Pacific Southwest Forest and Range
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WATER STORAGE CAPACITIES OF SOIL UNDER FOUR DIFFERENT LAND USES IN HAWAII[1/]

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ABSTRACT: Soil pore volume and pore size were correlated with land use or vegetation cover type. The top foot of forest soils had more large pores and higher water-holding capacities than that of soils under cultivation, in pasture land, or in idle grassland.

Size and continuity of soil pores, as well as total pore volume, determine the permeability and water-holding capacity of a soil. Water detained in large pores drains out by gravity 2 or 3 days after rain has wet the soil. Water is retained in the smaller pores. Moisture content at this time is called field capacity. Plants use part of the water retained in the small pores, but the remainder--water content at wilting point--is not available for plant use.

This report summarizes analyses of water storage capacity of 25 different soil types at 34 sites in Hawaii. Surface (0-12 inches) soils were analyzed for four different land uses or vegetation covers: forests, cultivated land, pasture land, and idle grassland.

Results

Total pore volumes for the land uses studied were nearly the same (table 1), but pore size distribution and consequently water-holding constants differed widely (fig. 1).

[1/] Study conducted by Pacific Southwest Forest and Range Experiment Station in cooperation with Forestry Division, Department of Land and Natural Resources, State of Hawaii.

Total potential water storage capacity is the sum of detained water (large pore volume) and available water volume (field capacity minus wilting point). Forest soils were found to have the greatest total storage capacity--13 percent more than pasture soils, 12 percent more than cultivated soils, and 10 percent more than idle-grassland soils.

After the soil becomes wet in a storm, the large pore volumes determine infiltration and percolation rate. Since forest soils have the greatest large pore volume, higher rates of percolation and infiltration are expected under forest cover.

Importance in Watershed Management

One primary aim of watershed management is to prevent or reduce floods. One of the best ways to accomplish this is to keep watershed soils in a condition to absorb large quantities of water rapidly. Results of this study show that forests do this best. For example, after a period of drought, the surface foot of forest soils can store up to 5.5 inches of water, pasture and cultivated soils only 4.0 inches, and idle grassland 4.3 inches before saturation would occur. When at field capacity, the surface foot of forest soils can still store 2.2 inches, pasture soils only 1.7 inches, and cultivated and idle-grassland soils only 1.2 inches.

Higher water storage capacity together with more large pores to encourage infiltration and percolation make soils under forests in Hawaii the most effective controller of runoff.

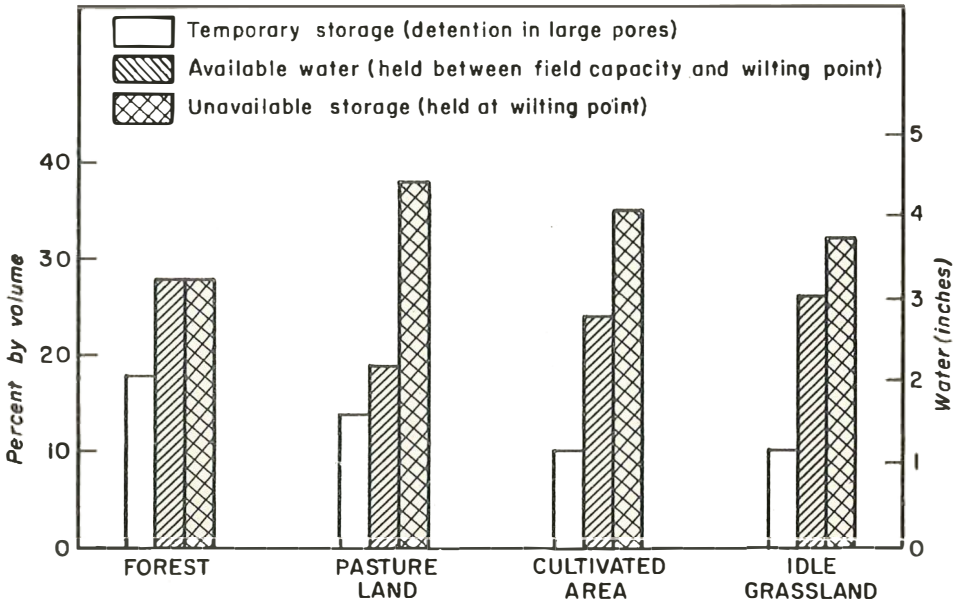

Figure 1.--Distribution of water storage capacities of surface soils (0-12 inches) under different land uses or vegetation covers. Total potential water storage equals sum of temporary and available water storage.

Table 1.--Organic matter content, bulk density, and pore volume of soils under different land uses or vegetation cover, 0- to 12-inch depth

Land use	Bulk density		Total pore volume		Large pore volume		Organic matter	
	Mean[1/]	Standard deviation	Mean[1/]	Standard deviation	Mean[1/]	Standard deviation	Mean[1/]	Standard deviation
	G/cm.^{3}		Percent					
Forest	0.76	0.22	74	6	18	7	6.5	3.0
Pasture land	.81	.34	71	11	14	6	8.7	8.7
Cultivated areas	.88	.26	69	8	10*	4	5.0	5.0
Idle grassland	.93	.36	68	11	10*	6	5.1	4.2

[1/] Number of sites: forest, 11; pasture land, 6; cultivated area, 10; idle grassland, 7.
* Significant at .05 level when compared to forest soils.

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1. A numbered series, U.S. Forest Service Research Papers.
2. A numbered series, U.S. Forest Service Research Notes.
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