FEASIBILITY OF TAPTI BASIN FLOODS MODERATION WITH UPDATED TECHNOLOGY AND MANAGEMENT

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Abstract:

The paper analyzed present management approach as available from Literature, Practice and Press reports. The system is based on: **a)** prediction of daily inflow (CWC), **b)** processing of data and decision making (Gov. of Guj.), **c)** rules for operation of reservoir to meet specified objective. It does not permit scope for considering changes in environment, flood plane, drainage (due to urbanization), economic analysis of overall national loss against benefits and torture to 3 million people for a month.

This case study has established a better approach by **a)** availing weather forecasting (IMD Data), **b)** creating a single valley authority with panel of experts having overall responsibility, **c)** giving flexible guidelines and powers to deviate in emergency **d)** control / improve drainage in flood plane by valley authority **e)** create a specific power supply independent warning system for downstream area, **f)** minimize national loss.

The study shows disaster damages of 2006 could have be minimized by application of recommended concept and related R & D for data 1972-2006.

1.0 Introduction

City of Surat is located between Bombay - Ahmedabad on banks of river Tapti. Tapti River originates from Multai in M.P. It travels total 720 km through M.P., Maharastra and Gujarat to merge into Arabian Sea at Dumas. The total annual runoff is 12,000 MCM (assured flow for 75 % of years). Maharastra has been allotted 6,000 MCM quota for its use.

Gujarat has created reservoir at Ukai about 100 km upstream of Surat for storage of 8,600 MCM. The water is used by Left bank canal from Ukai and Left and Right bank canals from Kakrapar weir 20 km downstream of dam. The weir lifts and reuses the flow from 4 units of 75 MW capacity hydropower (6000 cusecs/unit of hydropower). The Ukai Left bank canal inlet is at RL 270' and administration is keen to keep Ukai reservoir at 342'.

2.0 Ukai Dam

The 4,052 m main dam is earthen with 425 m long spillway with capacity of 21 lac cusecs (59,000 cumecs). The spill way has 22 gates x 48'6" high. The FRL for dam is 345' (105.16 m) and MWL as per design is 351'. The top of dam is 361' (110 m).

River basin has catchment of 3,120 sq.mile in MP, 18,660 sq.mile in Maharasra and 8,490 sq.mile in Gujarat. This basin is fed by South West monsoon, North East rains / Storms (Ravin Tailor, 2006). There are 3 rain-gauge stations in M.P. (Teska, Ded Talai, Burhanpur), 12 in Maharastra and 2 in Gujarat. The Central Water Commission is responsible for gauge and discharge measurements upto Gidhade. Hathnur dam is 595 km upstream of Ukai. The flood measured at Hathnur is expected to reach Ukai reservoir in 24 to 36 hours.

The CWC sends anticipated flow forecasts before 12 hrs to Gujarat Gov. This includes overflow of water from weirs upstream. The runoff of 70 sq.km of Ukai reservoir and between Ukai and Gidhade (125 km upstream), which enters reservoirs in less than 10 hrs is unpredictable. The project planers have considered only 12 hrs time available to manage reservoir releases.

3.0 Functions of Ukai Dam

The planners envisaged following benefits from projects:

a) Firming up and extending irrigation in 2,27,530 ha under Kakrapar command,
b) Provide direct irrigation to 1,52,400 ha under Ukai canal from dam.
c) Generate power (4 x 75 MW turbines) 1060 million units every year in initial stages of irrigation utilization.
d) The reservoir will provide effective flood protection to areas lower down including Surat city. On receipt of warning about incoming floods from upper reaches, storage in reservoir will be depleted in advance by regulating outflow from reservoir. Such advance release will enable greater degree of flood moderation being achieved.
e) Fisheries
f) Plantation & Tourism centre

"The main objective of Ukai project was and is to obtain the optimum irrigation and hydropower through simultaneously it also helps to achieve partial control over effects of heavy floods (1974)". "The standard design flood of 17.5 L cusecs can be moderated by restricting outflow to 8.4 L cusecs and HFL of 351' in dam". This requires Ukai reservoir level of 339' or less till end of Aug. (1974)

In 36 years, use has been extended to water supply to city, villages and industry from Broach to Valsad.

The GOG claimed "During 1970, flood almost as large as 1968, was moderated considerably and heavy loss of life and property in down stream area of 827 sq.km was obviated. The proposed construction of flood embankments (Pala - 1971) on both banks of Tapti between Kathore and Surat will protect additional area of 230 sq.km. The Ukai reservoir and flood embankments will together protect 1057 sq.miles with result that rural population of 70,000 and 4,71,800 inhabitants of Surat city will be protected from floods.

The irrigation requirements, requires minimum storage (URL) of 330'. For running hydro for year URL 342' is required. Rule levels recommended by Task group are: August - 316.40' considering irrigation, 324.7' considering power generation and 333' considering conservation (poor monsoon) (Ref: Operation manual – 2000, Ukai dam). For flood moderation, maximum URL designed is 351' against full reservoir level 345'. By unknown reasons project authorities have unofficially operated reservoir with MWL as 345', inspite of certification that there is no damage to dam above 345'.

4.0 Floods in & around Surat

The Surat city and villages around are part of flood drainage of Tapti River. The river can contain about 6 L cusecs flood within banks in major areas of city and around. Since 1882, 8 & 16 floods are recorded in Aug and Sept months. Major floods 1933, 1959, 1968, 1970, 1998 and 2006 recorded floods of 9 L cusecs. The dates and trends of unit hydrograph for 1968 and 2006 floods in August associated with storm East to West.

River regime in Surat has capacity of 4 L cusecs within banks, 6.5 L cusecs corresponding to Hope bridge flood level 9.5 m is critical for floods in city and surrounding (1968). In general city is safe for floods upto 6 L cusecs and with proposed Pala it can pass flood of 8.5 L cusecs without major spills to city.

1968 floods of 15 L cusecs was worst and economically disastrous for flood plane. This forced new strategy based on CWPRS hydraulic model studies. The "Pala Yojna" (1971) has planned embankments upstream of Hope bridge to contain floods upto 8.5 L cusecs. The inaugural booklet states, "The scheme is vital for protection against floods to 77,000 acres", "The population affected adversely is estimated as 87,600 in 54 villages (1971). As explained earlier moderation at Ukai with Pala will obviate loss of life & property in 1051 sq.km with result that 90,000 rural population and 4,71,800 inhabitants of Surat will be protected from floods.

The fact that 1998 and 2006 floods, though lesser than 1970 have failed to fulfill benefits of project, research and analysis was undertaken to evolve strategy to prevent reoccurrence in future.

5.0 Runoff Pattern

Prima facie, the rainfall pattern, storm intensity, days of rainfall, characteristics of catchments such as forest - land use, construction of dams / check dams on tributaries in past 5 years due to severe draught in central Maharastra do not follow trends adopted by Ukai project planners based on data of pre 1968. Pending a total studies of hydrology and storms, effect of number of reservoir, old model must be stayed from forecasting runoff and pattern of daily inflow.

The total 25,000 sq.miles drainage basin with range of 30" to 96" per year rainfall in average 60 rain days per year indicate minimum of 600 to maximum 1700 MCM runoff per day. For August first week with rainfall of 60 mm/day on average in East & West Khandesh (23360 sq.miles catchment) predicts 2500 MCM runoff.

The detailed analysis of sub-basin model for Tapti catchment on day today basis with travel time to Ukai from 24 to 12 hrs can be worked out and calibrated for factual data of past floods. (1972 – 2006)

In short, commonsense simple assessment with factor of safety, gave 2000 MCM inflow in August 4 – 5th 2006. Monsoon 2006 was predicted as Normal by IMD hence to assume no rains in Aug, Sept, Oct is illogical and unscientific. The SW monsoon was late by 2 weeks. Data base of Meteorological Storm of 1968 Aug 2 – 7th (P.S. Pant 1968) predicts heavy inflow.

6.0 Reservoir Data

6.1 Large 8.5 Lac ha.m (almost same capacity as Bhakra) extending 112 km from dam has spread of 614 sq.km area. The storage for power for tail dam will be available till Maharastra utilized its quota. Some relevant approximate data is tabled below to understand characteristics and operations.

Table showing total storage capacity (Dead storage 860 MCM)

RL (Ft.)	Capacity (MCM)
331	5690
333	5940
340	6840
345	7500
351	8270

Table showing approximate flood cushion between different reservoir levels

Range	Flood Cushion (in MCM)
331'-345'	1800
331'-349'	2320
345'-351'	770
329.5'-345'	2000
336.5'-351'	2000

The Ukai Reservoir Level (URL) 330'and 334' are adequate for irrigation and power production for the year (CWC – Hydrology Organization, 2000). As per design estimates minimum level required in 1st week of Aug for irrigation and power needs is 324.7' only.

6.2 The reservoir operations have been dictated by a mannual giving storage level on each week considering irrigation & power requirements. This secret rule book prepared & revised since 1980 has following principles:

Before Aug 31st – URL below 339'

31 Aug to 30 Sept raise URL by 0.2' per day to reach 345'. It is understood that MWL in high floods will be 351' (designed). The press conference report shows that filling to 345' ill be attained after 1st Oct (PIL 1998 floods).

The partial flood protection to downstream areas the releases are to be moderated to 8.7 Lac cusecs (24620 cumecs) and in very high floods URL will be allowed to MWL 351' for short period. The data analyzed in Table below for 1998, 2001, 2002, 2006 shows clearly breaches of rule book to conserve more water thereby increase probability of floods downstream.

6.3 The data available for floods of 1998 is analyzed as under:

Date	**Max. URL* as per Rule Level (1979)**	**Actual observed URL***	**Outflow (not more than 7 L cusecs)**	**Inflow**	**Flood Level at Weir (Surat)**	**Flood Level at Hope Bridge (Surat)**
	in ft.	**in ft.**	**in Cusecs**	**in Cusecs**	**in mt.**	**in mt.**
15.09.1998 (2.00 pm)	342.00	**342.50**	4,00,000	4,84,000	-	1.8
16.09.1998 (2.00 pm)	342.20	**345.08**	5,30,974	9,01,234	12.1	9.6 (> 9.5)
16.09.1998 (11.00 pm)	342.20	**345.88**	6,98,200	-	12.5	**10.3 (> 9.5)**
17.09.1998 (6.00 pm)	342.40	**345.03**	3,05,864	1,49,774	13.8	**11.5 (> 9.5)**
21.09.1998 (11.00 am)	343.20	**345.49**	21,820	35,000	7.0	2.4
23.09.1998 (11.00 am)	343.60	**344.80**	2,30,130	2,95,000	9.2	5.3

* URL: Ukai Reservoir Level

The rule book level for data available shows:

a) Rule book is ignored in operations

b) Tendency is to conserve extra water even risking Ukai maximum RL 345' and Surat protection, Hope Bridge safe level 9.5 m.
c) If anticipating rainfall trends on 13 – 14 - 15.09.1998, rule level was violated to lower flood level by releasing floods upto 7 L cusecs gradually, Ukai reservoir will not touch 345'. Surat, Hope Bridge will also not exceeded danger level 9.5 m $\pm$ 0.5 m.

6.4 The rule level for year 2001 as per flood memorandum 2001 (NWR & WSD) (Pg - 26) flood control cell is as under:

S.No.	Name	FRL	Tentative Levels as on				
			01/07/01	01/08/01	01/09/01	16/09/01	01/10/2001
		in mt. (in ft.)	in mt. (in ft.)	in mt. (in ft.)	in mt. (in ft.)	in mt. (in ft.)	in mt. (in ft.)
34	Ukai	105.15	97.85	101.5	103.63	103.63	105.15
		(345)	(321)	(333)	(340)	(340)	(345)

(This reduced level may be result of PIL in High Court during 1998-99)

Following table is for year 2002 flood (Reservoir operation rule level 2001)

Date	Max. URL* as per Rule Level (2001)	Actual observed URL*	Outflow	Inflow	Flood Level at Weir	Flood Level at Hope Bridge
	in ft.	in ft.	in Cusecs	in Cusecs	in mt.	In mt.
03.09.2002	340.00	333.20	16,695	3,57,858	4.73	-
07.09.2002	340.00	**341.07** **	2,34,061	2,34,061	10.64	8.10
17.09.2002	340.20	**340.80** **	22,444	12,850	6.54	1.50

* URL: Ukai Reservoir Level
** Rule book violated for extra storage.

Here again rule book is not followed to conserve extra water. Ofcourse, the operations did not encounter high flood and hence Ukai level was less than 345' and level at Hope Bridge for flood protection was below danger.

6.5 Rule book memorandum 2003 is cited by some authorities, we could not lay over hands to the document. The rule level is prescribed for 1st July to 10th of Oct (daily) for conservation of flood. It does not prima-facie, consider safety of Surat (Maximum hope bridge level, RL: 9.5 m). Thus on 3rd Aug, a rule level of 333.45 is prescribed on basis of water requirements of irrigation & power and conservation.

The following table will indicate that even this rule book was not operative in 2006.

Date	Reservoir level as per rule book 2003	Reservoir level as per rule book* as operation manual cited by CWC	Actual Reservoir level in 2006
	in ft	in ft (in mt)	in ft
31st July 06	332.61	-	-
1st Aug. 06	333.00	333.00 (101.50)	331.54
3rd Aug. 06	333.45	-	**334.44**
5th Aug. 06	333.90	-	**335.42**
7th Aug. 06	334.35	334.85 (102.06)	**342.98**
10th Aug. 06	335.03	-	**345.17**
15th Aug. 06	336.15	338.30 (103.11)	336.14
20th Aug. 06	337.27	-	331.00
1st Sep. 06	340.00	343.00 (104.55)	-
1st Oct. 06	345.00	-	-

* The level prescribed by Chapter 9, Pg 137 – 215 of operation manual July 2000 as refered by CWC. It appears that this rule levels were probably revised to account for reduced flood capacity of river at Surat. These levels are also shown in table. In both cases of rule level, whatsoever is applied / valid on 3rd Aug. onwards, the tendency was to fill above prescribed level to store more water. Outflow could have been increased over the inflow to keep URL lower than rule book (333' / 332') as a special case when high storm intensity rain fall was reported in catchment by press on 3rd – 4th Aug. 06. Such advance release could have kept URL to be below 345' and floods released suddenly on 10.08.2006 to Surat would be nearer to safe limits (Hope level 10.0 to 11.0 m)

6.6 Though emphatically stated by Gov. in special petition 190/1974, Para 13 / pg 7 and Para 13 / pg 7 the 1235 MCM flood cushion for flood between FRL 345' and 351' has never been availed by releasing all incoming flow even higher than 8.7 L with Pala to Surat. Thus officially though, there is no danger to dam, MWL is now 345' only.

There are 28 years when Ukai reservoir never touched 345' out of 36 years and hence following rule book may not create crisis for irrigation and water supply. The state has to be prepared for non-availability of storage even for power with upstream use of allotment of resources (by say 2010 – 12).

The rule book with slight conservative approach, with storage loss for power, would have prevented disaster to Surat as explained latter. As rule book is not followed nor made transparent and operation since 1998 of reservoir indicates non-consideration of constraints of not releasing more than 6.5 L cusecs (Pala incomplete), it needs to be scrapped. The divided responsibilities of gauging, measuring inflow, forecasting of next day inflow, interpreting of direct rains in

reservoir, deciding the outflow by project authorities with approval of ministers (as per press reports) needs to be streamlined. The operations have to be transparent and responsibility assigned to a specific, say "Tapti Valley Authority". Authority will be decide and will be working with team of advisors of IMD, CWC, District Administrator of Disaster, Flood management local experts, representatives of affected citizens, HADA industries etc. During flood, video conferencing, open to public view by media, daily is recommended. This only can reestablish confidence in operative system. This approach can permit consideration of National economic loss against gains of irrigation & power by more storage by authority.

7.0 Ukai Reservoir Level History

Last 5 years levels of Ukai reservoirs are:

Year	Max. URL (Ft.)	Min. URL (Ft.)
2001	322.44	272.11
2002	341.26	280.95
2003	343.81	294.60
2004	331.95	288.76
2005	342.20	276.68
2006	346.30	

The URL maximum and minimum are 346.3' and 320' for years 2006 and 1985 respectively.

Thus URL not reaching FRL is common and likely to be permanent in future with upstream utilization by Khandesh of their quota.

8.0 Operations of Reservoir during Floods

As explained in functions of dam the inflow is moderated for flood by restricting out flow to 8.5 L cusecs and allowing FRL to touch MWL 351' (Para 3.0). Though 1970 flood of 15 lac cusecs operation, has protected Surat from floods (Para 3.0), system has failed to protect areas downstream in 1998 & 2006. The primary analysis shows overall intension to store more water for irrigation, power & water supply in recent years. Dam authorities tend to keep high storages at dams like Ukai for maximizing power generation (Indian express, News)

The flood cushion with MWL - 351' has never been availed by the project. The officials confirmed that dam is safe for design flood level. The panicky release high flood on URL touching 345' is unexplained and has led to phobia that dam is unsafe if flood level touches design maximum level of 351'. This revised mode of operation results in loss of 770 MCM of flood cushion. The rule book seems to have ignored this and guidelines of not filling reservoir above 340' till end of monsoon by Gov. High court (PIL 1998 flood – press conference report)

9.0 Floods 2006

The flood moderation requires following estimates / data,

(a) Initial reservoir level,
(b) Expected rainy days and expected runoff in catchment,
(c) Constraints of maximum outflow for flood control at Surat with Pala's incomplete,
(d) Minimum storage for committed irrigation & power,
(e) Powers to decide sacrificing one or two functions for overall socio-economical national interest,
(f) Maximum water level for the reservoir designed, safe and operational,
(g) Changes in hydraulics of flood channel since construction of dam,
(h) Changes in the environment of catchment basin – rain period, intensity of storms, deforestation of basin, land use and activities of storage / check dams,
(i) Loss of storage by silting.

In 36 years since completion of dam many of above parameters have been drastically changing irregularly every year. These parameters need continuous monitoring and analysis to evolve strategy of flood control. Thus guidelines with critical data, daily in monsoon, in standard format will be monitored and reviewed by experts on video conference to arrive at best timely economical plan of operation for each flood cycle. This cannot be done by divided authorities bound by static rules laid down for data pre 1970-75, in time available.

For Ukai 2006, Ukai Reservoir Level on 1st Aug was 331.54'. The river in flood plane has been seriously constrained as seen from Table below for safe flood of 8 Lac cusecs.

Period (Activity)	**Hope Gauge level for 8 L cusecs flood (in m)**	**Hope Gauge level for 10 L cusecs flood (in m)**
Pre 1970 (no dam)	9.7	10.5
1970 – 1980 (Dam + Partial Pala)	10.8	11.8-12.0
1994 (Singanpore Weir + More Pala + Rly Embankments + HADA land development, Urban Growth)	11.6 to 12.0	13.5 to 14.0
1998 (Actual)	11.5	-
2006 Regulators on drains + some more Pala	12.0	

The earlier floods of July now tends to Aug – Sept period, with upstream water use it may shift to Sept – Oct. The rule book was violated to store more; not allowing MWL beyond 345', is seen from the flood outflow to Surat on 07.08.2006, 8.00 hrs exceed 8.5 L cusecs limit.

The options would be to a) allow flood flow storage to 351' and pray to god for rains to stop or b) release inflow totally to maintain 345' for 8th to 10th. The 10 L suddenly released at Surat on 08.08.2006 against safe flow of 7.5 cusecs (8.5 L with Pala, 6.5 no Pala) with partial Palas caused affluxed flood level of 12.0 m (Safe 9.5 m) to 13.0 m at Surat. This level toppled flood protections designed & under execution. Even banks spilled the water at Jahangirpua, Ved, Katargam, Variav, Bhatha, Magdalla etc. This unexpected fast flow of spills caused severe damages to city and surrounding.

This back water, through rivulets or storm drains manholes to Tapti entered city areas never flooded in the past. The unpredicted flood level breached walls and Palas near Dutch gardens. Water found entry into city posh area through storm water drains.

10.0 Reservoir Operations (Feasibility of Controlling Floods Aug - 2006)

10.1 Rainfall

The data of news 4th, 5th, 6th Aug. web site, gauging of CWC shows second cycle of heavy rainfall with storms / local rains as high as 200 mm/day in some districts of catchment basin of Maharastra.

The data of 04.08.2006 for Maharastra basin is predicted as 700 – 800 MCM. This will be reaching Ukai reservoir on 05.80.2006. The forecasts of IMD, BBC Setellites observed indicate trend of continued heavy rains. The anticipated inflow in Ukai was 1400, 3300, 800 MCM on safer side.

Date	Rainfall recorded in basin in Maharastra Estimated Rains (mm/day)	Runoff to Ukai Reservoir	Date of reach at Ukai Reservoir
04.08.2006	30-40	700	05.08.2006
05.08.2006	80	1400	06.08.2006
06.08.2006	140	3300	07.08.2006
08.08.2006	30-40	700	08.08.2006

In Aug 1968 similar heavy rainfall pattern was recorded

10.2 Based on the data with conservative inflow predictions the reservoir operation is worked out. For a total run, our estimate of flood cushion for changed topography, river regime & flood vagaries, of 2000 MCM has been adopted. Thus the reservoir on 3rd Aug will be kept at 330' maximum by releasing extra inflow. The

table is worked out for Ukai MWL 346', as authorities have never availed MWL design 351' in past. It was presumed that Sept rains are good.

10.3 The table below is official record of flood 2006 with URL and uncontrolled out flow to Surat to control URL to 345' as MWL.

Ukai dam Regulation Aug 2006 flood (official reports)

Sr. No	Date	Inflow per day (MCM)	Outflow Per day (MCM)	Total Storage at 24.00 hr (MCM)	Flood Cushion (MCM)	Reservoir Level (Feet)
1	04/08/06	137	59	6204	1294	335.06
2	05/08/06	128	82	6250	1248	335.42
3	06/08/06	662	445	6467	1031	337.12
4	07/08/06	2274	1511	7230	268	342.98
5	08/08/06	2516	2158	7588	-90	**345.65**
6	09/08/06	1951	1891	7648	-150	**346.05**
7	10/08/06	1315	1441	7522	-24	**345.17**
8	11/08/06	753	850	7425	73	344.45
9	12/08/06	589	545	7469	29	344.78

Remarks:- Outflow: 8.5 L cusecs, URL > 345', Hope bridge Max. Flood Level: 13.0 m

Note:- FRL: 345', MWL: 351', Storage at FRL: 7498 MCM (gross)

10.4 If advance prediction of rainfall (Para 10.1) as proposed by authors is used the operation of advance release, etc. is illustrated in table below.

Sr. No	Date	Inflow per day (MCM)	Outflow Per day (MCM)	Storage Per day (MCM)	Total Storage at 24.00 hr (MCM)	Flood Cushion (MCM)	Proposed Reservoir Level (Feet)
1	04/08/06	Collect data, analyze and decide for 3 - 4 rainy days entering Ukai on 5th, 6th, 7th, 8th Aug			6204.0	1294	335.06
2	05/08/06	700	1000 #	-300.0	5904.0	1594	332.69
3	06/08/06	1500	1500 #	0.0	5904.0	1594	332.69
4	07/08/06	2600	2000 ##	600.0	6504.0	994	337.44
5	08/08/06	2600	2000	600.0	7104.0	394	342.19
6	09/08/06	700 ###	1500	-800.0	6304.0	1194	335.85
7	10/08/06	700	1000	-300.0	6004.0	1494	333.48
8	11/08/06	700	700	0.0	6004.0	1494	333.48
9	12/08/06	700	700	0.0	6004.0	1494	333.48

Advance releases to accommodate inflow watching URL TO 333'

Restricting outflow to maximum 8.5 L cusecs

Decreased inflow (rainfall 7 - 8th) decrease outflow to maintain URL 333'

All the design obligations could be fulfilled with minimum disaster by flood.

The requirements of anticipating the rainfall and runoff, 3 - 4 days in advance was achieved by using the weather forecasts of IMD, BBC, CNN etc. & judgment. The process will have to be continued till end of monsoon (21st Oct 2006) for every cycle of the rain.

11.0 Actions to Prevent Future Floods

11.1 The present system of CWC and Ukai management Authority in operating the reservoir has failed in 1998, 2006 to,

a) Ensure URL below 345' FRL (= MWL),
b) Protect the promised 1057 sq.mile from floods by outflow not more than 7 L cusecs (for incomplete Pala),
c) Construct complete Pala yojana inaugurated in 1971 and ensure safety by maintenance and inspections every monsoon,
d) Provide disaster management and scientific specific warning in time to flood prone areas.

Thus present system and its interpretation failed repeatedly. There is enough ground therefore for rethinking.

11.2 The revised procedure with transparency and flexibility, coupled with specific responsibility, is possible by delegating powers to a Valley Authority with team of advisors on Video conference. The team shall include Hydrologist, IMD expert on rain-forecast based on settelite images, CWC - gauging & discharge data collector or with better auto non-power dependent quick communication system, disaster and warning management authority at Surat, Socio-economic experts to assess financial impact etc. This authority, can, in National interest decide against conservation or power needs of water as well as control all parameters influencing drainage of flood of river valley.

11.3 If the trend of reduction in flood drainage capacity is uncontrolled, it could, over years, make flood moderation to impossible stage. Valley authority will have to freeze flood plane and develop schemes of diversion, conserve for desalinization of coast-lands and future sweet water requirements.

11.4 The dredging of mined river for sand and raising of flood bank for partial flood protection downstream are illusions. Back water & breaches of raised bunds in alluvial deposits by piping cannot be prevented economically.

11.5 The R & D studies have lot of scope to evolve strategy for availing more time say preferably 4 days before flood enters the URL to plan advanced safe release to attain minimum required URL of 330'. This seems feasible with use of weather forecasting and special fast communication systems,

when losses runs to tens of thousands crores & more, such tools become inevitable & viable.

11.6 In technologically advanced era 2006 rule book, non-application of mind to facts of rains expected and releasing suddenly all floods to city of 30 Lac as URL touched FRL is non engineering and illogical. The individual authority even if the desires has no powers to act in National interest or economic evaluation of benefits of power & conservation of storage in August vis-à-vis torture to 30 Lac citizens, individual loss of 30,000 per capita on average. Losses to industry Hajira, Textile, Diamond etc. in terms of assets and production loss runs into twenty of thousands crores. A need therefore arises to evolve an authority to manage river valley floods, flood plane and drainage of flood areas.

11.7 For projects in extended city and industrial zones, including 2020 development plans for city, extensive study was referred to CWPRS (2000) to examine Ukai moderation and flood diversion. Urban planning and flood warning to downstream area including city can be developed to make every individual to decide flood problem for himself. Release of 6, 8, 10 L cusecs at Ukai can give warning sirens (non power dependent) with flood mark of expected level on electronic / phone pole near by. Mock pre-monsoon practice can minimize losses and panic. It helps disaster management much better. I.T. / Remote sensing / ISRO settelite images & forecasts can revolutionize flood management.

Warning like go upto 20' for safety is no warning for city with 0 to 20' depth of flood.

11.8 Rethinking on storm drains - overall drainage of city & flood plane is need of the hour. The flow from breaches and backflow from the end of embankment for protection can spread to all unexpected areas in city.