

Monitoring Patagonian Rangelands: The MARAS System

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Abstract—Rangelands in Patagonia have been managed with a lack of regulation since the introduction of sheep in the late 1880's. Most rangelands are under private freehold in 'estancias' and the rest are public and managed by small subsistence-type farmers. Natural resources of rangelands are property of the provincial states according to the Constitution, but they have no mandate or resources to monitor their condition and public support funds have not been tied to proper management. Government agencies designed in the 1990's two range evaluation systems that have been applied extensively but they focus on short time - scale processes to allocate forage resources at the "estancia" scale. The need of a regional monitoring system to evaluate rangeland condition and trend is slowly being recognized by governments and farmers, and scientists of Patagonia have been discussing a possible unified methodology. The system has been named MARAS and is based on Australia's WARMS (Holm 1998) and other similar methods. Lines of point interception and frequency samplers are used to evaluate herbaceous vegetation, Camfield lines to evaluate shrubs and patches, surface sampling, and estimates of soil condition. Ground observation points would be set one per cadastral unit (about 20,000 ha) and evaluated at five-year intervals. State funding has been obtained in 2004 to put in place the first monitors, and to design a web data base that would give selective access to the information to federal, provincial, or non-governmental institutions. The main challenge of the system is to assure funding through decades in order to assess long time-scale processes. We expect that ecocertification market requirements will induce farmers to support it, and that the new trend of public funding included in a new sheep promotion law will allow the system to continue.

Introduction

Cold semi-deserts in Patagonia are mostly rangelands stocked with about nine M sheep, 0.8 M cattle and 0.8 M goats. Most of the 75 M hectares of land are in private hands in medium sized estancias that range from 10 to 20 thousand hectares, under freehold type tenure, although smaller production units on public land are also frequent in the N of the region. These areas for sheep tending were colonized at the end of the XIX century, but even today the total population of 1.75 M is scarce (.23 inhabitants/km²) and concentrated in cities, as only about 0.2 M people live in the rural area. A more detailed description of the land is presented elsewhere in this Symposium Proceedings (Cibils and Oliva 2004).

Rangeland degradation is a concern for farmers and governments due to sheep stock decrease from the historical 20 M to less than half (Mendez Casariego 2000). The reasons of the crisis include low profitability of the sheep products, and mainly the decline in production indexes

that slowly reduce number of stock in individual estancias and make the systems sensitive to periodic natural disasters, such as snowfalls. Dwindling productivity and unfavorable macroeconomic policies placed most of the producers of medium sized estancias in trouble (Borrelli and others 1997). About 10 M ha of the Central Plateaus have been abandoned by the year 2000 in Santa Cruz province. Farmers of smaller enterprises remained in the land and survived with little commercial exchange and serious social problems. Big enterprises followed on with reduced employment rates and smaller profits.

The objective of this paper was to shortly summarize the state of rangeland science in Patagonia. We discuss the progress in range forage assessment at "estancia" scale with stocking adjustment and adaptive management. From this we will address the need of a monitoring system that would measure variables at an appropriate temporal and spatial scale. We will present the MARAS initiative of a group of range scientists of Patagonia, and discuss briefly the main challenges of such a system.

Range Science

Rangeland science in Argentina is recent, and still has to develop fully and build into the government policies and rural financial instruments. Although 90 percent of Patagonia is occupied by rangelands, their management depends entirely on the decisions of the farmers. Some early researchers have pointed out the need of a scientific approach of the management of rangelands taking into account early degradation indicators (Auer 1951, Soriano 1956a, b). However, range science development started in the late 70's, mainly in federal Agricultural Research Agencies such as INTA (Anderson 1980) and University of Buenos Aires in basic ecological research. By the end of the 1980's two different range evaluation methods were developed, one based on Pastoral Value indexes drawn from step-point quadrat estimations of forage species cover (Elissalde and others 2002), and a second one known as Santa Cruz method, that evaluates forage biomass by direct cuts of shortgrasses and herbs, and utilization degree using residue height of key species of short grasses (Borrelli and Oliva 2001). Range condition inventories have been used to aid management, and interpreted into State and Transition models (Paruelo and others 1993). Between 1990 and 1994, with international support of GTZ (Germany), INTA and other institutions performed a general assessment of the desertification status and reached to the conclusion that about 34 percent of the rangelands of Patagonia was in severe or very severe degradation status (Goergen 1995, Oliva and others 1995, Del Valle 1998, DHV-SWEDFOREST 1998). As a side effect of this project, image processing units and GIS training and equipment were installed in the area. Public funds for range evaluation were allocated to different desertification projects between 1989 and 2003, and allowed for training and support for rangeland evaluation that has reached to approximately 4.5 M ha by 2004.

Range Evaluation Methods

Range evaluation strategies have focused on providing objective assessment of the forage status at a typical estancia scale with reasonable costs. They are the basic input for management plans that are paid by the producers and performed by private or semi-private range professionals that are included in a provincial registry after being trained in special courses. Evaluation usually implies about 10 and 15 paddocks with a mean area of 2.5 thousand ha, and the production of detailed maps using satellite imagery. The pastoral value method is usually applied fully in an initial assessment, that includes cover of all species, but the stocking rates are adjusted furthermore in relation to rainfall (Rimoldi and Buono 2001).

The SC method involves annual evaluations of shortgrass biomass and height to adjust stock allocation, but less palatable plants are not included (Borrelli and Oliva 1999). The main assumption is that undesirable transitions will be avoided if sheep leave approximately half of the standing biomass of the main forage species.

The Need for a Monitoring System

After 14 years of the first range evaluations, it is clear that a monitoring system is needed for three reasons (1) The variables recorded in repeated rangeland assessments are few and not sensitive enough to avoid transitions, (2) the time scale (years) and the spatial scale (estancias) are not appropriate to monitor regional processes and (3) the private funding of range evaluations implies restrictions on data and limits the area of application.

Indicators are Needed

Research sites have demonstrated that cover of the dominant species in these rangelands dominated by long lived perennials is not a good indicator of the proximity of transitions to degraded states. Oliva and others (1998) monitored yearly vegetation cover in a stocking rate experiment in Moy Aike Chico, Santa Cruz for over a decade, and concluded that the rangelands had reached stable states under grazing, under high stocking rates (0.60 sheep/ha) the cover of the most important species and even the main forage items did not change at all or actually increased. Vegetation change had nevertheless took place under high stocking rates as the most palatable and rare species disappeared, the diversity index declined, soil texture changed where fine lime particles were lost by erosion (Oliva and others 2000), and N and organic matter diminished with long lasting effects (unpublished data). These rangelands also show distinctive patterns of mounds associated to tussocks (Oliva 1996) or shrubs (Rostagno and others 1991) that act as sinks of nutrients and facilitate grass establishment (Soriano and Sala 1986, Aguiar and Sala 1999), and their disruption may change the function of the grassland. An appropriate set of soil, vegetation, and structural indicators of the rangeland seems to be necessary in order to prevent unfavorable transitions.

Time and Spatial Scale

Range evaluations concentrate in annual variations of forage quantity that are clearly perceived by farmers and allow adaptive management practices. Long term declines in production that could be the result of range

degradation are regarded as signs of declining rainfall (Oliva and others 2004b), a tendency that is not evident in climatic data (Cibils unpublished). Demographic models have shown nevertheless that processes such as subdivision of tussocks under high stocking rates could determine the extinction of the tussock population after 4 or 5 decades (Oliva 1996). A monitoring system should keep track of slow changes that are best evaluated at long intervals to allow for cumulative processes to be revealed, but these changes will not be easily interpreted and recognized by managers.

Funding

The best efforts of range consultants and extensionists have reached about 6 percent of the total area of Patagonia. New financial tools tied to range evaluations may imply an expansion, but there is a small probability that they will reach the vast spaces of land withdrawn from sheep production, run by small subsistence type producers that may not pay for new practices or farmers that are simply not interested in new practices and stick to the traditional ways. The monitoring system should therefore be based on public funds and the ground points selected as a sample of all the rangelands.

The MARAS System

Since 2002, a group of range scientists (Oliva and others 2004a) of Patagonia backed by a National Action

Against Desertification (PAN INTA-GTZ Germany) program has been developing a monitoring system whose acronym MARAS (Monitoreo Ambiental Regional de zonas Aridas y Semiaridas) relates to regional monitoring of arid and semi-arid rangelands. The initial methodology has been established in two previous meetings and the first monitor was set up in the Rio Mayo INTA experimental field in April 2004. Our system aims to monitor ecologic units that range from 0.4 to 11.4 M ha. They would be covered by ground monitors at a density of one per 20.000 ha, that approximately matches the size of cadastral units. The location of the monitors would be set in a cadastral GIS layer divided into ecological units, and then reassigned in the field in order to avoid edges of vegetation communities or the proximity of waterpoints or fences. A web data base will validate the entries using a single species and indicators list for the entire region and connect the points in the GIS layer. Information will be selectively accessible to different federal and provincial governmental agencies and NGO's. The data base will be developed in order to connect with GIS software of different vendors that are used in the region, and will hopefully be adopted as a unified system by the different provincial departments of agriculture.

The field layout (Fig. 1) matches the one used by West Australia's WARMS method (Holm 1998). It consists in a photographic pole that bears the identification of the site. A trapezoid shaped polygon marked with permanent poles and delineated with ropes covers the area of a digital camera with a 50 mm lens. Three 50-m transects at the end of the trapezoid allow for the

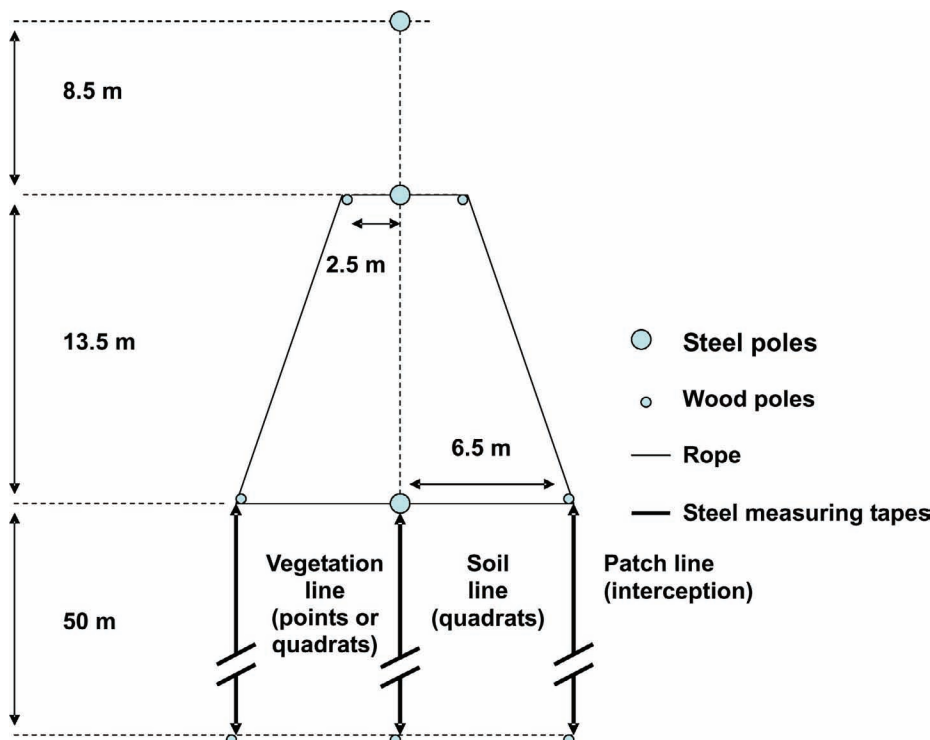


Figure 1. Schematic layout of a MARAS monitor.

Table 1.

Indicator	Method
Vegetation	
Cover of vascular species (except shrubs)	Point quadrat or Daubenmire
Bare ground %	Point quadrat or Daubenmire
Desert pavement %	Point quadrat or Daubenmire
Litter %	Point quadrat or Daubenmire
Standing dead %	Point quadrat or Daubenmire
Cover of Lichens and mosses	Point quadrat or Daubenmire
Forage cover %	Synthetic variable from cover estimations
Shortgrass cover %	Synthetic variable from cover estimations
Bunchgrass cover %	Synthetic variable from cover estimations
Dwarf shrub cover %	Synthetic variable from cover estimations
Shrub cover %	Interception lines
Non-native species relative cover %	Synthetic variable from cover estimations
Invasive species relative cover %	Synthetic variable from cover estimations
Shannon Weiner diversity index	Synthetic variable from cover estimations
Species richness	Synthetic variable from cover estimations
Patch structure	
Number of patches	Interception lines
Size of patches	Interception lines
Soil	
Rills (water erosion signs)	Visual inspection in soil quadrats
Nebkas (wind accumulation signs)	Visual inspection in soil quadrats
Surface crust stability	Slake test
Pedestals or plants with uncovered roots	Visual inspection in soil quadrats
Total N (%)	Kjendhal
Organic C (%)	
P (mg/kg)	Olsen
pH	
Resistance (ohm.cm)	
Clay %	
Lime %	
Sand	

evaluation of vegetation and soil (Table 1). Herbaceous and dwarf shrub cover are estimated along one transect using either the Dagget Poissonet's point quadrat method with 500 points or a modified Daubenmire with one hundred 0.20 m² quadrats and visual estimation of the cover of each species. The second transect serves as a Canfield line to estimate the number, size and type of patches of vegetation and bare soil, allowing also for the estimation of shrub cover, if present. The third transect is used to evaluate signs of wind and water erosion on soils, and soil surface aggregate stability using the slake test (Tongway 1994). A superficial (0-10 cm) soil sample will be extracted and analyzed in the laboratory. Evaluations will be performed by trained and registered private consultants or by government personnel. The monitors will be revisited every five years, and the initial number will be carefully assessed in order to assure fewer repeated measures instead of a high number of single observations based on WARMS experience.

Who will pay for the MARAS and why? Most of the land in Patagonia is under private freehold, and although the provincial governments in principle own the

natural resources of the rangelands, they have no legal mandate or resources to monitor them. Public funds for crisis relief or support of sheep farms have historically been distributed without taking into account the state of the land and management, but the trend of allocation of funds is slowly changing as the society becomes aware of the degradation of rangelands and producers involve in certification processes such as organic productions that require monitoring. It is foreseeable that some sort of ecocertification of sustainable practices will be eventually required to export products of rangelands, so that monitoring could be strategic from a commercial point of view. In a recently promulgated Sheep law, sustainable range management plans based on forage evaluations are mandatory to obtain benefits (Poder.Legislativo. Nacional 2004). Resources allocated to this law are managed yearly by a joint commission of government and producers and have been assigned in 2004 to construct the data base, train the evaluators and put in place the first ground monitors of the MARAS initiative in Santa Cruz province. A GEF funded initiative to aid in monitoring, environmental education, and conservation in Patagonia

is also expected to start shortly and may facilitate the scaling of this initiative to the whole region. Soft money may allow the system to start, but the real challenge is to assure that hard money of governmental budgets will be available in a long time scale, and to coordinate INTA as a federal agency and five provincial agencies to work together and interoperate. Progress depends on political decisions, but also on the evolution of public knowledge of goods and services that are provided by rangelands and the concern of producers in relation to ecocertification.

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