

SELECTIONS
FROM THE
RECORDS OF THE GOVERNMENT
OF THE
PUNJAB AND ITS DEPENDENCIES.

NEW SERIES,—NO. XV.

THE "CHOS" OF HOSHIARPUR

BY

B. H. BADEN-POWELL,
CONSERVATOR OF FORESTS, PUNJAB.



Lahore:

PRINTED AT THE PUNJAB GOVERNMENT CIVIL SECRETARIAT PRESS,
1879.

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A "CHO" OR SAND TORRENT AS SEEN ABOVE THE VILLAGE OF CHOHAL, DISTRICT HUSHIARPUR.

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DURING the last official year the Commissioner of the Jullundur Division called my attention to the inquiries that *Conservator's visit.* had been instituted by Mr. Coldstream, the Deputy Commissioner of Hoshiárpur, regarding the ever increasing damage done by the torrents or "chôs," which flow from the outer range of hills in the Hoshiárpur District. I promised to visit the district in the autumn, and accomplished this purpose in November last. I entered the district at Rúpar, and at once proceeded for some miles along the road which runs parallel to the range of hills at a distance of 4 to 6 miles, my object being first to see how these "chôs" affected the country at some distance from their source.

2. **Having** seen the same phenomena repeated again and again, *Outline of tour.* as I crossed sandy bed after sandy bed, I left the road, followed the course of a "chô" from Katgarh up to its source, and thus, having reached the hill tract, I pursued my march sometimes among the lower hills and sometimes at the foot of them, making excursions in various directions and crossing and re-crossing the range so as to see both sides of it, till I had traversed the whole range from one end to the other.

3. **I** have thus been able to form a pretty good idea of the formation and present condition of the range itself, and of these "chôs" or sandy-bedded torrents which flow from it. *Preliminary re- marks on the condi- tion of the range.* Before entering on a descriptive account or

suggesting any remedial measures, a few preliminary remarks have to be made.

4. It was my wish to have prepared a joint report with Mr. Coldstream, but he thought better to submit his report from a revenue and general point of view separately; this he has done, and has favored me with a copy.

Preliminary remarks.

5. I can only here permit myself one remark on the revenue aspect of the question, and that is, that at a time when taxation is becoming necessary to meet our heavy and possibly recurring famine expenditure, it seems to be a very important point in our economy that, while trying to raise new revenues, we should not endanger our existing sources of income, and especially that we should not neglect means (if means there are) by which lands, now barren and yearly extending in area as regards non-productiveness, might be restored to a condition of fruitfulness and so be able to pay revenue.

Danger to the land revenue.

6. In one tahsíl alone Mr. Coldstream says they calculate 35,000 acres of land covered with sand by "chôs;" it should not be forgotten that in this rich and well-peopled district, this land alone if reclaimed might be on our rent rolls bringing in a yearly revenue of at least Rs. 50,000.

Extent of area covered with sand.

7. Under any circumstances the preventative treatment of these "chôs," even if it did not result in the reclamation of land, would at least result in a cessation of yearly loss of revenue, which the continued action of these floods must entail.

Advantage of preventative treatment of these "chôs."

8. In order to convince the Government of the magnitude of the evil we propose to attack, *facts* are of the first importance. The most convincing fact would be a comparison of the accurately ascertained area under sand in the years of the old settlement, and the area *now* under sand as ascertained by a present survey; but this comparison is obviously unattainable at present. It probably will be so at the next settlement, and I fear that re-assessment will then convince the most sceptical what a powerful agent for mischief these "chôs" are.

The sort of facts that are available.

I submit, however, that though this is wanting, there is amply sufficient evidence to warrant Government taking action in the matter.

A systematic inquiry has been made, and the almost universal result has been that the villagers have everywhere asserted either positive loss or else the deterioration of their land. The same complaints were as universally made to me whenever I met the people on my way, although they did not know who I was, nor had they previous information either of my arrival or of the purpose of my visit. Indeed, it only needed a local inspection to convince oneself that what was said was in great measure true.

Mr. Coldstream has adduced distinct instances where it is on record that particular tracts were not affected by the "chôs" at Mr. Melville's settlement, which now are more or less ruined by their action.

9. Of course the result is not accomplished in a day. Owing to peculiarities to be noticed, hereafter, the action of many of the "chôs" is more gradual than that of mountain torrents properly so called. But no one with the smallest powers of observation can follow the course of almost any one of these "chôs" from the place where it debouches from the low hills downwards, without seeing unmistakable proofs of the damage, which cannot stop itself, and must in the nature of things grow gradually worse and worse.

Caution against being misled by the slow progress of the mischief.

10. It is also quite an idle objection to urge that these "chôs" have always been a feature of the Hoshiárpur District, and that it is hopeless to contend with them. Many evils, which are ultimately successfully combated, remained for years in operation before any one thought of taking notice of them; and, if it is only now that we have progressed to the study of such questions, it certainly is no argument that such study is useless, or that a remedy is impossible or not to be undertaken.

Argument that the "chôs" have always been there.

The evidence that the low hills were once well-wooded is quite complete; there are portions of them still well-wooded enough to show what they all might be, if subjected to proper conservancy; and there, too, it is easy to see how the soil is protected by the natural growth.

No insuperable difficulty to reboisement.

11. There are certain peculiar features regarding the hills and the streams flowing from them that require notice.

Peculiar features of the hills.

I have been unable to attain any geological information regarding them, but their characteristics may be described sufficiently for practical purposes.

The north-east boundary of the district is formed by ranges of Sub-Himalayan hills, most of which are in foreign territory, until we reach Amb, where the British territory extends further inland, over the hilly tappas of Daríri, Lohára and Punjal.

All these northern hills give rise to numerous stony torrents and ravines.

The Sohán rivers—one flowing north-west and joining the Beas, the other or main one flowing south-east to the Sutlej—flow along at the base of this inner range of hills, and on the south side, at some distance, rise the outer Siwáliks, the special object of my visit. The whole of this broad Sohán Valley, part of which forms the Jaswan Dhún, is subject to torrent action, stones being the chief feature rather than sand; and the valley is cut up, not only by the torrents from the northern range, but also by those on the other side of the Sohán, coming from the north-east slopes of the outer range.

12. I find that the people about Amb speak of this outer range (as they look at it across the river) as the "Katár, Dhár," but the people on the Hoshiárpur side and the villages actually in the range do not appear to have any general name for it.

Names of the outer range.

13. Thus the geography of Hoshiárpur for the purpose of this report is simply described: an inner barrier or series of hills forming the north-east limit of the district, then the broad stony valley of the Sohán, then the outer Siwálik running parallel to the Sohán, all through the length of the district (about 80 miles from the Sutlej to the Beas) and below the outer range again, the plains of Hoshiárpur, fertile and wealthy, but intersected by the dreary stretches of sand which the streams leave during the dry months of the year.

Geography of Hoshiárpur in brief.

14. To the northern side of the Sohán Valley it is impossible to apply any remarks at present. Most of the hills are out of our control, and of course the torrents will continue to increase, spreading out their great fan-shaped beds of deposit and creeping on to swell the

Remarks do not apply to the Sohán or valley to the north of the outer range.

vast stony bed of the Sohán, which is almost dry for a great part of the year.

Where the British boundary does extend, the forests in Daríri, Lohára, and Panjal "tappas" have been fairly well preserved. The forest is of extremely poor chil (*P. Longifolia*) on a sterile sandstone extremely hard as soil, but not perfectly formed as stone. A dense growth is hardly to be looked for. Though grazing is strictly and really excluded from all the reserved forest, the progress is very slow; seedlings are rare, and any undergrowth only occasional. It is impossible to spend any money on artificial cultivation, and we can only hope to secure a gradual amelioration of the soil by the deposit of vegetable mould in the course of years.

15. On the north boundary of Hoshiárpur then there is not much to be done; but it is on both slopes of the outer range that interference is most urgently called for, and specially on the south-west face, because it is from this face that the "chôs" descend, intersecting and destroying the fertile plain lands of the district, and carrying their destructive agency far down even into the Jullundur District, as the Commissioner has recently informed me. This range we can attack without much difficulty, and with a certainty of ultimate success.

I propose then to give a general description of the outer Siwálik range and of the torrents which flow from either side of it.

16. The whole range consists at present of a highly irregular and confused mass of fantastic cliffs, points and slopes, the result of the gradual dissolution and detrition (by the tropical rain-fall) of the up-heaved beds of sand, clay and pebble conglomerate, of which the hills consist. It attains no great elevation. The highest points on the atlas sheets are:—

Baraol station (Sutlej end)	... 1,582 feet.
Maidwani station	... 1,943 "
Pandú station	... 2,220 "
Munji "	... 1,878 "
Pamráh "	... 2,047 "
Koti station (just where the range divides into two spurs at the Beas end)	2,198 "
A station near Tung	... 2,430 "

17. Towards the Sutlej the range is comparatively narrow, with a well-defined crest or central line of greatest elevation.
 The Bít. But beyond the point whence the Nasári Ghát (Pass) crosses, the range widens out, and the centre is occupied by the almost level table-land around Manuswál, locally called the "Bít" of Manuswál. This consists of a stiff loam, which no doubt formed an extensive deposit capping the other strata; it has gradually been levelled by water action, but still numerous points and miniature cliffs are left standing not yet washed down by the rain. The fields are also in several cases again being eroded towards the edges, and deep hollow water-courses formed.

The fact that this level plain is due to a deposit of stiff loam is clearly seen by the sections as one passes down from the Rána's garden near Manuswál to Mehidpur, which is just below the hills on their north side.

A curious feature of the "Bít" is the total absence of wells. The people are dependent on large ponds locally called "toba," which are partly naturally, partly artificially, dug out in the stiff clay and banked up; whereas as in the rainy season of 1877 the rain supply fails, the water diminishes, and what remains becomes thick and dirty, and must, I think, be productive of disease among the people who are obliged to use it having nothing else.

18. Beyond this again, the range continues at an average breadth of 8 to 10 miles, but with a generally well defined high line or crest of very fantastic shape and indentation, having equally irregular side spurs separated by torrent beds, which in most cases form the "chós" of Hoshiárpur. At the extreme Beas end of the range the crest forms into two distinct branches separated by a broad stony torrent-bed. It is on the north-east arm that the Karanpur bamboo forest is and on the south-west that of Bindra-ban.

19. The range consists entirely of vast beds of sand, alternating with loams or clays in much smaller proportion, and extensive beds of loose conglomerate or gravel. The pebbles of the latter are never very small, nor are very large boulders found; they vary from the size of a pigeon's egg to twice the size of a large ostrich egg, but not as a rule bigger; they consist of metamorphic and quartzitic, gneiss and granite rocks, derived from the older Himalayan formations.

Materials of which the range is formed.

That these beds are all the result of aqueous action there can be no doubt ; but the strata so deposited have been upheaved, and distinct lines of dip can be traced in many places ; a good example is near Pamráh, where distinct stratification and a dip at about 30° to south-west is observable.

20. The strata are, as a rule, extremely soft; the consequence has been that the whole bed has been cut into by the rain ; and as the pebble beds naturally resisted longer than the sand, and as the sand has only in places (of this more hereafter) been hardened or compacted, there is every conceivable variety of fantastic shape communicated to the hills throughout.

At first, near the Sutlej, there is nothing but sand so soft as to be easily cut with a knife, and occasional layers of clay. The Sutlej has cut a clear section through this, leaving an abrupt cliff or face, which, however, is continually breaking away, as the river undermines it. But very soon the conglomerate appears, and bare pebble-covered slopes become common. As a rule there are more stony slopes on the north side, but there is very considerable variety throughout.

21. The sand next demands our attention. By far the greater bulk of the strata of sand are soft and ill compacted, their deposit having been too recent or too little subjected to geologic pressure to have been hardened into stone.

Nevertheless there are extensive strata of what may be called stone, chiefly towards the centre of the range, such strata varying from the very soft and brittle but distinctly laminated grey-stone, of which I found a specimen close to Chobál (in going from that place to Gagrét across the range), to the real hard building stones occurring in very considerable masses of a grey colour (and closely resembling in appearance such sandstone as we find below Murree and Dharmśála), which are met with further on the same pass beyond Pamráh.

The beds of this hard sandstone often enclose small rounded pebbles of older rock ; their structure seems to be simply sand with some mica in it, agglomerated by lime ; for though I could not make a regular analysis, it was

easy by the action of the diluted acid on the pounded stone to separate it into fine loose sand and a quantity of lime (deposited in the test tube in the form of a sulphate). Indeed, throughout this range, lime plays an important part. Besides the formation, by its aid, of these beds of stone, almost everywhere traces of the infiltration of lime (dissolved by the acid of the rain water, &c., and afterwards deposited) appear.

22. This infiltration of lime results (1) in the formation of narrow tubes or pipes of lime deposit, which traverse the soft sandstone and fill up all crevices. Often no doubt long fibrous roots have helped the formation, having become incrustated with lime and then decayed; (2) in belts of irregular nodular and stalactitic-looking stone which may frequently be observed exposed and projecting beyond the soft sandstone which the rain has washed away.

Such belts of stone often form a barrier across the beds of small torrent feeders. Pieces of the same material, nodular and irregular like "kankar," may be picked up on the sand everywhere in the "cho" beds.

Nodular lime concrete.

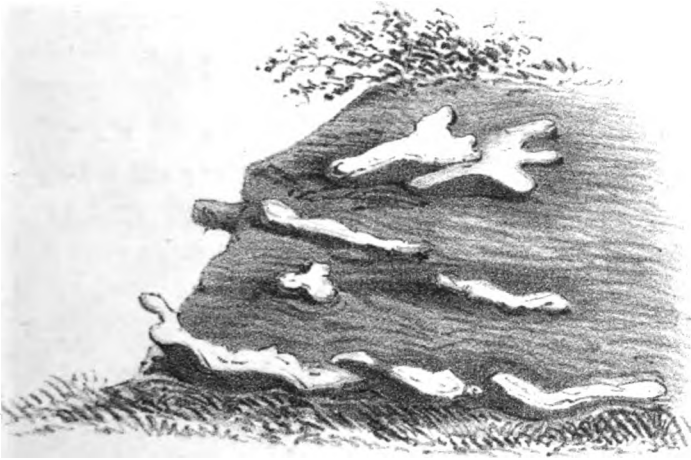
23. On the north side of the range, and notably towards Mehidpúr, below Manuswál, there are large beds of calcareous "tufa" alternating with gravel and clay. This is so nearly a pure limestone that it is extensively burnt for lime. The hard belts and nodules of stone first alluded to are not pure lime. In some cases they are of coarse sand cemented by lime, which when dissolved out by acid, leaves the grains of sand free; in others they are of a more compact granular-crystalline texture. Acid dissolves these, yielding lime sulphate and a large amount of argillaceous matter and a little fine sand.

24. Where the lime comes from it is impossible for me to say; but this feature of lime tubes on the sand and of concrete nodules and belts is too constant to be overlooked. It is seen abundantly where there are extensive road-cuttings in the soft sand, *e. g.*, on the road from Chohál to Gagrêt; every available crevice is filled with a sort of lime petrefaction; long fibrous roots (as already said) are covered with lime, and long pieces of brittle "lime tubing" may be collected. In other places the gradual formation of the concretionary belts and nodular may be observed.

This lime deposit is a characteristic feature.

The annexed sketch shows a bit of an exposed bank on the road alluded to :—

Fig 1



25. In another place on the road the intervention of pieces of hardened material of this kind had formed a protection to the sandstone which the rain had washed away all round, but could not touch under cover of the little protecting tablets of stone. The result is that the cliff stands fantastically cut up by longitudinal furrows, so as to resemble a great stack of organ pipes. This form of water action will be familiar to the readers of Lyell's "Principles of Geology." In one place I found

a belt of pale buff-colored *marl*, that is clay with a very large proportion of lime in it. That this lime should have been derived from the decomposition of organic remains seems hardly probable, although I notice that Mr. Syddeker speaks of Siwálik fossils as often being found at the heart of concretionary boulders, which would appear to be agglomerated round the bone by the aid of lime obtained from its partial decomposition.

26. And here I may take occasion to mention that I came on no place in the range where there is anything like an abundance of organic remains, whether of shells or of mammali, *in situ*; a piece of a bone or of a tooth is occasionally found among the hills or in the bed of a "chó," but that is all.

Scarcity of fossil remains.

27. I have given this detail about the lime, because it plays an important part in the structure of these hills; it is valuable for use, and it to some extent helps to form a consolidating agent in resisting the erosion of the slopes. Its presence is also the addition of a fertilizing ingredient to the *detritus*.

Reason for describing this.

28. Such being the general features of the hill range, it may naturally be supposed that the *detritus* of the hill slopes is not unfertile except where pure sand or stones predominate. The sand usually contains a fair admixture of clay and some lime. It is not unusual to notice that the deposit left by a "chó" on its subsidence consists of a thin layer of fine mud (pannah), and if a part of the deposit has been cut through, it will be observed that there is often a succession of thin layers ($\frac{1}{2}$ to $\frac{1}{4}$ inch thick) of sand and clay. In places among the conglomerate beds a vivid brown loam (colored by decomposed iron) may be seen. There is no reason to suppose that even the bare slopes where the surface is now covered with pebbles only would not produce in time at least a growth of brushwood. As it is, nothing gets a chance. Everywhere overcutting followed by the cropping down of every shoot that has attempted to push forth may be observed.

Soil generally not unfertile.

29. The species which are commonest in these hills may now be mentioned. -I was surprised not to see the *Dodonaea viscosa*, so abundant in other low, dry hills; but there may be a little at the extreme Beas end. There was,

Species of trees found on the hills.

however, plenty across the Sobán not far from Amb. Bushes of "kikar," "phuláhi," "bér" (*Zizyphus nummularia*) and "billan" (*Zanthoxylon alatum*) were common. Kúri (*Nyctanthes arbor-tristis*), *Feronia elephantum* and *Cassia fistula* were occasional, and there is plenty of Basuti (*Adhatora vasica*.) On the higher parts I found kinnu (*Diospyros*), but very gnarled and ill-grown; and in places chíl, but scattered and of very poor growth.

"Garna" (*Carissa diffusa*) is also abundant. *Flacourtia sapida* is also common, and "chilla," *Casearia tomentosa*, occasional, with "rajain" (a tree unknown to me). But so great has been the destruction that one may march for miles and miles with nothing in view, but bare mud-colored crests and rugged slopes, rarely dotted with greyish browsed-down bushes, while an occa-

Aspect of the country. sional "kikar" bush that has sprung up out of reach is alone green and flourishing. Herds of hungry goats reaching up for the last living twigs of the ill-used stumps of trees, may everywhere be seen. Nothing is more striking than the general bare, pale-brown or dust-coloured aspect of the landscape for miles together in these hills.

30. Almost the only place I saw anything like a fair growth still surviving and not cut away and eaten down to the ground was in descending towards Jaigon by the pass of that name. There I found a considerable tract, green and pleasant to the eye; the protecting influence of the bushes, in preventing the erosion of the soil, was palpable to the most superficial observation. A certain amount of herbage, an essential agent in soil preservation, was observed, consisting of grasses and flourishing beds of the weed *Cleome pentaphylla*. I would here refer to Mr. Coldstream's report for detailed evidence how different the condition of these hills once was. But evidence is hardly needed, for the villagers on the spot have witnessed the process of denudation under their own eyes.

Evidence of former forest. I must also leave it to Mr. Coldstream's report to describe how there are villagers on these hills whose chief occupation is to cut firewood, and how strings of men, women and children with loads on their heads may be seen early in the morning filing along the sandy "chos" whose dry beds serve so often as most

uncomfortable roads. These persons supply the larger towns in the plains, such as Dosua, Hoshiárpur, Hurriána, Garshankar, &c.

31. Not only so, but there are many charcoal-burners working on a most pernicious system of taking their payment by a percentage on the value of the charcoal produced. Charcoal-burners. I myself saw a splendid banyan tree (*Ficus indica*), which must have been the growth of a hundred years, being chopped into billets ; the whole tree had been bought as it stood, I think, for three rupees.

32. The fact is that as wealth increased, the population of the towns increased also, and with it the demand for firewood ; and as the supply has been hitherto no one's business but that of improvident villagers, it has been conducted regardless of all conservancy, as was of course to be expected ; for how should the peasantry know better ? The scarcer the brushwood becomes the wider is the area over which the destroying troops are scattered to search for it. Then the soil around deteriorates from erosion of the unprotected surface, and agriculture becomes more toilsome than cattle-keeping ; so cattle (and goats especially) increase, and all hope for the hills is at an end. Such is merely the natural consequence of non-interference. It is merely a repetition of the history of the Devoluy, of the hills of Savoy, of the Ardéche basin, and many other places. How the evil progresses. Cattle cannot increase if there is no herbage to feed on.

Such being a general account of the outer range of the Hoshiárpur hills, it is now necessary to describe (but briefly) some of the most noticeable features of the "chôs" themselves.

33. In the first place they are not "torrents" in the technical sense of the word as applied by Surell. A "torrent" has always a fall of not less than 6 in 100. The result of this declivity is a peculiar formation called the *cone de dejection*, a fan-shaped mass of *detritus*, which forms at the mouth. This also leads to the other special feature of torrents, which is, that when the water comes down, it is discharged along the top of a convex bed, not in a hollow, and as it cannot continue in this situation, the stream must necessarily divide and pour off on this side and that, in any direction which is easiest. These streams, flowing off in all directions, continue depositing more and more *detritus* and spreading wider the fan-shaped mass of *debris*. Character of the "chôs."



PARA. 35. THE BASIN OR SOURCE OF ONE BRANCH OF THE MAHLI "CHO."

34. But the "chos" of Hoshiarpur have nothing like this fall. Slight fall of the "cho." Mr. Coldstream was kind enough to have the levels taken for me of the "cho" which comes past Bhadi (Garshankar tahsíl) and the bed of which (for part of the way) is the high road to Nurpur. For about $2\frac{1}{2}$ miles or more up to near one of the main sources, levels were taken showing a fall of about 50 feet in the mile, or less than 1 in 100. The lowest level was taken at the mouth; but it would have required an expert on the spot to select further sites to show how, though the *cone de dejection* is greatly reduced in curve and extended in breadth, it is still traceable.

And there is no doubt that this sample fairly represents, within small limits of variation, all the "chôs" on the south side of the range.

35. This comparatively small fall is due to the extreme instability of the material of which the hill is composed. To what this is due.

One of the most instructive excursions I made was to follow into the final ramification of one of its branches the "cho," which is clearly enough shown in the atlas sheet as flowing past the village of Mahli (Muhlee in the map). I had halted for a time in the sandy bed of the "cho," near a well, by the aid of whose moisture several trees were flourishing.* Here I was not far from the very outskirts of the lowest spurs of the hill range. I naturally expected, before reaching the head of any one of the numerous branches into which the "chôs" usually split towards the source, to do a certain amount of climbing, or at any rate to find a sort of basin or sloping hollow down which the rain-water would pour in the first instance, at some considerable distance above the level of the "chô." On the contrary, the rise was hardly perceptible; but to my astonishment, I continued to pass between almost vertical cliffs of sand, so soft that I could dig my nails into it, and traversed by occasional belts of the hardened concrete I have before alluded to. These walls continued getting narrower and narrower, till I could with difficulty squeeze between; but still only at the bottom was there a channel for the water. At last through a narrow gorge I could see a sort of amphitheatre or

* I have often observed these wells close by the side of "chôs" in places where the bed is wide and near the point of debouchment. In high floods such wells must be temporarily engulfed.

cauldron, forming the source of the whole. Above it, no doubt, a convenient basin in the hills had formed a *focus* for collecting the rain-fall which had then crevassed the earth; the outer wall soon fell away, and left an edge over which the water fell, cutting it away, and eating out the bottom, just as what is called a "moulin" does on a glacier. This was enlarged till the water found an outlet, and then commenced hollowing out a passage between the hills; the extreme softness of the strata enabled it rapidly to find its way to the lowest level, and hence there was no part of its course where there was any great descent. While this is generally the case with the main line of the "cho," I do not mean to say that it is always the case with the side-feeders. I noticed many instances where streams did descend rapid slopes, and accumulated cones of *débris* at the base; but wherever this was the case, the water was so rapidly eating through the soft sandstone, that very soon the stream would be at its lowest level between two walls of sand like the one I have described. There are also many smaller torrents falling over the harder conglomerate strata, where cones of stones are formed in true torrent style.

The origin of the torrent stream above described will be made clearer by the sketch, from which may be seen the hill amphitheatre which collected the water, the edge over which it then fell, acquiring velocity enough to cut away the soil below, and the outlet by which it ultimately escaped.

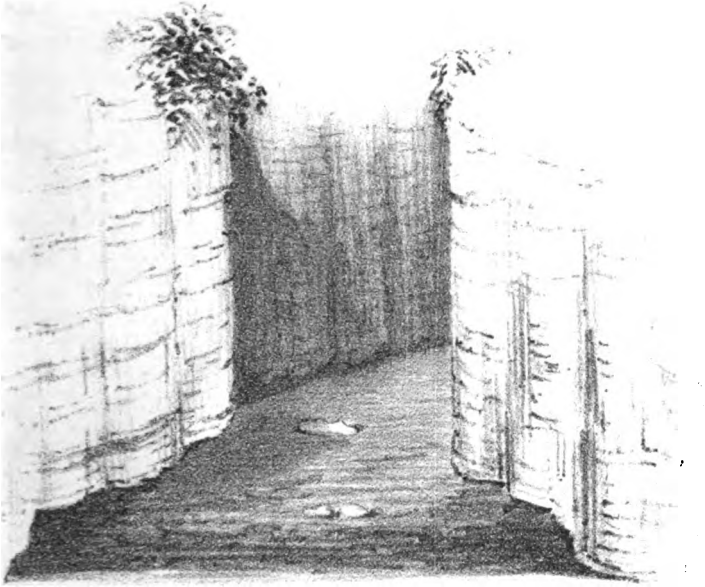
36. It is also necessary to remark on the method in which the vast mass of sand carried down by these "chôs" is supplied. In the first place, the general surface of the hills is cut away, resulting in the abrupt and scarped appearance so well seen on crossing the Sutlej from Rúpar. The *débris* of this is either accumulated in secondary ridges, so often observed at a short distance from the main range, or is absorbed into the current of a gradually-formed water-course. The rain-water as it flows towards the main lines of "chô" drainage is thus already charged with fine sand and mud, carried off from the surface abrasion of the hills, and thus it is already prepared to furnish a considerable amount of depositable material to the "chô."

37. But the bulk of the supply is furnished by the giving way of the scarped surfaces of sand strata, which have been cut through by the stream, and now form its confining walls.

How sand which the "chôs" carry down is collected.

The stream at first cuts *under* the edge of the wall, so that the section would be as in the figure:—

Fig. 2.

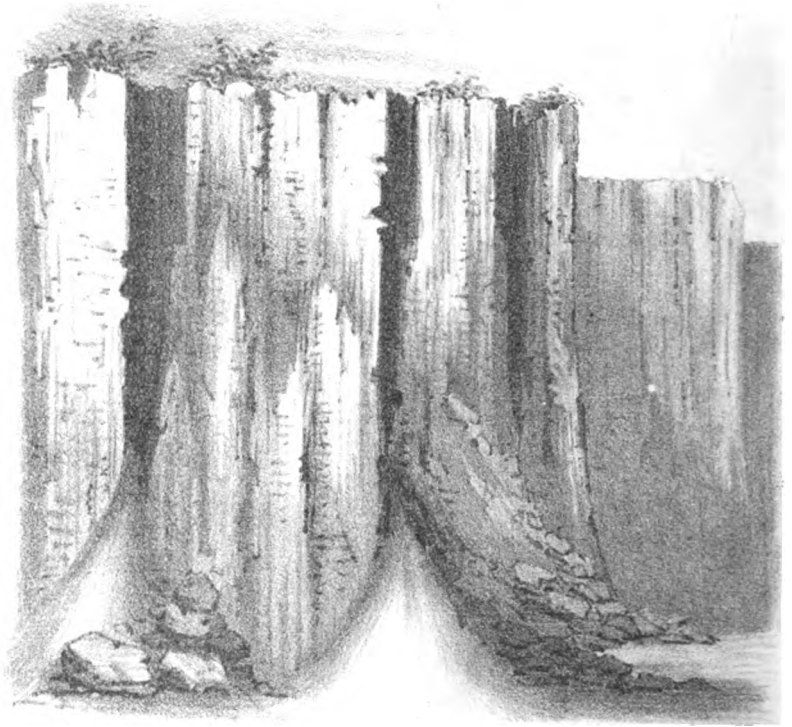


Under-cutting of the walls.

The masses above then become top heavy, and fall down, leaving a new sharp face exposed. But the water from above, falling over the edge, soon reduces this, and a series of cones, or one long sloping bank of *débris*, is made skirting the wall. This bank is easily washed away when the "chô" rises.

38. Here is a sketch taken near Banhi, which illustrates what I have said.

Fig 3



Sample of the erosion of sandy banks.

39. Where the high wall of the khud as in the well-known Kiri khud (near Mehidpur on the north side of the range below Manuswál) has alternate strata of sand, conglomerate, and material hardened by

lime these hard strata resist, and the sand exhibits a series of slopes rebutted or stayed up by the walls below.

40. To resume briefly the features characteristic of the "chôs," the comparatively slight fall of the beds depends chiefly
 Résumé. on the extremely soft nature of the strata, enabling the water very rapidly to cut through the soft soil rather than flow over the surface or down a channel only partly hollowed out, at a considerable angle.

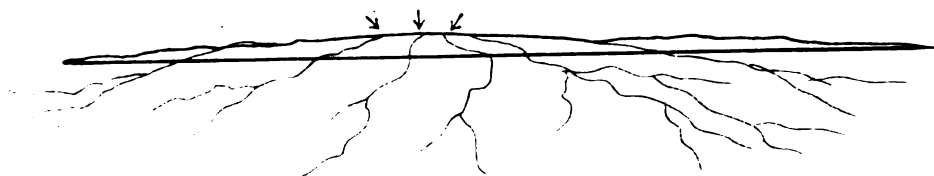
It has also the result of depriving the "chô" to some extent of the characteristics of true torrents. The chief of these is the absence of any *elevated* or highly convex cone or fan-shaped mass of *debris* at the mouth of the channel, and the absence of that fixed part of the mountain torrent called *canal d'écoulement*. There is probably no part of the bank of these "chôs" that is not unstable, and the mass of sand carried down is so light that it does not accumulate except slightly at the mouth. But it *does* accumulate, though in a very slightly convex and correspondingly *broad* fan-shaped cone of dejection at the point where the "chô" leaves the hills.

41. Where the "chô" has come almost entirely from conglom-
 rate strata, the heap of stones is very much more
 Case of stony perceptible; but even in the stony "chôs" the fall is
 "chôs" as compared very gradual, because, though the stones are hard
 with the sandy ones. enough, the strata as a whole disintegrate readily enough so as to enable the water to reach its lowest level. The only difference is that in one case the "chô" bed is full of stones, in the other it is full of sand.

42. Still the heaping up of material of the point of exit is quite
 sufficient to produce the destructive feature of all
 The heaping up of material at the mouth causes the spread of the "chô." torrent action, *viz.*, that the water discharged from the channel coming down on to the top of this heap cannot flow along in one straight course, but must fall off on either side in a thousand rivulets according to the line of greatest declivity: hence the water is divided into a series of streamlets, which in a very high flood spread into a broad fan-shape, and cut away on this side or on that, according as the obstacles on the ground tend to deflect the current this way or that. When the flood lessens, the water once more separates into diverging channels, one going this way, the other that. It is hardly necessary to introduce a

simple diagram to show how the water discharged on to a bed of accumulating material having *ever so slight* a convex form must disperse.

Fig 4



43. As, moreover, the mass of deposited materials is very soft, the position of what I may still call the *cone de dejection* constantly varies; for gradually a series of channels are cut into it, and when that is the case, the sand is cut away to be deposited further down.

Variation of the position of the deposit.

It is perhaps to this that is due the low mounds to be seen conspicuously near Badhi, at some distance from the foot of the hills, and which have been again cut through by the water.

44. The only rule which is constant is that the deposit must occur according to the weight of the material.

The water coming with great force bears along with it mud, sand and stones. Where stones are few, they are deposited before they have gone any distance, then the sand, and lastly the mud, which goes furthest of all. Two forces are at work; first the decrease of velocity (as the fall lessens) gradually depriving the water of the power of carrying on the mechanically suspended matter, and then the fact that the light sandy sub-soil absorbs the water. It would follow from this that the

fine mud would be carried furthest and would form a deposit of fertile soil, but the sand being largely in excess, one year's deposit of mud is covered with the sand of the next flood ; and above all during the dry hot months, the sand is lifted by the hot winds and spread over the surface.

45. This is one of the great sources of damage. If it were only water action the sand would be deposited and the water absorbed, and the danger would be very great from the constantly increasing supply of sand ; but we have to add to this the effect of the wind, which blows the dry sand about, burying fertile lands and raising great mounds of dry sterile sand, which continually encroached on the fields.

46. How far the water travels depends on the length of duration and abundance of the rain-flood ; but all the " chôs " in the winter and summer are perfectly dry except in the north of the district (*e. g.*, coming from Hariana to the Sadr Station), where a slender stream of sluggish water is more or less perennial.

47. The result is the aspect of the landscape that has been alluded to. Going along the main road that traverses the district from south-east to north-west at a distance of about 4 to 6 miles from the foot of the hills, we find that the road is perpetually cut across and the fields intersected by beds of dry hot sand, often half-a-mile and more in breadth, and these keep extending in *breadth*, owing to the action of the wind and water ; and in *length*, as each heavier flood carries its sandy deposit further plain wards, till at last not only the whole area of the rich plains of Hoshiarpur is affected, but the mischief extends to Rahun and the Jullundur District beyond.

48. The way is now prepared to consider what can be done, if anything, to effect the double object of preventing the further extension both in length and breadth of the " chôs " and of reclaiming the land which is or has been rendered unculturable by sand. And I may here remark that there are vast areas of land which are not wholly unculturable, but are nevertheless so far injured by a sandy deposit as to yield nothing but a wretched spring crop of " bherra," or gram and barley sown

together in varying proportions according to the degree of badness of the soil. But rarely is a second crop (and that a poor one) obtained; whereas these lands ought to be "do-fasli," and capable of producing the finest sugarcane and other valuable and paying crops.

49. The remedies obviously consist of two main works—(1) the control of the water discharge at its source, and (2) the confinement and straightening of the course of the water when it debouches on to the plains.

Land deteriorated, but not destroyed.

Two works also to be undertaken in controlling the streams.

50. The first remedy can never be overlooked. Before the effect of forest growth in retaining the soil on hill slopes and furnishing a power, which (a) diminished the violence with which the falling rain struck the soil, (b) absorbed a portion, causing the rest to flow off without violence, and (c) filtered the water so as to run off clear,*—before this power was investigated and generally understood, engineering skill alone was called on to deal with the lower part or course of the torrents, to dig out a straight bed, to construct dykes, or erect powerful side dams.

Control of the sources

in former days not acknowledged in Europe even;

51. But the works always failed, and for obvious reasons. As long as the water at the sources was uncontrolled, its power was usually on the increase, and consequently either the works had to be constructed of such enormous cost and solidity as to resist in anticipation the largest possible flood, or, being for economy's sake constructed of only sufficient strength to resist what was called "any ordinary flood," the moment a flood occurred (which is sure to happen) so heavy "that the oldest inhabitant could not recollect the like"—away went the works and the money spent on them.

and consequent failure.

52. Now, in all modern works in the Alps, the sources are attacked first, and then when some degree of control has been obtained, engineering works are called in and are successful to protect roads, bridges, &c., lower down.

The modern plan.

I cannot lengthen this report by giving instances, but I beg that

* This is a matter of great importance. It is never to be forgotten that the water of torrents does not affect the mischief as clear water, but as water whose laws are altered by its becoming viscid, owing to the mud and sand in suspension.

reference may here be made to the account or the treatment of the torrent of St. Marthe near Embrun (an affluent of the Duranee) at page 362, and again at page 376 of the "Forester" for April 1877 (Volume II, No. 4.)

But in attacking the sources of the evil, two preliminary objections must be disposed of; first it may be said that the greater part of the hills consist, as we have seen, either of soft unformed sandstone, or rather of beds of compacted sand, or else of beds of clay and uncemented conglomerates. These we have described as presenting, owing to past and presently continuing action of the rain-fall, a series of scarped faces, points and peaks, mostly bare of vegetation and only clothed with little grass and a few sparse and browsed-down bushes; these points *must* be washed down and the steep banks that have no solidity *must* give way, for in many cases they are so steep that nothing will grow on them.

Two objections to the practicability of control.

The first question.

To this I reply that the *gradual* levelling down or sloping off of such rugged surfaces is undoubtedly not only unavoidable but to be desired; but that while it is going on it will be possible to modify the rate and the violence with which it is effected, and above all, to prevent the land-slopes, into which the material invariably forms itself when it falls down, from being removed by subsequent floods.

Reply to it.

The sand as it lies in the hills is far from being unsuited for bushes and herbs and grass to grow on. There it is mixed with clay and lime and *detritus* of the conglomerates. It is the sand that has been cleaned and separated by water action and then dried up and spread by the winds that is unfertile.

And the very fact that the scarped walls which have been alluded to are so soft that, as I have said, the finger nails can be dug into them, render it exceedingly easy for roots to strike into them; and examples are not wanting to show how easily even a nearly perpendicular wall of such material can be clothed with vegetation, which soon covers and protects not only the sharp edges which are subject to the erosive action above described, but also the slope of gradually formed *débris* at the base.

Then the sand scarps can be covered with vegetation.

52½. The second objection is, what proof have you that these bare hills, which as you say present to the eye long desolate lines of irregular crests of a glaring dust color only relieved by rare specks of green, are the remnants of often cut and browsed bushes?

I have partly replied to this in saying that the soil, however reduced, is not unfertile, at all events as regards a growth of bushes and grass, which will correct the evil and prepare the way for a better growth to follow. But besides this there is ample evidence that these hills were once covered with dense growth and that enormous supplies of firewood have been cut off them, besides which some parts still growth enough left to show what the great bulk of the area might be restored to.

53. How far the whole work could be done by nature, and how far planting must be called in, cannot be determined by one tour. This much is, however, certain, that taking the data of previous growth and the natural fertility of the soil into consideration, where there is a fair rainfall protection and natural restoration will effect a very great deal. Now the annual average rainfall nowhere is less than 30 inches. In Hoshiárpur it is (on an average for the last ten years) 31·4 inches, at Dosudh, 35·8, at Garshankár 34·8, and at Unah in the valley beyond the outer Siwálik 37·9 inches. Besides this, *if experience shows it is desirable to plan, the same steps will have to be taken as a first measure in either case.* Hence there is no room for reasonable doubt as to what ought to be done.

54. The interests to be considered are—(1) the supply of firewood and the grazing requirements of the neighbouring villages. The former is not very pressing; there is so little wood left that in a very short time the supply will be stopped by natural causes, so that it can be very little hardship to stop it now, and *rigidly to confine permits to cut to places where there is really material in a fit state to cut.* As to the grazing, that can be provided for. The extent of it is, it should be borne in mind, one of the indirect results of ill-treatment of the forest. The more the invasion of sand spoils the land, the more there will be a tendency among the people to become less agricultural

and more pastoral. Cattle, especially goats (the worst enemies of the forest) and camels,* increase, and as the soil gets barer and poorer, the forage supply falls off, grass gets scantier and more wiry in growth; and the consequence is this, that the cattle are spread over a larger and larger area to seek their food, and the mischief increases till it reaches a climax.

55. By preserving portions of the forest, the grass supply will improve, a smaller area will then suffice to support a larger number of cattle; that will be an effect which will make itself felt in a very short time, and is of such chief importance that it is hardly necessary to allude to the more remote benefit, that as facilities for agriculture return, cattle not required for farm purposes will gradually diminish.

56. These preliminary objections being met, I would propose at once to demarcate from the crest (which is usually well defined) as far down both sides as circumstances will allow. Where there is a table-land the slopes on either side will be taken, leaving the table-land clear for cultivation. In addition to this, the slopes flanking certain "chôs" will have to be taken along their course through the hills, and in all cases the demarcation line must be so arranged as to include the "perimeter" or catchment area of all the head-waters of the chief "chôs."

57. All attempts to break up lands for cultivation, and all firing, must be stopped in this area. Wood cutting must be restricted to the places where material still exists fit for cutting. The cutting of all *trees*, especially ber and peepul, in the area must be prohibited under heavy penalties. And, lastly, selected areas in the general line must be declared closed against grazing. Thus a general provision will be made for the whole tract to be a "protected forest" under the new forest law and subject to the above restrictions.

58. But with a view to providing for grazing, which as I said is the chief difficulty, there must be a system partly within the protected area, and partly without it, of establishing what in Simla are called *ghasnis* and in Kangra *kharitars*, or grass preserves, which are to be assigned to villages or groupes of villages, and to be managed by the people them-

* That is, those cattle increase which are not kept for the plough, but for the profit of their use as beasts of burden or for the sale of their milk, those cheapest fed and kept being preferred: hence the abundance of goats and camels.

selves just as they are in Simla or Kangra. During the season of grass growth the grazing of cattle is strictly interdicted. When the grass crop is ripe it is cut and distributed, and then cattle are allowed in for a certain time, till the season of growth comes round. Firing is never allowed, nor must such bushes as spring up (but they are not as a rule numerous in any *ghasni* I have ever seen) be cut.

These grass preserves will not only supply the villages, but themselves help in protecting the soil.

59. All this can be effected either under the new law (as nothing can be clearer than that this area can be closed on account of its protective character and its influence on the protection of land from shifting sands, action of torrents, &c.), or The new forest law is amply sufficient ; it can be effected under the "Rules for the Hill District, of the Punjab 1855," which have the force of law under the Punjab Laws Act, and which provide as follows :—

"Section I. In any hill district, within British jurisdiction, the civil authorities may mark off *any* tract, plot, or ground, wheresoever situated, which they may consider to be specially adapted for the growth of timber or fuel."

Sections II., III., and IV. provide for fencing and prohibition of trespass, &c., in the tract.

And Section VI. provides :—

"No person shall be entitled to object to the foregoing rules, whether relating to enclosures or to particular species of trees, shrub, or brush-wood, on the score of proprietary or manorial right, provided always that the civil authorities do not interfere with the wood or fuel that may be really required by the occupants or owners of the land for agricultural or domestic purposes."

Section VII. "With the proviso above described, the civil authorities within the said hill district may prohibit, restrict or regulate any operation which they consider calculated to destroy or injure existing supplies of timber or fuel."

It will be observed that no reservation is made in favor of rights or privileges of any outsiders, *i. e.*, of any but owners or occupants of the land reserved.

These rules will not be repealed by the new law.

It is immaterial, it will be observed under this law, who *owns* the land ; the only condition is that certain reasonable wants are provided for.

60. But besides this general protection of an area in the outer range, it will be necessary to take some more decided steps for direct reboisement work in the actual catchment areas of some of the "chôs." At first I recommend this to be of an experimental character. I should select two or three "chôs" at different points, and demarcating closely the area round the heads of the sources, I should carry out such works as are usually connected with reboisement, *viz.*, the artificial levelling of places, the stopping up by hurdles, or fascines on the *Jourdan* method (*vide* "Forester," for April 1877, Volume II. No. 4), or by rough "barrages" of other material, the smaller basins which feed the "chôs," the planting of slopes so formed by sowings or cuttings of *viteæ* (Banna Shambalu) and other species, the protection of surfaces by fascines, or, as in Sind, by rough cheap matting pegged down. The cutting of water channels to divert the rainfall from accumulating in one rush, and carrying at gentle angles along the sides of slopes which are thus moistened and rendered fit for sowing or natural growth of shrubs and herbage, is also one of the works to be done.

Direct reboisement works at the sources of the "chôs."

Indication of cheap and simple works which may be carried out.

61. These matters can only be indicated in a general way : the application of one or the other, or all, must depend on the requirements of the sites selected for trial works. But in such soft soil they will be neither costly nor difficult.

62. If the sources of one "chô" could be attacked with success only, the result would necessarily be such as to render the pursuit of the work on a more extended scale beyond all question.

Success on one point only would be a positive proof.

63. It may here be necessary to remark that in these works the people are incompetent to act except in the way of respecting the restrictions and co-operating in the supply of labour, &c. They cannot do the demarcation, still less the works of actual protection. To

Impossibility of the peasantry doing all this for themselves.

suppose that any system of voluntary conservancy or protection without a demarcation or such a system of working as I have sketched, would be carried out, is wholly vain and chimerical. Nobody knows this better than the people themselves. It should be the business of all, and that (as Mr. Coldstream remarks) would be the business of no one.

64. Such being the work in the hills themselves and at the sources of the "chôs," it remains to be seen what can be done below, both in confining the beds of the torrents and in reclaiming the land already injured.

Work on the lower part of the "chôs."

I have already alluded to the fact that there is a point depending on fall and configuration of the land where at the debouchure of stream the bed or series of channels spreads out into a fan. From this point, the sandy bed either forms one vast expanse, or there are several diverging channels with small tracts of land between, which are, however, liable to be engulfed by the uniting of the streams during the heavy flood.

65. It is at these points that works may be carried out. There are also other points lower down, as where the stream cuts through a secondary deposit of mounds when the same sort of work may be repeated. But in all such attempts one great fact has constantly to be borne in mind, *viz.*, that as long as the floods continue from above with increasing violence, and as long as the mass of material brought down is not (in consequence) diminished, such works are only successful to a very limited extent, as will presently be noticed. *Therefore the attack on the slopes, crests and torrent sources is the first and fundamental work.*

Points whence the spreading out commences.

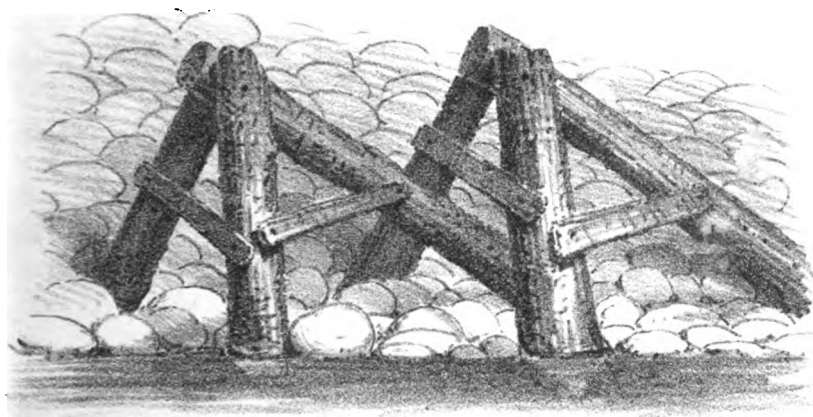
66. But supposing *that* advanced up to a certain stage of success so that its influence is perceivable below, then the object is to get the stream to cut out a deep bed, and to keep it as straight or as gently sinuous as possible.

Artificial excavation may be resorted to; but taking advantage of all stable soils and planting them, and then protecting the edge with strong hurdles and fascines, also the planting of living spurs or diagonal belts at suitable points down the stream, are the chiefly reliable means. Besides

Proposed course of operations.

hurdles, spurs as used in Switzerland, made of poles and filled in with stones, may be utilized.

Fig 5



67. The materials for planting are fortunately not wanting. Already in some cases successful plantings have been made, which even if they fail of their object *at present*, either from want of a system of action above or from being put in the wrong places, at least have shown that certain things will grow, and will affect the flow of the water, induce a deposit of material, and so help to create a bank. They also show how the sandy soil may be rendered culturable.

The chief plants are, among grasses, *Saccharum munja*, *S. spontaneum*, &c. (Munj and Chhúnd) ; among other plants Basuti (*Adhatoda vasica*), Banna or Sunbalu (*Vitex negundo*), and the small ber (*Zizyphus nummularia*.)

The best use of these separately or combined has still to be studied.

68. Where the object is to erect a line spur, no doubt a series of lines of tall grass with the *Banna* and *Basuti* got to grow into a mass are excellent.

The people at present plant the grass in tufts obtained by dividing the roots ; these do not offer a great resistance to the water flow, but

induce a deposit of material around the roots, so that a mound or bank is gradually formed.

The sowing of Munj seed, which would soon be productive of a dense mass, is not practised—partly, I suppose, because it does not so soon produce a resisting mass as the transplants.

The grasses have also an excellent effect in keeping back the encroachment of dry sand by the wind.

69. And here I beg to point out that there is no reason why this branch of work should not be sedulously carried out. The mischief done by wind may be prevented in any case. Whatever may be done as regards reducing the flow of the water, it is easy to take steps to prevent the sand being carried beyond the limits of the "chô" bed by *wind*, as it now is. Belts of grass and "banna" are excellent for this, and the ber should be also used.

Value of vitex for planting. 70. "Banna" is excellent; it grows very rapidly and strikes from cuttings with remarkable facility.

The value of the ber is not easily overrated. It has a wonderful power of consolidating the soil: it is in my opinion *the* agent for reclaiming sand-spoilt lands. The fruit is sown and the young plant soon comes up and spreads. When once it has taken hold on the soil, a change is perceived. Between the plants, "khabbal" grass (*Cynodon*)—a sure sign of better soil—begins to grow, and often when all around was dry in the early morning the patches covered with ber were observed to be wet with dew. Nor is this all. The leaves of the plant are a valu-

Fodder supply obtained from the ber. able fodder, and extensive planting of it will do a good deal for the support of the village cattle whose grazing might to some extent be prejudiced by closing tracts in the hills.

But when cutting for this purpose is allowed, the ber ought only to be partly cut: it is true that it recovers from the Caution in cutting it. root, but then it is an object to allow *some* of the leaves to fall on the ground and improve the soil.

Another species to be cultivated where possible is the Dhak (*Butea frondosa*), as its leaves are cut and spread on the fields and seem to be especially suitable to enrich sandy soil.

71. I have not made any special remarks about trees to be planted in the hills, because I have wished to trust a great deal to natural reproduction of the indigenous species.

Species to be grown in the hills themselves.

Whenever artificial sowing and planting are resorted to, the common indigenous species should be kept to for some time to come. The hills are not too high to enable one and all of the plants found in the plains to be grown: there the *viteæ* or "banna" will furnish an admirable staple for planting up protected slopes with quick growing cuttings.

The only shrub not commonly found in this outer range I would grow is the *Dodonæa viscosa* ("mendru sanatta" of other districts). The seed of this is obtained easily in large quantities; it is not eaten by cattle, is very hardy, and grows in the poorest soil. Otherwise I should confine sowings for promoting fuel growth to kikar and phulabi, both of which do well.

72. It is next absolutely necessary that all these operations should be properly supervised. Nor is it less important that some one should determine *where* there is any growth left from which the villages which Mr. Coldstream's report describes as gaining their livelihood by this trade may be allowed to cut. This would have to be determined by examination on the spot, and in detail.

Supervision.

Nor will any chance supervision do. A trained Forest Officer whose attention has been directed to the subject of damage by denudation and reboisement is required; the mere appointment of some Sub-Assistant from Roorkee or some one with the every-day capacities added to the tincture of surveying required from subordinates, will be of no use whatever.

73. I would therefore earnestly press upon Government the necessity of sending a trained Forest Officer to Hoshiárpur to act as Assistant to the Deputy Commissioner. I would suggest that the Home authorities might be asked to select one of those now studying who has a taste for this branch of work, and let him have special opportunities of visiting such works as the reboisement near Embrum, which successfully extinguished the torrent of St. Marthe, the reboisement of the Luberon in the Department des Hautes Alpes, that of Karst in Illyria, and other such works.

A Forest Officer as Assistant to the Deputy Commissioner wanted.

In the interval which would elapse, the general demarcation could be made without difficulty, and so much progress would be made as would greatly facilitate the work of the Forest Officer when he arrived.

74. That the small cost incurred by allowing the pay of an Assistant Conservator and a reasonable Forest establishment would, in the course of fewer years than many would expect, be repaid, cannot I think be doubted.

This would pay well.

A reasonable income from grass and fuel might be expected after allowing for the gratuitous supply of right-holders ; but the main value would be the cessation of a diminution of receipts from land revenue, and the increased receipts from reclaimed lands.

75. It may be said that as these hills have not been reserved as Government property, the interference of the State to manage them would be on the ground of public advantage, and that therefore the whole of the proceeds must be distributed among the village communities who may be supposed to be the owners. But I think it perfectly fair and certainly legally admissible that the expenses of management should be realized as a first charge, and if all the proceeds at first starting were so used it would not be hard on any one. In its present condition the forest can be of the smallest possible use or value to the so-called owners, and as it grows worse and worse it becomes less and less valuable.

There would soon be proceeds which would go towards meeting the cost.

As arrangements would be made to meet grazing requirements, it is impossible to conceive in what way it would be a hardship to assume the management of these tracts, or demand a small fee for such produce as they still yield with a view of paying the establishment, whose sole object is to increase the productiveness of the area at present so valueless, and at the same time to remedy the mischief which its denudation causes to the properties below.

76. In conclusion, I can only wish that to produce a more vivid impression than any writing of mine can, and to raise a plea more powerful than I can express, some of the leading authorities could travel over a few miles of the district of Hoshiárpur.

Conclusion.

To see that splendid district yielding a revenue of nearly fourteen lakhs annually, and yet to observe how mile after mile is cut up with the

broad dry beds of sand, not only useless, but spreading their desolation further and further with every hot wind and every flood, would certainly argue powerfully that a moderate expenditure to stem such an evil is better than letting the *steady* if small *loss* of revenue that goes on accumulating continually, remain unchecked and uncared for, till some day we wake up to find that the evil has slowly extended to a point either beyond our control, or to one that will cost millions to remedy when thousands will now suffice.

SELECTIONS
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PUNJAB AND ITS DEPENDENCIES.

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BY

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