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ASSESSING THE IMPACT OF SOUTHERN EXPRESSWAY ON LAND FRAGMENTATION: WITH SPECIAL REFERENCE TO WESTERN PROVINCE

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ABSTRACT- Assessing and quantifying land fragmentation enables transport planners to make informed decisions on optimizing infrastructure; routes; land uses and consider deeply on environment and public accessibility. The study aims to assess the impact of the Southern Expressway (SE) which is one of the mega-scale transport development projects in Sri Lanka, on land fragmentation (LF) near interchanges in the Western province. The study analyzed the land fragmentation at 5km buffer zone of Kottawa and Gelanigama interchanges between 2001 and 2021, utilizing ArcGIS 10.8, Landsat ETM+ images and Fragstat 4.2. Results revealed that, Number of patches (NP) and Patch density (PD) across all land covers, except built-up lands of Kottawa significantly increased from 2001 to 2021 indicating the SE has impacted LF over the area. Area mean (Area MN) of built-up lands of Kottawa significantly expanded (0.5548 ha in 2001, 3.1722 ha in 2021). The largest patch index (LPI) of cultivated lands in Gelanigama was 7.5716% (2001) and drastically dropped to 0.7159% (2021) indicating the patch sizes becoming smaller. The identified changes in LF and patch characteristics have several implications for future transport development. Future transport development requires sustainable and integrated planning considering environmental, social, and economic factors to create a resilient, livable environment for the area's inhabitants.

Keywords: Mega Transport Development; Southern Expressway; Land Fragmentation; Transport Planning; Land Use Planning

1. INTRODUCTION

Most land cover types evolved as a result of anthropogenic activities on the land surface. Degree of isolation and land fragmentation in the overall landscape are the processes that occurred as a result of various land use policies, mega transport infrastructure development and urbanization [1] while agricultural, industrial, and service-related activities support urban growth [2]. The construction of expressways has a significant impact on topography and regional landscape patterns [3] while they may generate threats to ecological backgrounds. Further, in the Sri Lankan context, very limited attempts have been taken to analyze the impact of transport development on land use fragmentation [4, 5].

The Southern Expressway (SE) was Sri Lanka's first expressway project. SE is 101 km long and operates as a dual carriageway (four-lane capacity) with 8 interchanges, connecting 2 districts (Colombo, Galle). It arises the question what is the level of land fragmentation that occurred near the interchanges of SE? Thus, the major objective of this study is to assess the impact of Southern Expressway (SE) on land fragmentation (LF) near the selected interchanges in the Western province of Sri Lanka.

2. MATERIALS AND METHODS

2.1. Study Site and Period of Study

From the 3 interchanges (Kottawa, Kahathuduwa and Galnigama) belonging to Western Province, the Kahathuduwa interchange was neglected as the 5km buffer overlaps the Kottawa buffer. 2001 and 2021(10 years before and after implementing the project) was considered as the period of study due to the availability of cloud-free images.

2.2.Method of Data Collection and Tools

Secondary data analysis method was entertained. Landsat ETM+ images at the path (141) and row (055, 056) with less than 10% cloud cover were obtained through https://earthexplorer.usgs.gov. The spatial resolution of both images was of 30m 30m (acquired on 14th March 2001 and 09th February 2021). The images were georeferenced to WGS_1984_UTM_Zone_44N. ArcGIS 10.8 was used for the supervised image classification and Fragstats 4.2 were used for capturing the land fragmentation.

3. RESULTS AND DISCUSSION

Seven land cover types, (Water, Natural Vegetation, Cultivated Lands, Homesteads, Built-up lands, Paddy and Barren lands) common to both interchanges were identified using the supervised image classification with an overall accuracy of 84% in 2001 and 85% in 2021. Land classification for Kottawa and Gelanigama interchanges are depicted in Figure 1.

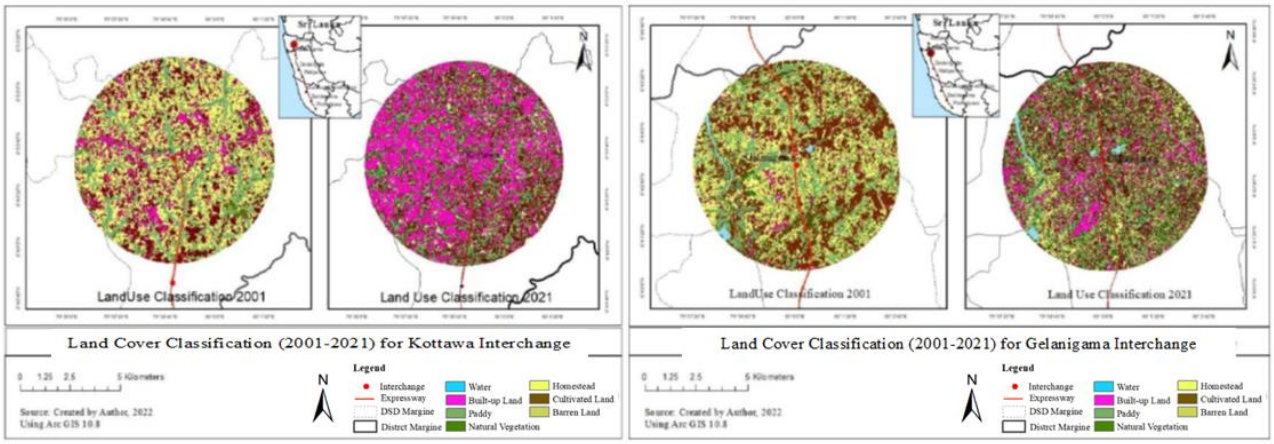

Figure 1. Land Cover Classification for Kottawa and Gelanigama Interchanges

All the land cover types except Built-up lands in the Kottawa interchange area have increased the number of patches (NP) and patch density (PD). The largest Patch Index (LPI) of the Built-up lands was 0.3351% in 2001 and 16.0311% in 2021 depicting the built-up land cover expanding and aggregating. Cultivated lands, homesteads, and paddy lands depict a declining trend referring to CA. In 2001, the largest LPI of the Kottawa interchange was homesteads (7.0756%). But in 2021 largest LPI was shifted to built-up lands (16.0311%). In the Gelanigama interchange, cultivated lands, homesteads and paddy lands showed a declining trend referring to CA while those were more fragmented by 2021 referring to the increased NP and PD. LPI of cultivated lands in Gelanigama was 7.5716% in 2001 and drastically dropped to 0.7159% in 2021 indicating the patch size became small during the time.

Table 1. Class Level Metrics for 5km Buffer Zones of SE Interchanges in Western Province

		CA		NP		PD		LPI (%)		AREA_MN (ha)	
Interchange	**Land Cover**	**2001**	**2021**	**2001**	**2021**	**2001**	**2021**	**2001**	**2021**	**2001**	**2021**
Kottawa	Water	0.18	2.88	1	6	0.013	0.0778	0.0023	0.014	0.18	0.48
	Natural Vege.	399.42	1263.2	1962	4112	25.4536	53.3462	0.2791	0.1424	0.2036	0.3072
	Cultivated La.	1986.3	1602.5	1861	2901	24.1433	37.6355	1.1302	1.0298	1.0673	0.5524
	Homestead	3157.38	344.7	1062	1664	13.7776	21.5876	7.0756	0.0315	2.9731	0.2072
	Built-up lands	633.6	2912	1142	918	14.8155	11.9095	0.3351	16.0311	0.5548	3.1722
	Paddy	1486.17	1093.3	1590	2226	20.6275	28.8786	1.47	0.3643	0.9347	0.4912
	Barren Land	45.09	489.42	115	1683	1.4919	21.8341	0.0397	0.0981	0.3921	0.2908
Gelanigama	Water	74.16	97.83	12	17	0.1532	0.2171	0.4861	0.5493	6.18	5.7547
	Natural Vege.	615.96	1817.5	2263	4203	28.894	53.664	0.1735	0.3022	0.2722	0.4324
	Cultivated La.	2939.22	2162.5	1310	3058	16.7261	39.0446	7.5716	0.7159	2.2437	0.7072
	Homestead	2542.32	1222	1588	3045	20.2756	38.8786	6.4316	0.3309	1.601	0.4013
	Built-up lands	136.17	884.88	515	1645	6.5755	21.0034	0.1264	0.5975	0.2644	0.5379
	Paddy	1508.58	1471.8	2625	3072	33.516	39.2233	0.7274	0.4619	0.5747	0.4791
	Barren Land	15.66	175.59	46	630	0.5873	8.0439	0.0276	0.0471	0.3404	0.2787

Reference: Wijesekara, 2023

4. CONCLUSION

The study analyzed the land fragmentation at the 5km buffer zone of Kottawa and Gelanigama interchanges during the period of 2001-2021. Results indicated that cultivated lands, homesteads, and paddy lands of the study area were drastically shrinking in size while fragmentation was high in both interchanges. Even though the land extent occupied by the natural vegetation of both interchanges increased, the land area was highly fragmented. Built-up lands were expanding and aggregating in both interchanges. Further, results denote quantitative measures of the impact of SE on land fragmentation near the interchange areas. The findings of the study are valuable for transport and land use planners in future planning attempts. Specially for the effective management of land use changes in the interchange areas of expressways. As well this study can be used as a case example for capturing the land fragmentation of future mega-scale transport development attempts.

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