

Memorandum on the nature and effects of the Flooding of the Indus on 10th August, 1858, as ascertained at Attok and its neighbourhood.—By Capt. W. HENDERSON, Engineers.

On the Indus, 7th January, 1859.

I begin by observing that this is not the first flood of the sort, but that one on a somewhat larger scale, but in other respects very similar, took place in May,* 1841. I have seen two very brief accounts of this flood, one I think collated by Col. Abbott, the other furnished by Col. Cunningham. I have also collected at Attok and the neighbourhood some information on the effects of this earlier flood; and as the two are very similar and mutually throw light upon one another, I shall have to refer to that of 1841, and so premise this allusion to it.

The first point on which information is called for is the spot where the obstruction took place. This can only be ascertained by sending up an Officer by way of Cashmere. In the meantime I may offer a few observations.

The obstruction of 1841, took place in the upper part of the valley of the Shayok River or northern Indus which joins what is considered as the main Indus at Keris, and I think brings down more water than the other, which from its long and straight course is naturally considered the principal or parent stream. The blocking took place in the part of the Valley where the stream runs at the back of a high range which separates it from the Nubra Valley. I have been over this ground and was struck with the frequency and solidity of the glaciers which occupy almost every valley in the range, with their tributary glens also. The range is granite, and large rough blocks of that rock form an important component of these glaciers.

The first information was received in the neighbourhood of Attok about the middle of July 1858, and of all that I have heard of, that which appeared most worthy of credit was a letter forwarding what purported to be a general warning by the Syuds of Kangra or

* I have no books to refer to, so that the date is assigned on native evidence, which is particularly uncertain as regards time.

Kangri. The Attok boatmen declared at once that the warning received in 1841, emanated from the same place; they recognized the style and stated that the same form of adjuration was employed, and that the signatures appended were the same, except that two or three individuals, who might fairly be supposed to have died in the interval, were omitted from the later document. Search was then made in the house of Bulloo, the oldest of the Mullicks of the boatmen, but though it was well known that the paper was preserved there till a year or two ago, the search proved unsuccessful.

There is a village named Kangri marked in the Surveyor General's map of the Punjab and adjoining countries, and I believe this is the place alluded to, it is at no great distance from the Nubra and Shayok Valleys, and if the fact be that both papers issued from it, a fair inference is that in both cases the obstruction was at no great distance from its site; for in these valleys such news would not travel far except it were down the course of the river. We know that the damming of 1841, took place within two or three days' march of the village, and, till better evidence be obtained, can but conjecture that this also occurred in the Shayok or in the Nubra valley. Both are well adapted for the purpose, being wide with stragulations at intervals, having comparatively a small slope of bed and being supplied from large glaciers above with considerable and unfailling streams of water. For though the main fall of the Indus-bed takes place between Kangri and Attok, yet the general character of all the streams I have observed in the Himalayas is to fall in steps, a comparatively sluggish portion intervening below the first rush of the minor tributaries, to be succeeded by the main stream making its way in a series of rapids for two or three hundred miles. Both the Nubra and the upper Shayok are thus comparatively slow flowing, and in the former especially there are numerous quicksands.

I have two or three times crossed the Shayok, and found it in the summer time a stream of considerable size.

On the other hand, and contradictory to the above, all Major Becher's information pointed to the river of Gilgit, and that pretty consistently; but as this cannot be reconciled to the facts I have noted, as I understand them, I am inclined, till more evidence is obtained, to discredit it. I do not find in the map alluded to glaciers

marked so far west as the River of Gilgit* nor are the mountains from which it comes so high or so snow-clad as those to the eastward. Indeed I do not know in any part of the Himalayas a region so likely to give birth to catastrophes of the kind as that around the upper part of the Shayok.

The solution of the point is, however, very easy. The whole Indus above the Gilgit river is open to travellers proceeding under the protection of the Maharaja of Cashmere, and any officer starting from that valley and striking the Indus at the foot of the Nunga Purbut, (a route which I recollect an officer of the artillery following in the summer of 1855,) and thence marching upwards, would very soon ascertain positively the exact locality of the obstruction. I should be glad if opportunity offered to proceed thither for the purpose, and regret that when in that country before, I gave less attention to the matter than I should have done had I thought that a flood like that of 1841, could by any chance occur again in any definite number of years.

The second point mooted is the nature of the obstacle. We may pronounce with almost certainty that this was the sudden irruption into a comparatively narrow valley of an immense fragment of a glacier. I have already alluded to the glaciers of the region where I suppose the obstruction to have taken place. I have never seen those of Switzerland, but from what I have heard of them I think that the ones now referred to differ from the character ordinarily assigned to those in Europe, as they certainly greatly excel the latter in magnitude. Yet even in Europe a catastrophe similar to those which have taken place in the Indus valley occurred in that of the Drance in 1818. When crossing from the Nubra to the Shayok valley in August 1855, my companion, who had been in Switzerland, would at first hardly admit that the enormous mass of earth, rock and ice commingled and agglomerated together, with a broad stream of the dirtiest brown water issuing from its foot, and which I pointed out, filling up a tributary valley on our left, was really a glacier; and several hundred miles farther south crossing the great shed between the Lanskar and the Chenab, he pointed out the features he had been accustomed to see, and which we generally find

* There are however glaciers in every direction and some remarkable ones. Eds.

in description, clear ice of various tints of green, and deep crevasses crossed by snow bridges, and with comparatively clean water running within them. The formation in this case was lime-stone, in the former case granite. With regard to the magnitude of these glaciers I need only say that I travelled nearly a whole day along one which was upwards of fourteen miles in length, varying in width from half a mile to two miles, and several hundred feet in depth.

The glaciers are, it is well known, in constant motion; their progress being subject to the same laws which regulate the motion of rivers. As they advance, their ends melt away and the Moraine gets washed down by the streams that issue from the body of the glaciers. The flow of one glacier measured by Prof. Forbes showed an onward movement of about 450 feet per annum, and it is evident, that where a glacier is cut off above the melting point by a stream running past its end, this motion must make it tend very considerably to encroach into the valley of the stream.

A landslip in one of those huge banks is quite a conceivable contingency, and in no case more likely than when the glacier protrudes with a narrow base and extended top from a small feeding glen coming in, nearly at right angles, into a narrow valley, whose stream crosses the path of the glacier, washing away the narrow foot which the mass behind protrudes, and on which it rests. This foundation being once undermined, the falling forward of a piece of the glacier is the result to be expected; and it is possible that this result often takes place, but that it is not often that circumstances so combine as that the process is delayed till a mass of formidable dimensions topples over.

The remarkable opacity of the water of the Shayok, caused by the glaciers I have described, struck the Messrs. Schlagintweit when carrying on their observations in the neighbourhood, and by adopting a simple test of comparison, they satisfied themselves that in this character it exceeded the water of any stream which they had encountered.

The third point is the "length of time the obstacle remained." On this head the only information to be obtained is native, and that is always vague with regard to matters of time. The warning that came down the river purported to bear date the 2nd July, but

it appears more likely that this date was subsequently inserted in the copy, because it would not allow time for the paper to have travelled down, it having been handed to the Assistant Commissioner Lieut. Shortt, at Shumsabad near Attok, in the middle of the month.

The paper stated that the river had been closed for three months, which would make the beginning of April, and, as the outburst took place apparently on the 8th August, would give for the whole duration a little over four months. But I do not think it likely that so long an interval elapsed—

1st.—Because the period is almost certain to have been exaggerated.

2nd.—Because the thawing powers of the May sun which make that month so peculiarly dangerous from the frequency of avalanches, is likely to have caused the slip.

3rd.—Because from the latter end of May to August those snow-streams are so large that a four months' supply, including that period in the four months, could hardly be supposed to remain stored.

4th.—Because a rather shorter period is assigned, and at a less favorable time of the year, from February to May, for the storage of 1841, which contained apparently about twice the quantity of water, while it is from previous considerations unlikely that any material difference existed between the sites of the two obstructions.

I am inclined to think that the stoppage took place about the middle of May, that it existed for a month before information was sent down below, as till that interval it would hardly be considered a really serious matter; the paper must then have taken about a month to reach Attok, which it did in the middle of July, and after that a delay of nearly another month occurred before the water appeared. The time could not be much shorter than that, though it may have been longer.

The fourth point referred to is the length of time during which a diminution of the stream was perceived below. On this point, I can state that though after the warning rumour came to be pretty generally discussed, people fancied that the stream was peculiarly low, and that it lent corroboration to the report, nothing occurred which would have excited much attention but for the alarm in the country around, and Major Becher assigned as a reason for

regarding the warning with suspicion, that there was nothing unusual to be observed in the conduct of the river.

But the truth is, that there is no reason to think that any of the tributaries, at the point where glaciers abound, is of importance sufficient to affect perceptibly the Indus at Attok; nor indeed is it conceivable that any stream, by the subtradduction of which the Indus could be sensibly diminished, could be dammed up for three months (and I have shewn that the time could not be much shorter); while it is certain that if this were possible, its occurrence would cause a flood far more extensive than that of the 10th August last.

The occurrence of a few cloudy days diminishing the snow melting, or of showery weather in the Hills, cooling the atmosphere there, produces changes in the river, when alternating with bright weather, far more than sufficient to disguise the cutting off of half a dozen of the rivulets which feed the upper waters of the Indus. The river rose last year rather early, compelling me to remove the usual boat-bridge a full month sooner than in 1857, while it afterwards continued for a considerable time at a moderately high level, fluctuating, but not making much progress. We were thus able to establish the bridge in another site, where it continued till 1st June. But all that can be gathered from this is, that along the upper Indus the spring of 1858 was warmer than that of the previous year, but that the genial April was succeeded by cold and cloudy weather. It is indeed a matter of tradition that in 1841 the river became very low previous to the flood, so much so, that men used to cross it by fording above Attok, and when I was collecting information on the subject, they told me that when the bridge of boats was up in February, the river fell in one night several feet, so much in fact that they had to remove boats from either side. I have considerable doubts as to the correctness of either story; and, presuming them both to be amplified from a real paucity of water, have still no reason to think that they had anything to do with the fact of one of the feeders of the river being dammed up some six hundred miles off; besides that, as I before hinted, the period of storage from February to May appears too short. It was also a prominent part of the tradition that the water was much warmer than usual;

as if the snow-supply had been cut off. This I think as improbable as the other circumstances narrated ; and to illustrate the probability of their being exaggerated into falsity, I may mention the facts with regard to another phenomenon universally insisted on.—All accounts of the flood of 1841 particularize the wave or wall which swept down the channel of the river, and the noise occasioned by it, which was the first harbinger of the approaching destruction. Some of my informants gravely talked of this wave as 50 or 60 feet high, and of the roar being heard while the water was still a considerable distance behind. In Col. Abbott's notes on the matter, these points are prominent, and it is added that in front of the great wave was a moving mass of carcases, trees, and other matter, swept on by the power of the water.

On this last occasion I was myself on the river in a row boat, which a wave one foot high would doubtless have swamped, but wave there was none, nor noise either, nor any appearance of carcases or anything of the kind. The river commenced rising quickly, but step by step, nor until it had attained a considerable height was there any sign of drift-wood, field-produce, or other floating material.

I made fresh enquiries into the circumstances observed on the previous occasion, and then discovered that there was living till 1857 an old boatman called Lutchoo, who it was well known to all the men had been sitting on his boat in the middle of the bridge at the time the flood occurred, and had managed to float away upon it and ultimately to come safe to land in the mouth of the Herrot. I do not deny that this was a very remarkable escape, nor do I doubt that one dam might give way in a more gradual mode than another, but I feel convinced that a three feet wave would have swamped every one of the old Attok boats, and looking to the ordinary action of running water, am certainly inclined to believe that the flood came down in 1841 much as it did in 1858 ; and that the wave, the roaring, and the mass of dead bodies, are all fictions together, and in the same way I think that the diminution of water in 1841 has been invented or exaggerated, and that if any such took place it was not owing to the obstruction at all ; for on the one hand the stoppage of the main stream of the Indus, at any point where it

deserves such a name, is too wild a supposition to be seriously advanced, and is not the least borne out by the extent and nature of the flood; while, as insisted, the feeders which run through the tract where glaciers are common are too insignificant to affect the Indus at Attok.

The fifth and sixth points enumerated, the height to which the waters rose at the obstruction, and the distance to which the stream was dammed back, are of course far beyond our ken, when the very location of the obstruction itself is indeterminate to a distance of about 300 miles, nor can they be ascertained in any other way than by actual inspection; for though a very rough approximation might be made to the quantity of water discharged, the high valleys vary so much in breadth and in longitudinal slope that the question would still remain undecided; early inspection will settle the point, and that alone will.

The velocity with which the flood water came down was very different at different points of the course, being in the general greatest at the first, and diminishing as the slope of the bed decreased. From Attok to Kallabagh the velocity was fifteen miles per hour, the fall of the bed being about two and a half feet per mile; and this leads me to note that the velocity of the prior flood appears to me to have been under-estimated in an account I have seen (prepared I think by Colonel Cunningham). It is there stated that the flood water passed a village on the upper Shayok valley at 2 P. M. and that it reached Torbela at the same hour just two days after. From this a velocity of between eleven and twelve miles is deduced.

I should rather be disposed to think that only one day elapsed, and that the velocity attained to nearly twenty-three miles per hour, but for one consideration, which is this. The water certainly reached Attok a little before sunset, say about 6 P. M. and from Attok to Torbela is forty miles. This would give therefore, if the hour at Torbela be correct, a velocity of but ten miles per hour. I should expect, from the river here debouching out of the hills upon the Chuch plain, a great diminution of velocity between Torbela and Attok, (to be to some extent recovered below Attok), but not such a falling off as this; and therefore I think it probable that the time at

Torbela was somewhat later than 2 P. M. on the day after that on which the dam gave way, giving a velocity of about twenty-one and a half miles per hour to Torbela, and of thirteen thence to Attok. But, however, that may be, as I was at Attok on the 10th and at Kallabagh on the 12th, as I made enquiries on the way down, and at Maree, opposite Kallabagh, found an European Patrol Officer who could speak with certainty on the point, the rate I have given above may be accepted as an accurately observed one for the portion of the river I have particularized. The highest velocity I have obtained in the annual floods at Attok is thirteen miles per hour, and judging from what I know of times of transit, I should estimate the highest ordinary velocity between Attok and Kallabagh at eleven miles for the whole way. With regard to the velocity on this occasion above Attok I can only offer the following,—presuming the obstacle to have taken place as on the former occasion in the vicinity of the Nubra valley, we cannot assume the place at less than 9000 feet above the sea-level, or say 8000 above the Indus at Attok. Taking the extreme distance at six hundred miles we have a mean fall of $13\frac{1}{2}$ feet per mile to set against the $21\frac{1}{2}$ feet per mile from Attok to Kallabagh, while we know that as far as Torbela the river runs in a comparatively confined rocky channel and at all times with considerable velocity. It seems probable then that up to Torbela the velocity with which the first flood water travelled, considerably exceeded 15 miles per hour, that from Torbela to Attok it did not attain this velocity, but that it did from Attok to Kallabagh, below which place again it fanned out more leisurely, until 150 miles below the effects were hardly to be discerned and the time of first arrival cannot be ascertained. The flood water reached Attok at 6 A. M., and the rise was at its maximum about 1.30 P. M.; the total height attained above cold weather level was 80 feet, while the earlier flood, I estimate from all the information and circumstantial evidence which I have been able to procure, culminated at 12 feet higher. The annual flooding in July and August reaches about 50 feet; in 1856 it was a little over that; in 1851 it was almost exactly 50 feet; while in the other years I have observed it, it has fallen a little short of that height; so that this flood may be taken at Attok to have been 30 feet over the ordinary flood

level. At the time the occurrence took place the river was about half level, so that the rise which ensued in $7\frac{1}{2}$ hours was 55 feet nearly. This rise was of course greatest at first, and during the last hour or two very gradual. About 10 o'clock the rapid increase ceased, and when I then crossed the river (not without danger) it was about 6 or 7 feet lower than the maximum height which it attained. This would give for the 4 hours a perpendicular rise, on the mean, of 12 feet per hour. I was close to the bank during the whole time, and though more intent on saving the boats &c. than on watching the progress of the water, can give an approximate conjecture as to the rate at which the river increased. During the first hour it rose about 26 feet, second 12 feet, third 7 feet, fourth 4 feet. At first it came welling up quite quietly, but very rapidly, not less for a little time than a foot per minute. This of course did not last very long, for as the width, the depth and the velocity increased, so did the discharge, and while the rise was very obvious till about 10 A. M. it then ceased to strike a transient observer. The width meanwhile at the narrowest part at Attok was a little over 1500 feet, the breadth before the flood came down having been about 800. I have not had an opportunity of ascertaining what the rise was at Torbela and above it, but it must have been in the general greater than at Attok; that is, in places with the bed as narrow, and the banks as steep and immovable, and with the egress as confined, a greater rise will have taken place; for below Torbela lies the Chuch plain, sloping in comparison gently to the river. Over this ground the flood-water widely extended, and gradually returned, while the general direction of the Indus and of the Cabul river a little above their junction is almost directly antagonistic, and the Indus flood, keeping in a great measure its course, rolled over the stream of the Cabul river and filled up its channel and the adjacent low ground to a length of about 30 miles, with an average breadth of more than 2 miles, and a depth at base of 60 feet above the original level of the stream. This large safety-valve exhausted much of the destructive effects which would otherwise have been felt below; though the country was probably a loser rather than a gainer by the exchange; for the valley of the Cabul river is low, well cultivated and thickly populated in comparison to any tracts I know near the bed of the Indus.

Below Attok we find a comparative diminution of violence, though between Neelab and Shadeepore where the river finds a passage through the limestone range of the Neelabgosha the channel being in general narrower, abounding too in sharp turus where dead walls of rock oppose a bar to a free run, and throughout being closed in by steep limestone cliffs, the height attained by the flood is in parts even greater than that recorded at Attok. Leaving the limestone for sandstone, the channel widens out and becomes less abruptly tortuous, so that between Shadeepore and Mokkadd, the maximum rise is much less than above; still more is this the case through the gravel hills which dip even less steeply into the channel, and which have at foot been worn more to the requirements of the river.

Here the rise reached only 10 or 12 feet over the annual flood mark.

The hills of the salt range, through which the river runs just above Kallabagh, did not cause such an additional rise as might have been expected; for the passage through is short and below all is open. The height as measured at Mr. Mathew's house at Marree gave only 8 feet above flood-level. The annual rise here which at Attok is 50 feet reaches only 16 or 17 feet over cold weather mark. Below Kallabagh the river fans out very remarkably, with however a strong set upon the right bank. Here the rise was very small indeed. The annual flooding at this part attains no great height, and is principally striking by its vast expanse. Damage resulted below Kallabagh, but not by submergence, it was the effect of the set of the current alluded to.

Farther down, the effects are marked not by inundation and destruction but by the after-result, a comparative subsidence which covered all the islands and flats along the right bank of the river with the spoils of the regions above. The extensive mud-banks and reed-jungles in the vicinity of Esankheyl were particularly rich in this deposit; and between Kallabagh and this place we were fortunate enough to recover 17 out of 20 of the large boats (about 30 tons measurement) which had been carried away from their moorings below Attok. A little below Esankheyl where the Koorum river falls into the Indus, we got the last of the

boats, and observed the harvest of drift wood, so abundant above, *tail* away and disappear. Beyond this only a few straggling pieces made their way. A slight rise, but insufficient to suggest anything beyond the usual rains of the season, was observed between Esankheyl and Dera Ismail Khan; below that, nothing was noticed unusual. The swelling of 1856 which at Attok we know did not attain by $28\frac{1}{2}$ feet the rise of the 10th August last, seriously injured Leia, and almost washed Dera Gazee Khan away, breaching an embankment which had been constructed above; so different are the effects after passing over a large extent of flat country of the continuous swelling of the river and a flood which alone attained a much greater height, but was transitory in its nature. The same fact I observed in my enquiries about the flood of 1841, which was also but little regarded below Kallabagh. With reference to the running off, of the flood-water, it is difficult to speak with much precision. There was a violent storm of rain about Attok on the 7th August, and I know that storms in the Himalayas are often very wide spread and extend far down into the plains, not I mean exactly synchronously, but about the same time a disturbance will be found to have occurred over a large tract, in some parts snow, in others rain, and in others again wind and dust. In the summer of 1855 I thus traced two storms by their visible effects, and by enquiries from European Officers, the one nearly north and south, and the other westward—the directions in which I happened to be travelling—and each for a distance of about 300 miles.

It is possible then that the storm I speak of may have been a portion of one which swelled the pent-up lake, and issued in its outburst, but whether this be the case or not, the probable occurrence of rain in the hills about the time of the flood makes it impossible to assign any correct date of its subsidence.

The fall was at first slow, but the river was about 8 feet below its maximum by sunset, during the 11th the water however continued higher than the yearly flood ever attained to, and it was not till the afternoon of that day, that the boatmen would venture to man a boat to go down, alleging that all their usual land-marks were covered, and that without them they dared not navigate the stream.

During the night, however, the river fell a little over 20 feet and during the 12th it had, in actual height, returned very much to the position it occupied before the flood came down. But the stream was very violent and disturbed, for there had taken place on a grand scale the action which on a small one is annually repeated in August and September, viz. the filling up of the bed above stragulations, and at other points where a check is imposed on the velocity, with *detritus* of a solid character brought down from above. This induced much swell and great rapidity over these banks, and the process of their being cut away from down stream upwards made itself apparent. For several days the ferry at Attok was nearly closed on this account, and the boatmen pointed out with some apprehension very rough water in places where it had never been observed before. Gradually the shingle banks were removed from under the main stream, but it appears that there is still an unusual amount of *detritus* in the bed at Attok, and that the surface of the stream is sensibly raised thereby.

With regard to the "effects of the flood" I have little information about the tracts much above Attok; but I should have known if there had been extensive loss of life or property. That these escaped so far I attribute to the warning received about one month before the occurrence, and which, though under-valued by most of the officers to whom it was made known, was less easily disposed of by people living on the very bank of the river and bearing in mind what had happened only seventeen years before.

Without precautions taken, and I know that they were very general as far up as my information reached, such immunity as resulted could hardly have taken place; for the flood must have passed during the night from near Chelass to a little above Attok, and though the upper part of this tract, say as far as Torbela, appears more scantily peopled than either above it or below it, some of the villages near the river are situated within the rocky channel and placed upon the deltas of detritus brought down by small tributaries.

In such situations they are of course greatly exposed to the danger we speak of; and had no warning been received more injury than appears to have taken place must have ensued.

Where the flood came down during the day, as it did probably

nearly all the way above Chelass, and certainly every where below and west of Attok, people unless caught in some peculiar position could without much difficulty escape, except, as always happens in such cases, the few who, by over-eagerness to save property, expose their lives to foolish risks. There were very few human bodies (not above three or four apparently) seen to pass Attok, and the cattle and stacks of grain, straw, &c. which came down in considerable numbers belonged principally to the vale of Chuch.

Accounts regarding the catastrophe of 1841 agree in stating that many bodies were seen to pass Attok, and allowing for the probable amount of exaggeration, it is I think unquestionable that a very considerable loss of life then occurred, and had it not occurred then, there would probably have been more to chronicle now. The great cause of difference is clearly the experience of effects and the expectancy of repetition in the present case. A flood of the sort having happened within the memory of all the grown population, and having proved very fatal, as soon as warning was received in 1858 the people not only took precautions, but became prepared, on observing or hearing of anything unusual on the part of the river, to place themselves at a safe distance from it; without the experience of a similar disaster it was hard to tell what was going on or where it was to stop, and thus at Nowshera some people placed their property on the top of their houses when the rise over-stepping their calculations, destroyed both house and property.

At Attok again I saw natives, who had in mind what they had heard of the previous flood, go off at once up the hills, while the river was rising, though quickly by no means alarmingly so. It is also to be borne in mind that the former flood was much greater, for not only did it over-top that of 1858 by 12 feet at Attok, and the addition of a single foot in height to a torrent of depth, width, and velocity such as the Indus then presented would have been a very great increase indeed, but occurring as it did in May when the bridge-of-boats was up at the lower site, it had a much lower level to start from. For the bridge in question has never been held by the native boatmen after the submergence of a rock near which is their well known water mark, and the actual rise which took place in a few hours must therefore have been upwards of 80 instead of about 55 feet.

Now this greatly added to the danger, for people who found the water coming down were, from having had no experience of the sort of thing before, peculiarly liable to fall into the fatal error (by which most of the lives lost were sacrificed) of getting upon knolls or other rising ground, on which they found themselves surrounded and cut off before they were aware. In the present instance the civil officer applied to me in behalf of some individuals who were thus surrounded, near a village a few miles above Attok; they most fortunately escaped through the flood not rising over their knoll, and their waiting till an exit was again provided by the subsidence of the waters. Had the stream risen a little higher, their case was nearly hopeless; for of course under the circumstances, no means of assistance could have been brought from a distance. At Attok many of the houses in the Mullah Tollah or boatmen's village, just below the fort, were demolished, so was part of the opposing village of Khairabad, but in both cases the property was almost entirely saved. In the Chuch valley lying between Torbela and Attok, a few villages were wholly or partially destroyed, and in the valley of the Cabul river all those near the water as far as Nowshera. But in both cases the principal losses were in grain and other field-produce, and in cattle, both districts being low and well cultivated. Heavy loss was also sustained, principally by householders, at the station of Nowshera, and by Government in the destruction of roads and bridges, and stores of various sorts collected at Khairabad opposite Attok. On this point some interesting information regarding the vicinity of Attok will be found in the report of proceedings of a special committee of which Major Robertson, Lahore and Peshawer Road, was president; and which was assembled in September last with the view of considering points relating to the catastrophe which had just taken place.

Below Attok most of the villages are placed on the high banks, between which the river runs and there is hardly any cultivation near the water so that no damage of any note occurred till at Mokkadd about 80 miles below Attok, where upwards of 100 houses were demolished and some cultivation destroyed. Marree also suffered, though to a less extent, and Kallabagh, the last place where injury of that sort occurred, lost some 10 or 15 houses.

Below this, the chief damage done was the eating into the land on the right bank, an action which appears to go on, though in a very minor degree, almost year by year. For some little time as the water was falling the process was rapidly carried on, so much so that I saw the people busy cutting down fine large trees in order to anticipate the otherwise certain loss of the wood by the agency of the water.

All common mud and stone buildings on which the water rose to any extent were of course destroyed, no buildings of substantial masonry were, as far as I know, subjected in sufficient measure to the test. The Nowshera Barracks were not seriously injured, but they were not exposed to the violence of the stream, and the lowest of them had not more than 5 feet of water in it. A good many trees were certainly uprooted, because we found several cast up on the subsidence of the waters; but trees were not prominently observed floating down, and except in circumstances like those noted near Kallabagh trees were rather destroyed where they stood than carried away.

The upper waters of the Indus, where I conjecture the stoppage to have occurred, run through a country almost destitute of vegetation and it does not appear that along the course of the main river there are forests so situated as to have been affected by this flood. A good deal of drift wood was floated out of the creeks into which Nullahs coming down from the more wooded country empty themselves, but this occurs always on the river being greatly flooded by the summer rains, and on this occasion was not a feature of unusual prominence.

Dead animals too were rare. The higher Indus valley is very destitute of cattle, and part of what did exist there probably owed their safety to the warning communicated to their owners.

The banks, where not rocky, suffered according to the set of the stream, but not at any place that I know of to any very remarkable extent except below Kallabagh, to which allusion has already been made. This extended from a short distance below that town to near Esankhey, varying of course at different points. The greatest action appeared to be about 5 or 6 miles below Kallabagh, as the river was falling.

Fresh channels were opened in different parts of the river's course, where it is not circumscribed by rocky banks. The most noteworthy was at Attok, just below the serai which lies up stream of the Fort. This is below the junction of the Cabul river, where the real bed consists of a double trough worked out in the slate Rock, which comes to the surface in the centre. This trough is 1300 feet broad, and hitherto since 1841 the river has in the cold weather run altogether under the right bank, leaving the other hollow filled up with large blocks of granite, boulders of various sizes, and sand. Since 1849 this has sometimes been entirely dry and sometimes has had an insignificant rill running over it, the tendency being for the rill slightly to increase year by year. But before the prior flood, a stream of considerable size ran here, and now again we have one upwards of 800 feet wide and about 5 feet deep. The river moreover seems to have set the materials in the bed above, so that a tendency to pour more and more water into the new channel has been established. The boat bridges now consist of one-third more boats than used formerly to be sufficient.

A little below Kallabagh again, where the set was so marked upon the right bank, its result has not been, as might have been expected, to deepen the channel running under that side; but by encroaching on the land it has actually shallowed it, so that the navigation, which was conducted exclusively in that channel formerly, cannot now make use of it, but is forced into another which was not previously passable for boats.

I do not think however that this change will prove of a permanent character.

Silt deposit has taken place to an enormous extent wherever there has been a checked or diminished current, particularly in the Chuch valley above Attok, the valley of the Cabul river, and every Nullah and stream opening into the river. Of all the effects produced, this is the most striking and will doubtless prove the most lasting. In constructing the Road Trans Indus, we passed over for several miles the silt deposited by the flood of 1841. Where cultivation had been carried over it, it was no longer to be recognized, but, where the land had been left unused, it was still found overlying, in the shape of a fine grey admixture of sand and clay about 15 inches

thick, the very different natural soil below. In August 1858 the Trunk Road for nearly four miles to the East of Attok, and on the west, wherever sufficiently low to come under the influence, up to beyond Nowshera, was buried under this deposit. The total length so covered was 12 miles, and the depth averaged one foot, while wherever the silt was left on the road it equally covered all ground on the river side and a good deal on the upper. The water of the flood was surprisingly muddy and wherever not agitated by a violent current deposited this silt in abundance. It seems, as far as I have been able to ascertain, that this silt is highly injurious to garden ground—and there is a good deal of vegetable cultivation near Attok—but that for the ordinary cereals it does not do any harm when ploughed up with the subsoil. The natives complain of it as burning up their cultivation through its not retaining a certain quantity of moisture and from the quantity of sand it contains. Where laid thickly and in sheltered situations, it remained in the form of a sticky mud for 2 or 3 months; but in the open fields it cracked in every direction, and in about a month and a half was fit to be ploughed up. Going from Attok towards Nowshera the extent visible was very great, and, before the grass and weeds burst through the cracks, the appearance was that of very striking desolation. But no where was this objectionable deposit productive of more annoyance than on the Grand Trunk Road, which, in spite of the measures taken at once, was impassable for about ten days, till the silt dried; and when that process was complete and the cake got broken up, it issued in a light fluffy dust, which causes a heavy drag on all traffic; and in dry weather, rises in clouds almost unbearable. All the road which has thus suffered had been metalled with shingle, was in all respects nearly finished, and was beyond all comparison, the smoothest and most pleasant piece of road between Lahore and Peshawur. It sustained no injury of any moment beyond what I have particularized; and it was not at first, nor till some three months had elapsed, that we became fully aware how much the silt deteriorated the road surface for purposes of traffic.

A good deal has been done to remedy the injury and in the course of another year it is to be hoped that it may be entirely effaced. The silt appears to consist of very fine sand with just sufficient

clay to cement it together, and if it could be kept damp (not wet) would yield a soft, but, for light traffic, a very pleasant and suitable surface.

The last point to which attention is directed is the peculiar effects of the flood upon the Cabul river.

The slope of the bed of this river is a little under 2 feet per mile and very uniform throughout the part affected. The directness with which it lies contrary to the course of the Indus has already been noted, and it would appear that the flood water, finding vent that way, ran over the down stream of the river, no doubt checking it and interfering with it in some degree, but probably not altogether destroying it.

The velocity with which the flood passed over the Cabul river was probably at first somewhat greater than what it had through Chuch, diminishing as it ran up. Nowshera was reached about 8 A. M. giving a mean speed of upwards of 10 miles per hour. The first effect observed there was, that the water was running backwards a little more rapidly than it usually ran forward; so singular a statement, as it would appear at first sight, was naturally, till often reiterated, met by incredulity. But when the fact became certain, there could not be much hesitation about the cause, especially as it was well known that on the prior occasion great destruction* had taken place at the city of Nowshera, and as the residents in the cantonments were well aware of the report that another such flood might be expected. Soon light materials, particularly stacks of wheat-straw, were seen floating up, and these were heaped against the bridge of boats, which now curved up instead of down stream, and at last in the course of the forenoon broke up by the snapping of the two strong cables (one inch and seven-eighth inch) which, heavily fastened down at their extremities, and passing over low towers, supported the boats against the stream. These being now in part released were carried up the river, and some were stranded on the open plain 7 miles above. The flood still continued rising and was at its maximum at Nowshera about 3 P. M., about which time the last of the dwelling-houses, which were mostly built between the Trunk Road and the river bank, fell to pieces. It was observed that such of the houses as were not provided with upper windows gave the appearance of a

sort of blowing up when they fell after the water had covered the doorway. There must have been, on such occasions, a certain amount of compressed air within and while I don't think that it could have lifted the roof, yet, when the walls gave way and the structure fell, it was to be expected that the air would make its exit through the breaking roof, and so carry a cloud of dust up with it. The barracks being of brick masonry (and particularly good brick masonry,) and being on higher ground than most of the other buildings in the station, escaped without material injury. The flood now reached about 80 miles up the river, but stopt short by about 6 miles of the point where that of 1841 was distinctly to be traced to.

The height attained in the lower part of the Cabul river valley was very striking. It appeared to surpass anything reached near Attok. The causes I think were, that below the junction the right bank, on which the Indus would infringe, is bluff, and a side-current would be set off up the Cabul river, while again, as is observed of the tide, which in gulfs far surpasses the height attained in the open sea, the water, pouring in through a narrow opening and spreading out into the valley beyond, would maintain a fall in that direction; and before the check reached back again to the mouth a quantity greater than the fair capacity of the closed *sea* would have been forced into it.

The stream turned perceptibly by the evening, and ran down during the night, and this circumstance was the cause of much loss of property which in the day light might have been saved. Natives appear also to have had a dread at Nowshera of entering the water on account of the number of snakes and rats which were driven from their holds as the water rose. Nothing of this sort was observed at Attok, though there were a few serpents in the water. This is usual however in the large rain floods which occur yearly.

During the morning of the 11th household furniture in considerable quantity from the station of Nowshera was seen to pass Attok; and stacks of straw, Persian wheels, and such things, in large numbers from the valley of the Cabul river.

The deposit of silt was very great throughout the valley, as might have been expected in such a blind opening, and the water, after the

turn, ebbed away with sufficient gentleness to leave it nearly undisturbed over all the open ground beyond the actual banks of the river.

The out flow in the bed also does not appear to have been peculiarly rapid, and no remarkable cutting away of the original solid banks was observed.

Letter addressed to R. H. Davies, Esquire, Secretary to the Government of the Punjab and its Dependencies.—By Major J. BECHER, Deputy Commissioner, Cashmere, 1st July, 1859.

SIR,—I have the honor to acknowledge your letter of 2nd April, 1859, directing me, in accordance with the instructions of a despatch from the Secretary to the Government of India in the Department of Public Works, to ascertain the particulars of the recent inundation of the river Indus in August 1858, and to trace the residence of certain syuds of “Kangri,” or “Kangra” who are reported by Captain Henderson to have conveyed to the boatmen of Attok, a written warning of the coming danger.

When your communication reached me, I addressed Captain Sandilands (who is Officiating at Attok during the absence of Capt. Henderson) requesting him to send me the original paper, from which I should best be enabled to identify the authors; I also asked him to record the evidence of the boatmen, who had affirmed that the letter was authenticated by the same signatures as that alleged to have been received by them in 1841 on the occasion of the previous flood.

It seemed surprising that such an intimation should not first have reached Jehandad Khan of Umb, the principal Chief on the river's bank above Attok, for if it came from the source of the obstruction it would have been passed downwards from point to point, as had, I knew, been done in 1841.

Captain Sandilands replied that no document had reached the boatmen direct,—that the writing alluded to was a copy, which had been forwarded to the executive Officer, from the Office of the Assistant Commissioner at Attok; and he appended a copy of this and the depositions I had requested.