Floods in the Arid Zones of West Pakistan

By

*Mr. G. A. N. STARMANS

Introduction

The following notes do not form a learned and a highly technical paper as the author has not been in West Pakistan long enough to be able to speak with authority but constitute the impressions as he has gathered during his work here backed by such factual data as are available.

2. As an Appendix, a list of high floods actually measured or calculated at various gauging stations is appended. Many of these flood discharges have been taken from a generalised curve built up on the basis of a few points which could be got during the 1956/57 rainy season. The flood curve so constructed is admittedly deficient in so far as it isbased on very few points but the author considers that it is at least a reasonable approximation and as such better than nothing at all.

3. A reservoir siltation curve is in course of preparation. Preliminary figures lead me to believe that for design purposes one should allow 3½ acre ft. of siltation per sq. mile of catchment for small catchments up to 400 sq. miles, beyond that a figure of 2 acre ft. per sq. mile is considered reasonable. Here again, we have little to go on, but the Nari flood quoted in the text gives a 24 hrs discharge of some 0·9 acre ft. per sq. mile for the particular day in question and it is, therefore, considered that the annual figure of 2 acre ft. per sq. mile is not unreasonable.

4. Some controvercial statements are made which, it is hoped, will provoke discussion.

The author apologizes for the simplicity of the paper presented, but trusts that it will be of some interest.

The Physical Aspects of the Region and its Rivers

The Baluchistan rivers and their tributaries rise, and for a considerable part of their course flow, through broken mountainous areas.

Flood damage is caused not only in the main plains and valleys but also in each and every tributary valley.

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*Hydrological Advisor, Quetta.

These are also the points of settlement and the lack of arable soil has led many of the villages to cultivate what are, in effect, the river beds. The inevitable trouble that arises from this will be dealt with more fully later.

The bed slopes are steep and flood velocities extremely high.

The nature of the carchments, unprotected, completely denuded and overgrazed gives rise to rapid times of concentration of the flood wave and excessive supended and bed loads. Short duration, violent floods are characteristic with even moderate rain intensities.

The easily eroded material of the area provides vast quantities of stones and heavy sands destructive to the lands they cover. In much of the Region the shortness of the rivers, the lack of population in many of the important upstream areas, the steep slopes and high velocities render useless any normal flood warning system.

The velocities are such that before a warning can be given to the villages likely to be affected the flood wave will have passed. The Kachhi Plain is discussed separately.

During rain periods the retention and absorbtion potential of the catchment areas is very low, notwithstanding the fact that the area is an arid one. This is, of course, a direct result of the lack of forest or grass cover and of the more absorbant parts of the soils.

II. Kachhi Plain

The Kachhi plain is, by it's very nature, a focal point of damage in the Quetta area. It can best be described an inland delta which the rivers around are attempting to build up so as to once more produce a free drainage towards the Indus. The heavily silt laden rivers spreading over the plain, as they inevitably do during the flood period, cause a gradual rise of the land level. As matters stand at the moment the Kachhi has a difficult and comparatively small outlet capacity. This has been estimated as being some 60 so 70,000 cusecs. The moment this figure is reached any water thrown on the plain will and does overflow causing wide-spread damage and destruction. It is incumbent. therefore, that in any consideration of the flood control and warning systems, we view the whole of the plain with that background in mind. The attached schedule shows that the Nari on it's own can and does quite often produce flows equivalent to and greater than the maximum drainage capacity of the Kachhi. The Bolan and Mula, in their turn, can also exceed or approach this capacity. Of the others, the Lari and Chatar will generally produce their quota at roughly the same time ts the Nari and although individually they are small their combined total is sufficient to cause flooding.

2. To be able to present a picture in which a warning system can be instituted, that will take into consideration the necessary time lag required to enabie populations and herds to be moved, a continual and complete daily record of flow will be needed. A day to day analysis of

the total flow being poured on to the plain must be assessed and considered in terms of it's drainage capacity. In addition each individual river if it approaches it's high floold stage, will cause damage in it's own plain area. This applies to all rivers around the Kachhi and whilst it will be possible to organise a system that will work and provide information for the plain as a whole, it will be incumbent upon the individual villages at or near the exit points of the streams to determine or be given the basis from which they can draw their own conclusions as to when a move must be made or extra protective work thrown up. Thus if the Lari, for example, rises and that it's gauge height adproaches the 20 ft. mark, flooding will be occurring on the Lari plain and that area will be in a position of flood danger, even though the Kachhi as a whole may not be effectod. Each of the streams considered, will, however, effect certain parts of the plain when their own area is filled and in the example quoted there is littlc doubt that a flooding of the Lari will effect the railway line when it's own valley has been filled completely.

3. The whole quesrion, therefore, is a complex one for which at this stage no solution can be found excepting to institute warning systems and to prevail upon the populations to move to safer ground if so required. In due course it should be possible to determine what protective measures can best be utilised after study has been made of the catchment areas of the rivers and sufficiently long records exist to be able to assess on reasonably rational basis the flows that can be expected under a variety of conditions. Some help will be possible by linking the Hydrological stations around the plain with the main Met. stations on the higher ground in the catehment of these rivers and instituting a system whereby the warnings will come from the upper reaches than to have to wait until the flood arrives at one of the lower stations by which time it would usually be too late to do very ;much. Lack of gauging equipment prohibits at this stage a more accurate determination of flow though it is hoped that this deficiency will be rectified shortly.

4. It is suggested, therefore, as a preliminary measure, that the gauge readers be instructed to report regularly to the administration office the moment any of the rivers starts to rise and that these reports be transmitted to the Water Resources Organization Office by the P.As concerned for a full analysis, but that each P.A's office be givcn a schedule to guide it so that no delay may occur. These schedules will naturally vary as time goes on and more knowledge becomes available. The W.R.O. central office would consider the plain as a whole entity and through the Commissioner's Office issue the necessary warnings when it is seen that any further flow or increased flow on to the plain will upset the drainage balance.

A telemetering system, based on automatic wireless transmission of the gauge heights to a central office, is being considered, as normal means of communication during the rains are virtually impossible.

Government should. I feel, take this up and request one or the other of the International Agencies to provide and set up the scheme.

The cost of the scheme, such as provided by Messrs Stevens of the U.S.A. is, when compared to the annual losses and damage, negligable.

III. Soil Erosion.

The soil erosion and denudation of the catchments in Baluchistan and some of the Hill areas is, to say the least, excessive. Particularly in Baluchistan hardly a blade of grass remains to serve as catchment protection.

2. I have no doubt that the Forest Department are aware of this, but very little appears to be done in the way of control of cutting and re-afforestation. From the old district gazetteers one gathers that a hundred years or more ago the area was well wooded. Today such trees or shrubs as attempt to live are promptly cut down or destroyed by the over-grazing of the goats and camels.

3. All this paints a dreary picure, but it does not end there. The denudation with its attendant excessive erosion of the high-lands means inevitably that heavy silt loads are thrown on to the agricultutal areas and the 1956-57 rainy season permitted some of these loads to be measured. For example, on the 19th of July, 1956 a small Nalla running through the Quetta Cantonment carried a silt load of 120,000 tons in 24 hours. This means a daily loss of the order of 5,700 tons per sq. mile per day. Similarly the Nari on the 14th of July and at a discharge of 52,000 cusecs was throwing some 13,800,000 tons on to the Kachhi plain every 24 hours. Say roughly, ·8 acre ft. of silt per sq. mile in one moderate flood. In both cases, these were not maximum floods and the amount of silt discharged at maximnm flood stages will be very much higher. It will be recalled that the progression is a geometrical one not an arithmetical one. From such figures as we possess at this stage, it can be reasonably assumed that in any 24 hour period during the 1956 flood season the rivers draining into the Kachhi Plain could and probably did deposit 42,500,000 tons of silt. This means that 425 sq. miles could be covered in one day with an inch of silt. Now, the denudation is such that the upper horizons of the soil have already been removed and in the majority of the cases all that remains are the useless fractions, which even in their natural state can hardly bear vegetation. The effect can be seen as one travels through the Kachhi plain by train. This process is going on all over, and whilst we are building the delta and raising the Kachhi Plain level, at the same time the upper areas of Baluchistan are being ruined at an ever-increasing rate.

4. It will be advanced that flood retention dams should be built, but let us consider one small dam 30 ft. high, which burst in 1956. This dam was only two years old and during the 1955-56 rainy season, which was normal or if anything below normal 5 ft. of silt was deposited behind the wall. Even if the dam had not failed, it's life would have been only of 6 years. Such a short life is definitely not economical. It is a sad waste of money. It is hoped shortly, once the Water Resources Organization is fully operative, to be able year by year to determine the losses of every catchment throughout West Pakistan and year by year show where the danger spots lie. A point which, it is pertinent to raise here, is that we are only dealing with the suspended loads and the question of bed loads has not yet been attacked. Broadly one can assume that the

bed load of a river is at least equivalent if not greater than the suspended load. This is, if anything, makes the picture infinitely worse.

IV. Fluvial Morphology

It is quite evident that little attention is or for that matter has been paid to the fluvial morphology of the rivers of West Pakistan. Man has built structures in the stream beds. He has abstracted water from the rivers and in general, changed the regime of the streams considerably. All this without any thought as to the effect of this upon the rivers themselves and upon their behaviour. In addition, the irrigation works designed and operated for many years were designed for a specific silt loading This loading was determined in size and quantity for such the works were adequate and properly built. But since that time many catchment areas of the tributaries of the Indus have been virtually rendered useless by deforestation and other mal-practices and the quality of the silt that is now carried is quite different from that which existed at the time when the major irrigation works were constructed. Because of this there is no doubt that the morphological aspects of the whole region present a problem and a danger that cannot be lost sight of.

2. The mountain streams are tending to raise their valley deltas and by so doing change their own regime year by year.

Further more, there is a tendency for them to change the levels of the bed of the Indus itself. Thus we are getting a two-fold change taking place. The Indus forms the base level for it's tributaries just as Indus delta forms the base level for the Main Stream. The changing conditions that are brought about by the excessive denudation and the carrying of excessive silt loads raise or lower the beds of the streams locally and by so doing upset the regime conditions that existed at that point. If this fact is not yet felt to the full, it is very probable that it will be felt very shortly. Aggradation of the Indus bed results in higher flood levels, because of it the inadequacy of the present bunding is a result that we must expect. The denudation of the upper areas throwing coarse material into the Indus is likely to be a major cause of this as the carrying capacity of the main stream is severely restricted because of its low velocities. A further factor which plays an important part is the fact that as the catchments deteriorate so the flood waves increase in size and destructiveness.

As the floods increase so does their carrying capacity and so does the aggradation or degradation of the beds. At present, a study of the flood characteristics of the Nari River and others indicates that the usual duration of a flood wave is of the order of 16 hours. Here lies the clear proof of the grave condition of the catchments. Retention and absorption have been reduced to a minimum.

3. If we are to safeguard the irrigation system of West Pakistan and at the same time safeguard much of its land which is at present in use, then the whole question must be considered as one picture. It will not help to raise the bunds on the Indus when by so doing we increase

water-logging. It will not help to attempt to dam up the tributaries when the dams will fill within very few years. The answer lies not in those methods, alone, which are like using Aspirin to cure Cancer. The Aspirin may well take away the pain but it does not remove the sources of the trouble. First and the foremost it is necessary to protect the catchments. Forestation on a heroic scale must be undertaken. Where this is impossible, the areas must be put under grass and any use of these areas very strictly controlled. This applies in particular to Baluchistan which should become predominently pastoral.

4. One is well aware of the tribal difficulties and the political reactions of such a sweeping change, but there can be little doubt that unless such a course of action is adopted, West Pakistan faces ever-increasing starvation. This is no longer a question wherein dubious rights of an individual can be considered ; the only consideration that must be given is to the country as a whole and in this the individual must not interfere. True democracy in this case implies strict control so that no man can ruin the soil of West Pakistan.

V. Correction and control and possible prevention.

The Region, whilst important to itself and the people in it has a very low economic margin – the large area to be controlled is disproportionately great in relation to that which is to be protected.

On the main streams the corrective and control works must be of the highest order of design and quality of material because of the extremely destructive and erosive forces they would have to resist and control.

This means heavy costs.

The ideal would be to retard the velocities of the floods, increase the absorptive capacity of the catchments, lengthen the retention periods and flatten out the flood peaks to keep them within the channel capacities.

To achieve these desirable ends means, in effect, that the catchments must be protected by suitable forest or grass covers, that over grazing and cutting be **strictly** controlled, that proper soil conservation is carried out in all agricultural areas, that the river beds are free from man made, badly designed obstructions and that there is **no** encroachment on the channel area.

The latter is particularly important as there appears no control whatsoever on cultivation in the river beds.

Whole fields are built up within the banks and the bed area is reduced to a fraction of its natural size and incapable of coping with the high flood flows which must then spill over the valley.

Whilst this shows considerable industry on the part of the people it also shows a deplorable lack of common sense, and is clear evidence that guidance and legal control do not exist.

Moderate protective and corrective works may easily cost Rs. 200/- per acre of catchment. What this means in terms of cost per acre of arable land protected can only be assessed when the proportion of good land in each catchment is known.

Even from these few notes it will be obvious that to supply flood protection and warning is a task that cannot be solved easily or quickly.

The following suggestions are however put forward as each will help in a modest way and give time to the Hydrolegical Survey to get the data needed so that a complete plan can be made for each river.

(*i*) That where feasible, warning systems be operated. This will apply in particular to the Kachhi Plain and requires full cooperation between the W.R.O. and the Admin. the Met. Service, the Post Offices and possibly other Departments and Units.

(*ii*) That *all* encroachment of the river beds be ruthlessly stopped and removed.

(*iii*) That where feasible, minor flood retarding structures be built.

(*iv*) That the Forest Department make ***determined*** efforts towards re-afforestation and that cutting be more strictly and properly controlled.

(*v*) That grazing be properly controlled.

None of the above will solve the problem but all will alleviate it and in the meantime the W.R.O. will be able to undertake the following work more or less in order of priorty.

(*i*) Establish the urgently needed Hydrological stations. (This is already in hand).

(*ii*) Examine each catchment area and establish its physical characteristics.

(*iii*) Determine the size, value and position of all arable land,

(*iv*) Determine the possible dam sites and assess the channel characteristics.

(*v*) Determine, with the Agriculture and other Departments the land use potential.

(*vi*) Assess, with Admin, the political and social factors.

(*vii*) Coordinate all the above into a complete plan which will show the needs and potentials of each river.

With such a background it will then be possible to determine in detail the type, size and position of the works that will be needed, to determine their economic and social sigeificance and after Govt. approval pass the plan on to the Design and Construction Departments.

Schedule of Flood Flows at Various Stations

Serial No.	Name of river	Gauge site
1.	Nari Gauge (H. W.)	U/S Head Works
2.	,, ,,	at Head
3.	Nari Bank	at road Bridge
4.	Thaka (Talli Tangi)	along 10′ u/s of C.B.M.
5.	Nari	Babar Kach 125′D/S Railway bridge
6.	Bolan	Kundlani road bridge
7.	Lahri	Ghorki tangi
8.	Baleli	Road bridge
9.	Sariab Lora	Murry Burry road bridge
10.	Karak lora	21 miles away from Quetta on Quetta Pishin road
11.	Pishin lora	at D/S Burj Azizkhan
12.	Shora Rud	at Punjpai road
13.	Sharinob Lora	at Sheikh Wahsal Railway Bridge
14.	Khorki river	Ziarat road crossing bridge
15.	Pishin Lora	6 miles towards Culistan
16.	Kowas Tangi	Near Ziarat Quetta road
17.	Kohan Tangi	Kohan village
18.	Pishin Lora	at Shebo Head
19.	Marha Tangi	along C.B.M. of W.R.O.
20.	Wahar	Near Loralai to Wahar road
21.	Narachi	at Head works D/S
22.	Anambar	U/S Head Works
23.	Ghati bridge	U/S road crossing Duki to Gumbat road
24.	Thul Rud	Thaddri village
25,	Baghoa Rud	Baghoa Gorge
26.	,, ,,	Shanjawi Gorge
27.	Kach	II bridge from road

in Baluchistan Area.

Drainage area	Height of H.F.L.	X-sectional area at H.F.L.	Velocity at H.F.L.	Discharge calculated and by P.F. Curve Cusecs
8087	16.30	7600	21.1	160000
8087	24.55	12645	12.7	160000
8486	22.42	12475	14.3	175000
349	24.84	6711	3.6	24500
685	23.22	8200	8.0	36000
1868	40.15	7907	8.0	61500
1294	31.75	3788	13.2	50000
127	21.90	2839	4.8	13500
18	9.86	367	11.5	4200
785	16.53	1710	22.5	38500
2687	20.17	3660	20.2	74000
647	6.97	1325	26.8	35500
1347	19.19	1994	35.1	60000
137	13.10	1812	7.7	14000
630	9.15	1850	18.4	34000
102	14.98	1407	8.4	12000
165	14.05	744	22.2	16500
655	11.80	1471	24.1	35500
134	11.99	1834	7.3	13500
209	7.59	899	20.0	18000
374	27.57	5380	4.64	25000
2866	14.78	6558	12.2	80000
3611	35.07	5094	19.6	90000
623	26,59	5702	5.8	33000
523	14.00	2730	11.3	31000
376	11.0	3863	6.5	25000
129	24.46	4304	3.1	13500