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Some Classical Methods of Vegetation Attributes Measurements in Rangelands

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ABSTRACT

Around the world in every single country rangeland considers the first animals feed source. Many years ago these sources contributing, supplying and securing animals' feed, besides of, its environmental benefits. Due to misused or unwise utilization; rangeland characters and features facing tremendous changes and degradation. Therefore, management sound and wise plans should be arising to protect, improve and develop its characters sustainably. Undoubtedly, rangeland managers and environmental activists must their mandate and task be in these trends. Rangeland's management and monitoring are based on the evaluation of vegetation attributes (cover, species frequency, species composition, plant density, and carrying capacity). To estimate these attributes their are so many techniques and approaches designed for this purposes. However, the application and selection of suitable methods depend on rangeland characters and vegetation types. Each of those methods has a special considerations. According to this and vegetation features it is being selected. Therefore, this paper is introducing and focusing on the most common using rangeland vegetation attributes sampling methods. That will help young scientists and rangeland managers to pursue their work easily.

1. Introduction

Rangelands cover vast areas of the earth and play a fundamental role in providing feed, besides the cheapest animal fodder source and wildlife habitats. Rangelands are characterized by multi-functionality and play a vital role at economic, social, and ecological levels. Sustainable range management systems contribute to securing fodder and habitat for livestock, wildlife, and pastoral and local communities' livelihood. Nonetheless, inadequate policies, misuse, and over-exploitation of these resources, often in combination with inappropriate practices adopted by local communities, lead to the loss of these valuable resources (Holechek et al. 1995; FAO 2017). Natural rangelands should be exploited by their potential energy to maintain it sustainably. To achieve these goals it needs management sounds and plans to adopt the principles of sustainability and integration of natural resources to preserve and protect from the different degradation causes.

The significant objectives of rangeland management and conservation are maintaining native plant diversity, detecting invasive species, and monitoring rare species (Stohlgren et al. 1998; Severoğlu 2018). Generally, to detect, monitor, and apply range management programs, it should select proper methods or techniques suitable for the studied range conditions and site. Several methods have been used for a long time to sample rangeland vegetation attributes. The classical sampling methods are still used in vegetation sampling. These methods include quadrate, transect, point-frame, step, and loop methods (Çakmakçi et al. 2002). However, this method should be re-evaluated from time to time. Some of these methods focus on describing existing homogeneous plant communities. But most of the ecological patterns have changed. On the same hand, some methods might reduce the variance in some parameters due to correlation effects. Rangeland's management objectives have changed. Moreover, rangeland monitoring and inventory have increasingly needed, to detect and find decreasing species and some changed features in the rangelands. Conducted sampling techniques must be effective (time, cost, and labor needs) (Stohlgren et al. 1998; Tsalyuk et al. 2015).

Vegetation sampling techniques of rangeland must be tested and compared to detect the best one for rangeland management. Several years ago there is common

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rangeland techniques used for vegetation sampling and monitoring. Moreover, these techniques are expected accurately measure the conditions and trends of plant diversity at narrative and wide scales (Stohlgren et al. 1998). Nonetheless, still, a few methods are consistent and appropriate to estimate vegetation. Sampling methods in vegetation studies are related to the vegetation type, time, effort, and reliability. Therefore, it is very difficult to find and select a suitable method properly and can be generalized to all vegetation types (Tosun & Altin 1986). The restrictions of using classical methods are; it could not suitable for all kinds of vegetation and conditions. Meanwhile, field application of some sampling method on the same area revealed different results. On the other hand, modern methods are introduced using sophisticated and advanced tools (remote sensing and geographic information system) to measure range attributes (Zhou et al. 1998). The method to be applied should be approved and accepted and not be concluded wrongly. In recent years, statistical applications have gained importance for quantitative vegetation analysis.

To study vegetation and to analyze its conditions, structural and vegetation composition must be sampled (Cetik 1973). All of up to date using methods agreed; that rangelands should be measured or managed to achieve more accuracy and reflect rangelands conditions. Recently, the exploitation of remote sensing (RS) data has proved to be efficient for monitoring the earth's surface (Phiri & Morgenroth 2017). In such a situation, modern remote sensing and geospatial techniques have an important role to classify and map the vegetation cover of rangelands and forests (El-Hassan & El-Tayeb 2014). Land cover maps are increasingly used to define guidelines for environmental action, and they are used as a powerful tool for natural resources management (Gbenga 2008). Satellite data and advanced cross-cutting classification techniques are required to detect and produce land cover change maps. Therefore, this review introduces some used methods in sampling rangeland's vegetation attributes for prospective rangelands managers.

2. Vegetation Measurements

Rangeland vegetation measuring attributes

It is extremely important to decide which attributes are going to measure, and that reflect the real status of the rangeland. Moreover, separating rangeland vegetation into different units makes it easy to measure and follow its change accordingly. It is very important to be familiar with the vegetation parameters;

Biomass: The weight of vegetation materials per unit area. Production or yield is often used interchangeably with biomass. Measuring plant biomass is regarded as an indicator of response to ecological and management practices of vegetation in rangeland. An ecological indicator is measures the most dominant species within the vegetation. The indicator also reflects the amount of energy stored in the vegetation, which can indicate the potential productivity of the site. Management indicators provide a variety of indicators for rangeland management. It is a valuable tool to assess range conditions, for short-term stocking rate adjustments according to the number of forage reserves and residual biomass. Biomass is used to estimate primary productivity, measure plant response to changes in management and environment, and estimate herbivore carrying capacity. Determine units should be selected clearly (g m^{-2}, lb $acre^{-1}$, or kg ha^{-1}) so it's very easy to express a plant weight (Holechek et al. 1995; Muir & McClaran 1997; Elzinga Ph.D et al 1998). This parameter has a good correlation with the plant's high and developing stage besides estimating herbivore carrying capacity and utilization patterns in the rangelands in a specific period (Muir & McClaran 1997; Babalik 2004).

Cover: The parts or plant parts, living and non-living or dead, on the surface of the ground. There are so many definitions of cover, but the objectives of being measured are determined by the definition. In general, the cover is usually expressed as a percentage (USDA 1999). Basal cover, ground cover, canopy cover, and leaf area index are also terms related to vegetation cover. The basal cover is generally considered more accurate measurement than canopy cover to identify vegetation changes since it is less influenced by climate fluctuations and grazing patterns (Muir & McClaran 1997).

Density: A number of individual plants or species per specific area (Abdelrahim & Abdalla 2015).

Frequency: It describes the abundance and distribution of plant species; it is a useful parameter to detect changes in vegetation over time (USDA 1999). To determine the frequency, the observer is only observing the presence or absence of a species in a sampling unit. It is the relation between the number of sampling units in which the species is present and the total number of used sampling units. The attribute is determined as a percentage of total sampling units, the frequency value range from 0% to 100% (Jadalla et al. 2015).

Species composition: Species composition or botanical composition is a contribution of each species to the standard vegetation. Practically it's the contribution of plant hits for each species. Species composition is expressed as a percentage of the total number of points where vegetation was recorded as a hit. The signifies of this attribute come out of dominance and well distribution of species in rangeland, botanical composition is used relatively to determine range condition and range trend (Muir & McClaran 1997).

Sample size and shape

The optimum sample unit size for rangeland sampling depends on the described attribute, the size of plants present and their types, and the exits of special patterns within the vegetation. Sometimes the size selected in a rangeland inventory or monitoring program is depending on a convention or previous practices. In fact, it is important to continue using the same sample units with the same size for repeated measurements, especially in the same locations. Therefore, sample unit size must be carefully considered in the planning stages because of its significant role in determining sample accuracy and detecting sampling bias. Sample unit size influences sample accuracy by controlling boundary decisions. Larger sample units have a lower perimeter: area ratio (Table 1), which reduces possible bias from incorrect boundary decisions (Muir & McClaran 1997).Sample size and sampling tool shape have a huge effects on observed data. For example; Brummer et al. (1994) showed that increasing quadrate size accounted for 68% or more of the observed decrease in variance. The effect of quadrate shape on reducing variance was inconsistent among vegetations. Rectangular quadrates were more efficient for reducing variance than square and circular shapes (ElzingaPh et al. 1998).

Table 1
Effect of size on perimeter: area ratios of sample units (Muir & McClaran 1997).

Dimensions	Perimeter: Area Ratio
1 x 1	4.0
2 x 2	2.0
3 x 3	1.3
4 x 4	1.0
5 x 5	0.8
6 x 6	0.7

The number of samples needed to obtain accuracy is determined by the variance of the quadrate. A large number of quadrates (sample size) must be sampled regardless of quadrate size or shape to estimate vegetation of individual species with high accuracy and precision. It is very important to consider effort and cost efficiency in combination with statistical efficiency when evaluating quadrates in different sizes and shapes. Small quadrates own significant variances but require less evaluation time. When time and statistical efficiency are considered for various sizes of quadrates, small quadrates are determined to be significantly more optimum (Brummer et al. 1994). Vegetation distributions (homogeneous or heterogeneous) have a great effect on the number of samples to be selected. Also, during vegetation sampling using different sampling tools, it is very important to sample sufficient samples for the highest degree of confidence (Cakal et al. 2012). Sample units should be large enough so that most of the areas completely covered, so that most dominant plants are included. Conversely, inefficient spending of time relative to the additional information acquired is apparent in sample units that are larger than necessary. Enought sample units are reguired to include different plant life forms. In contrast, smaller sample units are more convenient in full dense vegetation. An altirnative sampling system could be used to overcome problems faced when sampling species of different life forms or so many abundance species in the sampling area (USDA 1999).

3. Vegetation Sampling Methods

The most common and classical methods that are used to examine rangelands vegetation attributes;

1- Quadrate method

2- Transect (Line) method

3- Loop method

4- Point-Frame method

5- Line Intercept method

6- Step Point method

7- Daubenmire method

8- Estimation method

9- Remote sensing and Geographic Information System (GIS).

Quadrate method

Quadrate method in sampling techniques used to sample vegetation attributes in so many vegetation types. This technique has high efficiency in evaluating rangeland vegetation parameters. The quadrate sampling method is more efficient to analyze the species richness and abundance (Elina et al. 2015).

In this method, frames of certain sizes are used to examine rangeland areas. Quadrate is a two-dimensional sample unit of any size or shape. Sometimes, a tape might be laid on the ground level at the sampling area to represent the quadrate. Nevertheless, frequently the quadrate is a frame created from narrow steel or plastic and placed from one sampling site to another. The quadrate is applied in measuring most rangeland vegetation attributes in so many vegetation types (Muir & McClaran 1997). Quadrate size and shape differ according to the dominant species and measurement purposes. The size fills between 1 dm^2 and 1 m^2 or more, rarely with slight diameters. The most suitable quadrate size used in sampling rangeland is 0.5 m^2 and 1 m^2 (Erac & Ekiz 1986). Quadrate with a gird shape is used in different sizes e.g. 20 x 20 cm, 20 x 25 cm, and 1 x 1 m (Figure 1). Generally, the most suitable and common applied size is 0.5 m^2 and 1 m^2 in sampling rangeland. The fundamental of this method depended on counting or determining vegetation or plant species in a particular area. Mostly in terms of foliation, cover grades, or other quantitative consists of examining and identifying their characters (Muir & McClaran 1997; Babalik 2004).

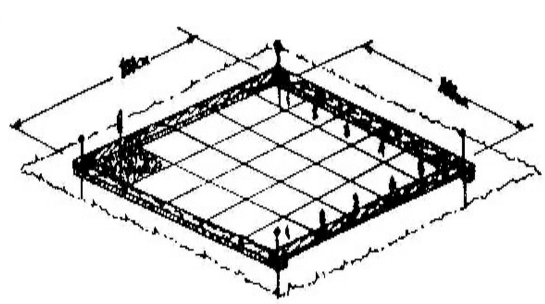

Figure 1
Quadrate shape (Gençkan 1985).

Study on vegetation with quadrates

Cover determination

Briefly, the observer is placing quadrate randomly or sometimes systematically in the specific sampling area. The examiner is looks in the quadrate and count and list each noted plant species inside the quadrate. Quadrate is placed and repeated so many times according to the study area and vegetation characters. Often gird could be used also. During the estimation process using gird, then the area covered by each species is estimated visually in every single gird, and then the total area covered by the species is summed, to represent a covered area of plant species. As the result, the sum estimate cover and the bare area should be 100%. The result is calculated as a percentage from the whole number of grids or direct visualization of the quadrate. Sampling cover with the quadrate method is very quick and easy to estimate.

Generally, the quadrate method is well adapted and widely used in sampling vegetation cover. It is induces reliable and accurate results in most vegetation types. However, to be applicable, the method is more suitable and practical in short plant vegetation. Estimating plant cover with this method depends on the vegetation density and species types.

Evaluation of frequency

Frequency is referred to the number of times that a species is appear within a used quadrate placed repeatedly across target vegetation. Frequency is expressed as a value between 0% and 100%, representing the proportion of quadrates where the particular species was found during sampling. It is generally expressed as a percentage of total placements of the quadrate and reflects a particular species at any location within the sampling stand. Only the occurrence sampled quadrates are recorded regardless of the number of species. Herbaceous plants must be rooted in the quadrate to be considered to exist (USDA 1999). Frequency is simple vegetation attribute to measure because it only requires identification of the species in each quadrate, and does not require that individuals are distinguished, measured, or counted. Therefore, data collection is usually a more rapid procedure than other vegetation attributes. However, quadrate size is very important to be considered regarding frequency sampling. The size influences the probability of occurring species within the quadrate. Where small quadrate results in low frequencies of most species and most species are not sampled. Whereas, a large one will include most species but it could not be the most common species that will eliminate the ability to detect the change in the abundance of these species. Therefore, choosing a suitable quadrate size and shape is a paramount function of the average abundance per area. Thus, in frequency sampling, more decision error is introduced in deciding if a plant is in or out of the quadrate boundaries (Despain et al 2021).

The field sheet to record frequency usually includes a species list and a tally is made for every quadrate where the species is recorded. Only a single tally is made for each quadrate, which represents the presence of the species regardless of its abundance. Once fieldwork is completed, data is summarized to estimate the frequency for each species in the sample. Procedures followed to summarize the data depend on the definition of the sample unit that was determined by the selected quadrate during the planning stages. The following formula is used to calculate frequency (Muir & McClaran 1997; Abuswar 2007).

$$\text{Frequency \%} = \frac{\text{Number of units occurrance of A species}}{\text{total number of used unit}} \times 100$$

Observing frequency with quadrate is very quick and effective. However, monitoring rangeland conditions is, overall, more a concern of abundance than distribution. Frequency data can show significant changes in percentage values whereas no real changes in abundance actually exist.

Density

Units to express density should be selected priory so that actual plant numbers are easy to visualize. Density is often used as a baseline inventory of the structure of rangeland or forest vegetation, by quantifying different species or various ages within a single species. Density data is also collected to monitor the effect of various land use treatments, such as plant survival following burning or overgrazing. Density measurements are sometimes unsuitable for the herbaceous, especially when there are so many plants to count or identification of individuals is difficult. Nonetheless, density is regularly used to evaluate seedling emergence and survival in a rangeland reseeding or rehabilitation program. Density can provide useful indicators in an inventory and monitoring program to determine range conditions and trends. Density is affected by range management especially grazing pattern and stocking rate (Bonham 1989; Muir & McClaran 1997; USDA 1999). Sampling density with the quadrate involves random and systematic sampling. Under the principles of random sampling, quadrats are located randomly, each quadrate represents a sample unit. And systematically using transect and placing the quadrate regularly along transect. Each transect represents a sample unit. The observer will count and list the occurrence plant inside each quadrate. A number of individuals per quadrate must be calculated for statistical analysis. Summarizing data involves adjusting values according to quadrate size, so density is expressed on a standardized area (i.e., m^2, ft^2, acres, and ha).

Botanic composition

Botanic composition in each rangeland site reflects the richness of this rangeland, and revealed the trends of management. Species composition can be expressed on either an individual species basis or by species groups that are defined according to the objectives of the study program. Species composition is commonly regarded as an important attribute in rangeland assessment, it is describing the characteristics of vegetation management during deeply detailed inventory programs. However, accurate determination of species composition can be hard, because all species must be sampled (Muir & McClaran 1997). To determine these attributes the observer is look in the quadrate and lists by tallying each plant species found inside the quadrate**.** Ultimately, data is summarized and arranged to be analyzed according to the plant composition and species composition. Species composition is based on the percent of the various species. The following formula is used to determine botanic composition:

$$\text{Botanic composition} = \frac{\text{number of species A in the quadrate}}{\text{total number of species}} \times 100$$

Plants biomass

Biomass is one of the most commonly measured attributes in range inventory or monitoring programs. Biomass data may be collected on an individual species basis, as species groups, or as a total weight of the vegetation. Species composition may also be calculated as the contribution (percent by weight) that each species makes to the total biomass (Holechek et al. 1995; Muir & McClaran 1997).

Biomass is an attribute that is time-consuming and laborious to collect, but easy to interpret. Vegetation productivity is estimated with the quadrate by clipping the plant inside the quadrate. Clipping is the most common method used to determine herbage weight in rangeland. Consistency is needed in terms of clipping height and separation into live and dead components. Herbage weight is determined by clipping the vegetation within the quadrate. In spite of, the labor and time-consuming method it is still widely used in monitoring vegetation. Moreover, Biomass is usually determined on a dry matter basis, which is the weight of plant material after the moisture within the plant material has been extracted. Moisture content varies among species and during the year, according to the stage of growth and growth form. Summarizing weights on a dry matter basis facilitates comparisons of biomass among sites and over time by eliminating other confounding factors (Holechek et al. 1995; Muir & McClaran 1997). Dry matter content is determined by drying a sample in an oven, usually, at 60 – 70 ° C, for 72 hours, or until they reach a constant weight is obtained, after that the weight is taken with a suitable balance (Severoğlu 2018; Osman 2019). Since moisture levels differ among species, samples of individual species may have to be dried and weight separately. Dry matter weight is always obtained on the base of the standard unit (gr m^{-1}, kg $acre^{-1}$, or ton ha^{-1}).

Transect (line) method

Transect is a linear used for quantitative plant ecology characters. Sampling a floristic quantitative of herbaceous in rangeland in most conditions using various transect lengths. Generally, transect length description as 1 cm wide and 100 cm in length, in this miner it is quite sufficient for vegetation sampling. The basis of this method is laying a 100 cm^2 long tape. To evaluate vegetation attributes in rangeland 105 – 120 cm transects are stretched with 1 cm in width along the target area (Eraç & Ekiz 1986; Yilmaz et al. 2016). Practically it took the sample centered 100 cm^2, and two transect ends are left blank. Besides of transect strip steel (measuring stick) and fixed metal are required in this method. Strip steel is used to hit a plant species along transect and to distinguish it easily, fixed metal is to stick the transect end for more accuracy and to make it fixed without any movement during noted and sampling (figure 2) (Eraç & Ekiz 1986; Babalik 2004; Altin et al. 2011). However, 20 m transect length is well applied and proposed by so many researchers. A narrow and slight transect is preferred since, when looked at it from above the bottom of transect should be well visible and all plants and easily distinguished. The method is widely used in measuring vegetation attributes; its sampling error is very small. The transect method is used to examine all vegetation measurements in rangeland even shrubs and trees (Altin et al. 2011).

The application of this method includes throwing transects randomly on the vegetated area. With the aid of a fixed stick, the transect bar is sticked, so that the bar does not move during the measurement. For every 1 cm^2 it tallies vegetation along transect. The measuring stick is moving forward to determine what is touching the tape. If there is a plant in contact with the flat part of the measuring tape during the forward movement, the species is determined namely, and if there is none, it is recorded as bare soil (Uçar 2019). During sampling, the observer record each hit points to estimate vegetation attributes (vegetation cover, species composition, density, and frequency) (figure 3). Transect number and arrangement depending on the study purposes and vegetation dens. Besides of some considerations i.e. soli type, sloping, and most dominant species (Yilmaz et al. 2016). With this method, it can estimate vegetation cover, botanic composition, and frequency. Ultimately the data are organized and interpreted according to the target parameter.

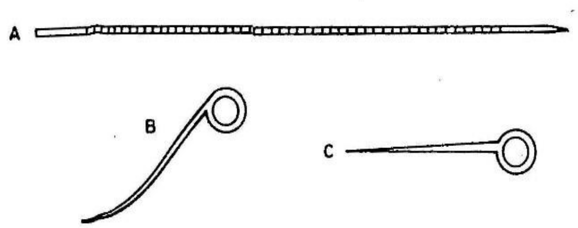

Figure 2
Transect method; A- transect tape, B- measuring stick, C- fixed stick (Altin et al. 2011)

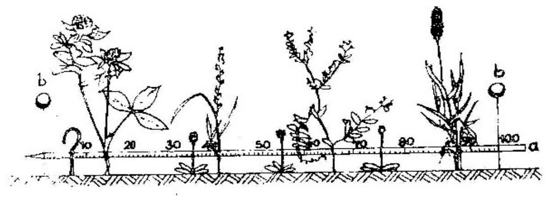

Figure 3
Application of transect method (Gençkan 1985).

Assessment vegetation attributes with transect method

The method consists stretching of 100 cm^2 of an area. To follow this method, points are taken every 1 cm^2 along with measuring tape, that is extended to create transect across the site. The tape could be stretched systematically or randomly in the study locations.

Defiantly, depend on some factor such as; species diversity and abundance, soil type, and slope. Each transect considers a sample unit, therefore it recommends to sample so many transects for statistical analysis. For each plant species, the sum of the hits found is given as a percentage of the area covered with vegetation. After the completion of fieldwork data is arranged and summarized to determine vegetation attributes;

a) Assess plant cover: The following formula used for this attributes.

$$\text{Plant cover} = \frac{\text{total hits on the plants}}{\text{total number of hits}} \times 100$$

b) Botanical Composition: it calculated with this formula;

$$\text{Species composition} = \frac{\text{No hits on the A species}}{\text{No hits on the plants}} \times 100$$

c) Frequency: Examined transect samples of a plant species how many times it's has been appeared in the sampling. It s simply calculated by this formula:

$$\text{Frequency} = \frac{\text{No of unit the A species is occurance}}{\text{No of used units}} \times 100$$

Loop method

The loop method is introduced by rangeland scientists to execute vegetation measurements. The method consists of a metal loop and measuring tape 20m in length. The loop contains a ring in the end which is used to direct and detect hits along transects. Briefly, the method consists of a 20 – 30 cm loop metal length with a 2 cm diameter ring, in the end, 20 m tape, or any type of measuring transect. In the direction of the loop every 20 cm a hit is taken, totally about 100 points are taken in each transects. This method is commonly used in vegetation sampling to evaluate range conditions and trends.

Practically, the method is based on the measurement of a plant with a directing loop on the line/tape at regular intervals every 20 cm. At every point from the beginning of the line, the loop is suspended in the vertical direction of the vegetation, and the plant, litter, rock or bare soil, etc., inside the ring, is recorded in the prepared relevant form (figure 4). Sometimes more than one plant might be noted in the same loop, in this case, only the strongest plant is considered present (Tosun & Altin 1986; Eraç & Ekiz 1986; Babalik, 2004; Altin et al. 2011).

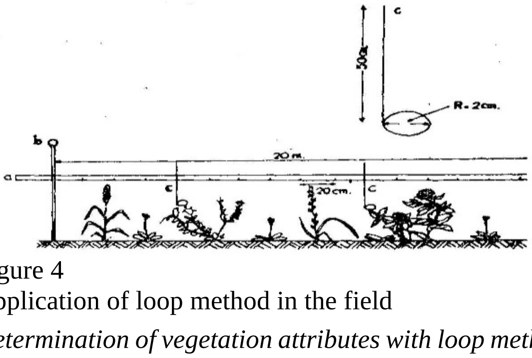

Figure 4
Application of loop method in the field

Determination of vegetation attributes with loop method

a) Cover: Since the hit points along measuring tape is recorded. Each hit point on the cover is automatically summarized and give the percentages of the vegetated area, by the following formula;

$$\text{Vegetation Cover} = \frac{\text{No of hits on the plant species}}{\text{total No of hits}} \times 100$$

b) Botanic composition: The parameter is determine according to this technique by summarizing the whole hit point on the specific plant species divided with the hit points on the vegetation. Here this formula used to determine a parameter;

$$Botanic\ composition = \frac{\text{hit on A species}}{\text{total hits on vegetation}} \times 100$$

c) Species frequency:

$$Frequency = \frac{\text{hit occurance on A species}}{\text{Total No of hits}} \times 100$$

Point-frame method

The point frame method is based on point sampling to determine range attributes. It consists of a standing frame that holds a set of vertically aligned pins, which are lowered as sampling points to record vegetation. The frame has about 10 pins consider a point. A common arrangement consists of 10 pins each 10 cm in the interval. The most suitable and common size of the point frame is 1m in height and width. So the same plant is not hit by all pins. Each point frame is usually considered a sample unit, so commonly cover data can be assessed in 10% intervals. Data from several frames are required for statistical analysis (Muir & McClaran 1997).

Generally, the method consists of a tool in frame shape that carries the pins. The frame width is 1 m horizontal axes length (standing on two legs in the side end) such that they can be movable fixes (figure 5). The frame carries about 10 pins (points), they are arranged on the frame 10 cm between each point (figure 5). The pins are passed through the holes on the vehicle (frame) the pins are placed in the vertical position and move up and down during sampling. The pins are made of metal, and the end of the point frame tool feet are tapered to ensure that remain in a fixed position in the ground (figure 5). The point-frame method is based on the analysis of the cover and botanical composition. In the process of application in the field, it is important to distribute the frame over the study area. It was proposed random distribution of the frame during sampling for more accurate results (Babalik 2004), and others propose to be applied across the field in sequence along a straight line. The number of points to be sampled in the range depends on the vegetation and the study area (Altin et al. 2011). The application of the technique depends on placing the frame at the interested measuring field, and then the pins are lowered down. These pins will hit the existent vegetation or (bare soil, rock, or litter) whatever it touches will be recorded (Tosun & Altin 1986).

The method provides significant accurate cover results, as long as enough points are observed. Somehow, eliminates much of the bias arising from subjective placing. The point frame is practically suitable for grasslands and other low-growing vegetation. However, the method becomes impractical in taller shrub lands and trees even with the mixed vegetation because of difficulties in placing the point frame above tall plants. It is also not suited to sample dense vegetation (Muir & McClaran 1997).

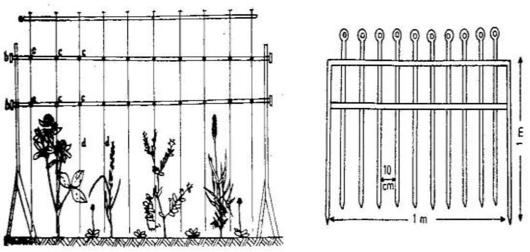

Figure 5
Point-frame shape and field application (Gençkan1985; Tosun & Altin 1986).

Line intercept method

The method consists of horizontal, linear measurements of plant intercepts along the course of tape (line). It is designed to measure grass or grass-like plants, forbs, shrubs, and trees (USAD 1999). The line intercept method was developed to estimate cover and botanical composition in arid and semi-arid grasslands.

To follow this method, a tape is extended to create transect across the site. The observer proceeds along the line transect, identify plants intercepted by the tape and records intercept distances. The cover is calculated by adding all intercept distances and expressing this total as a proportion of tape length. Each transect is represented as a sample unit, therefore several transects must be measured for more reliability of vegetation conditions and statistical analysis. Measurements can be made for either basal cover or canopy cover, according to the objectives of the study. Species composition is easily estimated from the relative proportional represent each species. Transect length depends on the vegetation and type of plants that are to be measured. In many sampling programs, 3 m is used (USDA 1999). However, 15 m transects have been found suitable in dense vegetation, while 30-50 m is needed to obtain a representative sample in spared vegetation area (Muir & McClaran 1997).

The line intercept method is well adapted to sampling variance densities and different types of vegetation and provides an accurate estimate of cover. In fact, the line intercept method is often used as the standard comparison when testing other methods to determine cover. However, the primary drawback of sampling with this method is time-consuming, particularly in dense vegetation (very difficult to recognize individual plants) or when intercept distances are difficult to define because of many gaps or irregular edges within the canopy. Therefore, the line intercept technique is best suited for vegetation characterized by discrete plants (Tosun 1972; Muir & McClaran 1997; USDA 1999).

To apply this method a baseline is established by stretching a measuring tape in a desired sampled area across vegetation. Sometimes for an extremely long baseline, intermediate stakes could be used to ensure proper placement of the tape. To collect vegetation data the observer will measure each intercepted area by the plant species along transects.

a) To estimate the percent cover for each plant species by tallying the intercept measurements for all individuals of that species along the transect line and converting this total to a percent.

b) Calculate the total cover measured on transect by adding the cover percentages for all the species. This total could exceed 100% when the intercepts of overlapping canopies are recorded in study.

$$\text{Cover} = \frac{\text{C}}{\text{B}} \times 100$$

C = Total intercepted area with all plants (cm)

B = Transect length (cm)

c) Botanical composition; species composition is based on the intercepted cover of each species. Determination of the parameter by measuring the covered proportion of transect with the plants (USDA 1999). The following formula shows how it can calculate:

$$\text{Botanic composition} = \frac{\text{A}}{\text{B}} \times 100$$

A= Target species intercepted area (cm)

B = Transect length (cm)

Step point method

A step point method is an approach based on point sampling to determine cover. To procedure this method, the observer uses a mark placed on the tip of his boot (often a pin or a notch) as the sampling point. Hits are recorded by identifying whatever falls directly under the mark along a placed transect. The step point method is regularly used for rangeland inventory or monitoring purposes because it is easy to apply and rapid to employ, allowing large areas to be quickly described. Nevertheless, undesirable variability often occurs among observers, caused by bias associated with point size and foot placement. Some modifications, including pointed tape that extends beyond the wheeled point apparatus, have been developed in an attempt to overcome the biases arising from subjective placing. Most relevant results are obtained by the step point method in open grassland. To implement this technique the observer is laying measuring tape along the study area. Then the sampler put a marker (usual pin) made of metal on the end of his boot and walk among transect, recording whatever hit the mark (plant, bare soil, litter, and rock) in the prepared form. The placed transect is considered the sample unit. Data from several transects are required for statistical analysis. It is used in loop or line-transect methods to determine vegetation attributes (Muir & McClaran 1997; USDA 1999; Altin et al. 2011).

Daubenmire method

The Daubenmire method consists of systematically placing a 20* 50 cm quadrate frame along measuring tape. The Daubenmire method is used to estimate vegetation cover, botanic composition, and frequency. The method is applicable in a wide variety of vegetation types especially in short grasses.

To implement this method a line tape is laid along the intended sample area. The quadrate is placed along the tape at the specified intervals, estimating the canopy coverage of each plant species. Recording the obtained data from each quadrate, to estimate cover class according to the Daubenmire form (see Table 2).

Table 2
Cover separate classes (Daubenmire 1959; USDA 1999)

Cover class	Range of covarege	Midpoint of range
1	0 – 5 %	2.5 %
2	5 – 25 %	15.0 %
3	25 – 50 %	37.5 %
4	50 – 75 %	62.5 %
5	75 – 95 %	85.0 %
6	95- 100 %	95.5%

The observer looks directly from above and estimates the cover class for all individuals of a plant species in the quadrate, all other plants species are considered separately according to:

a) Canopy Cover: Determine the percent canopy cover by species as follows:

- On the Daubenmire form count the number of quadrates in each of the six cover classes (by species) and record in the (Number column) on the Daubenmire summary form.

- Multiply this value with the midpoint of the appropriate cover class.

- Sum the result for all cover classes by species.

- Divide the sum by the total number of quadrates sampled on transects.

- Record the percent cover by species on the form.

b) Frequency: Calculate the percent frequency for each plant species by dividing the number of occurrences of a plant species (the number of quadrates in which a plant species was observed) by the total number of quadrates sampled along transect, multiply the resulting value by 100.

c) Species Composition: With this method, species composition is based on the canopy cover of the various plant species. It is determined by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species (USDA 1999).

Estimation method

The method is based on the evaluation of the vegetation qualitative by observing the vegetation in a specific area, rather than measuring the characteristics of the plants. In this method, small plots are selected and estimated visually. Some estimation methods are used clipping for comparison with optical estimation. Estimation methods require considerable training and constant checking on the part of the estimator. The method consists of estimating the weight of the plants in the plot unit and then clipping it for comparison. The method is very quick and the result is achieved easily. However, the disadvantages of the method are a) the evaluation results change from person to person, b) the assessment of the same person on the same vegetation can change over time, and c) the impossibility of evaluating the recorded qualitatively by observation in this way by other observers later on (Tosun & Altin 1986).

The application of these methods on a field consists, of a small part of the vegetation being bounded by the frame (approximately 1m2quadrate) and examination done by looking directly at the top and performing the prediction process. Firstly the estimation is carried by species, each covered area with specific species is estimated by eyes, and then the sum covered area by all plant species is calculated. The method is well suitable in short grass or after grazing or mowing, but the application of this method is very difficult in tall grass or even shrubs. Moreover, the accuracy of the observer depends on experiences and training (Eraç & Ekiz 1986; Babalik 2004; Altin et al. 2011).

Remote sensing and GIS

Remote sensing is an advanced and sophisticated tool that is used to qualify rangeland. Remote sensing is a modern tool contributing to sampling and monitoring vegetation in rangeland; it allows characterizing the spatial and temporal variability of biophysical parameters by quantifying and analyzing the electromagnetic energy reflected by the vegetation. The initiation of new freely available satellite imageries such as Sentinel- 2 and Landsat-8 has offered new biodiversity assessment and monitoring opportunities. These new satellites' improved spatial and spectral resolutions are also renewing for algorithm or methodological protocol development, particularly for different landscapes (Junges et al. 2017). Recently, exploitation of remote sensing data has been used efficiently for monitoring vegetation in a wide area of rangeland. In particular, depends on the reliable and precise definition of the existing terrestrial vegetation. In such a situation, modern remote sensing and geospatial techniques have an important role in classifying and mapping the vegetation cover of rangelands and forests (El-Hassan & El-Tayeb 2014).

Remote sensing is defined as the observation of objects from a certain distance without any direct contact using a special instrument or electronic device. The vegetation of an area can be determined from satellite images. Satellite data and advanced classification techniques are carried out to detect and produce land cover /change maps. Remote sensing and geographic information system technologies are appropriate tools for providing practical and near-real-time analysis capabilities, which could help to assess and monitor vegetation of rangelands, degradation, and management features (Jong et al. 2004; Marsett et al. 2006; Mohamed 2006). Remote sensing offers biophysical variables like vegetation indices that are utilized to detect variability and changes in rangeland ecology in large areas over several years (Bastin 2006; Amiri and Shariff 2010; Chuvieco & Huete 2010). In addition, the integration of remote sensing and geographic information system in environmental studies has increasingly become common in recent years. Remote sensing imagery is an important data source for the environment. Geographic information system capabilities are being used to improve image analysis procedures (Hinton 1996).

Remote sensing data and vegetation indices are effective tools to study rangeland and vegetation cover. Besides, it is used in large areas of rangeland to collect vegetation parameters. Combination of vegetation indices reflectance measurements from different portions of the electromagnetic spectrum to provide information about vegetation cover on the ground. The vegetation indices are radiometric measures of the spatial and temporal patterns of vegetation photosynthetic activity that are related to canopy biophysical variables such as leaf area index fractional vegetation cover and biomass (Jabbari et al. 2015; Ghorbani et al. 2012). More than 20 vegetation indices have been defined and used to detect change and estimate vegetation cover in rangeland. The Normalized Difference Vegetation Index (NDVI) is the most widely used in such studies. The NDVI values theoretically range from (-1) to (+1). In areas where there is a lot of green vegetation, the index value approaches +1, while in areas where there is little vegetation, it has minus NDVI values. Different image techniques are used in this technique for data processing and analysis which include geometric correction, radiometric correction, atmospheric correction, image enhancement, and false-color composite (Xue & Su 2017; Dharmawan et al. 2021).

The fundamental of this method is based on monitoring and/or measuring reflected spectral greenness or absorbed photo-synthetically active radiation and thus photosynthetic activity in the vegetation (Zhou et al. 2009). Extraction of information subsequently makes these extracted features available, and it is very easy to qualify without destruction or any type of damage to vegetation (El-Hassan & El-Tayeb 2014; Gandhi et al. 2015). This technique is very easy to apply to all types of vegetation without any restrictions. The method has a high degree of accuracy compared to the classical methods. Remote sensing systems provide more useful and practical data in determining the boundaries of grassland areas, detecting changes in vegetation over time, and generating classification of rangelands.

In conclusion sampling in rangeland is very important to the managers as a consequence of plans and monitoring programs. The selection of suitable and appropriate techniques is essential. The methods to be applied in the study and analysis of plant vegetation depend on the characteristics of plant vegetation. Observation and the purposes of the sampling should be considered. There are no standard techniques or methods that are recommended to sample or estimate rangelands. However, the methods and procedures to be used should give the most accurate data about the sampled vegetation. Likewise, the selected methods should be easy to apply during sampling and do not take so much time and labor. Moreover, the method must be approved, accepted, and well recognized. For the huge variation and differentiation in vegetation characters and rangeland conditions, the method and procedures should be adjusted to that condition.

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