Title: Managing Water to Create Sustainable Rangeland Systems

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Introduction

Sustainable systems are those that are capable of continuous system function while producing a desirable product. Appropriate function is defined by the goal, for example, healthy rangelands and livestock production. The National Academy of Science panel for rangelands suggested appropriate function includes soil water characteristics near the potential for the site, little soil erosion, and production and composition of vegetation that would be expected given a specified soils-climatic relationship. (Rittenhouse and Roath, 2001)

Sustainability implies that important attributes of the system vary over time within acceptable bounds, based on both intrinsic and human values. The managers dream would be that, over time, all the elements and attributes of the system would attain some steady-state condition consistent with a goal. In fact, that can not and will not happen. The system is fraught with uncertainty because of all the system dynamics and vagaries of external factors. All systems tend to organize within a range of variability. Management can, however, dampen the variability by timely system intervention.

It is quite uncommon for management choices to be based **first** on the capability of the land and **later** on the kind of enterprise we would like to operate! Generally, quite the opposite is true. Observations indicate that some of the greatest ecological wrecks achieved were products of failure to understand the land and its capabilities. It is my conviction that sustainable systems must, by the nature of the definition, be based primarily on what the land is best adapted to produce. This determination must come with experience with the land, observing it and its responses to management activities. It is unlikely that without experience on the land even the most skilled academic would be able to ascertain more than a crude assessment of the lands' capability. It is most skillfully done by those that have lived with the land, perhaps augmented by training.

"Partnering with the Land"

Intervention, mentioned above, should be rephrased as "Partnering with the Land". This is best described as a tenuous relationship where man/manager endeavors to use his knowledge to create continuity of outcomes from well-intentioned and hopefully harmonious choices about the activities on the land. From what we now know about system function, water is the driver for system response. Therefore, managing water is the key to our success, or demise in Partnering with the Land.

Water is Managed on the Land by Managing Cover.

If water is the driver in the system, then ground cover is then the regulator of the water. To be effective, the water in the system must infiltrate and percolate into the soil column. This crucial process is mediated by ground cover. The greater the surface cover of vegetation, litter, and rock, the more effective is the capture of incident and run-off moisture.

Let us for a few moments consider how the system works. In the Northern Great Plains, much of the moisture received comes during late winter and the spring with relatively large proportions of the moisture coming in few events. As few as four to six events will determine whether the year is dry or moist. This means the most important amounts of moisture come as relatively high intensity events. This creates a great impetus for overland flow, unless the surface soil environment is "prepared" for rapid rates of infiltration and reducing overland flow. Land surface arrayed with a continuous cover of vegetation, litter and other debris is extraordinarily capable of impeding run-off and infiltrating water at high rates.

Infiltration and percolation of water into the soil creates the first success in the process of managing water on/in the land. By maintaining shaded soils, plant height, good soils organic content and friable soil surfaces, soil storage of water is quite efficient. This water has three fates: 1) the plants may translocate it for plant use; 2) the water may be lost from the system by evaporation; or 3) it may move through the soil column by a process called inter-flow.

Translocation of the water by plants directly produces forage resources for grazing animals and creates our investment in the future of managing water. The soil moisture driving plant growth produces more forage, greener forage, and a much longer green forage season. This plant environment is more drought resistant and much more resilient to a variety of stresses, including grazing. Incidentally, diversity of vegetation especially, the forb component is a product of a more mesic environment. However, when large, persistent-leaved woody plants, like juniper, pines, and sagebrush, dominate the environment they have an extraordinary tendency to transpire moisture at very high rates and in large amounts robbing the associated understory plants of critical water resources to the point where they may no longer comprise any appreciable ground cover. Thus creates a much drier environment that is much in evidence across the west today.

Managing the "House" the Plant Live In

The plants' environment can be made either drier or wetter by how much above ground cover that we maintain. Above ground structure creates a buffer between the air flow/wind and the ground. This has major influence on the rate of surface and stored soil water evaporation and the desiccation of the soils and the plant material it contains. The cover also has a large affect on soil heating and cooling that is so typical to rangelands of the west. The combination of the above factors can determine whether you have a drought or an average year with the same amount of precipitation.

Why Streams Flow

Inter-flow is the process of gravity pulling the water laterally in the soil column toward the lowest position in the landscape. This is largely why draws and riparian areas maintain moisture long after the remainder of the landscape is bone dry. The water that moves by inter-flow and in some cases augmented by over bank flooding is stored in the deeper soils in the draws in what is called bank storage. This can be a relatively large amount of water that continues to be pulled toward the lowest position in the landscape, namely the streambed. When things are working right this creates and sustains a stream

Tools for Managing Water

Management choices that improve water relations in the environment are those that either change the ground cover or the above ground cover. The primary tool that does that, is stocking rate of grazing animals. The stocking rate will determine the amount of forage grazed and more importantly in managing water the amount of residual left. When using grazing animals as a tool, managing the residual vegetation left at the end of the grazing period and planning for the recovery of vegetation structure and vigor is the job to be done. The standing residual during and at the end of the grazing season combined with that material that will become litter will determine the watershed response.

How do We Know if the Land is Managing Water, Well?

The sustainability of the land will be a function of our ability to manage water. When we are doing a good job then all kinds of positive things are happening and when we are not then negative feedbacks happen. While whole system responses are difficult to measure, we can use some indicators of how healthy the system is and what the longer term impacts of the current management choices might be. We can look at these indicators at the plant level, at the plant community level and at the landscape level.

Landscape indicators are how much moisture the land retains and stores relative to the amount received! Do the streams run? Perennially? Are the draws moist when they should be? Does there always seem to be a drought? Do willows and cottonwoods grow where they should? Are they regenerating? While the expectation is not for wetlands to be everywhere on rangelands; it is my observation that many of rangeland areas can and will be more moist, given appropriate management choices. In fact, there are clear indications that there are many areas of the west where streams ran 100 years ago that do not now.

Community level indicators are ground cover and the presence or absence of active erosion. Most rangelands should accumulate some residual plant material to assist with erosion management. If our choice of animal stocking rate has been appropriate, then we should have positive indicators of low erosion and ground cover in balance with the productive capabilities of the plant communities.

A set of indicators that I use for the plant level are those that relate to assessment of the plant responses in a grazed environment. We know that plants responses to defoliation are predicated on **frequency of defoliation**, **intensity of defoliation**, and **opportunity of the plants to grow or to regrow** (Reed et al. 1999). If this is how plants respond, then we should be able to use them to monitor how plants are responding. If the plants are not responding as we would like, then we, now using this new set of tools, can adjust the defoliation events so that the results are more appropriate. This approach has been used to plan a grazing regime by first assessing the probable impacts of the new grazing program. If it predicts poor results a revised program is chosen and implemented. The implemented grazing program is then monitored by assessing the frequency, intensity and opportunity that the program produces. This approach has been field tested and implemented regionally. When the plants are responding positively, then there is a high probability that you are building the cover in the system, which regulates water!

The above descriptive mechanics of sustainable systems can be used to define, implement and monitor your system under its current management or to alter the management so that it comes more closely to the sustainability that you are after.

References:

Rittenhouse, L. R. and L. R. Roath, 2002. Monitoring grazing practices and stocking rates for sustainability. Acta Practaculturae Sinica 11(1): 91-95.

Reed, F. R. Roath and D. Bradford. 1999 The grazing response index: A simple and effective method to evaluate grazing impacts. Rangelands 21: 3-6