Needs for Soil Information in the Management of Range Resources[1]

JAMES O. KLEMMEDSON

Professor, Department of Watershed Management, University of Arizona, Tucson.

With present procedures of inventory and research, the kinds and amount of soil information needed for management of range resources is not always available, nor is the information always used when it is available. More effective use of soil information is hindered by 1) a communication gap between those who collect the information and the resource managers who should be using the information, 2) a priority system for soil survey which places more importance on standard soil surveys on a block basis than on special surveys conducted to meet the immediate needs of management, and 3) lack of a relationship between the soil survey programs and research designed to bring research results into context with land use problems.

Range managers have a good record in the use of soil information in managing range resources. From the beginning of range management as a science, range people have recognized the importance of soil as a reservoir of nutrients and moisture for the production of forage (Shantz, 1911; Sampson, 1923). They have zealously sought to protect the soil mantle against the ravages of erosion and were among the first to incorporate meaningful soil information into management planning.

In the late 1940's when rangemen turned away from the old range survey method of range analysis and began to think in terms of range condition they began to look at soils more closely than ever before. Soil became an object of study in terms of soil-plant relations, its potential to produce a vegetative crop and its resistance to damage. Rangemen began to find a greater need for soil information in management planning, in designing range improvements and in prescribing rehabilitation procedures for deteriorated and brush-infested ranges. Researchers helped point the way to use of soil information and found a knowledge of soils of great benefit in their own work.

There are two principal sources of soil information for range managers: 1) that provided by soil survey and 2) that obtained from a broad spectrum of research. Soil survey conducted according to procedures of the National Cooperative Soil Survey is the principal source. This inventory procedure is good both in theory and practice. It should, and is, in a large number of cases, providing the basic soil information needed to answer range management questions. Research should pick up where the inventories leave off, study problems of classification, interpretation, and application of survey data and investigate soil-plant-water relations in the context of important land use problems.

At present, the needs for soil information are not being fully satisfied by soil surveys and research. Perhaps this is too much to expect. But we could improve our effectiveness within the scope of resources presently available. The purpose of this paper is to point out problems of current procedures and suggest opportunities for improvement.

It should be recognized at the outset that soil survey on non-arable lands is a young program; only a small percentage of non-arable lands has been surveyed and at the present rate of progress several decades will be required to achieve complete coverage. But even when soil survey information is at hand, the kind and amount of information required is not always available, nor is the information always used when it is available. The extent and manner in which soil information is utilized varies between and within the various land management agencies. The procedure of range analysis used by the Soil Conservation Service (SCS) is more dependent on soil information and makes more complete use of soil survey information than that employed by other agencies. This is to be expected; soil surveys have always been an

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integral part of SCS programs and for many years it has been SCS policy that the soil scientist and range conservationist will work as a team planning and conducting surveys on range land. The SCS vegetal inventory is one of range condition within range sites and the soil information is of primary importance in delineating range sites.

In the U.S. Forest Service where soil surveys of National Forest lands have been underway for over a decade, there is no direct or necessary relationship between the soil survey and the range analysis. According to handbook instructions, soil information required as a part of range analysis is obtained by the range analysis team by direct field examination when soil surveys are not available. However, in practice, the range analysis team often collects the soil information required regardless of the availability of soil surveys. The Bureau of Land Management has no staff of people engaged in soil survey. They utilize existing surveys or depend on other agencies when specific soil information is required. For these reasons, soil information has not been incorporated into range management planning or rehabilitation to any great extent by the Bureau of Land Management to date.[2]

There are several reasons why soil information is not more effectively used in resource management. First and foremost is the communications gap between those who make the soil survey and report its results and the resource managers who should be using the information. The fault for lack of better communications does not rest entirely with either group. Both groups should work together more closely, become more aware of each other's problems, and adapt to the needs of each other. The success of the Soil Conservation Service in getting application of soil information on rangeland can in large measure be attributed to the close working relationship between the range conservationist and the soil scientist. Where this coordinated effort has not been achieved, or where the range manager has to dig the pertinent soil information out of a soil survey report by himself, use of the information may be incorrect,[3] ineffective or completely lacking. This situation is more frequently the case in agencies where soil scientists are in short supply and the range manager has neither the background nor the inclination to pursue use of the information for himself.

A principal objective of the National Cooperative Soil Survey program is to obtain surveys on all lands, arable and non-arable. Standard soil surveys are the backbone of this program, but are general purpose in nature as opposed to "special" surveys. Herein lies a second reason for inefficient use of soil information on wildlands. Standard soil surveys provide generalized information on soils and related environmental factors; the criteria evaluated and interpretations made are not specific for any one management function. On non-arable lands, including forest and range, soils are inventoried on a low to medium intensity. The mapping intensity will vary depending on value of the resources, potential use of the land, topographic situation, complexity of the soil pattern, and other factors.

Surveys that delineate soil series, types and phases are more valuable to the range manager, for these soil units are the most useful units in terms of making predictions regarding use, behavior and productivity of soils (Gardner, 1955; Retzer, 1953; Anderson, 1956; Heerwagen and Aandahl, 1961). If the soil survey available in any particular situation is of rather low intensity with a high percentage of variation within soil mapping units, the range manager may find that the survey is entirely suitable for general management planning purposes, but lacks information needed for rather intensive management purposes such as brush eradication, reseeding, game-range regeneration and other rehabilitation projects. Likewise, the researcher will often find the standard soil survey lacking in sufficient detail to meet his requirements, except perhaps for purposes of extrapolation of his findings.

The principal point I wish to make is not whether soil information is needed in the management of range resources but how can this information be most efficiently provided. It must be rather disturbing to the soil survey people to prepare soil survey reports on square mile after square mile of wildlands and then see improvement projects installed with little or no regard for information provided in the survey reports—but, this is actually occurring. An equally disturbing situation is to see the rangeman doing his work on one side of the fence, needing the soils information, but not having it, and the soil scientist on the other side of the fence making a standard soil survey but with no specific project or objective in mind other than an "across the board" regional soil survey as his directive. This situation is also occurring with considerable frequency.

Perhaps there is a solution to this dilemna. I fail to see the compelling reasons for standard soil survey on a county, district or other sub-division basis, particularly in time of manpower curtail-

[2] The Bureau of Land Management has soil scientists in a few selected positions at present and plans to increase their numbers to provide technical assistance in their range management programs, particularly those involving land treatment. Personal correspondence, Edward F. Spang and Myrvin E. Noble, BLM, Washington, D.C. and Denver, Colorado.

[3] The extensive failure of many resource managers and researchers to recognize the difference between a soil taxonomic unit and a soil mapping unit is a case in point.

ments and limited budgets. There are at least two other tasks with higher priority than the modern "block" standard soil surveys. The first priority belongs where the need is. In range management the need is on allotments scheduled for range analysis, on brush-infested ranges scheduled for revegetation, and on ranges in need of watershed rehabilitation. Here the problems and objectives should be clear, the needs for specific soil and land factor data can be defined by the rangeman and soil scientist working together and the soil survey can be designed at an intensity and scope to supply the necessary information. No more or less information need be collected than is required for the specific job at hand; yet, in a large number of cases, there is little reason to suspect that the "special surveys" cannot be easily meshed with standard soil survey legends at a later date for purposes of classification and correlation.

Before going on to a second priority I should point out that there are very good reasons for reconnaissance soil surveys on a "block survey" basis —and with high priority. Since reconnaissance surveys are of a very low intensity, they require relatively little time if conducted by competent soil surveyors. They are designed to delineate soils and landforms into broad qualitative groupings. These surveys have merit as the initial survey in that they serve to locate the most productive soils, those most susceptible to damage, and those areas most in need of rehabilitation. In many situations, this type of survey merits high priority, ahead of standard surveys, but not at the expense of special surveys.

Second priority goes to a task which hopefully would combat the communications gap and make resource managers more knowledgeable of soils. Too often publication of a soil survey report in traditional fashion becomes the end product for information collected in the course of the soil survey. But this is a poor stopping point in terms of efficient utilization of the basic information. A further step in analysis might help to overcome the communications gap and at the same time help land managers to become more knowledgeable about the soils of their areas. As a follow-up to soil surveys, existing soil survey information should be analyzed and interpreted further to develop systematic relationships between soils, vegetation and environmental factors. Zinke and Colwell (1965) pointed out this need several years ago. They illustrated the usefulness of more complete analysis of soil survey data by systematically grouping soils into developmental sequences. Their analysis has undoubtedly fostered a better understanding of those soils by resource managers who have read their paper and are working in the locale covered by the study.

As part of their technical range management program the Soil Conservation Service has been collecting herbage yield data by soil taxonomic units to aid them in estimating forage potential of various sites and soils.[4] In the Intermountain Region, Olson and Lewis[5] have conducted similar studies to make soil information more useable to Forest Service personnel. Studies such as these have undoubtedly enhanced the management job and the opportunity for land managers to become more knowledgeable about soils in their area. Almost any rangeman would delight in having at his finger-tips the relative ratings of the most important soils in his region for half a dozen characteristics from productivity to inherent erodibility. But his kind of information is not readily attainable on a broad scale at present. Ironically, much of the source data is available in the form of published soil survey reports, waiting for someone to pull out the significant relationships.

The answers to range problems, as they relate to soils, will often require information beyond that provided in standard soil surveys. In most cases only a more exhaustive search by the soil survey team, such as a "special survey" would involve, will be required to provide the necessary information. Bradshaw (1965) has shown by specific examples why special soil-vegetation investigations often have been required to achieve successful land management by the Forest Service in California. By example, in northeastern California the commonly brush-covered Tournquist series soil is equally suitable for growth of commercial timber and grass, but conifers require the deeper soil phases for economic growth. The very shallow and rocky phases may be too poor for grass. Bradshaw cites how a timber encircled brush patch was successfully converted to perennial grass following a special survey wherein it was found that the soils were too shallow for timber but deep enough for grass.

Situations involving more complex range problems may require field trials, administrative studies or even extensive research projects to get the soil information needed to accomplish management goals. Often the answers may come from a relatively simple field trial which may reveal fertilizer requirements, type of seedbed needed, or amount of competition that can be tolerated for successful reseeding of a troublesome site. The "scab ridge" problem of northeastern Oregon and southeastern Washington is a case where even a high intensity special soil survey (Strickler, 1965) did not provide

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[4] Personal correspondence with H. L. Leithead, Soil Conservation Service, Fort Worth, Texas.

[5] Personal correspondence with O. C. Olson, and M. E. Lewis, U.S. Forest Service, Washington, D.C. and Ogden, Utah, respectively.

the information needed to solve a range problem to the satisfaction of the land managers.[6] The usually untimbered "scab ridges" are commonly mapped as a complex of deep Albee soils which occur as mounds, and shallow, stony Rock Creek soils which occur between the mounds. These unproductive soils have concerned land managers because of the difficulty of revegetating them and because of the need for forage and soil stabilization (Klomp, 1968). A special survey disclosed the problem with these soils to a much greater extent than a standard survey would have. But it apparently has taken long-term research to determine how these soils should be treated to achieve soil stability and reasonable forage production (Klomp, 1968).

The third priority for better use of soil information relates to research. No plea for research on range soils is needed; its value is acknowledged. However, there are some important areas where this research effort is decidedly deficient. Either researchers have not been interested in these areas or the priority assignment of funds and manpower have left these areas lacking. One area is applied research to facilitate the interpretation and to make more meaningful and useable the information provided by soil surveys. Bradshaw (1965) was critical of research organizations for neglecting the practical research in their eagerness to explore the unknown. His criticism is justified—neglect of practical research serves only to widen the gap between accumulating scientific knowledge and its application. As Bradshaw (1965) pointed out "The need is great . . . for more research aimed at solving the routine problems of soil classification and interpretation and use and management of our wildland soils."

Research organizations could help to bridge the gap and make use of soil information already available. They are presumably better equipped than administrative agencies to handle problems such as determining forage potential for given soil taxonomic units, relating productivity to soil properties, and determining the reasons for wide variability in vegetal characteristics on some soil taxonomic units. The reluctance of researchers to tackle these problems—or inability to get the information fast enough has left administrative agencies the job of seeking this information for themselves. Such efforts as those of the Forest Service and SCS referred to earlier are frequently carried out of necessity on a "bootleg" basis and thus the rate of progress may be woefully slow. An exception is a formal study carried out by a Soil Conservation Service team in the Intermountain Basin since 1957 (Williams and Hugie, 1966). In this study, yield and composition of herbage collected yearly from relict stands are used to characterize the potential (climax) natural vegetation on important soil taxonomic units.

The research described by Williams and Hugie (1966) and similar work by many others (Anderson, 1956; Richard and Davis, 1964) has extended ecological understanding, assisted in range condition classification and fostered improved management for those range sites where an example of climax vegetation may still be found and where disturbance and soil deterioration have not changed materially the inherent potential of the site. But, on other range sites where examples of climax or even close to climax vegetation no longer exists, researchers have shown little interest and the knowledge of soil-plant relations is decidedly lacking. Studies are needed not only on sites where the inherent potential of soils to produce the original vegetation still persists, but also sites where deterioration has gone on for so long that productive potential, successional pattern and capacity for rehabilitation now may be quite different than that of the original site. In the absence of facts, the range manager is decidedly handicapped in prescribing management for these range situations. These are some of the real problem areas for range managers. Research on the soil-plant relations of these sites would help to speed rejuvenation of these ranges.

The soil-vegetation interpretation studies referred to previously seemingly have been preoccupied with the potential of the soil or site for production of vegetation. Granted this aspect is important, but the range manager needs to know more about soils than just their potential to produce native vegetation. Presumably he should know how the important soils in an area will respond to various cultural treatments and forms of management—such as fertilization, reseeding, intensive grazing systems, and watershed treatment. Researchers could assist in this phase of the range management job and at the same time get better interpretation of available soil survey data (priority 2) with studies over a broad range of soil taxonomic units. Questions needing answers are: Why do we get seeding failures on some soils and not on others? How much grazing will diverse sites stand without erosion or decline in condition? Why do some deteriorated ranges fail to respond to reduced stocking or complete exclusion of livestock—even after many years of such treatment? Anwers to these and similar questions very often can be found through a better understanding of range soils.

Although rangemen have sought and have been using soil information for many years, they have opportunities to more effectively use soil informa-

[6] Personal correspondence, Gerald S. Strickler, Pacific Northwest Forest and Range Experiment Station, La Grande, Oregon.

tion in the job of improvement and management of rangelands. Range resource problems, to the extent that they are soil problems, can be brought closer to solution by 1) a program of soil surveys guided and directed by specific management objectives, 2) development of systematic relationships from soil survey data that will increase the use of available soil survey information and facilitate understanding of soils by resource managers, and 3) filling the voids in the range soils research program to bridge the gap between accumulating soil information and application of that knowledge to critical range problems.

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