WATER STORAGE ON SURFACE AND UNDERGROUND IN AUSTRALIA.*

Few people realize what immense stores of water are always latent in the surface of the subsoils. Approximately it may be assumed that the voids in sands and gravels average forty per cent. of their total volume. Assuming on the average only half this quantity in the upper seven feet, and the surface evaporation to abstract during the summer the equivalent of the contents of the upper two feet, then the effective storage of this surface crust is equivalent to one acre foot per acre. Such vegetation as can tap this reservoir is drought-resisting. At the same time it must not be assumed that all soils, or even a small proportion of soils, are saturated to within two feet of the surface, or that soils so saturated will sustain vegetation. On the contrary, such soils as are completely saturated to this level are fatal to most forms of vegetation. What does happen, is that the moisture, which is assumed here as half what would suffice to completely saturate the subsoil, is in a state of continual circulation; a portion, when the surface is drying under summer heats and dry winds, rising to supply the loss, while the great bulk is continually passing down towards the bedrock, and the soil, in a sponge-like state, contains also quantities of air. The storage in the porosity of the lower rock gradually finds its way by fissures to the surface or the deeps below sea-level. The quantity of water so held in suspension varies from the limestones and sandstones, where it may reach to, perhaps, fifty per cent. of the total volume down to less than one per cent. in the more compact igneous rocks. It has been assumed that there is less loss by this seepage in Australasia than the average in other countries. The run-off of our rivers, where recorded, hardly bears out this view, and the very large area of forests in the Australasian coastal lands certainly should help to feed the underground waters. The factors which make for penetration of water to the depths are chiefly those which retain the moisture longest on the surface, so that it has time to soak in, and, of course, the absence of stiff clays between the surface and the bed rocks.

Of these factors, all the forestry exponents claim that the forests give the best ground water spring flows, while the majority of engineers seem to regard the effect of forests on run-off as negligible. The views held on both sides have been so forcibly put, and are so conflicting, that a brief consideration here may not be out of place.

The engineers, while admitting that forest denudation is invariably followed by the scouring out of ravines and gulches by the storm-water, where formerly little or no water channels existed, and the consequent necessity to enlarge the smaller culverts on roads and railways, yet point out that the maximum flood records on the large streams and rivers are usually found in the periods before the forests have been denuded, and gather from this that forests have practically no effect in moderating floods, and consequently in conserving water to be given off in the drought seasons. They point to the fact that the areas which give the best drought flows are the bare mountain sides, where the snow lies in deep drifts, and persists almost throughout the whole summer. The regions within the perpetual snow-line do not come within the consideration of Australian engineers, and in any case, owing to the great evaporation at those high levels, where surface tension is low, the flow-off is seldom so great as from such elevations as are found in the Dividing Range in Victoria and New South Wales from, say, 2,000 to 7,000 feet above sea level. Such a range is much more favorable to a moist climate than the Rockies, or other snow-clad mountains, where the coastal winds are effectually dried of their moisture before reaching the continental side. In our case, then, the conflicting theories of the engineers and the foresters are easier of solution. Here we have mountains thickly covered with forests, and having practically the same rainfall as mountains where there is less timber and more snow-drifts, and yet the former give the better summer run-off.

Briefly, the snows that fall in timber country are evenly spread, and lie melting for a sufficient time to give off most of the snow-water to the ground beneath, while in the bare, rocky country a vast quantity of the snow disappears by evaporation direct into the atmosphere. Then, too, the efficiency of forests as breakwinds will have a most remarkable effect in keeping the surface of the ground moist long after it has dried off on the cleared lands. It is perfectly true that trees abstract an immense amount of moisture from the soil, which is continually rising in the summer as sap, and gets dissipated by evaporation from the leaves. To this even more than the shade must be attributed the cool temperature of forests in the summer. In the primæval forests in Gippsland of a summer morning, an hour or two after sunrise, a beautiful effect is often seen. The trees up to 80 or 100 feet from the ground are practically bare trunks; at that level they spread out, and are well covered with leaves. These leaves catch the moist air rising from the ground—the dew that has just evaporated—and hold it half condensed again in the shape of a horizontal gossamer wreath of beautiful white cloud. This illustrates one of the most marked benefits of the forest country. Whatever else its effects may be on winter rains or on torrential equinoctial rains, there can be no doubt but that they are a most effective condenser to catch and hold summer rains.

This can any summer be noticed on the range from Healesville to Baw Baw, the Yarra watershed of which has been marked off for Melbourne's water supply. Here a repeated experience is to find frequent showers above the 1,500 foot level often sufficiently heavy to even influence ground flow during summer months, when below that level on the cleared lands there has been no rainfall.

If these forest ranges are not conserved for water supply, and if the irrigationists work on the lower Goulburn only, then in process of time the fruitgrowers will find that it is cheaper to clear the rich forest lands, where there is sufficient natural rainfall, to save their charges of 10s. an acre foot for irrigation, and so the fruitgrowing areas in the upper Goulburn, in spite of the cooler climate, will ultimately outvie those in the irrigation areas, with the consequent result that the forests will, before the pressure of population, be infringed, and gradually denuded to the ultimate heavy damage of the whole country.

There can be little doubt but that much of the desolation which swept away the irrigation works in North Africa and in Asia Minor came from similar causes to this. The solution to this difficulty is met by the modern method of appropriating all the mountain valleys for

* From a paper on "Water Storage" read before the Victorian Institute of Engineers, Melbourne, by Mr. J. T. N. Anderson, Past-president.