Spatial Accessibility of Airports in Nepal: A Geospatial Approach

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***Abstract*— This paper analyses the access in cost of travel distance variability for air passengers. The number of international and national tourists, emergency evacuations, rescue works, etc. heavily depends on accessibility to airport facility. The present increase pressure in air traffic has triggered the demand for new airports which can be accessible to all travelers. For generating the information about the accessibility of airport facility, various geographical studies and analysis are carried out. Network analysis is done with available airport facility and travelling distance through road network to generate service area with varying travelling distance within the country.**

Keywords— airport accessibility, service area, network analysis, accessibility coverage

I. INTRODUCTION

Air service development is the process associated with attracting, growing and retaining air services at airports [1]. Adequate access to airport is vital as in term of time, comfort and serviceability. The accessibility can be defined as in terms of travel time as the time required to reach airport from any particular location traveling through the highway which is preferable with minimum time of travel, implying minimum travel distance. Mobility of people from one location to another depends upon how accessible transport infrastructure are built in different levels starting from urban scale to national scale thus proving accessibility as main product of transport system [2]. Principal administrative region of Nepal has relatively higher access to air network as compared to other parts. Air transport is considered as rapid means of transportation as compared to roadway, railway and waterway.

In this study, whole area of Nepal is taken as domain. Nepal is a landlocked country in South-East Asia situated in Himalayan region. It shares border with China in north and with India in east, west and north direction. Nepal has vast geography ranging from gigantic Himalayan range, sparkling rivers, and flat Terai situated over Indo-Gangetic plain. Nepal is a home for multilingual, multicultural community which emphasizes unity in diversity. Most of economy of Nepal is supported by tourism. Owning tens of highest snow-capped mountains, wide variation in bio-diversity, variety of cultural heritages, appealing rivers and lake has made Nepal a hot destination for travelers all over the world. Extending airport facility would be a milestone in economic development of Nepal through tourism.

A Geographic information system (GIS) is the framework for gathering, managing and analyzing data [3]. A geographic information system is a special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines, or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc queries and analyses [4]. It provides platform for civil engineers to manipulate and examine the complex data usually required in the design and analysis processes.

Airport planning include the analysis of parameters like consistency of regional plan, operational capability, fitness of use, ground accessibility, topography, visibility, wind, noise nuisance etc., out of which ground accessibility is considered for this study. Airports are often viewed as spheres of influence for regional development [5]. Flourishing of tourism industry in any area depends upon the availability of airports. Air transport, air infrastructure, efficient and safe airline services and worldwide air transport networks are essential for tourism [6].

Airport access is defined as the process by which people and goods travel from their local origins to nearby airports. The people include air passengers, airport and airline employees, persons accompanying the air passenger to the airport, and casual visitors. The goods include freight, mail, fuel, and items used at the airport. And, the most critical of the access trips to the airport are generally conceded to be those of the

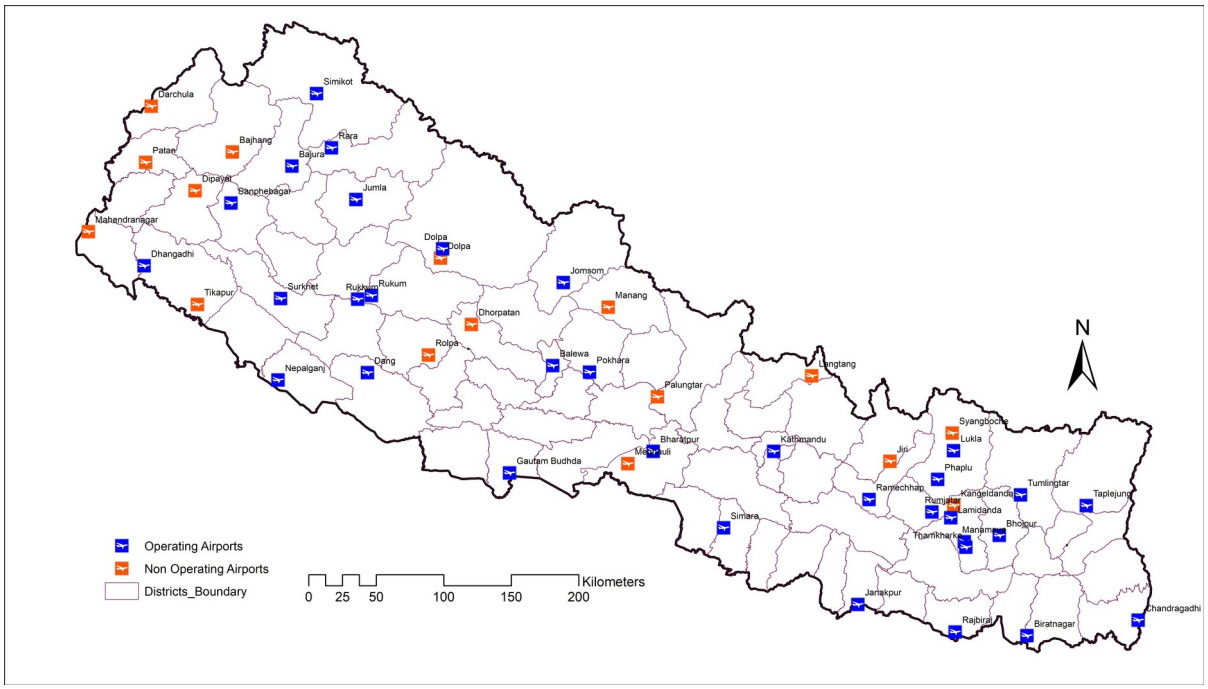

Fig 1. Airports in Nepal

air passenger, and it is air passenger access upon which this study is focused [7].

The passenger traffic can be increased by 2% with 1% increase of airport accessibility [8]. As the domestic passenger movement has increased by 16.17% and international passenger movement by 11.69% [9], it shows the increase in air traffic in recent year forcing the government to come with ideas for the development of new airports. The main aim of this study is to determine the coverage extent of air accessibility in Nepal and the effect on future tourism development. The result obtained would be beneficiary for extensive development of air network and for overall tourism development in Nepal.

II. METHODOLOGY

In context of Nepal, it is challenging to develop an accurate basis for measuring ground accessibility because of diversity in socioeconomy, demography and topography across the whole nation. Further, the airports accessibility also depends on their location, highway/road coverage and passenger segments.

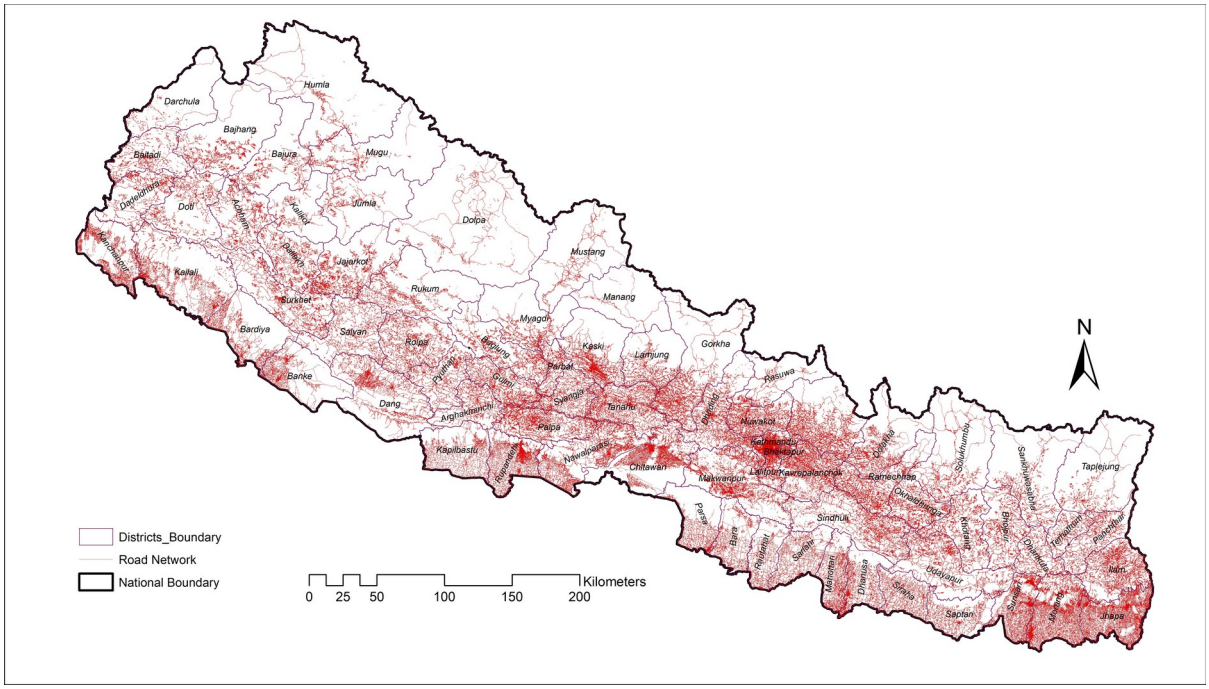

Fig 2. Road Network of Nepal

However, we propose a general framework as a function of travel road distance.

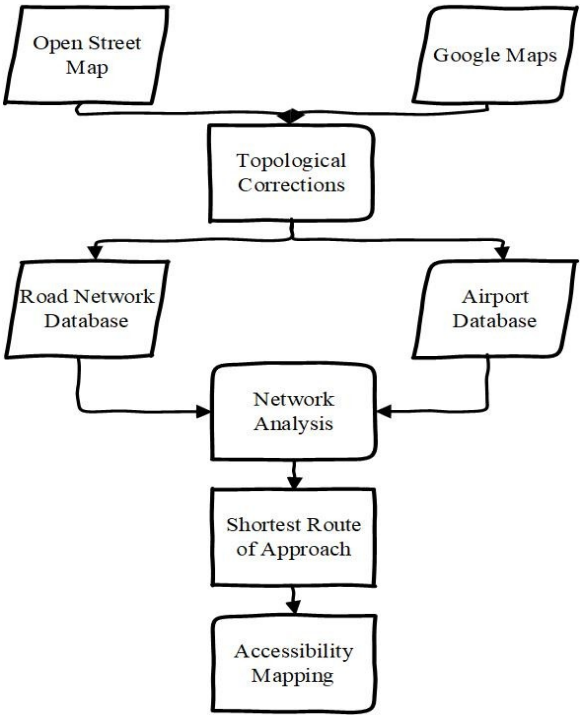

Fig 3. Work Flow Diagram

Accessibility can be measured in various ways. For example, Euclidian distance can be used as a measure of accessibility. However, the Euclidian distance between locations may not be a good proxy for accessibility if there is congestion on the road. Therefore, access travel distance through road network is likely to be a better indicator [10].

For the assessment of current airports in Nepal, manual digitization in GIS environment is done. Road network database is prepared for whole country with freely available Road Network data in Open Street Maps considering all types of road using the cost of access as length of the road link. Topological corrections are made in road network data for development of Network database in GIS environment and corrections are made for minimum topological errors of road network line elements.

Accessibility mapping is done as a function of distance of road and analyzed with distance of 25 km, 50 km and 75 km to find the accessible coverage within the country. The accessibility coverage for each class is obtained by overlay analysis of service area with the settlements in Nepal.

III. Result and Discussion

The spatial coverage obtained from service area generation of operating airports is presented in table I. Higher spatial coverage of spatial area is greater accessibility of the airport facility in the domain.

Considering travel distance of 25 km towards airport facility, only 916 settlements out of 3840 settlements of Nepal are accessible to facility. The spatial coverage is summed up to 81% of the total settlements of Nepal when 75 km of travel distance is considered.

TABLE I. Accessibility of Operating Airports

Travel Distance (km)	Settlement Count (nos.)	Settlement Coverage	Cumulative Coverage
0 - 25	916	24%	24%
25 - 50	1241	32%	56%
50 - 75	957	25%	81%

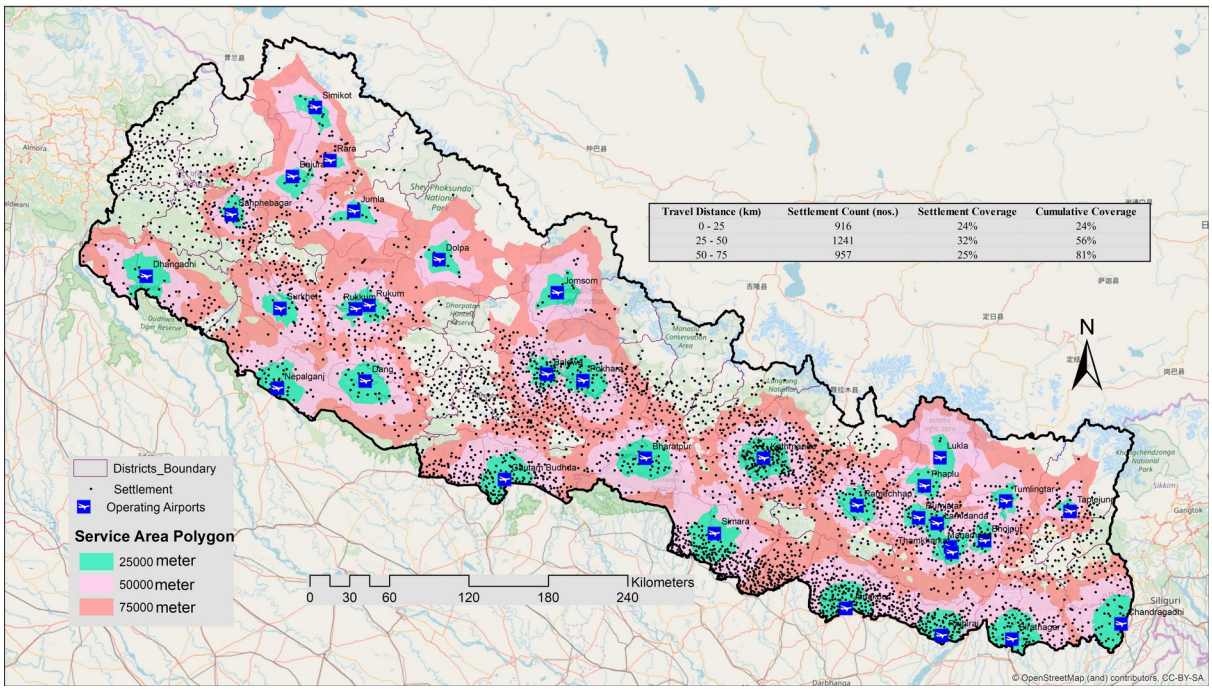

Fig 4. Service Area Generation of Operating Airports

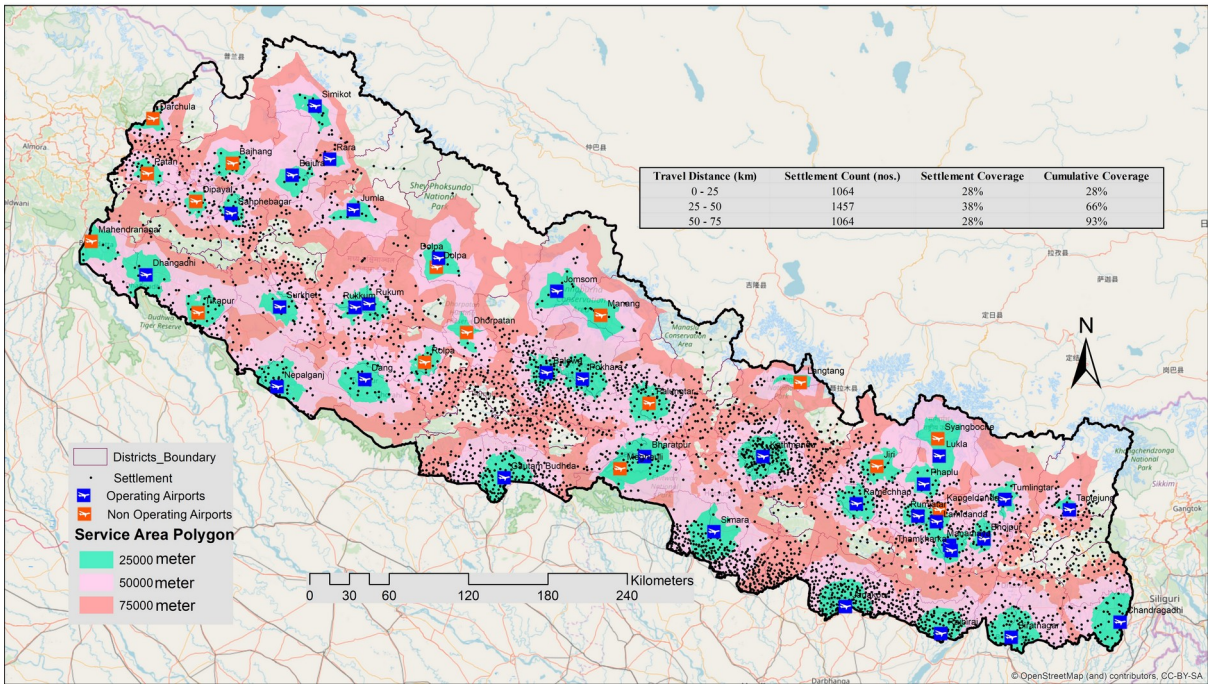

Fig 5. Service Area Generation of Total Airports

Fig 4. shows the spatial accessible area coverage for 3 different classes of travel distance for operating airports.

The spatial coverage obtained from service area generation with considering total 49 nos. of airports as facility is presented in table II. Considering travel distance of 25 km towards airport facility, only 1064 settlements out of 3840 settlements of Nepal are accessible to facility. The spatial coverage is summed up to 93% of the total settlements of Nepal when 75 km of travel distance is considered. Fig 5. shows the spatial accessible area coverage for 3 different classes of travel distance for operating airports.

In context of land-locked country like Nepal, the service of airport is directly connected with influx of international and national tourists within the country. Airport facility play a valuable role in economic development, and the more important they move is people.

TABLE II. ACCESSIBILITY COVERAGE OF TOTAL AIRPORTS

Travel Distance (km)	Settlement Count (nos.)	Settlement Coverage	Cumulative Coverage
0 - 25	1064	28%	28%
25 - 50	1457	38%	65%
50 - 75	1064	28%	93%

This study does not address the different categories of road network and permissible speeds in those routes. It does not provide spatial coverage in terms of travel time; however, this can be used for the overlay analysis with parameters like settlements/tourist spots within the country.

IV. CONCLUSION

For a country like Nepal which is land-locked domain, the air service facility has valuable contribution in domestic as well as global connectivity [11]. The movement of people and goods heavily depends on air facilities but only 24%, 56% and 81% of total settlements are accessible when 25 km, 50 km and 75 km of travelling distance is considered respectively with 33 nos. of operating airports. The 19% of settlements are yet to be facilitated with facility with consideration of 75 km of travelling distance.

The accessibility of settlements increased when both operating and non-operating airports are in operation. 28%, 65% and 93% of total settlements are accessible when all 49 nos. of airports are taken as facility. Many research works are to be carried out for accessibility analysis and significant achievements in air transportation.

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