1996 FLOODS OF BARAH BASIN

—A CLOSE GENESIS

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FOREWORD

TARUN BHARAT SANGH has been deeply involved in helping local communities revive their traditions of sustainable land and water management and, where necessary, develop and implement improved practices for such management in southern Alwar district which forms a part of Ruparel (Barah) basin. The calamitous 1996 floods drew us in to relief works in the flooded areas, which though not in our work areas, was so close to us geographically as well as activity wise that we could hardly stay aloof. When visiting the seriously flood-affected areas, and talking to the people, we started wondering about the various factors that had contributed to make these floods so calamitous and unprecedented. Some friends from OXFAM suggested that we undertake a scientific study into the 'genesis' of these floods. With some efforts we were able to assemble a team of 3 experienced professionals, Dr. G.D. Agrawal (a former Professor & Head of Civil Engineering, IIT Kanpur), Dr. S.K. Lunkad (Professor & Head of Geology, Kurukshetra University) and Shri Dinesh K. Mishra (a post-graduate Civil Engineer and intensive experience of studies of floods in Bihar) for this work. The teams was helped and assisted by Dr. Main Pal Singh, Dr. Sanjay Singh and other regular workers of TBS. The enclosed findings are based on the fieldwork and intensive studies by this team. The question remains – shall our efforts be of any practical use ?

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1996 FLOODS OF RUPAREL (BARAH) BASIN IN ALWAR BHARATPUR DISTRICT OF RAJASTHAN- A CLOSE GENESIS

1. The Event and the Colossal Damage

1.1 The catchment basin of R. Ruparel, also known as R. Barah, covering 3225 Sq. kms in Alwar and Bharatpur districts of Rajasthan, faced calamitous flood starting 24th June, 1996 and lasting till well beyond Nov. 96 in more than half of the over 100,000 hectares of highly productive agricultural land initially flooded, to eliminate Rabi crop also in addition to the Kharif destroyed. In atleast 5000 hectares each in Pahari, Kaman, Nagar and Deeg Tehsils of Bharatpur district, and similar areas in Tehsils Kishangarh, Ramgarh, and Lakshmangarh of Alwar District, flood waters persisted till mid-March '97 or later.

1.2 The damage caused by the above floods was truly colossal, including :

(a) Village Bamdoli-ka-Was was totally washed away.

(b) Atleast 300 villages got totally flooded and marooned for some periods; over

50 remained flooded and marooned for entire monsoons; more than half of the village was still under water till end-Nov. 96 in over 30 villages.

(c) At least 3000 hectares in Alwar distt. and 1000 hectare in Bharatpur distt. has become unfit for agriculture for long periods due to erosion, gully formation, sand-deposit etc.

(d) An estimated 2000 pukka, 6000 semi-pukka and over 20,000 kutchcha houses and hutments collapsed. Even larger numbers got damaged.

(e) Tens of thousands of humans had to flee their homes and live like refugees for months.

(f) Crores worth of food-grains, clothes and other belongings were destroyed or washed away. Hundred of families (including at least 100 from Bamdoli-ka-Was alone) had to flee before gushing waters with nothing but the clothes they were wearing.

(g) Tens of thousands heads of cattle and goats perished.

(h) Hundred of humans lost their lives directly due to floods

(i) Tanks, Johads, Wells and other sources of water were rendered unfit for use for months.

(j) The flood brought in their wake epidemics of arthropod-borne and enteric diseases including the famous outbreak of Malaria, Dengue-Falsi parum.

(k) The large number of breaches caused in the roads, railway lines, bridges, canals, dams etc. would in themselves need over a 100 crores for repairs and restoration.

In the estimation by TBS, the overall economic damage would amount to no less than Rs. 800 crores in Alwar Distt. and Rs. 1000 crores in Bharatpur Distt. parts of Ruparel Basin, leaving apart the in-estimable human misery and in-valuable loss of life.

2. The Un-precedented Nature of 1996 Floods

2.1 Ruparel basin like the basins of other small to medium rivers of north-eastern Rajasthan, arising from the slopes of Aravalis and flowing towards R. Yamuna, including R. Sabi, R. Banganga, R. Khari, R. Gambhiri etc. is characterised by extremely flat slopes and a large number

of natural depressions left behind by the tectonic movements in pre-historic times. Thus the drainage of the area has always been very poor and most rain-waters would get retained in these depressions or "Jheels" with only small parts over-flowing to R. Yamuna, the ultimate drainage channel for the area. **Floods thus, are not unusual for this area, particularly in years of abnormal rain fall such as 1996 was.** Floods of 1956 and 1987 are still remembered in the area. Even the immediately preceding year, 1995 had excessive rainfalls and large parts of the basin had got flooded. What was unprecedented about the 1996 floods, included :

(i) It came without any warning from, or any type of preparatory effort on part of, any government department or officials; it was not so earlier.

(ii) In earlier years floods would come and pass away in a few days, at worst in a week or two; This time they stayed for months;

(iii) As a result of the two factors mentioned above, **the damage and the misery caused this time was not just collosal, it was un-precedented.**

3. The Sequence of Events

3.1 Ruparel Basin had pre-monsoon showers of the 1996 season during June 5-8 and June 17-20, with rainfall totalling around 100 mm in the June 1-22 period. This not only cooled the weather but enabled farmers to plough the lands and complete sowing of Kharif crop in many parts of the basin. Heavy rains all over the basin started in the after noon of 23rd June and continued till 26th June. The total rain over the Ruparel basin during these 72 hrs. (23-26 June) averaged 402 mm, while the maximum was as high as 569 mm in these 72 hours recorded at the rain-gauge station in Alwar town. Such heavy and intense rain was bound to fill-up flat areas and depressions and even make a very large number of villages water logged.

3.2 Around dawn of 24th June a small event occurred that trigerred a whole catastrophe. A medium-sized masonry-cum-earth dam at Bamora along Alwar-Kishangarh road, overtopped and breached to empty all it's contents of stored up water, mud and sand in the form of a rushing muddy dragon. The catchment of Bamora Dam had been considerably disturbed (and somewhat increased) during recent years by the new Alwar-Rewari BG (Broad Gauge) railway

track. Besides, during the works for widening and easing out slopes and curves of the Alwar-Tijara highway, blasting had not only cut away part of the toe of the dam foundation, but also caused cracks in the masonry weir. These were more responsible for it's failure, rather than the intense down-pour, **the likes of which the dam had safely handled a number of times in the past.**

3.3 The gushing flows from the breached Bamora Dam picked up immense momentum as they descended from the higher altitudes of Bamora plateau to the low lands on the east of the highway and breached a number of earthen bunds and johads and flooded villages on way 'including Chor-Bassi, Khora etc.

3.4 In a manner somewhat similar to the situation at Bamora, "Oda-ka-Bandh" dam built under the Khanpur project at a cost of Rs. 4.5 crores had it's catchment area enhanced by over 20% by changes in road alignments with inadequate cross-drainage provisions and breached on 24.6.96. Same fate happened to several other dams.

3.5 The combined gushing waters from Bamora-Mothaka-Jhiroli-Khora region now reached the 10 km long Atari Bund near Bamdoli and breached it at 6 different points,

creating new drainage channels where none had existed in recent memory. It was one of these new channels that washed away entire village Bamdoli-ka-Was, with its 200 Pukka houses out of existence on 24th June afternoon. The gushing waters then breached the Alwar-Sohna-Delhi Highway at seven places in the Ramgarh-Nowgaon stretch and devastated scores of villages on the east of the road including Sunehra, Karoli, Manki, Alaora etc.

3.6 A number of dams had also breached and a similar gushing stream was also coming on the Rata Khurd-Chandoli-Nagla Behjira-Piproli Mansarovar side, devastating villages on that route. These streams from the north and the west, met the Ruparel channel near Ladpur again causing devastation at the meeting point.

3.7 **It may be noted that while it had also rained heavily in the Thana-Gazi-Sariska-Siliberi-Rajgarh-Lachmangarh area, there was no flood-damage in these areas as no bunds/dams breached and flood-waters were detained and drainages functioned effectively,** upstream of the Ghat Pick-up Weir.

3.8 The gushing flood waters from Govindgarh on entering Bharatpur district breached the

10 km long "Tasai Bandh" near Nagar town and also the "Sikri Patti Bandh" (which was built to convert Ruparel into 28 harmless slave channels), **foiling man's efforts to enslave nature.** The result was severe flooding and devastation in Nagar-Pahari-Kaman and Deeg Tehsils of Bharatpur districts, and even in parts of Kumher Tehsil.

3.9 The misery and devastation in Bharatpur district part of Ruparel basin was magnified manifolds by additional flood-waters arriving from Haryana via Ujjena drain into Kaman-Pahari drain, and U.P. Government not allowing flood waters to Drain through the Kaman-Pahari Drain Govardhan-Drain Complex by closing the Radha Nagri regulator. Discharge of flood waters into the Gurgaon Main Canal in it's upper reaches, followed by breaches in the down stream reaches, also added to the misery and delayed drainage of water from Kaman area.

4. Analysis of Events and Some Points to Note

4.1 Flooding is a routine event in the basins of Ruparel, Sabi, Banganga, Gambhiri etc. In fact flooding of vast cultivated lands is deliberately carried out each year under the Bharatpur, Inundation Irrigation System

devised by the illustrious Bharatpur Maharajas. Such short period flooding recharges ground-water, reduces surface run-offs, washes down salts keeping both the soils and the ground-waters "sweet", enriches the soils with fertile silt and significantly enhances the greenery and ecology of the area. This is achieved by a very large number (several thousands) small and medium storage structures termed Johads, tanks, Bandh, Naka, dam weir etc. These have been created and maintained in Rajasthan and most particularly in Alwar and Bharatpur districts including Ruparel basin.

4.2 The above mentioned large number of structures have together a very large storage capacity and play a major role in buffering sudden floods in the event of abnormal rains. Thus even the medium sized government owned storage structures alone in the Ruparel basin have a storage capacity of over 16 million cubic meters (MCM). If to this one were to add another 16 MCM, (a serious under-estimate for the storage available in village Johads and small dams) and 37 MCM (ref. page 23 of Rajasthan Govt. ID Manual referred in Para 61) for the 18 natural depressions, the total buffering capacity becomes over 70 MCM

or 7000 hectare meters. **This shall be adequate to absorb the entire run-off, generated by the abnormal 400 mm 72 hour rainfall during 23-26 June, 1996, without causing any devastations. It is this reason that while abnormal rainfalls and even abnormal floodings occurred off and on, significant damage due to floods is unheard of by even the oldest people in the area.**

4.3 Why then the disastrous floods of 1996 could occur ? It immediately becomes clear that **all flood damage of 1996 floods in Ruparel basin was linked to failures of storage structures, choking of drains and other types of obstructions to natural drainage that had arisen or had been created only during the past two decades.**

4.4 When one examines further, one finds that the failures of dams, breaches in bunds and canals choking of drains, silting up and encroachments of flood-buffering storage capacity were **not the results of the fury of the Rain-god or of other natural processes but of the various acts of omission and commission by man and his governments.**

5. Inferred Genesis of 1996 Floods of Ruparel Basin

5.1 The illustrious Maharajas of Alwar and Bharatpur had created and maintained, and

handed over to the present Rajasthan State, a system that was capable of absorbing the 1996 abnormal rainfall, without any disastrous effects, if it was in-operative condition. The above system which was properly maintained till independence (and for 15-20 years even after independence) by personal attention by the rules themselves has now fallen in dis-repair due to negligence and prevalent corruption in government departments.

5.2 Agricultural practices have vastly changed during the past 30 years, largely with government promotion in the name of new technology resulting in greater erosion of fields and corresponding silting up of storage capacities. The rather lax village administration has not only allowed but encouraged filling-up and encroachments of storages and drainage channels. Such reductions in capacities become critical in years of high rainfalls.

5.3 Road embankments, railway-tracks, canals, other structures - even irrigation "gul" from a tube-well, obstruct and disturb drainage. It was interesting to note that the locations of all the breaches of the Alwar-Delhi Highway between Ramgarh and Nowgaon were dictated by the location and alignment of some recently constructed pukka

buildings (often govt. owned). **The aspects of impact on topography and drainage of the area are almost always ignored when planning development works.**

5.4 While the above factors contributed gradually to create the circumstances when the devastating floods could occur, the immediate causes were :

(i) Serious disturbances in the catchment areas of some dams/tanks in the upper reaches of streams, obstruction of drainage as also physical damage to hydraulic structures in some cases, caused due to negligence in planning, design and construction and upgradation of roads, rail-lines and other "development works". Examples Bamora dam and Oda-ka-Bandh.

(ii) Negligence in operation and maintenance of storage and drainage structures built before Independence leading to their heavy siltation, choking and poor structural condition.

(iii) Total lack of preparedness and vigilance on the part of irrigation department, district administration and other organs of the bureaucracy.

6. Failings of Government in Respect to 1996 Floods

6.1 While the painful stories recounted by the victims invariably talk of the total negligence of irrigation department and other agencies towards maintenance and repairs of various flood-protection, water-storage and drainage structures, as also lack of preparedness and vigilance, absence of flood-warnings, delayed efforts at evacuation and in-effective relief and rehabilitation, many of which stories have already appeared in various TBS bulletins, the basic facts come from the "horse's mouth" itself in the **"Operation Manual-Bharatpur Irrigation System-1996"** brought out by the Chief Engineer, Irrigation Deptt. Govt. of Rajasthan. Some excerpts from this report are given below :

(i) **Page 6 Top Para**

"Lack of timely and efficient regulation (of the existing in-undation system) can result in catastrophic conditions and vast devastation".

(ii) **Page 7 Para No. 3 From Top**

"The role of storage dams as flood control structures was the main and most important part of this system (built by princely rules). The series of 197 dams and 19 large natural

depressions prove to be of immense help in flood moderation, and the failure of the dams or of regulation thereof, failure of warning and communication system and lack of preparedness can prove to be catastrophic and result in vast devastation in down-stream areas."

(iii) **Page 15 Para 2 and 3**

(b) Heavy (inflows coming in Ruparel from Alwar Distt.) resulted in breaching of Sikri Bund. The 28 off-taking channels **due to their silting and inadequate maintenance could not draw their design discharge** and this caused rise of water level of Sikri Bund **which would have otherwise not happened, had the off-taking channels been capable to draw off the authorised discharges. The ..... Sikri Bund breached at 16 places in a length of about 1000 feet."**

(c) "The breaching of Sikri Bund caused further breaching of series of tanks existing in the down-stream. The Nagar town and surrounding areas also got submerged".

(iv) **Page 16 Para 2**

(e) "Due to inadequate repairs of the existing flood-drainage system" ....."which were not repaired since long".

(v) **Page 16 Para 3**

(f) ....."Due to inadequate maintenance this (K.P.) drain system was lying in a very bad shape. It's bed is heavily silted up and it's banks too weak to sustain even authorised flow of water".

(vi) **Page 40 to 53**

A very detailed "Operation-Plan" for regulation of floods is given which includes titles like :

(a) Pre-monsoon maintenance and repairs of works

(b) Installation of telephone and wireless sets

(c) Setting up of Flood Control-Room and Flood-Cells

(d) Arrangement and Positioning of Staff and Materials

(e) Arrangement for flood-forecasting

(f) Re-conditioning of boats, pumping sets etc.

(g) Prior arrangements with police, army etc.

(h) **Pre-monsoon meeting with DM and Officials**

(i) Inter-State meeting with Haryana, U.P., Delhi and the Central Water Commission.

The report even goes in to the sincerity, commitment and competence of staff posted and into supervision and vigilance.

6.2 **Did the Government system function in respect to 1996 floods ?** In respect of Bamora Ataria, Sikri, Patti, Oda-ka-Bandh and many others there was no pre-monsoon maintenance, no watch and ward, no telephone or wireless, no flood-forecast, even no district-level, state-level or inter-state meetings. Is more evidence needed to prove that failure of the governmental system was the **primary cause** of the damage and devastation ?

7. Shall We Ever Learn Our Lessons ?

Well, the 1996 floods and the devastation they caused are now small parts of history

of the insignificant Ruparel Basin which has not produced any influential political leader in past several decades. **But has the government learnt any lessons from it ? The 1997 monsoon is already on the door-step and still there is no maintenance of works or even repairs of last year's breaches, no watch-posts, no wireless sets, no District level or Inter-state meetings.** Could the devastation of 1996 repeat itself in 1997 ? God forbid. The people shall not be able to take it. **It is the fears of the coming monsoon that people of Bamdoli, Sunehra and Sahera are saying with TBS, "forget the government, let us do it ourselves.**

SHOULD WE LET THE GOVT. OFF THE HOOK, ALL THAT EASILY ?

RAJASTHAN HARYANA FLOODS : NATURAL RESULT OF HUMAN FOLLIES A CASE STUDY OF CALAMITOUS 1996 FLOODS OF BARAH VALLEY

1. June 1996 Flood in Barah Valley & Losses Caused By It.

1.1 When it started raining on June 23 of 1996 over the entire region, people thought it was just another pre-monsoon shower. Earlier the region had already had wide-spread pre-monsoon showers during June 5-8 and June 17-20 and several locations in the region had received over 100 mm rain-fall already in the June 1 to June 22 of 1996 (Mandavar, Behrod and Kot-Kasim in Sahibi basin receiving 174, 169 and 110 mm respectively and Alwar and Thana-Ghazi in Barah basin receiving 106 and 103 mm respectively). However rainfall at many locations, particularly in most of Barah, Banganga and Gambhiri basins had totalled only 50-80 mm till June 22 which was only able to wet the soils parched during the hot summers and came as a relief to the people from the burning heat, particularly to the farmers who got busy preparing their lands for sowing the Kharif crop. Though somewhat uncommon, re-start of raining on June 23, after a mere break of 2 days since the showers on June 20, was still

not un-welcome. However, rather than stopping, the rains intensified on June 24, on which day in 24 hours 12 stations out of the 17 rain-recording stations in Alwar district, received over 100 mm and 8 stations over 150 mm rainfall and 4 exceeded even 200 mm (Alwar 261, Tijara 230, Ramgarh 225 and Kishangarh Bas 210 mm) in the 24 hours. The downpour continued on June 25 and in the 24 hours on this day again 11 of the 17 rain-gauges in Alwar district recorded over 100 mm and 8 stations over 150 mm with 5 exceeding even 200 mm (Govindgarh 295, Alwar 283, Katherwas 260, Malakhera 258 and Kishangarh Bas 218 mm). Over the 72 hour period during June 23-25 all the 17 stations in Alwar Dist. gauged over 100 mm but the range was rather wide from the smallest 145 mm at Rajgarh to as high as 569 mm at Alwar. Banganga basin had the least total for the 72 hours (145 and 146), Sahibi basin stations totalled 155 mm to 310 mm with an average of 248 mm for the 7 stations in the 72 hours. The worst-hit was Barah basin where the 8 stations totalled between 201 mm and 569 mm with an average of 402 mm in the 72 hours. Such a rain-deluge caused wide-spread misery with a large number of houses collapsing, hurting people and animals and damaging property and water-logging villages,

particularly those located in depressions and or having poor drainage. The damage was very wide-spread over the entire region, though much more severe in Barah basin.

1.2 While no-one had anticipated or been prepared for such heavy down-pours, these were not entirely unusual for the region, which once in 20-25 years, keeps facing such deluges when almost the entire quota of the annual average rainfall may fall over mere 72 hours. IMD data of 5000 stations for past 100 years reveals 3 pockets in this region (Dausa, Bassi and Bamanwas) which had over 300 mm, 400 mm and 500 mm as the peak 24, 48 and 72 hours rainfalls. Probably the Mahabharata story of lifting Goverdhan Parbat by lord Krishna to save people from a calamitous deluge was also meant to remind people of such occurrences in the region. Even 1995 monsoons had excessive rainfalls over a few days with several embankments breaching and large areas in north-east Rajasthan and southern Haryana getting flooded, Alwar town being one of the worst-hit. But none of these at-all compared with the calamity that was to fall on the un-suspecting and unprepared people of Barah Valley on June 24 and the following days.

1.3 On June 24 a large swift and mighty current (rather sheet) of water alighted from the hills in the west-central fringe of the basin around

Kishangarh Bas and rushed east-wards breaching embankment after embankment, flooding vast lands, washing off villages, eroding agricultural fields, spreading thick layers of sand and silt converting fertile tracts into worth-less deserts and cutting out wide and deep new river-channels where none had existed in recent memory. The 3 day period from June 24-26 seemed nothing short of the end of the world to the people of the north-eastern and eastern part of the Barah Valley from Kishangarh Bas, through Ramgarh, Naugawan, Niwai and Sikri, right upto Kaman-and further down-stream along Kaman-Pahadi and Goverdhan drains. Worse, while water from other flooded areas of the region drained out over the following 7-15 days, that in the Ramgarh-Niwai-Sikri-Kaman area did not; and large tracts were still under water even in late October. Several equally large tracts had been left deeply eroded or covered with thick layers of sand rendering them unfit for agriculture. The misery of the region proved to be a long term one, unlike normal flood tragedies which are followed by bumper crops, restoring the smiles on the faces of the suffering people.

1.4 In our society, intensity of a calamity is also judged more by the status, power and influences of the sufferers, rather than the intensity and extent of the suffering caused. The 1995 floods brought faster and more

intensive response and relief from government agencies since the urban areas of Alwar were then more seriously involved than the much more severe 1996 floods when no major urban centre was endangered. Even in 1996 itself, the Sahibi, Banganga and Gambhir basins attracted more media-attention than the relatively poorer and less influential rural areas of Barah valley. Official records are bound to drown the losses and sufferings of the Barah Valley communities by clubbing them up in district-wise, tehsil-wise or block-wise figures and statistics. Yes, floods-damage was quite wide-spread over several districts of Rajasthan, Haryana and Uttar Pradesh, but what needs to be brought to attention is the intensity of the losses and suffering of the Barah Valley communities. The following are just indicative of these :

(i) A complete village of 200 houses (Bamdoli Ka Bas), most of them Pukka, being totally washed away leaving hardly a trace, rendering all 200 families homeless and destitute with no food, property or belongings, except the clothes they were wearing. Several other villages partially washed away.

(ii) Flooding at least 30 villages in the valley with water standing for over 3 months in more than half of each of

these villages. Devastating half or more of the houses in the village and causing large scale damage to property, food-grain stocks etc.

(iii) Washing away thousands of heads of cattle and directly killing at least 35 persons. Destroying or seriously polluting drinking water sources and leaving behind mosquitoes, epidemics of fever and other diseases and death in its wake.

(iv) Destroying the Kharif crops with no possibility of any retrieval or re-sowing during this Kharif over more than 50% of the total cultivated land in Barah valley. Due to non-draining out of the flood-waters even till Nov. 96, even Rabi crop may not be possible during 1996-97 in at least one-third of the area that had got in-undated.

(v) The most serious long-term damage was the covering of at least 10000 hectares of agricultural land by layers of sand and serious erosion and gulley-formation in another 4000 hectares rendering all this land entirely unfit for agriculture for tens of years to come.

(vi) Ecologically the most serious and interesting was the cutting out and formation of new drainage channels.

(vii) Economically also the breach of highways, railway lines, and canals, dams etc. would need several hundred crores of rupees to repair. The damage to production, transport and business can only be imagined.

(viii) There can be absolutely no doubt or controversy in that the 1996 floods were entirely unprecedented in magnitude and truly calamitous in result, so far as Barah valley is concerned.

2. Scientific & Historical Background of Floods in Barah Valley :

2.1 Rivers and drainage channels are an essential component of the Hydrological Cycle. Their essential function is to return to the seas the evaporated water that moved land-wards to cause rain. While some of the rain on land may be essentially the recondensation of water evaporated from the land itself through evapotranspiration from vegetation, evaporation from wet lands, ponds, lakes and other inland water-bodies, bulk of the rainfall all-over, results from water vapour transported from over the oceans and to maintain the cycle, the water needs to be returned. Again, while a part of the rain-water may return sea-wards as under-ground flows, the bulk normally travels through drains, rivulets and rivers. Surface drainage networks are thus

essential features of all land-forms, though their intensity and pattern may vary depending on topography, soil and climate. Sometimes the drainage system may end in an inland lake (e.g. R. Luni in Sambhar Lake or R. Amu and R. Syr in Aral Sea) rather than in an open sea. Even arid regions and desert areas have a drainage system to carry the occasional (or may be rare) excess rain-water to the sea or at least to a large inland lake. The Alwar - Bharatpur region also had (and to an extent still has) a well-defined drainage network with R. Sahibi (or Sabi) and its tributaries in the north-west originating near Jaipur and travelling through Behrod and Riwari to join the Yamuna just upstream of the city of Delhi and rivers Barah (or Ruparel) Banganga and Gambhir, in that order, joining together to outfall into R. Chambal, upstream of Dholpur. Thus channelways to transport the excess rainfall reasonably rapidly to R. Yamuna, which is the main drainage of the area, were well-defined and well-formed. The drainage network as it would have existed a few centuries back is shown in Fig. 1. Floods would occur occasionally when rainfall was intense, but would not last long, nor cause much damage.

2.2 The Alwar-Bharatpur region of Rajasthan and its adjoining areas are semi-arid areas and the average annual rainfalls vary in

the 500-700 mm range. Obviously, this level of rainfalls can only support limited agriculture by dry-farming techniques, besides ofcourse, sustaining forests and grazing lands. Till a few centuries back, the region had lush forests on the Aravali hills and slopes and grazing lands in the lower plains. The population of the area primarily depended on animal-husbandry and on forest-produce, for their survival. Agriculture was limited to low-water-consuming crops of barley, millets, lintels, pulses and oilseeds. There was adequate percolation in the forest-areas to maintain drinking water in wells and irrigation was virtually unknown.

2.3 As population and consequently water-demands increased and concurrently deforestation started, natural percolation in forest-areas became inadequate to meet the demands and wells started drying in summers. To supplement the water-supply and also augment ground-water recharge, Johads started being built. Johads, formed by constructing an embankment in the path of flowing storm-water, detained it, and thus encouraged its percolation to recharge ground-water. As wells close to or downstream of Johads started having good water-availability, some well-irrigation was also started. Very soon, thousands of small Johads were built by the villagers themselves which turned the area green and

gave a boost both to agriculture and animal husbandry. The structures, though large in number, were too tiny to materially change the drainage pattern and the channel-ways stayed as they were with the Johad embankments (or Pals in local language) standing like punctuation marks in a long essay. The spill-ways (or Aparas in local language) of these would run on all major storm-events to keep the drainage channel alive and occasional floods would occur as earlier. The villagers maintained their structures and the drainage channel in a condition that they would neither breach, nor choke. Some water was encouraged to percolate, and the balance allowed to flow out quickly without causing damage or suffering.

2.4 Seeing the successful intervention by Johads to increase ground-water-recharge and make it available for irrigation, the illustrious Maharajas of Bharatpur and Alwar planned and executed a large number of major and medium storage works on the various rivers and streams to further augment water supply for drinking and irrigation both through direct surface canals and through wells recharged from percolated water. Soon the number of these also ran into hundreds. Irrigation Department of Rajasthan listed 60, 59, 167 and 222 such Johads, Tanks and Dams in Sabi, Barah, Banganga and Gambhir basins respectively. Among these

Rampur Bund (659.5 MCFT), Puchhara Bund (533 MCFT) and Chittoli Bund (442 MCFT) in Sabi Basin, Mansarovar Bund (654 MCFT), Jai Samand Bund (953 MCFT) and Sikri Bund (1437 MCFT) in Barah basin, Ramgarh Bund (2084 MCFT), Madho-Sagar (790 MCFT) and Sainthal Sagar, Kalakho, Murli Budia, Mangalsar, Mansarover, Jai Sagar, Ajan and Chiksana (each 400-500 MCFT) in Banganga Basin and Baretha (1860 MCFT), Juggar (991 MCFT) and Bishananand (408 MCFT) in Gambhir basin deserve special mention due to their size. Such large structures yielded large benefits in terms of increased agriculture, but were bound to interfere with the drainage patterns. They diverted water from drainage channels to irrigation canals, often leaving little water to flow in the naturally formed drainage channel. As an extreme example, Sikri Bund on R. Barah is a 10 km long embankment, spreading the incoming waters over an area of up to 50 Sq km and diverting it into 27 canals through 27 sluices in the Bund, leaving nothing to flow in the original river, except in a year of extremely heavy rainfall. Thus rather than outfalling into larger drainage channels, streams of the area were totally converted to canals and ground-water. This was 100% utilisation of water-resources but was outright MURDER so far

as the stream was concerned. In-time the channel of the dead stream was encroached upon for agriculture and other uses and all signs of the river having existed totally vanished. Fig. 2 shows the fate of Sabi, Barah and Banganga at the hands of this efficient water-resource-management. Fig. 3 shows the Barah situation in greater detail.

2.5 For the ruling princes of Alwar and Bharatpur, the novel and efficient water-management-systems, termed "Bharatpur System of Inundation Canals", and the boost in agricultural production of this semi-arid area that this resulted in, was their most valuable show-piece and they tended it with great care. **Maintenance and management were superb. Occasional flooding would occur, but it would help rather than hurt.** There is no record, memory or even tale of a calamitous flood having occurred in the area, during the last 3-4 centuries.

2.6 After independence, and consequently the Alwar and Bharatpur states merging in the reorganised Rajasthan, the maintenance and management of the structures and the system passed on to the Rajasthan State Irrigation Department. And the Irrigation Department of Rajasthan, set up after reorganisation of states in 1955, very soon not only caughtup, but vied to surpass the Irrigation Departments of other states in negligence, inefficiency, wastage of funds

and corruption. Like every-where else, the thrust was on costly new canal-systems fed by inter-basin transfer of water, like the Indira Gandhi Canal in the north-west, Narmada waters in the south-west and Gurgaon Canal based on Bhakra water in this area. As usual, engineers found maintenance work and optimal management of available water resources too tedious and un-rewarding in personal financial terms. Result-the beautiful systems built by the princes, in the present poor shape of maintenance and management, became a liability in place of the asset they were. This was amply proved by the floods of 1995 and even those of 1996 in the Barah valley.

3. Scenario of 1996 Floods in Barah Valley and the Overt and Covert Contributions of Govt. Officials in It.

3.1 From detailed field visits, site inspections and analysis of information available, this author comes to the conclusion that the calamitous floods of 1996 essentially started with the failure of the centuries-old Bambora Bund, a few kilometers south of Kishangarh Bas on the Alwar-Tijara-Bhiwadi-Delhi Highway. The bund is located on a spur, and the area downstream is over 50 meters lower. The failure of the bund released a gush of water and silt, that rushed towards Niwari-Ramgarh,

breaching one embankment after another and continuously strengthening itself. The areas coming in the way were flooded or even washed away. This dance of death washed away the entire 200 family village Bandoli Ka Bas, breached Alwar-Ramgarh-Delhi highway at as many as 6 places, cut a new channel, over 30 m wide and 5 m deep from Naugawan to outfall into R. Barah near Milkhapur and caused immense suffering to over 50000 people as stated earlier.

3.2 There were a number of man-made factors that triggered the failure of Bambora-Bund on 24th June, 96. The intense rainfall deluge was of-course there, but the Bund would have with-stood the onslaught of this deluge, much as it had done on several previous occasions during its life. The new factors in order of severity (in view of this author) that triggered the failure are listed below) :

(i) Blasting carried out near the toe of the masonry dam to ease the slope and curve in the highway resulted in seriously cracking the masonry foundation and the bedrock.

(ii) The easing of the highway slope and curve actually cut away part of the toe of the masonry dam, thus seriously weakening it.

(iii) The modifications in the embankment of the gauge-converted Jaipur-Alwar-

Riwari railway-line over the past few years have increased the catchment-area and modified the topography of the catchment to over-stress the Bambora reservoir and Bund.

(iv) The damage caused to the Bund during 1995 monsoon was not properly repaired till arrival of 96 monsoon.

(v) There was no watch or vigilance over the Bund on 24-6-96 and no early remedial actions were taken.

Some of the above factors are indicated in Fig. 4. Probably the above factors were applicable at, and were responsible for the failure of, many old bunds and weirs. Only Bambora was at the top and acted as trigger.

3.3 Had there been a proper and adequate spill-way on the 6 km long embankment near Bandoli Ka Bas and an appropriate channel downstream of the Bund to carry away the surplus water, the gushing water would not have had to cut a new channel and a lot of the misery, suffering and losses would have been avoided.

3.4 Complete elimination, through encroachment of the channels of Landhaw Nala and Chood-Sidh Nala, erasing the natural passage for their outfall in to R. Barah, intensified the problem.

3.5 Finally, the destruction of the normal channel downstream of Sikri Patti Bund ensured the months-long inundation of Kaman region. The only out-fall available was through the Kaman Pahadi Drain-Gobardhan Drain route, the capacity of which was too meagre and in-adequate. The partly built Gurgaon Canal also contributed to interrupting smooth and swift draining away of the water.

4. Lessons Learnt From Study of 1996 Barah Floods :

4.1 The biggest and most critical lesson learnt from the study is that **"nobody has the right to deprive a river/stream of the channel that it has cut for itself. As far as possible no developmental works, housing or agriculture should be allowed in the flood-planes of the streams. Flood-planes should be maintained as tree-belts and wet-lands. Under only critical conditions, seasonal agriculture may be allowed, but nothing else."**

4.2 When railway-lines or roads have to pass through, or to cross, channels or flood-planes, extreme caution is needed to ensure that no change in catchment of existing storage works occurs and adequate flow passages are provided with minimum interference to natural flow-paths.

4.3 When carrying out construction of new development projects, adequate attention should be given, and responsibility taken at the highest level, to protect safety and stability of existing water-management structures.

4.4 Realising that the present incompetent, inefficient and corrupt Irrigation Deptt. can not maintain, watch and protect small and medium bunds, weirs, dams and drains, a mechanism should be developed to involve the rural communities in this work and entrust it to them.

4.5 Efforts to utilise 100% of the water available in a catchment through storage, inundation, diversion, ground water recharge etc. is a grave folly. To maintain the drainage channel along it's entire length, no more than 40-50% of the average annual flows should be abstracted, stored or otherwise taken off the channel. It should be 100% ensured that (a) fair-weather flows in the channels are in no case reduced (b) no more than 50% of the monsoon flows are utilised (c) there are at least 2-3 times in each monsoon season when spillways run and drainage channels are utilised, so that the channels stay alive and healthy.

Fig. :-1 NATURAL DRAINAGE

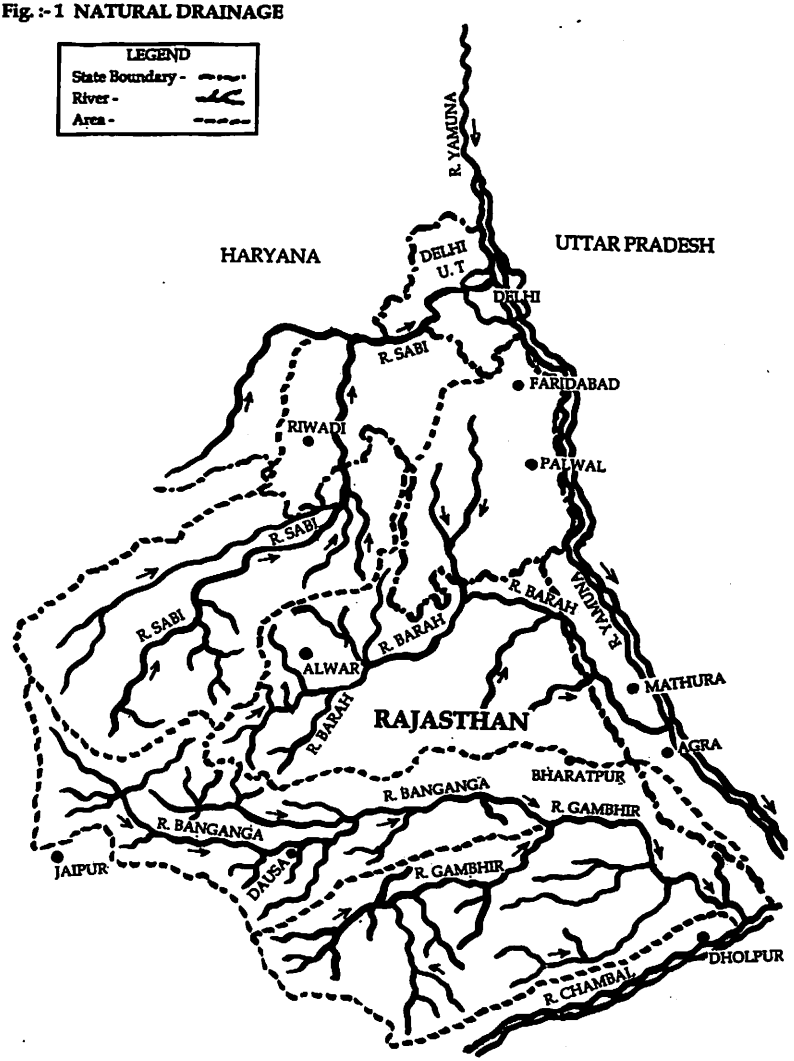
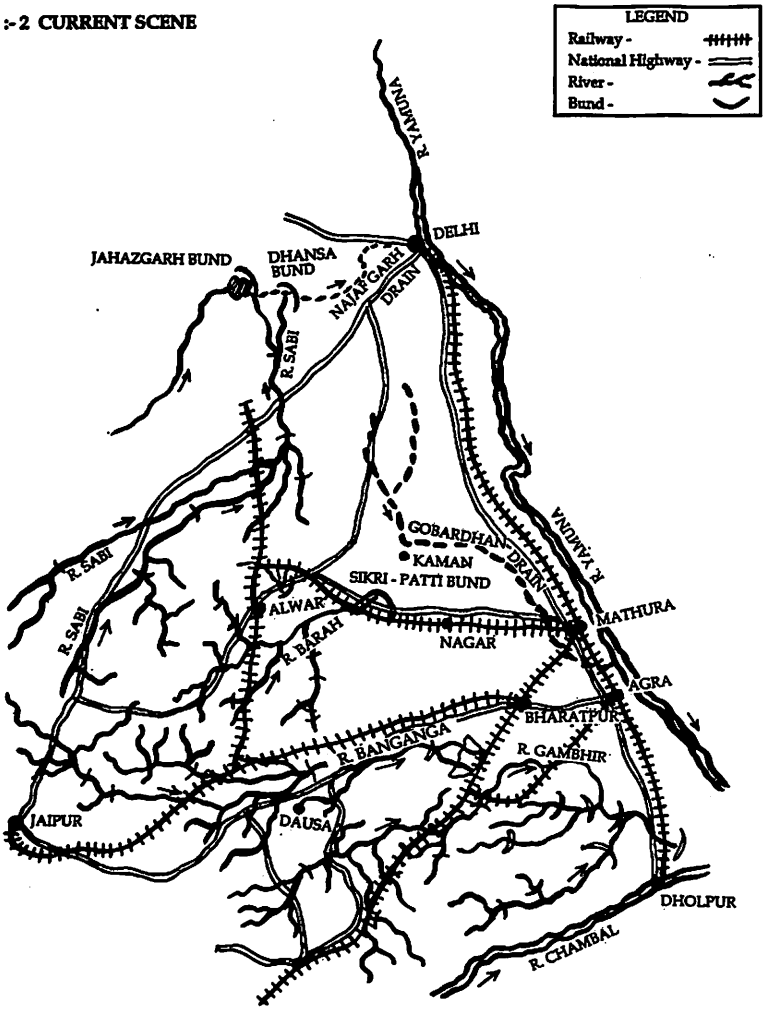


Fig. :- 2 CURRENT SCENE



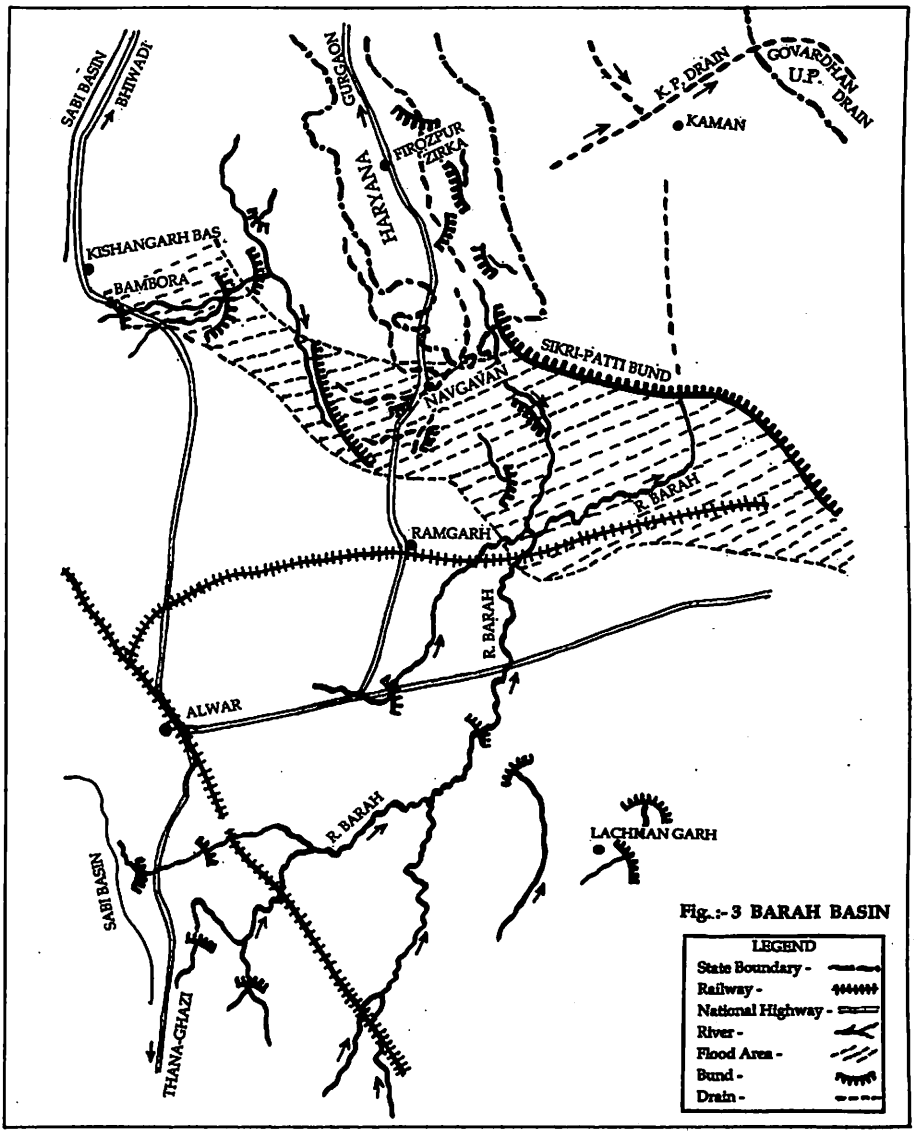


Fig.:- 3 BARAH BASIN

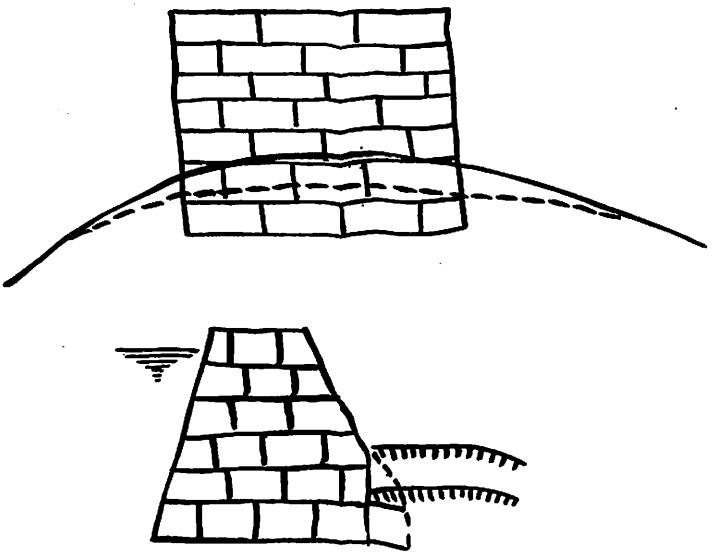


Fig. :- 4 LARGE STORAGE WORKS IN BASIN

R. SABI	MCFT
Rampur	(660)
Puchhara	(533)
Chittoli	(442)
Listed By I.D. - 60	

R. BARAH	MCFT
Mansarovar	(654)
Jaisamand	(952)
Sikri Patti	(1437)
Listed By I.D. - 59	

R. BANGANGA	MCFT
Ramgarh	(2084)
Madhosagar	(790)
Sainthal Sagar	(460)
Kala Kho	(400)
Murli Budia	(500)
Mangal Sagar	(450)
Jai Sagar	(480)
Ajan	(435)
Chiksana	(490)
Listed By I.D. - 167	

R. GAMBIR	MCFT
Baretha	(1860)
Juggar	(991)
Bishanan Moud	(408)
Listed By I.D.	222