Soil Information for Land Use Decisions: A Scientific Approach

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Abstract

Demand on our land resources have been increasing. Land use is a complex problem. We must make every effort to insure that the varied uses of the land are harmoniously related to the soil productivity with sound economic judgments while not being detrimental to the environment. Soil surveys provide physical information of unique value to help decision makers but are complex to use and understand. Detailed large-scale maps serve users well in planning for detailed site selection. Detailed soil maps can be made more useful by analyzing soils for combinations of factors which contribute to success of various land uses and which make economic assessment possible. Then various courses of action can be compared for efficient suitability for community planning. Computer methods of handling the soil property information make soil maps usage for land use decision simpler and more direct. The land area and soil identification can be stored on a cell basis (2.5 acres) followed by print-out of interpretive features in a map form. An advantage of the system is the ability to interpret for a large number of potential uses from the same source information. Examples are given here of adapting printouts of soil maps data in such way as to evaluate land suitability for homes with septic systems and for determining a base productivity index to underlie assessment of agricultural lands.

Introduction

Land use is a complex problem. Land use decisions sound or otherwise, are being made which are shaping the nature of life in every community and around the country. Some are made without considering the physical land resource suitability. Knowledge of trade-offs between present and future uses needs emphasis to allow sound economic judgments.

The detailed county soil survey is a basic inventory of soils and their properties. Soil surveys provide physical information of unique value to help decision makers even though they are complex to use and to understand. Detailed soil maps can be make more useful by evaluating soils for combinations of factors which contribute to success of various land uses. For example, soil drainage class (presence or absence of seasonal high water table) can influence suitability of an area for septic system usage. Slope and other soil characteristics affect agricultural productivity.

Computer methods can make the use of soil maps for land use decisions simpler and more direct. Detailed soil maps can be stored in the form of dominant soil symbol per unit cell in the computer. Then along with soil data files, these maps can be used to evaluate every soil map unit in a county. Rapid evaluation can be made for a large number of uses, like agricultural land assessment and septic suitability. This article describes the methodology used for soil map and data storage and the method of display and interpretation of the maps.

Soil Map Preparation

The computer is an effective tool for storing, analyzing and displaying resource data which can guide policymakers toward rational selections among land use alternatives. The computer has further advantages in terms of speed, accuracy and cost of interpretations.

First it is necessary to create a soil data bank. This includes all the soil series mapped in the state of Indiana. Each soil series has specific characteristics in terms of texture, drainage, organic matter content, productivity index, etc. Such information is recorded for each soil series, punched on computer cards, and stored in the computer memory system as a soil data bank.

Then it is necessary to prepare location data information. This is obtained from the detailed county soil survey map. This is done on a square-mile basis from the county soil survey map or from advanced atlas sheets if a county does not have a published soil survey map. A photograph of a particular section (one section will be equal to one square mile) is taken with a transparent grid laid over the map. The grid has 16 rows and 16 columns giving a total of 256 cells per section. Each cell is 2.5 acres in size, a unit about equal to the smallest soil areas separated in field mapping by soil scientists. From the enlarged photograph, the dominant soil symbol is identified and recorded on data sheets. Computer cards are punched with identification of county name, township, range, section, row and column. This information is assembled in a location data file and stored in the computer memory system.

Interpretation for Residences on Septic Systems

One can use soil data bank and location data file information to evaluate a variety of community plans or needs, as requested. For example, let us assume that a local community is interested in evaluating a residential area for septic systems. It is necessary to write or to formulate a computer program for interpreting the suitability of specific location data for residential areas using septic tanks, taking into consideration the factors developed for engineering interpretation by Soil Conservation Service. Surface texture, texture of the control section (family), natural drainage, stoniness, depth of bedrock, topographic position, and slope of the soil are the factors under consideration to formulate a rating system on the basis of soil limitations. One devised for trial in Indiana rates 100-88 as slight, 87-76 as moderate, and below 75 as severe limitation. So an overall index is constructed taking into consideration all of the factors for residential interpretation. This program will interact the location data file and the soil data bank to set an index value for each cell (2.5 acres) in a square mile area for residential interpretation. A simulated computer printout is given in Table I. A high numerical rating indicates slight limitations and more acceptability for residential sites with septic systems. Also in the table other features could be located. A flood plain in this example has been specified as '777' and the area under a lake specified as '666'. In this example, the values in column 16 are specified as zero because the cells fall partly outside that section hence are not considered for residential interpretation. If a county were able to provide printouts for all sections those would provide a rapid evaluation to potential use for residences on septic systems. By similar methods a wide variety of interpretive printouts could be made for other com-

TABLE 1. *This table represents an index value for residential homes with septic filter, fields—no basements. Each cell in the table below represents an area of 2.5 acres. A value of 100 would be the most suitable site based on natural physical features. A value of 111 indicates the area is 100 percent urban. A value of 222 indicates the area is highway or road. A value of 333 indicates the area is an organic soil. A value of 666 indicates the area is a lake or pond. A value of 777 indicates the area is subject to flooding.*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	777	73	73	63	51	777	777	73	73	63	63	63	63	63	777	0
2	777	777	777	777	73	73	73	51	73	777	777	63	63	63	51	0
3	777	777	777	777	666	666	73	73	73	777	777	777	51	51	63	0
4	777	777	777	777	777	777	777	777	777	777	777	777	777	777	777	0
5	73	73	73	777	63	777	777	777	777	777	777	777	777	777	777	0
6	73	32	51	51	73	777	777	777	777	777	777	777	777	777	777	0
7	73	73	32	51	63	63	777	777	777	777	90	90	777	777	777	0
8	73	73	73	73	73	73	63	777	777	777	51	51	51	777	777	0
9	32	32	32	51	51	63	63	73	73	63	51	63	63	777	777	0
10	51	51	32	51	51	73	51	73	51	51	73	51	73	777	777	0
11	51	51	51	51	51	73	51	51	32	51	73	73	73	777	73	0
12	32	51	32	51	51	51	32	51	51	51	73	63	777	777	73	0
13	51	51	32	51	32	51	51	51	51	51	73	63	51	777	777	0
14	73	51	51	51	32	32	32	51	51	51	73	63	51	777	777	0
15	32	51	51	32	51	51	51	51	32	51	63	63	46	46	777	0
16	51	51	51	51	32	51	32	32	32	63	63	73	63	63	777	0

munity development decisions (rating sewage lagoons, sanitary landfills and roads etc.).

Agricultural Land Assessment

A modern soil survey can be used as a guide for land assessment for property tax purposes. This use of the soil survey can provide a high return on the investment a county has made in obtaining their survey. The soil survey rates the productive capacity of land but does not determine the final valuation of land. Valuation is the province of the local assessor and soil ratings provide only a guide. The use of the survey for assessment is appropriate only for agricultural land; land under urban uses has values based more on buildings and locations. A computer method of land assessment furnishes a uniform and economical means of judging the potential productivity of land in a county; it is easily explained and defined resulting in fewer complaints, it reduces the influence of good or poor production practices on land evaluation, and the computer system speeds up the process and reduces costs.

Conditioned by weather, the physical properties of soil (moisture holding capacity, drainage class, slope, etc.) contribute to produce a given range in yield, year in and year out. By evaluating these soil properties, we can rate soils in terms of a 'capacity to yield' under a given set of climatic and management conditions. One has to consider the ability to produce a yield but also should consider the costs necessary to achieve this yield. So the rating used is called Productivity Index or PI (PI = gross return — production costs — conservation costs). The PI seems to be preferable to yield estimates since it includes costs necessary to obtain the production and recognizes that high yield costs more on some soils than on others. The PI also recognizes the fact that all soils cannot be cropped with similar intensity.

Assuming we consider the same section of land we have just discussed (in interpretation of residences) as one square mile of agricultural land. The soil data bank and the location data file will be the same. In land assessment it is necessary to create an ownership file. The land-owners name is recorded by county, township, range, section and by rows and column. There may be several owners in a section. All this information is transferred to computer cards to create the ownership file. Through a computer program for each owner in a section, the computer reads the soil symbol in each cell, looks up the PI for each, adds them up and finds out the average PI (average PI = adding all the PI in a parcel land and dividing by the number of cells a farmer owns) for each parcel of land or farm. Then the computer prints out a list of PI values for each cell in a section and also prints out the name of the owner and his average PI in the parcel of land. Simulated computer print outs are given in Tables 2 and 3.

These productivity indices can form the basis for improved agricultural and open land assessment. This gives a local assessor a ready opportunity to equate the soil resource of one farm to that of another. It also provides the county assessor with information for comparing soil resources throughout the county. The State Tax Equalization Board can use this kind of information in tax equalization between counties and school districts.

TABLE 2. *Land Ownership Information*

Name	Acres	Average PI
Farmer X	100	58.8
Farmer XX	30	41.7
Farmer XXX	125	52.8
Farmer Y	10	34.5
Farmer YY	20	54.9
Farmer YYY	50	54.2
Farmer Z	100	60.3
Farmer S	10	56.0
Farmer P	40	55.6
Farmer Q	60	63.0
Farmer N	55	48.1

An individual farmer or farm manager can utilize these productivity indices in his management planning. By knowing the different soils on his farm, the operator can compare his current net crop return with the potential net return (PI) for each soil. This would assist a farmer in planning for the most efficient management of his land. For example, improvement of a tile system on a given soil may or may not provide enough benefit to cover the cost of the improvement.

Another use for these values is in land appraisal. Using soil surveys, a farm appraiser can determine the acres of different soils on a given farm, then using the productivity indices, one can find an "average PI" for them. The same procedure can be used for other farms recently sold in the area. All this can help establish the fairness of price for land.

Times are changing and the demand on our land resources are increasing. Computer methods of handling the soil property information make soil map usage for land use decisions simpler and more direct. The scientific method of using a soil data bank with a modern electronic computer can aid community planners to make sound land use decisions. Another advantage of the system is the ability to interpret for a large number of potential uses from the same source information.

TABLE 3

P.I. VALUES IN THE CELLS BY FARM OWNERSHIP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	80	34	34	12	56	80	80	34	34	12	12	12	12	12	80	0
2	80	80	80	80	34	34	34	56	34	80	80	12	12	12	5	0
3	80	80	80	80	0	0	34	34	34	80	80	80	5	5	12	0
4	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	0
5	34	34	34	80	12	80	80	80	80	80	80	80	80	80	80	0
6	34	69	56	56	34	80	80	80	80	80	80	80	80	80	80	0
7	34	34	69	56	12	12	80	80	80	80	65	65	80	80	80	0
8	34	34	34	34	34	34	12	80	80	80	56	56	56	80	80	0
9	69	69	69	56	56	12	12	34	34	12	56	12	12	80	80	0
10	56	56	69	56	56	34	56	34	56	56	34	56	34	80	80	0
11	56	56	56	56	56	34	56	56	69	56	34	34	34	80	34	0
12	69	56	69	56	56	56	69	56	56	56	34	12	80	80	34	0
13	56	56	69	56	69	56	56	56	56	56	34	12	56	80	80	0
14	34	56	56	56	69	69	69	56	56	56	34	12	56	80	80	0
15	69	56	56	69	56	56	56	56	69	56	12	12	73	73	80	0
16	56	56	56	56	69	56	69	69	69	12	12	34	12	12	80	0

TABLE 3. *P.I. Values in the Cells by Farm Ownership.*