COLORADO'S WEALTH

A BULLETIN ON

CONSERVATION OF NATURAL RESOURCES

DEPARTMENT OF EDUCATION
THE STATE OF COLORADO
INEZ JOHNSON LEWIS
State S[illegible] Instruction

A Bulletin on Conservation *of* Natural Resources

DEPARTMENT OF EDUCATION

The State of Colorado

INEZ JOHNSON LEWIS
State Superintendent of Public Instruction

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The photographs have been selected and supplied by the Soil Conservation Service, Regions 6 and 8, with the exception of pictures in the last section on pages 74 and 85 supplied by the Forest Service, and the lower picture on page 71 supplied by the Farm Security Administration.

Many of the pictures were taken especially for this manual and are used as an integral part of the text.

FOREWORD

Conservation of natural resources is no longer an abstract problem. It is a vital and necessary part of our national economy. We, as a nation, must meet the issue. Even though the Federal Government, the state, and county should assume their proportionate share of responsibility, conservation of natural resources finally resolves itself into the question of individual appreciation of the problem and the use of individual initiative and intelligence in its solution. The fact still remains that the individual who owns or operates the land is the one who must assume the major portion of obligation for proper land use.

In view of the tremendous importance of the problem and also in view of the fact that education is the most important factor in approaching a solution to any problem, the State Department of Education sought to introduce conservation curricula activities in the public schools of Colorado. The present bulletin has been published as a part of this program.

This publication is addressed to teachers of all grades. Its purpose is to serve as source material or as basic information necessary in an understanding of land problems and the effects of the misuse of land resources on the entire population of our country.

This Department is indebted to an advisory committee of experts who have generously given of their time and talent in initiating a conservation program in the schools of our state.

Particularly, the State Department of Education wishes to recognize its indebtedness to Miss Julia B. Tappan, Chairman of the Publication Committee, who assumed the responsibility for writing and editing the material in its present form. Miss Tappan's experience as a member of the Soil Conservation Service and as a former member of the staff of the Federal Office of Education, has furnished a background which especially qualified her to undertake the task of preparing this bulletin.

The State Department feels special gratitude to Kenneth Chalmers who in addition to serving as a member of the publication committee has contributed to all phases of the development of the conservation program. His cooperation and driving force has made this program possible.

Other members of the publication committee—Anne Raymond, Field Representative in Education, Region 8 of the Soil Conservation Service; B. W. McGinnis, Information Division, Region 6 of

the Soil Conservation Service, and Rowena K. Hampshire, former Deputy State Superintendent of Public Instruction—rendered invaluable service in the planning of this publication.

The State Department wishes to give particular acknowledgment to Region 8 and Region 6 of the Soil Conservation Service, whose professional, technical, photographic and clerical staffs have given generously of their time and knowledge, and have permitted the inclusion of invaluable information from their material.

The material of the manual has been reviewed by technical experts in all of the various phases of agriculture, and due thanks and credit are hereby given to the Forest Service and the Extension Service of the Department of Agriculture for their valued contributions.

INEZ JOHNSON LEWIS,
State Superintendent of Public Instruction.

THE ELEVENTH COMMANDMENT

Thou shalt inherit the holy earth as a faithful steward, conserving its resources and productivity from generation to generation. Thou shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect thy hills from over-grazing by thy herds, that thy descendants may have abundance forever. If any shall fail in this stewardship of the land thy fruitful fields shall become sterile stony ground and wasting gullies, and thy descendants shall decrease and live in poverty or perish from off the face of the earth.

WALTER C. LOWDERMILK,
Assistant Chief, Soil Conservation Service, U. S. Department of Agriculture.

INTRODUCTION

No people can build an enduring civilization who are unable to adapt themselves to the climatic limitations of their region, and make efficient use of their natural resources; who, though having abiding faith in their culture and a deep sense of obligation to their posterity, are unable to transmit their culture and to conserve their basic resources of land, water, and forest unimpaired from generation to generation.

The settlement of Colorado offers splendid illustrations of the difficulties of pioneer people migrating from regions with humid climates and with individual and racial cultures incident thereto, in adapting themselves to living in a widely diversified region of arid climate and limited water supply.

With limited knowledge of mining, prospectors panned our stream gravels and scoured our mountain sides. Mines were developed under inconceivable difficulties. It is impossible for any of us to realize the time and labor required to transport heavy mining machinery, timber, and supplies over primitive roads by animal power, or the labor and experimentation necessary to develop successful methods of mining and of ore treatment.

Many sessions of the General Assembly and much court action were necessary to develop our mining laws and statutes governing transportation, use of water, stream pollution, and labor relations.

The abundance of game on the plains and in the mountains demonstrated the carrying capacity of our short grass and mountain ranges and encouraged the development of the domestic livestock industry. It is a long reach in development from the herds of Longhorns of the Seventies to the purebred herds of today. Practically every session of the Legislature was concerned with amendments to the herd laws and proposals affecting the livestock industry.

Our pioneer farmers had little knowledge of irrigation and very limited means of learning irrigation as practiced by the Spanish pioneers or by the farmers of Spain, northern Italy, or India.

David Wall found it profitable to divert water to his garden from Clear Creek and grow vegetables for the miners. Others followed his example using "cut and try" methods, and in thirty years placed nearly three million acres under canal, worked out

methods of measurement, distribution, and application of water in irrigation adapted to the different sections of the state, and developed our system of irrigation laws.

Encouraged by the production of lands under "dry farming" in occasional "wet" years, the homesteader crowded the cattleman from the eastern plains, and through heartbreaking experience adopted methods of cultivation and crops to the limited rainfall, gradually learning how to save the rainfall of two seasons for growing one crop, and how to protect the land from erosion by wind and water.

Transportation has been a limiting factor of development from the days of the ox-team freight, the stage coach, and the pony express. Cost of transportation prevented the development of many a mining prospect and delayed or sorely limited the development of many promising agricultural areas. Cost of transportation encouraged industry using local raw material to supply local needs and made Denver lead in the manufacture of mining machinery, and meat packing, and Pueblo in structural steel, rails, wire, and nails. Our railway systems, highways, bus and truck lines, privately owned automobiles and trucks show the effort made to meet the need of transportation.

The pioneer, miner, stockman, farmer, merchant, and professional man recognized the need of more information about the natural resources of the state and of their development and use, and had great faith in education. The public schools shared with the church the honor of priority of establishment in every pioneer community. The State University, the State Agricultural College, the State School of Mines, and the School for Deaf and Blind were all established by territorial assemblies. The splendid school system of today demonstrates the continued faith of our people in education.

In legislation Colorado has been progressive. It early extended the right to vote to women and adopted the Australian ballot, the initiative, and the referendum. Adjustments between mining and agriculure, the range and cultivated lands, between urban and rural communities, and the framing of laws affecting widely differing sections of the state are characterized by frankness, fairness, and the use of all available information.

Our progress in mining, agriculture, industry, transportation, business, education, and legislation demonstrates the ability of our people in adapting themselves to limitations of an arid climate and their efficiency in using natural resources; it shows how the

ideals and aspirations of a liberty-loving people are being realized and the success of our stewardship in conserving our land, our water, our forests, our range, and our mineral resources.

The development of Colorado from the few trading posts, the dwellings of hunters and trappers and the Indians of 1850 into the commonwealth of today is a wonderful record of courage, of mastery of difficulties, of achievement, and of occasional heart-breaking failure. Truly in four score and ten years our fathers builded here a state and a government of which each son and daughter of Colorado may well be proud.

Naturally the work of development is not finished. There is much to be done to care for our growing population, to overcome the results of lack of information, and wrong use of land and water, of forest and range and of mineral resources. While the comparatively easily developed deposits of ores have been worked out, the state has vast resources of low-grade ore awaiting less costly methods of mining and treatment for their development. All our rivers except the Colorado are over-appropriated for irrigation. In both the South Platte and Arkansas valleys the reservoir capacity is sufficient to store the non-irrigation season flow except in infrequent years of above normal run-off, and the farmers must look to transmountain diversion from the Western Slope for supplemental water supplies.

Due to shortage of water in recent years, heavy drain is being made on our underground water supplies. To safeguard the water of these underground reservoirs and channels from depletion and to protect established rights, we need much more information and laws regulating diversion therefrom.

Since water is the limiting factor of further agricultural, industrial, and urban development, research for better conservation through flood control, watershed management, for greater efficiency in distribution and in use in irrigation, and in industrial and municipal use is essential.

Recent land classification on the plains and investigations in land use show that the homestead laws were not adapted to settlement of this region; that more land than a quarter-section or a half-section is needed for a family to make a living under present economic conditions. The recent destructive wind erosion in southeastern Colorado called nationwide attention to the results of wrong land use.

In pioneer days our forests were denuded for timber and fuel

with no provision for replanting or for protection of the forest from fire, over-grazing, and erosion. Fortunately, the National Forest Service now requires the cutting of timber, the grazing of livestock, the protection of the water supply, and the use of the forests for recreation on a sustained use basis. But the state has six million acres of cut-over and marginal forest lands in private ownership which, under present economic conditions and the state taxing system, cannot be replanted or adequately protected from fire, over-grazing, and destructive erosion. Neither can adequate provision be made for safeguarding the water supply.

Until the enactment of the Taylor Grazing Act, neither the state nor the national government had any means for conserving the range lands of the state from over-grazing and the resulting loss of vegetative cover and destructive erosion. Fortunately, our most valuable crop—grass—is now receiving the protection and care its importance merits.

While splendid work is being done by the National Soil Conservation Service, by State Soil Conservation Districts, and by individual farmers in the control of erosion, much more education of the public generally in the importance of our soil resources is necessary to make conservation of our basic land resource mandatory on every landowner.

Unfortunately, much destructive land use is due to our land-taxing system, brought without change from the humid sections of the nation. Until this is changed to meet the conditions of farm, range and forest use, and management under arid conditions, effective conservation of these resources is not possible.

The Challenge to Our Schools

Our schools must be more effective in fitting our youth to take part in the development of Colorado by stressing the history of the state and its industrial, agricultural, and social development.

Our institutions of higher learning should provide books and bulletins about the resources and industries of the state to supplant the textbooks, based on information concerning the humid sections of the nation, now used. This material should also give comprehensive information about our natural resources.

Students should be encouraged to study local weather conditions, and the results of limited rainfall on plants, animals, and people, and to know the resources, and natural limitations of their

district, community, and state, and the need of their proper use and conservation. They should know the opportunities Colorado holds for young people of courage, of vision, and of training, in agriculture, industry, business, mining, and the professions. They should be encouraged to study the agriculture and economy of arid and semi-arid regions of the earth, to profit from others' experience there and avoid their mistakes. They should be familiar with the archaeology and Indian culture of our state.

In season and out of season our schools must teach the duty and obligation of constant and persistent effort on the part of individuals, communities, states, and the nation to conserve our natural resources of land, water, forests, range, and minerals. Most important of all, the schools must glorify the faith of our people in our state and in our nation. "Only through conservation of basic resources and of the spirit of our people can we maintain the human values of wholesome standards of living, of opportunity, freedom, justice, and faith in the destiny of our civilization."

CHARLES A. LORY,
Former President, Colorado State College of Agriculture and Mechanic Arts.

CARL HOLZMAN

This Our Colorado

This our Colorado,

Its heart great mountains dividing the continent, source of mighty rivers, the Colorado, the Rio Grande, the Platte and Arkansas,

Running to the east and south, emptying into the Gulf,

Running south and west, emptying into the Pacific.

Great mountains sloping down in a series of plateaus and great hills to the west, cut by canyons and rich valleys;

To the east dropping abruptly to foothills, to the plains which are ribbed by the shallow irrigated valleys of the Platte and Arkansas.

Mountains where tallest peaks are covered by perpetual snow—then a narrow belt of scrubby alpine growth, forests of fir, balsam, spruce and pines, woodlands of juniper and piñon—sloping to grass-steppes—to steppes clothed in sagebrush—to valleys where fruits, nut trees and vineyards grow—to great potato fields in the west—beet fields along the valleys of the east.

Colorado. Its soils varying from rough mountainous soils to the light brown sandy loams of the plains and the alluvial soils of the valleys.

The climate varying from desert to arctic.

The rainfall from less than ten inches in the San Luis Valley and the Grand and Uncompahgre drainages to over forty inches on the peaks and slopes of the upper ranges.

Its mountains once abundant with wildlife—its streams with fish.

Its mountains and plains and valleys abundant, too, with cattle, sheep, hogs, and other domestic animals.

And everywhere is man.

The men of the soil who plough and dig, irrigate—harvest.

Men who herd sheep in lonely places—men who round up the cattle.

The busy men of the cities—men who buy and sell, who turn the fruits of the earth into sugar, into flour, into bread—metal into wire and rails.

Men who are busy in stockyards, teachers, lawyers, doctors, public servants, bankers, merchants.

The men of the mountains—miners, lumbermen.

Men of adventure, who seek high peaks and lonely wilderness.

Men who fish in clear mountain streams—men who hunt fur-bearing animals, beaver, mink, foxes; who hunt deer and elk, duck and geese.

Men who come from the four corners of the earth seeking beauty, health, pleasure.

Men of many colors and races—a million or more—working, playing—struggling, being born, and dying.

White men, Indians, Negroes, Chinese, Italians, Japanese, Russians, Scandinavians, and many others—clustered around the skirts of Colorado — thinning out in the high mountains, gathered in river valleys and cities, scattered over plain and mountain.

Men traveling its great transportation arteries by car, by airplane, by rail.

Arteries which long ago were trod by the feet of the red man, by the early Spaniard, by the trappers, by the covered wagons, by the gold seekers.

This our Colorado then is not just the land—the rivers, the climate,

Not just the vegetation and animals, population, cities, industries, or transportation.

Not just a political division of the United States—

But rather all of these acting and reacting on each other and as a unit called Colorado—

Acting and being acted upon by many other units called Arkansas, Wyoming, New Mexico, New York, California, and all the others.

—JULIA B. TAPPAN.

B. BRIXNER

Colorado . . . Where Rivers Begin

A Land Inventory

Man's activity, his success and failure, his opportunity for leisure and pleasure, are affected by the physical factors which surround him. The amount and availability of natural resources, his ability to adapt himself to his environment and to use wisely these resources, determine the kind of life he will lead. Mountains, plains, plateaus, and river; climate; types of soil, natural vegetation; animal population; mineral resources—are matters of concern to him.

To understand Colorado today—its agriculture, distribution of products, employment, proper land use, control of dust storms and floods, and all the other problems that face a bewildered citizenry—one must bear in mind a few basic factors concerning the land itself.

Colorado may be described in several ways. It may be designated as a western state, bounded by other political units, the states of Kansas, Nebraska, Wyoming, Utah, New Mexico, and Oklahoma.

It may be located in relation to physical divisions according to its land formations: the Rocky Mountain system, the Inter-

montane Plateaus, the Great Plains. It may be located in the climatic area west of the 100th meridian where the average rainfall drops below 30 inches a year. It may be described by its river drainages and watersheds: the great Colorado, the Rio Grande, the Platte, and Arkansas. It may be described by its soil types, its native flora and fauna, its men. All these factors are important; they act and react on one another. They are interdependent.

The Rivers

Two-thirds across the continent, bisecting Colorado north and south, lies the great range of the Rocky Mountains—sometimes called the backbone of America. Here is the source of many rivers. Here is the continental divide. From the east side many waters find their way to the Gulf of Mexico and the Atlantic Ocean, from the west slope to the Pacific Ocean.

On the eastern slope of the mountains arise the many tributaries of the Arkansas and Platte Rivers, in the northeast the upper tributaries of the North Platte. From the southern Rockies arises the Rio Grande, the river that separates the United States and Mexico for many miles before it empties into the Gulf of Mexico. From the west slope arises the mighty Colorado River whose waters are of great importance to Wyoming, Utah, New Mexico, Arizona, Nevada, California, and the state of Colorado. Thirty-five percent of all the water in the entire Colorado River has its origin in that part of the Colorado River basin lying in the state of Colorado. Two-thirds of *all* stream flow produced annually in Colorado originates in the Colorado River basin on the western slope of the Rocky Mountains. So important is the distribution and use of water in all these southwestern and western states, that they enter into compacts or treaties to control the use of water from interstate streams.[1]

The care of Colorado's watershed influences states all along the river courses. It influences another country; it determines in part the water supply for irrigated lands many miles away, and the electric power and water supply of cities on the west coast. The washing of soils contributes to the silting of elaborate and gigantic reservoirs, to the increased destructive power of rapidly flowing water, the silting of stream beds, and the water-logging of valleys.

[1]Chas. A. Lory, *Conservation of Water in Colorado* (Colorado State College, Fort Collins).

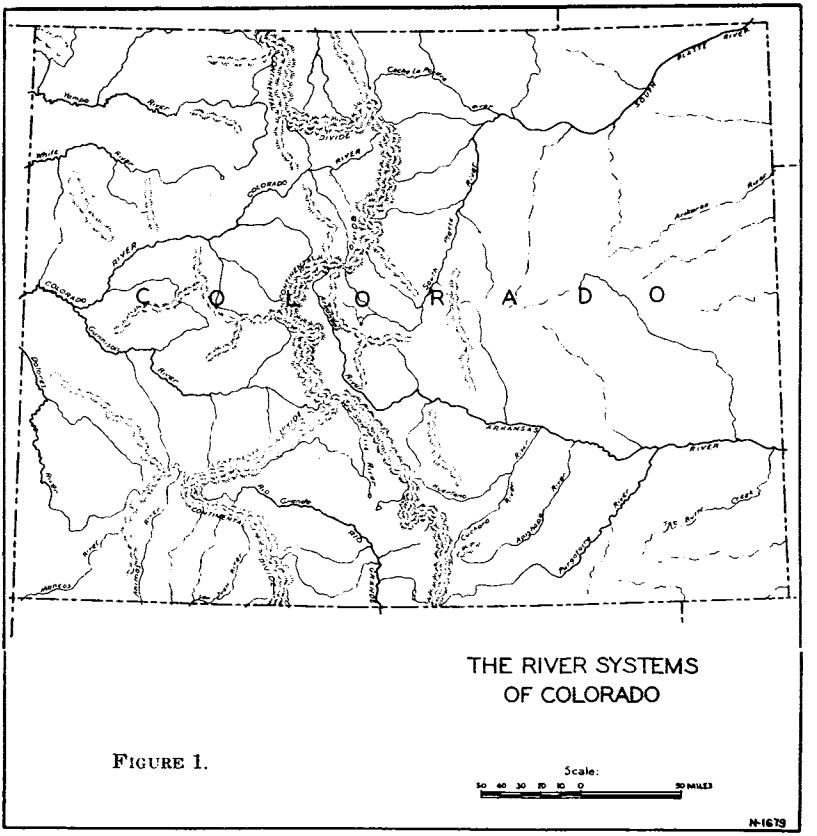


FIGURE 1.

Although people and land, soils, vegetation, climate, land formations, animals, are inextricably related and interrelated, the great body of information on the broad subject of land use is usually available under such specific headings as soils, vegetation, physiography, et cetera. Subject matter is usually organized by regions or areas, as physiographic areas, climatic areas, vegetative areas. And unfortunately for the layman these regions, though having some geographic similarity, are not identical, but overlap and vary as to boundaries.

Land Formations

The entire United States is divided, according to land formations, into eight major physiographic divisions. Colorado lies within three of these major divisions: the Interior Plains, the Rocky Mountain System, and the Intermontane Plateaus (plateaus that lie between mountains). Within each physiographic

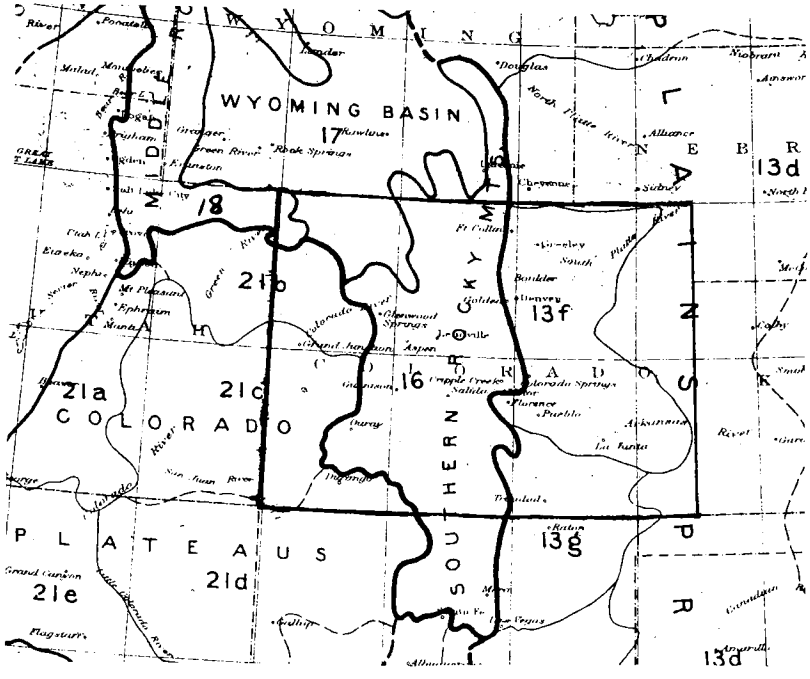


FIGURE 2. PHYSICAL DIVISIONS[2].

division are subdivisions of sections. Figure 2 shows the provinces and physiographic sections included in Colorado, with a brief description of each section.

Interior Plains

13-D High Plains—broad intervalley remnants of fluviatile plains

13-F Colorado Piedmont—late mature to old elevated plain

13-G Raton section—trenched peneplain surmounted by dissected, lava-capped plateaus and buttes

Rocky Mountains

16 Southern Rocky Mountains—complex mountains of varying types; intermont basins

17 Wyoming Basin—elevated plains in various stages of geologic erosion; isolated low mountains

18 Middle Rocky Mountains—complex mountains, mainly anticlinal ranges; intermont basins

[2]U. S. Geological Survey Map ("Physical Divisions of the United States," Department of the Interior, 1930).

Intermontane Plateaus

21-B Uinta Basin—dissected plateau; strong relief

21-C Canyon lands—young to mature canyoned plateaus; high relief

21-D Navajo section—young plateaus; smaller relief than 21-C into which it grades

Climate, vegetation, soils, and elevations of these physiographic divisions vary greatly and explain somewhat the diversified land-use picture that Colorado presents.

Climate of Colorado

The climate of Colorado ranges from the arid climate of the desert to an arctic climate in the high peaks of the Rockies. Temperatures vary from 115°F above zero to 54°F below zero. Over the entire area rainfall is erratic and limited, except in the mountains. Winds are high, evaporation is rapid, and there is wide variation in growing seasons.

Rainfall. The average rainfall of eastern Colorado, from its eastern border to the Rockies is 15 to 20 inches per year, progressively decreasing towards the mountains, falling largely from April to August. The elevation ranges from 3,000 feet to 5,500 feet above sea level. Summer showers are frequent near the foothills. Throughout the rest of the area, rains are few in number but often of cloudburst proportions. An irregular but persistent recurrence of severe drought with wide fluctuations in temperature and winds is characteristic of the area. Marked variations occur not only from year to year, but also in irregular minor cycles of several years' and in major cycles of many years' duration. Climatic conditions vary not only year by year but in areal distribution. A considerable portion of rainfall occurs as local showers and is spotty in distribution. One location may receive successive rains while an adjacent location may have no showers or very light ones.

Much of the precipitation of Colorado falls as winter snow in the mountains. So vital is the relationship of snowfall to the supply of irrigation water below that the federal government undertakes snow surveys on many western watersheds in order to be able to forecast the irrigation water supply for the next year.

On the upper slopes and peaks of the Rocky Mountains the rainfall often exceeds 40 inches, and on some of the peaks reaches 50 inches. There are in Colorado fifty named peaks over 14,000 feet in elevation, forming the largest block of high peaks in the United States.

On the high plateaus of the western and southern slopes the rainfall varies greatly. At Silverton the average annual rainfall is 26.69 inches, in the San Luis Valley 6.88 inches. This area is subject to extreme drought in places. The elevation ranges from 4,000 to 7,000 feet. Most of the moisture falls in the winter months as snow which gradually melts during the summer and supplies storage reservoirs for subsequent irrigation.

Wind. The windmills that dot Colorado are witnesses to the wind that is both friend and enemy, blowing at sufficient velocity nearly every day to move soil and to greatly increase the rapidity of evaporation. Average velocity on the plains is from 8 to 10 miles an hour. Around Denver the average wind velocity is 7.4 miles per hour, but the wind reaches a velocity of 20 or more miles an hour for an average of 143 days out of the year. At Grand Junction it reaches this velocity for 87 days.

The greatest velocity is from March through July. About seven times a year it reaches 40 miles an hour, a velocity equaled in the United States only around the Great Lakes region.

Horace Greeley thought the wind blew so hard that trees could not grow in the Plains area, and substantiated his theory by the story of a wind that blew metal tires off a wagon and straightened one of them out!

Soils and Native Vegetation

Soil, far from being an inert blanket covering the rocky skeleton of the earth, is a dynamic living thing. It is developed largely as a result of the action of climatic forces upon geologic materials. In areas of diverse climatic conditions, such as Colorado, a variety of soils occur. Fortunately, however, these variations follow a pattern which facilitates the establishment of groupings into which all soils may be classified.

Vegetation, which is largely determined by soil and climate, also follows the pattern, so that if a definite change is observed in any one of the three—climate, soil or vegetation—a relative change may be anticipated in the others. The pattern is composed of a multitude of designs making up increasingly greater segments.

There are three major segments or areas in the pattern of Colorado: a line drawn south from the midpoint of the north boundary, and another starting at a point halfway between the midpoint and the northwest corner and drawn to the southwest corner, would roughly outline the three segments. The eastern segment is occupied by the footslopes of the Rocky Mountains,

the central portion by the Rocky Mountains, and the western portion by a high desert plateau.

In the broad, open plains of eastern Colorado the soils are light brown to brown in color and are well suited to the production of grass. Through a long period of soil development under low rainfall, the fine textured materials have been moved downward by percolating waters so that the subsoil retains moisture and makes it accessible to shallow-rooted plants.

The dominant vegetative cover is composed of grama and buffalo grass.

The Rocky Mountain segment has a strongly rolling to rugged and mountainous topography interspersed with high plateaus and intermountain valleys. A subhumid climate with long cold winters has developed a soil in the higher elevations suited to the production of timber. The topsoil is usually dark in color and has a high organic matter content. The intermountain valleys at lower elevations have a moderate climate and rich alluvial soils which are highly productive whenever adequate water is available.

In western Colorado on the high plateaus the soils, because of low rainfall, are poorly developed and consequently reflect the varied characteristics of the parent materials. Sage, open stands of juniper and piñon, bunch grasses occur on the more productive soils; desert shrubs, shadscale, saltbush, and rabbit brush occur on the poor soils. Many of these soils are productive agriculturally where adequate water is available.

In the river valleys occur deep alluvial soils.

Native vegetation is classified by zones, but the change from one vegetative zone to another is gradual, with mingling of typical plants of each zone over a considerable area.

Grass-steppe—Great Plains of eastern Colorado; up to elevation of 6,000 feet.

Shrub-steppe—Greasewood and rabbit brush in San Luis Valley up to elevation of 8,000 feet.

Sagebrush in western Colorado up to elevation of 7,000 feet. One-fourth of Colorado is covered with shrub vegetation, principally sagebrush, the characteristic vegetation of arid western Colorado, which is the eastern limit of sagebrush formation dominating entire Great Basin area. Competition, not temperature, seems to be limiting factor in its distribution.

Chaparral (a dense growth of shrubs consisting in Colorado mainly of oak). Found in northern Colorado up to

elevation of 8,000 feet. Piñon-pine-juniper and chaparral usually found between grassland or sagebrush and the timbered slopes.

Coniferous woodland—Piñon and juniper; in southern Colorado at varying altitudes.

Coniferous forests—a. Yellow pine-Douglas fir; up to elevation of 8,000 feet.

b. White fir; belongs to southern mountains of state, where it grows at 8,000-10,000 feet; takes place of lodgepole pine of northern mountains.

c. Lodgepole pine; aspen, although found from elevation of 5,000 feet to timber-line, is best developed in lodgepole pine zone of 8,000-10,000 feet.

d. Engelmann spruce—balsam fir; elevation of 10,000 feet to timberline of about 11,600 feet.

"Life Zones" have been classified under many systems, one of the most used of which is Merriam's. This system was originally on a temperature basis, but the zones have come to be known by their vegetational aspects:

Upper Sonoran—zone of nut pine and juniper; covers most of foothill country.

Transition—zones of yellow pine, covering middle slopes of high ranges.

Canadian—zone of spruce and fir, covering higher slopes.

Hudsonian—zone of dwarf spruces, narrow belt of scrubby timberline trees around high peaks.

Arctic-Alpine—treeless zone capping many of the higher peaks.

Wild Life

The history of the plains is the history of the grasslands. All large mammals of the plains save the coyote and the wolf are grass-eaters. Historically, the buffalo had more influence on man than all other plains animals combined. It was life, food, raiment, and shelter to the plains Indians. 1876 marks practically the end of both, and today domestic stock has largely displaced the grass-eaters. In the early days when the buffalo herds and the antelope roamed the plains, many of the mountain animals also spent part of the winter in the plains. Driven back into the mountains with high competition from the domestic stock, they must now winter in high places where many of them cannot live.

The mountain regions and the plateaus of western Colorado were once inhabited by a wide variety of animal life and were at one time a paradise for big game hunters. Antelope, beaver, bear, mountain lion, fox, lynx, mountain sheep, raccoon, chipmunk, marten, mink, muskrat, otter, porcupine, skunk, squirrel, wolverene, and wildcats are among the mammals native to this region. Today the number of big game animals has been greatly reduced, and the mountain sheep and grizzly bear are approaching the point of extinction. Game birds are scarce and although the streams still abound in trout, the supply to a large extent is maintained by restocking.

CARL HOLZMAN

The Behavior of Soil and Water

In order to understand how man can best live on his mother earth, it is necessary to gather together from the great collection of knowledge which has been amassed by the human race certain basic principles of the behavior of soil, of water, of air and sunlight, of animals and man. It is necessary to apply this knowledge to our own lands, our own plains, our own watersheds.

Though long and painstaking experience has taught man to use the soil, the water, the sun, growing plants and animals for his own benefit and supremacy, he has often ignored his acquired wisdom. He is sometimes so at war with natural processes that he is in danger of being defeated by them.

Every Child Knows

As a little child he found a puddle of water. He idly drew a furrow down hill with his stick and down rushed the water. Every child has this knowledge—that water flows down hill, that the straighter and deeper the channel, the faster flows the water.

To stop its rapid flow, he knew how to obstruct it, how to hold it back. In his play he piled mud and sticks and stones, damming the stream. Naturally the water flowed out and widened —forming a pool.

Many a child has watched a stream at the bend of a river, has watched its constant flow against the bank, has thrown in sticks which are whirled hither and thither by the current, has seen a piece of the bank finally fall off, dissolve, and flow away. He knows that water flowing over or against soil carries it away. Damming a muddy ditch, he has seen the water quiet—drop its load of dirt, become clear. He knows by experience that when water slows down, it drops its load of soil.

Every child has watched clouds gather, has watched great drops begin to fall, has seen the drops fall on the dry earth and disappear, has seen the earth turn dark with the absorbed moisture, has seen the tiny rivulets begin to form—running to the lower parts of the ground—finally, forming a miniature river with many miniature tributaries. In his early activities and wisdom he knew a watershed, a river system, the precipitation of moisture, its absorption by soil, its runoff.

Man Ignores

Yet, today, when he is a man, he often ignores his early knowledge and plows his sloping fields up and down. He watches the rain run swiftly through the furrow—again gathering unto itself soil—digging the furrow deeper and deeper, depositing the silt wherever and whenever it slows down. He lets his sheep and cattle and horses make many trails, and through these trails the water flows swiftly gathering soil, leaving great gullies.

Man knows that rain and snow falling on grass sinks into the soil; that rain falling on grassy land does not flow away so fast; that the drops, the rivulets are stopped on their journey by many blades of grass. Yet, he has cut down his trees. He has left great tracts of land uncovered, although he knows that the water, unobstructed, flows swiftly—channeling through the forest litter, washing the twigs and leaves and needles and humus before it.

Man has watched a whirl of dust picked up by the wind, swirled around, carried away. He has seen it on dirt roads, in dry washes, on bare schoolyards, in plowed fields. He does not see this happen on lawns, in forests, in fields of alfalfa. It would seem an insult to his intelligence to ask why not. And yet, in the Great Plains man has plowed up acres upon acres of land, leaving them a prey to wind. He has let great herds of stock eat off the grass and browse and weeds, trample the earth, leaving it exposed to wind and water.

Man's failure to apply his knowledge of the behavior of soil

and water to his everyday farming and his everyday living has been disastrous. There are doubtless many reasons for this failure; lack of experience in semi-arid climates; the temptation of apparently boundless resources; periods of abundance of moisture; periods of drought; land speculation; periods of high prices; periods of economic pressure; and many another cause. The fact remains, however, that an alarming proportion of our tillable land is no longer productive, that our ranges are badly depleted. Yet there are places in the United States where the same fields have been tilled for 200 years and, because of careful husbandry, are as rich and fertile today as when the land was first cleared. There are ranges where grazing has continued successfully for long periods.

Disasters have startled man into the realization that it is sometimes wise to measure his own advantage by its effect on his fellow-men. He sees that certain problems require group planning and coordination, that he must learn to adjust so that all men may live, and live at peace with nature.

To do so, it is necessary to understand certain processes and sequences of nature—certain causes and effects—to know where to turn for further knowledge and help. Important among these processes are those that deal with water.

Many Waters

Bodies of water lying in the depressions of the earth—puddles, lakes, and ponds, and the shallow seas—have changed during geologic ages, changing their locations with the upheavals and recessions of the earth. Man and beaver have built their dams, big and little, forming their lakes, big and little, for a flash of geologic time. Only the oceans remain the most permanent aspect of the earth's surface.

The sun's rays generating heat, traveling their 93-million mile journey, warm the surface of the water and off it flies into the air—rapidly or slowly according to the temperature, but constantly. The currents of air—influenced by the topography of the land, by the turning of the earth, by climate and bodies of water—travel inland from the sea, outward from the land, deflected by mountains, pouring into areas of low pressure, cooling, heating. Warm air holds more vapor than cool air. Vapor condenses in clouds. When air is suddenly cooled, it is precipitated in rain, snow, mist, or hail.

When moisture falls to the earth, several things may happen to it. Much of it evaporates from the surface almost at once,

before being used by man or plants. In areas of dryness, of hot sun, even more evaporates. Some of the moisture sinks into the earth, is used by plants, and is evaporated or transpired through their leaves. Some types of plants send off a great deal of water, some a small amount. Native vegetation of semi-arid areas sends off little water. Cactus, yucca, palo verde, and many of our grasses, have slender sharp leaves with little surface exposed to the air, while their roots extend far in the search for water.

A small part of the total precipitation reaches the underground supply (the zone of saturation, the top of which is the water table) feeds springs and rivers, at last reaching the sea. This action of water takes place so slowly that the journey through the earth to the source of springs may take many years, causing some springs to flow abundantly during years of scant rainfall, and others to show a marked decrease during a year when precipitation is plentiful. The amount of water which is absorbed by the earth and reaches the underground supply also varies greatly with soil texture, with vegetation, rock structure, with slope of land, with ground cover.

Some of the water which falls to the earth runs over its surface, gathering together in streams and flowing, finally, to the sea. The majority of precipitation evaporates or runs off.

Man's Influence

Only in certain sectors of this intricate cycle within cycle can man, the maker of tools, interrupt or delay water's behavior. The supply of water remains essentially the same. Man cannot change the total amount of rainfall. He cannot make precipitation fall where he wishes it, nor increase its quantity. Though he has observed the movements of air, though he knows a good deal about the cycle of moisture in the air, he cannot do very much about it. The humid east remains the humid east, receiving two-thirds of the nation's precipitation in its mean annual rainfall of 48 inches. The great area of land roughly west of the 100th meridian (about two-fifths of the country) continues to have a mean average of 12 inches. Man cannot turn a dry year into a wet year, nor stop a downpour that is causing a flood. He cannot shift the winds of heaven to blow the cloud over his parched field.

He can, however, do many things. He can influence the amount of water that flows off the land. He can increase or decrease its rate of flow. He can, to an extent, influence its

destructive power by the amount of silt it carries, as silt-loaded water is more corrosive and erosive than clear water. He can, in certain places, influence the quantity of water that is absorbed by the earth. He can and does tap the underground supply and use it for his drinking supply, his crops, his stock, his cities, and his many activities. He can and has taken so much of the underground supply that in some places he has had to go deeper and deeper to reach it. He can dam great rivers as he has done, and hold great quantities of water in storage reservoirs. He can sometimes choose his site so that his reservoir will be narrow and deep or wide and shallow. But he cannot prevent evaporation from the surface of the reservoirs, although he can influence it. If he allows his storage reservoirs to be depositories of silt, their water holding capacity is lessened each year. The water becomes shallower and more of the total amount is exposed to the air, so that the amount of evaporation is proportionately greater and less water is available for use.

He can somewhat influence the amount of water transpired by plants. If he cuts down a forest, he changes the moisture content of the air. If he plants a field of alfalfa, he changes the moisture of the air. Coming down into an irrigated valley from a high, dry mesa, a marked difference is noticeable in the moisture of the air where fields of green are growing. He can destroy or protect vegetation, and vegetation is an extremely important factor in determining the relationship between the amount of water absorbed by the earth and the amount which flows over the earth's surface.

Forests

Man can destroy the forests by axe and fire. He can destroy the porous forest floor, the litter and humus. If he does, he greatly speeds the downhill travel of water. He adds to its quantity because he has made it less possible for the earth to absorb it. Rivers come tearing down the slopes, gathering volume and weight, gathering soil and rocks and trees, destroying farm lands, destroying cities.

Grasslands and Browse

On the plains and plateaus where the great grasslands lie, where sage and brush are abundant, and rainfall less abundant, man can again influence the relationship between absorption and runoff.

In much of the high plateau country little or no water reaches

the underground supply. Here, the water supply is far beneath the surface—fed by the waters which flow down from the mountains, along shelves of rock and crevices under the ground. Here, what rain falls, sinks only a short distance into the ground and is utilized by shallow growing grasses, brush, chaparral, and trees.

When man puts too many animals on the land or fails to distribute them wisely, letting them make too many trails or congregate too much around water, he allows the vegetation to be destroyed. The soil loses its absorptive powers, becomes sealed, is no longer protected by roots and stems and blades. Falling water rushes over the surface, picks up soil on its way, rushes rapidly into river channels, goes quickly away, serving no plant, no animal, no man. It leaves behind sheets of land where the topsoil has been washed away, finger gullies, and ultimately deep gullied gashes in the earth.

Gullies deeply cut in the earth draw down to their depths surface water from the surrounding country. Grass with its short spreading roots can no longer reach the water, cannot longer survive. Plants with deep tap roots take over. These plants are poor soil builders, leave the soil open to the action of wind and water. Usually they are of little value as forage. As the gullies deepen, even the plants with long tap roots and the trees may no longer be able to reach water.

If native grasses which utilize the available moisture, holding soil against the fierce power of the winds which blow so frequently and at such high velocity, are destroyed, topsoil is blown away, leaving a harder, less absorptive subsoil. Water is lost through evaporation, through runoff. Plowing up and down hill, forming straight channels where water gathers and runs rapidly, causes still more moisture to be lost in these areas. With no moisture stored in the surface of the soil, vegetation will not grow. Crops fail and the soil is left to blow.

The Valleys

The fertile valleys of the southwestern states have been built and are being built by natural aggradation or the depositing of soil. It is in these valleys that man carries on his most productive agriculture, for the soil is rich, deep, alluvial, and there is a great deal of seepage from the sandy river bottom so that the water table is high. Water may be taken from the river and sent through a network of ditches to water valuable cropland. Storage reservoirs may be built above these rich irrigated lands

so that during the winter months when moisture is most abundant, water may be stored to irrigate crops during their growing season.

Here, man has been more apt to plan his cultivation. He has irrigated his crops, rotated and fertilized them, and has selected his seed with care. Yet here, too, he has found disaster, sometimes from his own mismanagement or because the ranges above have not been cared for. The upland waters gaining speed, rushing down, have flooded his lands, have left rubble—coarse soil—behind them, have destroyed his harvest. Here whole fields along the river have been washed away, have dissolved into the river.

In some of the valleys, the rapidity with which silt is deposited in the riverbed has been speeded up by misuse of the upper watershed so that the land becomes rapidly waterlogged and useless for crops.

Man has often overdeveloped his irrigable lands. Sometimes he has used more water than is necessary for the production of crops, and as a result has had to build expensive and often unsatisfactory drainage systems. The irrigation systems are not always either adequate or well designed, so that a considerable amount of rich topsoil has been washed away and lost.

In some of the valleys, irrigation water comes from the underground supply, through pumping and artesian wells. Frequently the over-development of the land and the overuse of this water has lowered the watertable many feet. Deeper and deeper the wells have to be driven. The filling of this underground storage space is a slow business. How many years it has taken we do not know, but it is estimated that for the world at large the underground supply is equivalent to 40 years of precipitation or 100 years of runoff.[1]

Man can influence the absorption of rain in the valley, the amount of runoff, by his use and care of the land above it. He cannot prevent floods but he can and does add to their destructive powers by destroying the forests and the grasslands. He can influence the underground supply in the valley by his use of this supply, his use of the land, and his use of vegetation.

Delicate Balance

The balance in a country of little moisture is always delicate —easily upset. The rain itself often comes in swift, torrential

[1]Van Hise and Loomis Havemeyer, *Conservation of Our Natural Resources* (New York, 1937).

downfall. Vegetation is slow to come back, soil is slowly built, trees grow slowly. The native wild life in much of the country must travel far for water. Slopes are precipitous, winds of a high velocity. There are cycles of wet and dry years, the spacing of rain over a given territory is spotted and uncertain. Even in a dry year some land may receive sufficient moisture, and land not very far away will receive little or none.

All these factors add to the difficulty of agricultural pursuits. Man is too prone to optimistically consider the years of greatest rainfall as a norm and plan accordingly, whereas it would be safer to plan his production on the years of least rainfall. Prices and markets add to uncertainty. For a country of such large area as the United States, where produce is available from all parts of the country, local conditions and demands have little to do with production. When prices were high and weather conditions favorable, as during the World War, bumper crops at bumper prices were produced in the Great Plains, and land which should never have been plowed yielded crops for a few years. For many years following, its yield was blowing soil.

Here in this country with its wealth and beauty, but also its delicacy of balance, man must, if he is to continue to use his land, know its processes, its conditions; must plan wisely and act wisely in its use.

Important in understanding, planning, and acting, are the brief statements and charts given below concerning the watershed, the water cycle, soils, vegetation, erosion. No one process acts alone; the condition and use of one type of land often depend on the condition and use of another. All factors are inextricably woven together: water, soil, vegetation, climate, animals, man.[2]

The Ideal Watershed

Innumerable small, clear streams rising in high, forested mountains, converge into large streams until they meet the river. Here the local inhabitants met their needs for wood and timber under the guidance of a forester; a limited number of cattle and sheep harvest something less than the annual grass crop; forest and grass fires are held to the minimum; regulated hunting, fishing, and other forms of recreation play their part; small farms are carefully tilled and kept from washing. Some of the streams furnish an ample supply of pure water for towns and cities along the way. The river itself winding between tree-lined banks, serves a number of irrigated farms on its way to the great reservoir below.

[2]Julia B. Tappan.

Beneath the dam is a hydro-electric plant furnishing cheap power to town and farm, and an irrigation system that insures a perpetual supply of water to 100,000 acres of rich bottom land capable of raising the food and forage needs of a large population. Surrounding the valleys above and below the dam are grassy hills and mesas, on which big and little ranchmen alike graze their herds for home consumption and outside markets. By saving enough grass to prevent rapid runoff, and to take care of the lean years, the ranchmen are assured of a plentiful meat supply and a good wool clip, year after year. At the same time, they are helping to maintain a steady flow of good water in the river and its many branches. Many of their stock from the ranges are fattened on the products of the irrigated land.

Backed by a stable farming and range industry, and aided by the recreational facilities in the mountains close at hand, the towns and cities in the watershed show unmistakable signs of a healthy, permanent, steady growth. They help the rural districts by providing outlets for farm and range products, and by furnishing the best in educational and social advantages. Each group and each part of the watershed is dependent on the others. It is to the interest of everyone to help safeguard the whole area.[3]

The Water Cycle

Winds blow, clouds mount the wind, rain falls, and the lands are replenished. Streams and rivers flash to the sea, clouds form; and the cycle continues. "All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come . . . they return . . ."[4]

In summary, the natural circulation of waters (the hydrologic cycle) is essentially as follows:

a. The atmosphere absorbs water from oceans, lakes, rivers, the land, and other exposed surfaces—even from falling raindrops *(evaporation)*, and also that drawn from ground storage and exhaled by the leaves of trees and other vegetation *(transpiration)*. In arid regions evaporation may lower a reservoir of water 8 feet a year. Conifers will transpire the equivalent of from 3 inches (pines) to 8.5 inches (spruces) of precipitation.

b. Moisture-laden air is cooled as it moves upward, or as it comes in contact with other cooler bodies of air, and the moisture is dropped in the form of rain or snow *(precipitation)*. Fogs and dews are also forms of precipitation.

c. Generally the precipitated water, when it strikes the surface of the land, is absorbed and held by the surface soil *(absorption)*, and when the water content of this layer has reached a saturation point, any surplus penetrates by gravity

[3]Hugh G. Calkins.
[4]Russell Lord, *To Hold This Soil*, 1938.

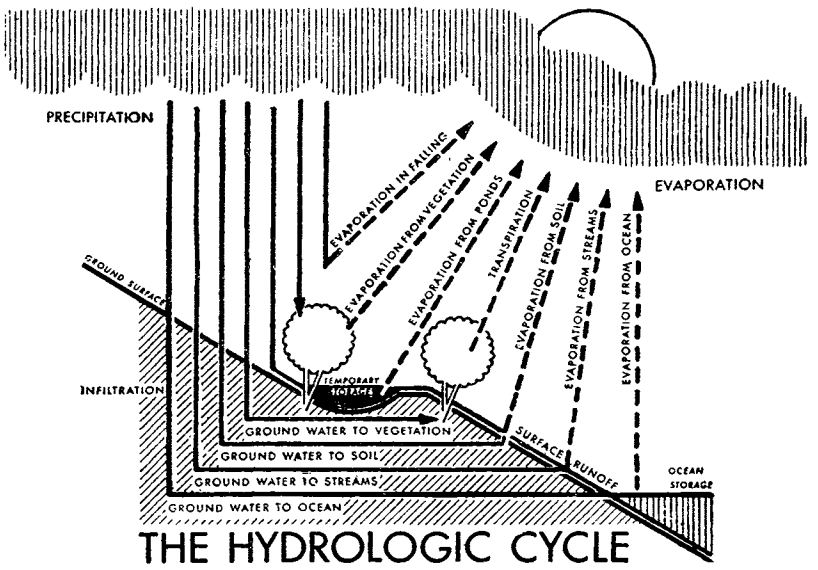


FIG. 3—THE HYDROLOGIC CYCLE, from *Little Waters*

to underground strata of soil, gravel, or porous rock *(infiltration)* where it is stored as *ground water*. The surface of this underground reservoir is called the *watertable*.

d. When the rate of precipitation is greater than the rate of absorption and infiltration, part of the water runs along the surface of the ground directly into streams and rivers, and thence into lakes and oceans.. This is called *surface runoff*.

e. Water exposed on the surface of oceans, lakes, rivers, and land, including that transpired by vegetative cover, is again absorbed into the atmosphere and the natural circulation is continued indefinitely.[5]

Plants and the Living Soil

Soil and plant relationships are most evident in the case of native vegetation, since this develops in balance with the climate and the soil. . The soil itself, in fact, is formed under the influence of the vegetation that grows upon it, and in the long run this may contribute more to its character than the geological materials from which the soil was originally formed. The native vegetation was used by primitive man and by early settlers as a guide to the choice of croplands or grazing land, and it is still used in reconnaissance surveys to indicate boundaries between soil types. In general, broad plant communities throughout the United States will be found to

[5]Adapted from H. S. Person's *Little Waters*, 1936.

coincide with soil associations, though there are some interesting exceptions, where for example, a certain factor such as rainfall has a more powerful effect on soil development than on plant growth, or vice versa.

Various plant communities broadly indicate regions of cool or warm climate; high or low rainfall; frequent drought; permanently dry, moist, or flooded subsoil; and land valuable for agricultural production or for grazing. On western raw land, certain plants indicate the best, the medium, and poorest soils for small grains and for the production of forage; and in the case of grazing land, they are correlated with the carrying capacity of the range.

Soils and plants, following parallel and interrelated paths of development from initial (algae, lichens, bare rock) to final stages, usually tend to vegetate a humid area with forests, a semi-arid land with forage grasses, and areas of deficient rainfall with desert shrub.

Grasses—Of all plants are the most useful to man. To the grasses belong the cultivated cereals (sugar cane, sorghum, wheat, maize, rice, barley, rye, oats) as well as the forage grasses for animals. On the Great Plains, the vegetative cover on "hard" lands is composed of short grasses, mostly buffalo and blue grama, while on sandy lands, the bunchgrasses, feather grass, three awn, porcupine grass and dropseeds predominate. At higher elevations, wheatgrasses, ryegrasses, bromes, fescues, and other similar tall grasses predominate.

Shrubs—"Hard" lands of the Great Plains are relatively free from shrubs except where grasses have been weakened and thinned. Here are found such invaders as snakeweed and prickly pear. Sand sage is abundant on sandy soils. On the western slope particularly, big sagebrush dominates the foothills. Above the sagebrush belt, oak, mountain mahogany, bitter brush and many other similar shrubs make up a large percentage of the cover.

Forests—The total forest area of the United States today aggregates about 60 per cent of the original forest. The Rocky Mountain region contains about 8 per cent of this timber acreage, the principal commercial timber of the central and southern Rockies being western yellow pine.

Soil is determined by

1. *Parent material*—Soil is weathered rock, to which have been added the environment's plant residues and small living creatures. As the rainfall decreases and fewer materials are carried through the soil by water, the influence of the parent material increases.

2. *Environment*—Plants build up complex organic matter and when they die add nitrogen, phosphorus, and other elements to the soil. Millions of small creatures make these dead worlds of organic (plant residues) and inorganic (parent rock) materials, a living soil. In one gram of soil may be found from several millions to many billions of microscopic

organisms—bacteria, molds, yeasts, protozoa, minute worms, and other members of the plant and animal kingdoms. These organisms prepare the food for plants, bring about chemical changes which influence the growth of plants, work over the soil, mixing its organic and inorganic materials, and in many other ways make a soil usable by plant and man.

The broad difference in soils may be easily seen when the soil layers are exposed, as by digging a trench in a field. These layers are called horizons, and the whole arrangement of the horizons from top to bottom is called the soil profile. In the surface layer, called the A horizon, life is most abundant, and this is the horizon that is normally cultivated for crops.. Below it is the B horizon, which may be heavier and have an accumulation of clay. The A and B horizons together are the true soil or solum. Below them is the C horizon, the weathered parent material from which true soil can be formed only by the slow, complex processes of soil formation. Soils formed under different conditions have different profiles, like different races of people, and some do not have all three horizons.

Soil is classified according to three orders and many subdivisions to designate those similar in crop adaptation, erodibility, or physical and chemical composition.

Zonal soils are produced under normal conditions from well-drained parent material acted on by climate and biological forces, including the Desert, Red Desert, Sierozem, Brown, Chestnut, Chernozeb (black), and other groups.

Intrazonal soils occur when either the parent material or the slope of the land (relief) has produced an effect that overbalances all other factors, such as soils characterized by an accumulation of salts or formed under water.

Azonal soils are those in which the parent material has remained just about as it was originally, almost unchanged by any forces, such as the dry sands.

Erosion

Erosion goes on fairly constantly, has gone on for geologic ages and will continue. Water running down hill picks up soil, wears away rock. Erosion has built our valleys, our cliffs, our canyons; has helped form our soil. Some sections of our country are undergoing rapid geologic erosion, some have settled down into a period of comparatively little change. But man has greatly speeded up the rapidity of loss of his topsoil by destroying the number and quality of the growing plants—the vegetative cover of the earth. Many factors have to do with the rapidity of erosion, but in every case, given the same conditions of climate, slope, soil texture, et cetera, erosion is more serious and rapid on a bare soil than on soil covered with vegetation.

Accelerated Erosion—by water

Sheet erosion is the stripping off of soil or soil materials, grain by grain, layer by layer.

During heavy showers thin sheets of muddied water flow across barren surfaces. The large volume of soil which can be removed from a field by this sheet wash is shown by the amount of sand and silt accumulated at the lower end of sloping fields after a hard rain. Plants high on the slope may be left with their roots uncovered. Others where the soil is deposited are often completely buried.

The clay and silt transported by sheet wash tend to seal the pores of the soil and form a waterproof crust, so that little water soaks into the ground to aid the return of vegetation. True sheet wash follows no definite channels, but water tends to concentrate its flow and small drainageways soon develop.

Gullies develop where running water is concentrated: ruts in old roads, depressed cattle and sheep trails, drainage ditches, improperly constructed terrace outlets, or deepening rivulets. Starting with a small channel or "shoestring gully" across which a man can step, a gully may increase in size until it is large enough to hide a cow, a house, or a whole village.

Streambed erosion is responsible for the cutting of deep gorges and undercutting of the lands bordering stream courses. Gentle flows in shallow channels often have been transformed into raging torrents which swing from one side of the valley to the other, broadening the flood plain and eroding away banks. Water that carries a heavy load of silt or debris has a greater power of erosion than clear water, just as sand paper rubs off a surface more quickly than a piece of cardboard.

The increase in flow is usually caused by the removal of vegetation in the upper watershed, thereby increasing the proportion of water which runs off during a rain.

Accelerated Erosion—by wind

The blowing of soils is influenced by climate, vegetative cover, the intensity and turbulence of the wind, the structure and humus content of the soil.

Vegetative cover protects soil from blowing. Close cover with roots that bind the soil is the best protection from wind.

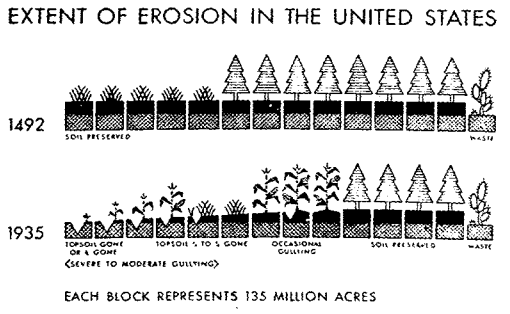
Soil structure—Sands and granulated clays are removed more rapidly than cloddy soils.

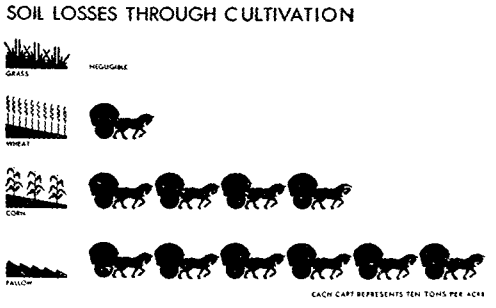
Winds—Turbulence, as well as intensity, is important in wind action.

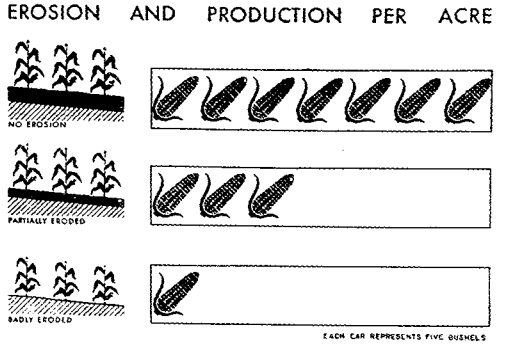
Crop cover, stubble, snow, moisture, windbreaks, decrease soil blowing.

Insect infestation affects crops and native vegetation, exposing the soil.

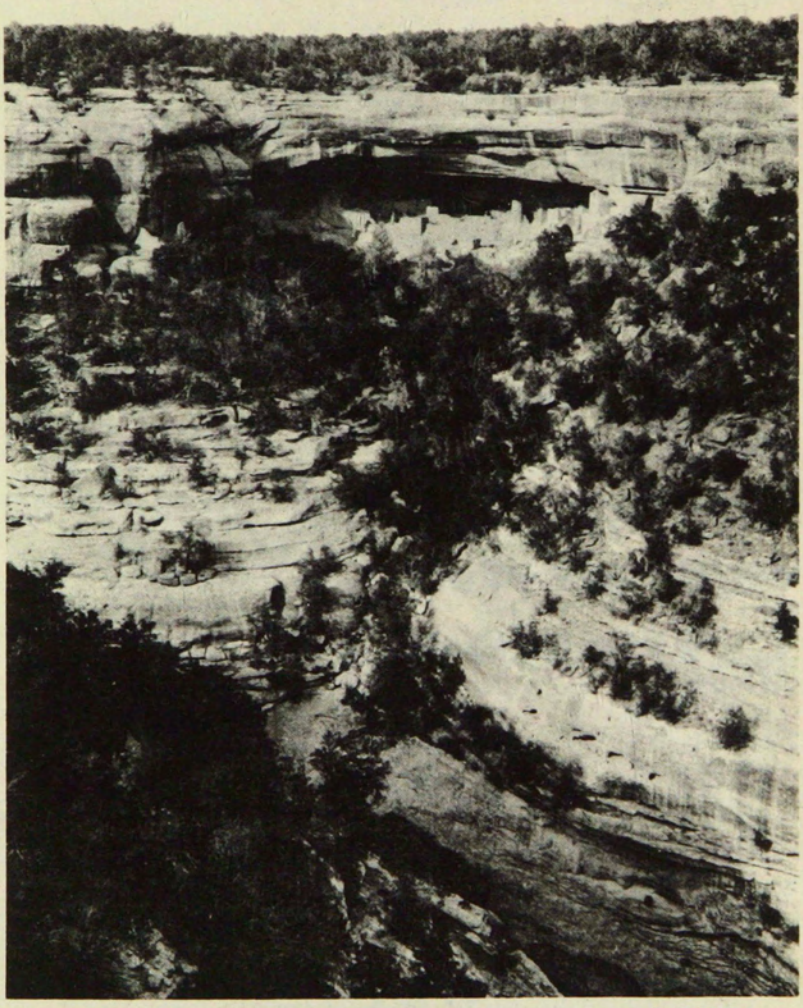
A GRAPHIC PRESENTATION OF EROSION







From *Little Waters*



B. BRIXNER

YESTERDAY

At Mesa Verde, the first farmers of Colorado lived and worked the land.

History of Land Use

History books have been written and history studied in terms of laws and treaties, rulers and wars. A fundamental approach might be in terms of land and man's use of it. Treaties, wars, laws

would all be part of the picture, but invariably they would be seen in relation to the land, products of the land, and their distribution among men.

Consider the history of our own Colorado, for example. Its story hinges very directly on man's attitude toward the land and the use to which he believed it might be put. To both Spanish and Anglo-American explorers, with few exceptions, the mountains of Colorado appeared impassable barriers, the great grassy plains useless for agricultural purposes. Spanish settlement stopped at the southern border, the Oregon trail went to the north and the Santa Fe trail to the south. Colorado was left almost entirely to the Utes and the plains Indians until the nineteenth century.

Later these very barriers became goals. As new potentialities of usefulness were discovered—beavers, gold, grass and browse for cattle and sheep, acres for wheat, irrigated valleys for fruits and grain—the pattern of man's activities changed and changed again.

If we could reconstruct, in a rapidly moving picture, the activities of men on this portion of the earth's surface called Colorado, beginning with the earliest known people and continuing to the present, the film would divide into definite periods, each presenting its own pattern of living—the period of the aboriginal Pueblo Indians in the west, the epoch of plains Indians, the day of the mountain men who scoured the streams for beaver, the gold rush, the cattle kingdom, and the agricultural period with its great wheat boom in eastern Colorado; the development of the great stock raising industry in western Colorado, and the day we live in, which might well be called "the problem period."

No clear-cut lines would separate one period from another. While most of the men in the picture were engaged in cattle raising, we should see a few beginning the more quiet business of farming and some still digging gold. In general, however, we should see that the predominating pattern of each period is strongly influenced, if not determined, by the way most of the men are using the land. Day-to-day life, customs and costumes, beliefs and laws, ideas of right and wrong—change and change again as man's relationship to the land changes. We should notice also that each new arrangement of the activity pattern has its source in something that happens in a preceding period. The agriculture of today, for example, began when a few trappers and hunters decided to settle permanently in the new country.

It grew during the gold rush with the demand for food to feed the miners and railroad crews. But it took the invention of barbed wire and windmills during the days of the cattle barons to make farming the occupation which dominated the pattern of living in eastern Colorado. This in turn drove the stock business finally into western Colorado.

The Earliest Coloradans

The earliest Coloradans of whom we have any evidence other than arrow points, dwelt in the San Juan district, probably nomads, living in brush shelters and eating small game, roots, and berries.

According to anthropologists, these people began to use corn and passed gradually to a more settled state. Slowly their agricultural practices improved. They progressed from pit houses to large communal homes, which we can study in the remains of the cliff dwellings at Mesa Verde park.

Small ears of corn, beans, and squash seed found in the ruins indicate that the people who lived in them so long ago were primarily farmers. Remains of little ditches and dams at various places in the region show that they understood and practiced irrigation in a small way. For the most part, however, anthropologists believe that the early inhabitants of Colorado practiced dry farming, probably employing about the same methods the Navajos use today.

These early Coloradans had already learned how to make soil and water work for them, not only by planting deeply but by building up ridges of earth around each hill of corn to catch the water as it fell. They had learned to plant their corn hills five to eight feet apart and rarely used the same place two years in succession. Growing beans in the same field with corn was a fortunate custom as it added nitrogen to the soil.

These early American farmers made no excessive demands upon the earth which supported them. Populations were comparatively small, resources practically untapped. The aborigine produced only for his own use. His demands were simple. He wove baskets and made pottery, hewed beams for his houses and gathered wood for his fuel. He knew little of metals and had no machines for elaborate products. He had neither horses nor other forms of transportation so that he could not wander far from home nor engage in extensive trade. At this stage of his development, after the rigors of his nomadic period—when most of his time must have been required to gather food or protect

himself from wild animals and from the elements—he had reached a comparative stability and security. His leisure was turned to making things he could use everyday. In baskets and pottery he expressed his feeling for the world he saw about him, the clouds, the rain, the mountains—and the gods who lived above and below the earth.

What happened to destroy this effective if simple pattern, we do not know, but as we watch the panorama of man's changing activity, we see him today swarming over the continent, exhausting his natural resources, buying and selling, roaring over the earth in trains and cars, sailing through the air, making his necessities in great factories; each new discovery, each new invention bringing its problems of adjustment.

The Buffalo People

By the time the first European set foot in Colorado the early Pueblo Indians of this area had disappeared and the country was sparsely peopled with roving tribes who wandered over the mountains and plains. The Utes or "Blue Sky People" dwelt in the mountains and plateaus, living much as the ancestors of the early Pueblo people had, on small game, roots, and berries. The plains Indians ranged over the level areas of eastern Colorado, securing all the necessities of life—food, clothing, shelter, and even fuel—from the buffalo.

> The maintenance . . . . of these Indians comes entirely from the cows, because they neither sow nor reap corn. With the skins they make their houses, with the skins, they clothe and shoe themselves, of the skins they make rope, and also of the wool; from the sinews they make thread, with which they sew their clothes, and also their houses; from the bones they make awls; the dung serves them for wood, because there is nothing else in that country; the stomachs serve them for pitchers and vessels from which they drink; they live on the flesh; they sometimes eat the fat raw, without warming it; they drink the blood just as it leaves the cows; and at other times after it has run out, cold and raw; they have no other means of livelihood.[1]

So one of Coronado's men describes the economy of a people who depended upon the buffalo for everything they needed.

When hunters and trappers entered Colorado in the early nineteenth century, the plains Indians still lived very much as they had when Coronado saw them, with one important addition

[1]Castenada, Pedro de *et al.*, ed. George Parker Winship, *The Journey of Francisco Vasquez de Coronado, 1540-42.* (San Francisco, 1933), p. 104.

—the horse. Galloping over the flat country instead of stalking his game on foot, intensified rather than changed the Indian's pattern of living, for he still depended upon the buffalo. Now, however, he could range farther, hunt better, and be more independent of his enemies.

For almost 300 years after the first European set foot in the Southwest, the plains belonged to the Indians. The Spanish conquerors had not ventured far beyond the southern borders of what is now Colorado.

Explorers

Several parties of Spanish explorers did wander into the territory, and Juan de Uribarri claimed the land in the vicinity of the modern city of Pueblo for Philip V of Spain, naming it Santo Domingo. But no serious attempt was made at settlement. Don Juan Rivera was in western Colorado as early as 1765 and Escalante's expedition in 1776 (the same year that the eastern colonies were signing their Declaration of Independence) traversed western Colorado, seeking an inland passage to the Spanish settlements on the western coast.

Explorers coming westward from the humid United States for the most part agreed with Stephen H. L. Long that the country was "almost wholly unfit for cultivation, and of course, uninhabitable by a people depending upon agriculture for their subsistence."

Trappers and Hunters

It took the whim of an English dandy—or so the story goes—to make the white man see in the land of Colorado a source of potential wealth.

Beaver hats became the vogue in London, and a horde of adventurers poured into the Rocky Mountain region for the broad-tailed animals whose skins had suddenly become so precious.

Fur companies were organized and expeditions sent into the wilderness. In the 1820's and 1830's trappers and hunters roamed over Colorado.

Men disappeared for months armed with traps, knives, pistols, and rifles. If they were lucky, they had several horses, a little coffee, sugar, and tobacco. Sometimes they traveled in groups of three or four, often they separated and lived in complete solitude. As weeks and months went by the trapper's hair tangled with his whiskers and his buckskin clothes became greasier and more bloodstained. Living was hard and crude with expedi-

ency the only law, and self-sufficiency the greatest virtue. Women scarcely entered the picture.

Life for the mountain man followed a certain rhythm—a long period of solitude and hardship punctuated with a week or two of trading, drinking, fighting, and dancing at a gathering place in some mountain valley where St. Louis men came with supplies and money to buy the furs. Brown's Hole in northwestern Colorado was one of the most famous of these meeting places.

As the demand for beavers slackened and the streams became depleted, a few trappers settled down with Mexican wives, acquired during brief visits to Taos or some other New Mexican settlement, and began to farm the valleys. Many of them turned their attention to the buffalo.

With the change from beaver trapping to buffalo hunting, came changes in the entire pattern of living. Buffalo robes were too bulky for transportation on pack animals. Besides it took many more of them to make a sizeable profit than it did of beaver skins. Wagons, already coming over the Oregon and Santa Fe trails, made it possible to handle skins profitably by sending them east on the "prairie schooners." Gathering places gave way to the permanent trading post—Fort Bent, Gants, Fort Lupton, and many others—where furs could be safely housed. Trading was supplemented by a little agriculture and stock raising. As the fur trade declined, several settlements were begun, one near present La Junta and one at the site of present Pueblo. All of them, however, seem to have been deserted before the discovery of gold in 1859.

The wholesale destruction of the valuable little dam builders and the buffalo herds forms a fitting prelude to the story of man's use of land in Colorado. For centuries the plains Indians used the buffalo to satisfy all the requisites of living, without depleting the herds. A few short years after traders showed the Indian that a buffalo's skin might be sold for money, traded for beads and cloth and firearms, the plains were dotted with heaps of buffalo bones whitening in the sun. The buffalo became a rare curiosity.

Still the grass was left. Nobody had yet discovered the way to make money out of this sea of waving grass, or thought of tearing it up and planting the earth beneath it in even rows.

When Coronado had come in 1540, probably crossing the southeast corner of Colorado on his way back from the search for

"Quivira", Castenado wrote of the grass which "never failed to become erect after it had been trodden down."

> "Who would believe," he wrote, "that 1000 horses and 500 of our cows and more than 5000 rams and ewes and more than 1500 friendly Indians and servants, in traveling over those plains, would leave no more trace where they had passed than if nothing had been there—nothing—"[2]

When the day of the buffalo was over, the grass still stood, not very different in its luxuriance from the time when Coronado and his men first passed through it. Gold in the mountains, however, was discovered before men realized the wealth that lay in grass.

Gold in the Hills

With the discovery of gold in the Cherry Creek district, changes in the pattern of living come thick and fast. The immediate scene is fast moving and hectic—fortunes made and lost, thousands of miners working in triple shifts, gambling palaces and saloons never closed. But this picture is a transitory one.

More important are the trends born of the discovery of gold. Weaving and interweaving they produce a constantly more complicated pattern, until the disentanglement of any single thread becomes difficult indeed. Towns were established. Land speculators appeared. Agriculture became a business. The railroad arrived. For the first time there appears in our picture a group of individuals who planned to make money not by work on the land—trapping, hunting, digging gold, farming—but by buying a portion of the land and selling it for more than they paid for it —as much more as possible. This element of speculation plays an increasingly important part as our picture widens and becomes more complicated.

As early as September 1858, Montana City was laid out on the east bank of the South Platte. Late in October, Auraria was founded on Cherry Creek, and in November the town site of Denver was established. Montana City soon disappeared, leaving Denver and Auraria to fight for supremacy. Rivalry between towns adds a new tone to the everchanging pattern.

Supplies from the east were brought to Denver and Auraria, where they were sent by stage to the various points needing mining materials, food, clothing, and shelter for the miners.

Five cities began to promise permanency—Denver, Golden City, Mountain City, Arapahoe, and Colorado City, for in spite

[2] *Ibid.*, p. 75.

of the depression in mining which came during the Civil War period, by the end of the sixties Colorado was recovering.

Farming Becomes a Business

In Colorado this depression of the Civil War period had been aggravated by the cost of importing food and supplies. The result was a new interest in the agricultural possibilities of the irrigable areas of the region. Up to this time farming had been regarded as a means of subsistence, not a business. A few settlements in the San Luis valley peopled by New Mexicans had continued since 1852. Others had sprung up here and there, but always the emphasis was placed on supplying the needs of the community itself. However, by 1869 the market value of grains, hay, and vegetables produced in the territory was estimated at three and a half million dollars—almost as much as the output of mines for that year. Commercial farming was well on its way, with large farms already established on the Huerfano, and in the vicinity of Golden, Denver, and Boulder.

Very important among the factors working for increased activity in the region was the approach of the transcontinental railroad. The completion of the Union Pacific Railway in 1869 was followed by the building of two roads into Colorado. In June, 1870, the Denver Pacific joined Denver to the main line of the Union Pacific; in August the Kansas Pacific reached Denver, connecting the city directly with St. Louis.

Both the Denver Pacific and Kansas Pacific were land grant railroads, eager to sell land. Costs of construction must be paid. And still more important, there must be settlers to use the roads. So out went a flood of literature describing the prodigious crops which could be raised in the fertile Colorado valleys through irrigation, and emphasizing the steady markets in the mining camps and towns.

The homestead laws of '62 offering free land for the taking, and chaotic conditions in the East following the Civil War accelerated the movement westward. By the early '70's the agricultural colony was the predominating type of settlement in eastern Colorado.

Most famous of the colonies was the one at Greeley, named for the editor, Horace Greeley, who had supported the enterprise. The colony was managed on a semi-cooperative plan, the colony, rather than individuals, securing land, laying out the town, dividing the lots, and constructing irrigation ditches. The

members owned property and carried on business on a purely individual basis.

Some of the so-called "colonies," Colorado Springs, and South Pueblo among them, were formed by companies affiliated with the Denver and Rio Grande Railway.

These agricultural colonies along the eastern base of the mountains depended upon irrigation from the mountain streams to water their lands. Water has always meant life in this arid country and with the beginning of farming on a commercial scale, problems arose.

English common law, which had been the basis of water use in the East, prohibited the diversion of water from a stream. Stronger than any preconceptions of right and wrong, however, was the demand of the land itself, and in 1861 the first territorial legislature of Colorado revoked the law completely and substituted the arid-region doctrine of appropriation, sometimes called the Colorado system. The act declared that persons holding lands on the banks of streams had the right to use the water for irrigation, and provided for rights of way for ditches to lands not bordering on such streams.

Growth in the scope of farming in the valleys demanded that irrigation developments keep pace. During the fifties and sixties irrigation ditches had been built by individual farmers to water small claims on the bottom lands beside the streams. In the late '60's and '70's members of communities united to build larger ditches. The canals built by the Greeley colony were typical of such community developments. Somewhat later irrigation projects were built by corporations. Most of the corporations went bankrupt and control passed to landowners under government guidance. Two of the large irrigation sections in western Colorado today are carried on by the U. S. Reclamation Service. Now the state engineer and his staff regulate the distribution of water, and the state has been divided into irrigation divisions and water districts.

Towns Increase

With the discovery of gold in the San Juan country in southwestern Colorado about a decade after the rush to Cherry Creek, such towns as Lake City, Silverton, and Ouray were established. One of the principal routes to the remote San Juan mines, not yet reached by rail, lay through the San Luis valley. Towns grew up along the way as outfitting points, among them Del Norte.

In the late '70's silver was discovered near Leadville. In 1880 lead deposits were found near the head of the Roaring Fork of the Grand River and such towns as Aspen and Gunnison sprang into being. Prior to this time, western Colorado was little known. Aside from the early Spanish expeditions of Rivera and Escalante in the eighteenth century and Major Gunnison's survey for a transcontinental railroad route in 1853, western Colorado was known principally by the wandering Utes, the hunters and trappers of the 1820's and 1830's, such scouts as Kit Carson, Jim Bridger, and Thomas Fitzpatrick. Brown's Hole in northwestern Colorado and Antaine Robidoux' trading post near the present site of Delta were the earliest settlements.

Forests Are Cut

One of the scarcely noted attendants of the mining period was the careless use of forests. Miners needed logs and lumber for their cabins, mining timber, and fuel. Enormous quantities of charcoal were used. Most of these people regarded themselves as transients who would go back home as soon as they had become rich. They saw no particular reason for being careful of trees.

The railroads also contributed to the depletion of forests by cutting great quantities of lumber for construction purposes and for fuel. Unheeded forest fires following the cutting added to the destruction. Still later lumbering was taken up as a business and the resources of the forests were "mined", rather than treated as a self-sustaining crop with a crop yield year by year. Not until long after the mining days did people realize that trees must be kept on upper slopes if valleys are to remain habitable and productive, that the even flow of streams is greatly influenced by the forest, that the forest is a great producer of fertile soil, that the underground flow of water, so important in our springs and wells and stream flow, is regulated by forests.

The Cattle Kingdom—on the Eastern Plains

While towns were growing along the base of the mountains, commercial farming expanding in the valleys, gold and other metals being dug out of the hills, a new way of life developed on the eastern plains. Men began to use the grass, and out of this new approach to the land grew a culture that formed the basis for some of the most romantic and melodramatic of American legends—the cattle kingdom.

In the back of their minds, at least, travelers in the flat country had always seen it as potential pasture land. In 1541

Coronado wrote to his king, "There is much very fine pasture land, with good grass."[3] Early in the nineteenth century, Zebulon Pike recorded in his diary the opinion that, "The inhabitants would find it most to their advantage to pay attention to the multiplication of cattle, horses, sheep, and goats, all of which they can raise in abundance, the earth producing spontaneously sufficient for their support. . . ."

Still the semi-arid treeless plain remained a *desert* to the forest-minded pioneers from the east: no trees, no logs for cabins, no rails for fences, few springs or streams. They pushed on westward.

Occupation of the eastern plains by the cattlemen grew directly out of an idea of J. G. McCoy, an Illinois shipper of livestock. McCoy decided to establish a cow town where drivers from Texas could meet eastern buyers undisturbed by thieves and swindlers. He chose Abilene, Kansas, as the strategic point where the cattle trail cut the railroad. In 1867 the first herds were driven from Texas to the little midwestern settlement.

Not all the cattle that reached Abilene were fit for market. Sometimes the market was dull. Surplus cattle were kept on the prairie where grass was free. The buffalo was gone and within a decade the range cattle industry spread over the Great Plains. With it came a completely new pattern of life—men on horseback, men in boots and ten-gallon Stetsons, round-ups, rodeos, and branding pens, bawling calves, and the smell of burning hair and flesh.

Until 1873 the cattle business expanded without interruption. Cattlemen suffered during the panic of '73, but by '76 the demand for beef was on the increase, the market rising. In the early '80's came the great cattle boom.

Not only easterners, but Canadians, Englishmen, Scotchmen, and Australians hustled to the Great Plains to become ranchers. Perhaps there was a premonition in the air that the day when a man could ride the range on a spirited horse and watch his fortune grow could not go on indefinitely. Perhaps they really believed it could. But barbed wire had already been invented, and the intrusion of a few farmers was becoming a source of irritation.

Men scrambled for ranches, cattle rose in price; ranges were overstocked. Cattlemen were more interested in making a profit while the making was good than they were in sustaining grass on rangeland that seemed limitless. An area that could have

[3] *Ibid.*, p. 115.

adequately supported one steer was forced to carry three or four. Tall grass was giving way to buffalo and grama grass. In some places sagebrush and purple iris came in—the grasslands had started on their downward path. Still prices rose!

Either a hard winter or a drought meant certain disaster, and with the winter of 1886-87 tragedy came. Millions of cattle perished. Cattle companies went into bankruptcy. The bottom fell out of the rancher's world.

In the meantime barbed wire crept farther and farther west. The windmill made fenced pastures practical. The railroads had already penetrated to most parts of the country.

In the late eighties more sheep came in and further complicated the cattleman's problems, by invading the summer ranges high in the mountains. When the farmers arrived in large numbers and began fencing in and plowing up the winter range on the flat lands, the situation became still more difficult.

By 1895 the transition was complete from the era of the cattle barons to a period when cattle raising became a business conducted more intensively and on a smaller scale. Ranches operated under a system of fenced pastures. Alfalfa and other hays were grown for winter forage. High-grade cattle replaced scrub stock and the breeding of fine animals became a part of the business. Wells and windmills furnished water, and railroads made long drives to markets unnecessary.

Most holdings in the plains country, however, were too small to permit proper use of the land. It was not until 1916 that Congress recognized in its land legislation that such a class as cattlemen existed in the West. In that year the unit of 320 acres for farms was increased to 640 acres for range land, with the restrictions that the land be fit only for grazing and must contain no timber, have no minerals and no irrigation facilities. This provision for the cattlemen was still utterly inadequate. In order to survive they were forced to violate nearly every land law made, and many of them had long since shifted to the great stock raising area of western Colorado, where homesteading did not particularly interfere with ranching and where livestock grazing was not confined to the land owned.

Wheat on the Plains

The same forces which brought about the end of the great cattle period—free homestead land, barbed wire, windmills, railroads—ushered in an era of dry farming on the plains.

The stock raisers had injured and depleted the grass. The farmers plowed it up.

With no thought in mind but the ever-expanding domestic and foreign market for agricultural products, and encouraged by unusual periods of abundant rainfall, the settler told himself he had found "the finest land on earth" and hastened to make it produce him a fortune. Much of the land should never have been plowed. In a sub-humid region where rainfall is low, erratic, and scattered, where wind velocity is high, the native stand of grass with close-growing, thick roots, serves to bind and hold the soil from the action of both wind and water, and to increase water absorption. Farmers who were used to the humid climate of the East, imbued with the tradition of land use in their mother countries were without experience in proper land use in a semi-arid climate. The lag of the homestead laws continued to add to the farmers' difficulties. A farm of 160 acres, enough to make a good living east of the 100th meridian, was pitifully and disastrously inadequate on the sub-humid Great Plains. By 1870 the tide of the westward moving farmers had almost completely passed into the regions where rainfall was less than 20 inches. Yet not until 1908 was the amount of land per homesteader increased to 320 acres.

The farmers did the best they could. They used the only methods they knew. They labored to superimpose the system they had always known.

Many of them happened to reach the plains in seasons of above-average rainfall, and their harvests for the first few years were all they could desire. Others struck bad luck right away. The entire period between occupation and the World War was composed of good years when the rains fell and crops were abundant, and bad years when rains were scarce and crops failed. During the bad years small dust storms and drifting soil annoyed the farmers. But the dust was limited to isolated areas under cultivation, for much of the soil was still protected by grass.

A fatal but too usual mistake in land use—particularly in semi-arid climates where moisture is scarce and erratic, and balance between moisture, soil, and vegetation is extremely delicate and easily upset—is to consider normal the years of heavy rainfall, abundant crops, plentiful feed for stock; to consider abnormal the years of little rainfall, heavy winds, small crops and small feed. We are all familiar with the cry of farmers and stockmen, "If it would only rain, everything would be all right."

True enough, if it would only rain when and where and how we want it. But it rarely has in this region, and for all practical purposes, it rarely will. There have always been long periods of drought, varying in intensity, varying in length. This is normal. If such land is to be used wisely, continuously, and in the future, these known facts must be the basis of planning and use.

Homesteader after homesteader failed during the droughts. The land was sold for taxes or lost to mortgage holders. In good years speculators resold land for such large amounts that the farmer found it difficult, in many cases impossible, to produce enough to make his payments and pay his taxes. Gradually much of the land passed into the hands of tenants who must plan their operations on a year-to-year basis, forcing them to work the land to the limit in order to make a living.

An arid spell from 1901 to 1904 during which many farms were abandoned, was followed by the discovery of new dry farming methods and a wave of resettlement.

Soon the tractor replaced the plow, and where the plow could tear up an acre of grass, the tractor could rip up twenty. With the World War came high prices for wheat. The pace was accelerated. More and more sod was destroyed for crop land. The wheat king succeeded the cattle king.

The end of the war brought a drop in prices, but between 1924 and 1929 cropland in the plains area increased by many thousands of acres. Then came the economic crash, followed by several years of extreme drought in the early thirties. The wheat king had had his day. So had the grass and much of the soil. Dust clouds were blowing all the way to the Atlantic Ocean.

In about sixty years the Great Plains had been transformed from an open-range area to a region of extensive dry farming, with almost complete dependence on wheat as the one cash crop.

Acres and acres of grassland stood utterly depleted. When the grass is gone from great areas, there is nothing to protect the earth from erosion. As early as 1900 scientists had pointed out the hazards of destroying the native sod:

> When the wild prairie is first broken, the soil is mellow, moist and rich, producing abundant crops. After a few years of continuous cropping and cultivation, the physical condition of the soil changes; the soil grains become finer; the soil becomes more compact and heavier to handle; it dries out quicker than it used to; bakes worse. . . . After a soil has been cultivated and cropped a long time, it tends to run together and is very sticky when wet, but when dry the adhesive

character disappears almost entirely. The grass roots which formerly held it together are decayed and gone, and now when loosened by the plow it is easily drifted and blown away.[4]

Stock Raising and Farming—In Western Colorado

The great pile of mountains in the center of Colorado, bisecting the state north and south, has like a mass of rock in a stream deflected the northern tide of population to east and west, the western flow to north and south. The movements of peoples, streaming past the mountains, have eddied back toward them from the west, from the northwest, from the southwest.

Today western Colorado presents a very different picture of land use from that of eastern Colorado. On the western slope the principal use of land is grazing. About 15 percent of Colorado's population is on the western slope and less than 10 percent of the land is used for the cultivation of crops. Much of this crop production is supplemental feed for livestock that utilize the great grazing lands of the western slope. Between one-fourth and one-third of the land is privately owned, about one-third is National Forest and National Park land, one-fifth is public domain, and the rest is Indian and state land.

Early land-use and population movements in western Colorado have been described—the first farmers, the Pueblo Indians; the early Spanish explorers; the Utes, who were hunters; the trappers and hunters of the 1820's and 1830's. But on the whole, western Colorado was in the possession of the Utes until the end of the nineteenth century, when the discovery of gold and silver brought miners, permanent settlements, and railroads; and the end of the cattle kingdom on the plains marked the beginning of the great stockraising industry on the western slope.

Irrigation in the upper Colorado River Basin dates practically from settlement, begun by prospectors and miners from the older mining districts on the eastern slope. The first settlement was made in 1860 at Breckenridge, on the upper Blue River. Most of the Colorado Basin was within the territory occupied by the Indians, and their hostile attitude toward the whites prevented further settlement for a number of years after that date. In 1873 a treaty was concluded with the Southern Utes, whereby the government acquired the land in southwestern Colorado and

[4] H. H. Bennett, "Emergency and Permanent Control of Wind Erosion in the Great Plains," *Scientific Monthly*, November, 1938, quoting Prof. Ten Eyck.

opened it to entry. Immediately prospectors and miners rushed in and, on discovering rich mineral deposits, settled the mining camps in the San Juan region. A few years later prospectors from the camp at Leadville explored and settled the nearby region at the head of the Eagle and Roaring Fork valleys, Redcliff being founded in 1879 and Aspen in 1880. In the meantime stockraisers had settled in Middle Park (now Grand County) in 1874.

The Uncompahgre or Northern Ute Indians continued to occupy the territory now included in Mesa, Delta, Montrose, and Garfield counties and prevented settlement until 1881, when they were removed to the Uinta Reservation, in eastern Utah. Immediately afterward settlers, chiefly farmers and stockraisers, came in and established homes.

Because of the scanty rainfall, irrigation was found necessary for successful agriculture. In mining regions the first ditches were constructed near settlements on the headwaters of the streams. As new settlers came in, additional ditches were constructed downstream, gradually approaching the mouths. This reversed the usual order in the development of irrigation, which generally begins at the mouth and gradually expands toward the headwaters. Grand Junction was founded in 1882, and in the next year Grand Valley canal was started as a mutual project to irrigate a large area in Grand Valley. With this exception, early ditches were all small individual or partnership affairs, constructed as cheaply as possible. Many of them were little more than plow furrows. The few diversion dams built were either loose-rock or brush-filled structures. This description holds true at the present time for most of the ditches in the upper Colorado River Basin.

On the Colorado River in the vicinity of Grand Valley and on the Uncompahgre, large areas of irrigable land and the need for constructing expensive headworks in the streams made it necessary to form mutual companies to build the required systems. After the passage of the federal reclamation act in 1902 the owners of the several large canals irrigating land in the Uncompahgre Valley petitioned the government to form an irrigation project in that section and increase the available water supply in the Uncompahgre Valley by bringing water from the Gunnison River through a proposed tunnel 6 miles long. The state had undertaken this work in 1899 and made a survey of the proposed site but could not induce private enterprise to construct the tunnel. The government acquired the larger canals in the valley and

constructed the tunnel at the site previously selected. The only other government project in the basin was the construction of a high-line canal to irrigate land in Grand Valley lying above existing systems. Under the state irrigation-district law a number of projects were started, of which the largest was that in the Montezuma Valley. Mutual companies irrigate mesa lands on the North Fork of the Gunnison, and on one or two of the smaller tributaries.

Irrigation in this region was subject to the general economic laws governing irrigation in the United States. The first great boom occurred during the late '80's and early '90's, when many large enterprises were promoted. Few of these were financially successful, although large areas were irrigated. This boom was followed by a long depression, which lasted until 1902-03. The reclamation law, passed in 1902, revived irrigation activities by private enterprise, and this revival lasted until 1910.[5]

According to figures of 1933, more than 2,500,000 acres were classified as dry farm land or irrigated land. This land, less than 10 percent of the acreage of western Colorado, produces 44 percent of the livestock feed and serves as a feed reservoir to carry stock through lean periods of forage and to fatten them for market.[6]

Dry farming in western Colorado has been increasing. In the Dove Creek area of southwestern Colorado, some World War veterans took up homesteads and have been growing beans for nearly twenty years. In the past six years the dry farming area has increased greatly, 15,000 acres of native sagebrush being cleared annually by immigrants from the dust bowl seeking new land. Will the history of plains farming be repeated or will it teach its lesson?

In the Great Divide area from 1912 to 1916 settlers came in large numbers in response to wide advertising of this region. They plowed and planted during years of above-average rainfall and their crops were abundant. But when more normal or so-called "dry years" followed, most of the settlers were forced to abandon their farms. Often, too, the overuse of range lands adds to the potential danger of serious erosion and soil loss.

The stock industry, which utilizes the bulk of the land on the western slope and is so dependent on the supplemental feed of the cultivated land, developed more or less simultaneously with

[5]Robert Follansbee, *Upper Colorado River and Its Utilization.*
[6]U. S. Geological Survey, *Land Classification of Western Colorado* (1933).

mining, irrigation, dry farming, and railroads at the end of the nineteenth century.

To be sure, the first cattle, sheep, and horses arrived with the early Spanish, and it was this stock that supplied the Indians. The few early Spanish settlers, mostly on the skirts of Colorado to the south, had a small number of stock to meet their own needs. And long before that period, indeed even before the occupancy of this territory by man, herbaceous animals were using the grazing resources of western Colorado—the grass, the shrubs, the trees. Nevertheless, in 1848 when western Colorado was ceded to the United States by Mexico, there were only a few head of stock, mostly cattle, in this area.

Sam Hartman was one of the early cattle kings, and the old Hartman Trail ran south from the North Fork country over Black Mesa through what is now Gunnison, and wound southward as far as Saguache in the San Luis valley. Early records describe the North Fork country of western Colorado as a land with

> A plentiful supply of wood, water, and wild game. . . . The wild life not only provided early settlers with food, but the San Juan mining camps and Black Canyon railroad crews were a good market for meat. . . . The North Fork country was entered through the now almost extinct shimmering white sage. . . . A fertile land within easy reach of water, on which the Indians raised corn. . . .[7]

Livestock statistics in the report of 1880 (prior to which time the stock industry was confined largely to the eastern part of the state) indicate a population of 51,000 cattle, 7,000 horses and mules, 68,000 sheep, and 430 swine—a total of 72,000 animal units (an animal unit is one cow, one horse, or five to seven sheep). About 55 percent of this livestock was in the San Luis[8] Valley, 30 per cent in the La Plata region, 7 percent scattered over the Rocky Mountains, and 8 percent in what is now Routt and Moffat counties.[9]

From 1884 to 1890 the cattle industry boomed. By 1890 the number of stock had increased to 300,000 animal units, in 1900 to about 625,000 animal units, and in 1930 to about 813,906. Sheep were brought into this section and as in other areas, there was almost constant war between the cattlemen and sheepmen. The

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[7]Rockwell, *The New Frontier*.

[8]The San Luis Valley, though technically on the eastern slope, is considered part of the western slope in a description of land use, because of its climate, soils, physiography, and population trends.

[9]U. S. Geological Survey, *Land Classification of Western Colorado* (1933).

majority of grazing land was federal land with no grazing restrictions except those set up by the users themselves. This restriction was an attempt by the cattlemen to restrict the use of the land to cattle; by sheepmen, to restrict it to sheep.

The cattlemen formed a cattle growers protective association, known as the *Night Riders,* with members in nearly every cow camp. At Meeker at one time over 2000 sheep were shot. The sheepmen retaliated by killing cattle and burning haystacks. Unwritten law sometimes set a boundary line. For instance, the Gunnison river was recognized as the dividing line between sheep and cattle, the south side for sheep, the north side for cattle. Any infringement led to inevitable trouble.

Not only were there feuds between cattlemen and sheepmen, but as early as 1893 it was reported that "the winter ranges were largely fenced in or overgrazed, and thousands of cattle died during the winter from starvation." In the first decade of the twentieth century the Forest Service was established and gradually it established control of grazing on National Forest land. In 1934 the Taylor Grazing Act put the public domain under the present Grazing Service.

It is possible to run stock on the range the year round by following the general practice of moving from the lower to the higher ranges and back during the appropriate seasons. The eastern part of the basin includes large areas of summer range, most of which is included in the National Forests. These ranges were formerly restricted largely to cattle, but during late years sheep have been permitted to enter. The grazing season in the forests averages approximately four months. At other times cattle are grazed on the lower ranges or kept on the home ranches and fed for a few months during the winter. Sheep are partly wintered on the semidesert ranges near Grand Junction and Delta, and some are fed locally, but most of the herds are trailed to winter ranges in eastern Utah.

The increase of cropland supplying supplementary feed has made possible the continued growth of the stock industry, for although some places were overgrazed as early as 1893 and many places have been improperly grazed for long periods, the stock industry continues to grow. The western flow of migration of man and stock is over, but stock continues to drift each year into Colorado from the north, from the west, eddying back and forth from one state to another, utilizing the National Forest land, the great stretches of public domain.

Today's Problem Period

Colorado today presents a complex picture, dramatic in its contrasts.

In about 80 years, no more than a long life's span, Colorado has changed from a wilderness peopled by roving Indians, a few hunters and trappers, and scattered farming settlements, to a region that holds within its mountains, plains, and valleys more than a million persons, engaged in a great variety of activities.

Agriculture—including stock raising, dairying, and farming—is the leading industry if judged by income. But except for isolated areas it is a highly specialized commercial agriculture, a far cry from the simple subsistence farms, herds, and flocks of eighty years ago. Colorado ranks first of all the states in sugar beet production. Ninety-five percent of all cantaloupe seed and a large share of the watermelons and cucumbers used in America are grown on irrigated farms in the Arkansas Valley. Cut flowers and seeds are shipped to all parts of the country, to Cuba, and to England. Grand Valley is one of the most highly developed peach producing sections in the entire nation. Colorado is the leading lamb feeding state. In 1935 the total livestock income exceeded that of all crops raised in the state.

Since the turn of the century factories have increased until the value of Colorado's manufactured products exceeds 183 million dollars each year. The largest steel plant west of Chicago is located at Pueblo. It annually turns out 225,000 miles of barbed wire alone, enough to build a 9-wire fence around the equator. Colorado manufactures nearly one-third of all the United States' sugar. Canning factories, smelters, foundries and machine shops, meat packing houses, flour mills and bakeries, employ many thousands of Colorado's citizens and send their products all over the country.

Beautiful Colorado—its crags and canyons and mountain peaks, its soft green valleys, combined with a healthful climate—draws tourists and health-seekers from all over the world. Supplying the wants of these tourists constitutes the third-ranking industry. During the past twenty years there has also been a marked increase in the number of persons employed in all the service industries so necessary to a highly industrialized and complicated pattern of life.

Mining and lumbering are other important industries. In addition to gold and silver, Colorado produces rare metals needed in the manufacture of steel: more than four-fifths of the world's

supply of molybdenum, one-fifth of the world's supply of vanadium. The state is first in the production of radium, second in tungsten. In 1936 the value of coal was more than 16 million dollars, almost as much as the combined value of gold and silver.

Four transcontinental railroads enter Colorado. Denver is one of the 93 metropolitan districts of the United States, and trade areas with small urban centers radiate around Grand Junction and Pueblo.

A highly *modern* picture, you say, with all the complexity, the specialization and rapidity of change we associate with contemporary life. And yet, there are places in Colorado where men carry on their subsistence farming much as they did hundreds of years ago, raising and making most of the things they need, trading their beans and corn for a few things they do not produce themselves, almost unaware of the kaleidoscopic hurry and confusion on the other side of the mountain. In northwestern Colorado is a section never surveyed and crossed only on foot and horseback. Not far from mines equipped with complicated machinery and manned by many men working in shifts, are streams where people still pan gold as they did in '59. Camp Bird near Ouray still depends upon the mule and his pack saddle to transport ore to mills and smelters. Men still live in mountain cabins making their daily round of traps, going only rarely to town to trade and buy supplies. In portions of eastern Colorado where great blocks of land have been abandoned by homesteaders and bought up by stock companies, large herds of cattle are still run and "rawhided" through the winter. In western Colorado round-ups and rodeos and branding still follow a pattern not so different from that of the great cattle days. Each of the periods that has contributed to the complex pattern we know today, exists in miniature, part of the patchwork.

Colorado shows great progress, great hope, you say, as you think of its beautiful cities, with fine buildings, efficient school systems, attractive homes, and well-kept lawns; as you think of the green irrigated valleys rich with tomatoes and cantaloupes and pumpkins, apples, peaches, and pears; the mountains with forests, the great forage lands of the western slope.

Still Colorado has more than 67 thousand unemployed. A recent survey shows that 2,700 farm families are living on land which is too poor or on units too small to provide an adequate living. Even a greater number, estimated at 3,000, need assistance through loans and technical guidance. On the eastern plains are

abandoned lands blowing in the wind, empty houses with doors and windows boarded, broken fences drifting in sand. In the foothills are disastrous floods, on the roads are shambling old cars piled high with bedsteads, stove pipes, ragged mattresses, driven by men "who wonder, who don't know," crowded with families who don't talk much, who don't laugh. On the plateaus are lands overcrowded with cattle and sheep, the forage dwindling, gullies forming, floods gathering, forming a menace to the fine irrigated valleys below.

A problem period, indeed.

Colorado's development is a little different from that of any other state in the union. For a long time men avoided her high mountains and grassy plains. The early east-to-west migrations were split by her mountains and passed to the north and to the south. Then as other frontiers were settled, men began to enter Colorado; a few New Mexicans from the south, cattlemen from the north, stragglers returning from the gold fields of California, cattlemen coming up from Texas, increasing waves of easterners seeking beavers, seeking gold, eager to become cattle kings, planning to be wheat kings, bent on making money one way or another. By the time settlement began in Colorado, as in other states settled after the Civil War, industrialism was already pretty well established on the eastern coast. Factories and machines, with certain men owning the tools, others working with them, dominated the pattern of living east of the Alleghenies. Markets were already waiting for whatever products Colorado might have to offer. The railroad was on its way to carry these products to their markets. Colorado had no time to go through a peaceful home period when her men used the land and its products to satisfy their own needs. She had no time to develop leisurely through a period that slowly separated some men from their tools, slowly changed the concepts of land use, making men see products of the land as potential money rather than immediate food, clothing, and shelter. The market was already established. Men came to Colorado to feed the market, as well as themselves.

Each successive wave of settlement in Colorado was either the result of a boom period somewhere else, or in some way connected with a pattern of life in which buying and selling had come to be the dominant factor. Men first came to trap beavers in order to supply the great demand and receive the high prices offered in England. The gold rush of '58 was greatly accelerated by the eastern depression in '57. Most of the men intended to

get gold, get rich, and get out. The great cattle period was the direct result of an effort to find an efficient and safe means of transporting cattle to the eastern market. It grew into a great inflated boom period. English papers reported that yearlings could be bought at $4 or $5 a head, could be fattened on free grass at the cost of another dollar, and sold at from $60 to $70 net. They demonstrated clearly on paper that if 100 cows and their female progeny were kept for ten years, the herd would number 1428, not counting an equal number of bulls to be sold. The homesteaders who followed the cattlemen expected to raise wheat for high prices on the eastern market. As soon as they discovered that years of drought were inevitable west of the 100th meridian, demanding that the balance between soil and water be carefully kept, they mined the soil more furiously than ever, hoping to make enough profit in good years to tide them over the dry ones. Buying and selling! Profit and loss! These were the concepts that conditioned and still condition men's minds and actions—not the land, and its continued usefulness.

Today we find it impossible to turn back. Even if we should like to, we cannot go back to the period when man gained a simple living from his work on the land, when transportation was limited, and the exchange of articles very small. New discoveries and inventions, new concepts and dreams, push us rapidly on into an ever more complicated and bewildering pattern. Shocking disasters, floods and dust storms, destitute farmers, workers without jobs—have jolted us.

Today we are faced with what we have, still rich, still full of possibilities, still able to support a population. We cannot wait for geologic ages to form new coal beds, new iron and gold and silver and oil. Our supply of minerals is limited. We must decide how much, in what manner, without waste, we shall mine them.

The soil on the other hand, the forests, the grass and browse, the animals are self-perpetuating. If we destroy any one of them faster than they can rebuild or reproduce, they will grow progressively more scarce and will eventually reach the vanishing point. Soil building is a slow process, but it is possible to keep the topsoil intact, to replace the ingredients of the soils that are necessary for growing plants. It is possible to maintain forests through sustained yield. It is possible to keep a balance between vegetation and animals so that animals may eat and plants may reproduce and grow. It is possible to keep a balance between the run-off and absorption of water. It is possible, if we recognize

the inevitable behavior of soil and water, if we recognize the possibilities of land use, if we select our use wisely. We do not attempt to grow orange trees in the arctic zone. It is just as foolish to attempt to grow crops where grass should grow. One man, even one community cannot settle every problem of land use, but many communities, many individuals, can.

Colorado, sitting astride the continent, sends its waters to the east, north, south, and west, holds in its mountains great wealth of minerals, of lumber; holds in its plains and plateaus and valleys, the possibilities of the fruits of the earth, the bread and meat and wine of man's existence. Its problems are inescapably part of the nation, part of the many states, part of the world. The problem of other states, the nation, and the world act and react on it.

We are suffering disasters from the misuse of land. We can learn much about its logical use by its natural flora and fauna, its climate, its soils, its available moisture. Each individual has a responsibility, but the individual cannot solve the great interacting problems of land, of water, of man. The county, the city, the state, the nation must all play their parts. We cannot go back, we cannot live alone, we know that we must solve certain problems involving distribution of the earth's products among men.

We don't know all the answers, but we are beginning to consider and to act.[10]

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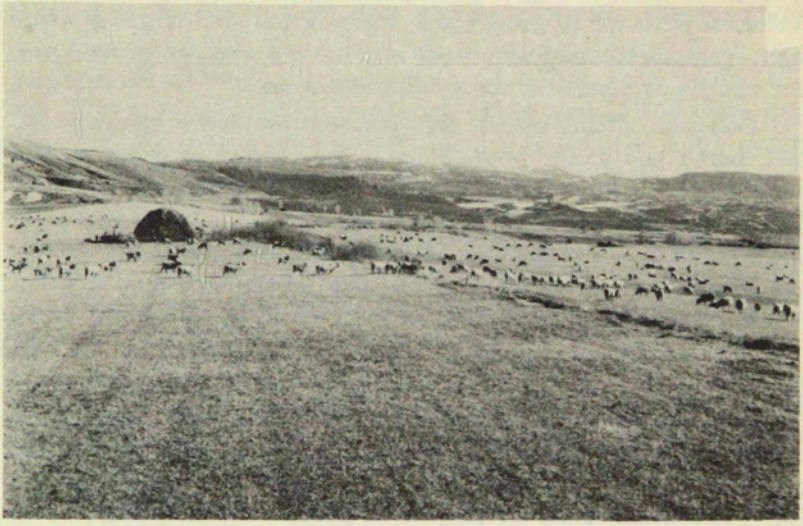
[10]Julia B. Tappan and Janet Kromer.

And Today



CARL HOLZMAN

WESTERN COLORADO.

B. C. McLEAN

EASTERN COLORADO.

The Land and Its Continued Usefulness

Against the wooded hill it stands,
Ghosts of a dead home staring through
Its broken lights on wasted lands
Where old-time harvest grew.
—John Greenleaf Whittier

Colorado too has wasted lands and dead homes, with all the implications of desolation and grief.

The land problem with its human problem is one of the most serious and demanding facing the citizens of the whole United States. No one person can hope to meet it, nor one county, nor one state. For rivers and floods know no political boundaries, nor wind and dust, nor the marts and activities of man.

There is no panacea for the condition, no one procedure which will solve the problems.

The needs of the land are definite and inescapable. The needs of man are definite and inescapable. Sometimes they conflict.

It would not be too difficult to cure the land. Slopes could be returned to trees or forests, blowing areas to grass and close growing vegetation, the early haunts of wildlife to their use.

But what of man? He must cut forests for his needs, must plant and plow and harvest his food, must harness water power for his great metropolises. He must earn money to buy those things he cannot himself produce. Above all he must eat.

Perhaps the land which he owns or uses to produce food or income is not fit for cultivation. It will blow or gully and ultimately be destroyed. Is he to starve? Or is he to destroy his land?

Some balance must be found between the needs of man and the needs of the land. Fortunately there is still enough good land to support our people with a high standard of living, *if* it is properly used, *if* its fruits are distributed.

It is a gargantuan task and takes the understanding, the thinking, the acting of all of us. We stand or fall together. All men depend on natural resources, all men are responsible for their use, their distribution, the conservation for the benefit of all men today and tomorrow.

Preceding chapters have presented (1) a rapid survey of Colorado's land resources; (2) behavior of soil and water, the needs of the land; (3) a history of land use with some of the consequences of misuse. The following chapter will describe some regional land conditions and general principles of land management and land practices.

But this is only part of the picture. Each one of us should know his own community, his state, and his nation, should be familiar with the many groups which have worked and are working on this great land problem.

Fact Finding

The first step in meeting a problem is to know the facts. Let us know the facts of our available resources, their use, and the results of their misuse in physical terms of lost soil, lost vegetation, flood, dust storm—and in human terms of unemployment, migration, tax delinquency, et cetera. Let us be familiar with the facts that have been gathered so laboriously for the whole nation by government agencies, by states, universities, individuals. Let us find out for ourselves where we stand.

Planning

The second step is planning. Let us therefore become familiar with the planning agencies of the federal government, states, and counties. *Let us remember that successful planning is not done from an armchair, but includes the individual who is concerned on the individual farm or ranch.* Unit farm planning, county plan-

ning, zoning, soil conservation and grazing districts, state planning, and federal planning are underway.

Work Programs

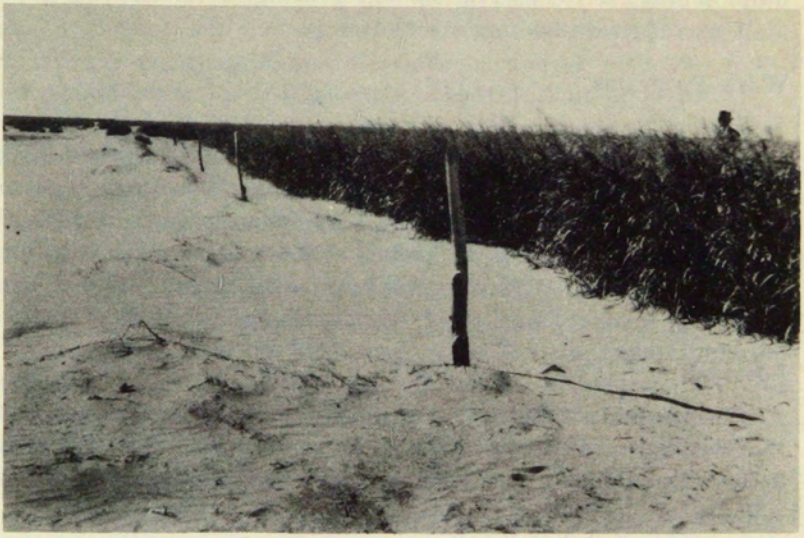
Let us become familiar with the programs of land use that are functioning, all the *work* agencies that are carrying on programs of flood control, water utilization, land utilization, forest control, grazing control, soil conservation. Let us become familiar with the programs and accomplishments of those organizations dealing with the purchase of submarginal land, loans to land users, efforts to combat tenancy, marketing, distribution of products.

Research

Let us realize that we have not the answers to all questions, that research and experimentation are necessary. Let us therefore become intelligently aware of the research organizations of our country.

Education

We cannot expect to become experts in all these fields, but as citizens we should know what is necessary, what is going on, what results have been accomplished, what we may hope for. We should be able to translate into terms of use for our pupils, for our communities, the knowledge we have, so that we may take our place in making the land continually useful.



B. C. McLEAN

A YEAR BEFORE THESE TWO FIELDS LOOKED ALIKE.

Working Out a Solution

In presenting what might be done about adjusting our use of the land, there is often a tendency to over-simplify the problem, presenting perhaps one phase and leaving out the many interrelated and overlapping factors, or to give a too detailed presentation which is confusing. There are hundreds of bulletins and books that describe in detail, conditions, programs, results. One short life time is scarcely long enough to master all phases. But it is not necessary nor desirable to become experts in all fields. If principles are known, if sources of information are available, and if we have enough knowledge to make clear and intelligent judgment of the facts before us, we can take our places as well-informed, open-minded citizens.

It would be possible to describe many land areas, telling what has happened, what is being done, and what can be done. Just as individuals are diagnosed as individuals when ill, and specific remedies and treatment recommended, so specific land areas must be diagnosed and specific treatments recommended. With land as with people, there are danger signals, general *symptoms* that show all is not well, that may be recognized by expert and layman alike. Fever, pain, eruptions, cough, extreme weariness, in an

individual are symptoms of some ailment. For the land there are *symptoms* which are evidence of land ailment: rapid loss of soil by wind or water; formation of gullies; increasing number of floods; severe silting of river beds and reservoirs; decreasing fertility of land; increasing severity and number of dust storms.

It is advisable therefore to make only a very broad diagnosis of Colorado's land problem, which is tied up with the needs of its population and the population of the whole country. It is advisable also to give only broad principles of planning and proper land use, and to describe briefly organizations which are assisting in specific programs. Communities can and are diagnosing their own situations; are seeking advice, planning, and by utilizing available assistance, are effecting their own treatments and assisting their own populations.

The following presentation of the problem and its solution is given in the form of questions, visual evidence and discussion:

Is the use of Colorado's land resources so well adjusted to the needs of the people and to the needs of the land that the mountains, plateaus, plains, rivers, forests, grasslands, farm lands may be used to bring forth abundantly for all men today and tomorrow?

HAS COLORADO A LAND PROBLEM?

A MIGRANT FAMILY.

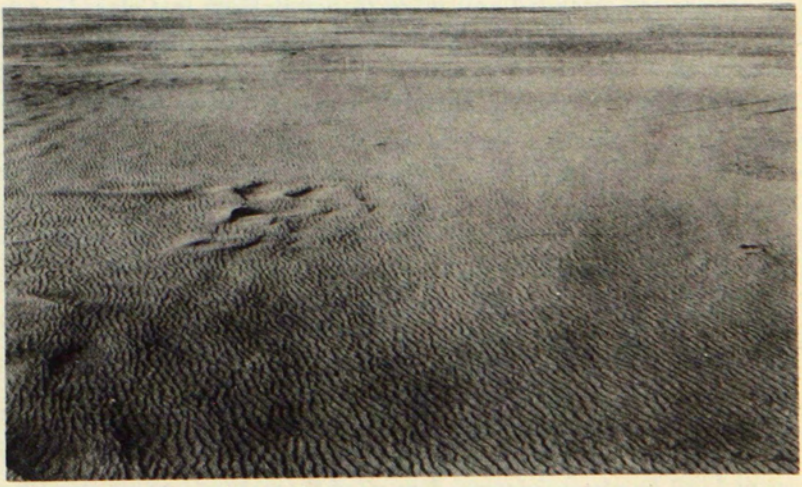
B. C. McLEAN

AN ABANDONED FARM. WHAT OF THE PEOPLE?

THOMAS G. MEIER

A BLACK-OUT.

FLOOD DAMAGE, IN COLORADO, 1935.



B. C. McLEAN

ABANDONED LAND.

E. S. SHIPP

DEVASTATED FOREST.

There are stranded and migrant populations in Colorado, unable to earn their living on the land; there is tax delinquent land, abandoned land; there is severe erosion; there are floods, dust storms, silted reservoirs, depleted ranges, burned and cut-over forests.

What are the principal physical evidences of maladjusted land use in Colorado?

As western and southern slopes of the Rockies differ markedly from the eastern plains area the question is discussed by sections.

Plains Area

In the plains wind erosion is severe. At its worst, soil is on the move, covering fences and roads, smothering vegetation. Much land has been abandoned, blowing fields jeopardize neighboring crops, endanger valuable irrigated land. Much of the range land has been over-used or used to such an extent that the vegetation is gone in some places, reduced in many places. Less spectacular evidences of water erosion are present in sheet erosion and gullies on farm and range land.

In the Foothills

In the foothills at the base of the Rockies water erosion is severe, wind erosion is prevalent. Torrential rains are common in this area and in adjacent mountains. Violent destructive floods have destroyed property and lives.

On the western and southern slopes of the Rockies and the plateaus of western Colorado most of the land is used for grazing. Here water erosion is the most striking evidence of maladjusted use, with sheet erosion, gullies, floods, silting of reservoirs, cutting of stream banks, destruction of valuable irrigated lands, depletion of the ranges.

Haven't floods, dust storms, gullies always occurred in Colorado? What has man's use to do with them?

Floods have always occurred. Certain combinations of circumstances cause floods. A torrential downpour or cloud burst comes so rapidly that the water cannot all be absorbed even by well-grassed or covered earth. Stream channels are filled rapidly and water over-flows. In the mountains when the snow is melting rapidly, when the soil is saturated with moisture, long continued and heavy rains cause rapid run-off and floods. *But* in late years floods are more frequent and more destructive. Gullies are forming and going deeper. When man cuts and burns the trees on the watershed, when he overgrazes the grass and shrubs, he increases and adds to the rapidity with which water flows. He adds to the destructive power of water.

In the Plains

Soil has always been moved on bare ground, around water holes and in dry washes, on sandy, unvegetated dunes. During years of drought some plants have always died. *But* over large areas the close roots and humus remained, the grass came up again; there was comparatively little movement of soil until man came with his animals and his plows to the Great Plains.

Men of the plains farmed in ways that were not in harmony with the climate, the lay of the land, and the make-up of the soil. The native grass cover was destroyed with great rapidity. Thousands of acres were plowed for farming. The loss of binding roots and spongy vegetable matter left the soil in a condition to blow. Wind velocity is high in the plains. Periods of low rainfall are frequent. Without cover, moisture is rapidly lost. Man cannot affect the climate, the wind, or the rain. He cannot lay down new soils; he *can*, however, farm only those areas suitable to

farming. He can conserve much of the moisture that falls. He can to a certain extent stop the shifting of soils. He can recover the land.

Western Colorado

Water has always run swiftly off the steep slopes of the mountains and has taken soil with it. It has cut the canyons and formed the alluvial valleys. Trees have been burned by lightning during countless ages. During periods of low rainfall plants have died. Heavy runoff has caused soil erosion and gullies. Silt has been deposited in stream beds. *But* on the whole this process was slow, and trees and grass came back. Soil was formed as rapidly as it was destroyed. Gullies filled in. Man has speeded this process of destruction. He has cut and burned the trees faster than they are replaced. He has grazed the grass and shrubs faster than any can grow again. He has plowed up and down slopes. He has speeded the waters' downward rush, has increased the quantity that runs over the ground.

ACCELERATED EROSION PATTERN

Land Use—Watershed Units

Forest
Fires
Poor forest management

Range
Poor range management
Overstocking
Improper road location and construction

Dry Farms
Cultivation of submarginal land and cultivation up and down slopes
Single crop farming

Irrigated Farms
Irrigation and cultivation down steep slopes
Bad Irrigation practices
Too much water
No care for waste water

Loss of protective vegetative cover
Increased intensity and concentration of run-off
Less penetration
Loss of ground water storage
Loss of productive top soil
Gully erosion
Wind erosion—Dust storms

Destruction of forest with loss in land value

Destruction of range with loss to livestock industry
Creation of low value land

Loss of soil and fertility
Development of submarginal land

Loss of soil and fertility
Development of submarginal land

Increased silt load in streams
Sedimentation

Infertile overwash
Bank cutting

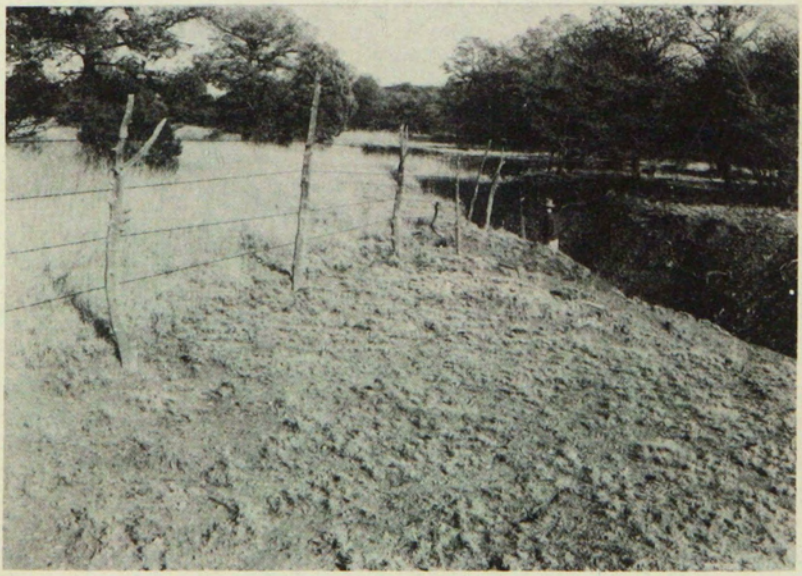
Silting of storage reservoirs
Loss of water
Abandonment of formerly irrigated land
Depopulation of area

Loss in depth and discharge capacity of streams
Increased frequency of floods

EVIDENCES OF IMPROPER LAND USE

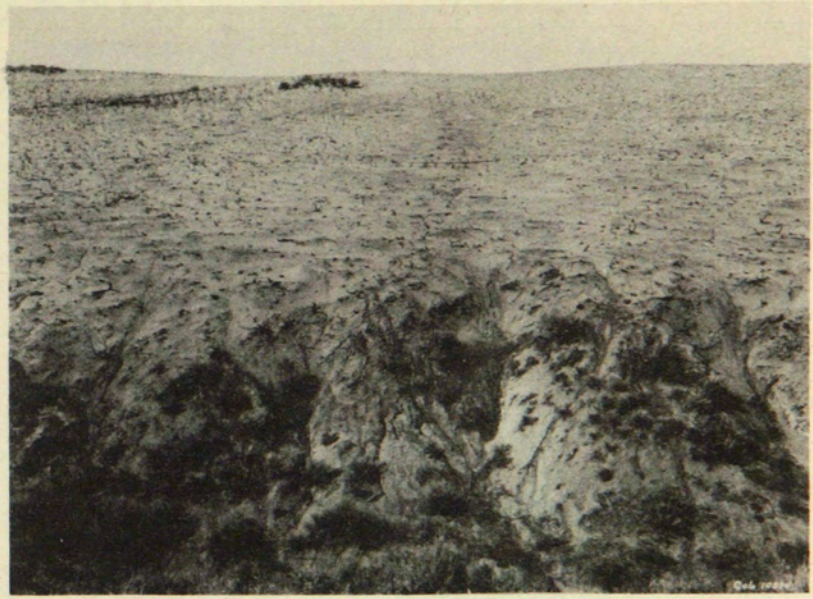
B. BRIXNER

FOREST FIRE.



CARL HOLZMAN

CONTRAST IN FOREST—CONTROLLED GRAZING INSIDE FENCE, NATIONAL FOREST, OVERGRAZING OUTSIDE FENCE.



B. BRIXNER

BURNED SAGE LAND. GULLIES ARE STARTING.

CARL HOLZMAN

OVER-CONCENTRATION OF STOCK. TOO MANY HOOFS, TOO MANY MOUTHS DESTROY VEGETATION.

WILLIAM G. PROPER

OVERGRAZED RANGE IN WOODLAND. NOTE GOATS' LINE ON TREES, NO YOUNG GROWTH, GULLIES BEGINNING.

B. BRIXNER

RANGE LAND DEPLETED. HUNGRY ANIMALS.

B. C. McLEAN

OVERUSED RANGE. A PREY TO WIND.

CARL HOLZMAN

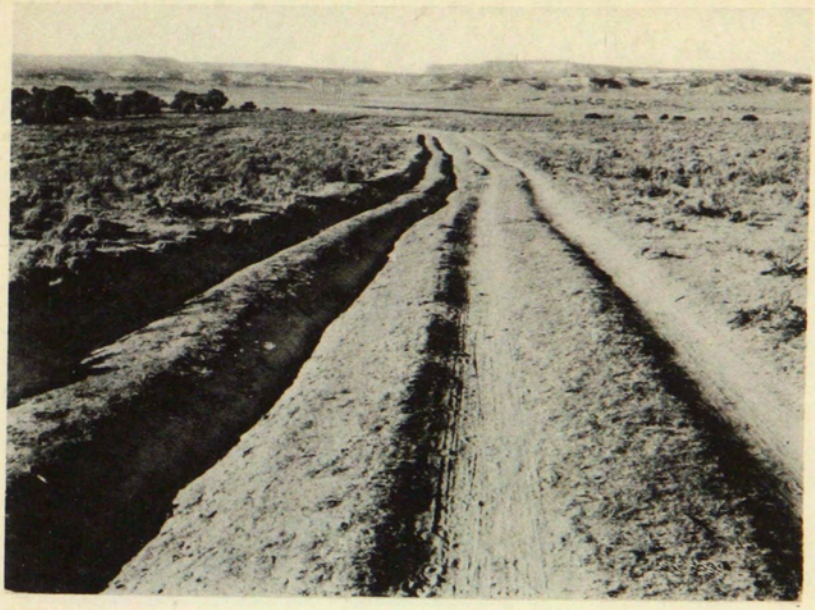
FARM PLOWED UP AND DOWN THE SLOPE; FURROWS BECOME GUTTERS.

CARL HOLZMAN

WHEN TOO STEEP A SLOPE IS PLOWED, GUTTERS BECOME GULLIES.

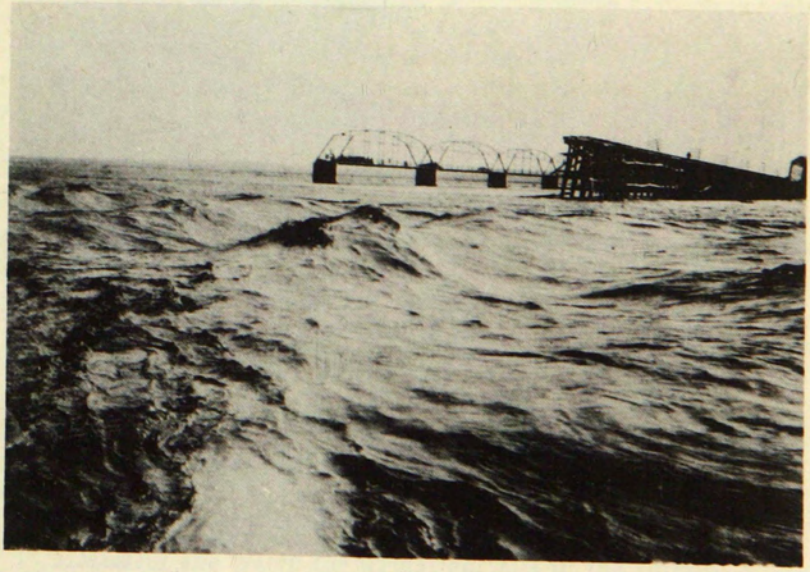
B. BRIXNER

IRRIGATED FARMS. IMPROPER DISPOSAL OF WASTE WATER. LAND CAVE IN, ACCELERATED BY TYPE OF SOIL.



E. R. WELLINGTON

IMPROPERLY BUILT ROADS. RUTS MAKE A RUNWAY FOR WATER.



G. A. ADDISON

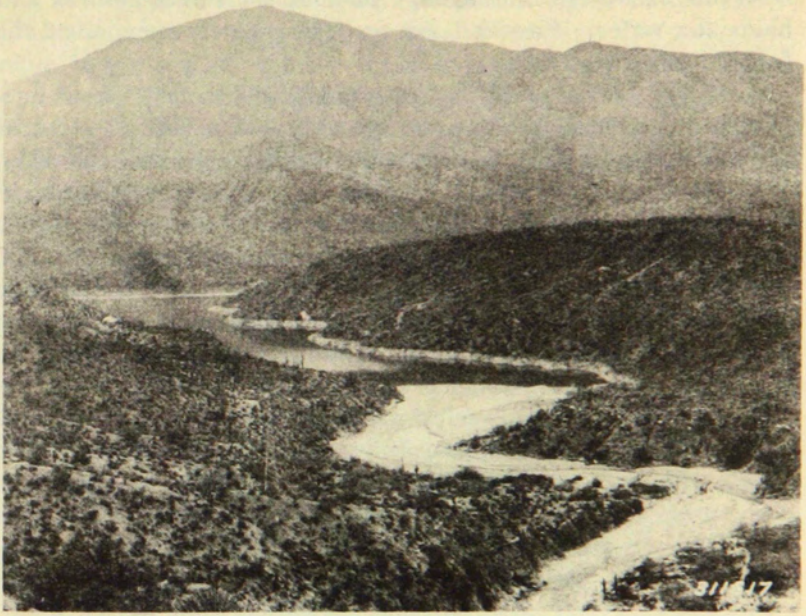
INCREASED RUNOFF.

B. BRIXNER

LOSS OF VALUABLE FARM LAND. ROAD ENDANGERED. RESULTS IN INCREASED TAXES FOR MAINTENANCE.

E. L. CRANDALL

STONES AND SILT COVER A CULTIVATED FIELD AFTER THE FLOOD.



F. L. KIRBY

STORAGE RESERVOIR WITH SILT DEPOSIT, RESULTING IN DECREASED STORAGE CAPACITY.

Does man know the principles of good land use for each type of land?

Man knows a great deal more than he practices. He is constantly trying to find out more. He is trying out principles in many places and is learning from his successes and failures.

The principles of forest management and use, range management and use, farm management and use, are largely a matter of common sense.

Watershed Planning and Use

The first principle in common sense usage of an area is to consider how the use of one type of land influences another. Any measure taken in the lowlands will be inadequate if the forest and grassland above is destroyed so that water rushes onto the land, and soil is dumped on fields, in stream channels, on irrigated land.

Most of the water for irrigation falls in the form of winter snows in the mountains. Some of it lies above timber line, gathering in gulches and draws, melting in the spring.

The forest is the first line of defense. It is the great natural reservoir of water. The spongy floor of the forest absorbs and holds the water. Fire and axe are the greatest enemies of the forest.

Of the total area of the state (66,000,000 acres), about one-fifth is in National Forests and an additional 3,956,000 acres of forest land are in state, county, municipal, and private ownership.

Wise forest management means harvesting the forest crop for man's use in such a way that the forest will continue to produce trees year by year, so that the forest floor remains intact.

Reforestation should be done on 250,000 acres of Colorado National Forests. Natural seeding is the least expensive and best method, but in some cut-over or burned areas it is necessary to plant trees. Proper grazing is good for most forests as it reduces fire hazards, and by lowering grass competition allows trees to seed and seedlings to grow. But not too much grazing! Too many animals feeding on the forest floor will quickly exhaust the grasses and small plants. Seedlings, twigs, and even the bark of the woody plants will go next.

Rangeland

Grasslands as well as forests must be restored and preserved, for grass slows down running water and keeps the soil from washing and blowing away. Grass—the basis of the great grazing industry—represents a capital asset. Proper grazing is good on a normal range. But overgrazing ultimately destroys the capital itself. Grass must be allowed to reproduce and remain healthy. Certain simple rules of management include:

(1) The number of stock must be adjusted to the capacity of the range, i.e. to the amount of edible vegetation which is normally produced.

(2) Stock must be properly distributed by means of adequate watering places, fences, etc.

(3) Rotation and deferred grazing, including seasonal use, are two basic facts underlying good range management and practices, i.e. changing of stock from one locality to another or keeping stock on specified areas until vegetation has a chance to reproduce. These practices permit plants to grow and seed and assure adequate reserve feed.

(4) The kind of stock should be adapted to the type of range.

The best feed, the fattest stock, and the least erosion are found on well-managed ranges.

Dry Farmland

In dry farming sections, severe erosion conditions throughout Colorado demand immediate remedial measures. The basic principle of protection by plant cover applies to cultivated fields as well as to forest and range lands. Loss of the original grass cover must be compensated by cropping practices that enable land to catch the water, resist runoff, and protect the soil against removal by wind and water.

Furrows should never be plowed up and down hill. Such furrows are gutters, carrying water swiftly away, and with it rich topsoil.

Contour furrows hugging the hills in rhythmical horizontal curves act as small dams, holding the water and storing it in the soil. Plains soils are able to hold three times the average annual effective rainfall.

The practice of strip cropping alternates clean-tilled crops such as beans, potatoes, with close growing or row crops, such as sorghums, grains, and corn. Soil-laden water from a clean-tilled strip is caught and filtered by the close-growing strip below. Strips are rotated from year to year to preserve fertility.

Strip cropping around the contours of the land protects gently sloping fields from erosion. On steeper slopes it may be combined with terraces. Height, width, and number of terraces are determined by slope, soil, and crop. Terraces resist the downhill rush of water. In Nebraska a level terrace, a half mile long, held 118,500 gallons of water after a single rain, or enough water to cover more than one-third of an acre of land at a depth of one foot.

A stubble from 8 to 12 inches high should be left wherever possible, to protect the land after the crop is harvested. If beans, potatoes, or some other crop that leaves little plant residue are being grown, strips of more fibrous-rooted crops should be alternated. Whether any one or any combination of the soil conservation practices are used will depend on conditions found in a particular area—slope, crops, soil, degree of erosion.

Irrigated Land

Farmers in the irrigated valleys must guard against wastage of water through poor irrigation practices, and must plan for proper drainage. They must take care not to lower the water-table in areas where wells are used. However, unless their problems are also solved in the grass and forest lands above them, proper irrigation practices will not suffice. In some of Colorado's most fertile areas, there may be little effect of erosion, but floods

CARL HOLZMAN

THE MOUNTAINS ABOVE, THE VALLEY BELOW.

EVAN L. FLORY

A STEADY SUPPLY OF CLEAR WATER IS INSURED BY FOREST COVER.

ANNE RAYMOND

LAKE MEADE BACK OF BOULDER DAM FED BY THE COLORADO RIVER, WHICH ORIGINATES IN THE HIGH MOUNTAIN SECTION. COLORADO HAS 16% OF THE DRAINAGE AREA ABOVE LAKE MEADE BUT PRODUCES 35% OF THE WATER.

B. BRIXNER

TREES MARKED FOR CUTTING IN WOODLOT. PROPER CUTTING INSURES SUSTAINED YIELD.

B. BRIXNER

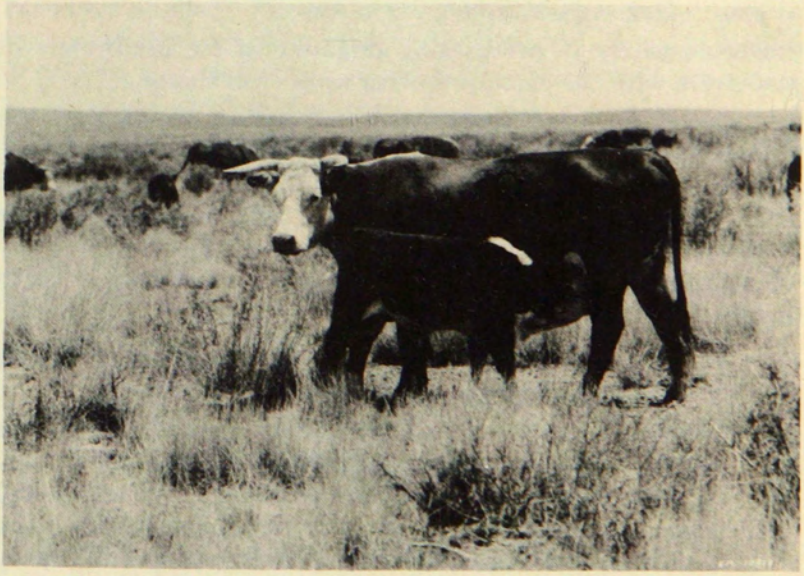
PROPER GRAZING RESULTS IN PROTECTIVE GRASS COVER IN OAK BRUSH SECTION.

CALVIN F. FINN

SALT LICK ON THIS AREA PLACED AT DISTANCE FROM WATER HOLE ASSISTS DISTRIBUTION OF STOCK.

E. R. WELLINGTON

NOTE CONTRAST. RESTRICTED GRAZING INSIDE FENCE; UNRESTRICTED OUTSIDE FENCE.



B. BRIXNER

FAT CATTLE. THE CLASS OF STOCK IS SELECTED WHICH IS BEST SUITED TO THE KIND OF RANGE.

L. D. LOVE

GOOD RANGE PRODUCES FAT SHEEP, MORE INCOME.

traceable partly to overgrazing originate in the headwaters of the rivers with the rapidly melting snow in the spring.

Range and forest management will protect the valleys from augmented flood waters and debris washed down from above. Control in the upper reaches will keep silt from being deposited below, filling reservoirs, raising stream beds, and water-logging valuable farm land. On the Great Plains, wind control in blow-areas will protect nearby irrigated lands from burial in drifting soil.

Will the principles of forest, range and farm management, if applied, take care of the present situation?

Not always. In some cases conditions demand that proper land use be supplemented by structural treatment—dikes, gully retards, water spreading devices such as diversion structures and percolators, sufficient number of stock tanks, soil saving dams, stream bank erosion control devices, including jetties and revetments.

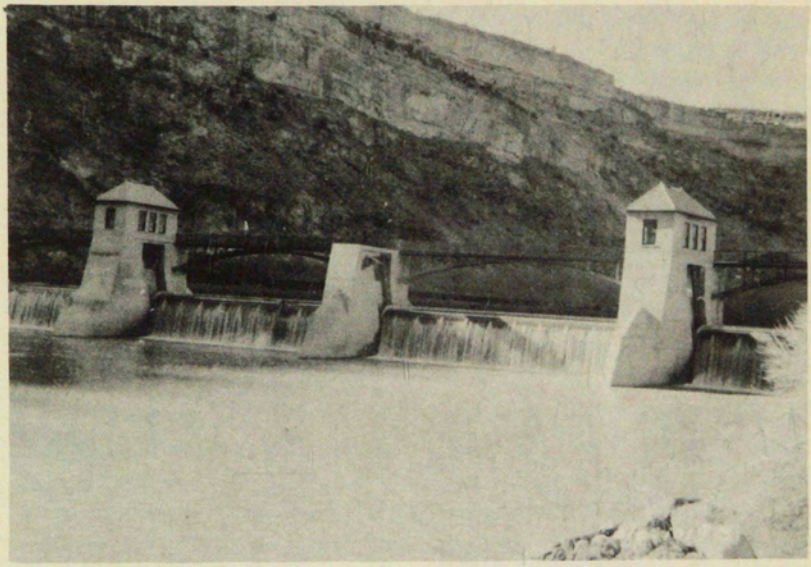
In general structural devices are used only on valuable land, or in case of emergencies such as severe dust storms. Often the

value of adjacent land which must be protected warrants the expense involved.

If a severely burned or cut-over forest, woodland, or grassland is important in the control of floods, planting and artificial seeding may be done. There may be reservoirs or a series of reservoirs to protect city property. In irrigated land reservoirs are built for the storage of water, i.e., the six mile Gunnison tunnel is one of more than six major engineering devices in the Uncompahgre irrigation project. Diversion of water from the western slope, across the Rocky Mountains is under way. Water from the western slope is thus to be used to irrigate valuable land on the eastern slope.

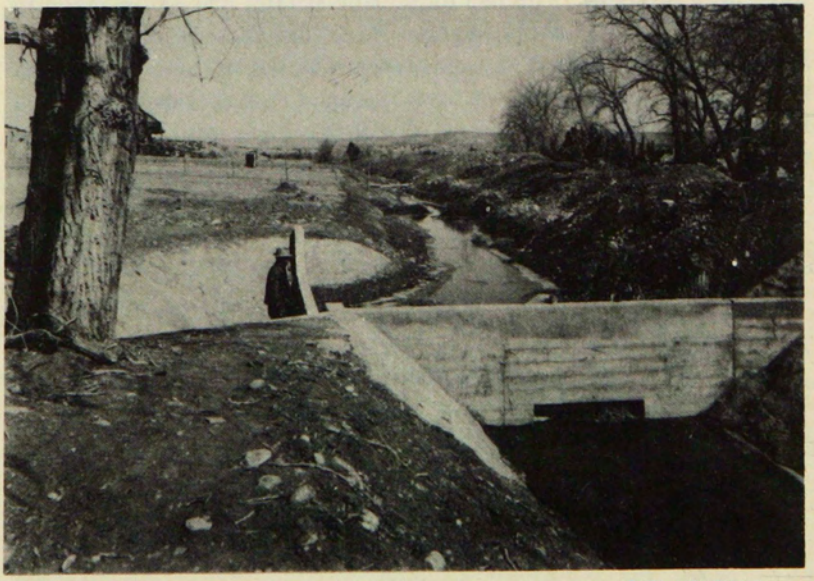
The specific problems of each area require different combinations of the various treatments. A cure for one area may fail disastrously in another.

No one yet knows all the answers to the problem of soil conservation. Study is still being made of types of terraces, widths for strip cropping, methods of pasture furrowing, successful means of re-establishing grass on retired land, more efficient structural devices. In general, however, certain principles have been worked out which are restoring vegetative cover where they have been applied. Further important studies are being made in the economic problems involved. For often the economic factors in an area may be and are an obstacle to better land use. Conservation is a problem of markets, prices, tax structures, cropping habits, tenancy, as well as one of soil types, degree of slope, and tillage systems.



E. D. EATON

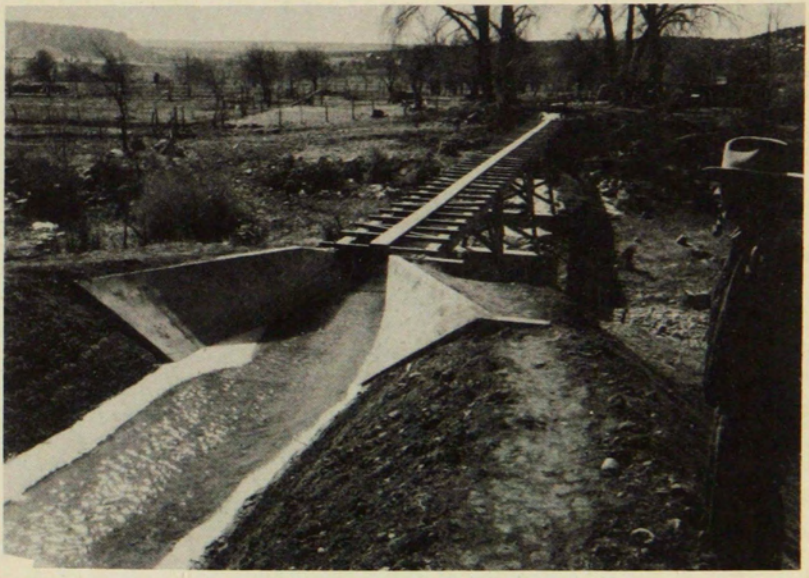
STORAGE AND DIVERSION OF WATER FOR IRRIGATION.



CARL HOLZMAN

GATE REGULATES FLOW OF WATER IN DITCH. OLD DITCH USED FOR WASTE-WAY FOR FLOOD WATERS.

STRUCTURES FOR IRRIGATION



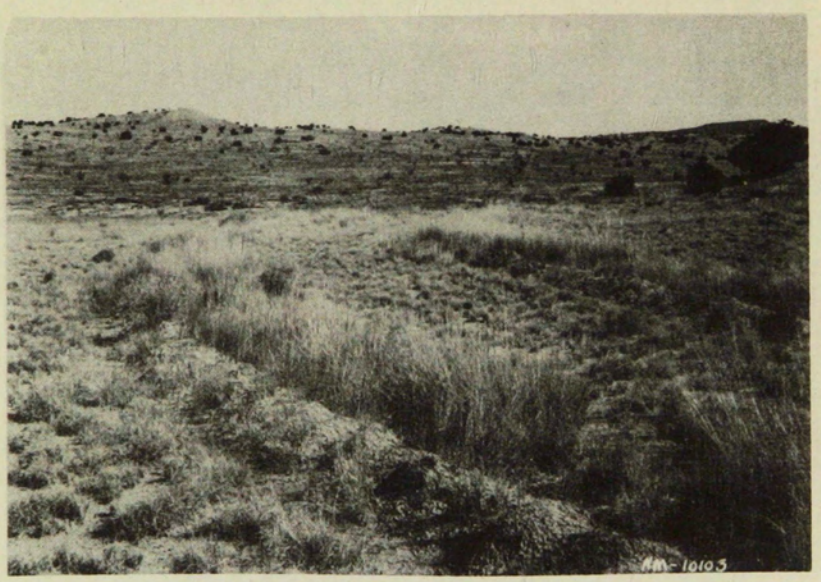
CARL HOLZMAN

FLUME FOR IRRIGATION WATER.

PROTECTIVE STRUCTURES ON RANGE

B. C. McLEAN

CONTOUR FURROWS CATCH AND HOLD MOISTURE.



B. BRIXNER

CONTOUR FURROWS. ADDED MOISTURE RESULTS IN INCREASED GRASS GROWTH.

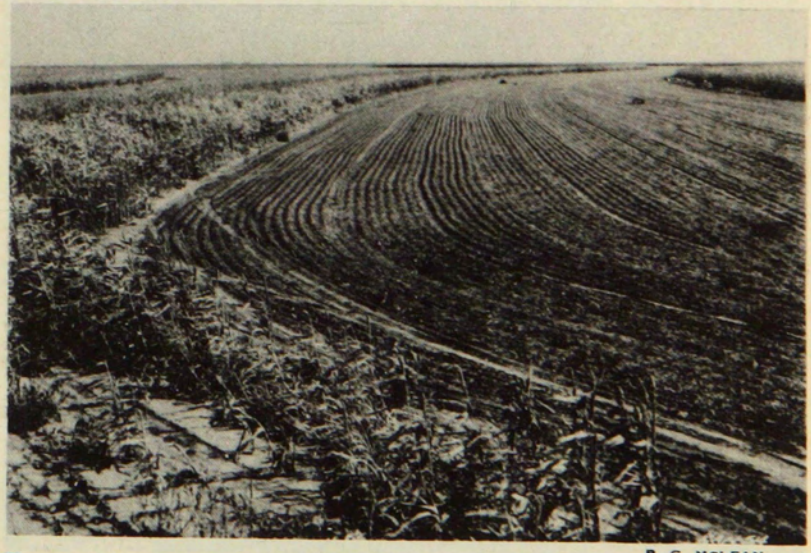
E. R. WELLINGTON

SUFFICIENT AND WELLPLACED STOCK WATERING PLACES ARE NECESSARY FOR GOOD RANGE MANAGEMENT.

EVAN L. FLORY

SEEDED GRAZING LAND AT HIGH ELEVATION HELPS PROTECT WATERSHED.

PRACTICES ON CULTIVATED LAND



B. C. MCLEAN

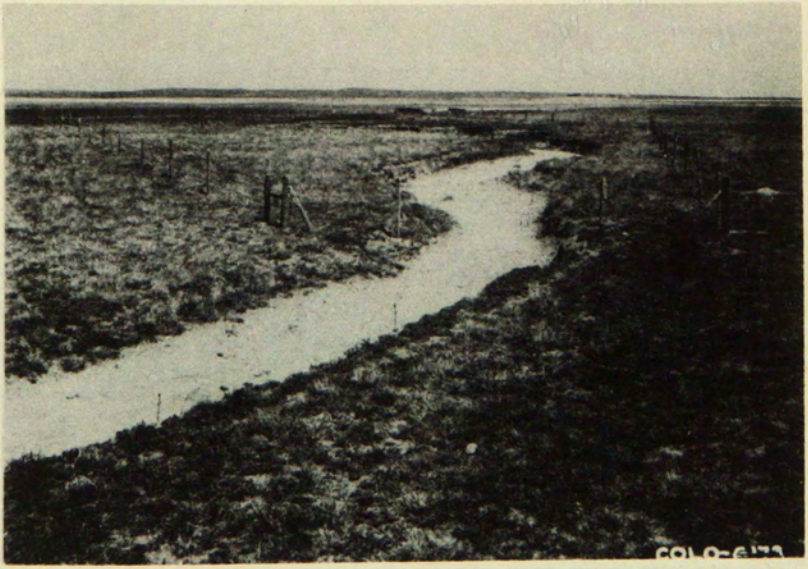
TERRACED FIELDS ON GOOD FARM LAND, STRIP-CROPPED TO WHEAT AND SORGHUM.

CULTIVATED LAND

B. C. McLEAN

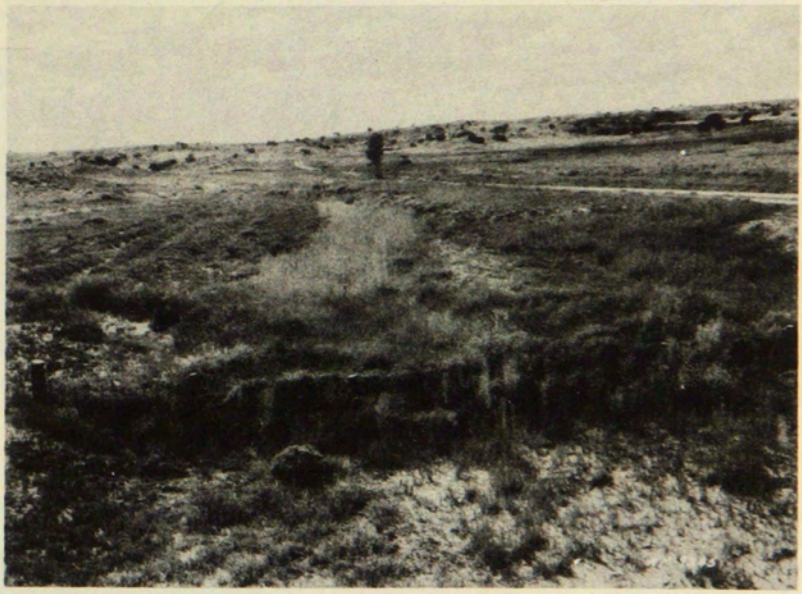
TERRACES ON VALUABLE CROP LAND HOLD WATER.

SUPPLEMENTARY STRUCTURES



A. D. HARVEY

HEAD OF GULLY IS FENCED TO KEEP OUT LIVESTOCK. DITCH ABOVE HEAD OF GULLY DIVERTS WATER FROM GULLY.



E. R. WELLINGTON

INEXPENSIVE WIRE GULLY STRUCTURE CATCHES SILT, HASTENS NATURAL HEALING.

GULLY HEALING

RICHARD W. HUFNAGLE

APRIL, 1936

LIVESTOCK EXCLUDED BY FENCE, SOME PLANTING, HASTENS NATURAL HEALING

JAMES N. SLACK

OCTOBER, 1937

STREAM CHANNEL STABILIZATION

B. BRIXNER

BANK STRUCTURE PROTECTS CULTIVATED LAND.

B. BRIXNER

CCC BOYS WORK ON REVETMENT TO PROTECT CITY PROPERTY.

B. BRIXNER

BANK STRUCTURE (REVETMENT) AND WILLOW PLANTING, PREVENT CUTTING OF ADJOINING LAND.

B. HODGIN

ROADSIDE IMPROVEMENT AND BANK PROTECTION.

What is Land Planning?

In the words of Mr. Ruben L. Parsons, of State Teachers College, Troy Alabama:*

"In a broader interpretation, land planning includes the whole land surface; its occupance—industrial, commercial, or agrarian; its cover—grass, trees, houses, or factories. It includes consideration of surface space occupied by structures for extraction of materials from below the surface, such as mine tipples, dumps, and other items that complicate the surface arrangement. In fact, *land planning, by directing man's energies toward efficient utilization and intelligent development of physical, economic, and cultural attributes of place, designs the adaptation of human occupance to the natural environment.*

"Land planning is important, because it concerns our greatest natural resource—our primary source of wealth—*the land.* Land planning is basic to other planning, just as primary production is basic to industry and commerce.

"During our brief national history, much of our vast land resources have been dissipated. Soil has been destroyed and human energy wasted in the cultivation of excessive areas to produce supplies more abundant than we have been able to distribute. Many land areas bear witness to the sequence of clearing, exploitation, erosion, and final abandonment. We have been made increasingly aware that social stewardship of our land must be accomplished. Such stewardship is what land planning strives to attain.

"To assign every unit of land to the use that will best serve human needs; to apportion the land areas possessing productivity according to their capacity to yield; to remedy maladjustments between land economy and land quality; to conserve human energies wastefully expended; to curb soil destruction incidental to land abuse; to preserve land resources as inexhaustible wealth without curtailing economical production:—these are among the ultimate objectives of land planning.

"Subordination of private ownership to collective enterprise; gravitation of people towards areas of superior quality; conservation of areas liable to destruction; and rehabilitation, where possible, of those already damaged:—these are immediate accomplishments sought by rural zoning and by other means.

"Such allocation of land to agriculture, forestry, grazing,

*Ruben L. Parsons, "The Responsibility of Geographers in Land Planning", *Education*, December, 1939.

industry, commerce, residence, and recreation as will most efficiently serve its occupants, is the ideal toward which land planning sets its course. In substantial measure, the future of our communities, our state, and our nation, depends upon the appropriate utilization of our land resources."

Have land management practices been applied successfully in Colorado?

Some farmers, some ranchmen have applied farm management and range management successfully and have kept their land in constant production.

The State College of Agriculture, the Extension Service, and Experiment Stations have been working with farmers and rangemen for many years for better agricultural methods.

The State Engineer's Office is responsible for the administration of all storage and direct-flow irrigation within the State, and as such, has much information available.

The Water Conservation Board is primarily concerned with the study and collection of data relative to Colorado's water resources and is in a position to make constructive regulations as to the beneficial use of those resources.

The State Planning Commission is involved in planning relating to the use of basic resources.

The State Land Board is constitutionally responsible for the administration and use of state-owned lands.

Counties are rapidly acquiring administration of tax delinquent lands and the possibility may arise whereby county governments will play an important part in land usage.

Soil Erosion Districts, consisting of groups of farmers and other land users, have been formed and are working with various agencies to make and put into practice a plan of use for all land in the district.

Community, county, and state planning committees are working out programs for their units.

The Bureau of Agricultural Economics is assisting county and community planning groups in the collection of economic data and information.

The Bureau of Reclamation is charged with the responsibility of the development of large irrigation, storage, and supply systems.

The Indian Service is responsible for the administration and use of Indian lands within the state.

The National Park Service administers the recreation areas within the boundaries of the national parks, and as such, occupies a very important position in watershed protection.

The Farm Credit Administration is in a position to advance Federal credit facilities to stockmen and farmers who can meet the requirements of the institution.

The United States Forest Service has regulated lumber cutting, fires, and grazing in forest preserves.

The United States Grazing Service is administering grazing districts and is regulating grazing practices on the Public Domain.

The United States Soil Conservation Service, in cooperation with farmers and stockmen, has made successful demonstrations of good land use on watersheds, farm and range land, has carried on an erosion control program on many types of public lands. Their program includes the purchase of and adjustment of use on certain submarginal lands, the development of farm woodlands and water facilities, and the treatment of land for flood control. An important part of the Soil Conservation Service program is active participation in the work of soil conservation districts.

The Farm Security Administration enables tenants to become farm owners through long-term loans; conducts a rural rehabilitation program of conditional loans to needy farmers, equitable farm debt adjustment, and guidance in farming methods; completes and administers homestead projects; provides emergency rural relief.

The Agricultural Adjustment Administration seeks the double objective of conserving the soil and adjusting our crop production, providing an ever-normal granary through commodity loans and marketing quotas; makes price adjustment payments when authorized.

Are there any examples of community land use planning in Colorado?

Community planning is related to state and federal planning and includes not only the local people, but the Colorado State College of Agriculture and Mechanic Arts, the Extension Service, and the many other Services of the United States Department of Agriculture. The Extension Service, with its state organization and county agents, plays a key role.

History of Development

In the summer of 1938 a statement dealing with the development of an organization in each state for effective agricultural program building and land use planning was developed by the Department of Agriculture. The Colorado Extension Service had previously encouraged county planning activities. It promptly acted to develop an organization throughout the state for county land use planning, and in September, 1938, the State Agricultural Clearing Committee approved the plan which the Extension Service submitted to them. This plan was designed to enable farmers to present their local problems as they saw them and to express themselves as to how these problems could be most effectively dealt with.

At the outset, the fact was recognized that any agricultural program for the State must have its beginning in the rural community if finally there was to be evolved a sound land use program, representative of the ideas of the land users. Subsequently the County Extension Agents throughout the state presented to their local people a plan for organization of land use planning committees and for agricultural program building, and arranged for meetings to be attended by the people of the communities to present this plan and to discuss problems and outline the type of community organization best suited to develop a practical community plan.

Following this series of preliminary educational meetings, the communities then proceeded to elect a local committee of representative men and women to serve as a community committee. Representatives of federal and state agencies who were in a position to contribute to the work of the committee were invited to assist as advisory committee members, chosen on the basis of their ability to represent non-members, for it is important that these members be truly representative as spokesmen for the group.

Formation of Community Committee

This committee does not do all the planning, but serves rather as a committee to give leadership and direction to the program of land use planning in the community. Subcommittees are set up to work on specific problems such as land use, soil conservation, taxation, community life, et cetera. These subcommittees may also carry on studies and stimulate interest throughout the community. They further determine projects which are to be studied or undertaken and which are to be submitted to the County Committee with recommendations that they be given attention by the committee or passed on by the State Committee.

The officers of the community committees compose the county committee which passes upon recommendations from

the community committees which are to be submitted to the State Agricultural Advisory Council. Thus each community seeks the solution of its particular problem in its own way and works toward a definite goal with the full support of the local people, and builds the foundation for successful county and state planning.

Their recommendations culminate in action when the State Committee transmits recommendations which have originated in the community to Federal or State action agencies which are able to effectuate an operation program for the benefit of the land user in the rural community.*

What are the major recommendations for conserving soil and water in plains, the mountains, the western slope of Colorado?

The Plains—According to Hugh Bennett in his Soil Conservation:

"Water, in a sense, is the beginning and the end of agriculture on the Plains. Plants cannot be grown without it, of course, and vegetation is needed to anchor Plains soil against wind. Cultivated soil, depleted of binding grass roots and spongy vegetable matter, without water is turned into a powdery substance susceptible to easy shifting by the wind. The plants of the Plains will not grow in shifting soil; shifting soil cannot be stopped in the Plains without plant coverage. Although rainfall is scant, usually there is enough to make a crop on the more favorable lands if none is wasted. Good land use, therefore, requires the retention of all possible rainfall on the land as the first step in protecting the soil from erosion or restoring it to use after erosion has started; and for this reason, conservation of rainfall is the first step toward the maintenance of a stable agriculture in the region.'"[1]

The National Resources Committee gives five types of measures for improvement of water supply in the Great Plains:

1. Small dams in certain areas devoted to grazing to make water available for stock on range lands that otherwise could not be grazed, or to reduce the distance which livestock must be trailed to water.
2. Springs improved, shallow wells dug, and deep wells drilled to supply water for livestock in favorable areas.
3. In grazing areas having adequate supplies of stock water, unappropriated water may be stored and used for the irrigation of forage crops, building up feed reserves for dry years.
4. Irrigate scattered tracts of dry farming areas from reservoirs or by pumping.

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*Stuart Moir, Assistant Regional Conservator, Soil Conservation Service, Region 8.

[1]Hugh Bennett, *Soil Conservation*, pp. 741-742.

"Emergency measures for controlling wind erosion on the Plains usually have been practiced *after* the soil begins to move . . . They consist principally of tillage operations which roughen the surface. . . ."[1]

"Permanent control of erosion in the Plains involves a combination of precautions that will prevent the soil from getting into a condition that favors erosion; or, if it is eroding, practices and measures that will restore soil stability must be installed. For the most part, such precautions and installations are less immediate in their effect, but far more lasting, than those of emergency tillage. . . . Specifically permanent control involves: (1) water conservation by detention, diversion and spreading structures, and contour cultivation of fields and contour furrowing of range land to promote continuity of vegetative cover; (2) the use of protective vegetated strips and borders of grass, crops, shrubs, or trees; (3) the adaptation of crops and cultural practices to varying topographic soil, moisture, and seasonal conditions; (4) the conservative utilization of increased organic residues produced by these measures; (5) the retirement of critically erodible areas to permanent vegetative protection; (6) a shift from extensive cash crop farming to (a) balanced types of livestock operation and farming or (b) livestock farming plus the growing of supplemental feed crops only; and (7) the proper distribution, rotation and deferment of grazing on range lands and adjustment of numbers to carrying capacity . . . Also, readjustments in the size of the farm unit will be necessary in many instances to establish an economically sound enterprise, especially where there is a shift from emphasis on crops to emphasis on livestock."[2]

Irrigated Lands

Several quotations follow:

National Resources Board

Crop agriculture of . . . Colorado . . . is usually considered in terms of irrigation. Colorado is second only to California in the extent of its irrigated areas. The eastern slope is deficient in water supply, while the western slope is definitely known to have a surplus of water, and whatever may be Colorado's final allotment of the waters of the Colorado River, a definite surplus can be considered as available for transmountain diversion to the eastern slope.

Colorado has always operated on the doctrine of prior appropriation and has never established a policy of arbitrarily setting a limit for the appropriation of the water of any one stream. This policy has developed senior rights that are reasonably sure of an irrigation supply for at least a portion of the irrigation seasons, whereas the junior rights in many cases go year after year without obtaining sufficient water.

[1] Hugh Bennett, *Soil Conservation*, p. 738.
[2] *Ibid.*, pp. 739-740.

The immediate concern of State officials is to conserve fully, by means of reservoir and ground water storage, all the waters now native to the eastern slope, and to import water from the western slope.

United States Department of Agriculture Farmers Bulletin 864, *Practical Information for Beginners in Irrigation.*

Experience throughout the arid region has demonstrated that the greatest danger to irrigated lands is lack of drainage. Water lost from canals or applied to crops raises the ground water, which brings with it the salts dissolved from the soil. Capillarity brings this water to the surface, where it evaporates, leaving the salts to accumulate until all vegetation is destroyed. The only insurance against this is proper drainage. The drainage conditions are therefore equally important with the water supply and should be looked into with as much care. When there is not good natural drainage, artificial drainage must be supplied.

The quantity of water to apply in one irrigation, the length of the interval between irrigations, and the total quantity used in any one season all depend on a large number of soil, crop, and climatic conditions. Few farmers possess the technical skill and equipment to determine unaided the quantity of water required per acre and the best methods to employ in applying it. Farmers needing such information should seek aid from the State Agricultural College, either through the County Agricultural Agent and Extension Service or the Experiment Station, or from the United States Department of Agriculture.

United States Department of Agriculture Miscellaneous Publication 338, *Soil Defense on Range and Farm Lands in the Southwest.*

Lacking sufficient rainfall to grow crops without supplemental water, except on a small acreage of the higher tablelands, Western Colorado can develop little agriculturally except along her streams. The life of the region literally flows in the rivers and streams that course through the valleys. Villages and towns are strung along the streams and rivers like beads on a string.

To the farmers of this area, her streams always have been her rain clouds.

State Plan for Land Use Planning, report of Colorado State College of Agriculture and Mechanical Arts and United States Department of Agriculture, cooperating.

Soil Productivity

The problem of organic matter depletion of soil is more acute in the irrigated areas than in the dry land farming areas of the State. The following is taken from Extension

Bulletin 356-A from material provided by T. G. Stewart, Extension Soil Conservationist:

"A 21-year experiment conducted at the Huntley, Montana, Experiment Station on Irrigated Land shows an average difference of three tons of sugar beets per acre in favor of pasturing alfalfa with hogs instead of harvesting it as hay. "During seventeen years on the irrigated experiment station at Belle Fourche, South Dakota, an average increase of three tons of sugar beets per acre in favor of pasturing three years of alfalfa with sheep was secured in comparison with harvesting the alfalfa as hay in 6-year rotations.

"In twenty-four years of experiments completed in 1934 at the Scottsbluff, Nebraska, irrigated station, a simple rotation of oats, sweet clover pastured and sugar beets two years, has averaged a net return per acre of $24.26, the second most profitable return from thirty-two cropping systems in the experiment.

"Farmers who continually raise and sell crops away from the farm will eventually become bankrupt because of the depletion of organic matter and fertilizing elements in the soil resulting in low yields . . .".

Development of Methods of Draining Irrigated Lands, by C. G. Elliott, Chief of Drainage Investigations, USDA, 1911.

The outstanding utilization of waters throughout the entire Colorado River Basin is and always will be for irrigation.

In the large reclamation projects of the Uncompahgre and Gunnison valleys in Colorado, drainage works of considerable extent have been necessary concomitants to irrigation. The difficulties to be met in draining lands in the Uncompahgre and Grand River Valleys in western Colorado are quite different and more serious than in many irrigated sections. The land is of a shale formation, which when wet becomes exceedingly soft, sometimes to a depth of 10 or 15 feet. The cultivated areas are frequently bordered on one or more sides by lands in which the shale is partially disintegrated and which convey the water from the higher irrigated land, or possibly from irrigating ditches, into the "soil blanket", where it fills up the land so completely as to make a permanent bog. As a preliminary to draining such land, soundings or borings are made to locate the position of the shale through which the water reaches the bog. Not infrequently it is entirely impracticable to place a drain through the wet part of the field because of its extremely soft and unstable condition. At least a part of the water must be intercepted and prevented from entering the field before complete drainage can be effected.

The difficulties of construction are often serious and perplexing. The sides of the trench must often be sheathed closely to prevent the earth from caving and filling the trench before the tiles or wooden boxes can be placed in position.

Western Slope Range Lands

"Accelerated erosion is a major problem over at least three-fourths of the range country. (Colorado River Basin Region.) Erosion by water is the principal form of soil stripping and the major cause of land depletion and siltation of reservoirs. Range depletion is both the cause and the result of erosion over a vast grazing area. Erosion and range depletion have a clear causative relation to accelerated floods, and all three are intimately associated with the impoverishment of occupants of the land . . .

"The Soil Conservation Service, the Forest Service, the Division of Grazing, the Bureau of Indian Affairs, the Agricultural Adjustment Administration, and other Federal agencies as well as state agencies, community organizations, and individuals are striving cooperatively to conserve the principal resources of the region—the land, water, and vegetation."[3]

"Watershed surveys, covering all phases of land use and condition and human need, provide an over-all watershed picture for these areas. This broad appraisal of conditions and needs is the basis for finding and selecting for immediate work the most critical erosion and silt-contributing areas within the watershed areas where erosion control is badly needed and which, in the light of the entire watershed picture, must come first in erosion-control operations. In this way, the lands throughout these large districts are treated as part of a unified plan for the whole instead of as separate units without relation to one another. Thus, farm and ranch, range land and irrigated land fall together into a living mosaic which forms the basis for the operations of the Service in the Colorado Basin area. . . .

"The key to control of erosion on the extensive range lands of the Colorado River Basin Region is proper range management."[4]

"Some of the most serious erosion of the entire Colorado River Basin region is encountered in the Plateau section. Sheet erosion is most serious, but gullying is destructive locally, particularly on the more productive alluvial and valley-fill lands. Over many large areas, gullying has become a characteristic feature of the valleys and basins. Most of them are of the straight-walled, undercutting type which branch and expand rapidly wherever the watersheds are overgrazed. Gullying, however, is not restricted to the valley lands; many overgrazed slopes have been scarred with short ravines, especially on the heavier shale-derived soils of high salinity. But sheet washing is the principal menace to the more sloping areas. It is taking place over the

[3] *Ibid.*, p. 781.
[4] *Ibid.*, p. 783.

greater part of the uplands, most seriously where the surface has been bared or nearly bared of vegetation. Because of the relatively larger area of sandy land, wind erosion is most serious in the southern sector."[5]

"From the standpoint of erosion control and water conservation, commercial production of small grain by dry farming should give way more to the growing of livestock feed. With respect to the range, such large acreages of cheap land are utilized that it is commonly felt that comparatively little expense is justified for conservation measures. The most economical procedure includes range improvement by proper stocking, better distribution of the animals, and adjustment of grazing to seasonal conditions, together with adequate stock-water development, water spreading, and conservation of rainfall by contouring in the more favorable areas.

"In cooperation with those using the range, the Division of Grazing, Department of the Interior, is undertaking here, as in many other parts of the Western range, to improve conditions through administrative grazing districts.

"A considerable part of the area—most of the rougher lands —consists of exposed geological material on which erosion has long been too active for the development of true soil.

"A very large part of the land of the Colorado Plateau is under public ownership or control, representing principally public domain, national forest, Indian reservations, and state lands. Privately owned lands consist chiefly of the large irrigated areas, "railroad" lands, and relatively small tracts of range. The Federal Government has made large investments in this region, as in the Indian reservations and Boulder Dam.

"For these and other reasons, responsibility for erosion control, conservation of water, and better land use is largely that of the Federal Government."[6]

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[5] *Ibid.*, p. 792.
[6] *Ibid.*, p. 795.

CONSERVATION PRACTICES ON THE PLAINS.

B. C. McLEAN

CONTOUR CULTIVATION HOLDS MOISTURE, INCREASES PROTECTION OF LAND, AND INCREASES PRODUCTION.

CONSERVATION PRACTICES ON THE WESTERN SLOPE.

B. BRIXNER

CONTOUR CULTIVATION. ROTATION OF CROPS—WHEAT FOLLOWED BY CLOVER, ALFALFA AND GRASS. (NOTE WIND BREAK OF TREES IN THE BACKGROUND.)

CONSERVATION PRACTICES—CULTIVATED LAND—THE PLAINS.

B. C. McLEAN

CONTOUR CULTIVATION CONSERVES MOISTURE.

B. C. McLEAN

SORGHUM STUBBLE HELPS HOLD SOIL FROM BLOWING DURING THE WINTER AND SPRING.

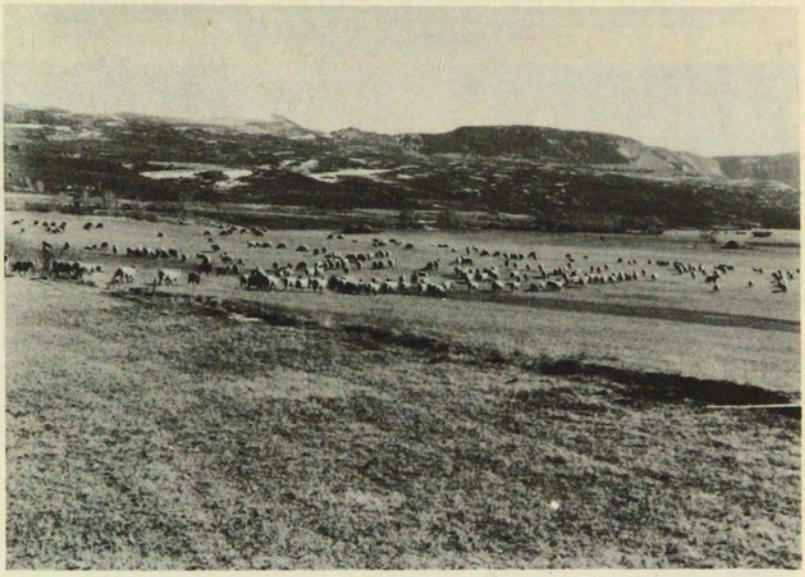
THE PRACTICES IN THE MOUNTAINOUS SECTIONS ARE GOOD FOREST MANAGEMENT, INCLUDING CONTROLLED GRAZING.

WILLIAM G. PROPER

CONSERVATION PRACTICES.

B. BRIXNER

PROPER GRAZING IMPROVES RANGE.



CARL HOLZMAN

SUPPLEMENTARY FEED FOR STOCK IS GROWN ON CULTIVATED LAND—WESTERN SLOPE.

CARL HOLZMAN

SUPPLEMENTARY FEED FOR STOCK.

CONSERVATION PRACTICES.
The Plains.

B. C. McLEAN

LAND WHICH HAD LOST TWELVE INCHES OF TOP SOIL. SORGHUM AND WEEDS PROTECT LAND FROM SOIL BLOWING.

E. R. WELLINGTON

RANGE MANAGEMENT SAVES THE RANGE AND PRODUCES MORE BEEF.

How Does a Soil Erosion District Work?[7]

In principle, a Soil Erosion District is one of the most democratic organizations yet devised for the purpose of an organized approach to any problem. The district is entirely self-governing; no public agencies have any supervisory or dictatorial powers in it. Its governing body, a board of five men elected and appointed by the land owners, is responsible to the electorate within the district for the care, treatment, and operation of the land.

In 1937, the State Legislature of Colorado enacted the Colorado Soil Erosion District Law.

The State Law

The legislative act authorizing the organization of Soil Erosion Districts defined the problem confronting Colorado in the following words: "The General Assembly hereby finds and declares that the State of Colorado, through wind and water erosion, has lost for agricultural and livestock uses approximately six million acres, or one-tenth of the total area of the state; that these losses range from severe damage to complete destruction of the top soils of these areas; that these losses have been caused largely by improper farm and range practices; and that the areas of land thus destroyed will increase until and unless a uniform method of farm and range conservation is established by law over the entire state."

This law is what is called an enabling act; that is to say—the law merely sets up the legal machinery whereby rural land owners can, if they so choose, set up conservation districts for the care, treatment and operation of land within the district. There is nothing mandatory about the Act—all actions for the formation of a district, which is in reality a political sub-division of the State, are dependent upon the voluntary action of the land owners. Before a district can be created, it is necessary to hold a legal referendum where all resident land owners can vote and express their views as to the creation of the district. If a majority favor the formation, then the Secretary of State is authorized to issue a Certificate of Organization.

Land Users Develop Program

In a district the land owners and operators develop a program of land use, based upon their experience and upon such technical information as can be obtained from the various State and Federal agencies who are equipped to supply these data. This information supplied by Federal and State agencies may include: types and characteristics of the soils; detailed topographic or aerial maps showing the present status of land use; vegetative surveys showing the quantity and kind of existing vegetative cover; analysis of the economic status of the people within the district; relationship of the district to the county or counties where it is located; and all other pertinent and applicable information.

[7]By Kenneth Chalmers, Colorado State Coordinator for Soil Conservation Service.

The powers of a district are broad and elastic. They have to be, in order to cope with the great variety of conditions there are in the State. In general, they provide that a district may carry on any type of work which relates to the care, treatment, and operation of the lands within the district. The statute further provides that the district may request and obtain the assistance of Federal and State agencies to aid in the carrying out of its work plan. For example, the Department of Agriculture is in a position to assist a district by furnishing trained technicians which include engineers, foresters, agronomists, range men, conservationists, economists, men trained in rodent and insect control work, and others. In addition, the Department is in a position to make available a limited amount of heavy equipment which can be loaned to the district at a nominal charge. Likewise, if CCC camps are located in or very near the locality the district can avail itself of this assistance, provided the services of the CCC camp are utilized on work which is of public benefit such as flood control, erosion control work for the protection of highways, et cetera.

Police Powers

In addition to the powers granted to a district for the care, treatment and operation of lands, the district can exercise certain police powers for the enforcement of land use regulations which may have been adopted by a majority of the land owners within the district. At first these police powers may appear to be a radical change from our present conception of land use, but upon more deliberate and mature consideration we find that there is nothing new in this procedure. For years we have been accustomed to traffic regulations in our towns and cities. When we build a house in town we have to conform to certain building and sanitary regulations. In many cities certain areas are zoned where business buildings cannot be erected and residences must be approved by the appropriate authorities. The general public has accepted these regulations and thinks nothing of them because they realize that they are for the general good of the community.

Land use regulations within a district are identical to those just discussed for cities. In a district it may be agreed upon by the land owners of the district that certain practices must be followed if the resources of that area are to be protected and conserved. To achieve this objective, it may be necessary to adopt land use regulations and have the power of enforcing the same. This procedure, however, should be used with judgment and caution. The success or failure of a district does not depend upon the power of the district to enforce regulations, it depends upon the sincere interest of the residents to put into effect sound and economical plans for the conservation of the resources.

A Soil Erosion District is merely a vehicle or a device which communities can use for a unified, coordinated approach to a problem of common interest. The working out of the plan of procedure for district operation has to be carefully considered

and it should fit into the general economy of the community and have as its objective the general good of the community. If this practice is followed, conservation districts will be of incalculable importance in conserving and using the natural resources of the State.

Soil Erosion Districts Are Successful

In the very center of the *plains area* of Colorado districts have been formed and are now in operation. In order to control the situation in this area, the land owners within the districts adopted the following land use regulations:

(1) No additional sod or brush land shall be broken out for crop production except after careful consideration and approval by the District Board of Supervisors.

(2) No land designated by the County Agricultural Conservation Committee as restoration land shall be broken out for crop production during the present program.

(3) All lands within the District which are subject to seasonal or continuous erosion shall, through a reasonable effort, be controlled by the use of appropriate vegetative and/or mechanical means.

These regulations provide a means whereby the residents of the district can more or less control and direct the type of agricultural production within the district for the benefit and protection of the resources of the district.

The first problem confronting the district was that of stabilization of badly blowing land which had to be done before any long time gradual readjustments could be put into effect. To accomplish this the District Board of Supervisors obtained leases upon large blocks of non-resident owned blow land. As soon as these leases were obtained the supervisors in cooperation with the Extension Service and the Farm Security Administration arranged for a loan from the latter agency; this loan being advanced on the basis of the assignment of Agricultural Adjustment Administration payments. Thus, the district has been able to obtain some financial assistance to enable it to utilize the services of the Soil Conservation Service to list and plant cover crops for the purpose of stabilization. To date approximately 50,000 acres have been so treated and sufficiently stabilized that they are no longer in a condition to blow. Wherever possible, this work has been done adjacent to resident operators in order that they would be afforded protection from adjacent, uncontrolled, non-resident owned land.

Another problem which confronted the district was that many of the owners and operators were attempting to make a living on units which were too small for economical production. In cooperation with the Extension Service, Land Utilization Section of the Soil Conservation Service, Bureau of Agricultural Economics, Farm Security Administration, and others, the Board

is working out a program of enlargement of operating units which will be of a sufficient size to permit at least a subsistence living.

The Board of Supervisors has already contacted the State Tax Commission and discussed with them the desirability of a reclassification of agricultural lands within the district so that a gradual readjustment from strictly cash crop production to a diversified, livestock, forage crop, and cash crop production can be more easily effected. The Board is considering and working upon a proposed readjustment of existing school districts so that by consolidation and realignment of boundaries, a more economical and efficient use of funds may be made.

The Board is continually working in close cooperation with the County Planning group so that the developments within the district will be consistent with the County program and will be an integral part thereof.

In the range country in *western Colorado* where a district has been in operation for more than two years the problems confronting the district are somewhat different. In this particular district the most acute problem was, first of all, protection of grazing lands within the district from itinerant livestock producers.

For many years it has been the custom for stockmen to lease a strategic piece of land controlling the water and from this base use all of the surrounding country dependent upon this water free of charge. This practice not only increased the rapidity of range depletion but mitigated against the local operators because, in many instances, they would be deprived of feed upon which their operations were dependent. By the creation of this district the local residents have been able to alleviate the use of this land in a more equitable and efficient manner. The board is obtaining leases on non-resident owned tracts and in cooperation with the Land Utilization Section of the Soil Conservation Service they are developing community pastures, separating the use of the sheep and cattle ranges, constructing drift fences for the proper seasonal use of the range, providing water holes for better distribution of stock, and are grazing the lands under this control in accordance with the indicated grazing capacities.

As in eastern Colorado this board is working toward a stable production, they are enlarging some of the units to provide for a stable subsistence living, and they are having considerable success in readjusting the grazing use of the area so that it will provide for a permanent use of the range.

Many of the long time objectives set up by the districts will be dependent upon the gradual change in the public thinking and conception of conservation. This process is slow and will be largely dependent upon education.

One point to be stressed is that in Colorado the district is not solely a medium for soil and moisture conservation in its strictest sense but it can be utilized for effecting many changes in land

use providing for the care, treatment, and operation of lands such as rodent control and weed eradication.

Are there any cooperatives in Colorado?

"From carnations to pinto beans, and honey to turkeys, there is scarcely an agricultural commodity in Colorado's wide diversity of farm products that is not handled cooperatively, Mr. Sherman reports. He says that approximately one crop dollar in every three is received or bargained for through cooperatives. Livestock cooperatives are reported to account for a third of the cooperative business in the State."[8]

Is wild life an important part of land conservation and use?

The conservation of wild life is often discussed from an aesthetic point of view and from a business point of view, due to the fact that hunting and fishing bring money into a state.

A balance in wild life is also desirable in the care of forests and grasslands. Mountain lions balance the number of deer, coyotes, rabbits, et cetera. But the conservation of less spectacular wild life is of great significance in individual farm life and economy. Birds are useful in controlling insects. Woodlots, stream bank thickets, shrubs, furnish shelter and food for wild life. Skunks, snakes, hawks have their place in rodent control. Rodents have their place in aerating soil. With wild life it is a question of balancing vegetation and wild life, rather than exterminating or protecting any one species.

What is the relationship of mineral conservation to land use?

Minerals are in a somewhat different category of natural resources. They are non-renewable and their plan of use is based on a different principle. We mine minerals. Forest, grass, wild life all are renewable resources.

Because mineral resources are non-renewable, a wise and intelligent use of those resources is essential if they are to be maintained for future use.

There are federal and state agencies as well as private interests which deal particularly with minerals—ore, coal, et cetera.

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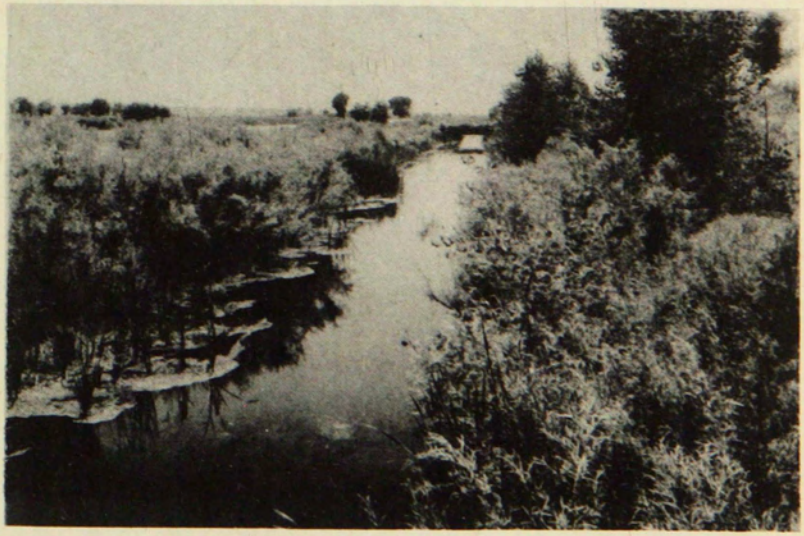
[8] *Land Policy Review*, March-April, 1940, commenting on Val C. Sherman, *Farmer Co-ops in Colorado*, Wichita Bank for Cooperatives, Wichita, Kansas, 1939.

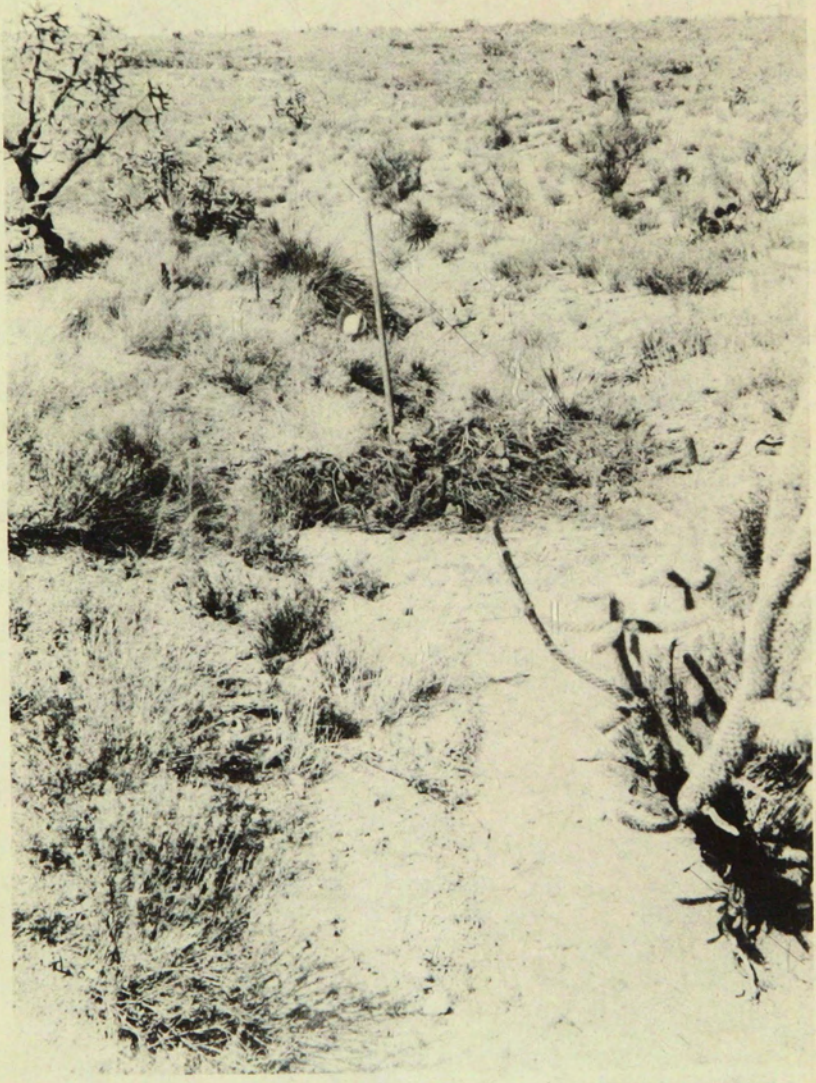
LESLIE N. GOODDING

A BEAVER DAM.



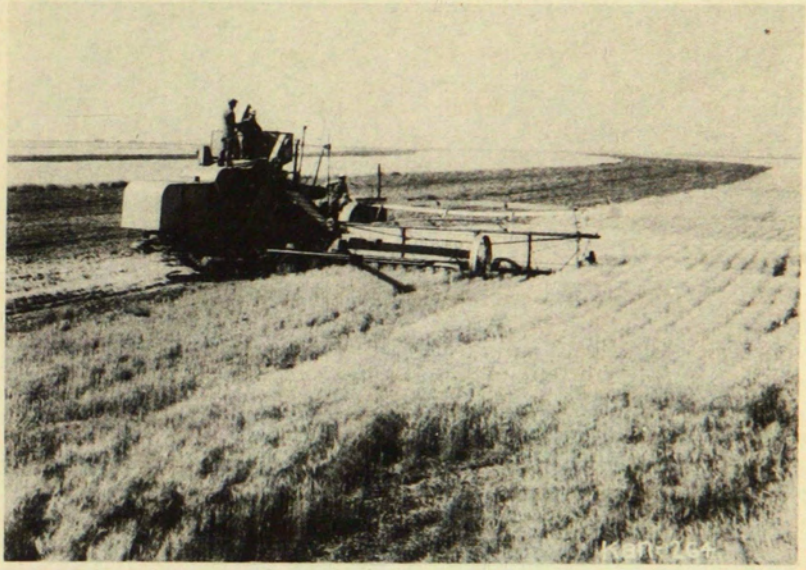
VERNE E. DAVIDSON

WILD LIFE HABITAT.



HARRIS R. McDONALD

CHECK DAM BUILT BY PACK RATS. (ARIZONA)



B. C. McLEAN

The Fruits of the Earth

To feed the world, men must plow and sow and reap. Men must tend their flocks and herds. To feed and clothe and shelter the world, men must husband their soil, their water, their forests, and plants and animals.

Men of the earth have built great towers in the sky, flung bridges over chasms and over the sea itself. Men sail through the air, travel on land and ocean and under the ocean. Men have made great inventions, have discovered cures for many scourges of humanity, have combined the substances of earth and water and air into new and strange and wonderful materials.

Yet still, man's very life lies in the riches of the earth. First and always man must live at peace and in harmony with the land.

CARL HOLZMAN

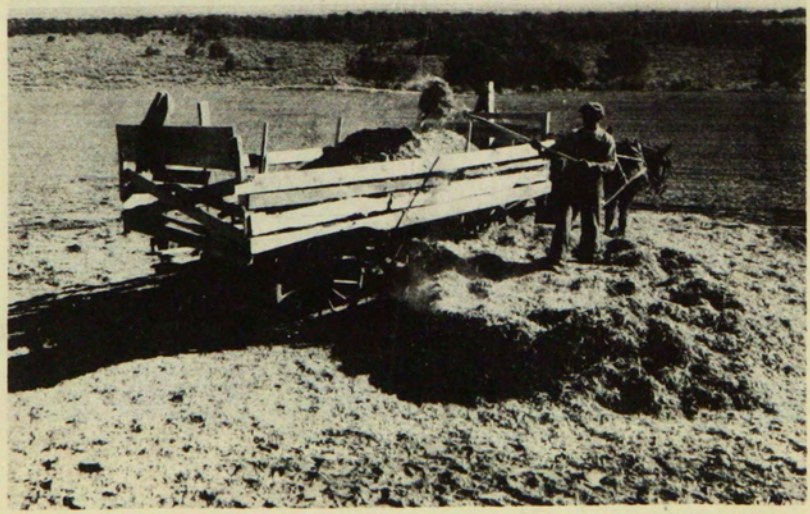
THE FRUITS OF THE EARTH.

CARL HOLZMAN

THE FRUITS OF THE EARTH.

THE FRUITS OF THE EARTH.

CARL HOLZMAN



CARL HOLZMAN

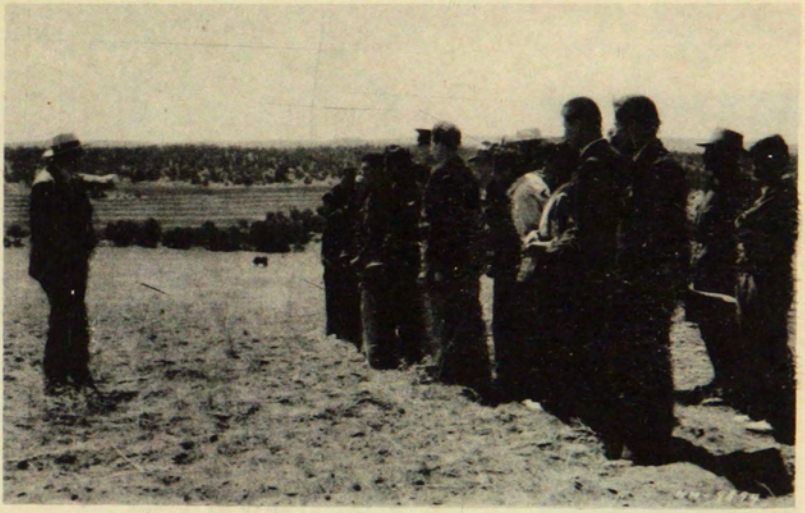
THE FRUITS OF THE EARTH.

CARL HOLZMAN

PRODUCTS OF THE EARTH.

CARL HOLZMAN

CARL HOLZMAN



E. R. WELLINGTON

YOUTH IS STUDYING THE LAND. HIGH SCHOOL STUDENTS FROM COLORADO, NEW MEXICO, ARIZONA, AND UTAH CONFER TOGETHER.

AL JARRETT

YOUTH IS CONSERVING THE LAND. CCC BOYS.

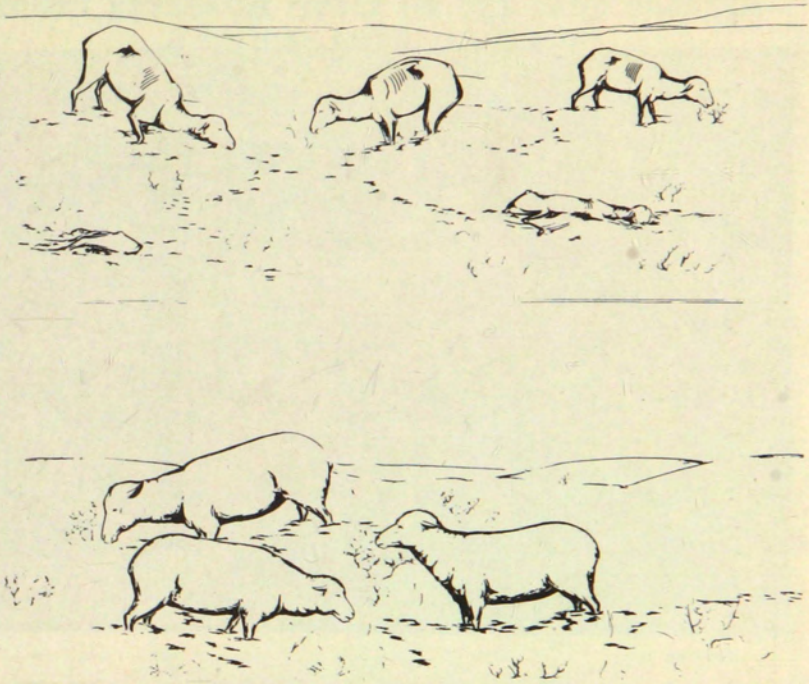
YOUTH IS STUDYING THE LAND.

CARL HOLZMAN

ANNE RAYMOND

ANNE RAYMOND

YOUTH EXPRESSES ITSELF ON THE LAND PROBLEM.



A NAVAJO BOY'S POSTER.

CARL HOLZMAN

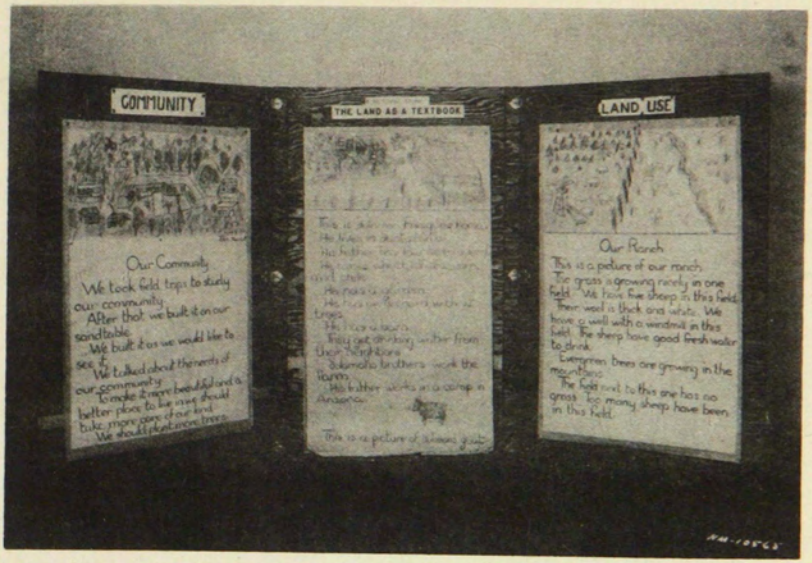
NEW MEXICO CHILDREN BROADCAST ABOUT LAND USE.

YOUTH IS WORKING ON THE LAND—NEAR SCHOOL.

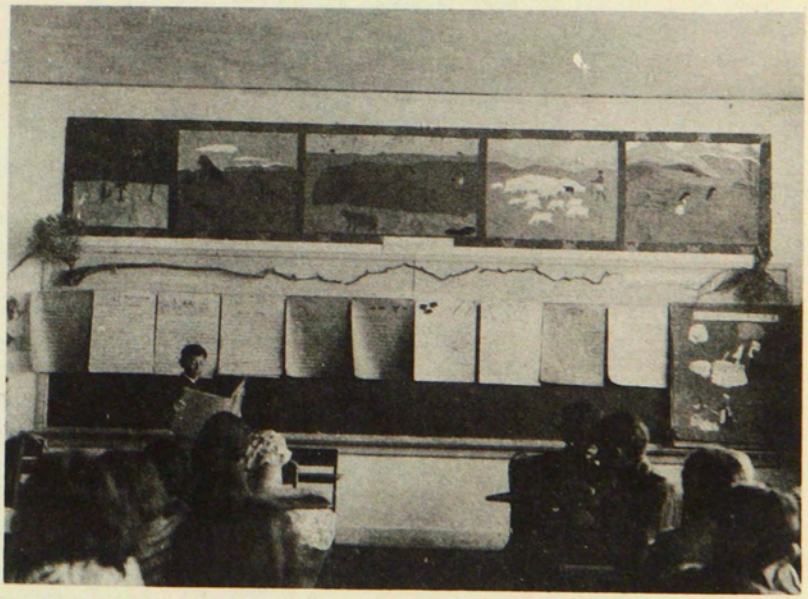
E. R. WELLINGTON

B. BRIXNER

YOUTH EXPRESSES ITSELF ON THE LAND PROBLEM— A SPANISH-AMERICAN SCHOOL.



B. BRIXNER



B. BRIXNER

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