

paying to remove them than of their being considered of any moment.* Yet, paradoxical as it may appear, almost the first act of the settler after destroying the entire forest covering is to plant certain Californian pines for shelter purposes† (*Pinus insignis*, *P. muricata*, *Cupressus macrocarpa*).

(1.) Effect on Rainfall.

It is a matter of very general belief that a tree-covering increases the rainfall of a country very considerably, and that if such be removed the land would become a desert. Before dealing briefly with this important question it must be pointed out that in estimating changes of climate individual experience based on memory is of no moment whatever, since meteorological facts can only be secured by accurate instruments in the hands of a careful observer during a long period of years.

That forests cause increased precipitation seems at first glance, on comparing the rainfall of treeless and forest-clad districts, to be indisputable. But a moment's thought shows that without sufficient rain such a forest as that of New Zealand could not exist at all, and that it is not a *cause* of the rain but a direct *result*. Reduce the downpour beyond a certain limit and the rain-forest will be no longer present. Thus in Canterbury-Westland, everywhere within the region of the western rainfall up to a certain altitude is a vast forest, but on the eastern side beyond the average point reached by the above rain the forest as a continuous covering ceases, being confined to sheltered gullies or slopes, or to places where sufficient ground-water is available. So marked is this effect of change in harmony with the average rainfall and number of rainy days that the two very closely related species of mountain ribbon-wood, *Gaya Lyallii* and *G. ribifolia*, approach within less than a mile of one another, but do not inter-mingle, the former being confined to the wetter and the latter to the drier district.‡

The relation of forests to rainfall is in fact very little understood as yet: the evidence is conflicting, and there is no unanimity amongst scientific men. It seems probable, however, that there is some slight relation, and that forests may have a certain local effect. Should, however, the climate be of a moist, insular character, such as that of New Zealand, then deforestation would make no appreciable difference. The whole subject is too complicated for discussion here, nor is sufficient literature available. It seems to me, however, that it may be confidently asserted that were the whole of the trees of New Zealand, native and introduced, removed, the rainfall, owing to the moist sea-winds and the mountain-ranges favouring precipitation, would not be affected in the slightest degree.

(2.) Effect on Distribution of the Rainfall.

It is easy to see that a continuous covering of trees must have a great effect upon the surface of the ground beneath with regard to the rainfall, and that the maximum result will be attained by a rain-forest with its many tiers of vegetation, each serving as a roof, its abundance of sponge-like mosses, and the surface layer of porous humus or vegetable matter still only partly decayed.

A land-surface unprotected by a plant-covering will be reached by the whole of a downpour, light or heavy. Some water will sink into the ground, the amount depending on the porosity of the soil, and some will flow away, if the surface is sloping. But in a forest-clad area the volume of water which gains the ground will depend upon the intensity of the rain and the length of its continuance. A light shower will not reach the forest-floor at all, and even heavy rain will at first be held in no small measure by the foliage of trees and shrubs, while the mosses on the trunks, spreading roots, and fallen trees will absorb a great quantity of water, and those of the ground-surface, together with the litter and humus, will function as veritable reservoirs. Long after the rain is over one soon gets wet through in traversing a New Zealand forest; water can easily be wrung from the mosses, the filmy ferns are dripping, and the great asteliads§ in the trees may each hold no small quantity. There is therefore under no circumstances a sudden accession of water by the ground which it cannot to some extent absorb, provided the soil be not already saturated.

It is also easy to be seen that on an unprotected area of land there is nothing to check the powerful evaporation from the soil caused by sun and especially by wind, such also increasing with altitude. To be sure, as shown above, a forest or shrubbery does arrest a considerable quantity of water which never reaches the ground, but this is merely a trifle compared with what would run off an uncovered surface, or be lost by evaporation. Not only does the forest as a whole provide a deep column of moist air which can only at times, and slowly, receive additional moisture, but the wet moss-covering on the one hand helps by its slow evaporation to keep the atmosphere within the forest saturated, and on the other hand to check all evaporation from the ground-surface until the moss itself is dry, when it will absorb moisture from beneath by capillary attraction. Moreover, this ground-covering hinders the rain-drops, already much broken by the tiers of foliage, striking on and consolidating the soil, which remains in consequence porous and with full absorbing-power. It has been calculated that in a European deciduous forest evaporation may be decreased to seven-eighths of that in the open, and certainly the New Zealand rain-forest must act still more powerfully in this regard.

It can be readily seen how forests, through this mere suppression of evaporation, function in the conservation of water and so assist in keeping up the underground supply on which the permanency of rivers depends, but at the same time it must be pointed out that the trees themselves take up moisture from the soil and assist in keeping it dry. The surface-rooting rain-forest trees, however, function

* In almost every district there are one or two enlightened property-owners who carefully preserve pieces of the native forest on their land.

† The popular notion that if a small piece of the natural forest is preserved, say, one or two acres, it is certain to die, is quite erroneous, but this is dealt with further on.

‡ This is owing to *G. ribifolia* having leaves rather better adapted to a dry station than those of *G. Lyallii*.

§ Plants with leaves something like a "flag-lily" (*Iris*); native name, kahakaha or wharawhara.