their progress closely monitored.

2.31 Recent advances in forecasting techniques have made it possible to provide warning sufficiently in

advance excepting in rare cases of flash floods with unforeseen intensity. Unless the warning reaches the concerned people in sufficient time, it may not serve its purpose. Telephones and telegrams usually fail during the monsoon season. The Posts and Telegraphs Department should have special arrangements to maintain these facilities during the flood season in the chronically flood affected areas. Teleprinters network should be established to connect the Sub-Divisional and District Headquarters in the chronically flood affected areas. The Taluk and Block Headquarters should be connected by phones. Temporary phones should be provided to all persons concerned with disaster management.

2.32 Police Wireless has been the most reliable source of communication during disaster. Since it is essentially meant for communicating messages regarding law and order, its capacity is stretched to the utmost during disasters. During monsoon, temporary wireless sets are established for meeting the requirements of Irrigation Department as well as the relief administration. The requirements in this regard are not fully met due to want of adequate number of sets and supporting arrangements. The Wireless net-work should be equipped to shoulder the additional burden imposed by natural calamities. A certain amount of modernisation is also necessary. The extra expenditure on the expansion and improvement of wireless system should come from resources earmarked for disaster preparedness and relief measures. The normal police budget is not able to provide for this.

2.33 There is generally no adequate stock-piling of essential supplies and there is considerable time-lag in procuring these after the occurrence of flood. Movement is also handicapped due to poor road communication facilities in the affected areas and transport arrangements. Certain items like power and country boats, lifebuoys, tents, tarpaulins etc., have to be kept at vulnerable locations before they are cut off.

2.34 Disaster preparedness measures are not a charge on margin money provided to State Governments on the recommendations of the Seventh Finance Commission. Margin money can be used only for rescue, relief and rehabilitation after the occurrence of the natural calamity. In view of the resources constraint experienced by State Governments, they are not able to provide adequate funds for disaster preparedness measures outlined in the foregoing paragraphs. Prevention is always better than cure. Disaster preparedness can mitigate the effects of disaster and funds allotted for this purpose can result in considerable saving in the post-disaster period and hence on recurring expenditure or reserve relief and rehabilitation. The present restriction on use of margin money on disaster preparedness measures should be reviewed. Funds need to be provided.

2.35 The Committee has emphasised the need for development of irrigation, crop production, protection to houses and property, disaster preparedness etc. This does not mean that the scope for other developmental activities in these areas does not exist. For instance, in certain areas of Bihar, keeping of buffaloes and undertaking fish culture in the stagnating water is an important subsidiary occuption in these areas. The proposed Project Authority, when it undertakes a complete survey, would naturally come to know about the potential possibilities. Whatever be the potential, it would have to be developed.

2.36 The Committee has already recommended a Sub-Plan approach for allocation of plan funds in respect of the backward areas. It has also dealt with extensively about the allocation of financial resources etc. The Sub-Plan approach would equally be applicable to the chronically flood affected areas identified by the States in accordance with the criteria recommended by the Committee. The Committee has recommended a special grant of Rs. 5 lakhs per block, on a phased basis, to take care of certain special items like surveys, investigation etc. As in the case of chronically flood affected areas, a block would not be the unit for identification, but a basin or a sub-basin, the allocation may be on an area basis. A suitable formula would have to be devised so that this additional allocation is also available in respect of the chronically flood affected areas.

ANNEXURE 2.1

FLOOD DAMAGE DURING 1953 TO 1980

S. No.	Year	Area Affected (lakhs)	Population affected (lakhs)	Damage to crops	
				Area (lakhs ha.)	Value (Rs. lakhs) at current price
1	2	3	4	5	6
1.	1953	59·4	252·8	9·3	4206·0
2.	1954	74·8	182·4	26·5	4100·1
3.	1955	111·7	309·5	54·0	7795·5
4.	1956	80·1	148·4	21·0	4203·2
5.	1957	49·7	77·9	4·5	1455·6
6.	1958	62·4	114·4	14·9	4353·4
7.	1959	42·0	138·9	15·4	5721·7
8.	1960	76·3	86·8	26·5	4613·2
9.	1961	65·3	93·1	18·3	2494·5
10.	1962	61·2	157·3	35·6	8028·7
11.	1963	35·6	111·9	19·7	3123·6
12	1964	46·2	140·0	24·7	5708·3
13.	1965	10·4	33·0	2·5	541·3
14	1966	42·3	124·1	16·1	6404·0
15.	1967	70·8	265·0	33·0	11955·0
16.	1968	82·5	214·7	26·9	13710·1
17.	1969	95·4	320·0	43·4	21101·9
18.	1970	84·5	322·4	48·5	16178·1
19.	1971	132·5	596·5	62·4	42262·8
20.	1972	57·2	271·6	24·4	9855·8
21.	1973	137·2	635·9	76·0	42803·0
22.	1974	67·0	294·4	33·0	41163·1
23.	1975	61·5	313·5	38·5	27118·8
24.	1976	178·9	505·2	76·8	59507·5
25.	1977	174·3	495·4	82·6	72062·7
26.	1978	186·1	704·5	99·6	91108·4
27.	1979	39·8	195·2	21·7	76997·4
28.	1980	114·2	540·9	55·5	36613·7
	Total	**2299.3**	**7644·8**	**1011·8**	**565887·1**
	Maximum	**186·1 (1978)**	**704·5 (1978)**	**99·6 (1978)**	**91108·1 (1978)**
	Average	**82·1**	**273·0**	**36·1**	**20185·3**

ANNEXURE 2·1 (*Contd.*).

S. No.	Year	Damage to houses		Cattle lost No.	Human lives lost No.	Damage to public utilities (Rs. lakhs)	Total damage to crop public utilities (Col. 6+8+11) (Rs. lakhs)
		Nos.	Value (Rs.)				
1	2	7	8	9	10	11	12
1.	1953	98838	924·0	57028	34	290·0	5420·0
2.	1954	220060	672·1	22514	279	1015·7	5787·9
3.	1955	1741978	3278·4	77437	889	795·6	11869·5
4.	1956	721199	808·0	16903	462	121·6	5132·8
5.	1957	314577	527·4	77537	304	419·7	2402·7
6.	1958	461316	616·3	18766	400	179·2	5148·9
7.	1959	652622	944·0	66479	622	1202·3	7868·0
8.	1960	651720	1482·6	14982	520	648·4	6744·2
9.	1961	817861	97·0	18061	1389	634·1	3225·6
10.	1962	520741	1145·5	39814	354	105·1	9279·3
11.	1963	406994	372·7	4915	419	312·0	3808·3
12.	1964	266634	479·8	5430	695	536·4	6724·5
13.	1965	32451	15·7	7294	68	4·2	561·2
14.	1966	156601	77·0	8868	165	41·0	6522·0
15.	1967	601316	984·0	5921	358	738·0	13677·0
16.	1968	798661	4028·3	130356	3498	2533·3	20271·7
17.	1969	1242287	5378·9	271073	1401	6850·6	3333·4
18.	1970	1434029	4860·6	19198	1076	7643·3	28682·0
19.	1971	2428044	8024·1	12866	1141	12911·3	63198·2
20.	1972	897257	1246·0	58861	544	4717·4	15819·2
21.	1973	869897	5257·2	261016	1349	8848·0	56908·2
22.	1974	746709	7240·3	16846	393	8494·0	56897·4
23.	1975	793704	3408·3	17345	685	16600·0	46127·4
24.	1976	1745501	9215·9	80057	1374	20151·9	88875·3
25.	1977	1666625	15228·8	556326	11316	32889·0	120190·5
26.	1978	3507242	16757·4	239180	3396	37610·1	145475·6
27.	1979	1328712	21060·6	618248	3637	23362·7	61420·7
28.	1980	2530936	17085·1	59401	1903	29302·7	83001·5
	Total	**27600457**	**131216·3**	**2710822**	**38693**	**218072·5**	**9153759**
	Maximum	**3507243 (1978)**	**210606 (1979)**	**618248 (1979)**	**11316 (1977)**	**37610·1 (1978)**	**145475·6 (1978)**
	Average	**985731**	**4686·3**	**96815**	**1382**	**7920·4**	**32692·0**

FREQUENCY AND INCIDENCE OF FLOODING IN SOME RIVERS OF ORISSA

Sl. No.	Name of river	Year	Gauge site (O. value of to gauge (—) 1·28)	Danger level	Flood Spilling level	Area Flooded			Year (10 years from 1971 to 1980)		
						Maximum gauge	Danger level	Low gauge 4′ - 0 below danger level	When flooding started	Date of flooding	Incidence of earlier flood upto 15th July dates and duration
1	2	3	4	5	6	7	8	9	10	11	12
1.	Baitarani	1971	Akhuapada	63·00	59·00	100005 ha	63·00 71232 ha	59·00 35616 ha	21-7-71	21-7-71 22-7-71 8-8-71 30-8-71	Nil
		1972		63·00	59·00	66·20 99887 ha	63·00 71232 ha	59·00 35616 ha	15-7-72	15-7-72 14-8-72	Nil
		1973		63·00	59·00	67·80 100069 ha	63·00 71232 ha	59·00 35616 ha	20-7-73	20-7-73 19-8-73 26-8-73 2-9-73 25-9-73	Nil
		1974*		63·00	59·00	67·70 100069 ha	63·00 71232 ha	59·00 35616 ha	15-8-74	15-8-74	Nil
		1975		63·00	59·00	70·00 118721 ha	63·00 71232 ha	59·00 35616 ha	12-8-75	12-8-75 18-8-75	Nil

Sl. No.	Name of River	Year	Gauge site (O. value of to gauge (—) 1·28)	Danger level	Flood Spilling level	Incidence of other floods (from 15 th July to 30th August) Date and Duration	Incidence of Flood (from September to October) Dates and Duration	REMARKS
1	2	3	4	5	6	13	14	15
1.	Baitarani	1971	Akhuapada	63·00	59·00	21-7-71 (12 hrs) to 22-7-71 (06 hrs) = 18 hrs (2 days) 27-7-71 (18 hrs) to 30-7-71 (06 hrs) = 60 hrs (3 days) 8-8-71 (06 hrs) to 12-8-71 (06 hrs) = 96 hrs (5 days) 30-8-71 (09 hrs) to 31-8-71 (24 hrs) = 40 hrs (2 days)		
		1972		63·00	59·00	15-7-72 (05 hrs) to 16-7-72 (09 hrs) = 28 hrs (2 days) 14-8-72 (06 hrs) to 15-8-72 (18 hrs) = 36 hrs (2 days)	11-9-72 (12 hrs) to 15-9-72 (06 hrs) = 90 hrs (5 days)	
		1973		63·00	59·00	20-7-73 (12 hrs) to 23-7-73 (07 hrs) = 67 hrs (4 days) 19-8-73 (02 hrs) to 21-8-73 (12 hrs) = 58 hrs (3 days) 26-8-73 (20 hrs) to 29-8-73 (18 hrs) = 70 hrs (4 days)	2-9-73 (15 hrs) to 6-9-73 (06 hrs) = 87 hrs (5 days) 25-9-73 (06 hrs) to 26-9-73 (09 hrs) = 27 hrs (2 days)	
		1974		63·00	59·00	15-8-74 (18 hrs) to 18-8-74 (11 hrs) = 65 hrs (4 days)		
		1975		63·00	59·00	12-8-75 (18 hrs) to 14-8-75 (18 hrs) = 48 hrs (3 days) 18-8-75 (21 hrs) to 22-8-75 (06 hrs) = 82 hrs (5 days)		

1	2	3	4	5	6	7	8	9	10	11	12
1. Baitarani		1976	Akhuapada	63·00	59·00	61·10 51673 ha	63·00 71232 ha	59·00 35616 ha	14-8-76	14-8-76	Nil
		1977		63·00	59·00	59·80 49976 ha	63·00 71232 ha	59·00 35616 ha	7-8-77	7-8-77 1-9-77	Nil
		1978		63·00	59·00	64·00 87476 ha	63·00 71232 ha	59·00 35616 ha	28-8-78	28-8-78 2-9-78 22-9-78	Nil
		1979		63·00	59·00	65·15 88679 ha	63·00 71232 ha	59·00 35616 ha	8-8-79	8-8-79	Nil
		1980		63·00	59·00	59·75 50076 ha	63·00 71232 ha	59·00 35616 ha	20-9-80	20-9-80	Nil
2. Brah-mani		1971	Jonapur Anicut	66·00	62·00	72·30 195300 ha	66·00 119880 ha	62·00 59400 ha	14-7-71	14-7-71 16-7-71 27-7-71 29-7-71 1-8-71	14-7-71 to 15-7-71 12 hrs 24 hrs. = 36 hrs. (2 days)
		1972		66·00	62·00	67·90 89278 ha	66·00 119880 ha	62·00 59400 ha	15-7-72	15-7-72 12-9-72	Nil
		1973		66·00	62·00	73·10 168006 ha	66·00 119880 ha	62·00 59400 ha	20-7-73	20-7-73 20-8-73 27-8-73 3-9-73 25-9-73 28-10-73	Nil

ANNEXURE 2·2—*Contd.*

1	2	3	4	5	6	13	14	15
1. Baitarani		1976	Akhuapada	63·00	59·00	14-8-76 to 15-8-76 = 34 hrs 8 hrs 18 hrs 2 days		
		1977		63·00	59·00	7-8-77 to 8-8-77 = 24 hrs 01 hrs 00 hrs 2 days	1-9-77 to 2-9-77 = 30 hrs 00 hrs 06 hrs 2 days	
		1978		63·00	59·00	28-8-78 to 30-8-78 = 48 hrs 12 hrs 12 hrs 3 days	2-9-78 to 3-9-78 = 15 hrs 15 hrs 06 hrs 22-9-78 to 23-9-78 = 48 hrs 06 hrs 24 hrs	
		1979		63·00	59·00	8-8-79 to 11-8-79 = 67 hrs 07 hrs 02 hrs	Nil	
		1980		63·00	59·00	Nil	20-9-80 to 21-9-80 = 24 hrs 00 hrs 00 hrs 1 day	
2. Brah-mani		1971	Jonapur Anicut	66·00	62·00	16-7-71 to 25-7-71 =228 hrs 00 hrs 12 hrs 10 days 27-7-71 to 24-8-71 =687 hrs 15 hrs 06 hrs 29 days 29-8-71 to 31-8-71 = 66 hrs 06 hrs 24 hrs 3 days	1-9-71 to 11-9-71 =249 hrs 00 hrs 09 hrs 11 days	
		1972		66·00	62·00	15-7-72 to 17-7-72 = 54 hrs 06 hrs 12 hrs 3 days	12-9-72 to 15-9-72 = 82 hrs 056 hrs 08 hrs 4 days	
		1973		66·00	62·00	20-7-73 to 22-7-73 = 53 hrs 7 hrs 12 hrs 3 days 20-8-73 to 24-8-73 = 99 hrs 03 hrs 06 hrs 5 days 27-8-73 to 31-8-73 = 99 hrs 06 hrs 09 hrs 5 days	3-9-73 to 8-9-73 = 114 hrs 15 hrs 08 hrs 6 days 25-9-73 to 30-9-73 =108 hrs 06 hrs 06 hrs 6 days 28-10-73 to 31-10-73 = 72 hrs 06 hrs 06 hrs 4 days	

1	2	3	4	5	6	7	8	9	10	11	12
2.	Brahmani	1974	Jonapur Anicut	66·00	62·00	69·50 113501 ha	66·00 119880 ha	62·00 59400 ha	14-8-74	14-8-74	Nil
		1975		66·00	62·00	75·20 199800 ha	66·00 119880 ha	62·00 59400 ha	19-7-75	19-7-75 10-8-75	Nil
		1976		66·00	62·00	68·60 110055 ha	66·00 119880 ha	62·00 59400 ha	20-7-76	20-7-76 31-7-76 13-8-76 19-9-76	Nil
		1977		66·00	62·00	68·40 110007 ha	66·00 119880 ha	62·00 59400 ha	5-7-77	5-7-77 31-7-77 1-9-77 10-9-77	5-7-77 to 88 hrs. 9-7-77 09 hrs. 87 hrs. = 5 days
		1978		66·00	62·00	66·80 101430 ha	66·00 119880 ha	62·00 59400 ha	30-6-78	30-6-78 31-7-78 5-8-78 13-8-78 28-8-78 3-9-78	30-6-78 03 hrs to 30-6-78 18 hrs = 12 hrs (1 day)
		1979		66·00	62·00	66·70 101416 ha	66·00 119880 ha	62·00 59400 ha	8-8-79	8-8-79	Nil
		1980		66·00	62·00	63·20 55376 ha	66·00 119880 ha	62·00 59400 ha	22-6-80	22-6-80 25-6-80 8-9-80	22-6-80 to 03 hrs 23-6-80 06 hrs =27 hrs (2 days) 25-6-80 to 00 hrs 26-6-80 06 hrs =30 hrs (2 days)

1	2	3	4	5	6	13	14	15
2. Brahmani	· ·	1974	Jonapur Anicut · · ·	66·00	62·00	14-8-74 to 21-8-74 = 181 hrs 08 hrs 8 days		
		1975		66·00	62·00	19-7-75 to 23-7-75 = 108 hrs 06 hrs 18 hrs 5 days 10-8-75 to 26-8-75 = 381 hrs 09 hrs 06 hrs 17 days		
		1976		66·00	62·00	20-7-76 to 21-7-76 = 18 hrs 18 hrs 12 hrs 2 days 31-7-76 to 1-8-76 = 30 hrs 18 hrs 24 hrs 2 days 13-8-76 to 17-8-76 = 96 hrs 18 hrs 18 hrs 5 days	19-9-76 to 22-9-76 = 72 hrs 03 hrs 03 hrs 4 days	
		1977		66·00	62·00	31-7-77 to 13-8-77 = 307 hrs 09 hrs 03 hrs 14 days	1-9-77 to 3-9-77 = 66 hrs 00 hrs 18 hrs 3 days 10-9-77 to 13-9-77 = 96 hrs 00 hrs 18 hrs 3 days	
		1978		66·00	62·00	31-7-78 to 1-8-78 = 24 hrs 18 hrs 18 hrs 2 days 5-8-78 to 6-8-78 = 42 hrs 00 hrs 18 hrs 2 days 13-8-78 to 16-8-78 = 72 hrs 06 hrs 06 hrs 4 days 28-8-78 to 30-8-78 = 66 hrs 00 hrs 18 hrs 3 days	3-9-78 to 7-9-78 = 111 hrs 03 hrs 18 hrs 5 days	
		1979		66·00	62·00	8-8-79 to 12-8-79 = 87 hrs 18 hrs 18 hrs 5 days		
		1980		66·00	62·00	Nil	8-9-80 to 9-9-80 = 30 hrs 18 hrs 24 hrs 2 days	

1	2	3	4	5	6	7	8	9	10	11	12
3.	Burhabalanga	1971	Fuladi	14·50 +9·50 24·00 RL	10·50	14·20 41210 ha	14·50 44346 ha	10·50 22170 ha	8-8-71	8-8-71 (Max) 28-8-71 5-9-71	Nil
		1972		,,	10·50	14·80 457210 ha	14·50 44346 ha	10·50 22170 ha	13-8-72	13-8-72 11-9-72 25-9-72	Nil
		1973		,,	10·50	19·50 11275 ha	14·50 44346 ha	10·50 22170 ha	21-7-73	21-7-73 27-8-73 1-9-73 22-9-73 12-10-73	Nil
		1974		,,	10·50	15·80 73910 ha	14·50 44346 ha	10·50 22170 ha	16-8-74	16-8-74	Nil
		1975		24·00	10·50	15·40 71205 ha	14·50 44346 ha	10·50 22170 ha	12-8-75	12-8-75 19-8-75 9-9-75	Nil
		1976		,,	,,	13·20 38060 ha	14·60 44346 ha	10·50 22170 ha	4-8-76	4-8-76 12-9-76	Nil

1	2	3	4	5	6	13	14	15
3.	Burhabalanga	1971	Fuladi	14·50 + 9·50 24·00RL	10·50	8-8-71 to 11-8-71 = 72 hrs 12 hrs 12 hrs 3 days 28-8-71 to 31-8-71 = 84 hrs 06 hrs 18 hrs 4 days	5-9-71 to 7-9-71 = 54 hrs 12 hrs 18 hrs 3 days	
		1972		,,	,,	13-8-72 to 15-8-72 = 48 hrs 18 hrs 18 hrs 2 days	11-9-72 to 16-9-72 = 120 hrs 06 hrs 06 hrs 5 days 25-9-72 to 26-9-72 = 24 hrs 06 hrs 06 hrs 1 day	
		1973		,,	,,	21-7-73 to 22-7-73 = 33 hrs 06 hrs 15 hrs 2 days 27-8-73 to 29-8-73 = 42 hrs 12 hrs 06 hrs 2 days	1-9-73 to 5-9-73 = 114 hrs 06 hrs 24 hrs 5 days 22-9-73 to 27-9-73 = 109 hrs 18 hrs 07 hrs 5 days 12-10-73 to 15-10-73 = 79 hrs 00 hrs 07 hrs 4 days	
		1974		,,	,,	16-8-74 to 19-8-74 = 84 hrs 00 hrs 12 hrs 4 days		
		1975		,,	,,	12-8-75 to 13-8-75 = 25 hrs 07 hrs 08 hrs 1 day 19-8-75 to 23-8-75 = 00 hrs 07 hrs	9-9-75 to 14-9-75 = 124 hrs 00 hrs 04 hrs 4 days	
		1976		,,	,,	4-8-76 to 6-8-76 = 50 hrs 22 hrs 24 hrs 3 days	12-9-76 to 15-9-76 = 74 hrs 03 hrs 05 hrs 4 days	

ANNEXURE 2·2—*Contd.*

1	2	3	4	5	6	7	8	9	10	11	12
3. Burhabalanga		1977		,,	,,	13·80 / 38750 ha	14·50 / 44346 ha	10·50 / 22170 ha	30-7-77	30-7-77 4-8-77 30-8-77 1-9-77 13-9-77	Nil
		1978		14·50	10·50	14·60 / 44560 ha	14·50 / 44346 ha	10·50 / 22170 ha	15-8-78	15-8-78 24-8-78 1-9-78 18-9-78 22-9-78 4-10-78	Nil
		1979		14·50	10·50	14·60 / 44560 ha	14·50 / 44346 ha	10·50 / 22170 ha	8-8-79	8-8-79	Nil
		1980		14·50	10·50	11·40 / 30510 ha	14·50 / 44346 ha	10·50 / 22170 ha	21-6-80	21-6-80 8-9-80 18-9-80	21-6-80 / 18 hrs to 21-6-80 / 21 hrs = 3 hrs
4. Subranarekha		1971	Rajaghat	15·00	11·00	18·40 / 42970 ha	15·00 / 32850 ha	11·00 / 16425 ha	15-7-71	15-7-71 27-7-71 2-8-71 30-8-71 1-9-71	Nil

1	2	3	4	5	6	13	14	15
3. Burhabalanga		1977		,,	,,	30-7-77 to 1-8-77 = 44 hrs 11 hrs 07 hrs 3 days 4-8-77 to 10-8-77 = 157 hrs 11 hrs 24 hrs 7 days 30-8-77 to 31-8-77 = 44 hrs 04 hrs 24 hrs	1-9-77 to 3-9-77 = 61 hrs 00 hrs 13 hrs 3 days 13-9-77 to 14-9-77 = 30 hrs 03 hrs 09 hrs 2 days	
		1978	Fuladi	14·50	10·50	15-8-78 to 19-8-78 = 104 hrs 16 hrs 24 hrs 5 days 24-8-78 to 31-8-78 = 181 hrs 11 hrs 24 hrs 7 days	1-9-78 to 4-9-78 = 90 hrs 00 hrs 18 hrs 4 days 18-9-78 to 19-9-78 = 36 hrs 06 hrs 18 hrs 2 days 22-9-78 to 24-9-78 = 66 hrs 06 hrs 18 hrs 3 days 4-10-78 to 7-10-78 = 72 hrs 12 hrs 12 hrs 3 days	
		1979		14·50	10·50	8-8-79 to 10-8-79 = 58 hrs 06 hrs 16 hrs 3 days	Nil	
		1980		14·50	10·50	Nil	8-9-80 to 8-9-80 = 10 hrs 07 hrs 17 hrs 18-9-80 to 19-9-80 = 36 hrs 06 hrs 18 hrs 2 days	
4. Subranarekha		1971	Rajghat	15·00	11·00	15-7-71 = 1 day 27-7-71 to 31-7-71 = 96 hrs 06 hrs 06 hrs 5 days 2-8-71 to 16-8-71 = 15 days 00 hrs 00 hrs 360 hrs 30-8-71 to 31-8-71 = 2 days 00 hrs 24 hrs 48 hrs	1-9-71 to 9-9-71 = 9 days 00 hrs 24 hrs 216 hrs	

ANNEXURE 2·2—*Contd.*

1	2	3	4	5	6	7	8	9	10	11	12
4.	Subranarekha	1972	Rajghat	15·00	11·00	18·50 42976 ha	15·00 32850 ha	11·00 16425 ha	14-8-72	14-8-72 12-9-72	Nil
		1973		15·00	11·00	20·30 39·30 RL 54750 ha	15·00 32850 ha	11·00 16425 ha	20-8-73	20-8-73 1-9-73 24-9-73 12-10-73	Nil
		1974		15·00	11·00	19·80 48750 ha	15·00 32850 ha	11·00 16425 ha	16-8-74	16-8-74 30-9-74	Nil
		1975		15·00	11·00	19·80 48750 ha	15·00 32850 ha	11·00 16425 ha	19-7-75	19-7-75 13-8-75	Nil
		1976		15·00	11·00	19·00 47097 ha	15·00 32850 ha	11·00 16425 ha	13-9-76	13-9-76 18-9-76	Nil
		1977		15·00	11·00	20·00 54600 ha	15·00 32850 ha	11·00 16425 ha	15-7-77	15-7-77 30-7-77	Nil
		1978		15·00	11·00	20·80 55745 ha	15·00 32850 ha	11·00 16425 ha	29-8-78	29-8-78 2-9-78 28-9-78 6-10-78	Nil
		1979		15·00	11·00	No remarkable flood below D.L. Hence nil					
		1980		15·00	11·00	No remarkable flood below D.L. Hence nil					

1	2	3	4	5	6	13	14	15
4. Subranarekha		1972		15·00	11·00	14-8-72 to 16-8-72 = 3 days 07 hrs 09 hrs 50 hrs	12-9-72 to 14-9-72 = 3 days 08 hrs 12 hrs 52 hrs	
		1973		15·00	11·00	20-8-73	1-9-73 to 6-9-73 = 6 days 00 hrs 24 hrs 144hrs 24-9-73 to 28-9-73 = 5 days 00 hrs 15 hrs 111 hrs 12-10-73 to 17-10-73 = 6 days 18 hrs 10 hrs 112 hrs	
		1974	Rajghat	15·00	11·00	16-8-74 to 21-8-74 = 6 days 06 hrs 06 hrs 120 hrs	30-9-74 to 2-10-74 = 3 days 13 hrs 24 hrs 83 hrs	
		1975		15·00	11.00	19-7-75 = 1 day 13-8-75 to 24-8-75 = 12 days 14 hrs 19 hrs 269 hrs		
		1976		15·00	11·00	Nil	13-9-76 to 14-9-76 = 2 days 10 hrs 24 hrs 38 hrs 18-9-76 to 22-9-76 = 5 days 16 hrs 19 hrs 99 hrs	
		1977		15·00	11·00	15-7-77 to 17-7-77 = 2 days 11 hrs 11 hrs 48 hrs 30-7-77 to 11-8-77 = 13 days 09 hrs 16 hrs =295 hrs		
		1978		15·00	11·00	29-8-78 to 31-8-78 = 3 days 07 hrs 16 hrs 67 hrs	2-9-78 to 6-9-78 = 5 days 03 hrs 24 hrs 117 hrs 28-9-78 = 1 day 6-10-78 = 1 day	

ANNEXURE 2·3

INCIDENCE OF EARLIEST LATEST & LATEST BUT ONE FLOODS IN MAJOR RIVERS OF UTTAR PRADESH DURING LAST FIVE YEARS

Sl. No.	Name of River	Gauge site	Danger level in Meters	Ever maximum flood level in meters with year	YEAR 1975		
					Incidence of earlier floods (when the river crossed danger level)	Incidence of other latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)
1	2	3	4	5	6	7	8
1.	Ganga	Hardwar	294·00	295·78 (1978)	..	..	..
2.	Ganga	Narora D/S	178·40	180·20 (1924)	21-7-75 (1 day)	9-9-75 (1 day)	..
3.	Ganga	Phaphamau	84·73	88·39 (1948)	..	..	..
4.	Ganga	Chatnag	84·73	88·39 (1948)	..	..	..
5.	Ganga	Mirzapur	77·72	79·53 (1971)	..	..	..
6.	Ganga	Rajghat (Varanasi)	71·26	76·61 (1977)	..	..	..
7.	Ganga	Ghazipur	63·105	64·37 (1971)	..	..	..
8.	Ganga	Ghaighat Ballia	56·39	58·65	25-7-75 (1 day)	11 to 21-9-75 (11 days)	11-8-75 to 13, 21 to 30-8-75 (6 days)
9.	Yamuna	Delhi Bridge	204·83	207·50 (1978)	26-7-75 (1 day)	14-9-75	..
10.	Yamuna	Auriya	108·95	109·02 (1978)	..	..	..
11.	Yamuna	Hamirpur	104·24	108·140 (1978)	..	..	..
12.	Yamuna	Chillaghat	100·00	106·34 (1967)	..	..	..
13.	Yamuna	Naini Allahabad	84·73	87·98 (1978)	..	..	..
14.	Gomti	Ghaighat Lucknow	110·49	113.20 (1960)	20-6-75	27-8 to 18-9-75 (23 days)	(11 days)
15.	Gomti	Jaunpur	74·06	77·74 (1971)	..	..	..
16.	Sarda	Paliakalan Kheiri	153·619	154·80 (1975)	23 & 24-6-75 (2 days)	5 to 22-9-76 (18 days)	.. (46 days)
17.	Sarda	Sardanagar Kheiri	135·49	135·95 (1969)	..	..	..
18.	Ghaghra	Katarnia Ghat Baharaich	136·78	137·00 (1970)	..	..	..
19.	Ghaghra	Elginbridge (Barabanki)	106·078	107·88 (1950)	24·6 to 10-7-75 (17 days)	6 to 13-9-75 (8 days)	(26 days)
20.	Ghaghra	Ayodhya	92·73	94·08 (1971)	..	..	..
21.	Ghaghra	Turitipar Ballia	64·01	65·16 (1975)	3 to 7-7-75	23·8 to 20-9-75	(21 days)
22.	Rapti	Kakardhari	131·00	130·16 (1978)	..	..	..
23.	Rapti	Balrampur Gonda	104·62	105·90 (1969)	..	..	..
24.	Rapti	Bansi (Basti)	84·90	87·44 (1966)	..	..	..
25.	Rapti	Birdghat Gorakhpur	74·98	76·63 (1925)	11-7-75	9 to 16-9-75	(24 days)
26.	Buṛhi Rapti	Kakrahi	85·679	87·465 (1978)	1 to 14-7-75	6 to 13-9-75	(30 days)
27.	Grade Gandak	Bhainsa	96·00	96·85 (1978)	2-7-75	9-10-75	(12 days)
28.	Tons	Azamgarh	74·725	75·08 (1980)	..	..	..

ANNEXURE 2·3—*Contd.*

Sl. No.	Name of River	Gauge Site	Year 1976			Year 1977		
			Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)	Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)
1	2	3	9	10	11	12	13	14
1.	Ganga	Hardwar	..	..	..	..	..	..
2.	Ganga	Narora D/S	29-7-76 (1 day)	22-8-76	..	..	..	..
3.	Ganga	Phaphamau	..	..	..	..	..	..
4.	Ganga	Chatnag	..	..	..	..	..	..
5.	Ganga	Mirzapur	..	..	..	..	..	..
6.	Ganga	Rajghat (Varanasi)	14 & 15-9-76 (2 days)	..	..	..	..	..
7.	Ganga	Ghazipur	..	..	..	10 & 11-7-77 (2 days)	6-9-77 (1 day)	2 & 4-9-77 (2 days)
8.	Ganga	Ghaighat Ballia	19-8-76 (1 day)	12 to 23-9-76 (12 days)	..	1 to 16-8-77 (16 days)	19 to 23-9-77 (5 days)	3, 5 & 13-8-77 (3 days)
9.	Yamuna	Delhi Bridge	2 & 3-8-76 (2 days)	20 to 8-76 (7 days)	8 to 14-8-76 (6 days)	28 to 29-7-77 (2 days)	14 to 17-9-77 (2 days)	3, 5, 13-8-77 (3 days)
10.	Yamuna	Auriya	..	..	..	..	..	..
11.	Yamuna	Hamirpur	..	..	..	..	..	..
12.	Yamuna	Chillaghat (Banda)	..	..	..	..	..	..
13.	Yamuna	Naini (Allahabad)	..	..	..	..	..	..
14.	Gomti	Ghaighat (Lucknow)	..	..	..	..	..	..
15.	Gomti	Jaunpur	..	..	..	..	..	..
16.	Sarda	Paliakalan Kheiri	..	..	..	..	..	..
17.	Sarda	Sardanagar Kheiri	..	..	..	..	..	..
18.	Ghaghra	Katarnia Ghat, Baharaich	..	..	..	..	..	..
19.	Ghaghra	Elginbridge Barabanki	19 to 28-8-76 (10 days)	11-9-76	..	..	17-7-77	14 to 16-9-77
20.	Ghaghra	Ayodhya	..	..	..	..	..	..
21.	Ghaghra	Turtipar Ballia	20 to 31-8-76	..	..	..	19 to 22-8-77	29-8 to 4-9-77
22.	Rapti	Kakardhar	..	..	..	..	..	..
23.	Rapti	Balrampur (Gonda)	..	..	..	..	..	..
24.	Rapti	Bansi (Basti)	..	..	..	..	..	..
25.	Rapti	Birdghat Gorakhpur	..	..	..	..	..	..
26.	Burhi Rapti	Kakrahi	24 to 27-8-76	..	..	..	26-8 to 4-9-77	..
27.	Grade Gandak	Bhainsa	24-8-76	..	..	..	27 to 30-8-77	13 to 15-9-77
28.	Tons	Azamgarh	..	..	..	..	..	..

ANNEXURE 2·3

INCIDENCE OF EARLIEST LATEST & LATEST BUT ONE FLOODS IN MAJOR RIVERS OF UTTAR PRADESH DURING LAST FIVE YEARS

Sl. No.	Name of River	Gauge site	Danger level in Meters	Ever maximum flood level in meters with year	YEAR 1975		
					Incidence of earlier floods (when the river crossed danger level)	Incidence of other latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)
1	2	3	4	5	6	7	8
1.	Ganga	Hardwar	294·00	295·78 (1978)	..	..	..
2.	Ganga	Narora D/S	178·40	180·20 (1924)	21-7-75 (1 day)	9-9-75 (1 day)	..
3.	Ganga	Phaphamau	84·73	88·39 (1948)	..	..	..
4.	Ganga	Chatnag	84·73	88·39 (1948)	..	..	..
5.	Ganga	Mirzapur	77·72	79·53 (1971)	..	..	..
6.	Ganga	Rajghat (Varanasi)	71·26	76·61 (1977)	..	..	..
7.	Ganga	Ghazipur	63·105	64·37 (1971)	..	..	..
8.	Ganga	Ghaighat Ballia	56·39	58·65	25-7-75 (1 day)	11 to 21-9-75 (11 days)	11-8-75 to 13, 21 to 30-8-75 (6 days)
9.	Yamuna	Delhi Bridge	204·83	207·50 (1978)	26-7-75 (1 day)	14-9-75	..
10.	Yamuna	Auriya	108·95	109·02 (1978)	..	..	..
11.	Yamuna	Hamirpur	104·24	108·140 (1978)	..	..	..
12.	Yamuna	Chillaghat	100·00	106·34 (1967)	..	..	..
13.	Yamuna	Naini Allahabad	84·73	87·98 (1978)	..	..	..
14.	Gomti	Ghaighat Lucknow	110·49	113.20 (1960)	20-6-75	27-8 to 18-9-75 (23 days)	(11 days)
15.	Gomti	Jaunpur	74·06	77·74 (1971)	..	..	..
16.	Sarda	Paliakalan Kheiri	153·619	154·80 (1975)	23 & 24-6-75 (2 days)	5 to 22-9-76 (18 days)	.. (46 days)
17.	Sarda	Sardanagar Kheiri	135·49	135·95 (1969)	..	..	..
18.	Ghaghra	Katarnia Ghat Baharaich	136·78	137·00 (1970)	..	..	..
19.	Ghaghra	Elginbridge (Barabanki)	106·078	107·88 (1950)	24·6 to 10-7-75 (17 days)	6 to 13-9-75 (8 days)	(26 days)
20.	Ghaghra	Ayodhya	92·73	94·08 (1971)	..	..	..
21.	Ghaghra	Turitipar Ballia	64·01	65·16 (1975)	3 to 7-7-75	23·8 to 20-9-75	(21 days)
22.	Rapti	Kakardhari	131·00	130·16 (1978)	..	..	..
23.	Rapti	Balrampur Gonda	104·62	105·90 (1969)	..	..	..
24.	Rapti	Bansi (Basti)	84·90	87·44 (1966)	..	..	..
25.	Rapti	Birdghat Gorakhpur	74·98	76·63 (1925)	11-7-75	9 to 16-9-75	(24 days)
26.	Burhi Rapti	Kakrahi	85·679	87·465 (1978)	1 to 14-7-75	6 to 13-9-75	(30 days)
27.	Grade Gandak	Bhainsa	96·00	96·85 (1978)	2-7-75	9-10-75	(12 days)
28.	Tons	Azamgarh	74·725	75·08 (1980)	..	..	..

Sl. No.	Name of River	Gauge Site	Year 1976			Year 1977		
			Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)	Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)
1	2	3	9	10	11	12	13	14
1.	Ganga	Hardwar	..	..	..	..	..	..
2.	Ganga	Narora D/S	29-7-76 (1 day)	22-8-76	..	..	..	..
3.	Ganga	Phaphamau	..	..	..	..	..	..
4.	Ganga	Chatnag	..	..	..	..	..	..
5.	Ganga	Mirzapur	..	..	..	..	..	..
6.	Ganga	Rajghat (Varanasi)	14 & 15-9-76 (2 days)	..	..	..	..	..
7.	Ganga	Ghazipur	..	..	..	10 & 11-7-77 (2 days)	6-9-77 (1 day)	2 & 4-9-77 (2 days)
8.	Ganga	Ghaighat Ballia	19-8-76 (1 day)	12 to 23-9-76 (12 days)	..	1 to 16-8-77 (16 days)	19 to 23-9-77 (5 days)	3, 5 & 13-8-77 (3 days)
9.	Yamuna	Delhi Bridge	2 & 3-8-76 (2 days)	20 to 8-76 (7 days)	8 to 14-8-76 (6 days)	28 to 29-7-77 (2 days)	14 to 17-9-77 (2 days)	3, 5, 13-8-77 (3 days)
10.	Yamuna	Auriya	..	..	..	..	..	..
11.	Yamuna	Hamirpur	..	..	..	..	..	..
12.	Yamuna	Chillaghat (Banda)	..	..	..	..	..	..
13.	Yamuna	Naini (Allahabad)	..	..	..	..	..	..
14.	Gomti	Ghaighat (Lucknow)	..	..	..	..	..	..
15.	Gomti	Jaunpur	..	..	..	..	..	..
16.	Sarda	Paliakalan Kheiri	..	..	..	..	..	..
17.	Sarda	Sardanagar Kheiri	..	..	..	..	..	..
18.	Ghaghra	Katarnia Ghat, Baharaich	..	..	..	..	..	..
19.	Ghaghra	Elginbridge Barabanki	19 to 28-8-76 (10 days)	11-9-76	..	..	17-7-77	14 to 16-9-77
20.	Ghaghra	Ayodhya	..	..	..	..	..	..
21.	Ghaghra	Turtipar Ballia	20 to 31-8-76	..	..	..	19 to 22-8-77	29-8 to 4-9-77
22.	Rapti	Kakardhar	..	..	..	..	..	..
23.	Rapti	Balrampur (Gonda)	..	..	..	..	..	..
24.	Rapti	Bansi (Basti)	..	..	..	..	..	..
25.	Rapti	Birdghat Gorakhpur	..	..	..	..	..	..
26.	Burhi Rapti	Kakrahi	24 to 27-8-76	..	..	..	26-8 to 4-9-77	..
27.	Grade Gandak	Bhainsa	24-8-76	..	..	..	27 to 30-8-77	13 to 15-9-77
28.	Tons	Azamgarh	..	..	..	..	..	..

Sl. No.	Name of River	Gauge Ghate	Year 1978			Year 1980		
			Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)	Incidence of earliest floods (when the river crossed danger level)	Incidence of latest floods (when the river crossed danger level)	Incidence of other floods (when the river crossed danger level)
1	2	3	15	16	17	18	19	20
1.	Ganga	Hardwar	2 & 3-8-78 (2 days)	3-9-78	6 & 11-8-78 (2 days)	..	..	..
2.	Ganga	Narora D/S	5 to 16-8-78 (12 days)	5 to 7-9-78 (3 days)	29 & 30-8-79 (2 days)	3 to 12-8-80 (10 days)	..	..
3.	Ganga	Phaphamua	14 & 15-8-78 (2 days)	6 & 11-9-78 (6 days)	..	1 & 2-9-80 (2 days)	..	..
4.	Ganga	Chatnag	5 to 11-9-78 (7 days)	..	..	31-8 to 3-9-80 (6 days)	..	..
5.	Ganga	Mirzapur	..	..	..	..	..	..
6.	Ganga	Rajghat Varanasi	14 to 16-8-78 (3 days)	6 to 13-8-78 (8 days)	..	30-8 to 3-9-80 (6 days)	..	..
7.	Ganga	Ghazipur	..	..	..	12-8 to 5-9-80 (25 days)	..	..
8.	Ganga	Gaighat Ballia	9-8 to 1-9-78 (24 days)	4 to 6-9-78 (3 days)	..	7 to 21-8-70 (15 days)	27-8 to 13-9-80 (18 days)	..
9.	Yamuna	Delhi Bridge	11 to 12-7-78 (2 days)	2 to 10-9-78 (9 days)	19 days	..	..	..
10.	Yamuna	Auriya	7-9-78	..	..	..	..	..
11.	Yamuna	Hamirpur	6 to 8-9-78	..	..	..	..	..
12.	Yamuna	Chillaghat Banda	5 to 9-9-78	..	..	29-8 to 2-9-80 (5 days)	..	..
13.	Yamuna	Naini (Allahabad)	14-8-78	6 to 11-9-78 (6 days)	..	31-8 to 2-9-80 (3 days)	..	..
14.	Gomti	Gaughat Lucknow	..	..	..	25 & 28-7-80 (2 days)	..	..
15.	Gomti	Jaunpur	..	..	..	4-8 to 15-8-80 (12 days)	22-9 to 1-10-80 (10 days)	17-8 to 20-9-80 (35days)
16.	Sarda	Paliakalan Kheiri	..	..	..	..	..	..
17.	Sarda	Sardanagar Kheiri	29-8-78	..	..	..	..	..
18.	Ghaghra	Katarniaghat Bahraich	19-7-78	..	..	..	..	..
19.	Ghaghra	Eliginbridge (Barabanki)	4 to 17-7-78 (14 days)	27 to 30-8-78 (4 days)	..	10-7-78 (1 day)	3 to 10-9-78 (8 days)	18-7 to 18-8-80 (31 days)
20.	Ghaghra	Ayodhya	..	..	..	6 to 10-8-80 (5 days)	..	..
21.	Ghaghra	Turtipar Ballia	20 to 22-7-78	28 to 31-8-78	..	21-7 to 21-8-80 (32 days)	24 to 26-9-80 (3 days)	26-8 to 1-9-80 4 to 15-9-80 (19 days)
22.	Rapti	Kakardhari	17-7-78	..	..	..	..	..
23.	Rapti	Balrampur Gonda	17 to 19-7-78	..	..	..	..	..
24.	Rapti	Bansi (Basti)	19 to 22-7-78	..	..	..	..	..
25.	Rapti	Birdghat Gorakhpur	21-7 to 31-8-78	..	..	26 to 30-9-80 (5 days)	..	..
26.	Barhi Rapti	Kakrahi	17 to 25-7-78	8 to 11-8-78	30-7 to 5-8-78	..	..	..
27.	Grade Gandak	Bhainsa	17 to 18-7-78	..	..	1 & 2-8-80 (2 days)	7-9-80 (1 day)	2-9-80 (1 day)
28.	Tons	Azamgarh	..	..	..	11 to 25-9-80 (15 days)	..	..

ANNEXURE 2·4

FLOOD PERIOD IN DIFFERENT AREAS OF WEST BENGAL

Year	Period of Flood in River	Station at	MONTHS					
			JUN.	JUL.	AUG.	SEPT.	OCT.	TOTAL
1	2	3	4	5	6	7	8	9
	TEESTA	DOMOHANI						
1980								
1979								
1978								
1977								
1976			10	8	6			24
1975			7	10	4			21
1974			9					9
1973								
1972								
1971			17	12	5		5	39
	TEESTA	CORONATION						
1980			8	3	1	1		13
1979				11		2		13
1978			5	3	1	1		10
1977			1	4	12			17
1976			1	2	6			9
1975								
1974			5	21	8	4		30
1973								
1972			1	7	1	6		19
1971			1	5				6
	TORSA	GHUGUMARI						
1980								
1979				2				2
1978								
1977								
1976								
1975				1				1
1974			1				1	
1973			1				1	2
1972				1				
1971								
	JALDHAKA	ROAD BRIDGE N.H. 31						
1980			1	9	2	4		16
1979				16	9	9		34
1978			8	20	10	7	1	46
1977					3	2	1	6
1976			10	3	4			17
1975								
1974				3	1			4
1973			2					2
1972				1	1			2
1971								

N.B. Flood period shown in days in the Columns for months.

ANNEXURE 2·4—*Contd.*

1	2	3	4	5	6	7	8	9
	MOHANDNDRA	FULBARI						
1980				1				1
1979				1		1		2
1978								
1977					1			1
1976			1					1
1975				1				1
1974				2				2
1973				1	2			3
1972				1	2			3
1971				1				1
	MAHANANDA	ENGLISHBAZAR						
1980								
1979								
1978								
1977								
1976								
1975								
1974					6			6
1973								
1972					26	26		52
1971								
	GANGA	MANIKCHAK GHAT						
1980					2			2
1979					31	26		57
1978					21	6		27
1777					13	16		29
1976					16	14		30
1975					31	6		37
1974				2	21			23
1973								
1972								
1971				9	31	23		63
	GANGA	NURPUR						
1980				12	31	19		62
1979				3	8			11
1978					17	18		45
1977					20			20
1976					11	14		25
1975				3	20	14		37
1974					19	4		23
1973					13	20		33
1972								
1971				8	31	22		61
	BHAGIRATHI	BERHAMPORE						
1980								
1979					5	7	1	13
1978								
1977								
1976								

ANNEXURE 2·4 — *Contd.*

1	2	3	4	5	6	7	8	9
1975								
1974								
1973								
1972								
1971					31	21		52
	BHAGIRATHI	KATWA						
1980								
1979								
1978						2	11	13
1977								
1976								
1975								
1974								
1973								
1972								
1971					9	30	14	53
	CHDRNI	HANSKHALI						
1980					5	30	4	39
1979								
1978						13	26	39
1977								
1976								
1975								
1974								
1973								
1972								
1971					23	30	13	66
	AJOY	KATWA						
1980								3
1979								
1978				1	2	12		15
1977								
1976								
1975								
1974								
1973								
1972								
1971					12	18	11	41
	JALANGI	SWARUPGANJ						
1980						5	26	31
1979								
1978						22	30	22 74
1977					10	23		33
1976								
1975								
1974								
1973							7	2 9
1972							7	2 9
1971					2	31	27	60

3. CROPPING STRATEGY

3.1 According to the Government reports, 40 million hectares of land are generally liable to flood in the country. Of this, only 10 million hectares have so far been provided with reasonable flood protection measures. For geographical or seismic reasons, extensive areas in the flood plains of the Ganges and the Bramhaputra river systems continue to remain chronically flood prone. There are also situations where changes in river courses and avulsions make the river flow over land, outside its natural channel and flood extensive areas. This is witnessed generally in the Adhvara group of rivers in north Bihar and in the deltaic region of coastal Orissa. For these reasons, most of the chronically flood prone areas lie in the five States of Uttar Pradesh, Bihar, Assam, West Bengal and Orissa. In some of the worst flood years, large cropped areas have been affected by flood in these States. For instance, during 1976-78 block of years, the cropped area affected by flood aggregates on the average to 41.05 lakh hectars annually for these States. At the constant prices, the crop damage suffered has been valued at Rs. 7860.01 lakhs (National Flood Commission Report, 1980, Vol. I page 62). Such magnitude of flood damage to cropped area in these States keeps the conditions of the local farmers backward and unstable. Crop damages occur due to both breaches and other causes. The flood damage analysis for the year 1978, for two subdivisions of Cuttack district of Orissa, reveals that breaches accounted for 40 and 60 per cent respectively of the total damages (including crop damages). An appropriate cropping strategy has, therefore, to be adopted in these States for the chronically flood prone areas. The obvious pathways would be to popularise suitable flood escaping or flood tolerant cropping systems or intensifying crop production with irrigation in the flood free months there. Keeping these in view the Committee has dealt with some of the cropping strategies and sequences for chronically flood prone areas of these States in the following paras.

UTTAR PRADESH

3.2 Annual floods inundate the riverine areas to varying depths along the perennial rivers of the State. These flooded areas are locally known as 'Khadir Land in the Western Districts and 'Diara Land' in the eastern districts of the State. According to the report of the Technical Committee on 'Diara' areas in Uttar Pradesh and Bihar, Government of India (1972), about 15.41 lakh hectares of Diara land lie along the rivers like Ganga, Yamuna, Ghaghra, Sarda, Ramganga, Gomti and Kalinadi and occur largely in the districts of Ballia, Ghazipur, Allahabad, Farukhabad and Etah. With reference to the river channel and the location, the 'Diara Land' has been classified as (i) river bed 'Diara' (ii) main land 'Diara' and (iii) upland 'Diara'. The river bed 'Diara' with fine sand to course sand deposits generally becomes available for cultivation from December or January to June, until the rains. Extensive cultivation of cucurbits (melons, bottle gourds, pumpkin etc.) and other vegetables is practised here by taking land on lease and irrigating the crops by low lift irrigation from the river. Lying along the banks in varying widths, the main land 'Diara' gets frequently flooded during the rainy season. Thereby standing crops suffer heavily. Next in contiguity lies the 'Upland Diara' in the land side, which has risen in elevation due to earlier alluvial deposits and is less frequently flooded. Hence people practice normal agriculture in upland 'Diara' The flood free period in 'Diara' land ranges from 3 to 10 months, the period being shortest in river bed Diara where preparatory tillage starts in January. On the main land 'Diara' the flood free period, extends from October/November to June. The 'Upland Diara' land practises normal agricultural except in the exceptionally high flood years when this land gets flooded.

3.3 On main land and upland 'Diara', sole crop of cereals or crop mixtures with cereal and pulses or cereal and oilseeds are raised under rainfed conditions. In 'Rabi' season, mixtures of wheat and mustard, barley and gram, barley and 'Khesari' are popular. 'Khesari' and Lentil are also raised as sole crops. During 'Kharif', mixture of maize and jowar are grown, using early maturing varieties of 60—70 days duration. These crop mixtures are so chosen as to harvest them before the major floods. The State Government recommends 'Madhukar' and Chakia-59 varieties of paddy for kharif cropping in situations where flood submergence or water logging is experienced upto about a week. At some locations like the 'Karanda' 'diara' in the district of Ghazipur, intensive cropping in flood free months is becoming popular with irrigation facilities. The concerned State Departments and a limited number of land owners have taken to direct pumping of water from the river or tubewell irrigation for such cultivation. Farmers here, are using 5—10 Horse Power diesel engines and low capacity pumping sets for lifting water from the neighbouring stream or river. The pumping installations are, of course, set up suitably over the high flood level to operate electric power. Although there exists a popular urge for intensive crop production in flood free months, with modern technology and irrigation water, the spread of this practice in 'Diara' areas has so far been limited. The Committee, therefore, advocates such intensive agriculture in flood free months with irrigation and an appropriate State programme for its spread may be taken up on a campaign scale.

3.4 Adequate research support needs to be provided to solve 'Diara' land problems. Suitable research projects should be taken up on crop and varietal improvement, efficient methods of village for timely operations, efficient use of irrigation water, pests and disease management etc. Organised marketing system to pick up the farm produce from the producers and fetch remunerative prices will go a long way to promote this cropping strategy.

3.5 Given such facilities, and subject to local requirements, the general cropping pattern for the chronically flood prone area should be (a) intensive

'Rabi' cropping after recession of flood water with irrigation and raising crops with improved varieties of wheat, potato, peas and mustard; (b) after 'Rabi' irrigated summer croping (Zaid) be practised, using suitable short duration varieties of summer maize, mung or paddy so as to harvest the crops before rains; and (c) 'Kharif' cropping, when taken up, mostly flood tolerant paddy varieties like Madhukar, Chakia-59 etc., may be adopted.

BIHAR

3.6 The 'Diara' land in Bihar constitutes the most flood affected areas of the State. These land aggregate to 8.63 lakh hectares (Report of the Technical Group Diara Area, 1972, Government of India) and occur in the sub-basins of the rivers Ganga, Gandak, Burhi Gandak, Sone and Kosi. Diara lands of Bihar are similar in character to those described earlier for eastern Uttar Pradesh. Based on their past experience with flood incidence and flood frequency local people practise a variety of cropping programme. In Ganga-Sone area, flood prone areas raise 'kharif-rabi' crop rotations of maize-wheat, jowar-barley, arhar-gram, paddy-mustard etc. In Gandak area, people follow annual rotations like maize-wheat, arhar-gram, deep water paddy-summer mung or jute. In Kosi area, popular rotations are paddy-wheat, early maize or black gram-barley. In these areas farmers are increasingly practising irrigated farming in flood free months. Shallow tube-wells and low lift direct pumping from surface water sources are popular with the local farmers. In Kosi area people are using bamboo tubewells for profitable cropping. For flood prone areas outside 'Diara' land a contingent crop plan similar to West Bengal may be adopted as is suitable to local conditions.

3.7 The various practices in the 'Diara' land can be applied to other chronically flood affected areas wherever suitable. In recognition of the above, the Committee is convinced that access to irrigation water is essential for promoting intensive crop production programmes during flood free months in chronically flood prone areas of Bihar. Some of the profitable irrigated cropping sequences in such situations will include (i) wheat, potato or other vegetables in 'Rabi' followed by short duration summer maize *or* (ii) 'Rabi' wheat or barley followed by short duration summer maize or (iii) sugarcane planted in September/October. Other rotations for unprotected flood prone areas may include wheat in 'Rabi' followed by paddy in Kharif for Kosi area. In Gandak areas wheat and gram or gram and mustard mixture followed by maize in kharif, maize and arhar mixture in kharif followed by standing arhar continuing in 'Rabi' are advocated. In deep water situations, deep water paddy may continue to pre-dominate in the existing locations, depending development of alternate farming systems for these areas. Adequate research support as advocated for 'Diara' lands in Uttar Pradesh holds good for Bihar.

ASSAM

3.8 All the districts of Sibsagar, Nowgong, Lakshimpur, Darrang, Kamrup, Goalpara and Dibrugarh in the Bramhaputra Valley experience large scale flood every year and suffer heavy damage to crops. Flood incidence has been observed to be worst near the confluence. The annual average of crop area affected by flood in Assam Valley has been reported to be 8.85 lakh hectares during the period 1971-78, while the maximum cropped area affected being 15.4 lakh hectares during the same period. These areas which are chronically flood prone may continue to lack adequate flood protection for long years to come. Hence there is an urgent need for restructuring the cropping programme to minimise crop damage and loss of production.

3.9 The National Commission on Agriculture in its report (1976) and National Commission on Flood (1980) have dealt with the topic of reorientation of cropping system for chronically flood prone areas. They have favoured a farming strategy which can escape and/or endure flood and emphasised on cultivation during the flood free months. The Committee also holds the similar view for restructuring the cropping strategy for such problem areas. In Assam Valley worst floods are experienced in the months of July and August, although in some years floods have been reported in early June or in end of September. In general, however, the cropping has to be restructured to avoid the months of July and August.

3.10 There are two kinds of flood situations obtained in the Assam Valley. They include the one experienced in the low lying areas and the other experienced in the riverine areas when flood flow spills over the bank. In low lying areas, over land run off from the nearby areas and spill from the natural stream channels, starts entering in May and June and stands there upto depths ranging from 1 to 5 meters till October and November. Locally they are known as shallow water areas if the water depth is 1-3 meters and deep water areas when water depths are 3-5 meters. In the riverine areas, floods in June damage the standing crops of 'Ahu' paddy and jute. In case of early sown jute, the plant is tall enough to escape loss. Floods in July and September are very devastating as they seriously affected the 'Sali' paddy which is the main kharif crop and accounts for more than 75 per cent of paddy area in the valley.

3.11 Recognising the flooding pattern occuring in the riverine areas, the appropriate cropping strategy would be to raise early 'Ahu' paddy from February to June, followed by late transplanted 'Sali' paddy, from September to December. However, farmer's acceptance of this strategy hinges on the availability of irrigation water for early planting of Ahu and for saving the 'Sali' paddy from moisture stress in the valley for year round surface flow irrigation due to topography, the ground water resources appear to be abundant. It is indeed reported that in most parts of the valley ground water is available within a few meters of the surface and offers great scope for exploitation at fairly low cost. There is already an awareness of the State Government for such a strategy to improve crop production with irrigation and minimising flood losses. The Department of Agriculture has included in its programme the popularisation of early Ahu paddy followed by late transplanted 'Sali' paddy among farmers. The Department of Irrigation is implementing a World Bank funded scheme for extending low lift irrigation and shallow tube-wells with which one can assure at least one good

crop for the farmers during the flood free months. In appreciation, therefore, the Committee advocates that steps should be taken to popularise an irrigated cropping programme of early 'Ahu' paddy or jute, in the pre-flood season, followed by late 'Sali' paddy or 'Rabi' wheat, mustard or pulses in the post-flood season. The State efforts in the direction need to be intensified using available high yielding varieties and technology.

3.12 In the low lying deep water areas, farmers raise crop mixture of 'Ahu' and 'Bao' paddy. When Ahu paddy is damaged by flood, 'Bao' paddy takes over and is harvested in November or December. Otherwise both the paddy crops are successfully harvested. Where the depth of water is shallow 'Asra' paddy is chosen as the companion crop. Suitable 'Asra' paddy varieties like Saila Badal', 'Dhala Badal' etc., are popular. For 'Bao' paddy, varieties like 'Kekoa Bao', 'Negheri Bao' etc., are recommended. Nevertheless, the modern technology of paddy cultivation has not yet benefited the deep water paddy culture and there is no break through yet is deep water paddy cultivation. More intensive research has to be undertaken on deep water paddy.

3.13 However, an alternate pathway to improve production from such land would warrant systematic development of deeper areas as organised water bodies for acquaculture and use the same water as supplementary irrigation source for intensifying crop production in the remaining peripheral areas when properly drained. Recognising its merit, the Committee considers it would be worthwhile to test the economic viability of this concept by undertaking a few operational pilot projects in the State before its large scale adoption.

WEST BENGAL

3.14 In the 1971-78 block years, the cropped area affected by flood has been an annual average of about 4.66 lakh hectares. During the same period, the maximum cropped area affected by flood in a year has also been stated to be as high as 13.3 lakh hectares. These are indeed, extensive crop areas affected by annual floods which cause heavy loss.

3.15 In recognition of the annual flood problem, the State Department generally keeps ready with contingent or alternate croping plan. The State advocates the strategy of raising of short duration varieties of maize, jute (Corchorus capsularis), till, mung etc. early enough so as to harvest the crop before flood. Also community nurseries are organised to keep seedlings of paddy varieties (like IR-20, IR-26, IR-30, NC-1281 etc.) ready for transplanting in flood affected areas when water recedes by July or before the end of August. For September floods, late transplanting has been recommended with overaged seedlings (60-80 days old) of paddy varieties like Jagannath, CR-1014 etc. which are harvested with good yields at the end of December. Alternately short duration black gram and mustard are raised before seeding the irrigated wheat variety of Sonalika. However, after October floods raising of irrigated wheat, unirrigated gram, lentil or oilseed as suitable to the locality is suggested. In view of their merit, our Committee endorses these contingent crop plans and alternate cropping.

3.16 In recent years, where irrigation is available, cultivation of summer paddy (Boro), followed by wheat in 'Rabi' is increasingly gaining popularity in the State. As a result, there is a demand now for more shallow tubewells, low lift points etc. With availability of irrigation water, profitable vegetable cultivation will also benefit the farmers. Hence, the Committee supports such a cropping strategy with irrigation in the unprotected flood prone areas.

ORISSA

3.17 The coastal deltas of the river basins of Mahanadi, Brahani, Baitarani and Subarnarekha experience recurring flood, water logging and saline inundation. In consequence, extensive crop areas are damaged in the coastal districts of Puri, Cuttak and Balasore. According to the crop damage analysis made by the National Commission on Flood for the period 1955-70, on the average, the affected crop area accounted for about 40 per cent of the State's total area, annually affected by flood. However, during the seventies this figure has since gone upto 54 per cent. Hence the Committee urges the restructuring of the cropping during flood free months for flood prone coastal Orissa. It is, however, hoped that the future programmes envisaged for a dam at Bhimkund (Orissa) in the Baitarni basin and at Chandil (Bihar) in the Subarnarekha basin, will substantially moderate flood and reduce flood damage in the north eastern parts of coastal Orissa.

3.18 In general, agriculture in Orissa, means raising of paddy. It occupies more than 70 per cent of all cropped area in the State. In the coastal areas, paddy is virtually the only crop grown in 'Kharif' (June-January), which corresponds to South-West Monsoon as also the major flood period in the State. In its report, the National Commission on Agriculture has dealt in detail with the statistics of rice production according to seasons. It has been identified that three crops of paddy are raised in Orissa during the period namely (i) February-May, (ii) June-September, and (iii) October-January. Their comparative spread and yield in the State is given below:—

*Area and yield levels of paddy in Orissa**

Season (based on sowing period)	Area as per cent of State's paddy area	Yield	
		As per cent of all India Yield	As per cent of overall State Yield of Orissa
1	2	3	4
February-May	12	49	60
June-September	83	80	98
October-January	5	198	241

*Source : Report of the National Commission on Agriculture 1976, Part VI, page 57.

The above data clearly brings out that the performance of paddy sown in February-May and in June-September is poor. Former suffers from moisture stress and rains at harvest while the latter is affected by flood. The October-January sown crop of paddy, though covers only upto 5 per cent of the State's paddy area, is practically free from flood and performs best. The season is comparatively cloudless and favours increased photo-synthetic efficiency for better yields. Given the irrigation facilities from November onwards, all efforts should be made to expand paddy area in the October-January season. The Committee advocates this strategy in the flood prone coastal of Orissa.

3.19 The cropping strategy for the flood prone coastal Orissa may follow similar lines as advocated earlier. Using suitable crops and varieties available today, a cropping plan to intensify production in flood free months, or to escape flood damage, has to be developed. As earlier advocated, the success of such a strategy depends on the availability of irrigation water. The Committee, therefore, reiterates its recommendations that immediate steps should be taken to increase irrigation facilities in the flood prone areas. Given the irrigation facilities, we advocate for July-August flood prone situations early jute followed by paddy from October to December. After the paddy crop, a short duration 'Rabi' crop of pulses or oilseeds may be chosen. If floods occur in September and October, damaging the standing rice, 'Rabi' crops like wheat, groundnut or soyabeen may be raised with irrigation while under irrigated conditions alternate crops like sesamum, mustard, rape, linseed may be chosen. In the saline coastal areas, paddy is the main 'kharif' crop and salt tolerant varieties like Hamilton, Getu etc., are advocated for highly saline conditions. In moderate saline situations, paddy varieties like Patnai-23, OC-1391, SR-26-B, Kumangore etc., are recommended.

Crop research and deep water paddy

3.20 Intensive research, carried out in the country by the scientists of the Central Rice Research Institute, Cuttak, Agriculture Universities etc., and elsewhere on paddy, now offers newer varieties and technology suitable for flood prone areas. Photo-Senstitive high yielding varieties like CR-1009, CR-1011, CR-1018, Pankaj and Jagannath can successfully be grown in rainfed, shallow and intermediate water-logged areas (15-50 cm water depth). For recurrent flood areas, flood resistant varieties like FRG-7, FRG-8, BR-13, BR-14, FR13A and FR-43B are recommended. Where semideep (50-100 cm) flood water conditions are experienced, rice varieties like CR-1030, CR-260-30, CR-260-31 etc. would be the suitable varieties. Floating rice varieties like Jaisuria, CNDW 332, 327, 326 and 325 have shown great ecological adaptability and are recommended for deep water areas.

3.21 In short, it may be stated that suitable crop varieties are available today. The Committee advocates the restructuring of the cropping, which can escape or tolerate flood damage in the flood prone areas. For popularising such a cropping strategy, it is reiterated that steps should be taken to make available irrigation facilities in such areas.

3.22 Deep water situations occupy large areas in chronically flood prone tracts of Uttar Pradesh, Bihar, West Bengal, Assam and Orissa. Some 2-3 million hectares account for such areas, where local farmers raise deep water paddy or floating paddy. Almost 25 per cent of these areas experience deep water conditions, more than 50 cm. water depth. In rest of the areas water depth is less than 50 cm. Due to management difficulties, deep water paddy produces low grain yields ranging from 0.5 to 1 tonne per hectare. Such factors as (i) dependence on monsoons, (ii) low yield potentials of local varieties, (iii) grain shattering habit of varieties, (iv) poor management practices including pest management are a few of the major production constraints, responsible for low yields of this crop. Scientific research works carried out so far have been mostly in the field of varietal improvement. As a result, a number of improved varieties are now available like (a) BR-14, BR-15, BR-46 for deep water situations in Bihar and (b) for shallow water or water logged conditions, latisal, Patnai-23 in West Bengal, Manoharsali in Assam and T-141 in Orissa are popular, varieties like FR-13-A, FR-43-B of Orissa (in Bihar BR-13 and BR-49) are reported to withstand complete submergence upto 10 days. However, in the Gangetic plains, there are situations where paddy crop remains submerged about 20 days during the flood season of July-September. Suitable varieties are to be evolved to tolerate long periods of complete submergence under these conditions. Some of the crosses involving semidwarf varieties and local floating paddy have yielded promising results with 15-50 per cent increase in yield. Nevertheless there appears no break through in deep water paddy cultivation. In view of the importance of deep water paddy in the flood prone areas and the formidable problems faced for attaining any break through in its production, the Committee strongly advocates intensification of scientific research on deep water paddy on priority basis.

4. IRRIGATION STRATEGY

The chapter on cropping strategy for chronically flood-prone areas already described the different types of cropping patterns to be adopted in such areas. It has been suggested that by and large this strategy for such areas should be for flood escaping or flood tolerant cropping systems and intensifying crop production with irrigation in flood free months.

4.2 Chronically flood-prone areas have been defined as areas having (i) flood frequency of at least once in three years (ii) flood duration of about seven days period at a stretch (iii) flood depth of more than the standing paddy at that time and (iv) flash floods with strong current liable to uproot the plants even if the duration is less than seven days.

4.3 Even-though flood-prone areas in different States have been broadly identified, the areas which are chronically affected by floods have not been scientifically demarcated. It is, however, known that such areas lie mostly in five States of Uttar Pradesh, Bihar, Assam, West Bengal and Orissa. Irrigation strategy in the chronically flood areas will depend on their geographical location, and availability of water resources during the flood free months.

4.4 In the chapter on cropping strategy, the chronically flood affected areas in different states have been broadly indicated. It is important to mention that Khadir lands and diara lands are fairly well identified in different states referred to above. Generally such lands which are in the vicinity of rivers have a fairly high water table and it is possible to arrange for irrigation by tapping ground water through wells, shallow tubewells which have to be covered or sealed during the monsoon season when there is high flow in the rivers with consequent submergence. The other alternative for the areas which are in the fringes of the dry weather flow line of the river can be irrigated by providing river lift pumps and the distribution can be arranged by portable aluminium or flexible polythene pipes which can be removed before floods inundate the areas. In either case the pumps and motors have also to be portable and have to be removed during the high flow of the river. In fact, to meet the requirements one set of pump and motor can be utilised by rotation for a number of such tubewells. Location of such tubewells have to be decided after ascertaining the area to be irrigated by each unit. So far as the khadir lands are concerned it may be possible to provide overhaul electric transmission lines which may not get affected during the flood season. So far as the island diaras are concerned and the khadir areas where the submergence during flood season is high, diesel sets have to be preferred even though the cost of pumping will be higher. This is suggested because it would be very costly to take the electrical transmission lines nearer the river edge with high submergence and also across the rivers to supply power to the lands. Also power supply to these areas tend to be highly unstable and unreliable.

4.5 A typical case of a large island diara near Patna which is known as Raghopur diara is inhabited by a large population. These people sustain themselves on whatever crop they can grow during the flood-free season. They have been demanding bamboo tubewells which are cheap structures so that they could irrigate their lands during the dry part of the Rabi season and the summer season. These tubewells are quite cheap to construct and with portable pump sets a number of such tubewells can be operated with one unit of pump set. Similar situation prevail also in other diaras and similar solutions will apply.

4.6. Apart from the khadir areas and the island diaras there are several other pockets in the States referred to above where water stagnates in the natural depression even after flood season for a long time and no crops are grown. The chaurs of North Bihar and the "Beels" in West Bengal are typical examples of such areas. In earlier plan periods the chaur drainage schemes were undertaken in North Bihar which provided for drainage channels from the chaurs to the nearest natural stream with anti-flood sluice provided at the outfall so that when the outfall river level drops after the monsoons the chaurs could be drained during the months of October and November to allow rabi crops to be grown in the areas rendered free from water. The experience is that even though the moisture availability is there in the earlier part of the rabi season after the drainage has been effected, once the chaurs dry up completely there is no scope to grow summer season crop. In such areas a strategy to retain some water in the natural depressions for providing lift irrigation during the later part of the rabi season and during hot weather season should be considered. If part of these chaurs are deepened and isolated by wire netting and retain water, even inland fisheries and water plants which command good market can be developed. It may also be possible to carry canal water for irrigating lands rendered floodfree during Rabi and summer seasons if there is any major, medium or minor surface irrigation scheme operating in the relatively higher areas in the neighbourhood. The distribution arrangements can be made from the nearest canal water course either through portable pipes or through underground pipe system which may remain undisturbed during the floods. Such irrigation will provide gravity flow to the areas rendered free from floods for Rabi and hot weather crops in and around natural depressions. Drip irrigation with portable polythene pipes through which water could be pumped during the Rabi Season and hot weather season would also be suitable for proper distribution of water. Portable sets of aluminium pipes with fittings for sprinkler irrigation which are readily available could also be tried with economy in the distribution and consumption of water.

4.7 Wells could be sunk in the areas which are rendered flood-free after the monsoon months which

should be normally covered during the period of submergence and can be used for irrigation purposes with manual or animal operated devices as well as with portable pump sets to lift water from the wells. The covering of the mouth of the wells is necessary to prevent chokage during submergence in areas where it would not be possible to build the structure of the well with crest above the flood level.

4.8 In West Bengal many channels keep on flowing after the monsoon season even after the lands are rendered flood free. To raise boro paddy or wheat the farmers are used to put up kucha bundhs across the flowing channels to impound water and lift the same for irrigating the areas. The system is very crude and adversely affects the regimes of the natural streams or the drainage channels. Instead of putting up, temporary earthen bundhs, if a systematic programme of construction of sluices with gates are drawn up and construction undertaken, perhaps the purpose will be better achieved and during the monsoon season the gates can be kept opened to allow flood water to pass freely.

4.9 In Assam there are many small tributaries of the Bramhaputra which carry perennial flow. A system of lifting water during the Rabi and summer season is already in vogue in some parts of the State. This programme should be accelerated.

4.10 As has been stated in the chapter on cropping strategy for chronically flood affected areas, in Orissa the coastal deltas of Mahanadi, Brhamani, Baitarani and Subarnarekha experience recurring floods, water logging and saline innundation. Principal crop grown during Rabi and hot weather seasons is paddy but there is need for irrigation. They hydrogeological studies have revealed that good quality ground water is available at varying depths which can be harnessed mostly through deep tube wells. These can also be provided with portable pumpsets and distribution pipes. The latter may also be underground concrete pipes with outlet valves which can be closed during flood season. The well mouths have also to be sealed during floods, wherever scope exists the same may be tried. The inland low lying areas which get water-logged during monsoon season can also be tackled in the manner to be adopted for chaurs in North Bihar.

4.11 In some flood affected areas in these States there are abandoned river channels where water accumulates during the monsoon season which can be harnessed through lift pump for the purposes of irrigation during the flood free months.

4.12 So far as areas subjected to flash floods are concerned, the same strategy of tube wells, wells and river lifts can be considered with similar portable arrangements for pumps, motors and distribution system for providing irrigation during Rabi and hot-weather seasons. In such areas it is not advisable not to try any crops during flood periods.

4.13 Farmers in the chronically flood affected areas are generally economically weak and it is important that they are provided with necessary credit facilities (long, medium and short term) to enable them to go in for irrigation arrangements of the type suited to a particular situation and also to procure other essential inputs. Subsidies for small/marginal farmers would be desirable. State responsibility for supporting small farmers for minor irrigation should be there.

4.14 The strategy of adopting suitable cropping pattern coupled with provision of irrigation facilities and other essential inputs will lead to utilisation of extensive areas which mostly remain fallow even after the floods have receded. And even where crops are grown the yield is very low due to lack of moisture.

5. MEASURES TO MITIGATE FLOOD DAMAGES

5.1 It is fully realised that absolute immunity from flood damage is not physically possible even in the distant future because of unpredictability of several natural forces which might cause unprecedented situation. Even so, with proper planning and continuous effort we can certainly look forward to an appreciable diminution of distress with an accelerated implementation of flood management measures.

5.2 The Committee has already stressed that the measures to mitigate flood losses need to be part of a comprehensive scheme wherein modifications of floods, reduction of damage susceptibilities to infrastructure and property and bearing the loss are looked at in an integrated fashion. These have been viewed mainly as physical methods of protection from floods. This Committee agrees with the suggestions of the R.B.A. (Rashtriya Barh Ayog) that all types of measures, physical or otherwise, have to be considered for flood management. These may comprise physical, biological, economic, social and administrative such as soil conservation and afforestation reservoirs, embankments, drainage channels, dredging, flood plain regulatories, flood forecasting and warnings, emergency measures etc. The Rashtriya Barh Ayog report has given comprehensive treatment to engineering and other aspects of flooding whereas the prime concern of the present report is with the aspects affecting the chronically flood affected areas only. Broad endorsement of the relevant recommendations of the R.B.A. is there and wherever necessary modifications and additional recommendations have been highlighted.

Upper Reaches Control

5.3 There has been a controversy as to whether watershed management (sometimes described as flood abatement) or flood protection is the more efficient adjustment to floods. This has come to be referred to as the "up-stream & down-stream" controversy or the conflict between "big dams and little dams". On the one side are those who argue that the best way to deal with floods is to control them where they form. They suggest that deforestation and devegetation are major causes of floods and so the most appropriate course of action is to plant trees in the place of those that have been cut down, to improve vegetative cover in areas subject to soil erosion and to phase out farming practices that contribute to such erosion. They see dams as a means of controlling run-off but feel that these are most effective in the headwaters rather those down-streams. They point out further in this connection that up-stream reservoirs are less likely to take out of production agricultural land or forest land. On the other side are those who believe that the most efficient way to deal with floods is to control these where they are likely to do most damage. They point out that it takes several small reservoirs in the up-stream region to do the work that one large reservoir further down-stream may do. They also argue that the contribution of programmes of reforestation and conservation to run-off control may be insufficient to deal with flood problems. Big dams and various down-stream control works are seen as more effective alternatives. This Committee feels that Flood abatement measures up-stream and control measures down-stream are not necessarily alternatives. These should be considered as complementary components of an overall programme adjustments to floods. A typical case relating to Howai River Basin is given in Annexure 5.1.

5.4 In India the overall storage capacity created in all the river basins, as indicated by the R.B.A. accounts for hardly a tenth of the average annual flow. In terms of utilisable quantity of surface water resources, the per cent utilisation is estimated to be nearly a fourth.

5.5 Moderation of spectacular variations in the flow of water, can be had through the increasing provisions of storage in natural lakes, artificial reservoirs, soil mantle and underground acquifers.

5.6 Erosion causes destruction of fertile land. Torrents get widened over time and through damaging or eroding fertile land affect the streams as well as reservoirs adversely due to much of silt inflow. Satellite photographs and available topographic maps have been utilised to study the widening of torrents in the shivalik range in U.P. The data gathered for four point times and different rows in the interval of seven years shows an overall average 15 per cent increase in the width of rows. The satellite photographs were taken on the 14th of November, 1972, 8th of May, 1974, 13th of April, 1977 and on 21st of April, 1979. The details of the estimated measure width are indicated in the following table:—

Table : *Estimated measured width (in meters) at the level of* 1972

Name of row	14-11-72	8-5-74	Annual increase from 72 to 74	13-4-77	Annual increase from 74 to 77	21-4-79	Annual increase from 77 to 79	% of increase of width in 7 years	% of annual increase in width
1	2	3	4	5	6	7	8	9	10
Badhsahi bagh	125	150	10%	225	17%	300	17%	140%	20%
Badkela	500	750	25%	875	6%	1000	7%	100%	14%
Shakumbhari	450	500	5%	600	6%	775	15%	72%	10%
Khajanavar	375	550	23%	775	14%	875	6%	134%	19%
Mohand	125	225	40%	250	4%	300	10%	140%	20%
Total	1575	2175	19%	2725	12%	3250	9%	106%	15%

Source : Data worked out by Shri P.N. Gupta, Project Director, Land Survey Directorate, Uttar Pradesh.

5.7 Generally the satellite photograph is about 80 × 80 metres and as such may not yield very precise idea of the measurement. Taking full account of such like aspects it may be said that the width would not increase by less than 10 per cent per year. The impact of such denudation on adjoining areas can well be realised.

5.8 The Committee would like to recommend that full potential of the Landstat Imagery be utilised to know precise details is about the behaviour of various upper reaches in the country. This technique provides a greater degree of flexibility than the maps obtained from traditional sources Aerial photographs afford this possibility but in that case a much larger number of prints have to be handled and transfer of interpreted details on to maps for terrain with extremes of altitudinal variations is a problem. Small scale maps with full details of river systems and with so much of accuracy are extremely difficult, if not impossible, to get by another method.

5.9 Expert handling of interpretation and map making from the imagery alongwith survey in conjunction with photo interpretation of aerial photographs, can greatly facilitate in the preparation of actual afforestation and watershed management plans. The Committee recommends that full potential of the repetitive imagery data be exploited by analysing the same with the aid of electronic computer. Along side the inherent knowledge about the local conditions would greatly facilitate in carrying out the whole process efficiently and expeditiously towards the good of the community welfare.

5.10 The availability of data about the effect of soil conservation measures is rather very limited in character. However, even that limited data do provide some useful clues. The data, already quoted by the R.B.A.. is given in the table that follows:

Table—*Effect of soil conservation measures on sediment discharge in Bhakra and Ramganga basins**

Reservoir	Catchment area (000 ha)			Sediment yield (ha.m/ 100 Sq. Km.)			
	Critical	Treated	% of critical area treated	Assumed	Original	Observed	% reduction
Bhakra	557	126	23	4·3	6·9	5·2	25
Ramganga	104	42	40	4·3	22·0	16·8	23

*Source: Tecd. Bull, Soil & Water Conservation in the catchment of river valley projects, Soil Cons. Dte. CWC (G.P. Gupta).

5.11 The above figures show very conclusively the desired effect of soil conservation measures. Specially in the case of Ramganga one notices that 40 per cent of the critical area got treated leading to 23 per cent reduction in sediment yield. The committee would like to recommend and emphasise the importance of undertaking extensive soil conservation measures. These measures of providing vegetative and forestry cover to help in modifying the floods and controlling the run-off. The moderation of run-off would directly help the chronically flood affected areas. For reduction of run-off, the Committee would also like to recommend (i) prohibition of production in the hilly catchment; (ii) contour bunding in hilly catchment; (iii) construction of flood detention reservoirs; (iv) small check dams on the tributaries to delay run-off to point of concentration; and (v) elaborate arrangement for flood fighting arrangements at vulnerable points with adequate support of flood forecasting and warning thereof.

5.12 Some steps have been taken towards afforestation, though much more needs to be done to arrest the trend towards denudation and to reforest these areas. Intensification of these measures will serve to reduce the amount of sediment entering the river systems. Part of the afforestation drive should be devoted to horticulture at suitable lower altitude, fruit orchards could not only arrest erosion of soil but also provide livelihood to many.

5.13 The Committee would recommend the construction of a number of smaller flood retention reservoirs of suitable capacity on or near each river, by excavation if necessary. This will serve to regulate the ferocity of flash floods down-stream of these reservoirs. The retained flood waters in various reservoirs can provide ample water supply during the dry season. Discharges from these flood retention reservoirs can also be used for power generation using low-head water turbines, the water in the tail races being used to augment the levels in the river or remote reservoirs as required.

5.14 The upper reaches management can be most effective on a watershed management basis. However, at times a judicious choice between conflicting alternatives has to be made. For instance, watershed may serve either for low flow augmentation or flood reduction. Rarely both the aims can be satisfied simultaneously and a decision regarding the importance of one or the other has to be made in a given situation. The challenge can be rightly met by deciding about the trade-off, between the two alternatives, through the technique of cost benefit analysis.

5.15 Any individualistic attempts at soil conservation measures may not yield the effective results. The whole watershed needs tackling in totality by the Governments and the individual farmers should be made to work within the prescribed norms. In consonance with the overall objectives, any financial needs of the individual farmers should be satisfactorily backed by governmental agencies.

5.16 Watershed measures can serve as a useful complement to the protective measures to be adopted lower down the stream. Besides, it would help in encouraging the increasing use of flood-prone areas. **Herein, the Committee would like to recommend that the programme, like that in case of flood protection, need to encompass the measures which temper increases in the flood loss potential.**

Maintenance of Embankments

5.17 Embankment construction has been one of the age old method of reducing flooding. The Committee agree that the object of remedial measures of the protection of a chronically flood affected area should be to train the rivers on their way to the sea by constructing protective embankments, judicious drudging flood escapes etc. After the devastating floods of 1954 about 10,000 km. of embankments have been stabilised (covered up) in various river basins in the country. While these have been providing reasonable protection to large population, breaches have been too many causing severe damages to the areas in the neighbourhood. One of the main reasons attributed to such frequent breaches has been found to be inadequate maintenance. The VIIth Finance Commission had gone into this question and had made the following recommendation which this Committee fully endorses.

"The Department of Irrigation have indicated that in the last couple of decades, the funds provided for the maintenance of flood control works in most States were inadequate, with the consequence that embankments breached often, leading to substantial damage to life and property, and also to large expenditures on repairs and restorations of the works, rehabilitation of the people affected, etc. Ministers' Committee which reported in March, 1972 had recommended that the annual provision for maintenance of embankments and drainage works should be 4 to 5 per cent of the capital cost worked out to the price levels of 1972, and 5 to 13 per cent in the case of river-training and anti-sea erosion works. That Committee found that in fact about 0.5 per cent of the capital cost was being then spent on the whole for maintenance of these works. The Sixth Commission provided 4 per cent of the capital invested at the end of 1973-74 for the maintenance expenditure for flood control works. The Central Water Commission have now stated in a communication to us that there are about 10700 km. of embankments and 18700 km. of drainage channels constructed till March, 1978, apart from anti-sea erosion works and river training works. They have indicated the norms of maintenance expenditure for different kinds of works, observing that a uniform percentage of the capital cost would not be appropriate. The Department have suggested that earthen embankments would need between Rs. 7,000 and Rs. 10,000 per km. annually at current price levels during the first 3 years and between Rs. 5,000 and Rs. 7,000 thereafter. On current costs of construction the Department has worked out that these norms would be 3 per cent of the capital cost initially and 2 per cent thereafter. Armoured embankments are stated to require annually from Rs. 5,000 to Rs. 7,000 per km. For drains, broadly classified into three categories by capacity, the norms of maintenance suggested by the Department are Rs. 1,000 per km. (upto 200 cusecs capacity), Rs. 1,500 per km. (upto 500 cusecs capacity) and Rs. 3,000 per km. for capacities above 500 cusecs. On the basis of these norms, the Department have roughly estimated that the annual maintenance costs would be Rs. 15 crores for all flood protection works in the country. The actual expenditure as seen from the accounts, was over Rs. 23 crores in 1976-77, but this figure probably includes special repairs as well as reconstruction after damage by floods, which are not included in the calculation of the annual costs done by the Department.

In the light of the above, we have estimated the annual requirements for maintenance of flood control and drainage works, and anti-sea erosion works, taking into account the physical data from the Central Water Commission and the States, the maintenance norms suggested by the Department of Irrigation, the actual expenditure in each State in 1976-77, and such data as are available in the budget documents and the finances accounts of the States".

Drainage

5.18 Properly maintained drainage system can help to reduce the intensity and duration of flooding considerably. At times the improper and inadequate maintenance of the channels gets aggravated with the presence of obstacles in the nature of embankments on roads, railways and canals and the people's indiscipline. The importance of preparing a comprehensive plan of action, as already emphasised, assumes greater strength in the context of drainage management. The Committee would like to emphasise involvement of all the concerned authorities/agency which would be responsible for clearing all construction works in the flood plain areas and would thus avoid cross-purpose strategies.

5.19 The Committee would like to highlight the maintenance of drainage by dredging and utilisation of the material thus dredged for filling up the hollow areas on the other side of the embankments. It would also like to recommend that the maintenance of major/medium drainages wherever maintained by Revenue Department, must be taken over by the Irrigation Department.

5.20 The Committee, while endorsing the comprehensive treatment of the subject by the R.B.A., would like to re-emphasise and recommend the following measures:—

1. There is need for closer coordination amongst concerned agencies like the Railways, National Highways, State Irrigation/Flood Control Departments so as to ensure that structures like bridges, roads, railways etc. do not aggravate flood problems.

2. Prior consultation by National Highway authorities, State P.W.Ds and Railways with the State Irrigation/Flood Control Departments should be made obligatory. To facilitate an expeditious check, the Government of

India should evolve a guideline/checklist for the purpose of vetting of waterways by the State Irrigation/Flood Control Departments.

3. It should be mandatory that assessment of adequacy of existing waterways should be made by the State Committee of Engineers or some other Technical Board and the waterways for bridges to be constructed in the future should be vetted by the State Irrigation/Flood Control Department.

4. The Standing Committee for settling disputes on waterways and sharing of costs, headed by the Chairman, Central Commission, should be vested with statutory powers for implementation of its decisions.

5. The State should undertake legislation to prevent unauthorised river bed cultivation and encroachments into drains etc., and where such laws already exist, the enforcement agencies should be strengthened. Cultivation of crops like water-melons, vegetables, etc. in river beds and berms, may however, be allowed with caution. The practice of cultivation in the abandoned beds of Dhars which discharge into main rivers should be stopped.

6. Where suitable legislation with a penal clause for unauthorised crossings over drains has not been enacted, the same should be done and enforced.

The Committee would recommend that flood relief channels should be constructed at suitable points to drain excess of flood water to remote artificial lakes; these should also be provided towards the downstream end of enlarged channels to carry away surplus water to other artificial lakes. The flood relief channels can be used as feeders for minor irrigation canals.

Sanding/Silting

5.21 Chronic floods, quite apart from causing the loss of life and property, carry heavily siltladen water down to the estuaries. The silt, instead of being a most useful—agent in soil fertilisation merely serves to clog the water channels.

5.22 The amount of sediment/silt in certain basins is quite high and its entrapment and removal has not been attempted to any significant length and the resultant benefits have not been availed of in the process.

5.23 Embankments are provided with sluices opening both ways. These are to drain out water from the countryside to the natural stream where the water level of the latter so permits. The other purpose contemplated was to let in some silt laden water in a controlled way to the countryside to provide fertilising silt and also to maintain continuity in the natural land building process, though in a somewhat limited manner. Unfortunately these sluices have not functioned properly and there are no foolproof methods laid down for operation of these sluices to serve both the purposes. The Committee would recommend a complete review of the operation of these systems of sluices for drawing up a necessary operational manual for the same.

5.24 In the absence of objective data on the behaviour of river beds during and after floods conclusive ideas on the subject are rather difficult to form. To get some concrete ideas about the problem the Committee got a study through the Government of Orissa. The study has been confined to the Mahanadi, Kathajori, Kuakhai and Surva rivers and has considered comparable eleven cross-sectional points. The data reveals practically stability of bed levels. The details of the exercise can be seen from the following table:—

Generalising the behaviour of river beds from above would be rather risky and the Committee would recommend the undertaking of similar exercises for the various river systems so as to have an in-depth understanding of the problem. Such an understanding would greatly help in devising judicious remedial measures.

5.25 During high floods the spillage of water over the banks sometimes creates the problem of sand casting in the agricultural fields. The paucity of data inhibits in making any objective ideas about the problem. The Committee would like to recommend undertaking of studies whereby assessment of the problem in the right perspective can be had.

5.26 The problem of sand casting, beyond a limit, is quite harmful for the crop growth. The Committee would recommend the initiation of scientific studies on the subject so that suitable crop planning can be devised.

Protection of Human Settlements

5.27 Floods in their wake even with low intensity, cause intolerable distress for the human settlements and more so in rural areas. The houses get damaged as these generally lack a strong ground floor structure and also do not have a high foundation.

5.28 To ward off the ill effects to human settlements, strengthening of house structures, raising the level of the whole villages or ring bunds around villages have been considered as the possible alternatives. Each of these alternatives have their positive and negative aspects.

5.29 The rural houses, facing flood fury, are generally made of materials which cannot withstand greater degree of stresses and strains. In the event of raising pucca structures the damage susceptibility can be considerably reduced. But the great majority of the owners of these houses belong to the poorer sections of the society and cannot afford the needed cost. A single pucca room with a loft or with an additional room on the first floor of each house can save the inhabitants from shifting during flooding. Even the affording of this much cost appears to be beyond the means of the significant segment of the affected lot. Left to the natural play of forces implementation of such like ideas are not likely to materialise in foreseeable future. The alternative appears to

COMPARATIVE STUDY OF CHANGES IN BED OF MAHANADI RIVER SYSTEM FROM NARAJ TO JOBRA WEIR AND NARAJ TO OFF TAKE SAURA (FROM 1899 TO 1979)

Sl. No.	Name of River	Cross Section No.	Location of Cross Section	Year	Average river level in ft.	Year	Average river level of bed in ft.	Rise or fall	Remarks
1	2	3	4	5	6	7	8	9	10
1.	Mahanadi River	1 M.	At 2604 ft. U/S (Along River Course) of Jobra Weir	1899—1900	62·05	1971—72	61·55	Fall in 1971—72	0·50 ft.
2.	Do.	2 M.	At 4950 ft. U/S (Along Course) of Jobra Weir	1899—1900	65·03	1971—72	66·67	Rise in 1971—72	1·59 ft.
3.	Do.	3 M.	At 12540 ft. U/S (Along Course) of Jobra Weir	1899—1900	66·91	1971—72	67·26	Rise in 1971—72	0·35 ft.
4.	Do.	4 M.	At 32340 ft. U/S (Along Course) of Jobra Weir	1899—1900	70·23	1971—72	71·15	Rise in 1971—72	0·92 ft.
5.	Do.	5 M.	At left end of Naraj Weir	1899—1900	74·17	1971—72	67·08	Fall in 1971—72	7·09 ft.
6.	Do.	6 M.	At right end of Naraj Weir	1899—1900	59·70	1971—72	60·09	Rise in 1971—72	0·39 ft.
7.	Kathajori River	1 K.	At 4620 ft. D/S (Along river Course) of Naraj Weir	1899—1900	66·67	1975—76	75·00	Rise in 1961—62	8·33 ft.
8.	Do.	2 K.	At 25740 ft. D/S (Along river Course) of Naraj Weir	1899—1900	63·30	1961—62	64·00	Rise in 1961—62	0·70 ft.
9.	Do.	3 K.	At 33000 ft. D/S (Along river Course) of Naraj Weir	1899—1900	64·13	1961—62	59·00	Fall in 1961—62	5·13 ft.
10.	Kuakhai River	4 Ku.	At 40000 ft. D/S (Along river Course) of Naraj Weir (3000 ft. inside Kaukhai)	1961—1962	69·39	1979—80	70·68	Rise in 1979—80	1·29 ft.
11.	Surua River	5 Su.	At 47800 ft. D/S (Along river Course) of Naraj Weir or (10000 ft.) D/S of Kathjori Railway bridge) (in river Surua).	1961—1962	56·54	1978—79	54·00	Fall in 1978—79	2·54 ft.

be in provision of public funds for achieving the desired ends. Considering the magnitude of the problem in the areas liable to normal flooding, the whole proposition does not seem to be feasible. However, in case of chronically flood affected areas the magnitude of the problem might be in the realm of practicability and hence adoption. The Committee would like to support such a scheme in areas where alternatives are not found to be feasible. In case of its adoption strict enforcement would be desirable as otherwise additional numbers in the hope of receiving doles for construction may get settled in affected areas.

5.30 Raising of villages as a whole offers another alternative to mitigate the hardships of human settlements. Raising the present site of the village is not feasible straightaway without wholesale demolition of the existing structures. Moving the whole village to a new higher site would involve construction of new structures altogether. Without liberal support from public funds the proposition can rarely succeed.

5.31 Some inherent contraditions have been noticed wherever the scheme of village raising has been attempted. Generally with the raising of the villages, roads etc. have been raised as well and no proper allowance for drainages etc. has been made. This has rather led to aggravation of the flood situation. The Committee would recommend that in case of raising of villages, roads should not be raised correspondingly so as to avoid any interference with drainage aspects. The roads may be allowed to get submerged during floods. Availability of country boats in sufficient numbers would be able to solve the problems of the chronically flood affected areas during that spell.

5.32 Construction of ring bunds around the villages or human settlements is another way which has been experimented at certain places. The major drawback of the scheme has been noticed in the draining out of the water from within the settlements. Pumping out the water has been visualised as one of the possibilities. The Committee would support such a scheme in the even cost-benefit favouring the same in comparison to other alternatives. The Planning Commission had suggested that instead of putting up raised platforms to provide shelter for people living in villages which get marooned during floods resulting in loss of human lives, and who also get affected by various types of epidemics during the post flood period, it is preferable to excavate tanks at suitable points in the villages, utilise the excavated earth in putting up embankments all around sufficiently wide to provide shelter to the marooned villages. At the same time the tanks so formed would collect good water from rains and provide the villages with safe drinking water during floods when water all around get pulluted.

5.33 The Committee would recommend that structural changes and land elevation wherever undertaken by individuals or groups, should be encouraged and suitable monetary and other assistance be provided keeping in view the overall policy objectives. It is well recognised that structural changes and land elevation for human settlements do tend to encourage persistent occupancy of chronic flood affected areas. At the same time they do offer, however, a means of reducing potential losses and they do place part of the burden on the flood plain occupants.

5.34 The Committee would recommend strict regulation of land use in the chronically flood affected areas. Such a measure brings in its fold some distinct advantages. The most important among them being that it encourages careful weighing of the costs against the benefits of flood plain occupancy. Along side it forces consideration of the relative advantages of being in the flood plain as against the location elsewhere and leads to a valuable complement of other types of adjustments in the nature of emergency action. flood-proofing, structural changes and flood control. The Planning Commission has already provided for soil conservation and afforestation measures in the upper catchment of flood prone rivers in the Sixth Five Plan (1980-85). This programme will require to be implemented on sub-watershed basins after identifying the critically affected ones. Effective implementation of this programme will require building of inter-disciplinary teams for each of the basins. The pace of the programme will have to be accelerated along with effective measures to prevent deterioration of new areas. The Committee would recommend special efforts in this direction.

5.35 One of the approaches to the management of flood losses can be through modification of the incidence of burden. This can be achieved either by spreading it over a larger segment of the society than that is immediately affected or by spreading it more evenly over time. The modes of such measures could be through disaster relief, land revenues exemptions and other taxes, write-offs and other emergency measures. In all these measures naturally governmental role has to be of prime importance. Disaster relief, while warding off the immediate distress, encourages certain attitudes which need to be deplored. There is a tendency to consider relief measures as a right rather than a charitable gift. This in turn tends to remove the incentive to avoid future flood losses and encourages persistent human occupancy of the flood plain. The Committee would recommend that effective measures in that direction need to be comprehended.

5.36 Effective steps should be taken to train and organise local volunteers in fighting flood hazards due to threatened breaches in embankments and also to utilise effective steps to plug the breaches as and when the same occur.

5.37 On account of pressure of population it may not be possible to totally prevent flood plain occupancy even if there be a legislation for the same but the Committee feel that there should be a law to ensure that any building that is constructed should provide for a plinth above the normal flood level. In such areas provision of boats is a must to enable the marooned people to maintain communication with the unaffected areas.

Sd/- B. SIVARAMAN,
Chairman.

NEW DELHI,
12th November, 1981.

ANNEXURE 5..

Extracts of the report on Irrigation, Drainage and water management in China by Shri R.S. Saksena (pp. 14-17).

Hwai River Basin

"The Hwai is one of the China's major rivers along with the Yanglese and Yellow rivers is more than 1000 km. long. It has got 500 tributaries with an average drainage area of 100 km each".

"In the year 1931, the flood submerged 4 million ha. of farm land and affected 20 million people".

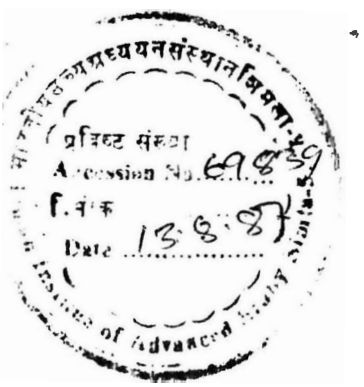
"Maximum emphasise was placed on flood control for which the following steps were taken:

(i) Reservoirs were built in the upper reaches of the main tributaries—35 big reservoirs and 5000 medium and small size reservoirs were completed with a storage of 23×10^9 M^3 in the upper reaches. In addition, work of afforestation and soil conservation was taken up in the areas.

(ii) In the middle reaches, the river courses were enlarged and full use was made of lowlying land for sharing the water. The flood deduction so made had a storage capacity of $28 \times 10^9 M^3$.

(iii) In the lower reaches, embankments were re-inforced and more channels were dug to provide increased outlet with a flood discharge of $22000 M^3/Sec$.

(iv) In coastal areas, embankments were built, dredging of channels and drains was taken up to control water logging. Drainage capacity was built for a standard frequency of draining 120-180 mm of rainfall in 3 days. New channels and canals were built for reducing water logging. Out of 8.7×10^6 ha. of low lying land, it has been possible to protect 4.7×10^6 ha. of land now, which has been transformed into paddy fields".



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