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EROSION IN THE PUNJAB HIMALAYA AND ITS PROBABLE
EFFECT ON WATER SUPPLIES.

By

L. B. HOLLAND AND H. M. GLOVER, I. F. S.

The subject of erosion consequent on the disappearance of forests in the outer Himalaya is engaging the attention of the Punjab Government, and it is thought that you may be interested to learn the views of Forest Officers on this very important subject.

Two technical papers have recently been published, 'Denudation of the Punjab Hills,' by B. O. Coventry, I. F. S., Indian Forest Records, 1929, and 'A Report on Denudation and Erosion in the Low Hills of the Punjab,' by L. B. Holland, I. F. S., 1928: the latter as the result of a special enquiry in 1927-28. In this paper the general aspect and extent of erosion and its probable effects on water supplies will be discussed, and in order that the problem may be easily understood some description will first be given of the geographical, climatic, geological and other factors.

The Punjab consists of low lying alluvial lands in front of the Himalaya, and these lands are now irrigated by a magnificent system of canals dependent for their water supplies on the rivers which debouch from the Himalaya. The catchments of these rivers, with the partial exception of the Indus and Sutlej which rise in Thibet, lie either in British territory or in States under the political control either of the Government of India or the Punjab Government.

The rivers are tapped by canals where they enter the plains and again lower down where drainage from the country below the head works has caused an appreciable amount of water to collect in the old river channels. The rivers all show more or less the same periodic variations in supply. The winter is a season of low water and all is used for irrigation: in the spring the water rises with the melting snow; and in the monsoon the rivers are in full flood and are uncontrollable and the greater portion of the water escapes to the sea and is lost to the Province. Some approximate figures of discharge of the Sutlej river may be of interest:—

Year 1926-27—Cusecs at Bakhra.

October	..	..	7,000
November	..	..	5,500
December	..	..	4,500
January	..	..	3,750
February	..	..	4,000
March	..	..	4,250
April	..	..	5,000
May	..	..	8,500
June	..	..	20,000
July	..	..	50,000
August	..	..	75,000
September	..	..	25,000

Maximum flood August 10th, 150,000 cusecs.

Rainfall.

The rainfall is profoundly affected by the summer monsoon. During July, August and September the moisture laden winds from the Arabian Sea and from the Bay of Bengal strike the barrier formed by the Himalaya and the clouds drop the greater part of their water contents, and as they pass in succession over the inner ridges more and more water is dropped until the great Himalayan range is reached where the last rain is precipitated. Beyond this barrier very little rain falls and the country is dry and sterile. In the spring and autumn little rain falls for weeks on end. In the winter snow falls in the inner hills and accumulates to depths of several feet. In Tibet there is no rain during the spring, summer and autumn and in the winter snowfall is less than in the inner hills. Some figures may be quoted :—

Dharmasala on the slopes of the Dhauladhar has a rainfall of over 100 inches : Dalhousie 85 inches : Simla 63 inches : Kotgarh 50 miles beyond Simla 45 inches : Kilba 120 miles beyond Simla 31 inches : Purbani 140 miles from Simla 30 inches : of which 19 inches is due to winter snow : Poo 200 miles by road from Simla has a rainfall of only 14 inches. Rainfall varies with elevation, and whereas the tops of the hills are often moist the valleys are dry and sterile. In the inner Himalaya the streams are glacier fed and towards the Thibetan border winter snow and glaciers form the sole sources of supply of water to the streams.

Geology.

A sketch of the geological features must of necessity be brief and only a short general account is given in order to render this paper intelligible. The main mass of the Himalaya consists of granite and crystalline rocks. Spiti contains thick beds of fossiliferous limestone and sedimentary strata: the inner Himalaya consists of crystalline rocks and metamorphosed sedimentary strata twisted and contorted till all traces of their organic contents have been lost. All these formations are more or less stable and the hard rocks are not liable to displacement. The mountain ranges of the Himalaya were formed by the effects of pressure from the north which caused their upheaval when confronted with the buttress formed by Hindustan. In front of the rising Himalaya were deposited in shallow sea conditions the Tertiary sandstones and clays which in their turn took part in the general uplift and were folded and bent and now occupy the zone of the outer hills from Sabatu to Hazara. In front of and on these strata were deposited detritus and the Siwaliks form a range in front of the Himalaya consisting of soft friable sandstones and pebble beds which in their turn have been folded and elevated. The plains consist of vast alluvial sediments deposited in front of the Himalaya.

Effect of forest on rainfall.

The rainfall is affected by the geographical position of the locality and is due to causes on which forests have little effect. It is thought that forests increase local precipitation but the evidence therefor is somewhat vague and indeterminate.

Effect of forest on run off.

A forest consists of trees or scrub and below the trees is a mass of young growth, bushes, herbage or grass and humus growing on a deep porous soil into which rain water percolates and enters cracks and fissures in the underlying rocks, emerging eventually in the form of springs, many of which are permanent. Only when the surface soil is super-saturated does the water run over the surface. Thus rain which falls during the summer monsoon emerges some weeks or months later from springs and replenishes the autumn and winter supplies of the rivers. The soil is retained *in situ*: the water in forest streams is clear and does not contain much sediment in suspension. Far different is the effect of rainfall on barren slopes. The soil is thin and hard, and rain when it falls runs over the surface soil and enters the streams during the monsoon.

As forests disappear more and more water enters the streams which constantly broaden their channels which are insufficient to carry the largely increased supplies. Floods occur which increase rapidly in intensity, and when rain storms synchronise in neighbouring catchment areas sudden and high floods are caused in the rivers, which in their turn are incapable of retaining their water in their channels and floods spread over the adjacent country side. We all remember the disastrous effects of the floods of September 1924 in the Jumna and Sutlej rivers; of August 1928 in the Chenab and Jhelum rivers and the floods of 1929 in the Jhelum and Indus rivers to quote only very recent history.

It appears that floods are greater now than formally, and now that the waters of the Punjab are being utilised to their full capacity, are likely to be greater in their economic effects. We may take it as axiomatic that the intensity of floods is rendered greater by the disappearance of forests and it is of interest to examine the sources of supply of the rivers and the condition of forest growth and soil covering in their catchment areas.

Conditions in Catchment areas.

We may for the purpose of this note divide the Himalaya into three broad belts—

- (a) The zone bordering on Tibet,
- (b) The inner Himalaya, and
- (c) The outer Himalaya.

(a) The zone bordering on Tibet.

The great Himalayan range forms a barrier beyond which the effect of the south-west summer monsoon is very slight and the sources of water supply are the glaciers and winter snow near the Tibetan border. The country is desolate in the extreme and only where water channels have

been built is cultivation possible. A few briars and junipers occur at wide intervals ; carragona and wormwood bushes take the place of grass, but usually there is nothing but bare precipices and rock screes. At high elevations there is sometimes a little grass and in side valleys some forest. Vegetation here is scanty and has little effect on the water supply.

(b) The inner Himalaya.

As the region of monsoon rainfall is approached vegetation appears and forests, which at first are confined to the side valleys, gradually cover the uncultivated slopes. To the south of the great Himalayan range vegetation increases ; forests clothe the catchment areas in a continuous belt ; above and below them are wide stretches of grass lands, many of which are fired annually for the sake of improving the grass. There is no doubt that the whole country was formerly covered with forest and that trees have been ousted from the present grass lands by fire. Shifting cultivation aided and hastened the disappearance of the forest, but has been put a stop to within demarcated forests since British occupation.

In the forests the soil is deep and moist and when the trees were cut and burnt magnificent field crops were raised, but at the end of three or four years the soil had largely eroded and had become sterile. The land was allowed to lie fallow for many years until a fresh crop of bushes or trees again covered the ground and was burnt for manure.

Below the main forest belt the ground was terraced and field crops were raised ; but as the forest disappeared the soil became thin and sterile and capable only of supporting a thin crop of grass. Over large areas in the Sutlej valley there are remains of cultivated fields which are now incapable of carrying field crops except in a few favoured places where the soil has been retained. The springs have dried up and no longer is there sufficient water for irrigation.

The more valuable forests have been demarcated and worked for timber for export, but as the price of timber in the plains rose some Indian States took advantage of rising prices to cut down their forests of which the Suket State in recent years forms the worst example. During the war the Suket forests were cut down till in 1919-20 the Commissioner asked for them to be inspected; every timber tree in accessible areas was felled or marked for felling, and although a temporary check was given to exploitation in 1920 timber has since been extracted ; the fires of 1921 ravaged the forests and little or no timber can now be available for future generations.

Fires both accidental and malicious are always to be feared and in 1921 in connection with the general propaganda against Government hundreds of thousands of acres of forest were burnt to the great depletion of the economic resources of the country. In 1924 floods occurred in the east of the Province and it is thought that their intensity was aggravated by the destruction of forests by fire in 1921.

Fortunately in the inner Himalaya the geological structure of the rocks is stable ; grass and bushes take the place of forest when trees disappear and although the soil is eroded and becomes thin and sterile and much less capable of absorbing and retaining water the vegetation helps to prevent serious erosion and some water is retained.

The conditions of the inner Himalaya are on the whole satisfactory and no special action is called for provided always that the present forest policy is adhered to and that fires and shifting cultivation are kept in check. In the Indus catchment area the deodar forests of transborder states have been cut over heavily in recent years, but the country has lately been brought under British influence and it is hoped that the forest will be preserved.

(c) The outer Himalaya.

In the outer Himalaya conditions are very bad indeed : the forests have largely disappeared and all vegetation in the village waste is subject to very heavy grazing by both local and migratory flocks which are slowly but surely destroying all tree and bush growth. For details regarding the disappearance of the forests you are referred to Mr. Holland's Report on denudation and erosion, 1928.

Throughout the outer hills forests have either entirely disappeared from the village waste lands or are in danger of extinction. Tracts of land are still scantily covered with trees, but one feature is common to all forests such as are not demarcated as reserved or protected forests under the control of the Forest Department, namely the complete failure of reproduction of any species except the more xerophytic bushes, such as *carissa*, *dodonea* and *adhatoda vasica* which are not liked by sheep and goats. Over wide areas the destruction of the forest growth has laid bare the soil ; the grass itself has disappeared and the productivity of the locality has most seriously diminished.

On the Tertiary formations the hard sandstones interbedded with clays prevent the formation of extensive landslips ; but surface erosion is universal and no check is given to excessive run off ; the streams come down in rapid spate and carry off the rain water directly it falls and soon abate and form mere trickles of water, whilst the country rapidly dries up. On the Siwalik formation of friable sandstones and pebble beds the disappearance of the forest cover is immediately followed by deep erosion and the formation of ravines ; the streams carry thousands of tons of sand and sediment to great distances and have frequently destroyed large areas of fertile land in the plains.

It may be thought that we are exaggerating the evils : we know that we have understood the case and will end with a quotation dated 1877 from the Punjab Land Administration Manual, paragraphs 728 to 730, concerning the Hoshiarpur *chos*.

" 728. Effects of denudation of Siwaliks on cultivated lands in the plains.

A generation later the effect of the denudation of the low hills, which inevitably resulted from the policy then adopted, on the rich Siwal tract of Hoshiarpur and Jullundur had become so great that the matter was forced on the attention of Government. The Deputy Commissioner Mr. Coldstream, and the Conservator of Forests, Mr. Baden Powell united on urging the necessity of prompt remedial action, and the Commissioner of Jullundur, Mr. Arthur Brandreth, strongly supported them.

729. Mr. Brandreth's presentation of the case.

His graphic description of the effects of neglect is worth quoting :—

" The lower Siwalik * * * * is a long low range of sandy hills which stretch across the whole of the Jullundur-Doab, forming the northern boundary of that fertile and productive tract. In the days of the Rajas, when the village common was the property of the Raja or lord of the manor, and not made over to the peasantry, these hill slopes were covered with a low stunted brushwood with a few trees here and there

* * * This manor forest growth was not of great value to the Rajas or to their successors, the Sikh kardars, but it yielded a sort of cover for game, and was consequently generally protected ; and as the towns were not then very wealthy, and peasantry had hard enough work to produce the heavy revenue then demanded there was little demand for fuel, and few persons with leisure to cut it.

* * * * *
 " The stunted brushwood had, however, one great value. It covered the sandy soil by its roots and by the grass which grew in its shade. The cool air from the shaded hill-side arrested the passing clouds and produced a constant and almost regular rainfall, which, checked by the leaves of the brushwood and grass, poured down the hillsides at a gentle pace, and, bringing with it all the soluble products of the decayed leaves and grass, spread its wealth-laden waters over the plains below, which thus became so renowned for their fertility as to be known as the garden of the Punjab.

" The scene now is far different.

* * * * *
 " The hillsides were divided among the villages located on the hills, and the whole brushwood and minor forests declared to be their property village common open to every one.

" With the introduction of English rule, towns increased, wealth and property abounded, and the cessation of the continual demand for forced labour created a class of labourers with abundant leisure, and in search of employment. With the increasing wealth arose increased wish for comfort, and a large demand for firewood of all sorts consequently

soon sprung up, and the unemployed class found the brushwood and low jangal of these hillsides a mine of wealth open apparently to every one. With our large public works and railways the demand increased still more, and the hillsides were consequently in a few years stripped of everything that could by any possibility be used for firewood. Where the distance from the towns was too great the still more destructive charcoal burner appeared on the scene and consumed three times the amount needed to render his firewood portable. It might be supposed that the new proprietors would have taken some steps to protect their quasi-forests, but the sense of proprietorship was new, and they were in doubts how far they were entitled to interfere. Most of the labourers and woodcutters were residents of their own villages, and what is everybody's business is nobody's business, and consequently none of the former copyholders, now all become joint owners, endeavoured to check this waste: indeed, on the contrary, they rather encouraged it. Many persons paid them some little sum for the rights of cutting and the charcoal burners generally paid Rs. 2/- or Rs. 3/- for a year's license. They could not be expected to consider the future loss to their children, still less to care for the villages below the hills, which were slowly being ruined.

"Yes, I may almost say ruined, the injury is so great and so increasing. As the bare hillsides have replaced the green forests, the heated air of the dry sandy soil drives off the rain clouds to pass on to the upper ranges. When, owing to the increasing pressure of the clouds, rain does at last fall * * * The condensation produced by its fall on the heated soil produces * * * a great downward rush of the heavily laden upper air, and the * * * late rain soon descends in torrents. The fall is no longer arrested by leaves and brushwood and grass, and the increasing torrent pours rapidly down the sandy slopes, bearing with it thousands of tons of sand instead of the fertilising deposits of former days. These vast floods spread themselves over the village below, tearing away all the fertile fields which formerly lined the edges of the stream, and covering the rest of the country with a deep sandy deposit. For the first few years this sandy deposit was not so very injurious. It was fresh soil and still held a good deal of the decayed roots of the grass and brushwood of the former vegetation. Moreover, a thin layer of sand is often a great protection to an Indian soil: it protects and supports the young and tender plants, and enables the soil below to retain its moisture for a long period. But gradually the tale became very different. Constant reports of deteriorated crops and distressed villages and tenants unable to pay their revenue replaced the uniformly prosperous report of former days: traffic and trade was checked by the great development of these vast sandy beds, which intersected all the main roads: and further demands for remission began to pour in from villages beyond the action of flood, but whose fields were being buried by the masses of dry sand brought from these torrent beds by the windstorms of the hot weather. Nor was the injury confined to the agricultural peasantry only. The increased volume of waters thus suddenly brought

down soon carried away the bridges sufficient for former times and compelled a speedy extension of "waterways" and further expensive bridging both on the Grand Trunk Road and the Railway, and when even these proved insufficient the waters submerged the country far and wide. *

730. Results of delay in taking action.

The picture is highly coloured, but it can hardly be said to be exaggerated. Soon after in reporting on the assessment of the Hoshiarpur tehsil Captain J. A. L. Montgomery pointed out that, owing to the destructive action of the *chos* or sandy torrents issuing from the Siwaliks, cultivation had decreased by 12 per cent. in 30 years.* As we shall see, action was greatly delayed, and things went from bad to worse. In 1897 the Financial Commissioner wrote :—

"During the last period of ten to twelve years on account of the action of the *chos* in Hoshiarpur and Jullundur 16,650 acres of land have been converted into *cho* beds, or have totally lost their productive power, while 23,260 acres in addition have been damaged. Government has remitted Rs. 11,855 land revenue, and has in addition suffered or is about to suffer by reductions in the rent rolls of the two districts an annual loss of Rs. 34,719 land revenue, while the people have lost at a low estimate over 20 lakhs of rupees in the market value of their lands."

The *chos* increase in size every year despite remedies provided by the partial application of the *Chos* Act 1900; the water level is sinking in the Hoshiarpur, Jullundur, and Ambala Districts and enquiries are now being made by Irrigation Specialist Officers as the fertility of large tracts is endangered. This apart entirely from the danger to canals and the shortage of winter supplies in the Punjab rivers.

Summary of the causes of the recent disappearance of the forests.

Previous to the British occupation the Punjab was in a very disturbed state and life and property were unsafe. Each little hill baron lived in his castle and his people pursued precarious occupations within the enclave of the state protected by the troops, and raids and fighting were common. No one could wander far afield without armed protection and the migrations of nomadic flocks were by no means so extensive as they are at present. To quote from Lyall's Land Revenue Settlement of the Kangra District 1865-1872: "I have heard old shepherds say that down to British rule it was like running the gauntlet to convey a flock across the low country to its 'ban' (winter grazing ground). Every petty official or influential landholder tried to exact something as the flock passed him: a mild man easily daunted had no chance, and the *gaddis* picked out their ugliest customers for the work."

* The action of *chos* is not purely destructive. Far away from the hills after the heavier sand has been dropped, the deposits they spread are often very fertilizing. But wherever the hills from which they run are denuded of vegetation and consist of sandstone rocks, loss must far exceed gain."

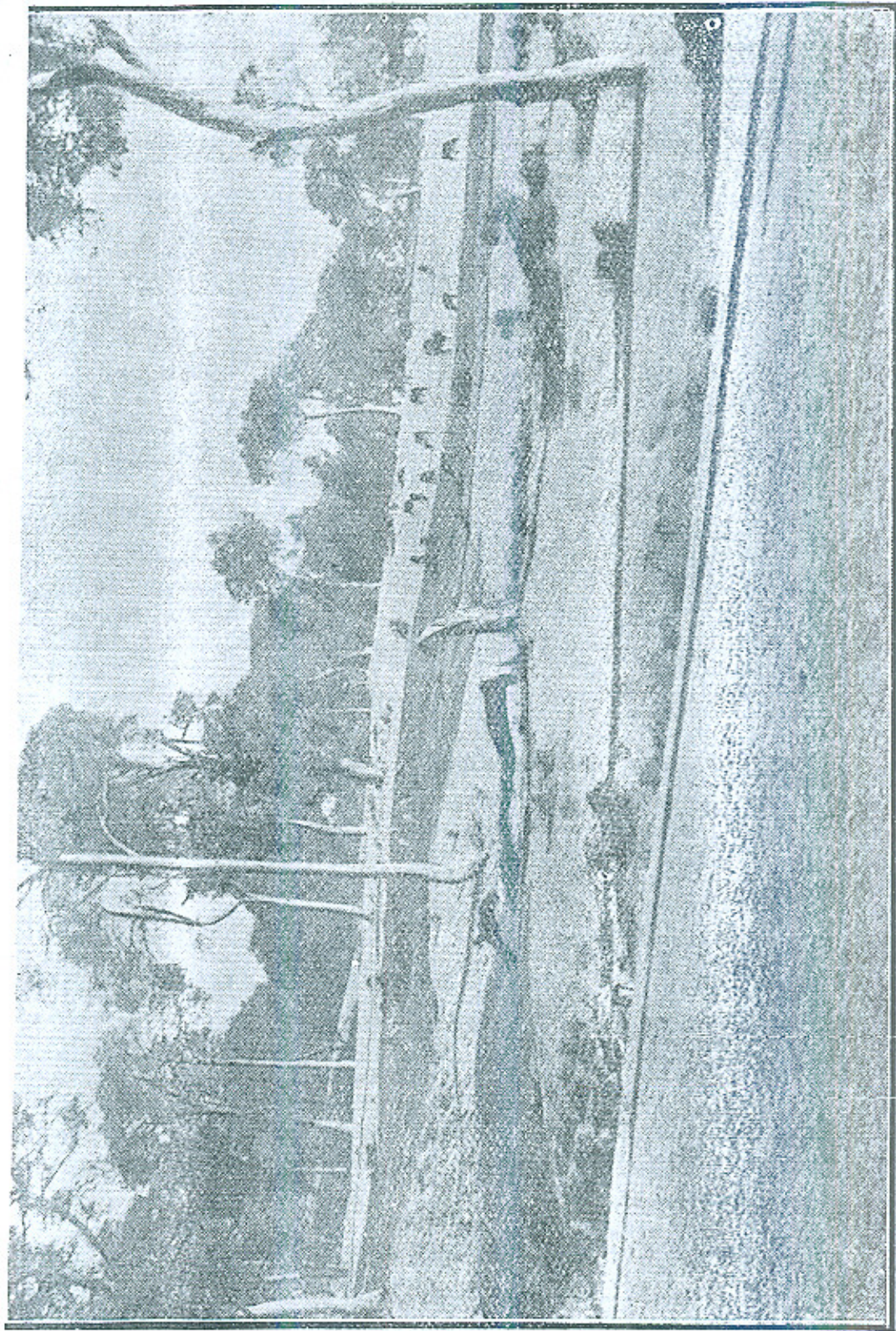
With the peace and prosperity brought by British occupation not only did local flocks increase but they wandered farther from the homestead and literally ate their way through the forest: a superimposed burden was and still is the grazing and browsing of nomadic flocks. During the summer they graze on the luscious pastures of the high hills whence during the autumn, winter and spring they are forced down by snow and spread over the lower foothills devouring any vegetation that is left in a constant endeavour to tide over the winter till they can once again enjoy the luxuriant pasturage of the high hills. There is not enough for these flocks to eat: *gaddis* from Kangra with numerous flocks of sheep and goats, graziers from Kanawar and the high hills and Gujars with numerous buffaloes all compete with the local village flocks for the rapidly disappearing fodder, and year after year as the supplies are lessened competition therefor is greater. Not only are grass and bushes grazed to the ground but the branches of all fodder trees are lopped and eventually the trees die and the forest disappears. The early land revenue settlements are much to blame—the Settlement Officers did not realise the consequences of a weak forest policy on the destruction of natural resources.

The Rajas had regarded the forests as their own special property and prevented encroachments thereon and grazing therein as interfering with their sport: as a consequence the forests were intact when the British first occupied the Punjab. The first British land revenue settlements handed over such areas to the villagers as *shamlat*, or village common lands, and as the villagers realised that they now had rights in lands from which they had previously been excluded each man endeavoured to gather what he could for his own and reaped a present advantage from the sale of firewood to the nearest cantonment or town which sprang up shortly after the land was conquered, and peace prevailed.

Remedies.

The means to be adopted are the limitation of flocks and herds to the capacity of the country side, the introduction of systematic pasture management and the preservation of the village waste and the forests from abuse. Early and serious steps must be taken to foster and preserve from destruction the scanty remains of the once extensive forest.

Proposals have recently been made for dams below catchment areas in order to increase the winter water supplies of the rivers: these dams can only be constructed at vast expense and we think you will recognise that they are of little effect as compared with the immense reserves which nature herself provides in the form of forests, and would not be required if proper forest and land revenue policies had been pursued. Engineering works made by man are expensive, are mere palliatives and do not remove the disease itself; we must look farther afield and seek our remedies in a more suitable management of the waste lands of the Province.



Old "CHIR" Pine Forest, Heavily Grazed, with on young seedlings.

Nadaun Jagir, Kangra District.



“CHIR” Forest on friable sandstone formation—Erosion commencing.
Nadaun Jagir.



Typical Scrub Forest closed to grazing.

Kangra District.

Photo., Aggarwal, 1929.

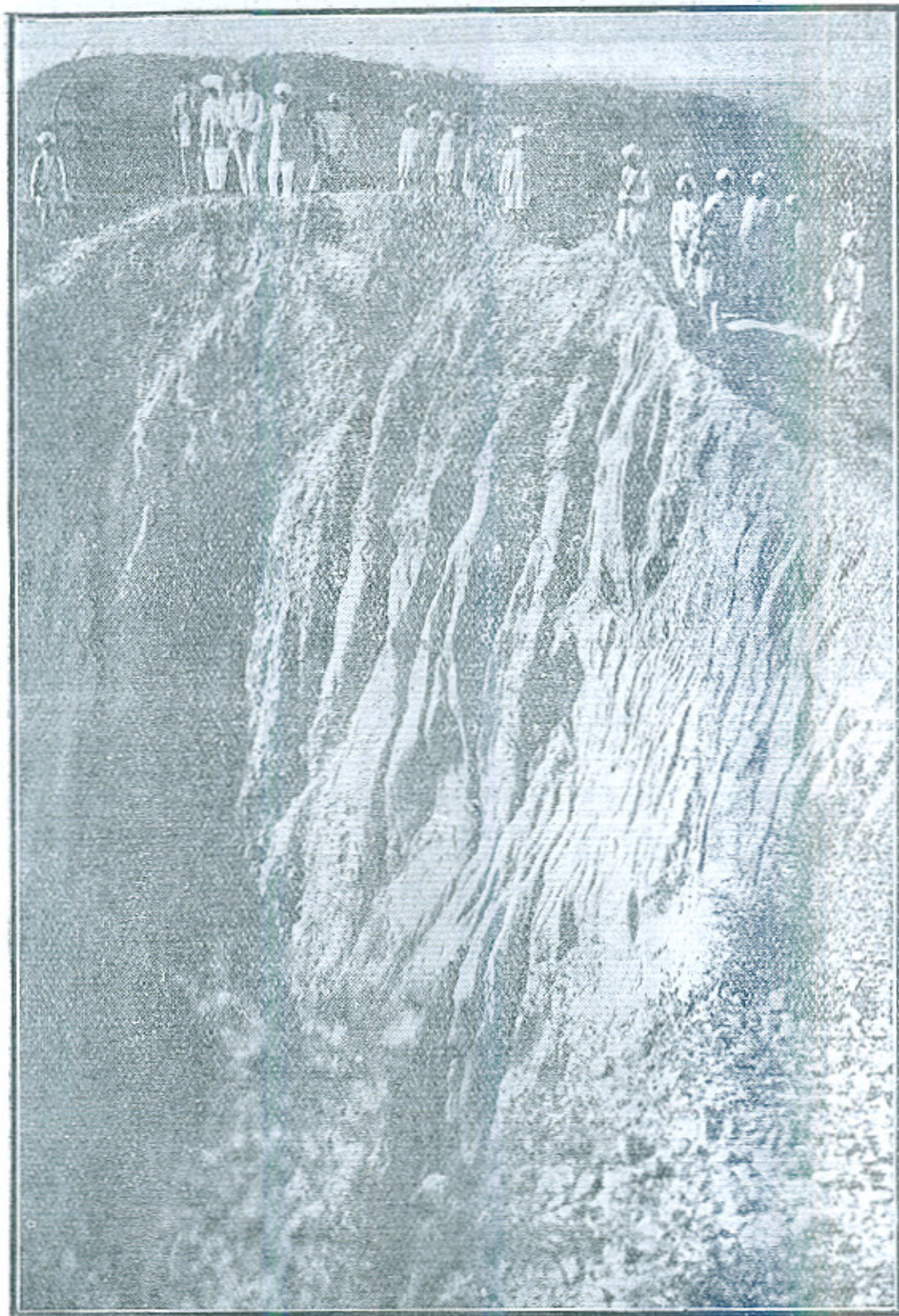


Scrub Forest—Trees lopped by Gaddis for fodder—Erosion shown in background.

Kangra District.



Scrub Forest—Heavily grazed—Erosion well advanced.
Kangra District.



Scrub Forest—last stage of erosion—Villagers protesting against
proposed closure to grazing.

Kangra District.

DISCUSSION.

Introduction.

Mr. Glover introduced the paper and referred to the opening address of His Excellency the Governor in 1929, in which he suggested that it might be necessary for Engineering Officers to be associated with Forest Officers in order to devise means of checking erosion.

Erosion had increased greatly in the last eighty years and was due largely to the destruction of the forests by herds of sheep, goats and buffaloes, which had multiplied owing to the peace and security brought by the British occupation. He dealt with the evidence afforded by history and quoted from the Kangra Gazetteer showing that in Shah Jahan's time dense scrub forests had covered the foot hills in the neighbourhood of Mirpur but had now largely disappeared. He introduced Mr. Holland who had wide experience of erosion in the outer Himalaya.

Mr. Holland in opening the discussion made the following remarks :—

“ Since I toured the low hills of the Punjab in 1927 and 1928 from Attock to Gurgaon to report on the erosion and denudation I have been convinced that the time is rapidly approaching, if not already arrived, when the ever increasing destruction of the vegetation, not only in the forests but also throughout the village waste, is bound to threaten your canals.

I believe the canals are threatened in two ways—

first, by ever increasing floods in the rains and

secondly, by steadily decreasing supplies in the rivers during the cold weather.

Some of you may not have considered the effect of well covered hills on the run off.

I would compare a well covered hillside to a bungalow with a thatched roof. The roof absorbs a very large quantity of rain and after the rain is over it goes on dripping for hours. In the same way a well covered hillside absorbs the rain during the monsoon and during the cold weather gives out the water again in the form of springs, perennial streams and a high sub soil water level at the foot of the hills. Within the hills there is too a steady drainage into the beds of the rivers.

A denuded hillside resembles a corrugated iron roof. The rain runs off in floods and the ground a few hours later is dry. Hardly any soaks into the soil.

People are inclined to look on forests as inexhaustable but their destruction is only too easy and once destroyed it may take generations to replace them.

You cannot plant up a denuded hillside with useful trees, you have to begin with a poor form of shrub growth and as the soil conditions very slowly improve you may be able to introduce a better form of vegetation.

You have only to consider the Hoshiarpur and Ambala Siwaliks which in 1854 were well covered with forest but which 20 years later were naked. To-day the conditions are not much better. Certainly this is so in those parts which drain into the Sutlej and Beas.

While mentioning Hoshiarpur and Ambala I would suggest that the shrinking of the water level in the wells in these districts and Jullundur is directly due to the denudation.

These hills used to absorb a very large quantity of water for the chos in 1854 are said to have been well defined stream with deep beds but to-day they are sandy wastes.

To give you some idea of the amount of water which comes off these low hills I would refer you to the superpassages over the Sirhind canal at Budki and Siswan.

The Budki passage is about 10 miles from the foot of the hills. It is 395 feet wide and 14 feet high. The following floods are recorded :—

1914	..	31 floods maximum flood	7.5 feet.
1925	..	31 floods maximum flood	8.3 feet.
1926	..	25 floods maximum flood	7.5 feet.
1927	..	21 floods maximum flood	10.4 feet.

That is to say a volume of water 395 feet wide and 10½ feet deep. The duration of the flood is not recorded.

The Siswan passage is 250 feet wide by 10 feet deep.

In 1916, 1921 and 1927 floods overtopped the sides of the superpassage.

What sum you have had to spend on training works owing to deforestation of the hills I do not know.

During my tour I saw a very large area of country which does not affect any canal but does affect roads and bridges and as I had to report only on the Punjab hills I was not able to inspect the low hills of Poonch, Jammu, Chamba, Mandi, Suket, etc. I have however seen a certain amount of these areas at different times and I believe conditions there are every bit as bad as in the Punjab.

To take some of the areas which affect the canals, for example the Kangra Valley and Gurdaspur, that part between Pathankot and Duneera which drains into the Ravi and Beas.

On first visiting Kangra you get the impression that it is very well wooded district but on closer inspection you will find that 90 per cent. of the trees are very heavily lopped. Every tree so lopped can bear no flowers. No flowers means no fruit and no fruit no seed and consequently when the trees die as they must one day there are no young trees to replace them. The shrub growth is similarly steadily diminishing and the local shepherds are complaining that they have had to abandon some of their old grazing grounds.

I have no hesitation in saying that the time is not far off when the Kangra Valley will be reduced to the same state of desolation as the Hoshiarpur and Ambala Siwaliks.

The Gurdaspur District is worse than Kangra.

Take the Salt Range or that part which drains into the Jhelum above Rasul. It is almost entirely denuded of all vegetation and most of the soil has been washed away. I may tell you that the only forest produce in some of the forests is stones.

In the Jhelum forest division we still have 116,000 acres of so-called forest which is open to goat grazing for at least nine months of the year. As the goats devour every seedling which tries to establish itself under the most trying conditions these 116,000 acres of forest are bound to disappear.

The cause of the destruction which is going on everywhere is the unrestricted grazing of hosts of goats, sheep and cattle. As the village grazing grounds become unable to support the animals the burden on the forests become heavier and heavier and they too deteriorate.

To give you some idea of the number of animals which this unfortunate country is expected to support :

In Kangra in addition to local animals you have every winter the nomadic Gaddi shepherds pouring down from the high hills of Kangra, Kulu and Chamba. Every year they come down to the tune of well over three hundred thousand. In Gurdaspur between 50 and 70 thousand animals appear. In the Hoshiarpur Siwaliks I found that there was on the average 1.4 acres for each head of cattle. The Agricultural Department say that it requires five acres of good grazing to keep a cow in good condition. How is it possible to expect the vegetation to improve?

There is now a motion before the Legislative Council to abolish the tax on goats, sheep and cattle in Kangra. If this is carried the number are certain to increase and the destruction will be aggravated.

It is easy enough to point out the destruction which is going on and to indicate the remedy but I confess the problem how to reduce the numbers of animals and to regulate the grazing appears quite insoluble but I am convinced that unless action is taken you must expect the floods to increase and the cold weather supplies in canals to diminish.

Mr. Kitchingman.—

In south-east France you have a country not unlike the Punjab in its physical configuration. You have hills and plains and each year the rains drop on the hills and the water drains down and waters the cultivations in the plains. Professor Huffel, the foremost authority in France on the relation between hill vegetation and floods, goes so far as to say that the very existence of the plains people depends here upon a proper proportion of forest and shrub vegetation covering the catchment areas of the rivers.

In the middle ages the land was owned by large landowners who carefully preserved the forest for hunting; rules were very strict. In 1727 the rules were revised and the punishment for forest offences made very severe; the penalty for felling trees without the King's permission was for a first offence whipping and banishment and for a second offence perpetual galleys. If fire was used to destroy the forest the penalty was either the galleys or even death. These revised rules remained in force until the French Revolution. After the revolution the forests were divided up and declared the property of the villagers, in accordance with the new ideas of democracy introduced by the revolutionary democrats. Wholesale destruction followed, as it was bound to do. Not many years passed before official reports spoke of "Forest clearings are on the increase. Many slopes of the old beautiful hills are denuded. Several villagers have lost their fields, herds and houses from the floods" . . . This is the stage we are now in the Punjab. Having handed over most of the forests to village rights in accordance with our democratic principles we now watch the forests being destroyed—the only ones remaining being those in the Native States where the forests are the sole-property of the Raj, and in reserved forests, which are the sole-property of Government. It is a maxim of Forest management that divided-ownership spells the ruin of forests and it may interest to know that the English, who are the most famous destroyers of forest in the world, have at last come to their senses, for since the war forests in England are gradually being transferred back to one sole-authority—the new English Forestry Commission started in 1919. Let us come back to France and see how they solved the difficulty. They started by spending a lot of money on building large bunds in the river beds to stop the force of the floods and save their fields. But they soon learnt that this was insufficient because the floods got worse and worse every year and destroyed the bunds as soon as they were built; and it was not till 1843 that they realised that they must do something to diminish the floods if they were to do any good at all. They surveyed the land and divided it into 1,462 nullahs which were liable to floods. Of these 1,462, 168 nullahs are now finished. They are gentle flowing streams, cultivation has come back and prosperity returned. The Forest service estimates that by about 1950, just about 100 years after work started all floods will have ceased. Now how did they do this?

Describing what was done in one particular nullah the speaker said: Let us take the Ubaye river. The catchment area of the river is 255,000 acres of which less than 20 per cent. are under forest. The length of the nullah is 48 miles and the river has 42 tributary nullahs. There are grazing rights for 30,000 animals (28,000 sheep, 2,000 cattle and horses). No goats are allowed. Nomad sheep equal 25,000 annually. It was decided to acquire 98,000 acres for reafforestation, but so far only 19,000 have been acquired and closed because to close the whole catchment area would have interfered too much with the grazing rights. But, as in all these nullahs where work is going on, the villagers have gradually realised the value of the work and have voluntarily closed their lands and

sold to the Forest Department no less than 14,000 acres of their own village forests. To-day floods have entirely stopped in four distributaries which are now beautifully wooded.

Now all this has not been done without a great deal of trouble politically. It was not till 1860 that a law was passed authorising Government to acquire land which was required for turning into forest. There was at first a terrible outcry against the Forest Department, the hill-people complaining that their rights were being ignored for the benefit of the rich cultivators in the plains. In the words of Professor Huffer "The very title of the 1860 law 'Reafforestation of the Mountains' " frightened the people. Was the Forest Department going to seize the whole mountain, cover it entirely with forest, forbid agriculture and pasturage, so as to bring back the solitude and peace of prehistoric times? Violent resistance was made by the hill-people to this law chiefly because much of the cost of the work was debited to the hill-villages where the denudation had taken place as they were considered responsible for the damage. After much political agitation a new law was passed in 1882 and this is in force to-day. It gives Government power to take over the catchment area of nullahs which are in a bad condition but the cost of all work is borne by Government, *i.e.*, the taxpayer, because everybody in France is considered to be interested. So you see that we in the Punjab are not alone in our difficulties—other countries have the same difficulties to face and we can learn a lot from the experience of others.

Mr. Prem Nath.

He was afraid he was not fully prepared to speak on the subject before the Congress.

In connection with his duties he had on several occasions to visit the inner valleys of the Himalayas which form the basin of the Sutlej, the Ravi and the Chenab. He had noticed that the process of disintegration of rocks and the denudation of hill sides is rapid. This was largely due to the exposure of soil or in other words the absence of vegetation and to the free grazing of sheep and goats in the alpine pasture lands. If we are to save the situation endeavours must be made to protect vegetation in the high hills and so he entirely endorsed the suggestions made by Mr. Holland.

Mr. Mohammad Azim, Extra Assistant Conservator of Forests, expressed his agreement with the views of the authors and urged the necessity of afforestation to check landslips.

Mr. Brayne, I.C.S., Deputy Commissioner, Jhelum, supplied the following written communication :—

He had been going into the question of flooding in the Jhelum District and found that except for the phenomenal flood of 1929, serious flooding has only been caused when heavy local rainfall coincide with a spate from Kashmir. This means that the denudation of the Salt Range is helping materially in the ruin of the riverain tract of the Jhelum District. The people complain that the bed of the river has risen and

this appears to be true. But the cause to my mind is not the Rasul Weir but the silt dropped when the flow of water is checked by the meeting of the Jhelum with the Salt Range torrents.

A large area in the Pind Dadan Khan Tahsil is being rapidly depopulated by increasing salinity. The cause of that at first sight appears to be the laying bare of the salt strata of the salt hills by erosion. So much for the terrible damage being done by our neglect of the hills.

Reafforestation is a far easier problem, however, than many people seem to believe. In the Gurgaon hills we have the Maconochie experiments which are 100 per cent. successful, and we have work started in 1925 which inspite of two failures of the rains already shows phenomenal success, and near Jhelum we have the Pabbi experiment. The Gurgaon hills consist of hard quartzite rock, whereas the Salt Range is already in an advanced stage of decomposition, while the cold weather rains are heavier and the frosts are far more severe than in the Gurgaon District so that afforestation in the Salt Range is far easier than in the Gurgaon hills, and if in Gurgaon in five years (including two famine years) such wonderful results can be achieved we need have no anxiety about the success which will attend any efforts made in the Salt Range.

The question has been recently discussed at two well-attended public meetings at Jhelum and there was a remarkable unanimity both as to the necessity of eliminating the goat and as to the possibility of very largely replacing it by the sheep, and an equally remarkable unanimity as to the disastrous results of deforestation, and all that is required is a careful organised campaign of public education to enlist the help of the villagers in this important question.

Granting land revenue remissions on similar lines to those granted for afforestation in the Hoshiarpur and Gurgaon Districts will meet with an instant response and immense success, while with a little tact he was convinced that goats can be removed from the Government Rakhs. A campaign of propaganda for the substitution of mutton for goats' meat and wool for goats hair would effect a very large reduction in the number of goats kept. These things would cost very little and constitute a very signal advance. The erection of bands in the Salt Range would be extremely popular and could be combined with afforestation in such a way as to make that also popular.

The main ingredient to success in all schemes is the careful and patient education of the villagers to realise the damage done by deforestation and the possibilities and advantages of afforestation.

He wondered if it would be possible, in order to convince the educated public of the urgent necessity of afforestation, for the afforestation of the catchment area to be included in the cost of maintenance of such engineering projects as dams, bridges, banks, etc. Could the forest experts and engineers make a rough calculation as to the run off of a catchment area in its present state and the estimated run off, say 10 years

hence when denudation has continued at the rate it is going on now, and draw up the estimate for the project in the alternative? One estimate assuming that afforestation would be done to and the other assuming continued neglect and allowing a larger outlay to meet the increasing force of the water due to further denudation. In this way it is possible that the sanctioning authorities would prefer the annual outlay on afforestation with its many other advantages in preference to the increased initial expenditure on the capital outlay, necessitated by the continued neglect of the catchment area. As it was, large sums were being spent on strengthening every work and even then it seems certain that as denudation proceeds the floods are bound to win, whereas if regular sums were spent on afforestation, within a measurable distance of time the remedy will catch up the disease and floods will begin to decrease.

Colonel Battye said that apparently engineers were being asked as to what they could do to help. In this matter he was of opinion that lawyers could do more to help than engineers.

Regarding Mr. Brayne's suggestion he said that it was by no means original. It was now common practice in the North American Continent to adopt afforestation with a view to postponing the date when the construction of storage dams became a necessity and in some cases to reduce their capacity. Afforestation was often a much cheaper method of obtaining storage than the construction of dams.

He also enquired as to what sort of area could be afforested. In order to save the forests from grazing he put forward the suggestion of fencing, making grazing a criminal offence and predicted that in time to come Government would have aerial police for these forests.

Mr. Glover's reply.

Mr. Glover in reply to remarks by Colonel Battye as to the cost of operations, emphasised the improvement which could be obtained by simple closure and prevention of abuses. Nature if given the chance would clothe the ground with forest without a large expenditure of money on artificial works. He drew attention to the similarity of conditions in the Punjab with those which had prevailed in France some generations ago as so well described by Mr. Kitchingman.