

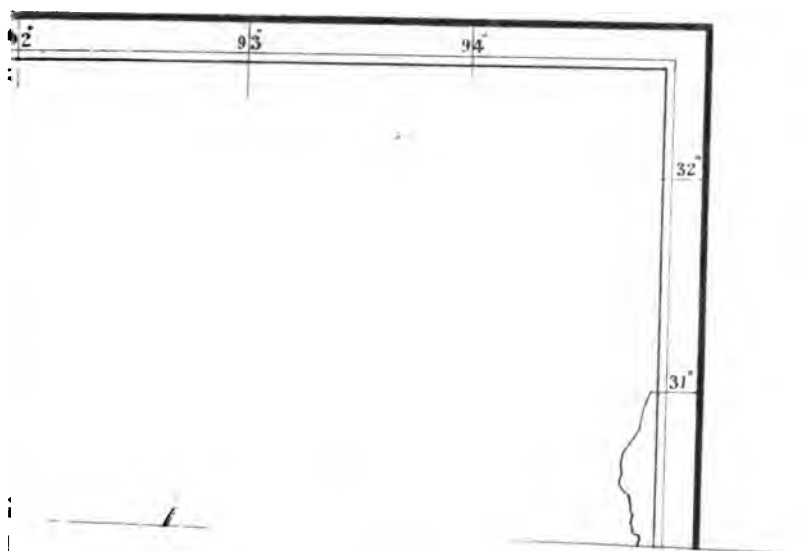
Note on the Limits of Perpetual Snow in the Himalayas. By
J. D. CUNNINGHAM, *Engineers.*

I have just read Lieut. R. Strachey's interesting paper limits of perpetual snow in the Himalayas,* in which he torily establishes that the elevations hitherto assigned to the menon have been under-estimated, and that in truth snow to be permanently found at about 15,000 feet, on the southern, about 18,000 feet on the northern boundaries respectively, instead about 13,000 and 16,500 feet, as hitherto supposed. Lieut. S very well shows that Humboldt has attached undue weight to the or partial observations of travellers and others in fixing upon the numbers, but he appears to me to be himself in error when he the greater elevation on the northern side almost solely to the quantity of snow which there falls, although he is pleased to value to my testimony that such quantity is indeed relatively small thus to make me in a way a supporter of his theory.

Humboldt's view of causes correct.—Humboldt, in his “(Sabine's Trans. I. 328,) enumerates the contingencies on which limits of the snow line are dependent, and to me he seems refer the superior height on the northern side of the Himalayas to the general elevation of Tibet, i. e. to the heat due to radial reverberation even at that great height above the sea. This strikingly borne out by what that able officer, the late Dr observed with reference to the Hindu Koosh.† He found it lying very much lower on the northern than on the southern side he gives as a reason for the large difference the existence of the lands of Cabul on the south side, or the fact that these high contain latent heat which melts the snow, while on the northern the slopes merge into the swampy flats of Toorkistan, scarcely above the sea, and are thus met by a cold atmosphere, down to level, in aid of the coldness due to a northern aspect.

* Journ. As. Soc. of Bengal, No. 102, April, 1849.

† Reports on Sindh, Afghanistan, &c., by Sir A. Burnes, Lieut. Leech, and Lieut. Wood. (Geographical Memoirs, p. 48, &c.)



Relative heights on extreme edges of mountain belts.—It will indeed be found that in any broad mountain chain resting on a plane inclined to the sea level, and running nearly east and west, the effect of latitude on temperature may be discarded, and that elevation above the particular country, and not above the general ocean, is mainly, although not solely, to be considered in determining the limits of perpetual snow on the two edges of the belt. The line of snow will rise as the plane of the country rises, and keep above it at a continually decreasing distance, until the diminishing temperature due to increasing height causes the two to coincide—a phenomenon which of course cannot occur in the temperate zones, as we know of no table-land so high as to be always frozen on the surface.

Relative heights on opposite sides of the same single hill of a chain.—This reasoning does not however apply to the limits of snow on the northern and southern slopes of any one hill or mountain, of a broad and complex chain, and as a rule, the snow will be found to lie lower on the northern than on the southern face of a single peak. In such an instance neither difference of latitude nor inclination of plane can ordinarily have any effect, and the only element to be taken into consideration is the direct play of the sun's rays, which in the northern hemisphere have most power on a hill side looking to the south. Captain Hutton, in his papers on Dr. McLelland's Journal of Natural History, had such isolated hills in view when he asserted that the southern limit of snow was higher than the northern one, and when he sought the support of my experience on the subject, as I was then, 1842, moving about in Ludâkh and Kunâwur.

Description of illustrative sketch.—The accompanying sketch represents what I believe to be the true state of the case with regard to the Himalayas, whether a line be drawn north and south across them, between the Gogra and Ganges, or east and west in the neighbourhood of Cashmîr. Towards the plains of India the limit of snow on the southern sides of the extreme hills will be found at about 15,000 feet above the sea, as Lieutenant Strachey shows, and on the northern face of the same hill, at about 12,000 feet, a figure however which I have assumed for the sake of illustration, as I know of no observations directly bearing on the subject. On the Tibetan side of the chain the heights will be found to be about 20,000 feet on the south, and 18,000,

or 18,500 feet on the north face of the same hill. These latter estimates are Lieut. Strachey's, and they are, I think correct, while the southern height of 20,000 feet is an approximation only.

I have taken the height of the Manasarawar lake, viz. 15,000 feet, in making this sketch, but even Humboldt's mean elevation of Tibet, viz. 11,500 feet (*Cosmos*, I. 330,) will not affect the argument, that the distance between the planes of the mountain bases and of the snow limits goes on decreasing as the former ascend.

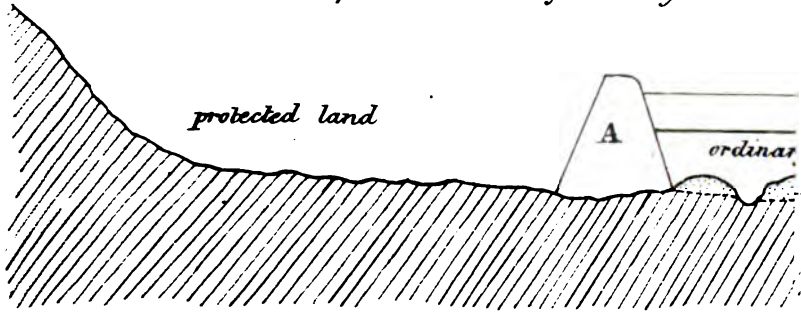
Quantity of snow falling in Tibet, and the permanency or renewal of snow generally.—With regard to the quantity of snow which falls to the northward of the main peaks of the Himalayas, I may refer to my statement at p. 238, of the 148th No. of the *Journal*, where I say that it did not appear to exceed two feet and a half in depth, where not drifted. This refers to the tract around the junction of the Sutlej and Spiti rivers. In addition to the details there given, I may also mention that the larger streams began (in 1842) to swell after the middle of February. This was due, I would say, to the radiation from the mountain masses causing the lower surface of the snow to melt—the recently accumulated snow itself forming a protection against the chilling winds, and so allowing the earth to part with its heat. At this period the temperature of ordinary springs was about 42°, while the air at sunrise was sometimes below zero, and the mercury would not rise above 60°, when exposed to the sun's rays in the early part of the afternoon. I state these particulars partly in support of what I consider to be Capt. Hutton's meaning with regard to snow not being perpetual—an opinion to which Lieut. Strachey somewhat slightly alludes.* Both observers are right, because the one simply means that the snow is ever being simultaneously destroyed and renewed, and the other that hills of a certain elevation always exhibit a covering of snow.

The Tibet of the Himalayas not a plain or table-land.—Lieut. Strachey, and indeed most people, talk of the "plains" or table-land" of Tibet, but I doubt whether between Imaus and Emodus, or any where in the valleys, or basins of the Indus and Brahmaputra to the north of the Himalayas, there are any plains. The range separating the upper courses of the Indus and Sutlej is indeed inferior in height to that which gives rise to the Ganges and Jumna, but it is still a lofty

* *Journ. As. Soc. of Bengal*, April 1849, p. 302, note.

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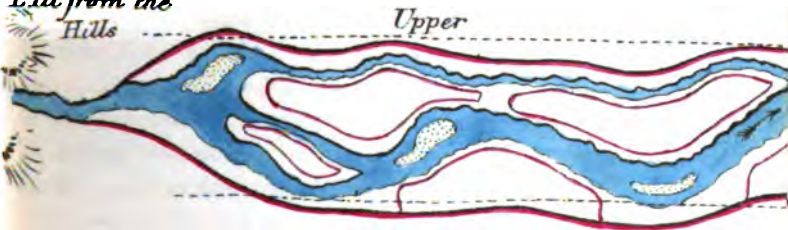
A-Primary or greater Embankments
on limits of Belt of Variation to
protect the Country Generally.



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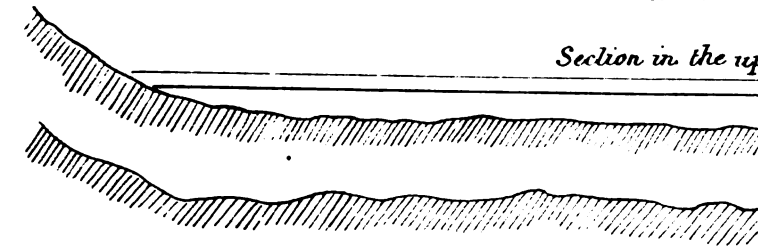
TYPICAL SKETCH

Exit from the
Hills



The dotted black line shows
and lower Plains. The thick

Section in the up



Level of highest flood

Section in th



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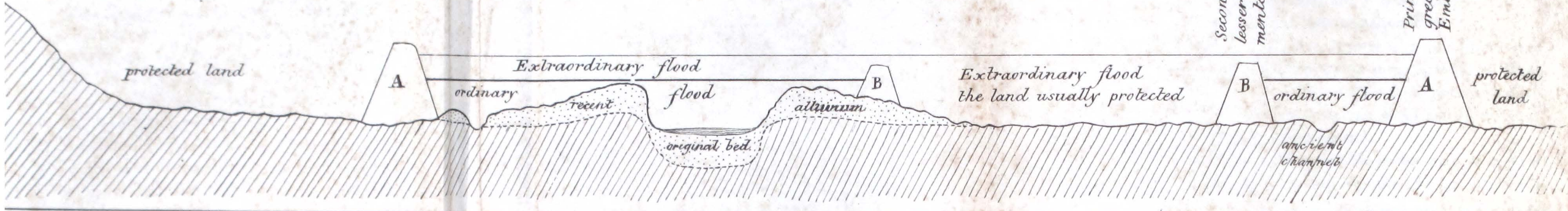
SYSTEM OF EMBANKMENTS PROPOSED

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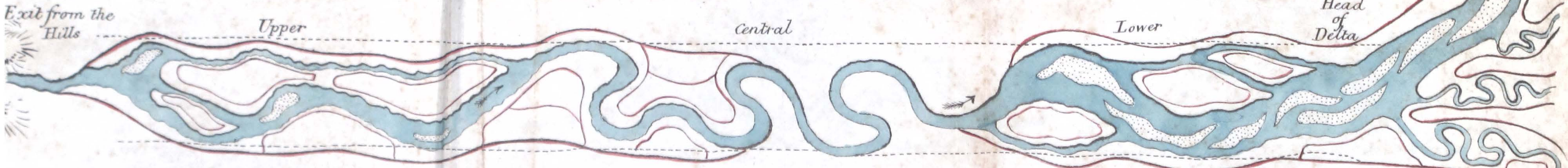
A - Primary or greater Embankments on limits of Belt of Variation to protect the Country Generally.

B - Secondary or lesser Embankments to protect limited tracts within the Belt of Variation.

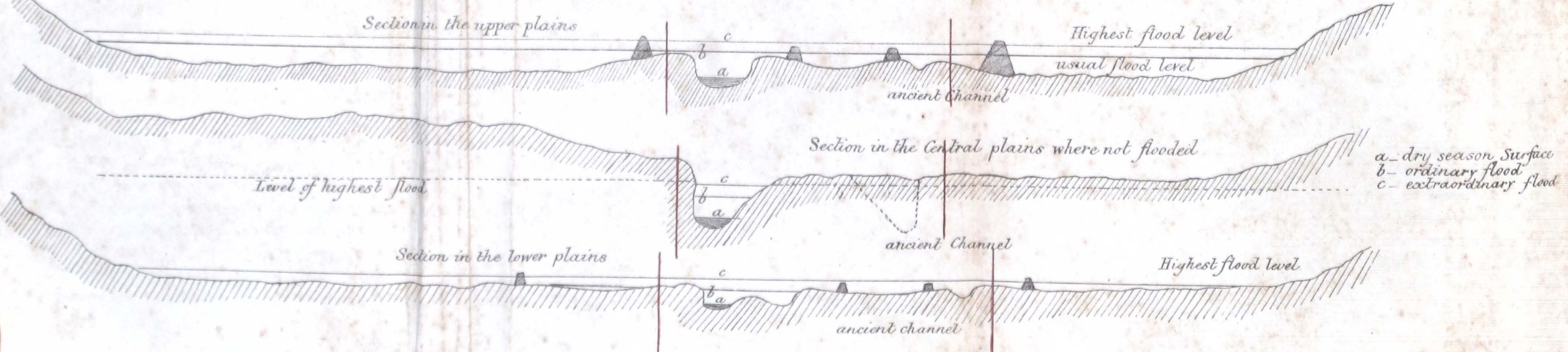


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TYPICAL SKETCH OF A TROPICAL RIVER IN DILUVIAL PLAINS.



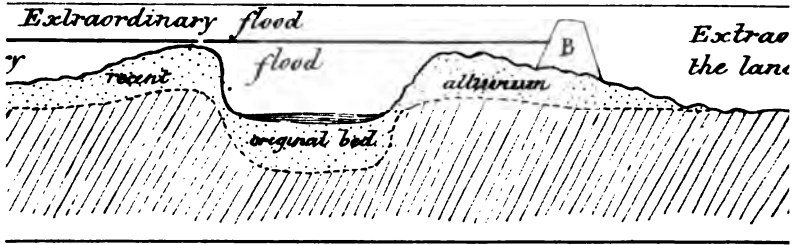
The dotted black line shows the limits of Variation of the Channel assumed as the same in the upper Central and lower Plains. The thick red lines show primary Embankments, and the thin red ones the secondary Embankments.



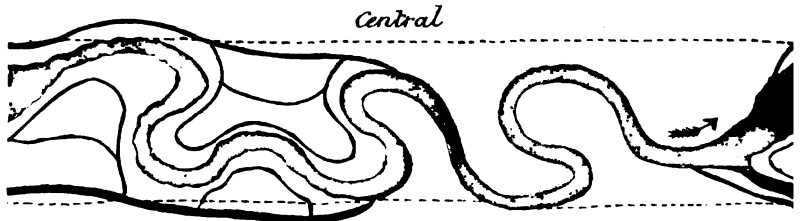
The perpendicular red lines represent the breadth of the belt of Variation.

EM OF EMBANKMENTS PROPOSED

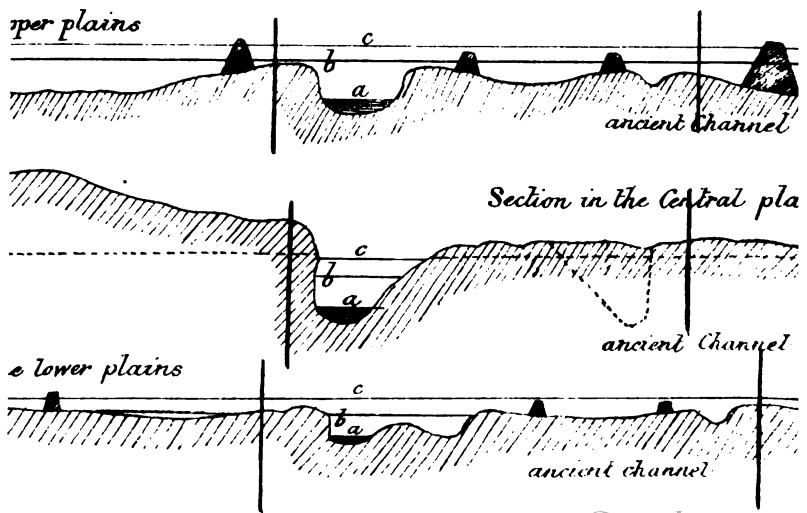
B- Secondary or lesser Embankments to protect limited tracts within the Belt of Variation.



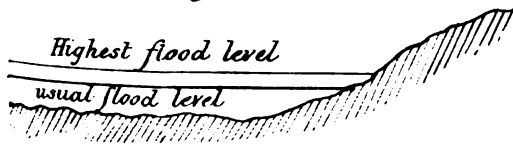
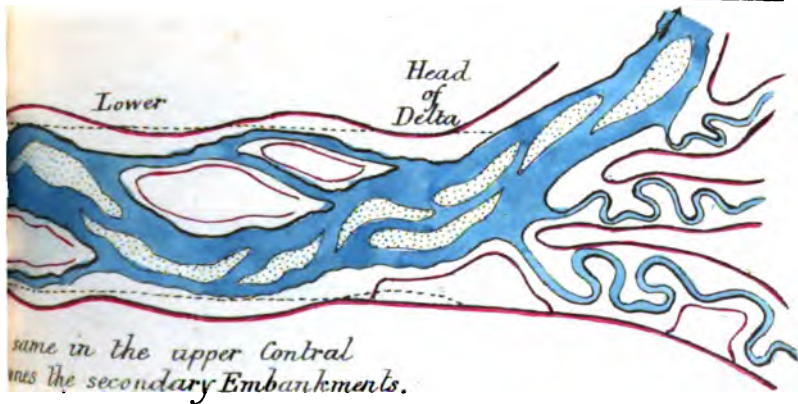
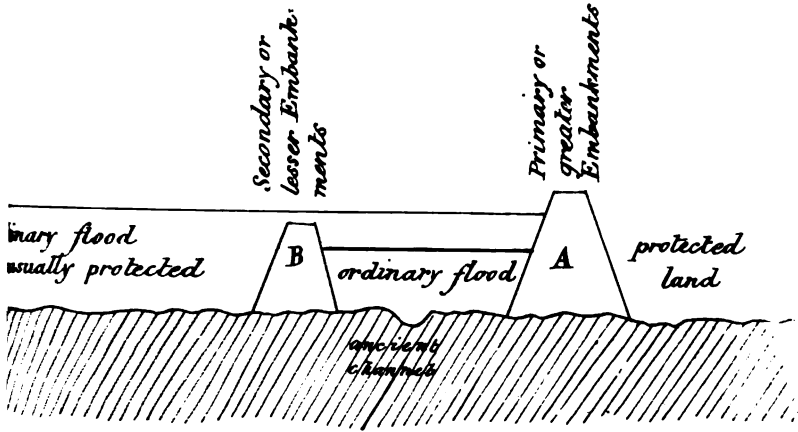
OF A TROPICAL RIVER IN DILUVIAL PLAINS .



the limits of Variation of the Channel assumed as the red lines show primary Embankments, and the thin red



perpendicular red lines represent the breadth of the belt



of Variation.

To the northward of the Indus, or on a line running from towards Yarkund, I dare say that undulating ground or moderate rather than deep ravines with steep sides, may perhaps be found. The downs or steppes, or at least tracts, afford pasturage to the description of shawl-wool goats, and Lieut. Strachey is right in his that, elevated although they be, they are as free from snow summer as the plains of India. What he supposes of the Kailás giri of the Manasarawar lake, viz. that the height of its (northern) line may be 19,500 feet, would also be fully verified on any mountain which may break the sameness of these steppes, and not be so far north as to be much affected by the latitude.

On the Embankments of Rivers, and on the Nature of Overflowing Rivers in Diluvial Plains. By Capt. J. D. CUNNINGHAM, Engineer.

A short time ago I addressed the Editor of the "*Englishman*" about embankments of the Damooda and other streams, and partly because my propositions were well spoken of by that paper (see issue of 1st May, 1849), I am induced to write to you more at length on the general question of such dikes, and also to make my views more by a few illustrative sketches.

Proposed Scheme of Embankments.—My scheme is founded on the fact that rivers, how capricious soever they may seem to be in any one neighbourhood, do nevertheless on the whole usually wind or vary within certain limits, or will ordinarily be found to flow between lines parallel to an ascertainable distance—although in their deltas and in the upper portion of their courses, they do also, after long periods, occasionally strike out such belts of petty variation, and strike out new channels for themselves at considerable distances to the right or left. Hence, disregarding these latter changes as not giving cause for yearly care, I recommend that there should be two sets of embankments, one primary, and one large section, following generally the limits of the belt of variation, the other secondary and smaller, surrounding islands, or covering the checked portions of land within the belt, which can be enclosed without materially impeding the flow of an ordinary inundation. By keeping