Utility of Soil Classification Units in Characterizing Native Grassland Plant Communities in the Southern Plains

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Environmental factors instrumental in the development of a native plant community and the soil on which it occurs have much in common and are interdependent in many respects. The nature of the relationship between kind of soil and kind of plant community is becoming more apparent as a result of joint field evaluations by soil scientists and range conservationists in connection with the National Cooperative Soil Survey.

Millions of acres of rangeland are now being mapped by this survey. In portions of the Plains states, sufficient adjoining counties have been mapped to provide contiguous soil maps for distances of several hundred miles. For example, detailed soils maps are available, with but few interruptions, from eastern Oklahoma to eastern New Mexico.

Within the next decade it is probable that most privately owned rangelands in the Southern Plains will be mapped by such surveys. Therefore, the contribution that these surveys make to rangeland resource inventories is of direct concern to rangeland users.

Relationship Between Soil Classification Categories and Native Grassland Plant Communities

Soil is the upper part of the earth's mantle in which land plants grow. The lower limit of soil has not been clearly defined but it includes the material in which most of the plant roots grow.

The characteristics of the soil at any given point depend on the properties of the parent material from which it was formed, and the extent to which this material has been changed by nature. An extremely young soil has been altered very little. Most soils, however, have been appreciably altered by the environmental forces of nature.

The degree that parent material may be changed in the formation of a soil depends on (1) the resistance of the material to change, (2) climate, (3) vegetation and other biological activity, and (4) time. Relief or topography modifies the macroclimate of an area, resulting in localized soil and plant microclimates. Thus the soil is both a result of the environment and a part of the environment.

In the National Cooperative Soil Survey, soils are indentified, described, and classified in accordance with a nation-wide classification system (Kellogg. 1936, Baldwin et al. 1938, Riecken and Smith, 1949, Thorp and Smith. 1949, Soil Survey Manual. 1951). The taxonomic units of the classification system, beginning at the highest level, include order, suborder, great soil group, family, series, and type.[1] Mapping units are defined in terms of kind and properties of taxonomic units. The detail of mapping varies with the nature of the land and its potential uses. Generally the delineations on soil maps of rangeland areas include soil series or types or combinations of these. In addition, soil phases such as slope, erosion, and stoniness may be mapped as subdivisions of taxonomic units when these factors are significant to the use and management of the land.

Numerous field observations indicate that the most definitive relationship between kind of soil and kind of native plant community exists at the soil series, soil type, and soil phase level of differentiation. Prior to a more detailed consideration of this relationship, a brief evaluation of the significance of higher classification categories is warranted.

1. The Soil Order:

The soil order includes zonal, intrazonal, and azonal soils.

Zonal soils are formed on well drained areas from materials that are not extreme in texture or chemical composition. They have well developed profiles. The characteristics of these soils are the best reflection of the climatic and ecological zone in which they occur. In the Southern Plains, they are best typified by deep, loamy textured, well drained soils of nearly level convex upland slopes.

Intrazonal soils also have well developed profiles, that is, the characteristics of the parent materials have been appreciably altered during soil formation. Most of these soils occupy flat or depressed positions in the landscape which are more moist than typical for the area. In some places the drainage also has been or is restricted, resulting in the accumulation of excess salts in semiarid or arid climates. Some intrazonal soils are the result of parent materials being unusually high in calcium or sodium salts. These soils reflect the influence of climate to a lesser degree than zonal soils.

Azonal soils are young soils lacking well developed profiles. They are young because the parent materials have been in place a very short time, geologic erosion is rapid, the soil climate is more arid than common for the area, the parent materials are very resistant to alteration, or because of various combinations of these factors. Alluvial soils, Lithosols, and Regosols are included in this group.

Zonal, intrazonal, and azonal soils are not limited in occurrence to a specific climate. Each group includes many kinds of soil. Even in a given locality there generally are several kinds of zonal soils with significantly different soil characteristics and different kinds of native plant communities. The same is true of intrazonal and azonal soils. In a specific locality the soils of these groups have many species in common, however, the grouping of these species into characteristic plant communities is highly variable. The native plant communities of zonal soils best reflect the potential vegetation of a climate, thereby imparting a characteristic aspect to the native plant cover of extensive landscapes.

2. The Suborder:

The suborder includes six subdivisions of zonal soils, three of intrazonal soils, and one of azonal soils. Examples of zonal soil groupings are as follows:

a. Light-colored soils of arid regions.

b. Dark-colored soils of semiarid, subhumid, and humid grasslands.

c. Light-colored podzolized soils of timbered regions.

Only very broad relationships exist between native plant communities and the soil suborder. Subdivisions into various groupings of zonal soils serve to characterize major life forms of vegetation such as desert shrub, grassland, and forest. However, in each subdivision there are significant differences in kinds of soil and kinds of native plant communities.

3. Great Soil Group:

A great soil group includes soils with similar profiles differing mainly in texture, structure, and mineral composition. There are about 21 zonal great soil groups, 13 intrazonal, and 3 azonal. As contrasted to the order and suborder, soils of a great soil group are limited in occurrence to a more specific kind of climate. Therefore, this category is useful in characterizing the life form and structure of extensive native plant communities of regional distribution. In the Southern Plains, for example, mixed tall - and mid - grass plant communities are associated with the Reddish Prairie soil group, mixed mid and short grass communities with Reddish Chestnut soils, and short grass communities with some of the Reddish Brown soils.

Care must be taken to avoid over-generalization in ascribing a specific kind of plant community to a great soil group. Even the zonal soils of a great soil group frequently have sufficient

[1] *Some revisions in the classification system have been proposed. This discussion is based on the system in current use.*

differences in soil characteristics to result in significant differences in native plant communities. For example, some zonal soils of the Reddish Brown soil group support plant communities dominated by short grasses with negligible amounts of mid grasses while others support plant communities dominated by mid grasses with minor amounts of short grasses. Therefore, a great soil group lacks the specificity required to characterize a definitive plant community for a local land area.

4. The Soil Family:

The soil family has not been used much in the past to characterize native vegetation. During the past several years, however, soil scientists have devoted considerable effort to grouping closely related soil series into families. It is anticipated that climatic and other phases of these families will have considerable utility in helping to identify native pant communities of similar potential.

5. The Soil Series, Type, and Phase:

Soils included in a series are developed from parent material that does not differ appreciably in texture or mineral composition. They have horizons similar as to differentiating characteristics and arrangement in the soil profile. The texture of the "A" horizon may differ but many series have only one texture. These are monotype series.

The soil type is a subdivision of a soil series. All features of the soil types of a series are comparable except for the texture of the "A" horizon. Thus the Dalhart series includes several soil types such as Dalhart sandy loam, Dalhart fine sandy loam, and Dalhart loam. These are comparable soils except for surface soil texture.

Phases of a soil type are differentiated on the basis of such characteristics as stoniness, alkalinity, slope, depth, and degree of accelerated erosion. Major emphasis is given to characteristics which are significant to uses of the soil. On rangelands, specific emphasis is given to those phases which influence plant growth and, therefore, the nature of native plant communities. Phases of series, families, and great soil groups may also be recognized.

The geographical distribution of a zonal soil series is limited to an area of land having substantial similarity in major environmental factors. Thus the Dalhart series and its associated types, for example, is limited to a portion of the Southern High Plains having gentle relief and a semiarid climate in which average annual precipitation is from 16 to 20 inches. Seasonal distribution of precipitation, ranges in temperature, and evaporation rates are reasonably comparable throughout the area in which the series occurs.

Correlation Between Native Plant Communities And Soil Types

Correlations with specific native plant communities can best be made with soil types and phases of types. In the absence of major disturbance a relatively distinctive plant community identified by a characteristic grouping of plant species is apparent for a specific soil type. This characteristic grouping of species is not evident in terms of a precise composition percentage of the individual species that reoccurs wherever the soil type is found. However the relative proportion of species in terms of dominance and association is evident. This plant community is not one that is restricted to presumed pristine relict areas. Its occurrence is generally apparent on a number of pastures or grazing units that have had conservative grazing use for a number of years and in which the soil has not been subjected to pronounced physical deterioration. As an example, Richfield silt loam is a zonal soil occurring on gently undulating uplands in southwestern Kansas and the Oklahoma panhandle. Throughout this area this soil type is characterized by the dominance of blue grama *(Bouteloua gracilis)* and the occurrence of buffalo grass *(Buchloe dactyloides)* as the major associated species. Each soil type occurring in the same area as Richfield silt loam has its own characteristic plant community, some of which are similar to that found on Richfield silt loam, and others that are markedly different.

Plant communities that vary materially from the characteristic grouping of species found on an individual soil type occur as a result of varying degrees of disturbance and physical soil deterioration. However, careful observation of the numerous examples normally available within the area of occurrence of the soil type generally provides a clear pattern of the characteristic plant community.

While each soil type having major differences in soil characteristics from another soil type supports a relatively distinctive kind of plant community, those soil types having closely related soil characteristics support essentially similar kinds of native plant communities. Therefore, depending on the degree of plant community differentiation desired for a specific purpose, it is feasible to group closely related soil types to express similar plant community potentials. For example, Ulysses silt loam, Richfield silt loam, and Pullman silt loam support plant communities dominated by blue grama with buffalo grass as the principal associated species. Despite minor variations in the characteristic plant communities of these soil types, they may be grouped for the purpose of developing range management and range improvement plans.

The differences in kinds of native plant communities found on the several types of a soil series may be greater than the differences found on similar soil types of closely related soil series. As an example, the plant community found on Dalhart loamy fine sand is characterized by a mixture of mid, tall, and short grasses, while the plant community of Dalhart loam is dominated by short grasses. However, the plant community found on Vona loamy fine sand is comparable to that occurring on Dalhart loamy fine sand. For this reason it is essential that comparisons of native plant communities be based on comparable soil types rather than solely on comparable soil series. Plant communities having the most features in common occur on comparable soil types of closely related series.

The range of occurrence of some soil series and types may encompass a change in climate great enough to result in a sufficient change in herbage production and plant composition to have significance in management and use. Thus the nature of the characteristic plant community may change to some degree for soil types having relatively extensive areas of occurrence. Such variations in plant community potential can be identified by recognizing climatic phases of such soil types. Similarly, the stony phases of certain soil types may sufficiently influence soil moisture relationships to produce a recognizably different plant community.

The impact of accelerated erosion on native plant communities is variable for different kinds of soil. Severe erosion of some soil types markedly changes their potential for plant growth and, therefore, changes the kind of plant community found on them as compared to relatively uneroded areas.

Effect of Climatic Gradation on Plant Communities of Closely Related Soils

While soil is but one of the environmental factors determining the nature of native plant communities, it is apparent that the influence of climatic change on plant communities can most effectively be evaluated by comparisons based on a sequence of closely related zonal soils along the line of a climatic gradation. At any point along such a line,

Table 1. Sequence of Native Plant Communities on Closely Related Soils from a Subhumid to a Semiarid Climate in the Southern Plains.

Soil Series and Type	Location	Climate	Soil Characteristics	Characteristic Plant Community
Newtonia silt loam	Eastern Oklahoma	Moist subhumid Annual ppt. 40″ PE Index 70.	Zonal Reddish Prairie soil on gently rolling uplands; moderately acid; "A" horizon silt loam, "B" horizon silty clay loam; underlain by limestone and shales.	Tall grass aspect dominated by big bluestem and little bluestem. Indian grass and switchgrass important secondary species.
Norge silt loam	East Central Oklahoma	Moist subhumid Annual ppt. 35″ PE Index 56.	Zonal Reddish Prairie soil on gently rolling uplands; slightly acid; non-calcareous to 6 feet plus; "A" horizon silt loam, "B" horizon clay loam; underlain by calcareous old alluvium.	Dominated by mid grasses with little bluestem the major species, big bluestem an important secondary species; minor amounts of Indian grass and switchgrass.
St. Paul silt loam	West Central Oklahoma	Dry subhumid Annual ppt. 27″ PE Index 42.	Zonal Chestnut soil on nearly level uplands; neutral to mildly alkaline reaction; calcareous below 30 inches; "A" horizon silt loam, "B" horizon silty clay loam; underlain by calcareous silty clay.	Dominated by blue grama; side oats grama is a significant mid grass component; buffalo grass a secondary species; little bluestem a minor component.
Richfield silt loam	Oklahoma Panhandle	Dry subhumid Annual ppt. 19″ PE Index 27.	Zonal Chestnut soil on nearly level uplands; weakly alkaline; calcareous below 20 inches; "A" horizon silt loam; "B" horizon silty clay loam; underlain by strongly calcareous silt loam materials.	Definite short grass aspect dominated by a mixture of blue grama and buffalo grass, mid grasses rare or lacking.
Baca silt loam	Southeastern Colorado	Semiarid Annual ppt. 14″ PE Index 25.	Zonal Brown soil on undulating uplands; mildly alkaline; highly calcareous below 10 inches; "A" horizon silt loam to silty clay loam; "B" horizon heavy clay loam; underlain by silt and clay loess-like materials.	Short grass aspect dominated by blue grama with buffalo grass as the principal secondary species; small amounts of galleta grass *(Hilaria jamesii)*. Substantially less total plant cover.

FIGURE 1. Upland plant community dominated by tall grasses on zonal Reddish Prairie soils in northeastern Oklahoma.

the plant communities of associated azonal and intrazonal soils and also zonal soils of different texture may differ more than widely separated plant communities of closely related zonal soils.

Observations of plant communities on closely related zonal grassland soils of similar texture extending from a moist subhumid climate in eastern Oklahoma to a semiarid climate in southeastern Colorado and northeastern New Mexico, reveal a gradual transition from a plant community dominated by tall grasses to a plant community dominated by short grasses (Table 1).

This sequence of zonal soils includes Newtonia silt loam, Norge silt loam, St. Paul silt loam, Richfield silt loam, and Baca silt loam. Newtonia and Norge are Reddish Prairie soils, St. Paul and Richfield are Chestnut soils, and Baca is a Brown soil. Texture of the "A" horizons is silt loam, while that of the slowly permeable subsoils is silty clay loam. Climate is moist subhumid with an annual precipitation of 42 inches and a PE index of 70 in the area of occurrence of Newtonia silt loam with a gradual transition to a semiarid climate, 14 inches annual precipitation, and a PE index of 26 in the area of Baca silt loam.

The plant community of Newtonia silt loam has a tall grass aspect due to the abundance of big bluestem *(Andropogon gerardi)*. Little bluestem *(Andropogon scoparius)* is the most important associated species. Indian grass *(Sorghastrum nutans)* and switchgrass *(Panicum virgatum)* are important secondary species (Figure 1). Little bluestem is the dominant species on Norge silt loam. Big bluestem is a secondary species. Indian grass and switchgrass are minor components (Figure 2). St. Paul silt loam is dominated by blue grama with side oats grama as an important associated species and little bluestem a minor secondary species. Richfield silt loam is dominated by blue grama with buffalo grass as the major associated species. No significant amounts of mid grasses occur on this soil (Figure 3). Baca silt loam is overwhelmingly dominated by blue grama with buffalo grass as a secondary species. Galleta grass *(Hilaria jamesii)* occurs as a minor secondary species.

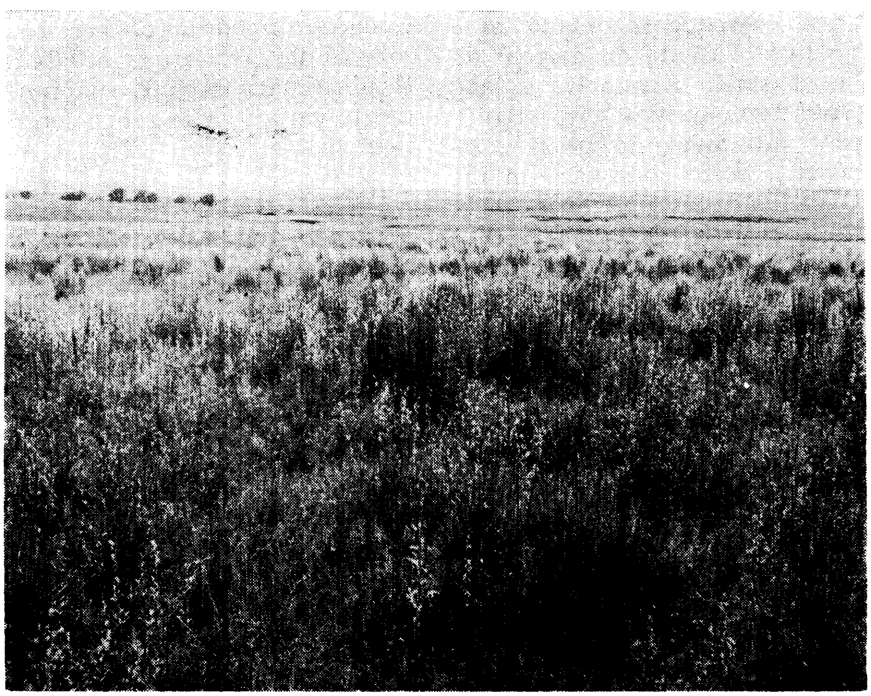

FIGURE 2. Characteristic plant community dominated by mid grasses on zonal Reddish Prairie soils in central Oklahoma.

FIGURE 3. A short grass plant community on zonal Chestnut soils in the semiarid High Plains.

A gradual transition from plant communities dominated by tall grasses eastward and short grasses westward is not apparent if the sequence of closely related zonal soils is ignored. Plant communities with significant tall grass components extend to a semiarid climate on certain alluvial soils. Similarly, upland plant communities with significant tall and mid grass components occur westward in the High Plains on some deep sandy soils, and those deep stony soils which concentrate soil moisture. Plant communities with significant short grass components extend eastward into subhumid climates on some Planosols and some Lithosols.

An example of a contrast at a point along the line of this climatic gradation on soils of comparable surface texture is found in central Oklahoma on Norge silt loam and Kirkland silt loam. The latter soil is an intrazonal Planosol. As contrasted to the mid and tall grass community on the zonal Norge silt loam, the plant community on Kirkland silt loam supports significant amounts of blue grama and buffalo grass. Mid grasses, principally side oats grama and little bluestem, are secondary species. Tall grasses are sparse or lacking. Failure to recognize the difference in potential of these two soils would erroneously attribute the difference in plant communities to variations in range condition.

Use of the Soil Survey in Determining Range Sites

In the Soil Conservation Service, range conservationists and soil scientists work together to determine the kinds of soil that are included in a range site and to establish soil mapping legends for rangeland in which the boundaries of mapping units can be used to determine the boundaries of range sites. Soil survey reports include a brief description of the range sites within the survey area, a listing of the soils included in each site, and the identification of the site or sites associated with each soil mapping unit.

The number of soil series, types, and phases within a single range site is variable. In the Southern Plains most range sites in current use include approximately two to six soil types of one to four soil series. In a few instances a range site is limited to a single series and type.

Summary

1. The nature of the relationship between kinds of soil and kinds of native plant communities is becoming more apparent as a result of joint field evaluations by soil scientists and range conservationists in connection with the National Cooperative Soil Survey.
2. Higher soil classification categories aid in making broad generalizations about extensive native plant communities. They lack the specificity needed to identify specific local areas of rangeland having potentials for producing essentially similar native plant communities.
3. The most meaningful correlation between kind of soil and kind of native plant community occurs at the soil type and soil phase level of differentiation.
4. Variations in plant communities associated with climatic gradients are best determined by comparisons of characteristic plant communities on similar soil types of closely related soil series.
5. Recent soil survey reports of areas including privately owned rangelands list the soils included in range sites and identify the range sites delineated by individual soil mapping units.

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