much less in this regard than those of other regions with deeply descending roots. Nor must another most important attribute of forests be overlooked—namely, their sheltering function against the ever-present wind, that greatest evaporation-causing factor. Nowhere is this effect more marked than in the low and wind-swept coastal forest of the Auckland Islands, within which is a wind-still and saturated atmosphere, while without is blowing a fierce antarctic gale.

The amount of water which penetrates into the ground, and the rate of penetration, depends upon the permeability of the soil—a very variable factor, governed by its texture; coarse-grained soils (coarse sand, volcanic cinders, &c.) being extremely permeable, and fine-grained (clay, heavy loam) being the contrary. But the covering of mosses, decaying leaves, &c., renders the surface of the soil granular and so more permeable, while descending roots, and the channels left by those which have rotted, make special downward paths for the water. Furthermore, the floor-conditions, referred to at greater length below, of a New Zealand rain-forest are very favourable towards preventing the water running off the ground-surface, and so lengthen the time during which it can penetrate. Briefly, then, forest-conditions, and those of a rain-forest more especially, assist materially in maintaining the sub-terranean water-supply.

Run-off.—Closely bound up with the permeability of the soil is the volume of water which can flow away when the ground is sloping. Such flow is called by the Americans "run-off," a sufficiently expressive term. On the clay soils so common in New Zealand—which, although finally holding a large amount of water, receive the same very slowly, being extremely impermeable—the run-off is very considerable, and if there is a scanty plant-covering a quite moderate shower soon swells the volume of the neighbouring streams, which, where not sheltered by trees, decreases with equal rapidity.

It is easy to see from what has gone before that a covering of trees, or even of shrubs, will have a powerful effect on moderating the run-off, and if a typical rain-forest* occupies the ground a considerable amount of rain must fall before the streams are affected; or, if there has been a dry period, and the mosses, &c., are no longer wet, even a heavy downpour will have no result. This restraining of run-off is even more important than the evaporation-checking function of forests, and has a very marked effect in hindering an excessive volume of water swelling the streams in a brief period of time—*i.e.*, it helps in preventing floods.

The melting of the winter's snow is a powerful element in causing floods. Forests, of course, have a considerable effect in regulating the gradual meeting of what falls within their precincts, but in New Zealand their importance in this matter is not so great as in colder lands, the winter snow-line being above the subalpine forest belt. Their effect will be rather to restrain the volume of water descending after a warm rain than to hinder the melting. The shrubs along mountain streams will play an important part in the above matter, and their protection from fire is eminently desirable.

Perhaps even more than anything else does the irregularity of the forest-floor, by offering obstacles to the flow of water, operate regarding run-off. Everywhere lie the fallen trunks rotting and water-holding, heaps of humus stand high above the level of the floor, depressions large and small are common, moss-cushions, tussocks of sedges with water-absorbing decaying leaves at their bases, prostrate stems of climbing-plants,† the general close-growing ground-vegetation—all these collectively form a powerful obstacle to surface streams during the downpour. But, on the other hand, the steep slopes and innumerable gullies, shallow or deep, so characteristic of the New Zealand topography, play their part in rapidly conducting the water downwards, and no forest, however dense or crowded with obstacles, can altogether check their power.

(3.) *Effect regarding Denudation.*

It is with regard to the prevention of denudation and in regulating the flow of streams, touched on above, that forests play their most important part. Their services in this particular are of course greatest in mountainous countries, such as our own, and cannot be overestimated. Their power to restrain denudation is plainly manifest to any one who looks at the now bare and scarred foothills of the Tararua Mountains while journeying by train through western Wellington. Nowhere, however, can the protective effect of a tree covering be better seen than when traversing the old coach-road from Springfield to the West Coast. There, on the eastern portion of the dividing range, climate has not permitted the natural afforesting of many of the ranges, and in consequence gigantic *débris*-fields clothe most of the peaks, sometimes from summit to base (see photo opposite page 89). This result of intense weathering has been increased to no small extent by the action of the runholders since the earliest days of settlement, in burning the patches of subalpine shrubs, which, but to a lesser degree than actual forest, act as a protection to the substratum. Once reach the wetter region, and close forests succeeded by a belt of shrubs clothe the mountains, while it is only on the highest slopes that *débris*-fields of comparatively limited extent are in evidence.

Not only burning, but overstocking, exercises a deleterious influence. The various plant-associations of the mountains have arisen by a slow process of evolution, and still all stages of development may be observed, from the vegetation of rocks to a close shrubby covering, by way of loose *débris*-fields, which are being gradually occupied by plants and turned into a scanty pasture. Upset the balance of nature by burning or overstocking, and a reversion to *débris*-fields takes place, which in the presence of stock can never become reclothed with pasture, but, on the other hand, will pour their stones on to the land below. Certain creeping shrubs, especially the mountain totara (*Podocarpus nivalis*), are

---

* A beech forest (*Nothofagus*) of the drier districts has much less undergrowth than a taxad forest, or even beech forest of a wet area, and so functions less powerfully in checking run-off or evaporation, although its action is by no means feeble in this regard. A sub-alpine mountain-beech (*N. Cliffortioides*) forest will have, in places, a most dense undergrowth of young beeches.

† This class of plants becomes much less abundant above 2,000 ft. elevation.