

mouth and Jackson's, the line was laid almost entirely with *Fagus fusca* sleepers, which had an ultimate life of about ten years.

38. And in Southland it is *Menziesii* they are using?—They are getting some *fusca*, but a comparatively small quantity.

39. From Ruapehu or Rangataua you would use both *Fagus fusca* and *Menziesii*?—They are marked separately for our purpose.

CHARLES ANDREW COTTON, M.Sc., sworn and examined. (No. 85.)

1. *The Chairamn.*] What is your profession?—Lecturer on Geology in connection with Victoria University College.

2. Do you wish to tender some evidence with regard to the effects of denudation?—The effects of reckless clearing. The term "denudation" has been applied to the matter in a report I would like to bring under your notice. It is an American report—Paper 7, on "Denudation and Erosion in the Southern Appalachian Region and the Monangahela Basin, 1911." This is the only copy in the University library, and therefore I am sorry I cannot leave it with you. Perhaps you will be able to obtain a copy. The term "denudation" has been applied to the subject, but the other word "deforestation" is, I think, very much better. "Denudation" is usually used in the sense of the second term mentioned in this report—"erosion"; but I would prefer to call it "deforestation and erosion." This paper is of special value because it contains a very careful study of the results of reckless clearing in a climate which appears to be very similar to ours. Most of the accounts have dealt with rather arid climates, and the results which have taken place on limestone plateaux. I suppose you know of cases in eastern Austria, Greece, and Cyprus, where in the old days there was a thin soil covering which supported the forest growth, and evidently had taken an enormous length of time to accumulate. The Turks, I suppose, and others cut down the timber and made use of it, and these areas then became limestone deserts on which soil has to be accumulated again in order to enable timber to be grown. This American report, however, deals with an entirely different region—the Southern Appalachian region, in the United States, which is considerably loftier, and regarding which it has been found that the trouble is caused by the reckless clearing of slopes which are really too steep to be cleared. From what I have seen in parts of New Zealand—I have not as yet had much experience in it—it seems to me that certain slopes in this country have been cleared on which the bush ought to have been allowed to live. The result brought about in that way seems to be twofold: there is, first, the direct result—a little grass may be got to grow on these slopes, although too steep at first; but apparently, after the tree-roots decay, slips cause a loss of surface soil, and so the slopes become absolutely barren. One point which is brought out in this paper is that the angle of slope on which it is safe to clear is not a fixed one—it varies with the underlying rock, and the type of soil which is produced by weather on that rock, and no doubt also to a very great extent by climate. The variation is so great on the Southern Appalachians that some slopes of 10 degrees should not be cleared, while other slopes of 30 degrees it is quite safe to clear. This paper by the United States Geological Survey Department is a complete application of correct physiographic principles, as far as I have seen, to the consideration of this question, to which I have given a considerable amount of attention, and as far as I can see the results seem to be justified. This is the first result: the slopes become useless in respect of cultivation or the growing of grass. The second result is, however, very much more far-reaching: the soil exposed by reckless clearing is washed off, and when clearing has been resorted to too much at the headwaters of streams that material is carried down-stream, leading in the lower courses of the rivers to a much greater liability to flooding. That result affects very large areas of agricultural land down-stream, and is due to the much more sudden rainfall on the land. It is well known that afforested ground holds the water that falls on the soil, but the bare ground runs that rain off immediately, with the result that there are floods, as seen recently, in the lower courses of the rivers. Another reason is that the gravel and soil when washed down into the lower courses of the rivers fills up the channels, the effect being that the channels have not the holding-capacity they formerly had, and immediately the flood takes place on the plains and in the lower courses of the rivers. A similar case results in the very rapid filling-up of reservoirs erected for different purposes. The reservoirs in the Southern Appalachian Mountains are built chiefly for power purposes, and some very large ones have been rendered almost useless for their purpose in two years. Denudation began as late as from 1885 to 1890 in that region, and the disastrous floods there have been brought about in a very few years, and the silting of the channels in the lower courses of the rivers has rendered them almost useless in some cases for navigation. At any rate it has entailed a very great expenditure of public money to keep the channels clear. I do not know that that remark applies to our rivers; but about £2,000,000, I think, has been spent in a few years in keeping open the Tennessee River, but I think that in spite of that expenditure the channel is worse than before.

3. *Dr. Cockayne.*] Have you ever been to Lake Waikaremoana?—No.

4. That lake is surrounded entirely by forest, and it is a very important place, because from it will be derived the electrical energy required for a great part of this Island. Will it be detrimental to the conservation of the water of that lake if the forest were burnt off all round the lake?—I am sorry that I am not able to give an opinion on the point. You will quite understand my reason; it requires a study on the ground to allow one to form an accurate opinion of that kind. I believe it is a limestone country there. Speaking, however, without very much authority, I should say that the basin is so large that it is not likely to be filled very readily by the removal of the forest owing to the increased amount of waste washed into it. Of course, floods