FLOODS IN MAHANADI RIVER BASIN, ORISSA (INDIA): A CRICITAL REVIEW

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ABSTRACT

The Mahanadi Delta in Orissa has experienced several severe floods causing huge damages to life and property. An analysis of earlier historic flood events clearly revels that even after construction of Hirakud Dam; the peak floods in the deltaic region are not reduced to a safe flood limit (24660 cumecs). The important reasons behind its inability to control floods at delta head are: (i) Hirakud intercepts only 58.9 % of the catchment leaving aside an area of 43820 sq km uncontrolled which contributes significantly to flood at delta, (ii) Hirakud is a multipurpose project, which provides benefits like irrigation and hydropower in addition to flood control and flood storage space is very limited. It is due to this, when there is heavy rainfall in the upstream catchment during the last part of monsoon (end of September), there is little space to accommodate high inflow into the reservoir, causing heavy releases from the reservoir. This release combines with downstream contribution (Tel and its tributaries) and creates flood havoc at delta. In addition, a study on historic flood events in Mahanadi Delta (1969 to 2011) reveals that 69% major floods are caused due to contribution from downstream uncontrolled catchment beyond Hirakud reservoir up to Munduli (head of Mahanadi Delta), 23% were jointly due to contribution from Hirakud and its downstream catchment up to Munduli and another 08% major floods were caused due to contribution from Hirakud releases only. This shows that contributions from uncontrolled catchments beyond Hirakud up to Delta alone is sufficient to create flood havoc at delta, even if there is zero release from Hirakud reservoir. Furthermore, the existing embankment system in Mahanadi Delta is capable of carrying only 24660 cumecs of flood (computed using software package HEC-RAS 4.0, 2008), against the highest flood peak experienced during last 50 years of 44785 cumecs. This shows the in sufficiency of existing embankment system, to carry the design flood.

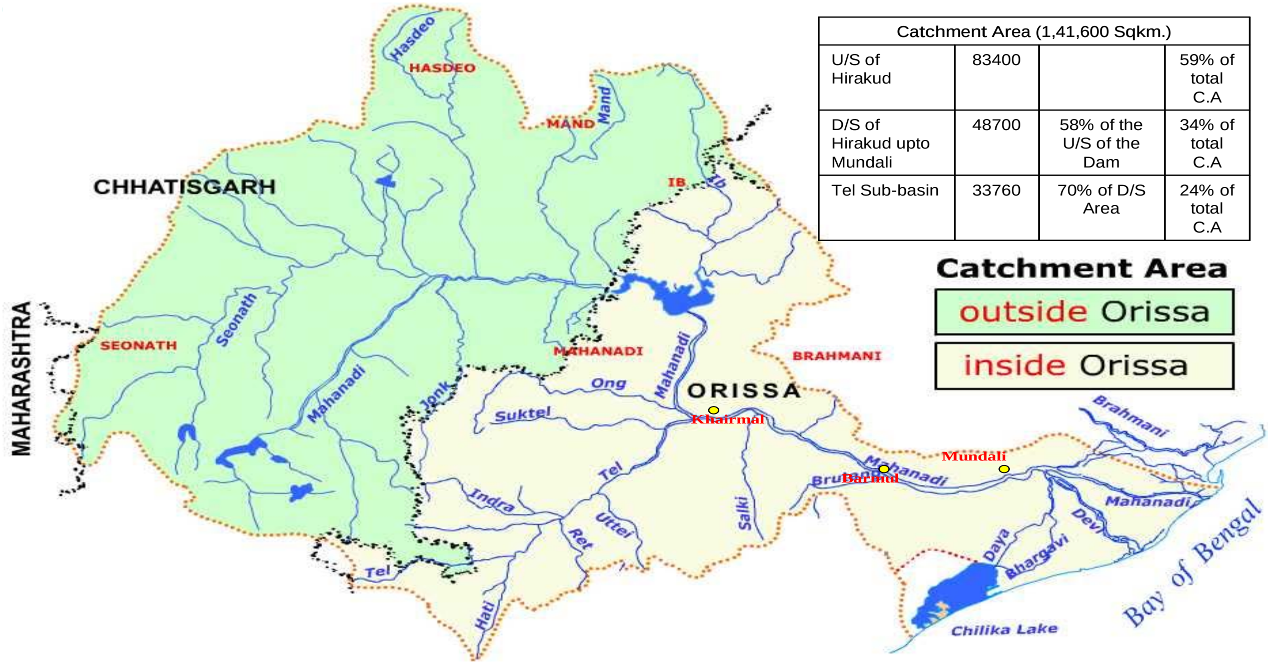
In the above context, this paper suggests, a technically feasible and financially acceptable Flood Management Plan (FMP) for the Mahanadi basin to bring down the flood to a manageable threshold (which in this case is the no-distress flood peak of 24660 cumecs at delta head). The suggested measures include among others a) construction of flood control reservoirs in the tributaries of Mahanadi with sufficient flood space, particularly in River Tel, which alone contributed 75% of flood peak at Mahanadi delta b) development of computer programs to optimally operate reservoirs to safeguard delta c) construction and strengthening of embankments and levees including channel improvement in deltaic region to increase its flood carrying capacity up to about 42500 cumecs d) use of updated techniques for accurate flood forecasting so that timely flood warning and evacuation process becomes possible e) preparation of flood plain maps and demarcation of flood plain zones to restrict any future development in the demarcated flood zones f) management of watersheds of Mahanadi catchment to reduce runoff and maximize ground water recharge, thus reducing the intensity of flood.

INTRODUCTION

Flooding is one of the costliest natural disasters in the history of India in general and Orissa in particular. Large numbers of severe and devastating floods, endangering both life and property have been recorded in Orissa. So far as Orissa is concerned, flooding is caused primarily due to the Mahanadi River. The entire deltaic region of Mahanadi River beyond Munduli Barrage intercepting a catchment of 48700 sq km (Mishra and Behera, 2009) gets affected by medium to severe flood almost every year causing immense loss to life and property. The problem starts when the flood at delta head of Mahanadi (Munduli) exceeds the safe limit of 24600 cumecs.

FLOOD SCENERIO IN MAHANADI SYSTE

In the context of flood scenario, the Mahanadi system can be broadly divided into two distinct reaches: (i) Upper Mahanadi (area upstream of Mundili barrage, intercepting a catchment of 132100 sq km) (Mishra and Behera, 2009, which does not have any significant flood problem (ii) Lower Mahanadi (area downstream of Mundili barrage, intercepting a catchment of 9304 sq km). The key area downstream of Hirakud up to Munduli intercepting a catchment of 48700 sq km is mainly responsible for flood havoc in the deltaic area of Mahanadi. Figure 1 shows the details of catchments of Mahanadi Basin inside and outside of Orisssa and Figure 2 shows the schematic diagram of Mahanadi lower reach beyond Munduli up to Bay of Bengal respectively.



Catchment Area (1,41,600 Sqkm.)			
U/S of Hirakud	83400		59% of total C.A
D/S of Hirakud upto Mundali	48700	58% of the U/S of the Dam	34% of total C.A
Tel Sub-basin	33760	70% of D/S Area	24% of total C.A

Fig 1 Details of Catchments of Mahanadi System inside and outside of Orissa

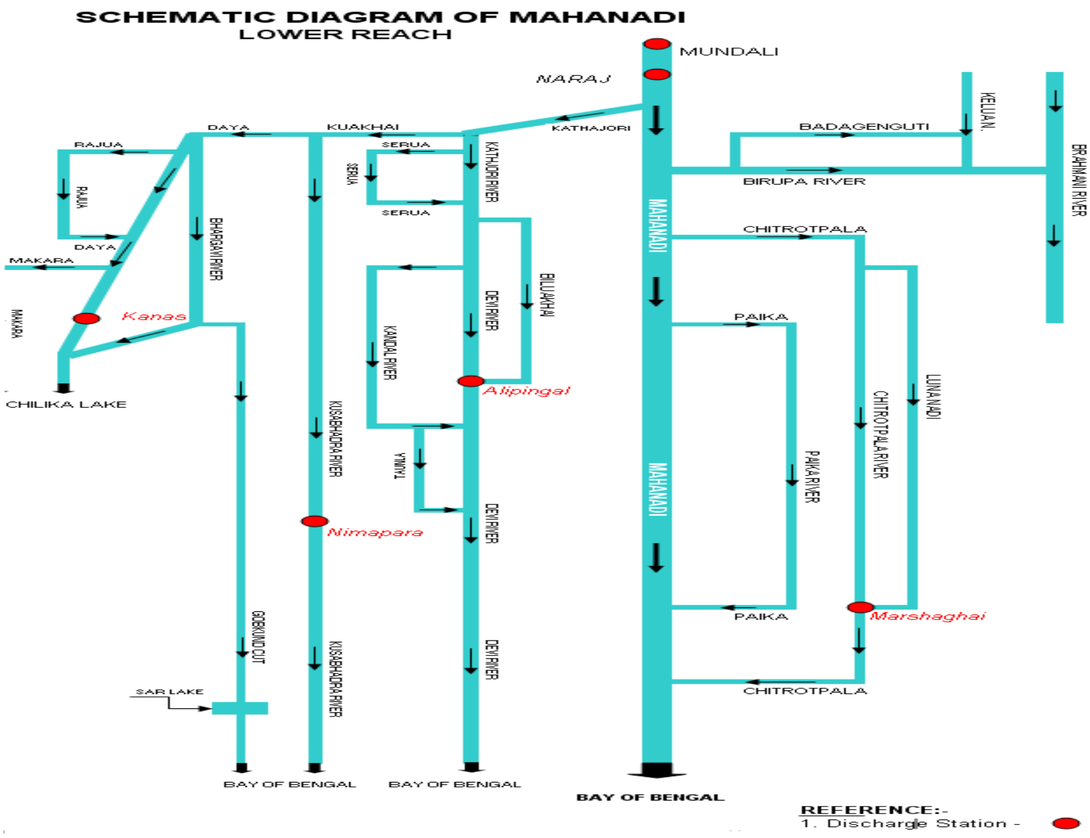


Fig 2 Schematic diagram of Mahanadi Lower Reach beyond Munduli up to Bay of Bengal

Historic Floods of Mahanadi Basin

The Mahanadi basin has experienced many historic floods. Among others the floods of 1855, 1933, 1937, 1955, 1980, 1982, 2008 and 2011 were highly severe and devastating and had caused huge damage to life and property. The most recent severe floods recorded after independence was in 2008. During this flood the peak observed at Munduli was 44775 Cumecs (Flood Buletin, 2008) against the capacity of existing embankment system to carry 24800 cumecs (78% excess).

CONTRIBUTIONS FROM DAM/DOWNSTREAM CATCHMENTS TO PEAK FLOOD AT MUNDULI

A critical study on historic flood events in Mahanadi Delta (1969 to 2011) reveals that 69% major floods are due to contribution from downstream uncontrolled catchment beyond Hirakud reservoir up to Munduli (head of Mahanadi Delta), 23% are jointly due to contribution from Hirakud and its downstream catchment up to Munduli and another 08% major floods are caused due to contribution from Hirakud releases only (Mishra and Behera, 2009). This shows that contributions from uncontrolled catchments beyond Hirakud up to Delta alone is sufficient to create flood havoc at delta, even if there is zero release from Hirakud reservoir. This is due to the fact that Hirakud intercepts only 58.9% of the catchment leaving aside an area of 43820 sq km uncontrolled which contributes significantly to flood at delta. Table 1 shows the peak release from dam, peak contribution from uncontrolled catchment and corresponding peak flood at delta head.

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Table 1 Peak Release from Dam, Peak Contribution from Uncontrolled Catchment and Corresponding Peak Flood at Munduli

Flood Event (date/year)	Peak Release from Hirakud Reservoir	Peak Contribution from Uncontrolled Catchment Beyond Hirakud up to Munduli	Peak Flood at Delta Head at Minduli
Sep 19-30,1980	32011	3966	35977
Aug 30-Sep 6,1982	15694	29178	44873
Aug 12-21,1991	6516	29490	36006
Jul 8-Aug 2,1992	6487	25637	32125
Aug 16-30,1992	14788	17110	31898
Jul 8-19,1994	20765	8244	29009

Aug 6-11,1994	16232	14391	30623
Jul 25,1995	9235	16572	25807
Jul 14-22,2001	24186	15718	39904
Aug 25-Sep 15, 2003	24979	13254	38233
Sep 16-25,2008	7030	37745	44775

ROLE OF HIRAKUD RESERVOIR

Hirakud Reservoir is a multipurpose project, which provides benefits like irrigation and hydropower in addition to flood control. Hence and flood storage space available in Hirakud is very limited and very often dedicates this space to balance the conflicting needs of irrigation and power against flood control. It is due to this, when there is heavy rainfall in the upstream catchment during the last part of monsoon (end of September), there is little space to accommodate high inflow into the reservoir, causing heavy releases from the dam. This release combines with downstream contribution (Tel and its tributaries) and creates flood havoc at delta. Notwithstanding this deficiency, the Hirakud dam very often plays an admirable role in preventing the catastrophic floods in Mahanadi delta.

EMBANKMENT SYSTEM IN MAHANADI DELTA

The existing embankment system in Mahanadi Delta is capable of carrying only 24660 cumecs of flood (computed using software package HEC-RAS 4.0, 2008), against the highest flood peak experienced during last 50 years of 44785 cumecs. This shows the insufficiency of existing embankment system, to carry the design flood.

EXISTING FLOOD CONTROL MECHANISM AND ITS DEFICIENCIES

At present the existing flood space in Hirakud reservoir is sufficient to moderate inflow flood only during early monsoon. However, during end part of monsoon (end of September) reservoir is operated considering the damage causing potential of flood hydrograph with an eye to: (i) safety of dam (ii) safeguard delta area (iii) travel time of flood between Hirakud to delta head (iv) contribution from uncontrolled catchment from dam to Munduli. However there is a need to update the reservoir operation process using latest softwares/computer programs..

Contribution from uncontrolled catchment from dam to Munduli alone is capable of producing a flood peak of 42520 cumecs against the no distress flood peak of 24800 cumecs at delta. However, no flood control reservoirs with reasonable flood space are constructed in the catchment downstream of Hirakud to moderate down stream contribution.

Existing embankment system and levees in Mahanadi delta are not at all sufficient to carry 50 years flood of 44785 cumecs, which requires improvement.

Live storage capacity of Hirakud reservoir is further getting reduced from 5818 MCM (million cubic meter) in year 1956 to 4823 MCM in year 2000 (Pattnaik, 2009), because of sedimentation, which needs improvement.

SUGGESTED MEASURES FOR FLOOD MANAGEMENT IN MAHANADI BASIN

In the above context, a technically feasible and financially acceptable sound Flood Management Plan (FMP) can be suggested for the Mahanadi basin to bring down the flood to a manageable threshold (which in this case is the no-distress flood peak of 24660 cumecs) at delta head. Then suitable protection measures for (i) protection of agricultural lands and villages (ii) protection of communication network (iii) measures against health hazards (iv) construction of flood shelters (v) management of watershed (long term) can be taken in to consideration.

Flood protection measures can be broadly classified into two categories: (i) structural measures (ii) non-structural measures.

The structural measures that can be suggested as a part of FMP includes

- Construction of new flood control reservoirs and completion of ongoing reservoirs in the Mahanadi system with sufficient flood space, particularly in River Tel, (contributes 75% of flood peak at Mahanadi delta), can be taken up to avoid down stream contribution to delta. A computer based flood moderation system can also be developed to moderate reservoirs to safeguard delta.
- Available flood space in the Hirakud reservoir (4345 MCM) (Das, 1998) may be increased reasonably to accommodate the design flood volume during end part of monsoon.
- Accumulated sediment (995 MCM) needs to removed to accommodate flood and also to increase the live storage capacity of the reservoir

- Existing embankment system and levees in Mahanadi delta which are not at all sufficient to carry 50 years flood of 44785 cumecs needs improvement and strengthening.
- Long term measures such as management of watershed to maximize ground water recharge and reduce runoff in the uncontrolled catchment needs to be paid importance.

The non-structural measures that can be suggested include:

- Mathematical models for flood moderation in reservoirs including Hirakud needs to be developed to balance the conflicting needs of irrigation and power against flood control.
- Preparation of Flood Plane Maps (Inundation Maps) using RS & GIS may be taken up to speed up early warning system and to speed up advance evacuation system.
- A mechanism for reliable real time flood forecasting can be suggested, which can help a great way to give early warning to the administration.
- Long term measures such as Management of watershed to maximize ground water recharge needs to be considered

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