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Interaction between Road Network Connectivity and Spatial Pattern

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Abstract

Road network is considered to be one of the keys to regional development of a region. The huge developmental cost of the road network demands effective utilisation, which can be attained only when there is proper connectivity and orientation. But the road network in many urban areas develop in an organic growth pattern. Hence a great emphasis needs to be given to the connectivity pattern of the road network. Urban road network has less theoretical research. Only some developed countries have carried out the evaluation of urban road network and hence it has great potential for development and application prospects.

In this study an attempt has been made to analyse the road network connectivity and spatial pattern existing in Calicut city in India, and hence to determine if the network connectivity can explain significant variance in the spatial pattern of the network structure. Analysis reveals that transport network fractality is directly varying with respect to connectivity and coverage of the study area. Network density could better predict fractality of the road network than any other connectivity indicators. This means that there is significant relationship between the level of road network development and the network spatial structure within the study area.

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1. Introduction

Road transport network is primarily designed to connect local resources and people to distant markets and population centres. Thus it provide support to urban system development. An efficient transport network is essential for maintaining and improving the quality of life within cities and ensuring sustainable development. Because of the huge developmental cost of the road transport network, effective utilisation is essential, which can be attained only when there is proper connectivity and orientation. Hence, a great emphasis needs to be given to layout and pattern of the urban road transport network. Urban road transport network evaluation have less theoretical research, and relative project cases are also not enough. Only some developed countries have carried out urban road network evaluation and hence it has great potential for development and application prospects.

Extraction of the basic connectivity indices, which provide fundamental information to delineate a given network character had been the focus of many studies. Very few studies concentrated on finding the spatial pattern of the network and to understand its structural attribute. Interaction between network connectivity and the structural attribute of the road network is not clearly understood. To increase the understanding of this interaction we explore the concepts of Connectivity and Development. Also Fractality, which help in characterising and understanding the spatial pattern of road network is focussed. Hence the main idea of this study is to determine if the road characteristic variables indicating connectivity can explain significant variance in the spatial pattern of the network structure. Calicut city region has been chosen as the study area for preparing the road network basemap across the zonal tracts and hence for road network characterisation using ArcGIS 9.3 software.

2. Literature review

A network is a framework of links, connected within nodes. Several network based indicators have been developed to analyse the transport network since 1960 and these indicators can be classified as connectivity, cyclic property, efficiency measures. [4, 6] developed graph theory measures to quantify the spatial structure of road network and to verify their relationship with regional economic characteristics. Traditional interest in understanding network structure has been limited to geographers who view the spatial nature of the road network as a vital input to regional development [11]. In recent years, there has been considerable interest to understand the topology of transport networks that connects points in geographic space [17, 5]. [18] investigated the potential application of proposed network measures namely, heterogeneity, connection patterns and continuity, in quantifying the structure of road networks. The proposed network measures were later applied to trace the changes in network characteristics over time [3]. In short, various spatial metrics provide quantitative information for urban transport network analysis.

3. Objectives

1. To understand the existing road network of the city in terms of connectivity and development.
2. To characterise the spatial structure of the road network in terms of fractal dimension.

4. Characteristics of road network

Road network display both topologic and geometric variations in their structure. There are a variety of indices, proposed in earlier studies applicable for evaluating road network properties. These measures find further application in planning and transportation practice. Selected measures used in this paper are discussed below.

4.1. Connectivity

Connectivity measures evaluate the intensity of connections between road segments. Connectivity refers to directness of travel between destinations. A well-connected network has many short links, numerous intersections, and minimal dead-ends providing continuous, direct routes to destinations. Several types of connectivity indices are developed in the past. Various indices used for evaluating connectivity pattern of road transport network are Alpha Index, Beta Index, Gamma Index, Eta Index [6] and Grid Tree Pattern Index [9].

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