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Editorial: Land Degradation and Rangeland Management under Changing Climates

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Introduction

Land degradation is a complex geo-environmental hazard resulting from the interaction of physical, meteorological, biological, socio-economic and cultural factors leading to changes in soil, vegetation, water, climate and the socio economic conditions of the people. Globally, there is widespread disagreement in the spatial distribution of land degradation and the broad estimates of total area under land degradation varies from less than 1 billion ha to over 6 billion ha. These degraded lands are often looked upon as a way to expand the area of the crop lands through suitable remedial measures to meet demand of teeming populations. But the location, area and condition of degraded lands is not exactly known and it is a significant roadblock to a more reality-based strategy. There is no unifying framework that simply and effectively explains land degradation. However, four approaches have been used to assess degraded lands at the global scale: expert opinion, satellite observation, biophysical models and recording inventory of abandoned agricultural lands. Current estimates of potential production on degraded lands are greatly hindered by missing and often unreliable information (Grainger, 2009; Lewis and Kelly, 2014; Zucca *et al*., 2012; Squires and Ariapour, 2018). Indeed, no clear consensus exists as to the extent of degraded land, not only globally, but even within a particular country (Bindraban *et al*., 2012; James *et al*., 2013; FAO, 2008; Lepers *et al*., 2005). Degraded or marginal lands are areas where low and variable rainfall, low temperatures and/or steep slopes severely limit natural biological productivity. They are called 'marginal' because intensive agriculture is not possible. Mapping and monitoring of land degradation extent, along with the information on the type and severity of degradation, are prerequisites in preparation of action plans to combat land degradation.

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The contributions to this Special Issue gives insight regarding four aspects viz., conceptual, biophysical, anthropogenic and spatial. In a conceptual model on shrubbiness-desertification on arid rangelands in Argentina, it has been observed that overgrazed areas with a shrubby component normally leads to an increase in the dominance of shrubs and the conversion of grasslands to less desirable shrublands. The existing relationship between shrubbiness and desertification has been reviewed and a future research approach proposed (Torres *et al*. 2018).

Globally, there are several models, with some local variations, existing for the assessment of desertification hazards. However, there is no perfect model available. Hosseini *et al.* (2018) tried to apply MEDALUS model to determine desertification hazards for a province of Iran. The primary and secondary factors, influencing desertification based on Iranian Classification of Desertification (ICD) model, were determined to identify risk zones. However, the addition of more regionally-specific parameters into the model (MICD) allows for a more accurate representation of desertification processes.

High climatic variability has its impact on all ecosystems, regions and sectors, but the nature and extent of vulnerability to the climate change differs with variability in the adaptive capacity. Large population density and inappropriate changes in land-use are enhancing the risk of degradation of soil, water and other natural resources affecting the support base of inhabitants. Therefore, human-land relationship over the long period of developmental activities and alterations of earth's surface through anthropogenic shifts in land use has become an important topic of research. Positive and negative impacts of human population and number of livestock respectively indicated a link between poverty dynamics and soil degradation in small-holder

agriculture as large households were able to invest in soil fertility management while the poorer households were mining nutrients in the soils (Singh *et al*., 2018).

It is hard to determine the value of rangelands in terms of environmental services like carbon sequestration, watershed management, bio-diversity and eco-tourism (Yadava *et al*., 2018). The major indicators of rangelands degradation are shift in species composition, loss of range biodiversity, reduction in biomass production, less plant cover, low small ruminant productivity and soil erosion (Ahmad and Ehsan, 2012). The productivity of the rangelands can be managed through soil and water conservation, soil fertility management and plant species manipulation, etc. Approaches such as conservation tillage which reduces decomposition, fallow, agroforestry and improved pasture and optimal fertilization and increased C input by enhancing biomass production (Raji, 2018). Some adaptive options like modernization of irrigation and, adoption of supplementary irrigation and water harvesting have also been recommended (Abdalla and El Gamri, 2018) for reducing the impact of climate change and variability in rainfall.

Multi-season Landsat TM data of 30 m spatial resolution revealed that waterlogging and sodicity were the major processes of land degradation in agricultural land that dominates in the Ballia district (Uttar Pradesh, India). An increase in area under sodicity in agriculture land from 23.04 km^2 in 1992 to 25.08 km^2 in 2016, while waterlogging in agricultural land from 199.92 km^2 in 1992 to 210.25 km^2 in 2016 have been reported (Christian *et al*., 2018).

ETM data have also been used to characterize the spatial distribution of the risk of water-induced soil erosion in the Tartus district, Syria. It has been clearly brought out that in the severe eroded areas, anti-erosion measures should be specified so that erosion is clearly defined and remedial action is applicable (Al-Abed *et al*., 2018).

Assessment of land degradation caused due to water erosion in the Ejura Sekyedumase District (Ghana) could also be done through a multi-criteria decision module with a standardized and weighted linear combination approach (WLC) in IDRISI Kilimanjaro. It has been established that land degradation risks exists in the southern and central parts of the district due to erosion (Allotey, 2018).

Time series Normalized Difference Vegetation Index (NDVI) is commonly employed to find state of crop vigour and dynamics of agricultural vulnerability. Variability in Start of Cropping Season (SOS) - both during kharif and rabi cause a reduction in the phenological growth of crop at various stages, thus adversely affecting agricultural production and causing economic losses to farmers by way of loss of livelihood and pressure of mounting debt besides food and fodder shortages in Peninsular India (Ramachandran *et al*., 2018). Additionally, landscape function analysis (LFA) and trigger-transfer-reserve-pulse (TTRP) could also be used in the arid region of Lajaneh (Iran) to derive eleven soil surface indicators that facilitated calculation of three indices of infiltration, stability and nutrient cycling (Shahriary *et al*., 2018).

The traditional pastoralists faced adverse impact in low rainfall areas because of their strong dependency on the rangelands for livelihoods. The collapse of traditional migration patterns has put great pressure on community pastures and increased the use of purchased feeds and crop residues. Two major impediments to the revitalization of traditional management systems identified are the reduction of the grazing areas and the opportunistic behavior of community members (Squires *et al*., 2018).

International program widely recognize that dryland restoration is the key to revert the current global dryland degradation, ensuring at the same time a future global sustainability of such degraded areas (UNCCD 1994; James *et al*., 2013). Further, rehabilitation and ecological restoration are critical to (a) control the effects of desertification on the biophysical environment and (b) revert the complex social and ecological constraints (Busso and Pérez, 2018).

The impact assessment of future climate change with respect to water resources, based on SWOT model with future regional climate models, established that there shall be an explicit deficit in water as well as crop yield toward the end of the 21st century in Karkheh Basin (Iran). Activities like terracing, strip cropping, grade stabilization structure (GSS), changes in land use and cropping pattern, etc. may significantly

influence the desired hydrologic components (Solaymani and Gosain, 2018).

The collection of fourteen papers presented here are valuable reviews of scientific knowledge and the various interventions on the arid lands. The arid landscapes, the world over, also include people and so papers on social aspects should have received more attention than in the present Special Issue (Squires *et al*., 2018). However, we believe that the reader will be richly rewarded from the information contained in this collection. We hope that this special issue will be appealing to both experts and practitioners in this area and encourage further insightful studies in near future.

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