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Soil Erosion in Ohio

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OHIO
AGRICULTURAL EXPERIMENT STATION
Wooster, Ohio

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FOREWORD

This bulletin is designed to present the extent of the erosion problem in Ohio and to point out, in a general way, the relationship of erosion to land use.

A generalized erosion map of the State made in connection with a national reconnaissance erosion survey of the United States is included. The map[1] was compiled under the direction of the Soil Conservation Service of the United States Department of Agriculture, with the cooperation of the Bureau of Chemistry and Soils, United States Department of Agriculture, and the Ohio Agricultural Experiment Station. In the preparation of the erosion map survey parties covered the State at intervals of approximately 10 miles; topographic sheets of the United States Geological Survey were used to help locate erosion area boundary lines. No areas less than ½ mile in width were considered. The map indicates the location of the predominating erosion conditions. It must not be construed that it represents in detail the actual erosion condition within any given area or that the boundary lines as drawn represent the limits of the various erosion conditions.

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[1]Erosion Survey by A. H Paschall, in charge, G. W. Conrey, C. H. Atkinson, W. L. Cook, H. Kohnke, and P. L. Zwerman.

SOIL EROSION IN OHIO

G. W. CONREY, J. S. CUTLER[2], AND A. H PASCHALL[2]

THE SOIL EROSION PROBLEM

A study of Ohio crop statistics for the past 50 years shows that in spite of the increased use of fertilizers and lime, better methods of tillage, improved varieties of crops, and the like, yields have been maintained at about the same level, but have not been increased. The only logical conclusion is that the soils are deteriorating, and that this is resulting in a decreasing productive capacity.

Soil deterioration has been the inevitable result of the system of farming commonly followed. Plant nutrients have been removed from the land in crops produced and only a part have been returned through plant residues and manures. The growth of cultivated crops has resulted in the destruction of organic matter and a consequent decrease in the nitrogen supply. This has brought about an unfavorable physical condition in the soil, as well as decreased water-holding capacity. On sloping lands, the loss of soil by erosion has contributed greatly to the decrease in productive capacity.

Soil erosion is a major destructive force in the depletion of soil resources. Many acres of land once cultivated have been literally destroyed by gullying. A much larger area has had its productive capacity greatly reduced by gradual removal of the fertile topsoil.

A reconnaissance erosion survey of the United States completed in 1934 by the Soil Conservation Service shows that 60 per cent of the land has been subjected to erosion in one form or another. Approximately 100,000,000 acres of formerly cultivated lands have been destroyed for practical agriculture. About 50 per cent of this land can still be farmed on a "patch" farming basis, but fully half of this area is unfit for cultivation. In addition to these areas, 192,300,000 more acres of farm land have lost the greater part of the topsoil with the result that these lands are only one-tenth to one-half as productive as they originally were. Wind erosion has destroyed about 9,000,000 acres of former cropland and has damaged 80,000,000 acres. Along with rapid erosion go clogged stream channels, silt-filled reservoirs, and higher flood levels.

A surprisingly large percentage of Ohio's land area is damaged by erosion. All sloping lands that have been used for intertilled crops have lost some surface soil; especially is this true in the southeastern part of the State. The extent of erosion in Ohio is given in Table 2.

Soil erosion in Ohio is the result of soil movement by surface runoff waters. Consequently, the problem of erosion control is primarily one of water control. All factors favoring the absorption of rainfall tend to reduce the amount of runoff. Moreover, even in humid regions, the water supply is often a limiting factor in crop production. Thus, soil erosion control and water conservation are interrelated problems.

SOIL EROSION DEFINED

Soil erosion is caused by the action of water or wind moving over the surface of the soil and transporting particles of soil from one place to another. The point of deposition may be many miles from the original position of the soil particles.

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[2]United States Department of Agriculture, Soil Conservation Service.

The process of erosion has been active through the ages, for it is by this process that the land has been worn down and hills and valleys have been produced. Under natural conditions the rate of erosion is usually slow. The natural cover of vegetation in forest or grassland protects the land surface and reduces soil removal to a minimum. Erosion under these natural conditions is termed *geological erosion.*

With the removal of the natural vegetative cover in clearing and cultivating the land, the action of wind and water in removing soil is greatly accelerated. Such erosion is known as "man-induced" or accelerated erosion. The annual loss of soil that occurs from this destructive agency has not commonly been realized, largely because the visible effects are not readily apparent. *Sheet erosion,* the most difficult to recognize of all types of erosion, is that phase of land washing which removes, more or less uniformly, a thin layer of soil during runoff-producing rains. It is only after the slopes are denuded of

Fig. 1.—A. Moderate sheet erosion. Zanesville silt loam. Muskingum County. "B" slope (8 per cent). No. 2 erosion. The result of a rain of 1.14 inches falling in 4 hours. B. Severe sheet erosion. Wooster silt loam. Wayne County. "B" slope (8 per cent) No. 3 erosion. Courtesy United States Soil Conservation Service

topsoil with a resulting change in soil color that the effects are easily recognized. The so-called "galled spots" observed in plowed fields are the result of sheet erosion. Frequently, reduced crop yields have been attributed to the removal of nutrient elements by the crops harvested or leaching when, as a matter of fact, the decrease is due, in a large measure, to soil losses from sheet erosion.

A *gully* is any wash or channel that has been cut into the soil to such a depth that it cannot be filled by ordinary cultivation or plowing. Gullying is more spectacular and more clearly evident than sheet erosion. In Ohio, gullying rarely occurs except on lands which have first lost all or the greater part of the topsoil through sheet erosion. Gully erosion thus represents the final stage of land destruction by erosion.

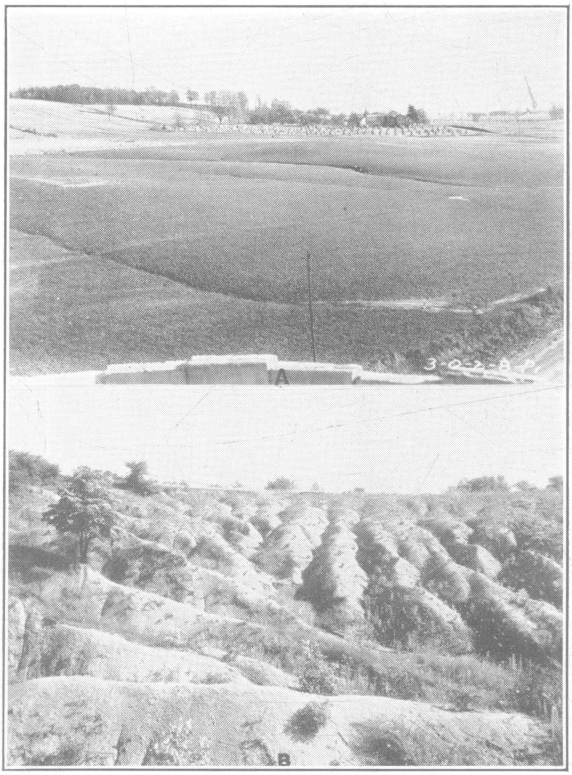

Fig. 2.—A. Occasional shallow gullies in gently sloping land. No. 8 erosion. Wooster silt loam (12 per cent slope) in background, Chenango fine sandy loam (3-6 per cent slope) in foreground. Courtesy United States Soil Conservation Service. B. Land completely destroyed by gullies. Muskingum silt loam (10-20 per cent slope). Athens County. Planted to pine in 1930. No. 9 erosion

Wind erosion may be a rather uniform drifting of soil from a large area or it may be the concentrated removal of soil from localized spots or "blowouts". This type of erosion occurs in Ohio only on the lighter sandy soils near Lake Erie or on the heavier soils or muck soils under special conditions where the soil surface is loose, friable, and dry. On the deep sands, wind erosion occurs where the protective vegetative covering has been destroyed. Sandy soils that have lost most of their organic matter are especially subject to wind erosion. Wind erosion may cause severe damage to muck areas by blowing the loose, finely divided surface soil. Frequently, this type of erosion will remove several inches of soil from the surface, thus causing the loss of fertilizer treatments and seed or seedlings.

Slips or landslides are the results of large blocks of land slipping down grade. Water and gravity are the main contributing factors. An impervious layer of rock or soil stops downward percolation and causes water to accumulate. Eventually, the lower part of the overlying soil becomes saturated to the point where it flows, thus causing slips and landslides. This form of erosion occurs chiefly on steep hillsides where the soils have a fine or clay-like texture.

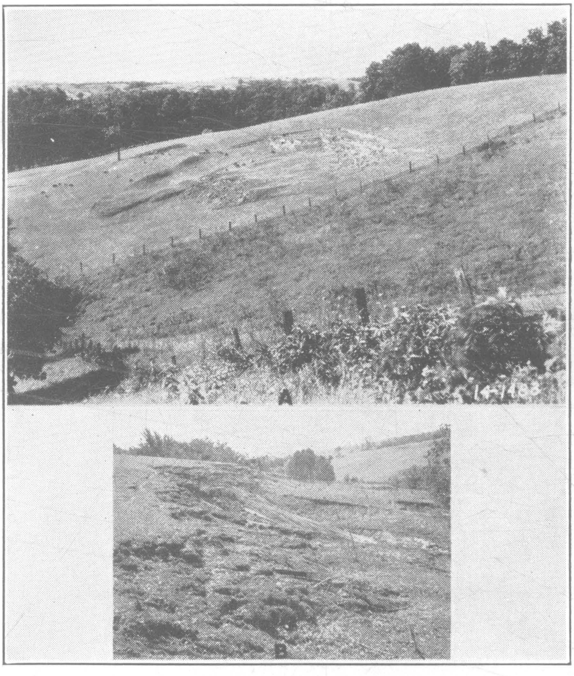

Fig. 3.—A. Large slip or landslide formed after 2 days of rain, August 5-6, 1935. Shaly phase of Muskingum silt loam. Guernsey County. 30 per cent slope. No. 6 erosion. Courtesy United States Soil Conservation Service. B. Slip or landslide. Upshur clay. Noble County. Such slips are of common occurrence on this soil. Gullies develop very rapidly below such bare areas. No. 6 erosion

FACTORS AFFECTING EROSION

The extent and severity of erosion vary with the climate, the topography, the soil, and the vegetative cover.

CLIMATE

In any given locality rainfall is the chief climatic factor causing soil erosion. Total rainfall, although a factor, is not as important as the intensity or the rate and the manner in which the rain falls. Heavy, torrential rains, where a large amount of water falls in a short time, usually result in more erosion than gentle rains. Excessive runoff may result during gentle rains after the soil has become saturated with moisture. Summer showers may cause exces-

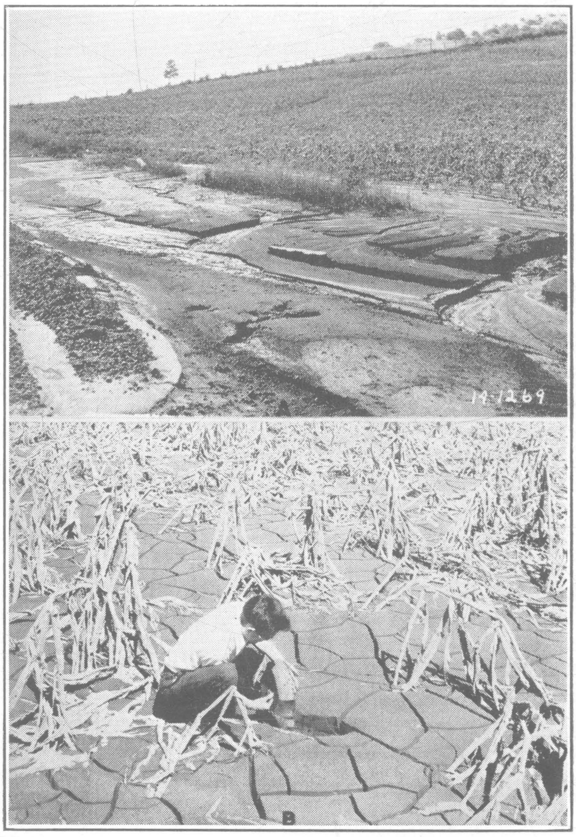

Fig. 4.—A. Gravel, sand, and silt washed from a corn field (20 per cent slope) during rain of July 4, 1935. Upland soil Muskingum silt loam. Tuscarawas County, Ohio. B. Silt and clay deposited by the flood of August, 1935. Flood plain of the Muskingum River below Gaysport, Muskingum County. Deposit 4½ inches thick. The corn crop was destroyed. Courtesy United States Soil Conservation Service

sive runoff where the soil surface is hard and dry, a condition unfavorable for the infiltration and downward percolation of water. In the case of a loose, dry soil, the compaction of soil particles resulting from a heavy downpour of rain will give a condition favorable for considerable runoff.

Temperature may affect runoff. Occasionally in the spring, rains occur when the surface 1 or 2 inches have thawed and the lower part of the soil remains frozen, thus preventing percolation of rainfall and increasing runoff and erosion. Melting snow may contribute to runoff and cause considerable erosion.

TOPOGRAPHY

The ability of water to scour and erode soil depends upon its velocity and volume. These, in turn, are related to the slope of the land and the size of the drainage area upon which water collects. It has generally been assumed that slope is the most important factor affecting runoff and erosion. Experimental results do not wholly justify this assumption, but, in general, the greater the slope, the greater the amount of erosion. At Bethany, Missouri[3], on an 8 per cent slope in continuous corn, the soil loss was 61 tons per acre per year. At Columbia, Missouri[4], a similar soil under similar conditions but with a slope of 3.7 per cent lost but 20 tons of soil. At Tyler, Texas[5], two plots of 8 and 16 per cent slopes had soil losses of 19 and 35 tons, respectively. The amount of erosion occurring upon a slope is affected by the size of the drainage area. On the narrow ridge tops that are common in southeastern Ohio the drainage areas are too small to furnish much water, but on broad rounded ridges, such as are found in western Ohio, the areas are sufficiently large to shed considerable water. This greatly increases the volume of water moving over a slope and consequently increases erosion.

SOIL

Some soils erode more readily than others under the same conditions of rainfall, cover, and slope. Capacity for water absorption and permeability of the soil determine to a great extent the amount of runoff. Certain other physical characteristics of the soil also undoubtedly affect the amount of erosion.

The amount of water absorbed is influenced by the texture and structure of the soil. In sands and other coarse-textured soils high permeability results in rapid water absorption and, hence, in little erosion. However, a sandy soil may be highly erosible when it is saturated with water, especially where the amount of organic matter is low. In fine-textured soils, structure is an important factor in determining erodibility. A soil with a granular structure in which the fine particles are arranged in clusters or aggregates absorbs water fairly readily and is fairly resistant to erosion, if the aggregates are not easily broken down.

The organic matter content of the soil is important because of its high water-holding capacity and tendency to improve granulation. As the organic matter content decreases as a result of the growth of cultivated crops, the erodibility of the soil increases.

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[3]Bennett, H. H. 1934. Dynamic Action of Rains in Relation to Erosion in the Humid Region Transactions of the American Geophysical Union, Fifteenth Annual Meeting. Part II, page 481. National Research Council.

[4]Ibid, page 481.

[5]Ibid, page 482.

The amount of erosion which has occurred must be considered. Loss of surface soil exposes subsoils lacking in organic matter. They have less capacity for water absorption than does the natural topsoil. In addition, Ohio subsoils are usually finer in texture than the surface soils, and for this reason tend to erode more readily.

COVER

The kind and quality of the vegetative cover have a marked effect on the rate at which water flows from the land. In a forest there is practically no surface runoff where the wooded area has not been grazed and no serious fires have occurred. The rain reaching the ground is absorbed by and held in the leaf litter and in the porous soil beneath. Grazing destroys the leaf litter and compacts the soil. Fire may destroy the leaf litter entirely.

Pasture grasses are somewhat less efficient than forest in controlling runoff. The many fine grass stems aid materially in checking the speed of water movement, and the root systems favor the development of a granular soil structure. These effects vary greatly with the amount of growth and the denseness of the sod.

On croplands the common cultivated crops, such as potatoes and corn, present conditions favorable to the greatest erosion. The small grains, such as wheat and oats, are intermediate, and a good legume-grass meadow permits very little soil loss. Land in oats will ordinarily erode more than that in wheat, because the former crop commonly follows corn and the land remains bare over winter; whereas wheat provides some winter cover. A cover crop following the corn and plowed under before planting oats will greatly reduce erosion. Soybeans are conducive to erosion because of the loose condition of the soil following their removal. The soil loss will be decreased if soybeans are followed immediately by a close-growing crop, such as fall-sown wheat or rye. More erosion always occurs from a bare land surface than from a surface protected by vegetative cover.

Table 1 gives a comparison of erosion and runoff from several soils under intertilled and thick-growing crops.

TABLE 1.—Comparison of Erosion Losses and Runoff under Cultivated and Thick-growing Crops[6]

Soil and location	Slope	Intertilled crops		Thick-growing crops		Averages for periods covered by data from
		Soil loss per acre per year	Rainfall loss Runoff	Soil loss per acre per year	Rainfall loss Runoff	
	Pct.	*Tons*	*Pct.*	*Tons*	*Pct.*	
Shelby silt loam Bethany, Missouri	8.0	60.8	27.4	0.300	7.7	1931–1933
Shelby loam Columbia, Missouri.......	3.7	19.7	30.3	0.300	12.5	1918–1931
Kirvin fine sandy loam Tyler, Texas.............	8.8	19.1	20.0	0.200	1.5	1931–1933
Marshall silt loam Clarinda, Iowa............	9.6	44.6	12.5	1.300	6.5	June, 1932–1933
Clinton silt loam LaCrosse, Wisconsin......	16.0	59.9	19.2	0.003	2.9	1933
Cecil sandy clay loam Statesville, N. C...... ..	10.0	13.8	9.3	0.700	5.5	1931–1933

[6]Excerpt from Table 15, "Comparison of Erosion and Runoff from 12 Widely Separated Important Soil Types". National Resources Board Report, 1934. P. 165.

The most effective cover in the control of erosion is a forest with a good leaf litter. Other types of cover, in the order of effectiveness, are bluegrass, timothy-alfalfa mixture, timothy, small grains, as oats or wheat, Sudan grass, and soybeans. Annual crops are not as effective as perennial crops.

THE RECONNAISSANCE SOIL EROSION SURVEY OF OHIO

The reconnaissance erosion survey had for its primary object the determination of the extent of both sheet erosion and gullying on the various soils of the State. The degree of sheet erosion was based on the extent to which the original surface soil had been washed away. Extent of gullying was based primarily upon the frequency with which gullies occurred and also on their length and depth. The classification into erosion types is as follows:[7]

1 Little or no erosion
17 Slight sheet erosion with occasional gullies
2 Moderate sheet erosion
27 Moderate sheet erosion with occasional gullies
28 Moderate sheet erosion with frequent gullies
3 Severe sheet erosion
37 Severe sheet erosion with occasional gullies
38 Severe sheet erosion with frequent gullies

In this survey *little or no erosion* was indicated where less than 25 per cent of the surface soil had been removed; *moderate erosion*, where 25 to 75 per cent of the surface soil had been removed; and *severe erosion*, where more than 75 per cent of the surface soil had been lost. *Occasional gullies* were indicated where the gullies were over 100 feet apart; *frequent gullies*, where they were less than 100 feet apart.

The results of the erosion survey are shown on the accompanying map (in the pocket inside the back cover). The different areas on the map indicate the distribution and extent of the various erosion types in the State. The approximate acreage and percentage of each are given in Table 2.

TABLE 2.—Summary of Erosion Conditions in Ohio

Erosion conditions	Acres	Per cent
Total area exclusive of large cities and water	26,073,600	100.00
Area with little or no erosion	13,502,318	51.80
Total area affected by sheet erosion	12,567,323	48.20
One-fourth to three-fourths of the topsoil lost. (Moderate sheet erosion)	8,403,023	32.20
Over three-fourths of the topsoil and some subsoil lost. (Severe sheet erosion)	4,164,300	16.00
Total area affected by gullies	8,980,166	34.50
Occasional gullies	7,394,406	28.40
Frequent gullies	1,585,760	6.10

EROSION CONDITIONS BY CLASSES[8]

1	Little or no erosion	13,502,318 acres[9]
17	Little or no sheet erosion, occasional gullies	3,959 acres
2	Moderate sheet erosion	3,554,302 acres[9]
27	Moderate sheet erosion, occasional gullies	4,267,223 acres
28	Moderate sheet erosion, frequent gullies	581,498 acres
3	Severe sheet erosion	36,814 acres[9]
37	Severe sheet erosion, occasional gullies	3,123,224 acres
38	Severe sheet erosion, frequent gullies	1,004,262 acres

[7]These numbers correspond to those appearing on the reconnaissance erosion survey map.
[8]Class numbers correspond to those on reconnaissance erosion survey map.
[9]This area does not include the area in the same sheet erosion class affected by gullies.

LEGEND

Generalized Soil Map of Ohio

I. Glacial limestone soils.
- a. Late Wisconsin Drift soils.
  1. Miami, Crosby, Brookston, and Clyde silty clay loam.
  2. Bellefontaine, Miami, and Crosby silt loam; Brookston and Clyde silty clay loam.
  3. Miami and Crosby loam and silt loam; Brookston clay loam and silty clay loam.
  4. Mixed sands and fine sandy loams—Coloma, Miami, Nappanee, Wauseon, etc.
- b. Early Wisconsin Drift soils.
  5. Russell and Fincastle silt loam, with Brookston silt loam.
- c. Illinoian Drift soils.
  6. Clermont, Avonburg, Rossmoyne, and Blanchester silt loam.
  7. Cincinnati and Rossmoyne silt loam; Fairmount silty clay loam.

II. Glacial sandstone and shale soils.
- a. Late Wisconsin Drift soils.
  8. Wooster, Canfield, Volusia, and Trumbull silt loam.
  9. Wooster and Canfield loam and sandy loam.
  10. Rittman, Medina, and Trumbull silt loam.
  11. Ellsworth, Mahoning, and Trumbull silty clay loam and silt loam.
  12. Alexandria, Cardington, and Bennington silt loam; Marengo silty clay loam.
- b. Illinoian Drift soils.
  13. Hanover and Fallsbury silt loam.

III. Lacustrine limestone soils.
  14. Brookston clay, with Nappanee clay loam, Wauseon fine sandy loam, etc.
  15. Paulding clay, with Nappanee clay.
  16. Toledo silty clay, with Fulton and Lucas silty clay loam.
  17. Toledo very fine sandy loam, loam, silt loam, and clay loam.
  18. Plainfield, Berrien, and Newton fine sand.

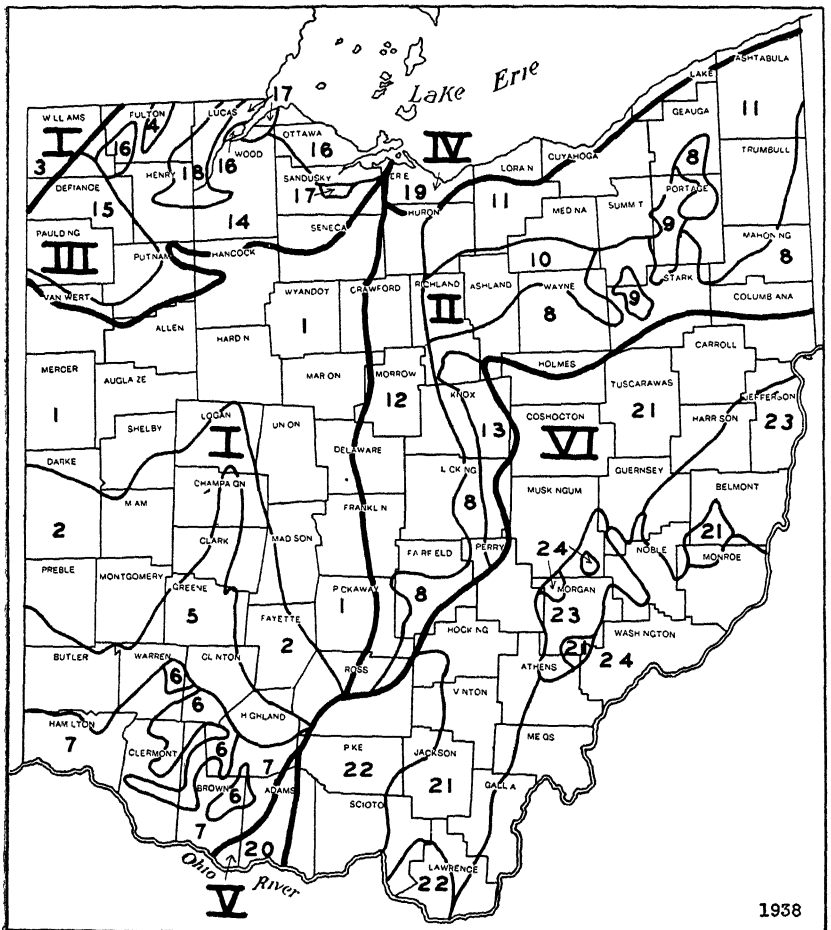
IV. Lacustrine sandstone and shale soils.
  19. Painesville, Caneadea, and Lorain loam to silty clay loam; Plainfield and Berrien fine sand.

V. Residual limestone and shale soils.
  20. Hagerstown, Bratton, Maddox, and Ellsberry silt loam; Heitt, Eden, and Fairmount silty clay loam.

VI. Residual sandstone and shale soils.
  21. Muskingum silt loam, with Muskingum loam.
  22. Muskingum silt loam (largely steep phase).
  23. Westmoreland and Belmont silty clay loam, with Muskingum silt loam.
  24. Meigs silty clay loam and Upshur clay, with Muskingum silt loam.

THE EROSION PROBLEM IN OHIO

As shown in the preceding tables, nearly one-sixth of the entire State has been affected by severe sheet erosion with a loss of over three-fourths of the topsoil. About one-third of the land area has lost from one-fourth to three-fourths of the surface soil. This erosion loss has occurred on the rolling croplands of the State, being most severe in the southeastern part. The principal factors contributing to these erosion losses are soil type, slope, and improper land use. In certain localities the extent of erosion varies with soil type, in others, with degree of slope. In all cases, the corrective measures must be based upon the proper land use. Further discussion of the erosion problem will be made by principal soil areas as outlined in the map, Figure 5.



(G.W.Conrey and E.M.Burrage)

Fig. 5.—Generalized soil map of Ohio

RESIDUAL SOIL AREA, V AND VI (MAP, FIG. 5)

The residual soil area includes a large percentage of the hill lands. It occurs in the southeastern part of the State. The area is highly dissected by entrenched streams; ridge tops are narrow, and hillsides are steep and irregular. The soils in Area V are derived from limestones and calcareous shales, and those in Area VI, from sandstones, shales, and clay shales with occasionally some interbedded limestones. Because of the rolling to steep topography and the variations in the parent rocks, the soils are variable in their characteristics. These soil differences are shown in several well-defined belts—residual limestone soils, steep Muskingum soils, rolling Muskingum soils, Westmoreland and Belmont soils, and the Meigs-Upshur soil belt.

ROLLING MUSKINGUM SOILS, 21 (MAP, FIG. 5)

The most serious erosion problem in southeastern Ohio occurs on the rolling Muskingum silt loam area. The topography is rolling with slopes ranging from 10 to 30 per cent. The soil is acid in reaction. The original vegetation

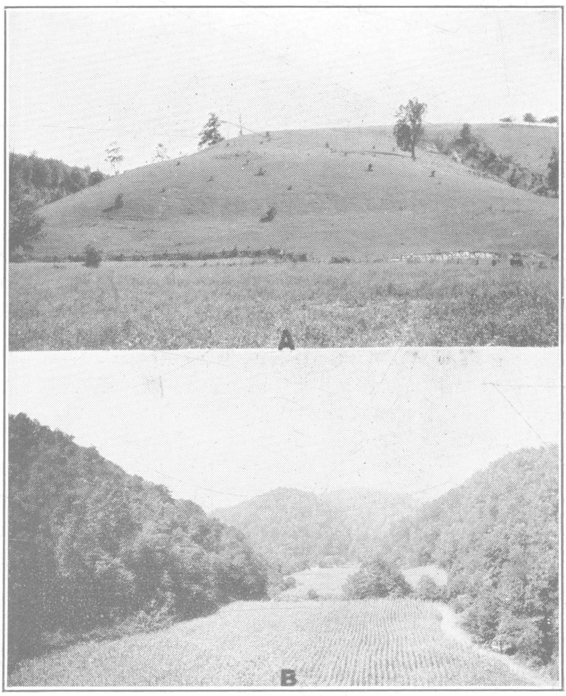


Fig. 6.—A. Muskingum silt loam. Scioto County. This soil is best adapted to pasture or forestation where it occurs on a 20-30 per cent slope. "C" slope (24-26 per cent). B. Muskingum silt loam. Scioto County. Large areas of this soil with a slope of over 30 per cent occur in southern Ohio. Such land should be left in forest. "D" slope (45 per cent)

consisted of a mixed hardwood forest. When the land was first cleared, fair yields of corn and other general crops were produced, but the soil was only moderate in natural fertility and in content of organic matter. With the depletion of the organic matter supply, a highly erosible condition developed. A large proportion of the area has been cleared and used for a time for cultivated crops; only the steeper lands have been reserved for permanent pasture or forest. In 1929[10] in five representative townships, 75 per cent of the land was in farms; of this area 23 per cent was in harvested crops and 41 per cent, in pasture.

The deterioration of soils through erosion has been accomplished in progressive stages. On many farms, sloping fields were used for cultivated crops with a resulting serious loss of topsoil by sheet wash. In time, yields decreased to the point where cropping was no longer profitable, and the land was used for permanent pasture. Pastures were neglected and allowed to deteriorate to a point where poverty grass and broom sedge formed the dominant vegetation. Under these conditions the loss of soil by sheet wash continued and gullies started in many fields. Where this process of soil destruction went on unabated, the inevitable result was land abandonment.

Severe sheet erosion with occasional gullies is in evidence over a large part of the area. In places, gullies are so numerous that the land has been practically destroyed for any agricultural use. Although almost 50 per cent of the land is at present in permanent pasture, the sparse vegetation on much of the pasture land furnishes only partial protection from sheet wash. The woodlots have, to a considerable extent, been pastured and allowed to burn over periodically; this has destroyed the leaf litter which would normally retain runoff. Thus, even in the forested areas, there may be some sheet wash.

WESTMORELAND AND BELMONT SOILS, 23 (MAP, FIG. 5)

Erosion is not as severe in the Westmoreland and Belmont soil areas as on the rolling Muskingum lands. The Westmoreland and Belmont soils are residual from interbedded limestone, sandstone, and shale and, because of their favorable reaction and natural fertility, are well adapted to bluegrass production. They are the best pasture soils in southeastern Ohio and an extensive dairy and livestock industry has developed in this area. In 1929 in four representative townships, 92 per cent of the land was in farms, and of this farm land 22 per cent was used for harvested crops and 60 per cent, for pasture.

In much of this region, gently rolling ridge top areas are very limited in extent, so that cultivated crops are commonly grown on the sloping land. Because of the heavy texture of the subsoil the permeability of these soils is somewhat less than that of the Muskingum; hence, under similar conditions, the runoff may be somewhat greater. The very granular nature of the soil serves to slow down soil loss by sheet wash. The close-growing bluegrass cover of the pasture lands is also effective in preventing loss of soil. However, where sheet wash has become active, gullying soon follows because of the fine texture of the subsoil material. Overgrazing and the running of livestock on the land in early spring while the soil is still wet are important factors contributing to erosion in this area.

Slips and landslides are common to the area, particularly on steep slopes that have been cleared of all trees or where there are numerous wet weather springs.

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[10]Data from United States Census Report, 1930.

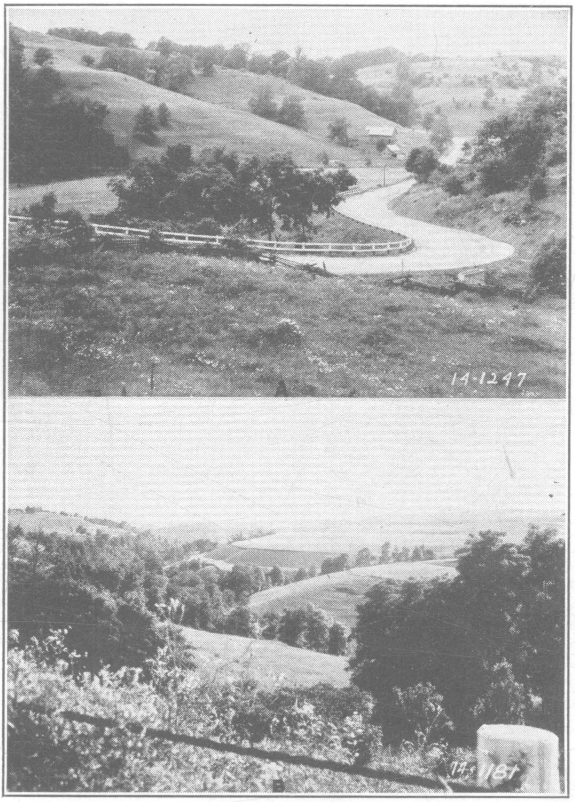


Fig. 7.—A. Typical topography of Meigs and Belmont soils. Such land should be kept permanent pasture. Noble County. "D" slope (35-40 per cent). B. Westmoreland silty clay loam. Belmont County. Strip-cropping makes it possible to grow cultivated crops on these steep lands. Land plowed for corn (center of picture) has a slope of 42 per cent. Courtesy United States Soil Conservation Service

MEIGS-UPSHUR SOILS, 24 (MAP, FIG. 5)

The Meigs and Upshur soils are the most erosible in the State. Severe sheet wash is soon followed by gullying. The most severe gullying in the State occurs on these soils. Slips and landslides are of common occurrence, for when these soils become saturated with water they resemble a semifluid and great masses may move down the hillside.

These soils are of only moderate natural fertility. Because of their heavy texture they are very plastic and, hence, hard to cultivate. The extremely fine texture also results in a slow penetration of water by percolation. The percentage of rainfall which runs off the land is probably higher than that on any other soil in the State.

RESIDUAL LIMESTONE AND SHALE SOILS, 20 (MAP, FIG. 5)

In the area of residual limestone and shale soils erosion varies from moderate to severe because of the range in soil and topographic conditions. This area, which occupies a portion of Adams County, is predominantly gently rolling. The soils are largely residual from limestone (Hagerstown and Bratton silt loam). Cultivated crops including corn and tobacco occupy a considerable acreage. Throughout most of this portion of the area there is moderate sheet erosion with occasional gullies. This is well shown in many fields by the reddish-brown color of the present surface soil where the original brown topsoil has been washed away.

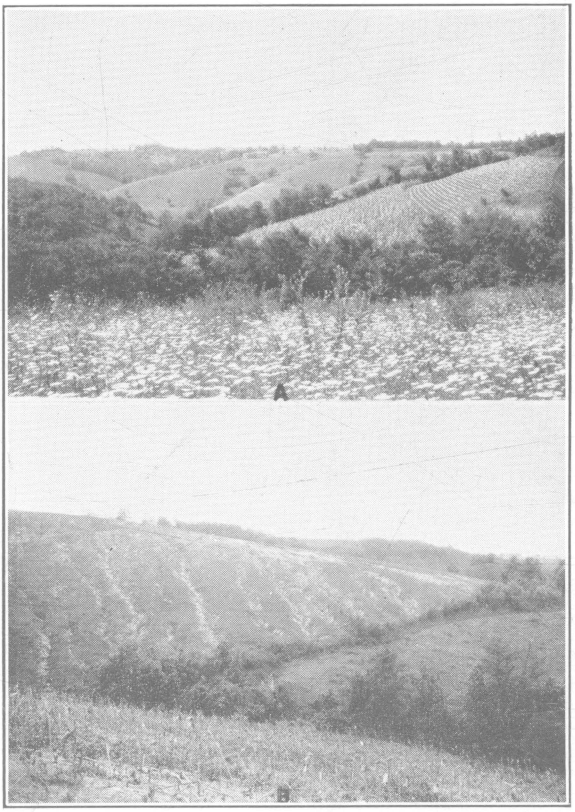


Fig. 8.—A. Fairmount silty clay loam. Adams County. Corn and tobacco are produced on these very steep slopes. "D" slope (45 per cent). B. Fairmount silty clay loam. Clermont County. Severe gullying soon follows if the land is used for crops for more than 1 year. "D" slope. No. 8 erosion

Adjacent to the Ohio River and tributary valleys, the topography is very rolling, with slopes of 40 to 50 per cent. Here, the soils, which are heavy silty clay loams (Fairmount, Eden, Heitt), are residual from calcareous shale and limestone. Because of the heavy texture, the soils have a low permeability; hence, the percentage of runoff is high. In spite of the steep slopes a considerable acreage is utilized for tobacco and corn, although this percentage of the total area is low. This cultivation of steep slopes has resulted in severe sheet erosion and frequent gullies. The gullies may extend the full length of the slope, but their depth may not be great because of the shallow covering of soil over bedrock.

STEEP MUSKINGUM SOILS, 22 (MAP, FIG. 5)

The extent of erosion on the steep Muskingum soils of Scioto, Pike, and Ross counties is not as great as might be expected. In this area, slopes of 40 to 50 per cent are common and the soil is thin because geological erosion has kept pace with the soil-forming processes. Much of the land has not been cleared. For example, in Niles township, Scioto County, only 27 per cent of the land is in farms, and of this area only 17 per cent is used for crops or pasture. Under these conditions accelerated or "man-induced" erosion is confined largely to the small areas of cultivated lands.

GLACIAL SANDSTONE AND SHALE SOILS, II (MAP, FIG. 5)

In the section of the State ordinarily considered as northeastern Ohio the erosion problems vary with the soil conditions. The greatest extent of eroded area occurs in the Wooster-Canfield-Volusia soil area, and the Alexandria-Cardington-Marengo soil area shows the least erosion. The factors contributory to these soil losses vary somewhat with the different sections.

WOOSTER, CANFIELD, AND VOLUSIA SOILS, 8 (MAP, FIG. 5)

The erosion map accompanying this report shows that a large proportion of the area has lost between 25 and 75 per cent of the original topsoil and that occasional shallow gullies are of common occurrence. This appears to present a very serious problem. However, when considered in the light of the State as a whole, the problem is less serious than might be expected for a highly developed agricultural region which has 44 per cent of its area in harvested crops. That erosion is not more severe is due largely to the nature of the soils, which are of glacial sandstone and shale origin and have open, porous subsoils. These open subsoils permit the rapid penetration of water, thus decreasing the runoff.

Loss of surface soil does not decrease the productivity of these soils as much as other soils of the State, as there are no hard, compact subsoils to be exposed in this section.

WOOSTER AND CANFIELD LOAM AND SANDY LOAM AREA, 9 (MAP, FIG. 5)

In the Wooster and Canfield loam to sandy loam area the erosion relationships are similar to those of the Wooster-Canfield-Volusia area. Although the topography is much more broken, irregular, and steep, this is offset by the more open, porous nature of the soil.

HANOVER-FALLSBURY SOIL AREA, 13 (MAP, FIG. 5)

The soil conditions of this area, which occurs chiefly in Knox and Licking Counties, are somewhat similar to those of the Wooster-Canfield area in that they are glacial sandstone and shale soils. However, they differ in age, being derived from older glacial drift (Illinoian). The topography is rolling to hilly, similar to that of the rolling Muskingum area. Because of greater age the soils have developed moderately heavy subsoils which retard the downward movement of water and thus increase runoff. Erosion is general over the area, but, as the percentage of the land in cultivated crops (31 per cent) is small and the percentage in pasture (45 per cent), large, the severity of the soil losses is less than in the areas to the east. The presence of intertilled crops on steep slopes has been the chief factor contributing to erosion throughout this area.

ELLSWORTH-MAHONING SOIL AREA, 11 (MAP, FIG. 5)

The physical character of the soils of this area is favorable to erosion. The soils are heavy silt loams to silty clay loams with silty clay to clay upper subsoils underlain by heavy-textured lower subsoils. Because of the tight, impervious nature of the subsoils, water penetrates very slowly and, were it not for the undulating to gently rolling topography with slopes seldom in excess of 5 to 8 per cent, the rate of erosion would be great. Under similar conditions of topography the soils of this area are more erosible than those of the Wooster-Canfield area. Furthermore, removal of the surface soil exposes the heavier, less productive subsoil. The 1930 census data for four representative townships show 67 per cent of the land in farms. Of this area 31 per cent was in harvested crops and 30 per cent, in pasture. Hence, a smaller acreage is exposed to the dangers of erosion, as most of the erosion occurs on land utilized for intertilled crops.

RITTMAN-MEDINA SOIL AREA, 10 (MAP, FIG. 5)

According to the erosion map, this area has lost more soil than the Ellsworth-Mahoning area. In this area the soils are intermediate in texture between the Wooster-Canfield and the Ellsworth-Mahoning soils and, hence, intermediate in permeability. Because of this higher permeability, less runoff would be expected than on the Ellsworth-Mahoning area. However, as the topography is somewhat rolling and the slopes are steeper, the rate of runoff is greatly increased. The land use is about the same as that in Area 11.

CARDINGTON-BENNINGTON AREA, 12 (MAP, FIG. 5)

The erosion problem in this area is somewhat similar to that of Areas 10 and 11. The soils have heavy to moderately heavy subsoils and the topography is gently undulating. In places in the eastern part of the area the topography is morainic, consisting of successive low knolls with intervening low-lying areas. In 1930, of the land in farms (87 per cent) in five representative townships, 44 per cent was in harvested crops and 37 per cent, in pasture. Erosion losses are slight to moderate. The most severe losses are in the area of morainic topography where there is considerable sheet wash from the elevated areas to the adjacent level lands.

OLD GLACIAL LIMESTONE SOILS, I-6 AND 7 (MAP, FIG. 5)

Some of the most spectacular erosion in the State occurs in southwestern Ohio. Many hillsides have lost nearly all their soil. Rounded ridge tops have been so badly gullied that they are worthless for cropland. This is especially true in the Cincinnati-Fairmount soil area. Back some distance from the river the lands are, for the most part, level to undulating and the erosion problem is not so acute.

CINCINNATI-FAIRMOUNT AREA, 7 (MAP, FIG. 5)

These soils occupy rolling to steep lands in the area adjacent to the Ohio River and tributary valleys. Cincinnati silt loam is a deeply weathered glacial soil derived from calcareous Illinoian glacial drift. The upper soil is very silty, almost free from gravel or pebbles, and is acid in reaction. Slopes vary from 10 to 20 per cent. The land is utilized for general farming with a considerable area in cultivated crops. Much of this soil has been severely sheet washed and has many badly gullied areas. Because of its very silty nature and stone-free character, this soil washes very readily. In this respect, it resembles the silty loess soils of the Mississippi valley.

Fairmount silty clay loam occupies the steep slopes (30 to 50 per cent) below the Cincinnati soil. Although a large percentage of this soil is used for hay and pasture, a considerable acreage, even on steep slopes, is utilized for the production of tobacco. For the first year in a cultivated crop following sod or brush there is only moderate erosion but, unless a good covering of grass is secured by the second year, sheet wash is severe and gullying soon follows. Many hillside areas are furrowed by gullies running the full length of the slope.

ROSSMOYNE-CLERMONT AREA, 6 (MAP, FIG. 5)

These soils, which occur on the level to gently undulating uplands, are derived from deeply weathered glacial drift (Illinoian). They are very silty in texture and highly acid. On the Rossmoyne soil, even on gentle slopes (5 to 8 per cent) there is considerable sheet wash; the subsoil is exposed on practically all land utilized for intertilled crops. Erosion is not a problem on the Clermont soil, which occupies a level to very gently undulating topography.

GLACIAL LIMESTONE SOILS, I-1 TO 5 (MAP, FIG. 5)

The glacial limestone soils cover a large part of western Ohio. Several variations in topography, texture, and development of the soil profile can be observed in various parts of the area.

RUSSELL-FINCASTLE SOIL AREA, 5 (MAP, FIG. 5)

These soils occur through Butler, Warren, Clinton, and Highland Counties and extend northward through central Greene, Clark, and Champaign Counties. They are of intermediate age, having been derived from glacial drift of the "Early Wisconsin Period". Because of age these soils have weathered to a depth of 3 or 4 feet and have developed a subsoil layer heavier than the surface layer. Streams have altered the topography so that there are many long, gentle slopes in the area. According to the 1930 census, 94 per cent of the land in three townships representative of the area was in farms, of which 52 per cent was utilized for harvested crops and 27 per cent, for pasture. The combination of heavy subsoils, which inhibit water percolation, long slopes, which permit accumulation of considerable quantities of water, and the large percentage of cropland, which offers little protection against runoff, creates a condition favorable for erosion. A loss of 50 to 75 per cent of the topsoil by sheet erosion is not unusual. Occasional gullies occur over much of the area, particularly where corn rows run up and down the slope rather than across the slope.

MIAMI-CROSBY-BROOKSTON AREA, 1, 2, 3 (MAP, FIG. 5)

The Miami-Crosby-Brookston soil area includes three distinct districts—the silt loam area, 2, the silty clay loam area, 1, and the silt loam and loam area with light subsoil, 3. All of these soils are derived from calcareous glacial drift (Late Wisconsin). They have been leached of carbonates (lime) to a depth of only 24 to 30 inches. The topography for the most part is level to undulating. Gently rolling areas occur in narrow, roughly parallel belts which cross the region in a general east-west direction. Between the gently rolling areas, the land surface is gently undulating with low knolls rising from several inches to a few feet above the general level.

The area includes some of the best agricultural lands of the State. In five representative townships of the Miami-Crosby silt loam area 95 per cent of the land was in farms in 1930, and of this percentage 62 per cent was utilized for cultivated crops and 26 per cent, for pasture. In seven representative townships of the Miami-Crosby silty clay loam area 90 per cent of the land was in farms in 1930; 60 per cent, in harvested crops; 24 per cent, in pasture.

Throughout the more level portions of the area, there is relatively little erosion except in the narrow belt of sloping land adjacent to the streams. During hard, beating rains, considerable soil may be washed from the higher areas of Miami and Crosby onto the level areas of Brookston soils. It is not uncommon for subsoils to be exposed on the tops and sides of the low-lying knolls which are common throughout much of the region. This is shown by the yellowish-brown to reddish-brown color of the exposed subsoil.

Erosion is greatest in the Miami-Crosby silty clay loam area, 1. Here the soils are heavy and tight, so that water seeps into the soil at a very slow rate. Gullies are cutting back along old waterways, often blocking off sections of fields so they can no longer be tilled as a unit.

In the silt loam and loam areas, 2 and 3, the subsoils readily permit the penetration of water, so that erosion occurs only where the slope is sufficient (3 to 10 per cent) to cause rapid runoff.

LACUSTRINE SOILS, III AND IV (MAP, FIG. 5)

These soils have developed in the old lake bed of northern Ohio. On the generalized soil map, Figure 5, they are shown in Areas 14, 15, 16, 17, 18, and 19. The area has almost level topography. The predominating soils are clays or silty clays through which water moves rather slowly. However, the slope of the land is so small that runoff is very slight and erosion is a minor problem.

Throughout the lake plain area are low ridges of sandy and gravelly materials which were the beaches of the lake formerly covering this area. Because of the sandy-gravelly nature of the soils, they are highly permeable; hence, the percentage of runoff is relatively low. Even so, there may be some sheet wash on the sloping areas. On the very sandy areas, such as the "oak-openings" in western Lucas County, wind erosion has caused some movement of soil as is shown by the presence of sand dunes in some places. These sandy soils drift badly when left for any time without a covering of vegetation.

PLANNING FOR EROSION CONTROL

Control of erosion is largely a matter of proper land use. The soil conservationist's slogan is "A proper use for every acre; every acre in its proper use". Although complete erosion control cannot be obtained under any system of farming, it is possible to modify farming practices so that a major portion of the soil loss may be prevented.

The Soil Conservation Service of the Department of Agriculture has divided all agricultural lands into four groups or classes. This division is based on the uses for which particular ranges of slopes are best adapted. These groups are designated by the letters A, B, C, and D. They are defined as follows:

> "A" group—Those comparatively level areas upon which there will be a minimum of erosion under normal conditions of tillage are in this group.
>
> "B" group—This includes that range of slopes above the "A" group on which, under prevailing conditions of use, erosion is active on areas in cultivation, but on which effective control methods can be established. Occasionally this group is subdivided into "B" and "BB" for convenience in farm planning work. The subdivision "BB" includes the steeper slopes of the group.
>
> "C" group—Slopes upon which erosion cannot be controlled, except when they are used for close-growing crops which provide cover throughout the year, make up this group. These are mainly meadow and pasture lands. Clean-tilled crops should not be grown on these slopes.
>
> "D" group—These slopes are too steep to have effective erosion control unless maintained under permanent cover. In Ohio these slopes should be maintained in forest cover.

The actual slope percentages included in each of these slope groups vary with the nature of the topography and the soil type. The best information available at this time indicates that the limits for certain groups in different parts of the State should be those given in Table 3.

TABLE 3.—Suggested Slope Limits for Certain Ohio Soil Areas

Slope group	Residual sandstone and shale area (Muskingum)	Calcareous shale in parent material (Westmoreland, etc.)	Soils of glacial origin (Russell)
	Pct.	*Pct.*	*Pct.*
A	0–5	0–5	0–3
B	5–20	5–25	3–12
C	20–30	25–40	12–20
D	30+	40+	20+

Were the recommended land uses to be followed for the limits set in Table 3 for each slope group, we should have "ideal" land use throughout the State. Not all farms can approach this, but it is possible for all farmers to make some changes which bring the general farm layout more in line with the correct land use and to adopt erosion control measures which will aid materially in the conservation of soil and moisture.

The erosion control measures to be used will vary under different conditions. Some measures can be used only under certain specific conditions; others are applicable under most conditions. The measures most commonly used are crop rotations, contour tillage, buffer strips, field stripping, strip-cropping, terracing, combination of terracing and strip-cropping, pasture improvement, and woodland management. Brief definitions and discussions of these measures follow.

Crop rotations present the simplest form of all control measures. They are adaptable everywhere. The best rotations are those which include 2 or more years of close-growing, soil-building crops and only 1 year of intertilled crops.

Contour tillage, which consists of breaking and tilling the ground along level lines running across the slope, can be utilized on gentle slopes which are sufficiently uniform to permit long rows and which do not require short turns. This practice is not satisfactory on long slopes where a considerable quantity of water may accumulate.

Buffer strips are bands of close-growing vegetation, as bluegrass, sod, or timothy meadow (in some instances Sudan grass, wheat, and the like) placed along the contour to divide large fields. These can be used to supplement contour cultivation. In themselves they do not give satisfactory control.

Field stripping consists of alternating bands or strips running across the general direction of the slope of intertilled crops and "close-growing" crops, such as wheat or meadow. The strips are generally uniform in width and vary slightly in elevation. The practice may be used where slopes are not suitable for strip-cropping.

Strip-cropping differs from field stripping in that the strips are laid out along the contour. Such strips cannot be uniform in width and the width of the strip will be dependent on the soil and slope conditions. The practice can be used wherever slopes are over 250 feet long and not badly scarred by gullies and ravines which would necessitate many short turns. It is one of the most effective control measures.

Terraces are broad ridges of soil thrown across the hillsides on the contour. In constructing the ridge a broad, shallow channel is formed along its upper side; through this any collected water flows at a low velocity to an outlet channel. The entire terrace is cultivated. Crop rows may run at an angle across the terrace on gentle slopes, but better results are secured when the rows are parallel with the terrace. The maximum slope of land which can be terraced to advantage is about 10 per cent. Terraces can be built only where slopes are fairly uniform and the soil is deep. The practice has been successful in controlling erosion, but the cost of installation of a system of terraces is often prohibitive.

A combination of terraces and strip-cropping is the most effective erosion control measure applicable to cropland. In this combination, alternating strips of intertilled crops and "thick-growing" crops are planted; the terrace ridge forms the center of each strip.

Pasture improvement is necessary wherever weeds, poverty grass, and broom sedge predominate over the clovers and bluegrass. A good pasture gives almost perfect erosion control.

Fig. 9.—A. Erosion control. Strip-cropping. Muskingum silt loam. Muskingum County. Slope, 12-16 per cent. Strips 80 feet wide. Rotation, corn-wheat-grass-grass. Courtesy United States Soil Conservation Service. B. Erosion control. Terracing. Wellston and Muskingum silt loam. Muskingum County. "B" slope (about 10 per cent). Terracing has a place in Ohio on the more gently sloping lands.

Woodlands erode when subjected to frequent burning or heavy grazing. Good management will control all this damage.

Information on desirable land use in relation to erosion control is meager. However, it is possible to make some tentative suggestions for the control of erosion by various land-use measures. These recommendations are based upon studies made on the several soil conservation projects, experiences in CCC camp areas, and the cooperative surveys made jointly by the Agricultural Adjustment Administration, Bureau of Agricultural Economics, the Ohio Experiment Station, and the Soil Conservation Service.

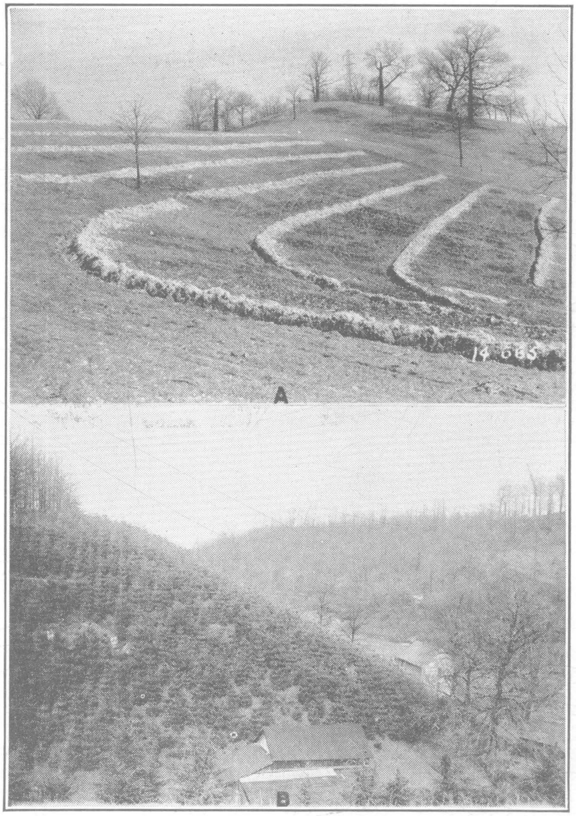


Fig. 10.—A. Erosion control. Contour furrowing. Water is intercepted by the furrows. This cuts down on runoff and adds to the moisture in the soil. Several years may be required to reestablish a sod on the plowed strip. Muskingum County. Slope 20-25 per cent. Courtesy United States Soil Conservation Service. B. Erosion control. Seven-year-old white pine planting. Waterloo State Forest, Athens County. Large areas of badly eroded steep lands of southeastern Ohio that were once farmed should be planted to forest. Courtesy Forestry Department, Ohio Agricultural Experiment Station

For convenience, the State has been divided into districts which correspond to the principal soil areas shown on the map in Figure 5. In dividing the State, similarity of soils, topography, or erosion has been the criterion, since the land factors are, in general, the most important in determining land use.

RESIDUAL SOIL AREA

Data on the Salt Creek Project area in Muskingum County indicate that certain land-use shifts are not only desirable but also essential to the future agricultural prosperity of this section of the State. Approximately 10 per cent of the cropland is on land too steep for any use except permanent meadow, pasture, or woodland. Corn and other intertilled crops should be shifted from the "BB" and "C" slopes (slopes over 12 per cent) to the smoother lands; whereas land of less than 12 per cent slope that has been in pasture should be used for cultivated crops. About 6 per cent of the "D" slopes (slopes over 30 per cent) is now in pasture and should be retired to forest. This shift would cause an increase of about 5 per cent in the land in forest.

ROLLING MUSKINGUM SOILS

Cultivated crops may be grown on slopes up to 20 per cent provided proper soil conservation measures, such as strip-cropping, adequate fertilization and liming, and a rotation containing not less than 2 to 3 years of a good legume-grass meadow, are followed.

The bottoms now in pasture, with the exception of the wet, "crawfishy" lands, should be utilized for rotated crops. Slopes up to 30 per cent, not too seriously eroded, can be utilized for pasture with proper management. Rough, broken, or severely gullied areas which cannot be treated with machinery should be retired to forests. Attention should also be given to the avoidance of late fall or early spring grazing and overgrazing in midsummer. Occasional clipping, too, is necessary to control weeds. Forest lands should be protected from fire and grazing. With proper management a much greater future return can be obtained.

The soil conservation measures should be adjusted to the erosion problem as indicated by the steepness of slope and present erosion condition. Table 4 gives suggested recommendations of erosion control practices for the typical sandstone and shale soils in this area.

WESTMORELAND AND BELMONT SOILS

Slopes up to 20 per cent on these soils are satisfactory for cultivated crops when good soil conservation methods are used. Conservation measures should be adjusted to the erosion problem. All short slopes above 5 per cent should be contour farmed. All long slopes (200 to 300 feet in length) and all slopes in excess of 10 per cent should be contour strip-cropped. The width of strip and length of crop rotation to be used are the same as for the Muskingum soils (Table 4).

Since lime is present in the parent material of these soils, they usually support better pastures than the Muskingum area. Slopes up to 40 per cent can be used for pasture with adequate fertilization and good pasture management. All badly gullied areas of less than 40 per cent and all slopes over 40 per cent should be reforested (Table 3).

MEIGS-UPSHUR SOILS

Recommendations for this area follow closely those made for the rolling Muskingum soils. Crop rotations should be lengthened to include at least 3 years of legume-grass meadow.

RESIDUAL LIMESTONE AND SHALE SOILS

With the possible exception of tobacco, cultivated crops should not be grown on slopes of more than 12 per cent. Tobacco may be grown on slopes up to 25 per cent provided the crop is planted in narrow strips on the contour

TABLE 4.—Recommended Erosion Control Measures for the Typical Sandstone and Shale Soils

Slope	Erosion class*	Recommendations
A 0-5 per cent	2 and 3	Good farming practices and contour cultivation where possible
	4	Contour cultivation Crop rotation including 1 year of legume-grass meadow
B 5-20 per cent	2 and 3	Contour cultivation and strip-cropping. Strips to be 125 feet or less in width. Crop rotation including 2 years of legume-grass meadow
	4	Contour cultivation and strip-cropping. Strips not to exceed 85 feet in width on slopes of 12 per cent or less If slope over 12 per cent, width of strip reduced by 5 feet for each 1 per cent increase in slope Crop rotation with not less than 2 years of legume-grass meadow. Cover provided for corn stubble ground in winter
	48	Permanent meadow or pasture
	9	Reforestation
C 20-30 per cent	2, 3, and 4	Permanent pasture or meadow Fertilization, liming, maintenance of good grazing practices
	48 and 9	Reforestation
D 30 per cent and over	All erosion classes	Maintenance in woodlot under proper management

*Erosion classes indicated by number, as follows:
2=0–25 per cent of surface lost through sheet erosion. Corresponds to 1 on reconnaissance erosion map.
3=25–75 per cent of surface lost through sheet erosion. Corresponds to 2 on reconnaissance erosion map.
4=75–100 + per cent of surface lost through sheet erosion. Corresponds to 3 on reconnaissance erosion map.
7=1 to 3 gullies per acre.
8=over 3 gullies per acre.
9=completely destroyed by gullies.
(Combination 27 means 0–25 per cent of surface lost by sheet erosion and 1–3 gullies per acre).

and the strip is not used for a clean-tilled crop 2 years in succession. Soil conservation measures, such as those recommended for the Russell area (Table 7), are necessary for erosion control on croplands.

Land with slopes up to 35 per cent should be maintained in pasture. All slopes over 35 per cent and all badly gullied areas should be reforested and maintained under good forest management.

STEEP MUSKINGUM SOILS

Securing sufficient cropland for local farm needs is a distinct problem on the steep Muskingum soils. All bottom lands, except the wet, "crawfishy" areas, should be utilized for rotated crops. Uplands with slopes of 20 per cent or less may be used for crops provided a 4- to 6-year (or more) crop rotation is followed.

All areas should be contour cultivated and all slopes of 200 to 300 feet in length should be strip-cropped. The general recommendations given in Table 4 for width of strip should be followed.

Slopes up to 30 per cent may be used for pasture provided adequate liming, fertilization, and management are furnished. All slopes over 30 per cent, all slopes with shallow soil, and all severely eroded areas should be retired to forests.

GLACIAL SANDSTONE AND SHALE SOILS

Studies on the Soil Conservation Service projects at Wooster and Mount Vernon and a special survey in Jackson Township of Ashtabula County show that there are enough slopes of less than 12 per cent in those areas for the production of the intertilled crops now grown. Cultivated crops on steep slopes should be shifted to slopes of less than 12 per cent now in pasture, except where these areas are wet and swampy.

At present about one-fifth of the cropland in northeastern Ohio is on slopes too steep for erosion control. These lands should be retired to pasture or forest. Recommended land use varies with the soil areas in this section of the State.

WOOSTER, CANFIELD, AND VOLUSIA SOILS

On these soils rotation cropland should be limited to slopes of less than 12 per cent. Pastures should be limited to slopes of less than 20 per cent and, within this range, to those slopes which are regular enough to permit the use of machinery. Slopes in excess of 20 per cent and badly eroded or broken areas should be forested.

TABLE 5.—Recommended Erosion Control Measures for Cropland in the Wooster, Canfield, and Volusia Soil Areas

Slope	Erosion classes*	Recommendations
A 0-3 per cent	2	General good farming practices
	3	Contour cultivation in addition to good farming practices
	4	Contour cultivation Crop rotation including 1 or more years of legume-grass meadow
	47	Contour cultivation
	48	Strip-cropping. Strips 150 feet or more. Four-year rotation including at least 2 years of legume-grass meadow
B 3-7 per cent	2 and 3	Contour cultivation Four-year (or more) crop rotation including 2 years of legume-grass meadow. All fields divided across direction of slope when slopes are 200 to 300 feet in length
	4	Contour cultivation and strip-cropping. Strips not to exceed 100 feet in width. Crop rotation including 2 years of legume-grass meadow Where field too irregular in topography to strip-crop, crops should be planted in parallel strips across the direction of major slope (field stripping). Five-year crop rotation
	48	Permanent meadow or pasture
BB 7-12 per cent	2 and 3	Contour cultivation with strip-cropping. Strips to be less than 100 feet in width (about 85 feet). Five-year (or more) crop rotation including 3 years of legume-grass meadow
	4	Contour cultivation and strip-cropping. Base width of strip, 100 feet, to be decreased by 5 feet for each 1 per cent of slope increase over 7 per cent. Rotation of at least 5 years Retirement to meadow where topography too irregular for strip-cropping
	48	Permanent meadow or pasture

*See footnote, Table 4.

Soil conservation methods for erosion control will vary under different conditions of slope and erosion. As slope and erosion increase, the control measures needed become more complicated. Recommendations are given in Table 5.

RITTMAN-MEDINA AND ELLSWORTH-MAHONING SOIL AREAS

The land-use and cropping recommendations given in Table 5 are applicable generally to the Rittman-Medina, Wooster-Canfield loam areas and to the more rolling parts of the Ellsworth-Mahoning soil area. The areas of Ellsworth-Mahoning soils which occur on nearly level topography, such as that in Ashtabula and Trumbull Counties, present less of a problem in erosion control. In these sections stress should be placed upon the growth and incorporation of leguminous sods and green manures, essential for their effect on the physical condition of soil. Steep slopes along streams should be reforested.

HANOVER-FALLSBURY SOIL AREA

Erosion control measures for this soil area are similar to those recommended for the rolling Muskingum soils.

CARDINGTON-BENNINGTON AREA

Studies on the Soil Conservation Service project at Mount Vernon show that the present area of rotated lands is less than the area of "A" and "B" slopes. However, 11 per cent of the "BB" slopes is now in cultivated crops. Approximately one-third of the cultivated acreage is now on marginal slopes or those on which it is difficult to maintain productivity because of erosion. Of the idle land (5 per cent of the area), approximately one-half is now on slopes too steep for cultivation and should be retired to pasture and forest.

Rotation crops should be limited to slopes of less than 7 per cent. Soil conservation measures are needed on all slopes in excess of 3 per cent. Long slopes (200 to 300 feet) should be broken by means of strip-cropping or field stripping to reduce the volume of runoff water. Rotations should be 3 or 4 years in length and include a good legume-grass meadow.

Pasture lands should be limited to slopes of less than 20 per cent. Gravelly soils now in pasture should be retired to forest because of their drouthy condition. All slopes above 20 per cent should be in forest.

The type and extent of soil conservation measures needed for erosion control will vary with the amount of erosion and the steepness of slope. A set of general recommendations for erosion control measures on cropland is given in Table 6.

OLD GLACIAL LIMESTONE SOILS

The two distinct types of topography in this area give rise to two sets of land-use conditions. In the Cincinnati-Fairmount area, corn and small grain should not be grown on slopes 12 per cent or above on the residual limestone soils (Fairmount) or 7 per cent or above on the glacial soils (Cincinnati). Attention must be given to erosion control methods on all slopes in excess of 3 per cent. Tobacco may be grown on limestone slopes up to 25 per cent, provided the land is reseeded after each tobacco crop. The practice of following

TABLE 6.—Recommended Erosion Control Measures for Cropland in the Cardington-Bennington Area

Slope	Erosion class*	Recommendations
A 0–3 per cent	2 and 3	No mechanical control measures. Three-year crop rotation including a legume-grass meadow plus good management
	4	Contour cultivation and 4-year crop rotation including 2 years of legume-grass meadow
B 3–7 per cent	2 and 3	Contour cultivation with a 3- to 4-year rotation including a legume-grass meadow. Slopes over 200 feet long should be broken by strip-cropping or field stripping. Strips may be 125 to 150 feet wide.
	4	Strip-cropping with contour cultivation if topography is regular enough to permit this practice. If not, field stripping, strips to be 100 feet or less in width. Four-year rotation with 2 years of legume-grass meadow
BB 7–12 per cent	2 and 3	Same measures as on "B" slopes with 4 erosion, with exception that strips should be 85 feet or less
	4	Strip-cropping with contour cultivation if possible. Four-year rotation with 2 years of legume-grass meadow. Strips to be 85 feet in width. This width to decrease by 5 feet for each 1 per cent increase in slope If topography is too irregular for strip-cropping, field stripping. Five- or 6-year crop rotation with only 1 year of corn and 1 year of small grain
	47 and 48	Permanent meadow or pasture

*See footnote, Table 4.

tobacco with corn should be discontinued because of the excessive erosion occurring the second year after breaking. Tobacco fields should be laid out in narrow belts parallel to the contour. Slopes up to 35 per cent, on limestone soils, can be pastured satisfactorily if properly fertilized and not overgrazed. Badly gullied areas and all slopes above 35 per cent should be reforested.

In the Rossmoyne-Clermont area a large percentage of the land is nearly level; soil drainage is the major problem. Rotation crops may be grown on slopes up to 12 per cent provided conservation measures are utilized on all slopes over 3 per cent. The recommendations made for the Cincinnati-Fairmount area apply to slopes of more than 12 per cent in this area.

GLACIAL LIMESTONE SOILS

RUSSELL-FINCASTLE SOIL AREA

Studies at the Soil Conservation project at Hamilton, Ohio, indicate that one-tenth of the cropland is now on slopes too steep for cultivation and should be shifted to the smoother areas now included in pasture. About one-sixth of the pasture land is on "D" slopes. This should be retired to forest. The following land-use suggestions can be made.

Rotated cropland should be limited to slopes of less than 8 per cent. On the longer slopes (200 to 300 feet) either strip-cropping or terracing is essential to the reduction of runoff. In general, a 4-year rotation with 2 years of hay will be more satisfactory than the common 3-year rotation. Steep slopes of less than 20 per cent should be retired to permanent meadow or pasture. All slopes above 20 per cent should be reforested.

The general recommendations for erosion control measures to be used in the Russell-Fincastle area are given in Table 7.

TABLE 7.—Recommended Erosion Control Measures for the Russell-Fincastle Soil Area

Slope	Erosion class*	Recommendations
A 0–3 per cent	2	Good farming methods including a crop rotation Contour cultivation
	3	Crop rotation including legume-grass meadow
	4	Contour cultivation with crop rotation including 2 years of legume-grass meadow. Strip-cropping or terraces on all slopes of over 200 to 300 feet in length, strips 125 to 150 feet in width
B 3–8 per cent	2 and 3	Contour cultivation and at least a 4-year rotation including 2 years of legume-grass meadow. All slopes over 200 to 300 feet long divided by strip-cropping or terraces where suitable outlets are available. Strips should not be over 125 feet in width.
	4	Contour cultivation with strip-cropping on terraces. Four- or 5-year crop rotation with not more than 1 year of small grains. Strips to be 100 feet or less in width on 3 per cent slopes and to decrease in width by 5 feet for each 1 per cent increase in slope
	48	Permanent meadow or pasture
BB 8–12 per cent	2 and 3	Contour strip-cropping and contour cultivation with at least a 4-year rotation including 2 years of legume-grass meadow. Strips to be 100 feet or less in width by 5 feet for each 1 per cent increase in slope. Terraces may be used to replace, or in connection with strip-cropping if satisfactory outlets are available.
	4	Contour strip-cropping and contour cultivation with a 5-year (or longer) rotation with 1 year of row crops and 1 year of small grains. Strips to be 85 feet or less on 8 per cent slopes and to decrease 5 feet for each 1 per cent increase in slope. Terraces may be substituted for strip-cropping or used in combination with strip-cropping.
	48	Permanent meadow or pasture, or reforestation
C 12–20 per cent	All classes	Permanent meadow or pasture
D 20+ per cent	All classes	Reforestation

*See footnote, Table 4.

MIAMI-CROSBY-BROOKSTON SOIL AREA

The Miami-Crosby-Brookston soil area includes three distinct districts—the silt loam area, the light subsoil area, and the silty clay loam area.

The land-use and erosion control recommendations for the silt loam and light subsoil areas are similar to those for the Russell-Fincastle area. However, in many places the topography is so irregular that contour tillage and contour strip-cropping are impossible. In these places it is necessary to substitute field stripping and longer rotations with more legume-grass meadows.

In the silty clay loam area surveys indicate that few shifts are necessary for the cultivated lands, pasture lands, and woodland, except that occasional breaks bordering the streams should be retired to pasture and forest.

Increased growing of deep-rooted leguminous crops for their effect on the physical condition of the soil and upon drainage should be encouraged. Surface drainage should be developed where needed. Permanent grass cover should be established on all slopes above 7 per cent that are not used for forest.

LACUSTRINE SOILS III AND IV

No major shifts are necessary in land use on the areas of level topography. Soil conservation is, however, an important problem. The following measures are suggested.

A crop rotation providing for the systematic use of legumes, both as meadow and green manure crops, on the dark-colored soils and legume-grass mixtures on the light-colored soils should be adopted. The depletion of the organic matter in these soils through grain farming has markedly increased the difficulties of tillage. From the viewpoint of soil conservation, more livestock is desirable. The existing tile drainage systems should be protected and extended. The heavy soils should not be worked while they are wet.

SUMMARY

Accelerated erosion has been a major contributing factor in the depletion of soil resources in Ohio. A national reconnaissance erosion survey made in 1934 shows that sheet erosion has affected to some degree 48 per cent of the total land area in the State. Gully erosion has affected 34.5 per cent of the State. Of the area influenced by sheet erosion, approximately two-thirds has lost between one-fourth and three-fourths of the surface soil. Wind erosion is not active except on scattered areas of sand or muck. Slips and landslides occur in the southeastern part of the State.

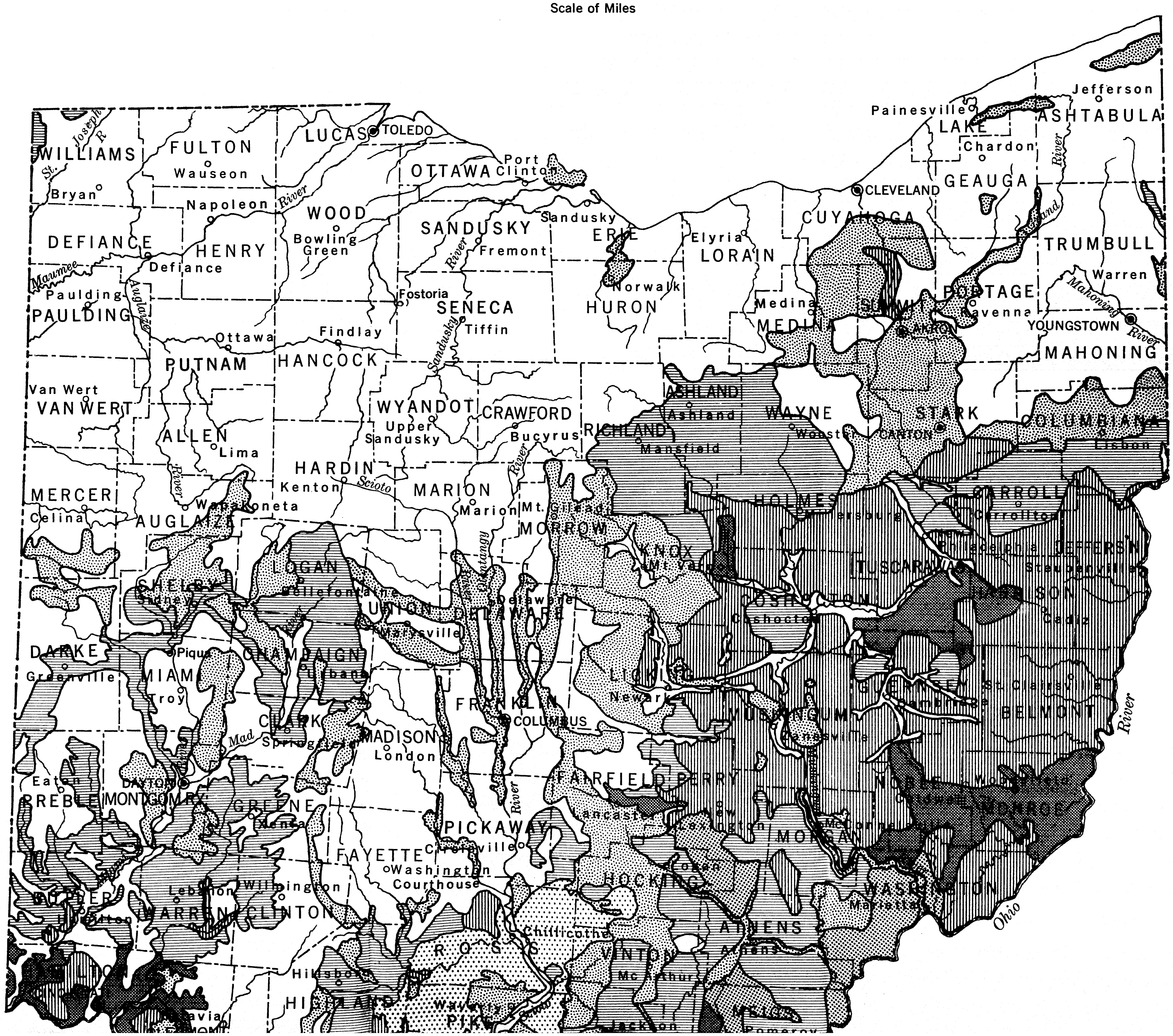
Four factors, climate, topography, soil, and vegetative cover, affect the extent and severity of erosion. Heavy, torrential rains, one of the most important climatic factors, produce considerable runoff; whereas gentle rains do not, as a rule, produce much runoff. The slope of the land, the length of the slope, and the size of the drainage area involved affect to a considerable extent the amount of erosion occurring in any particular locality. The texture and physical structure of the soil are of great importance where erosion is concerned. The vegetative cover of the land determines to a great extent how much water will run off and how much soil will be lost. The most effective cover for erosion control is a forest with good leaf litter. Other types of cover that are effective are bluegrass, timothy-alfalfa mixture, small grains, Sudan grass, and soybeans; annual crops are less effective than perennials.

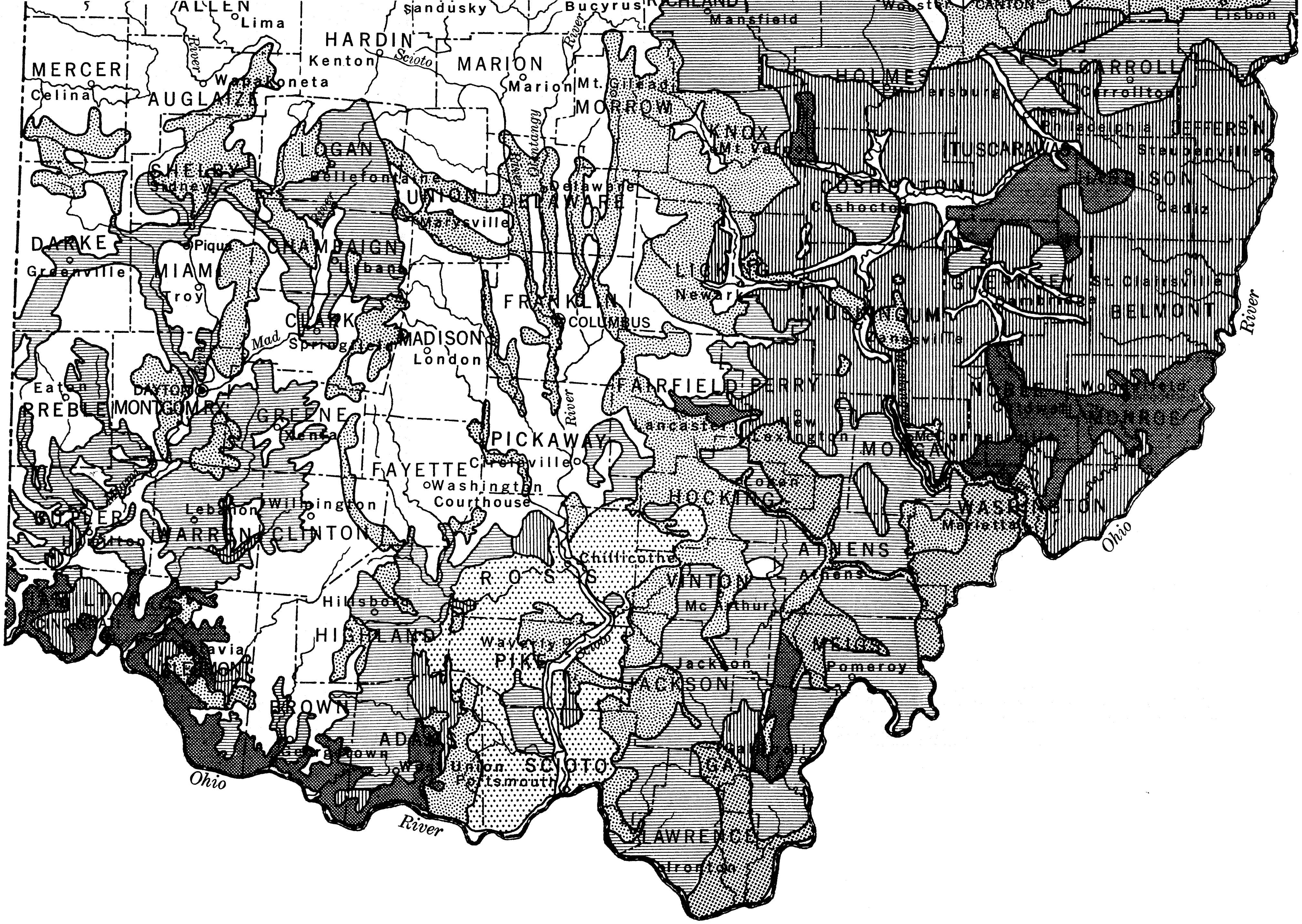
The extent and seriousness of the erosion problem and the principal contributing factors to erosion losses vary in the different sections of the State. For the most part these variations correspond to the general soil type areas. Therefore, the problem has been discussed from the standpoint of these soil areas.

Control of erosion is largely a matter of proper land use in combination with such soil conserving practices as crop rotations, contour tillage, field stripping, strip-cropping, terracing, pasture improvement, and protection of woodland from fire and grazing. As a result of studies made in Soil Conservation Service project areas and CCC camp areas, as well as cooperative studies made by the Ohio Agricultural Experiment Station, the Bureau of Agricultural Economics, and the Soil Conservation Service, it has been established that all sloping lands in Ohio fall into four main classes where land use is concerned. These are: (a) those lands which may be cultivated under normal tillage conditions with minimum soil loss by erosion; (b) those lands which may be cultivated if special soil conserving measures are used; (c) those lands which should be kept permanently in grass or grass-legume cover in order to prevent erosion; and (d) those lands so steep that they should be kept under permanent shrub or tree cover if erosion is to be controlled. The slope percentages to be included in these various land-use classes vary with the soil areas. General recommendations for land use and soil conserving practices have been developed for the general soil areas in the State.

RECONNAISSANCE EROSION SURVEY
OF THE
STATE OF OHIO

10 0 10 20 30 40
Scale of Miles





LEGEND

Areas within which more than 25 per cent of the land has been affected as indicated below.

- Little or no erosion Level lands
- Little or no erosion Hill lands
- Moderate sheet erosion
- Moderate sheet erosion Occasional gullies
- Moderate sheet erosion Frequent gullies
- Severe sheet erosion Occasional gullies
- Severe sheet erosion Frequent gullies

Adapted from May 1935 compilation
RECONNAISSANCE EROSION SURVEY of the STATE of OHIO

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