DOI: https://doi.org/10.4038/ta.v168i2.55

Tropical Agriculturist, Vol.168 (2), 2020

Land-use systems based approach for land degradation assessment

H.K. Kadupitiya, M.A.K. Munasinghe, K.M.A. Kendaragama, W.M.A.D.B. Wickramasinghe

Natural Resources Management Centre, Department of Agriculture, Peradeniya, Sri Lanka

Abstract

Land degradation is one of the most threatened issues in the world. It has many consequences for sustainability of the natural resources. Land degradation directly links with land-use and influenced by many other factors. LADA-QM is a tool designed for mapping land degradation by integrating local understanding and expert judgement on degradation status in spatial units of land-use-systems (LUS). This approach was successfully tested for many other countries and accepted as common method which allow comparison among countries. The study aimed at evaluating LADA-QM approach for assessment of land degradation status in central province of Sri Lanka. GIS map of LUS was generated with 18 land-use classes by aggregating 35 land-use categories following LADA-QM guidelines. Degradation status was evaluated through guided brain-storming sessions and field assessment with locally experienced expert group. LUS specific information on degradation type, degradation intensity trends and degradation area proportions were assessed and generated maps. The degradation results found comparable with results of previous studies. The land degradation was high in lands under annual crops, marginal tea lands and un-organized construction sites. Lack of land ownership, poverty and population pressure were also identified as prominent land degradation drivers. Though, initial data preparation is intensive, the LADA-QM approach is relatively more time saving and cost effective than other input data intensive assessment methods.

Keywords: Expert knowledge, LADA-QM, Land degradation, Land-use system

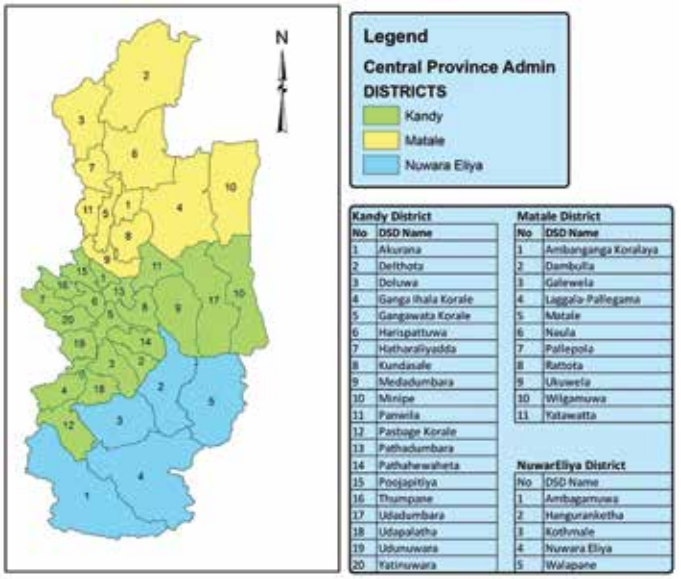
Introduction

Land degradation still remains as one of the most threatened issues in many countries as it has adverse impact on environment sustainability, food security, agronomic productivity and the quality of life (Adams and Eswaran, 2000). Land use changes in Sri Lanka have been transformed vegetated lands into agriculture lands, human settlements and urban centres at the expense of natural vegetation and thereby aggravated the land degradation (Nayakekorala, 1998). Rate and level of land degradation varies in a same land-use with many aspects such as management conditions, climatic settings, topographic conditions, soil type and many other influences (FAO, 2005). Although, Sri Lanka is smaller in extent, spatial heterogeneity is very high in those aspects (Munasinghe, *et al*., 2001, Wickramasinghe, *et al*., 2013). The area of same land use can further be classified into different units based on aspects mentioned above and these units are commonly referred to as land use systems (LUS) which exhibit more or less uniform conditions. Land degradation status in LUSs can be analysed and evaluated using ranked based score system by integrating opinions collected from the local staff and expert judgements. A questionnaire mapping (QM) system for regional level degradation assessment was developed by the Land Degradation Assessment in Drylands (LADA) program which is a global initiative funded by the Global Environment Facility and implemented by Food and Agriculture Organization (FAO, 2011). LADA-QM is a tool which can link questionnaire data to GIS for mapping degradation related information (Koohafkan, *et al*., 2003). LADA-QM has already been tested in many other countries and regions for land degradation assessment and provides access to compare degradation status among countries in a region (Freddy, *et al*. 2010). This study aimed at evaluating the applicability of LADA-QM LUS based expert judgement approach for land degradation assessment in Sri Lanka.

Materials and Methods

Study region

Soil erosion is the most threatened land degradation process in Sri Lanka, terms of severity and extent. Although it is an island wide occurring process, it is well understood that the Central Highland is the most important area that should be conserved, primarily due to the importance of water resources of the whole island. Thus, pilot scale assessment programs were conducted in the Central Province of Sri Lanka (Figure 1).



Kandy District	
No	DSD Name
1	Akurana
2	Delthota
3	Doluwa
4	Ganga Ihala Korale
5	Gangawata Korale
6	Harispattuwa
7	Hatharaliyadda
8	Kundasale
9	Medadumbara
10	Minipe
11	Panvila
12	Pasbage Korale
13	Pathadumbara
14	Pathahewaheta
15	Poojapitiya
16	Thumpane
17	Udadumbara
18	Udapalatha
19	Udumuwara
20	Yatinuwara

Matale District	
No	DSD Name
1	Ambanganga Koralaya
2	Dambulla
3	Galewela
4	Laggala-Pallegama
5	Matale
6	Naula
7	Pallepola
8	Rattota
9	Ukuwela
10	Wilgamuwa
11	Yatawatta

NuwarEliya District	
No	DSD Name
1	Ambagamuwa
2	Hanguranketha
3	Kothmale
4	Nuwara Eliya
5	Walapane

Figure 1. The study area and the administrative divisions of the Central Province of Sri Lanka

LADA-QM approach

The LADA-QM tool is based on the mapping questionnaire (Koohafkan, *et al*., 2003). The questionnaire pays more attention to issues on type of degradation, degree of degradation, spatial extent, causes and impact on eco-system services of each LUS. Linking the information obtained through the questionnaire to a Geographical Information System (GIS), the approach permits the production of maps as well as area calculations on various aspects of land degradation and conservation. The map database and mapped outputs provide a tool to obtain an overview of land degradation and conservation in a country, a region, or world-wide.

Land degradation assessment units

LADA-QM methodology accepts the fact that land use is the most important factor that governs the land degradation. Sri Lanka is a country with lot of heterogeneity in dynamic situation has result a large number of land uses and land use systems. However, in-order to make the study feasible, some land use classes were clustered into broad categories. LUS is the spatial unit for collection of data used in LADA-QM approach, through the questionnaire. LUSs were developed by combining land use types

(35), slope categories (10), soil (34), climate (46), conserved area, low land paddy, irrigated region and administrative units (36) in the region using GIS and large number of units resulted. Later all land use types were aggregated to 18 types and combined with 36 admin divisions to develop LUS. National database on land uses contain 35 land use categories (Department of Surveys). However, for the LADA assessment purpose, some of those land uses were merged based on their management and finally 18 land use systems were identified for the assessment process. The land use systems were 1. Forest-Unmanaged (forest outside reserves), 2. Woody Perennial-Protected (within forest reserves), 3. Sparsely used vegetated area, 4. Grasslands, 5. Bare Area-Protected (within forest reserves), 6. Bare Area, 7. Perennial Agriculture-Coconut, 8. Perennial Agriculture-Rubber, 9. Perennial Agriculture-Tea, 10.Woody Perennial Crops, 11. Crop Lands, 12. Paddy, 13. Urban, 14. Rock, 15. Wetland-Protected (within forest reserve), 16. Wetland-Unmanaged, 17. Open Water-Protected (within forest reserves), 18. Open Water. Land use system analysis resulted that there are 20 land use systems existing within the Central Highland. Among them, woody perennial crops, perennial agriculture (Tea), Unmanaged Forest and sparsely vegetated areas are the most dominant land use systems (Figure 2).

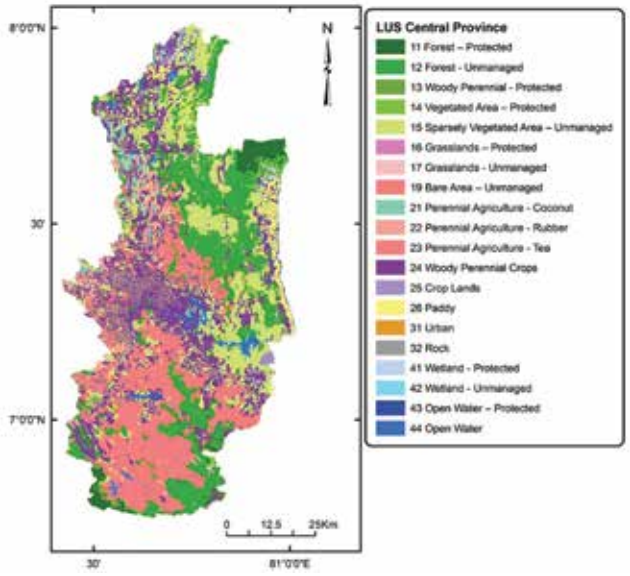


Figure 2. LUS map of Central Province

Assessment by expert group

Institutes dealing with land related activities were contacted and 48 expert officers with long-term development & research experience in land degradation and related fields and formed the assessment group. The selected experts are broadly from sectors such as agriculture, animal husbandry, water resources management, soil conservation, forestry and local and national agencies who has local level knowledge as well as expert knowledge. LUS were elevated for different aspects of land degradation through guided brain-storming session, workshops with expert group and field investigations.

Evaluated aspects of land degradation

Degradation type, degradation intensity trends and degradation area percentage were generated and maps were evaluated. Further, land degradation drivers and pressures, impact on production and ecosystem service and status of land degradation prevention measures specific to each unit were evaluated.

Results and Discussion

Land degradation types

Initially it was attempted to determine the degradation types occurring within the Central Province. The figure 3 depicts the spatial distribution of degradation types happening within the province under the context of present land use systems. It was revealed that surface erosion, gully erosion, loss of habitats, fertility decline, loss of soil life, and loss of top soil are the degradation types taking place within the Central Province at present. However, most significant degradation types were surface erosion (41 %), Gully erosion (20%) and loss of habitats (20%) in the study area.

Land degradation intensity trend

Intensity trend indicates whether a particular degradation process was intensifying its severity within a given locality. Results were evaluated in GIS and land degradation intensity trend map prepared for Central Province. Results showed that 43% of the area showed moderately increasing trend while 'no major change' and 'moderate decreasing' situations were occurring in 32% and 21% of the extent, respectively. However, major increase was exhibiting only in an area of 3% from the total (Figure 4).

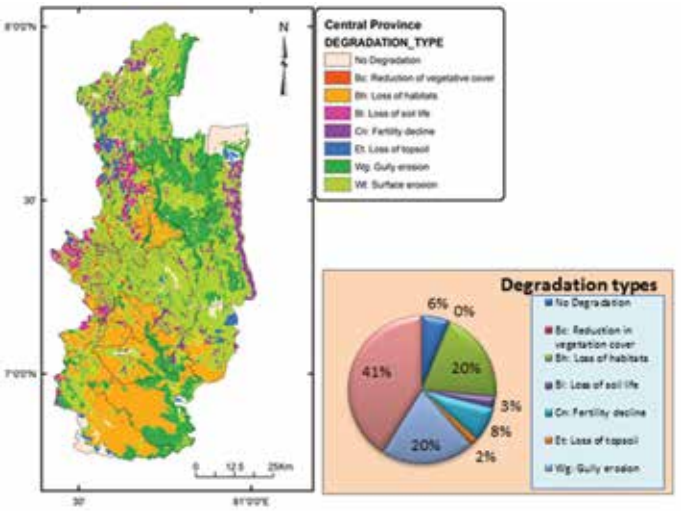


Figure 3. Major degradation types of Central Province

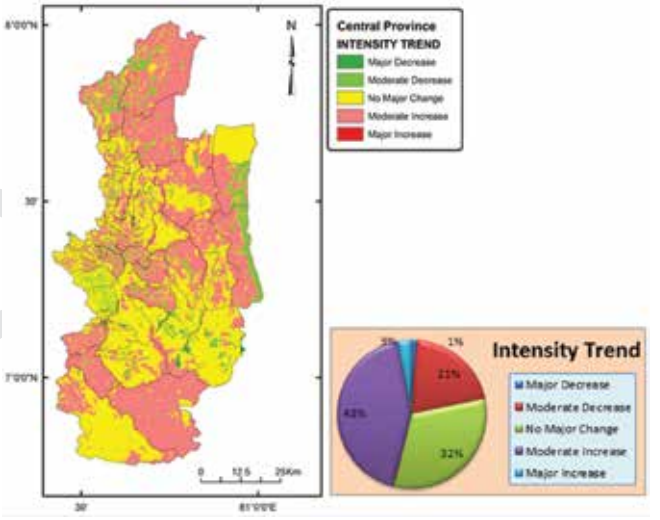


Figure 4. Intensity trend of degradation in Central Province

Land degradation area percentage

The land degradation area percentage indicates the area as percentage that degraded. In this analysis, it was observed that almost all the area in Central Province was fall range 10-100% (Figure 5). The "no degradation" or "less degraded" percentages could only be observed in areas with thick forest cover.

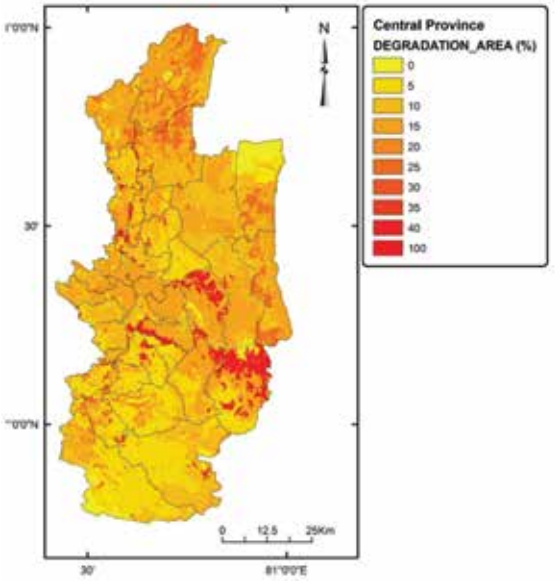


Figure 5. Degradation area percentage in Central Province

The results were compared with previous studies done with other approaches and found that the approach of LUS based expert judgments are comparable with most of the degradation categories (Kadupitiya and Madana, 2006, Munasinghe, *et al*., 2001).

Land degradation drivers and pressures

It is general belief that the natural factors are dominant causal factors for land degradation while human induce factors enhance the process. Information revealed that, in the study region, the land degradation, particularly the soil erosion was high in lands under annual crops, marginal tea lands and un-organized construction sites. Lack of land ownership, poverty and population pressure identified as prominent land degradation drivers in some localities. According to the opinion of local level experts, prevention and control measures implemented at field level are highly localized and scattered. Thus, mapping at a scale of provincial level seems inappropriate.

Conclusion

This study proved that the LADA-QM approach could successfully be implemented for evaluating land degradation status even regions comprises with high spatial heterogeneity. Location and LUS specific information on degradation type,

degradation intensity trends and degradation area proportions were assessed and possible to generate map information. Compared with previous studies on land degradation assessment within the study region, spatial pattern of degradation levels found in this study shows similarity in most of the locations. Further, the land degradation was high in lands under annual crops, marginal tea lands and un-organized construction sites. Lack of land ownership, poverty and population pressure were also identified as prominent land degradation drivers.

Acknoweldgement

This research was a part of the regional project on "Land Degradation Assessment and Monitoring for Sustainable Land Management and Climate Change Adaptation in South Asia" which was funded by FAO through Global Environmental Facility (GEF). The invaluable contribution of expert group and technical staff from different organizations are greatly acknowledged.

References

Adams CR, Eswaran H 2000. Global land resources in the context of food and environmental security. In: Advances in Land Resources Management for the 20th Century, Ed. Gawande SP, p. 605. Soil Conservation Society of India, New Delhi.

FAO 2005. Agro-ecological zoning and GIS application in Asia with special emphasis on land degradation assessment in drylands (LADA). Proceedings of a Regional Workshop, Bangkok, Thailand 10–14 November 2003. FAO, internet website: ftp://ftp.fao.org/ agl/ agll/ docs/ misc38e.pdf, accessed Jan 21, 2014.

FAO 2011. Land Degradation Assessment in Drylands: Manual for Local Level Assessment of Land Degradation and Sustainable Land Management. Part 2: Field Methodology and Tools. Food and Agriculture Organization of the United Nations, Rome, Italy.

Freddy NA, Riccardo BB, Sally BC, Hubert G 2010. Land Degradation Assessment: the LADA approach. 19th World Congress of Soil Science, Soil Solutions for a Changing World. 1 – 6 August 2010, Brisbane, Australia.

Kadupitiya HK and Madana P 2006. Characterization of watersheds and prioritizing erosion prone areas using GIS and remote sensing for conservation planning, Annals of the Sri Lanka Department of Agriculture 8: 79 -90.

Koohafkan P, Lantieri D, Nachtergaele F 2003. Land Degradation Assessment in Drylands, (LADA): Guidelines for a Methodological Approach. Land and Water Development Division, FAO, Rome.

Munasinghe MAK, Pushpakumara V, Bandara TMJ, Herath HMB 2001. Use of geographical information systems for soil erosion hazard assessment of the central province of Sri Lanka, Annals of the Department of Agriculture. 3: 148.

Nayakekorala HB 1998. Human induced soil degradation status in Sri Lanka. Journal of the Soil Science Society of Sri Lanka 10: 1-35.

Wickramasinghe WMADB, Kadupitiya HK, Munasinghe MAK, Kendaragala KMA, Chandrapala AG 2013. National Level Report of Land Degradation Assessment in Drylands, LADA - Sri Lanka. Final report, http://cdn.asocon. org/ LADA/ SriLanka/ 1&4workshops/ LADA-Report/ LADA-Final-Report-Sri-Lanka. pdf, accessed Mar 23, 2015.