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Land Use Land Cover Change Analysis (2000-2018) of Tehsil Katlang District, Mardan, Pakistan, using GIS and Remote Sensing

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Abstract: During the past two decades the tehsil Katlang has witness a remarkable expansion growth and developmental activities. Due to increasing the population drastic change have occur in the land use pattern. This study monitor's land use land cover variations between 2000 – 2018 through GIS and Remote sensing method. The study Aims to identify different land use land cover classes in area of interest and find the last 18 years changes in land cover land use pattern. The Landsat images used in the study are obtained from United States Geological survey (USGS) images data base. The vector data derived from topographical sheet of the study area. The data was analyzed using Arc GIS band composition and other image enhancement techniques. Images are classified using supervised maximum likelihood classification. Accuracy assessment carried out through confusion matrix. The vegetation covered is decreased from 34% to 17% of the total area in the past two decades. The built-up cover area is also increased from 39% to57%. However the water covered is improvedfrom 1% toward 4% of the entire area. The Barren land is decreased from 24% to 20% in past eighteen years.

Keywords: urban Expansion, land use conversion, change detection, remote sensing, GIS.

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1. Introduction

Variations in land use land cover are considered to be one of the most important global environmental concerns (Guan et al., 2011; Li et al., 2018; Powers and Jetz, 2019; Veldkamp and Lambin, 2001). These variations frequently occur because of anthropogenic activities (eg deforestation, urbanization, intensification of agriculture and further land degradation), yet natural factors can contribute to these variations (Noszczyk, 2019).

Changes like conversion to intensive and large scale farming, and overgrazing are among the main factors of land degradation in dry lands (Ajai and Dhinwa, 2018; D'Odorico et al., 2019; Farshad et al., 2019). These anthropogenic changes can lead to a decline in biodiversity (Isbell et al., 2017; Mori et al., 2018; Sánchez-Bayo and Wyckhuys, 2019) and other natural resources, and can smashed food supply in these areas, which can have severe social and political consequences (Creutzig et al., 2019; Purswani et al., 2020; Ramankutty et al., 2018; Turner et al., 2007). Changes in land cover by no land use necessarily involves land devaluation. However, many of the shift the use of land changes occurs by a different community reasons (Gibb et al., 2018). Changes in land cover affect variety, water and radiation budgets, trace gas emissions and other procedures that combine to influence climate and the biosphere (Bawden, 2018; Vico and Davis, 2019; Yin et al., 2019). The land use dynamics of an area reflects the characteristics of the natural and human environment (Borrelli et al., 2017; Gerssen-Gondelach et al., 2017; Li et al., 2017). In terms of the physical environment, it varies from natural topography to the classification of land cover, as well as water and natural resources of an area (Issaka and Ashraf, 2017; Giri and Qiu, 2016). On the other hand, it also focuses and narrates the human activities carried out in the past, such as the urban structure and the main routes, including use of agricultural land, the road transport network, urban development and industrialization. Changes in land use coverage are taken one of the main policy for

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controlling natural resources and gauge the environmental variations (Arnous et al., 2017; Hegazy and Kaloop, 2015). To guarantee a maintainable controlling of physical properties, it is important to recognize and enumerate the processes of landscape variation. Patterns of landscape reform are the result of composite connections among physical, biological and social forces (Turner, 1987).

Different human activities are carried out to utilize natural resources of earth. These natural resources are rapidly decreasing due to huge agricultural and urbanization burden. Therefore, the study of changes in land use and land cover is of great significance, in order to meet the growing demands of basic human needs and well-being. Human needs are subject to land, water and vegetation. Remote sensing satellite data proved to be very useful for land cover mapping and analysis (Levizzani and Cattani. 2019; Vadrevu and Lasko, 2018). The monitoring of such variations is possible through geographic information system methods, even if the resulting spatial data sets have different resolutions (Sarma et al., 2001). It is important to update information about land and for effective controlling and planning of resources for sustainable growth (Alphan, 2003).

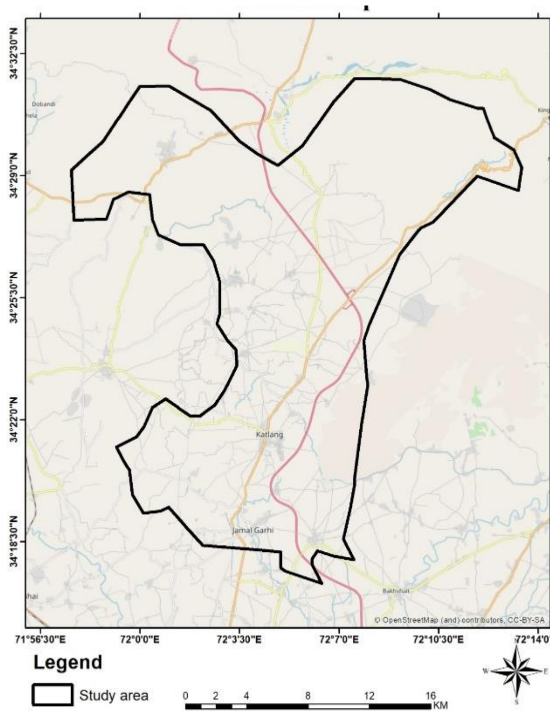

Fig. 1. Map of Tehsil Katlang

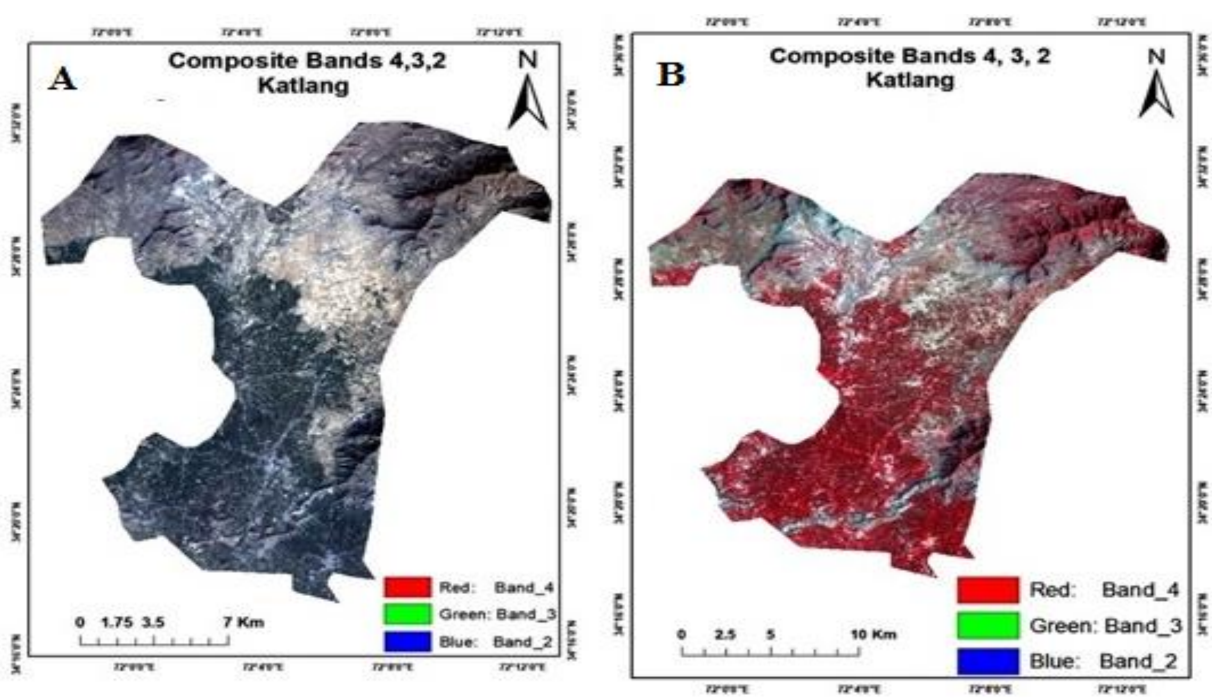

Fig. 2.Satellite images of study area for the years (A 2000) and (B 2018).

Accurate and update information on changing land cover is important to understand and evaluate the environmental significances of such changes (Giri et al., 2005). These data sets make it possible to study soil cover variations at spatiotemporal scales, low cost and with higher precision (Giordan et al., 2018; Kachhwala, 1985; Matese et al., 2015; Schnebele et al., 2015; Xue et al., 2017).

2. Materials and Methods

2.1. Study area

Tehsil Katlang is situated in Mardan district Khyber Pakhtunkhwa province of Pakistan. Geographically, Mardan is located at 34°05' to 34°32' north latitude and 71°48' to 72°25' east longitude at an average altitude of 283m. It is located 19 km north of the city of Mardan, on the border with the Buner district and Malakand. It is surrounded by canal in the northwest. Katlang became Tehsil in February 2010. Fig. 1 Location map of Tehsil Katlang, Mardan District.

2.2. Satellite Data

Imageries of 30 meter of Land-sat 7 and Land-sat 8 were downloaded from the United States Geological Survey (USGS): //earthexplorer.usgs.gov/. USGS delivers free of cost imageries for study purposes, but generally the images are of low resolution. One satellite image covers an area of 185 km ×185 km.

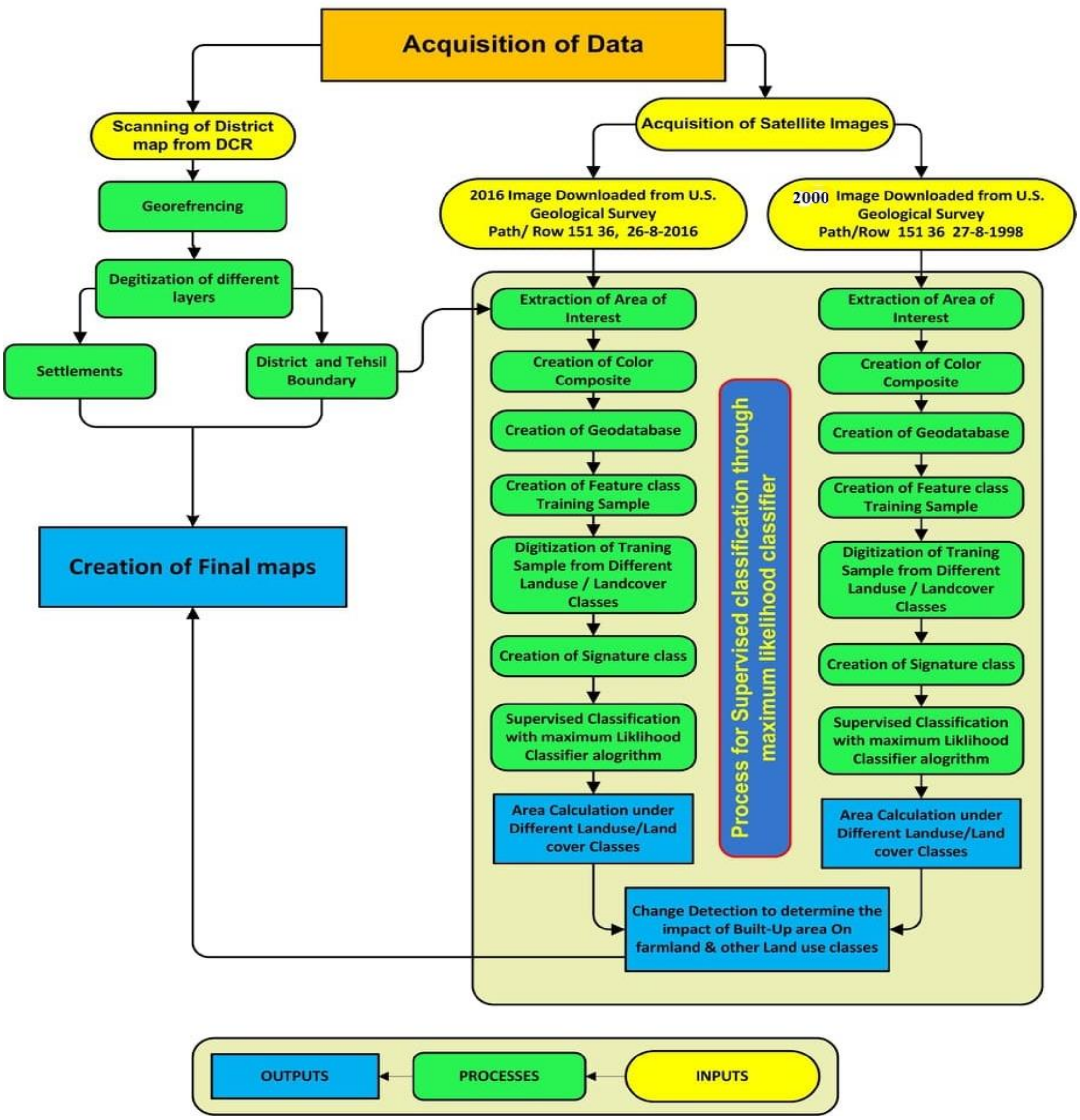

Fig. 3. Methodology flow chart

2.3. Area of Interest

A full image was downloaded in raster format was opened in Arc GIS 10.4 and the shape fileof the study area was overlapped onto these images. The area of study within the border is separated from the rest of the image. Satellite images of the study area for 2000 and 2018 shows in Fig. 2.

2.4. Image Classification

The supervised classification of the satellite data was carried out in accordance with the following classification scheme:

1) The Agriculture comprises all the greenery that is, parks, gardens, cultivable lands.
2) The built-up includes buildings, roads, pavements, stable structures.
3) The bodies of water include ponds, canals, and rivers.
4) The sterile area consists of fallow land, non-cultivable area and harvested land.

The supervised rating supports the idea that a user can select a sample of pixels in a specific category image and t the image processing program to use these training sites as a reference to categorize all other types. Pixels in the image Training sites (signature signature) are chosen based on user knowledge. The user also determines the number of categories in which the image is categorized.

2.5. Supervised Classification

Satellite image of each year were classified by a supervised classification method. The supervised classification operation is performed in steps including collect training samples, describe signature and process a supervised maximum likelihood classification.

Many representative samples were collected for each class using area interest tool. When the signatures file were created, the pixels of the image are classified into classes according to the samples by using a maximum likelihood classification , that is, by executing a supervised classification command on a raster image using the signatures respective. The resulted file is a rasterized image.The methodology was shown in Fig. 3.

2.6. Accuracy assessment

After the classification result accuracy assessment were obtain. For that purpose user, producer and over all accuracy matrix were run in order to access accuracy. User accuracy was obtained by dividing all correctly classified cells by total reference point's .for this study reference points were taken from Google earth. Producer accuracy were also obtain by dividing total correctly classified cells of land use land cover classes by total ground trout pixels .in order to obtained overall accuracy all correctly classified cells were divided by all pixels. The result of accuracy assessment was shown in Table 1.

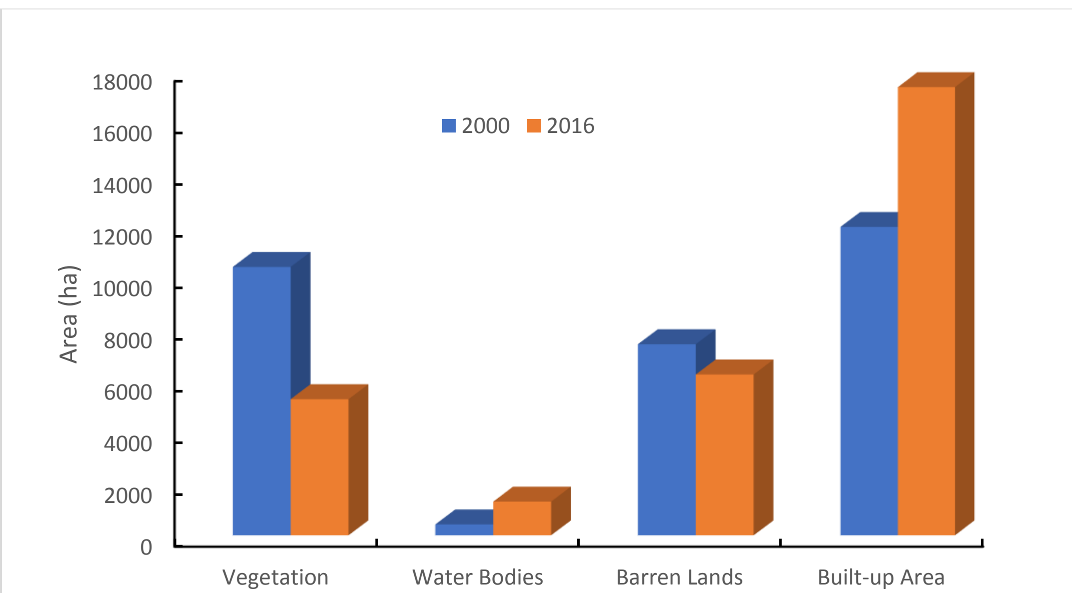

Fig. 4. Land use / Land cover Changes in (2000-2018) of Tehsil Katlang.

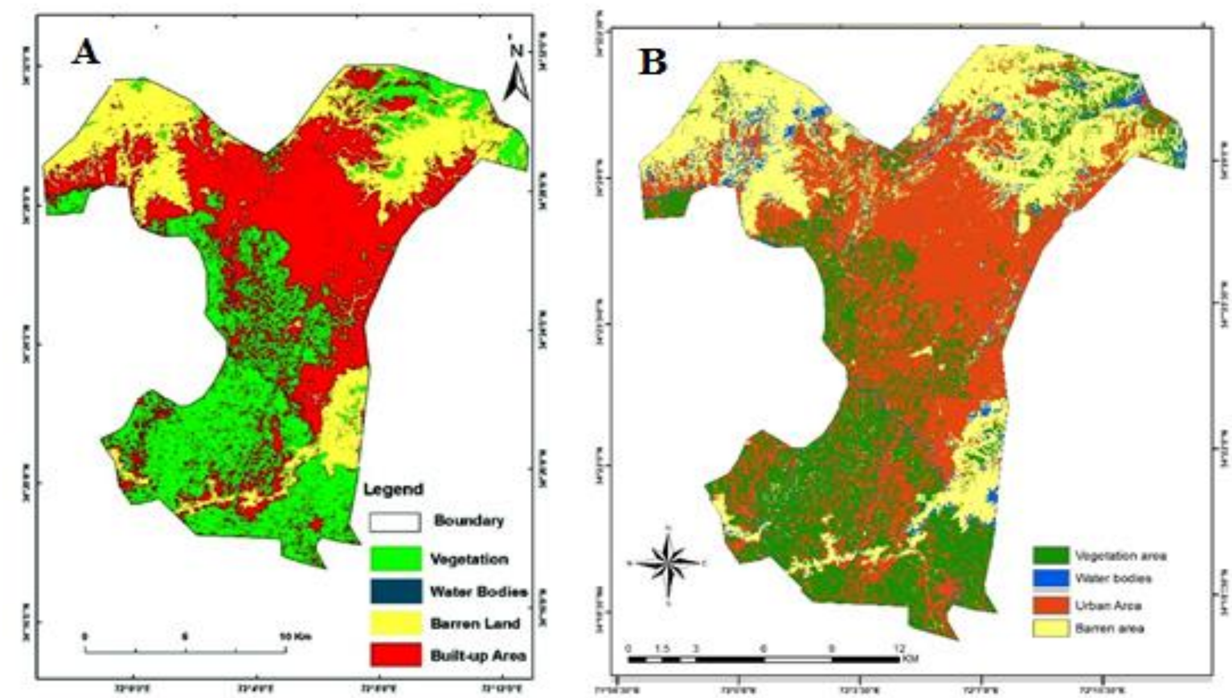

Fig. 5. Classified land use Maps of tehsil Katlang (A 2000), (B 2018).

3. Results and Discusion

After applying the GIS techniques, images of the year 2000 and 2018 of the study area were classified. For the classification, four LULC classes named built up area, water bodies, natural vegetation and barren land were used. The overall land use change for the year of 2000 and 2018 map of study area were shown in Fig. 4, 5, the accuracy of the classified image was 90% and 94%.

The overall kappa coefficient were 0.90 and 0.93 respectively. According to (Lea and Curtis, 2010), that accuracy assessment report always required for Landsat images above 90% or are equal to 90% which successfully achieved in this present study. The classification result for the year of 2000 and 2018 were shown in Table 1. The result disclose that area of vegetation Decreasing whereas the area of urban area increasing yearly. Vegetation cover drastically change from 34% to 17% while water class which is the smallest cover area class increases by 3% due to the recent fluids and high rate of annual rainfalls in the area.

The manner and shape of urban area increased very rapidly it was 39% in 2000 and change to 57% in 2017 similarly barren land also decreased from 24% in 2000 to 20% in 2018. The comparison of both years shows drastic change in land use for last 18 years. Same study were carried out by (Butt, et al, 2015) for Smiley Watershed, Islamabad, Pakistan. They reported that vegetation land shrank from 69% to 43% of the total area while Water class, which was least area covering class in 1992, further lost area under its cover and reduced from 4% to 1%. The share of Settlements was 6% of the total area which increased up to 11%.

Table 1. Temporal changes in area under different land use classes between 2000 and 2018

	Area (ha)	Area %	Area (ha)	Area %	Area (ha)
Vegetation	10373.68236	34.45950898	5257.679594	17.46396793	-5116.00276
Water Bodies	422.6156963	1.403853413	1303.222549	4.328798739	880.6068525
Barren Land	7384.447562	24.52980806	6214.20491	20.64117322	-1170.242652
Built-up area	11923.23051	39.60682955	17330.76359	57.56606011	5407.533083
Total	30103.97613	100	30105.87065	100	4237.290431

Table 2. The accuracy matrix for classified images 2000, 2018.

Class name	User accuracy %	Producer accuracy %	Over all accuracy %
A) 2000 image			
Water cover	100	100	
Barren land	93.02	100	94.0
vegetation	100	97	
Urban area	100	93	
B) 2018 image			
Water cover	100	72.5	
Barren land	75	60	90.12
Vegetation	80	87	
Urban area	61.7	72.5	

The Agriculture class was increased from a share of 11% to 29% and the bare soil/rocks faced an increment in the total share from 10% to 16%. The achieved overall classification accuracies were 95.32% and 95.13% and overall kappa statistics were 0.9237 and 0.9070 respectively for the classification of 1992 and 2012 images.

3.1. Tehsil Katlang land use land covers change 2000-2018

From the 2000 and 2018 image analysis, it was clarified that the urban area in 2000 was 39% of the total area, which rose to 57% in 2018. The water bodies cover 1.4% of the area in 2000, which rose to 4% 2018. Vegetation land declined from 2000 to 2018 (34% to 17%). barren land covered an area of 24% of the total area in 2000, which decreased to 20% in 2018. The maps are listed for the Katlang Tehsil for the years 2000 and 2018 in Fig. 3.

4. Conclusion

The objective of this study was to provide a recent perspective for land cover land use change that taken place from last sixteen years in katlang Tehsil Mardan. The advance tools of Geographic information system were used to assess the land use land cover changes in the study area. From the analysis it's found that the study area suffered a very stark land cover variation as a result of development projects eitheragricultural or traveler. A significant rise in built-up has taken place as well as huge increase in agricultural land. The area of natural vegetation has decreased considerably. The main cause of agriculture land degradation is the unplanned development of towns and different commercial markets. The people from around villages start migrating to tehsil katlang for business and any other work because katlang market is one of the busiest markets in the district Mardan. Integrating GIS and remote sensing provided valuable information on the nature of land cover changes especially the area and spatial distribution of different land cover changes. From the analysis of our images classified for 2000 and 2018, the area covered by the built area increased by 17%, the vegetation decreased by 16.9% and the area increased by 2%. Dry lands have fallen by 3.8%. The study shows that in the province of Katlang, Mardan is the main land use class, which consists of a region. 39.6% of the total area of Tehsil in 2000 and increased to 57.5% in 2018. The second category of the main land uses is the vegetation cover, which comprises 34.4% of the total area in 2000, which fell to 17.4% in 2018. Arid lands from 24.5%. And it fell to 20.6%. The area covered by bodies of water was 1.4% in 2000; an increase of 4.3% in 2018. Proper planning should be developed to protect and advanced agricultural lands from industrialization, so that basic needs, such as the demand for food and water, can easily be met in the coming days. This study can be continued using different programs and other methodologies

List of Abbreviations: GIS, Geographic information system; RS, remote sensing; USGS, United States Geological Survey.

Competing Interest Statement: This is declared that the authors of this article do not have any competing interest.

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References

Ajai, and P.S. Dhinwa. 2018. Desertification and Land Degradation in Indian Subcontinent: Issues, Present Status and Future Challenges. In: Gaur, M.K., Squires, V.R. (Eds.), Climate Variability

Impacts on Land Use and Livelihoods in Drylands. Springer International Publishing, Cham, pp. 181-201.

Alphan, H. 2003. Land use changes and urbanization in Adana, Turkey. Land Degradation Dev.14: 575-586.

Arnous, M.O., A.E. El-Rayes and A.M. Helmy. 2017. Land-use/land-cover change: a key to understanding land degradation and relating environmental impacts in Northwestern Sinai, Egypt. Environ. Earth Sci. 76(7): 263.

Bawden, R. 2018. Global Change and Its Consequences for the World's Arid Lands. In: Gaur, M.K., Squires, V.R. (Eds.), Climate Variability Impacts on Land Use and Livelihoods in Drylands. Springer International Publishing, Cham, p. 59-71.

Borrelli, P., D.A. Robinson, L.R. Fleischer, E. Lugato, C. Ballabio, C. Alewell, K. Meusburger, S. Modugno, B. Schütt, V. Ferro, V. Bagarello, K.V. Oost, L. Montanarella and P. Panagos. 2017. An assessment of the global impact of 21st century land use change on soil erosion. Nat. Commun. 8(1): 2013.

Butt, A., R. Shabbir, S.S. Ahmad and N. Aziz. 2015. Land use change mapping and analysis using Remote Sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan. Egyptian J. Remote Sens. Space Sci. 18(2): 251-259.

Creutzig, F., C. Bren d'Amour, U. Weddige, S. Fuss, T. Beringer, A. Gläser, M. Kalkuhl, J.C. Steckel, A. Radebach and O. Edenhofer. 2019. Assessing human and environmental pressures of global land-use change 2000–2010. Glob. Sustain. 2: 1-17.

D'Odorico, P., L. Rosa, A. Bhattachan and G.S. Okin. 2019. Desertification and Land Degradation. In: D'Odorico, P., Porporato, A., Wilkinson Runyan, C. (Eds.), Dryland Ecohydrology. Springer International Publishing, Cham, p. 573-602.

Farshad, A., E. Pazira and A.A. Noroozi. 2018. Human-Induced Land Degradation. In: Roozitalab, M.H., Siadat, H., Farshad, A. (Eds.), The Soils of Iran. Springer International Publishing, Cham, p. 213-227.

Gerssen-Gondelach, S.J., B. Wicke and A.P.C. Faaij. 2017. GHG emissions and other environmental impacts of indirect land use change mitigation. GCB Bioenergy. 9(4): 725-742.

Gibb, R., D.W. Redding, K.Q. Chin, T.M. Blackburn, T. Newbold and K.E. Jones. 2018. Effects of land use on zoonotic host communities: a global correlative analysis. The Lancet Planetary Health. 2(1): S2.

Giordan, D., D. Notti, A. Villa, F. Zucca, F. Calò, A. Pepe, F. Dutto, P. Pari, M. Baldo and P. Allasia. 2018. Low cost, multiscale and multi-sensor application for flooded area mapping. Nat. Hazards Earth Syst. Sci. 18(5): 1493-1516.

Giri, C., Z. Zhu and B. Reed. 2005. Comparative analyses of the Global Land Cover 2000 and MODIS land cover data sets. Remote Sens. Environ. 94(1): 123-132.

Giri, S. and Z. Qiu. 2016. Understanding the relationship of land uses and water quality in Twenty First Century: A review. J. Environ. Manage. 173: 41-48.

Guan, D., H. Li, T. Inohae, W. Su, T. Nagaie and K. Hokao. 2011. Modeling urban land use change by the integration of cellular automaton and Markov model. Ecol. Modelling. 222 (20-22):3761-3772.

Hegazy, I.R. and M.R. Kaloop. 2015. Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governate Egypt. Int. J. Sustain. Built Environ. 4(1): 117-124. 35

Isbell, F., A. Gonzalez, M. Loreau, J. Cowles, S. Díaz, A. Hector, G.M. Mace, D.A. Wardle, M.I. O'Connor, J.E. Duffy, L.A. Turnbull, P.L. Thompson and A. Larigauderie. 2017. Linking the influence and dependence of people on biodiversity across scales. Nature. 546(7656): 65-72.

Issaka, S. and M.A. Ashraf. 2017. Impact of soil erosion and degradation on water quality: A review. Geol. Ecol. Landscape. 1(1): 1-11.

Kachhwala, T.S. 1985. Temporal monitoring of forest land for change detection and forest cover mapping through satellite remote sensing. In Proceedings of the 6th Asian Conf. on Remote Sensing. Hyderabad,. 77-83.

Lambin, E.F., B.L. Turner, H.J. Geist, S.B. Agbola, A. Angelsen, J.W. Bruce, and P. George. 2001. The causes of land-use and land-cover change: moving beyond the myths. Global Environ. Change. 11(4): 261-269.

Levizzani, V. and E. Cattani. 2019. Satellite remote sensing of precipitation and the terrestrial water cycle in a changing climate. Remote Sens. 11(19): 2301.

Li, J., Z. Wang, C. Lai, X. Wu, Z. Zeng, X. Chen and Y. Lian. 2018. Response of net primary production to land use and land cover change in mainland China since the late 1980s. Sci. Total Environ. 639: 237-247.

Li, X., G. Chen, X. Liu, X. Liang, S. Wang, Y. Chen, F. Pei, X. Xu. 2017. A New Global Land-Use and Land-Cover Change Product at a 1-km Resolution for 2010 to 2100 Based on Human–Environment Interactions. Ann. Am. Assoc. Geograph. 107(5): 1040-1059.

Matese, A., P. Toscano, S.F. Di Gennaro, L. Genesio, F.P. Vaccari, J. Primicerio, C. Belli, A. Zaldei, R. Bianconi and B. Gioli. 2015. Intercomparison of UAV, aircraft and satellite remote sensing platforms for precision viticulture. Remote Sens. 7(3): 2971-2990.

Mori, A.S., F. Isbell and R. Seidl. 2018. β-Diversity, Community Assembly, and Ecosystem Functioning. Trends Ecol. Evol. 33(7): 549-564.

Noszczyk, T. 2019. A review of approaches to land use changes modeling. Human Ecol. Risk Assess. 25(6): 1377-1405.

Powers, R.P. and W. Jetz. 2019. Global habitat loss and extinction risk of terrestrial vertebrates under future land-use-change scenarios. Nat. Climate Change. 9(4): 323-329.

Purswani, E., B. Pathak, D. Kumar and S. Verma. 2020. Land-Use Change as a Disturbance Regime. In: Shukla, V., Kumar, N. (Eds.), Environmental Concerns and Sustainable Development: Volume 2: Biodiversity, Soil and Waste Management. Springer Singapore, Singapore, p. 127-144.

Ramankutty, N., Z. Mehrabi, K. Waha, L. Jarvis, C. Kremen, M. Herrero and L.H. Rieseberg. 2018. Trends in Global Agricultural Land Use: Implications for Environmental Health and Food Security. Annu. Rev. Plant Biol. 69(1): 789-815.

Sánchez-Bayo, F. and K.A.G. Wyckhuys. 2019. Worldwide decline of the entomofauna: A review of its drivers. Biol. Conserv. 232: 8-27.

Sarma, V.V.L.N., G.M. Krishna, B.H. Malini and K.N. Rao. 2001. Land-use /land-cover change detection through remote sensing and its climatic implications in the Godavari Delta Region. J. Indian Soc. Remote Sens. 29(1-2): 85-91.

Schnebele, E., B.F. Tanyu, G. Cervone and N. Waters. 2015. Review of remote sensing methodologies for pavement management and assessment. Eur. Trans. Res. Rev. 7(2): 7-10.

Turner, M.G. 1987. Spatial simulation of landscape changes in Georgia: A comparison of 3 transition models. Landsc. Ecol. 1(1): 29–36.

Turner, R.K., D. Burgess, D. Hadley, E. Coombes and N. Jackson. 2007. A cost–benefit appraisal of coastal managed realignment policy. Global Environ. Change. 17(3-4): 397-407.

Vadrevu, K., K. Lasko. 2018. Intercomparison of MODIS AQUA and VIIRS I-Band Fires and Emissions in an Agricultural Landscape-Implications for Air Pollution Research. Remote Sens (Basel). 10(7): 978.

Vico, G. and K.F. Davis. 2019. Ecohydrology of Agroecosystems: Interactions Between Local and Global Processes. In: D'Odorico, P., Porporato, A., Wilkinson Runyan, C. (Eds.), Dryland Ecohydrology. Springer International Publishing, Cham, p. 511-532.

Xue, J. and B. Su. 2017. Significant remote sensing vegetation indices: A review of developments and applications. J. Sens. 1-17.

Yin, J., P. D'Odorico and A. Porporato. 2019. Soil Moisture Dynamics in Water-Limited Ecosystems. In: D'Odorico, P., Porporato, A., Wilkinson Runyan, C. (Eds.), Dryland Ecohydrology. Springer International Publishing, Cham, p. 31-46.