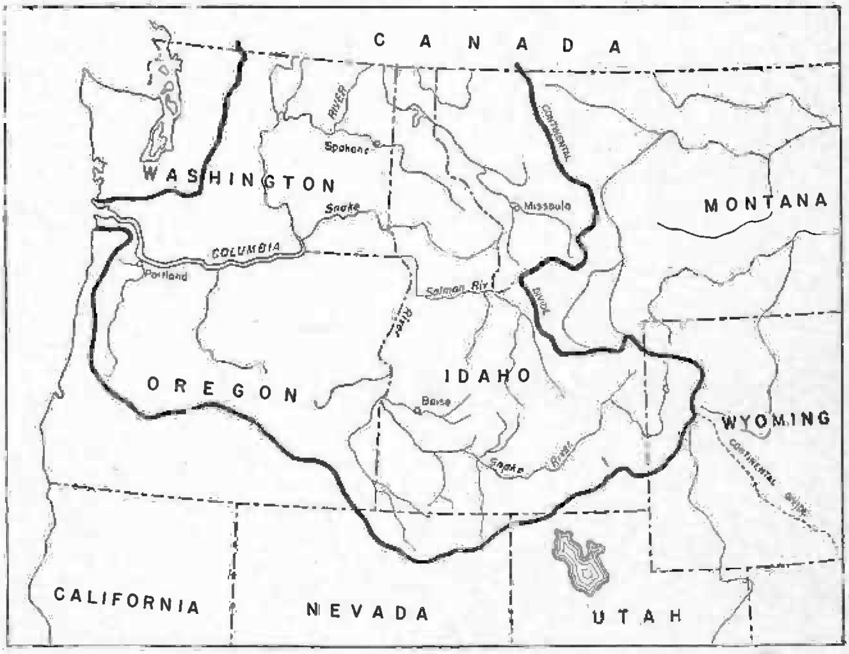
HOW FOREST CONDITIONS AFFECTED THE 1948 COLUMBIA FLOOD

UNITED STATES DEPARTMENT OF AGRICULTURE

Forest Service

AIB No. 10



Columbia River Basin in the United States.

HOW FOREST CONDITIONS AFFECTED THE 1948 COLUMBIA FLOOD[1]

What the Flood Did

Good forests help lessen floods. Snow melt is slower under timber than in the open. Not that the best and most complete forest cover could have prevented the Columbia River flood. There was simply too much water from melting snow and rain even for Nature's vast soil reservoir to hold it all back. But without the trees and other vegetation the flood would have been larger and more destructive. Trees wrote that story in white on many timbered high-mountain ranges in the Columbia River Basin in the spring of 1948.

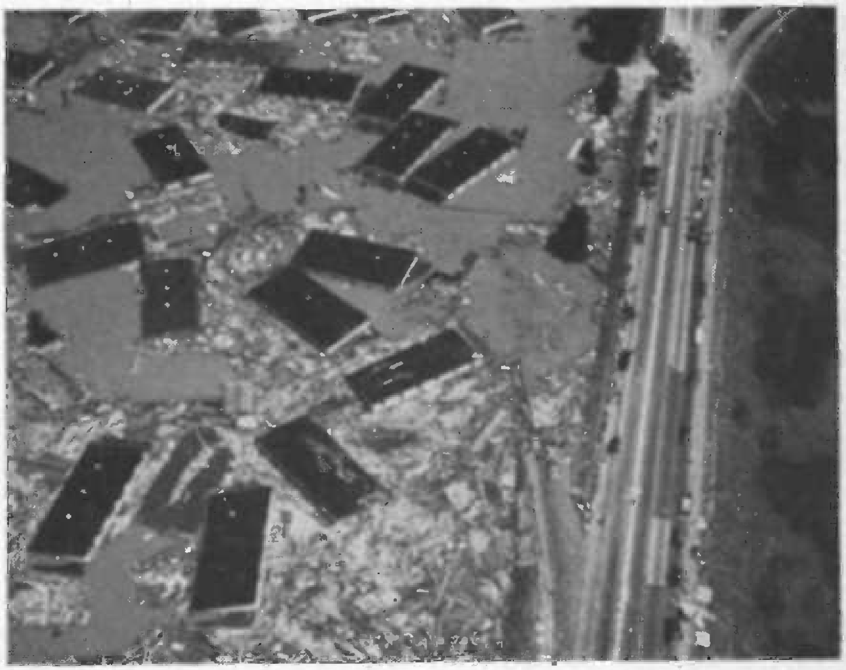
In the valleys upstream and downstream the Columbia was on its worst rampage since 1894. Rivulets became creeks, creeks became

Surging waters of the Columbia River burst the dike that protected lowland farms near Rainier, Oreg. Water poured through the opening and spread over hundreds of acres to a depth of several feet.

[1] Acknowledgment is made to the Soil Conservation Service and other agencies of the U. S. Department of Agriculture, and to the Weather Bureau, U. S. Department of Commerce, and the Geological Survey, U. S. Department of the Interior, for data on precipitation and runoff used in this publication.

rivers. The Kootenai River at Bonners Ferry, Idaho, rising to an even higher stage than in 1894, poured water and silt over thousands of acres of farm land. The Clearwater, Salmon, and Spokane Rivers rose out of their banks and spread over their valleys. Other tributaries all up and down the basin nearly everywhere were in flood. The lower Columbia was lapping at Portland and still rising.

Then came the day when the waters broke through a levee and drowned war-born Vanport—Oregon's newest city. In 1 hour of a Sunday afternoon, while children were playing in their yards, the city



of 18,500 people was engulfed. Men, women, and children were fished out of the water or taken from roofs. Some 5,000 families lost their homes. Houses were smashed and valued possessions ruined as the frames eddied about with other debris, caught in the muddy backwash of a swollen river.

That tragedy seemed the climax of human misery and suffering. It was really only the dark beginning. Not even until the next day, May 31, did the lower Columbia reach its peak flow. It did not subside until about the middle of June. For a month weary crews toiled day and night, sandbagging here, building a levee there, then scurrying off to strengthen another threatened point. During all this time, more than 38,000 people were homeless and some 65,000 more were kept from whatever homes they had left. Many were cold, sick, and hungry; families remained separated; and some of the 50 dead lay unburied or were lost. Human suffering was great.

Fields and homes, crops, mills, and factories were flooded for weeks, while mud and rot and rust compounded the damage done by the first high water. That was why the direct, immediate damages alone totaled well over $100,000,000. If all the damages were figured up the total would be much larger. One corporation, for instance, reported in a financial statement that the loss of inventories and reconditioning expense resulting from the Columbia River flood was $1,128,206.

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The Floan sawmill at Kamiah, Idaho, was completely inundated. Lumber floated away and railroad and highways serving the mill were blocked or destroyed.

The story of human suffering and property loss and damage has been told by newspapers and magazines. There remains to be told the role of the mountain forests in keeping this great tragedy from being far greater.

From High Mountains, Much Water

The 1948 Columbia River flood really began with the heavy rains of October 1947. They came the way most of the basin's water comes—on the cool, moist winds from the Pacific Ocean. They fell where two-thirds of the basin's rain and snow falls, in the forest on the three great mountain ranges that run through the basin from north to south. First the Coast Range, then the higher Cascades, then finally the Rockies—each a formidable barrier—forced the passing wind upward high enough to cool it so that it dropped some of its water.

The early rains were followed by others throughout the winter. Some were heavy—rains that produced local flooding, such as that in the Willamette River in January. They filled the entire soil mantle—that immense, often deep storehouse of water—nearly to capacity.

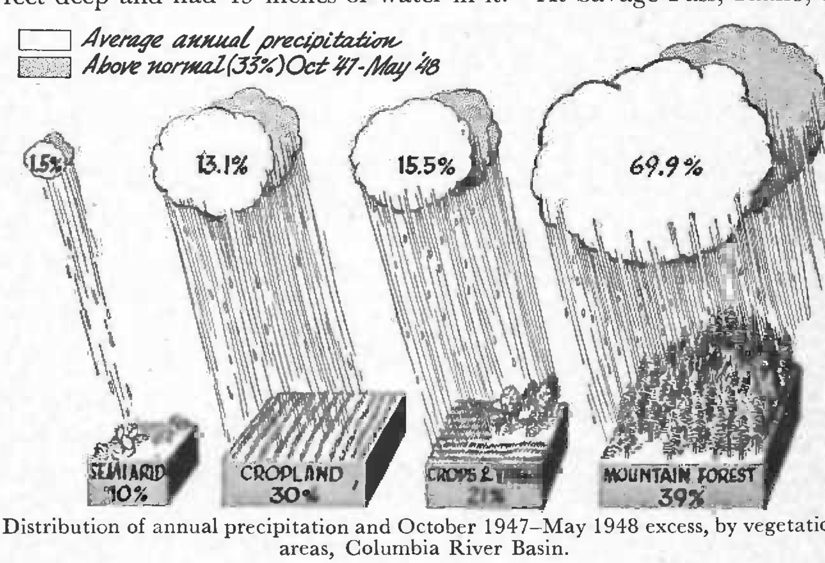
Before much of the water could drain out or be used by plants, the cold of winter descended upon the basin. Water oozed out of the soil more and more slowly: evaporation almost stopped. Then came the snow. It came early. It lay gently among the pines at the lower and middle elevations and throughout the great interior plateaus. It lay deep among the spruce and the fir high up on the mountainsides, but it lay even deeper in the alpine forests and on the barren areas above timber line, where the long, cold, drying winter winds and short summers make establishment of tree growth impossible.

Less snow fell on the forests on the lower slopes, of course, and some of this disappeared before spring, especially on the drier, sunnier sides. But in the high mountains, the mantle of snow was deeper than usual. In some places 10 or 15 feet of snow fell, possibly more. Some of it was caught by the crowns of the dense evergreen forest and clung to the branches until it evaporated. But most of it sifted down through the trees to the ground. There, as the long winter wore on and more snows came, it packed tighter and tighter, locking in its innumerable crystals the water of many a storm.

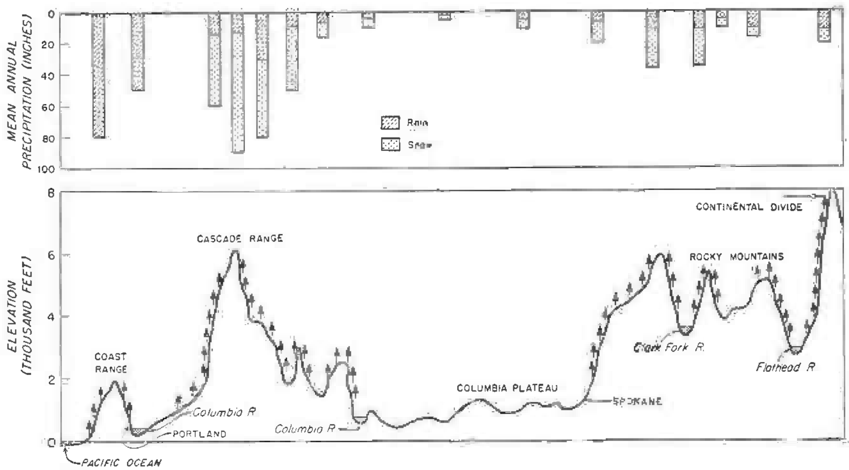
"April showers" were both rain and snow. The snow deepened the white blanket; it caught and held the rain, preventing its reaching the soil. April was unusually cold, too; spring was late. Mountain streams that should have begun carrying off the water from the first melting snow remained low.

By May it was evident that the Columbia River, which probably gets more of its water from winter snow than any other of our great rivers, would this year get a supply far larger than usual. The 62 million acres of mountain forest that make up nearly half of the basin's land area were thoroughly wet; much of this area was blanketed with a snow pack one and a half times as heavy as in most other years.

At mile-high Marias Pass, Mont., inside the boundary of Glacier National Park, the snow pack held 15.3 inches of water, twice as much as usual. At Revelstoke, B. C., 6,000 feet above sea level, snow was 9½ feet deep and had 49 inches of water in it. At Savage Pass, Idaho, at



Distribution of annual precipitation and October 1947–May 1948 excess, by vegetation areas, Columbia River Basin.



Snowfall, rainfall, and forested land in a cross section of the Columbia River Basin.

6,600 feet, the snow was 6 feet deep and had 32 inches of water. Near Gibbon's Pass, 7,100 feet up in the Montana Rockies, the 4-foot-deep snow cover had 21 inches of water. At 5,600 feet on the slopes of Mount Hood, the water content of 14 feet of snow was 72 inches; 10 feet of snow in the Deschutes River Basin had 55 inches.

So by May, things were ripe for a flood. And it kept on raining and snowing. May precipitation was 400 percent of normal in some parts of the basin and above normal almost everywhere. Eastern Washington received 355 percent above the average and northern Idaho 238 percent, the greatest for May in 56 years of record. Fortunately, however, the precipitation in the upper Snake was a little below normal.

More rain came in early June—five times as much as usual in the western tributaries of the mid-Columbia, and more than usual in the rest of the basin.

In most years the Columbia River Basin warms up gradually from south to north. The lighter snows of the southern areas, of the south slopes, and at the lower elevations are usually well on their way to the ocean before the rest melt. This year, 1948, the weather throughout stayed cold until mid-May. Then, high and low, north and south, it turned warm all at once. Temperatures rose fast. What is more, once the sun began to warm things up, the temperatures stayed warm, even at night.

The snow began to melt rapidly. At the lower elevations, which had the least snow, and from the southern slopes, the snow melted first. The water that had been confined in the snow cover for so long came off with a rush. The snow line moved higher and higher up the mountainsides. Rains fell again, warm rains that melted more snow. The melt was so fast that the Snake River system, which usually reaches its peak 2 weeks ahead, hit its high-water mark only 2 days before the main flood peaks on the lower Columbia.

Over a large part of the basin, the snow melted rapidly. On the higher forested slopes, however, where trees quieted the wind and shaded the ground from the sun, snow remained longer, sometimes until the high water downstream was safely past. At the height of the downstream flood, airplane flights over the northern Rockies revealed great open areas at the high altitudes completely bare of snow while neighboring forested land was still covered. Even small patches of woods kept some of their snow.

Forest rangers on the ground during and after the peak of the flood reported the same thing:

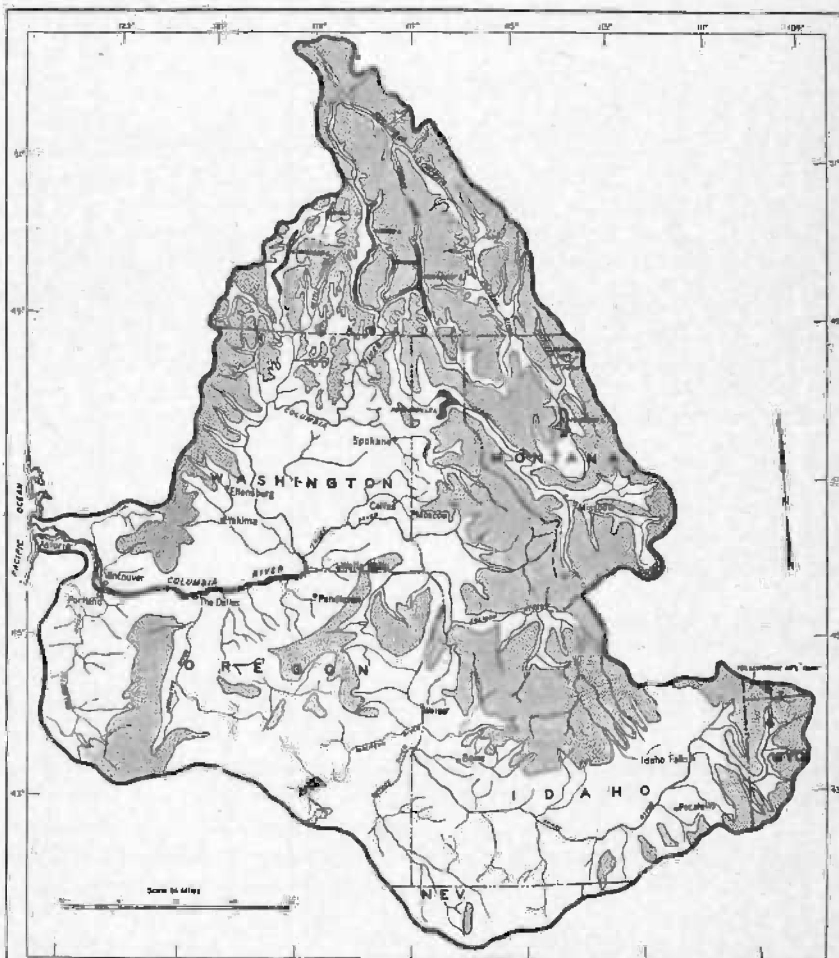
"Snow stayed in timber nearly 3 weeks longer than on bare slopes."

"Forest land had patches of snow while brush-grown land was bare."

"A stand of white pine on a slope facing northeast has 6 inches of snow under it. Burned and open ground has none."

"Snow all gone in a meadow but 2 feet left in spruce stands."

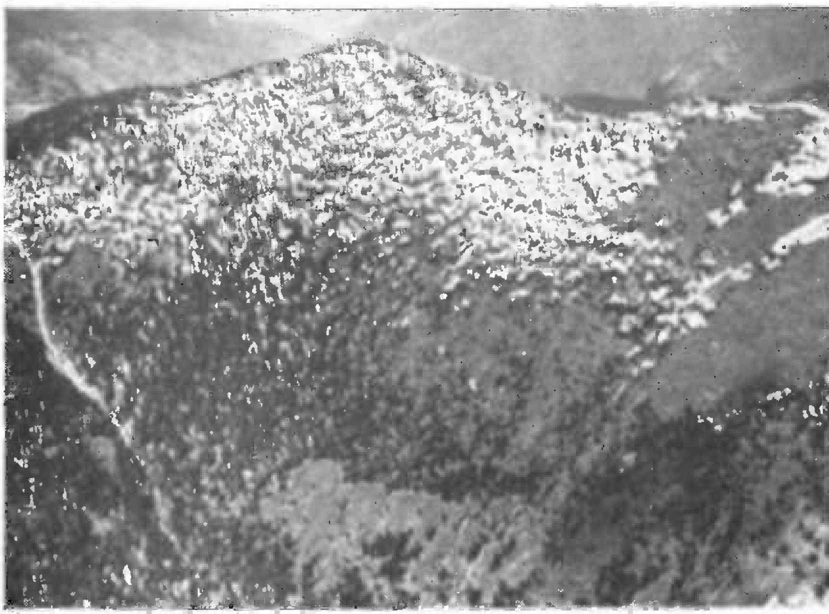
"On bare ground snow melted 2 weeks earlier than in timber."



Snow cover on Columbia Basin, May 1, 1948.

In several places at the higher elevations forested slopes had continuous snow 1,000 feet below the snow line on denuded land facing the same direction. Often cool north and east slopes, bare of trees, lost their snow while timbered west and south slopes, though warmer, were still white.

Clearly, the high mountain forests, although they too were losing their snow cover, were still holding back much water. Clearly, too, the great stretches of high mountain land lacking their former forest cover had more quickly released their water to add to the flood that was raging downstream.



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West slope, Bitterroot Mountains. Snow remained in timber longer than on barren areas.

The Watersheds Denuded

What had laid bare to the sun and wind these vast stretches of the forest land whose snows make the Columbia our second largest river in volume of flow? Why did they not have a forest cover? Fire was the arch enemy.

Fire after fire had swept through these mountain forests of the Columbia River watershed in the past. The upper basin had a million-acre forest fire in 1865, a similar one in 1868, another in 1889. Three and a half million acres in northern Idaho and western Montana burned in 1910, and 1919 was also marked by big forest fires. In 1926 a third of the Kaniksu National Forest burned. More bad fires burned there in 1934, as well as in British Columbia. There were smaller ones elsewhere.

On the 31 national forests in the basin, more than 5 million acres were burned—11 percent of the total area of these units. As in other forest regions, many of these burned lands had suffered not one but two or three fires on the same tract in recent times. On the national forests in northern Idaho and western Montana alone, these multiple burns in less than 50 years devastated 786,000 acres, or 14 percent of the total acreage burned during that period.

The action of trees and protected soil in reducing surface runoff has been demonstrated before in the basin. A large part (18 percent) of the Clearwater River drainage burned in 1919. After the fire, spring flood

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Fire destroys the forest canopy, consumes litter and humus.

peaks were 11 percent greater than before, and badly needed summer flow was 32 percent less. The average spring peak flow came 14 days earlier than it did before the fire. In brief, fire damage to the watershed caused much water to run off in spring floods instead of going into the ground to feed the streams in the dry months. On the nearby Salmon River drainage, which had been burned much less, the average spring peak was only 2 days earlier after the burn than it was before.

On the lower slopes, some of the burned forests, especially those burned only once in many years, have grown back. Gradually some of the richness of the soil has been restored as the annual litter of needles and twigs has decayed. Although better conditions are evident, it is very doubtful that good watershed conditions have been fully restored in many cases.

Fires that sweep over the same area more than once in a generation do serious damage to the watershed. This is true even where the soils are deep. The first fire may leave tremendous quantities of fuel for the second one; and it exposes the forest floor to be dried out by the sun and wind. Thus provided with tinder-dry forest fuels, the second fire burns hotter and spreads faster than the first, consumes most of the ground cover and humus, and burns the life out of the soil. Such devastating fires decrease the protection values of the watershed.

But it is in the high mountain or alpine forests near timber line that fire damage to the watershed has been worst. Here the thin soils and the harsh climate have all too often made single fires as devastating as repeated burns lower down. For example, some of the alpine forests of the upper watershed, burned in the big fires of 1910, are clothed today only with scattered brush—a poor substitute. On a few areas, scattered young trees are making an appearance, but it will be many years before a new forest covers the area. Second fires in these high mountain forests are even more disastrous. The damage to watershed values is enormous. It may take centuries for a new forest and good humus cover to develop.

Especially in Idaho, Montana, and British Columbia, great areas of high land are virtually bare. Yet many have burned only once in the last half century. One-half to two-thirds of the now practically treeless burned areas on the Clearwater and Flathead National Forests are at the higher elevations.

The loss of the forest cover at these elevations is serious not only from the standpoint of the lost watershed values, but from others as well—timber, recreation, and wildlife. Some of these high forest areas, largely in national forests, would grow commercial timber. Others are incapable of producing such timber. But all of them are very important from the water standpoint. Because these areas occupy the higher elevations in the mountains, good forest cover on them would protect from too early and too rapid melting some of the deepest snows that fall within the basin.

Clearly less water would have come off the high mountains during the 1948 flood if less forest land had been ravaged by fire.

With all the basin's streams in flood, except a few in the lower basin and in the upper Snake, the effect of forests on snow was plain to see. Many of the unburned alpine forests did not lose all their snow until June 14. In one place on the Kootenai River, snow melt was 14 days earlier in the open. Over the entire upper basin, on a rough average, melt in the high country was some 10 days earlier on bare ground than in timber. In a normal, cooler spring these differences in melting times probably would have been greater.

Mill Creek, near Anaconda, Mont., is an extreme example of what happens when a watershed is made almost completely bare. Smelter fumes have killed three quarters of the plant cover on this drainage. A similar watershed nearby, German Gulch, is well timbered. This spring of 1948 the peak flow on German Gulch was only half as high as that on Mill Creek, and came a full 10 days later. After high water, moreover, the flow from Mill Creek fell off much faster than that from German Gulch.

On one small watershed after another the pattern was the same. The damaged watersheds usually peaked earlier than the undamaged ones, and the peaks were always higher. After high water, flows from damaged watersheds dropped much faster than those from forested drainages.

National forests in the Columbia Basin. A good forest cover at the higher elevations on these areas would materially reduce damage from floods.

These differences were partly due to the fact that trees slowed up the snow melt. Partly too they mean that on the undamaged watersheds the soil mantle was capable of taking up much water and slowing its movement into the streams. Because of its absorbent qualities, an inch of good humus (decayed litter) alone can hold back a half-inch or more of water. In some unburned western mountain forests the humus layer is deep. Twenty inches of litter and humus were found under an unburned old-growth spruce forest on the Flathead River watershed, and deep layers were recorded elsewhere at moderate elevations. Deep humus layers may also develop under protected vegetation at higher elevations, even though the mineral soil beneath may be shallow and have relatively little water-storage capacity. In mature lodgepole pine stands, for instance, humus depths ran up to 6 inches.

Once destroyed, humus requires years and years to build up again. An uncompacted humus layer 3 inches in depth was found at 3,000 feet elevation under a dense stand of coniferous trees that had grown up after the fire of 1889. The decomposing litter in a nearby stand that had started after a burn 20 years ago was only a half-inch thick and fairly compact. Humus development in lodgepole pine stands after fire or cutting is usually very slow. Considering the repeated hot fires over large areas during the past century, the depth of the humus layer over much of the upper basin's forests probably does not average as much as 2 inches.

Fire on the upper basin threatens the people who live below with larger and more frequent floods. These aggravated flood threats will remain as long as the large areas of critical watershed lands lack an adequate tree and humus cover.

Soil Moved Off the Land

When water comes off land as fast as it did in the Columbia Basin, there is bound to be erosion. And there was—in the mountain stream channels and in the valleys. Yet only a little of the lower Columbia's huge load of silt came from the high watersheds. Some of the upland tributaries, like the Kootenai and the Blackfoot Rivers, carried heavy loads of silt, most of it from the valleys in which the rivers flow, a large part from the stream banks themselves. Great quantities of soil and rock were washed out of the Yakima and Wenatchee Rivers. The Boise River in 1948, as in other years, carried large quantities of sediment. The heavy rains eroded much additional silt from overused or improperly

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Repeating the tragedy on other upland tributaries, the Methow River gouged tons of silt from its own banks. At this point State Highway 16 was cut in two places.

handled grazing or farm lands lower down. All together, some 78 million tons of it muddied the Columbia River during the first 21 days of the flood.

Yet many of the high watershed lands did not erode seriously. In part, their porous mineral soils allowed water, especially that from melting snow, to soak in easily. Even when melting was fastest, most of the water from the mountain snow pack took this safer way into streams. Fresh sheet erosion and especially gullying caused by runoff from melting snow were generally slight, even on severely burned, poorly recovered areas.

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Result of torrential storms on overgrazed areas near Nespelem, Wash. Debris from such land will contribute to the sediment load and damages of future snow-melt floods.

Of course there were exceptions. Wide stretches of the burned-over high country and the upper parts of south and west slopes lower down did show scattered evidences of erosion during the flood period. Some of it was fresh, and doubtless from the rapid snow melt, especially on the steepest slopes.

Much of the erosion was caused by the hard rains during the flood period. Water that fell on compacted, exposed, poorly vegetated, or tight soils could not readily be absorbed and as it ran off over the surface it carried considerable quantities of material. The presence of old gullies, some large, indicates that there had been severe erosion in the past also. Such erosion was undoubtedly widespread on many areas. When both the litter and the soil mantle, including its humus layer, had all the water they would hold, the surplus passed rapidly over the surface or through the soil and flowed into the streams so fast that on many steep areas channels were unable to confine the flow.

A great many streams, large and small, cut old channels deeper or wider—often for the first time since records have been kept—and sometimes entirely new channels. Many channels were ripped out to bedrock along their entire length. Channels draining both burned and unburned land were torn out, but the erosion was much worse on drainages where fires had been most severe. That was to be expected, in view of the excessive flows resulting from the faster melt and diminished water storage on such areas.

A lot of the material eroded from the mountain channels was coarse gravel and boulders. When the Lochsa River, on the Snake drainage in Idaho, was in full flood the clatter and din of the great mass of debris it was carrying made conversation difficult. In their downward rush even small creeks carried a heavy load of gravel and stones and dumped the material on roads, recreation areas, and fertile bottoms.

Especially heavy loads of dirt and rock came from unprotected road slopes and roads ripped out by raging waters.

Often this coarse material and finer sediment, together with old logs and other debris, piled up in slow water sufficiently to change the course of the stream. At times the debris helped form temporary dams that later suddenly let go, releasing debris-laden surges of water that knocked out a bridge here, washed out a road there, and spewed rocks and other erosional wastes over a picnic ground farther on.

Part of the coarser sediment remained in the stream beds. For example, a stream on the Lolo National Forest piled up 5 feet of silt and gravel above its normal bed. Small floods will now find it easy to climb over the banks until a major flood comes again to sweep the material on downstream, perhaps into some reservoir.

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Areas like this one, destructively logged, burned, and overgrazed, produced severe flood runoff and erosion.

F-456630
Poor logging practices that lead to deep scarring by gullies contribute to flood disasters. Snow melt is more rapid on such areas.

Fire was an important, but not the only factor in the flood runoff that caused the erosion in the flood of 1948. Cut-bank or fill slopes played their part. Without enough plant cover to stabilize them, they eroded deeply and the increased drainage dumped large quantities of displaced soil directly into the streams. And in some places mining operations had left much dirt and rock exposed in and near stream channels. Water from such drainages carried especially heavy loads of dirt and rock. Smelter fumes were also a factor. Where they had killed the plant cover—as they have on tens of thousands of acres in several parts of the basin—erosion was very great. Near Anaconda, Mill Creek's peak flow was black with silt.

Logged-over areas appear to have contributed little debris to the big flood, mainly because most of the logging had been along the lower valleys and on the gentler slopes, where snow had gone before the big melt began. However, there were instances that showed what unwise logging practices can do. Poorly built woods roads and destructive skidding practices accounted for severe local erosion. Also, on the Selway, Salmon, Payette, and Boise River drainages, a combination of soil-scouring logging practices, fire, and severe overgrazing caused severe flood runoff and erosion.

Overused crop and pasture lands in the farming areas were another factor in the flood runoff. They eroded badly and added quantities of sediment when water from rapidly melting snow rushed over their surface or when they were hit by the sudden hard and frequent rains. These lands, however, are not considered in this discussion.

Conclusion

As we have seen, the best watershed conditions couldn't have prevented the big Columbia River flood. On the other hand, the burned and otherwise damaged lands contributed far more than their share to the flood waters and debris.

One big job is to restore these damaged watershed lands. Denuded slopes need to be revegetated with trees or other suitable plants, logging and other erosion scars healed, stream banks and channels stabilized, road and highway banks protected from washing. Another task is to maintain good watershed conditions where they already exist. This calls for the best possible protection from fire, especially in the higher mountains, and for careful soil- and water-control practices in road building, timber harvesting, and livestock grazing. It will also be necessary to acquire for public ownership some of the highly critical watershed lands, and to safeguard with especially careful management practices other such lands in private ownership, so as to assure watershed stability in the future.

Many of these jobs will be unusual, requiring great care in planning and lay-out to accord with the varying climatic, soil, slope, and cover conditions in the Columbia Basin. Similarly, many watershed management practices will need careful study in advance of widespread application to make sure that they accomplish their purposes.

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Watersheds like this one, almost completely destroyed by fire, should be restored and protected. They are a major source of floods.

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Well-managed watersheds give maximum protection from flood runoff and soil erosion. They mean good water supplies for agriculture, industry, cities, communities. They are your security.

The best guarantee of success in this complex undertaking is the immediate launching of a thoroughgoing program of research and experimentation. Such a program will involve the development and testing of watershed rehabilitation and management measures on a small scale. It will also find out what kinds of timber harvesting, grazing, road-building practices, and the like can safely be carried on without impairing the stability of soil and water flow, and what special measures may be needed to further enhance the values of the watershed lands for flood reduction and water supplies.

All these essential activities will bring many benefits besides less flood and sediment damage to valley homes and farms. Water supplies for downstream agriculture, industries, communities, and cities will be improved and in some cases augmented. The forests will be made more continuously productive for timber growing, ensuring steadier and more lasting employment. Mountain meadows and other grasslands will provide better and steadier forage for cattle and sheep. Hunters and fishermen and the public in general will benefit by the maintenance of good cover for wildlife, and the unpolluted and otherwise improved conditions of stream flow.

U. S. GOVERNMENT PRINTING OFFICE: 1950

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 10 cents