Pastoral Land Use and Grazing Measurement through Remotely Sensed Data

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Pastoral land use and grazing measurement through remotely sensed data

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Introduction

About 60 percent of the world's pasture land (about 2.2 million sq km), just less than half the world's usable surface is covered by grazinglands. These are distributed between arid, semi arid and sub humid, humid, temperate and tropical highlands zones. This supports about 360 million cattle (half of which are in the humid savannas), and over 600 million sheep and goats, mostly in the arid rangelands (grasslands) (IFAD, 2005). Grasslands around the world can have drastically different grazing management systems depending on the political, social, economic, and cultural settings. Livestock grazing is the predominant type of land use, providing the livelihood for more than a billion people. Still, livestock grazing is associated with large uncertainties, as the productivity of the pastures depends strongly on the low and highly variable precipitation (Behnke *et al*., 1993; Sullivan and Rhode, 2002; Westoby *et al*., 1989). In the semi-arid areas of western Rajasthan, the sparse yearly rainfall is concentrated in a distinct and short rainy season that is followed by the crop growing season and also the grassland vegetation. For a risk-averse herder, the challenge of grazing management is to optimally adapt to this highly variable and highly uncertain rainfall scenario while taking into account ecosystem dynamics. Extensive livestock rearing by Raika / Dewasi community has been a major occupation for centuries and traditional nomadic herding lifestyle in western arid Rajasthan. Its open grazing lands have so far, more or less, sustained this activity. But, with the teeming population of small-ruminants, management and control over village pasture use has slackened as a result incidences of encroachment have increased during recent past.

We studied a pre- and post- monsoon pasture in the Nimbol village of Pali district using Clark's Animal Tracking System (GPS) and remote sensing techniques. Our objectives were to: 1) understand the changes in pastoral land use management and document grazing land use patterns during the pre-grazing (pre-monsoon) and post-grazing (post-monsoon) periods at a local scale using remote sensing mapping methods, 2) evaluate changes in grazing land use from the pre-grazing and post-grazing period, and 3) assess the effects of land use changes on rangeland vegetation productivity using LISS-IV Mx satellite images.

Materials and Methods

In this study, two different large flocks of sheep were fitted with GPS collars that recorded date, time, and position at every 15 seconds intervals during their movement. Oregon State University provided custom built GPS collars based on the u-blox Max-7C Global Navigation Satellite System (GNSS). (Clark *et al*., 2006). These collars required weekly change of batteries. During their movement, all animals in the herd were treated similarly. Collected GPS information was overlaid on LISS IV Mx satellite data, as well as satellite images with a ground pixel resolution of 5.8 m.

Results and Discussion

Examination of the recorded track logs of sheep revealed 15 second-by-15 second movement of animals including their resting, grazing and watering activities (Gaur *et al*., 2013). Sheep track logs were plotted on the interpreted land use maps and NDVI was estimated. It has been estimated that NDVI from the pre-grazing and post- grazing period using LISS-IV Mx satellite images and compared the mean NDVI estimates from these two periods. Our results indicate that two major changes occurred in pastoral land use management. First, grazing distribution changed from localized clusters to a more evenly distributed pattern. Secondly, grazing intensity increased by over 200 animal units due to return of herds. Our results also indicated that NDVI values from the post-grazing period are significantly lower than the NDVI values from the pre-grazing period indicating that rangeland vegetation productivity might be declining in Nimbol village due to grazing. This decline in NDVI might be largely associated with the increased grazing intensity from the pre-grazing period to the post- grazing period. It has also been found that flock did not follow same route to graze. They return to a particular route only after 7-10 days. It is well known that sheep browse ground-level grasses very intensely, thus leaving very little or nothing behind. So, herders, on their own, return after 7-10 days and follow optimal grazing management strategy and allow grasses to re-grow. This can be termed as "*rest rotation system*". Rest provides an opportunity for the vegetation around natural or developed water to recover. Additionally, rested pastures provide forage for emergency use during severe drought years, and provide opportunities to implement relatively long-term grassland improvement practices (e.g., burning, reseeding, brush control) during scheduled rest periods. Because livestock is the major user of primary production in arid and semi-arid regions, degradation has always been attributed to this subsector (Sidahmed and Yazman, 1994). But, the strong seasonality of grassland production is highly influenced by the rainfall in the western Rajasthan, so it limits the risk of overgrazing that damages the environment to short periods and consequently confined areas. During the monsoon period, livestock grazing pressure was distributed at a few localized pockets, while it was distributed more haphazardly during post-monsoon period, local grazing is allowed during lean season in Nimbol village. As soon as local resources (water and forage) are exhausted, herders start migrating to greener pastures like Haryana, Gujarat, Madhya Pradesh, etc. Another significant feature in the composition of animals has occurred. The number of goat has increased 1.43 times (over 2003 census) whereas population of sheep has declined sharply (2.95 times over 2003 census). This might be due to meat and dairy consumption.

Conclusion

The optimal grazing management strategy, as adopted by the Raika community, is to give an opportunity for grazing in which current rainfall exceeds some threshold and has a relatively low degree of risk involved. Further, due to the particular intra-annual variations of grassland grazing due to variability in rainfall, this optimal grazing management rule is quite effective in grassland restoration. Also, semi-arid regions contain dynamic and highly resilient ecosystems, with a strong capacity to regenerate rapidly when the rains return. Similarly, traditional pastoral systems of Raikas have conserved biodiversity because they have a direct interest in preserving a wide variety of plants and animals (Louhaichi *et al*., 2014). Our results indicate that rangeland productivity has declined in the rural areas. This decline appears to be associated with the changes in grazing land use management over the last 25-30 years. In particular, increased number of livestock might be associated with this decrease in rangeland productivity. Such patterns could continue and further reduce rangeland productivity in study area and elsewhere.

References

Behnke, R. H., I. Scoones and C. Kerven. 1993. *Range ecology at disequilibrium: New models of natural variability and pastoral adaption in African savannas*. Overseas Development Institute, London.

Clark, P. E., D. E. Johnson, M. A. Kniep, P. Jermann, B. Huttash, A. Wood , M. Johnson, C. McGillivan, K. Titus. 2006. An advanced, low-cost, GPS-based animal tracking system. *Rangeland Ecol. Manage*., 59: 334-340.

Gaur, K., Mahesh, K. Chand, M. Louhaichi, D.E. Johnson, A. K. Misra and M. M. Roy. 2013. Role of GPS in Monitoring Livestock Migration. *Indian Cartographer*, Volume XXXIII: 496-501.

IFAD, 2005. IFAD Annual Report 2005.

Louhaichi, M., K. Chand, A. K.Misra , M. K. Gaur, S. Ashutosh, D. E. Johnson and M. M. Roy. 2014. Livestock mobility to cope with global climate change in the state of Rajasthan. *Journal for Arid Land Studies*. 24(1):61-64.

Sidahmed, A. E. and J. Yazman. 1994. *Livestock Production and the Environment in Lesser Developed Countries*, pp. 13-31, In: J. Yazman and A. G. Light (eds). Proceedings of the International Telecomputer Conference on Perspectives on Livestock Research and Development in Lesser Developed Countries, IDRC, INFORUM, Winrock International, November 1992- April 1993.

Sullivan, S. and R. Rhode. 2002. On non-equilibrium in arid and semi-arid grazing systems. *Journal of Biogeography*, 29, 1595–1618.

Westoby, M., B. H. Walker, I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. *Journal of Range Management*, 42, 266–274.