

Soils Affecting Urban Uses—A Teaching Program

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Agricultural workers have recognized for a long time that soils vary greatly in their suitability for crop production. Factors like natural fertility, fertilizer response, texture, slope, drainage and erosion all affect soil productivity.

Soil characteristics also affect the use to which soils are subjected near growing cities. Soil bearing strength, frost heave potential, permeability, compactibility, shear strength and reaction are important characteristics which affect many urban uses of soils. Because of the variability in these properties and others, soils differ in their suitability for building sites, highway subgrade, parks, airports and other uses.

Both the rapid population growth in numbers and its increasing mobility have placed more people in situations where soil conditions directly affect them. This is especially true in rural-urban fringe areas where people are moving to enjoy country living.

A lack of appreciation for soil differences by many users has resulted in many costly mistakes. These mistakes are due to the use of soils for purposes for which they are unsuited. Many problems have arisen simply because people do not realize that soils are different. They may see homes built successfully in an area near which they would like to live. Yet when they attempt to build a new home themselves in the nearby area, they may find, too late, that those soils are unstable, have a high water table or won't absorb the effluent from a septic tank. Some persons learn to their sorrow that their new home is on a flood plain which overflows occasionally. Builders may encounter hardrock during construction which is expensive to remove. Later the owner may find that this same rock or in other cases hardpan subsoil layers cause seepage during wet seasons. These may keep basements wet or make it difficult to grow lawns and shrubbery. Mistakes like these can be avoided by people who realize that soil characteristics influence the suitability of soils for urban uses.

Because farmers are close to the land and work on or dig into the soil, they are usually well aware that soils are quite different from place to place. Educational efforts by the Cooperative Extension Service, Soil Conservation Service and other agencies have also helped farmers understand soils. Today many farmers use soil maps, which define areas of different soils as basic tools in developing their management plans.

Unlike the farmer, most urban people do not have sufficient contact with the soil to develop an appreciation of how soil features may affect its use. While many depend upon the judgment of architects, engineers, and developers as they plan new projects, others do not seek sound advice. Some are misled by developers who do not know about adverse conditions. Yet, there is a wealth of knowledge uncovered by soil and geologic surveys which could help urban people with soil problems just as it has helped farmers.

Awareness Phase

A few years ago in Indiana, soil specialists began to promote wider understanding of how soils affect our urban people. Through our county extension agents and our Soil Conservation Service workers we have begun to reach out to groups with whom we have not usually contacted in the past. We have developed contacts with state and county health workers, county planning commissions, the State Division of Community Planning, builder and developer associations, watershed sponsoring groups, highway departments and many public officials. They have been shown how soils differ and how soils maps can clearly locate these differences. Some groups have been taught how to use soil maps and other geologic and water information that is available and of value to them. Special schools have been conducted in 20 counties to help people understand soil and water resources as they affect community development. This initial work, which can be called the "awareness" phase, has involved teaching urban people how soils knowledge can be useful. This "awareness phase" is well along in Indiana and in certain other states. Now we approach an "action phase" which involves the teaching and dissemination of soils information in such forms that people can use it.

Soil Teaching Techniques

Many of the techniques for teaching and conducting such "action programs" can be adapted from methods used in teaching farm people soil information. Effective visual aids are needed to illustrate soils and soil principles.

Monoliths (trays of natural soil sections to a 4-foot depth) and colored soil slides with brief, clear labelling are proven devices for use with urban audiences. Soil descriptions pointing out the features of interest to the audience need to be brief, concise and graphic. Block diagrams help greatly when used to relate soils to parent material, topography and location in the landscape. These techniques all have been used successfully for years with farm groups and work well for both indoor meetings and field trips (1).

Soil maps and reports contain a wealth of detailed information helpful to urban users, however, because of their great amount of detail these can be confusing to the average user. To help them understand these detailed reports, soil association maps, which show geographic groups of closely related soils, are used to consolidate the detail. Overhead projection of these specially prepared soil association maps works well when addressing large audiences indoors. On soil field trips, soil association maps help people relate the soils and soil features seen to other areas not observed due to lack of time.

Rapport can often be established with an audience early in a meeting by relating soil areas delineated on soil maps to familiar local landmarks like schools, highway intersections, parks, quarries, lakes and streams. Interesting soil features recounted about one or two soils in each soil association also helps interest the audience, because each person will have some knowledge of the soils and their properties found in their locality.

To place modern surveys into more immediate use, interpretations have been developed for certain urban uses concurrent with field mapping. As these are published, generally as brief reports, they become guides for using soil survey field sheets as they are completed. Such reports are taken to public meetings and explained to representatives of various groups who would benefit from a knowledge of soils in their work. Special soil survey use exercises are employed to teach each person how to read a soil map and how to interpret the soils information in the report.

In some counties copies of each soil survey field sheet are purchased by a county official as they are completed. Individuals also buy them for their own use. Where field sheets are being used locally for city or county planning, brief "interim" reports such as the Munster report have been prepared and financed with local funds. These "interim" reports allow use of soil data and soil maps obtained early in the survey some five years prior to the availability of the published soil survey report. Thus the needs of those groups wanting to use soils information can be fulfilled as the survey progresses.

Surveys in Comprehensive Planning

Greatest interest in using soil surveys has come from counties organizing planning commissions and those beginning comprehensive planning. For example, Lake County, Indiana employs a soil scientist in the Cooperative Extension Office to interpret soil maps being made by the progressive soil survey. He works closely with the consulting planners who are preparing a revised county master plan and also with all persons or groups requesting special soils help. He conducts an aggressive educational program which includes the preparation of soil maps and brochures for city officials interested in planning the future growth of their city.

Soil areas on a detailed soil map when interpreted and shown on a suitability map for a single purpose act as ready information for planners. These maps prepared as colored overlays may show three to five classes of suitability for a particular use such as residences needing septic disposal systems. Planners find maps such as these are very useful in zoning areas most adapted for particular uses.

Soil Interpretations

During the course of soil surveys the soil scientists are consulted for information and advice on urban land use by planning commissions, sanitarians, highway engineers and others. Until now most of this advice has been based on the experience and opinion of the soil scientist because no uniform suitability classification exists for each of the many potential uses of soils.

A soil sampling and testing project, which provides test values used in making soil interpretations, is being conducted in cooperation with the Bureau of Public Roads and the Purdue Joint Highway Research Project. This sampling and testing will continue until topsoil, subsoil and parent materials of all important Indiana soil series have been studied.

The Soil Conservation Service and Cooperative Extension Service in Indiana have begun preparing tables of soils interpretations for many purposes. These tables will act as references of soils data for easier use and serve as guides to keep soil suitability ratings uniform.

To date suitability interpretation of the major soils in Indiana have been prepared for the following uses:

1. Estimated physical and chemical properties.
2. Engineering test data for about 65 soil types.
3. Interpretations for use in rural and urban developments.
4. Interpretations of engineering properties for nonagricultural (urban) uses.
5. Interpretations of engineering properties for agricultural uses.
6. Interpretations for six types of outdoor recreational uses.
7. Interpretations for wildlife habitat and kinds of wildlife.
8. Predicted yields of soils under two levels of management.

In these tables soils are rated as having a slight, moderate, severe, or very severe degree of hazard for a potential use. Factors causing the limitations are also given.

All of these interpretations have been prepared in limited quantities for use by technicians. While wide distribution of these tables is not anticipated they will give the background information necessary for the preparation of brief "interim" reports covering soil areas near expanding cities, townships or counties.

Demonstrations Explain Principles

In teaching people about soils it seems far more valuable to explain principles which people can think about and apply than to describe specific features they can read elsewhere. Discussion of principles of water movement and storage in soils appear to be most important since water is involved in most of our urban soil problems. Four simple but effective demonstrations illustrating principles of soil and water movement we have used successfully are outlined below.

1. Soil infiltration and permeability.

Glass columns filled with soils of the same texture but differing in degree of natural granulation and organic matter content are placed near each other. A known quantity of water is added to each column and time is recorded. The audience observes the rate of infiltration and percolation of the water and notes the decrease in percolation and gradual sealing of the poorly granulated soil. In discussion, factors affecting infiltration and percolation rates such as grass cover, mulches, soil texture and structural stability can be pointed out. These can be related to soil erodibility, water runoff, and soil drainage.

2. Effect of limiting layers in soils.

Two damp synthetic sponges with medium size pores placed back to back are held horizontally before the audience while water is poured on the sponges. The amount of water absorbed is recorded.

Water is squeezed out of the sponges and a piece of blotter paper slightly larger than the sponges is placed on the top sponge leaving a lip extending over one end. Water is poured slowly on the blotter and

the amount absorbed by the blotter and sponges is recorded. The audience sees that only a small amount of water is absorbed before it begins to run off the edge of the blotter compared to that absorbed by the sponges alone. This illustrates the effect of pore size on infiltration with the blotter acting like a fine pored, puddled surface or a severely compacted one.

Repeat above sequence with the blotter between the sponges. Water is absorbed quickly by the top sponge but very little enters the lower sponge. This illustrates the effect of natural soil pans, plow pans or severely compacted layers found under many lawns, playgrounds and athletic fields resulting from poor construction practices.

3. Hydraulic head and underground water movement.

The simplest illustration of hydraulic head involves wetting a sponge, held in a horizontal position, until water just begins to drop from the bottom. Then when the sponge is turned in a vertical position water will quickly run out the bottom. The vertical dimension which is 3 to 4 times the thickness of the sponge can be compared to an increase in hydraulic head. Thus the audience can see that the same amount of water in a narrow vertical column has a greater "head" than when in a wide but shallow column.

A more sophisticated approach involves using soils of different textures in a system where water in funnels is connected by plastic tubing to other funnels containing the soil. The head is adjusted by raising the water filled funnels so the water reservoir exerts pressure on the soil. The time needed for the water to reach equilibrium on each side is a function of soil permeability which is related to soil texture, structure and porosity.

This demonstration can be used to develop an understanding of how ponding around a foundation will result in faster penetration of water into a soil due to an increase in hydraulic head. This results in greater pressures on basement walls and floors where soils are porous and sandy than where the soils are fine pored such as in silts or clays. Also, it can help explain the adverse effects of high water tables on basements in soils of different textures.

4. Soil capillarity and water rise.

Small damp sponges of different pore sizes are placed vertically in a shallow dish of colored water and the time is noted for the water to rise to their tops. When started early in a meeting, the fine pored sponge may wet completely by the middle of the meeting whereas the coarser pored sponge may wet only part way. This illustrates the principles of capillary rise such as occurs in fine textured soils and rocks.

A system of water in a porous clay cup sealed to a mercury manometer will illustrate the suction forces exerted by dry soil for moisture. The water filled cup is placed in sieved silt loam soil and the manometer is held at the same height. The cup will release water to the soil which exerts a suction on the mercury reservoir causing mercury to rise in a capillary tube. When started early in a meeting, the mercury will rise 10 to 15 inches by the end and evidence of wet soil can be observed through the glass jar containing the soil.

These demonstrations show how water moves from a moist zone to a dry zone through fine pores with a suction force exceeding the force of gravity. This principle can be applied to illustrate the height water will rise above a water table depending on soil texture. The need for a vapor barrier in basement construction and the reason builders can plan basements in some soils and not in others is easier to explain by using this demonstration.

What Lies Ahead?

The foregoing has told of the situation in Indiana which makes soil surveys valuable. It describes the nature of teaching programs used thus far with urban audiences. Much more experience is needed before we will perfect techniques needed to adequately reach this new audience with its many interests and diverse backgrounds. Better methods must be developed to reach these people who are not accustomed to dealing with the Cooperative Extension and Soil Conservation Service. More printed material about soils must be developed which can be distributed by agencies such as state and local health boards and planning commissions. Soils training needs to be given to the many individuals who have regulatory or inspection functions so they can understand soil principles and make intelligent recommendations. Magazine and newspaper articles will continue to call attention to soils problems and possible solutions. Demonstrations need to be developed for use in meetings, to illustrate important soil properties in addition to those involving water.

If this were to be rewritten 10 years hence, much more experience could be related. The methods of reaching people may be different at that time. However, no matter how completely planning commissions, engineers and developers use soil facts to make better decisions, we can be sure of one thing. That is, teaching simple fundamental facts about soils and how to use knowledge collected by soil surveys will still be high priority items as we work with the urban audiences of the future. Many more people will be available for these audiences. They will have needs just as urban people do today. The job ahead is a very large one.

Literature Cited

1. GALLOWAY, H. M., and BASS, T. C. 1959. Streamlining Soil Survey Information for Practical Use. *Proc. Ind. Acad. Sci.* **68**:354-359.
2. Munster Soil Survey Report, Lake County, Indiana. Indiana Cooperative Extension Service, U.S.D.A.-Soil Conservation Service, and Purdue University. June 1964.