Spatial Patterns of Urban Growth - Does Location Matter?

A Case Study of Nepal

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Abstract

Between 1952 and 2001, the number of urban settlements in Nepal grew from 10 to 58, while their share in the country's population increased from 2.6 to 14.4%. However, the spatial distribution of urban growth was uneven. The fastest growing urban localities are situated near major population centers, close to highways, and in the vicinity of the Indian border. Urban localities elsewhere exhibited sluggish economic growth and poor socio-demographic performance. Data for this analysis were drawn from databases maintained by Nepal's Central Bureau of Statistics; the Municipalities' Association; the Ministry of Local Development and its Department of Topographical Survey. In the GIS-assisted analysis, spatial reference data (e.g., distances between individual municipalities and major rivers, roads, international borders and major population centers) were matched against five performance indexes, viz. annual population growth, per capita income and expenditures of local municipalities, telephone ownership, number of primary schools, and number of industries.

Keywords: Urban growth, Nepal, GIS, regional development, location, geographic region, Terai, Mountain, Hill

1. Introduction

Nepal is a developing country of medium size (ca. 28 million residents in 2005). In 2004 it was Asia's poorest country, with a US$ 260 per capita income (Atlas Method). It remains predominantly rural with the lowest urbanization level in South Asia – 14%, much less than the Philippines - 53%, Myanmar - 26%, or even Cambodia - 20% (see Table 1). However, Nepal is changing: before the ongoing civil war, its ***rate of urbanization*** was the highest in Asia, 7.1% per annum, higher than in Sri Lanka (2.2%), India (2.9%), Pakistan (4.4%), or even in Bangladesh (5.3%) (Skeldon, 1998).

<<<<< Table 1 about here >>>>>

Currently, 58 municipalities in Nepal qualify as urban centers. Five - ***Kathmandu, Lalitpur, Biratnagar***, ***Pokhera*** and ***Birjung*** - have more than 100,000 inhabitants; the population of 11 others ranges from 50,000 to 100,000 residents; 22 towns have 25,000 to 50,000 residents, while the 20 smallest towns have less than 25,000 residents. Between 1952 and 2001, the population of urban localities in Nepal and their number grew rapidly (see Table 2), especially in the ***Terai*** and the Central Development Region (Fig. 1).

<<<<< Table 2 and Fig. 1 about here >>>>>

Before the 1950's, the ***Terai*** was a malaria-prone region, labeled ***Kalapani*** (poisonous water area), which served as place of exile for criminals (Koirala, 2002). With the introduction of quinine and DDT in the 1950s, and the eradication of malaria, the Terai started attracting migrants from the less fertile Hill and Mountain regions. The government tried to turn it into an agricultural region (Schwartz, 2000). However, gradually, the Terai became densely populated and urbanized. In the late 1980's, it provided 65.3% of Nepal's

cultivated area, 61.7% of its grain production, and 34.4% of its road mileage, while hosting 62.5% of all industries (Gurung 1989). On 17% of Nepal's surface, the Terai hosts 29 urban centers, compared to the Hill region's 27 centers on an area four times larger, and to the two urban centers of the mountain region on 15% of Nepal's area (Fig. 1).

The simplest explanation of this uneven urban development is topography. Nearly 80% of the country is mountainous, constraining both rural and urban growth. Jodha (1990) describes the Mountain region as having large frictional distances, poor infrastructures and limited population mobility. Human settlement is difficult, due to harsh weather, rugged terrain, steep slopes, high altitudes, and seasonal hazards. In contrast, the Terai is a plain, its road and communications networks expand easily, and its urbanization is rapid.

The above explanation is, however, often insufficient. Harsh climate and steep topography have not prevented some cities from developing in the Hill and Mountain regions. Thus, *Amargadhi, Narayan, Baglung, Pirthivinarayan, Bhimeshower* and *Khandbari* are rapidly growing, showing that Nepal's uneven urban growth cannot be solely attributed to topography and climate variation. To find out whether location is an additional factor, we test the effect of proximity (to major population centers, international borders, major rivers, highways, etc) on the socio-economic performance of urban places.

Neo-classical growth theory (Jacobs, 1969; Handerson, 1974; Glaeser et al., 1992) advocates a 'non-spatial' approach to regional development (Gotlieb, 1996), claiming that occupational and educational differentiation grow with development and eventually receive spatial expression. Then, as people of similar backgrounds, incomes and environmental preferences "flock together," location differences emerge. We advocate the 'spatial paradigm' of regional development (see *inter alia* Krugman, 1999; Sachs et al.,

2001), which considers that location (with respect to major population centers, physical infrastructures, water resources, etc.) causes development disparities, rather than just expressing them (Portnov, 2004).

The paper starts with an outline of urban growth in Nepal and reviews previous studies. The research methodology is then described and a series of non-parametric tests, multivariate analyses, and spatial association tests are run, to find out whether the location of a town significantly affects its socio-economic performance.[1] In the concluding section, we discuss the findings and their implications.

2. The effect of location on urban growth

Urban location is often understood as remoteness from major population centers (Clark, 1982; Krakover, 1987; Krugman, 1999; Portnov, 2004). Similarly, Gurung (1969), McCall (1985), Jodha (1990), Smith (1992), and Aguilar and Ward (2003) define remote urban localities as physically and frictionally distant from economic foci and centers of political power. Such localities often lag behind in their development, as their attractiveness to investors and migrants tends to be limited (Portnov, 2004). The remoteness of a town from transport terminals and manufacturing centers increases transportation costs, especially for building materials (Isard, 1956; Clark, 1982; Resmini, 2003; Cohen and Paul, 2004). Moreover, unless an urban community is large enough, it may suffer from lack of diversity, while local businesses experience problems in recruiting skilled labor, which is more readily available in large population centers (Portnov and Erell, 2001).

[1] The distinction between towns and cities refers to population sizes. In the literature, the minimal population threshold for defining an urban place as a city varies from 100,000 to 1,000,000 residents. In what follows, the term "town" will be used to indicate an urban place. When a city or major population center (as opposed to a town) is referred to, it will be made explicit.

Geographic location thus strongly affects regional growth and interregional wealth distribution. According to Sachs *et al* (2002), a region's physical geography largely determines its economic performance. Thus, coastal regions, with their easy access to sea trade, usually outperform inland areas. Also, tropical location tends to lower growth, due to the difficulty of farming under hot weather. The study attributes a crucial role to geography in shaping income distribution, at both the local and the global scales. However, empirical studies on the topic are fragmented and mostly limited to developed nations (Fujita and Mori, 1996; Sachs *et al*, 2002).

The New Era study (1986) in Nepal found that prices of agricultural goods are high and skilled labor in short supply in remote localities. Inaccessibility, due to poor infrastructure, was also found to affect health and education services (Thapa *et al*, 2000). Government provision of such services is poor outside the Terai, while private sector providers find it hard to operate, due to low effective demand (Bird *et al*, 2002). As K.C. (1991) and Gurung (1989) point out, migration from Nepal's remote rural areas in the Hill to major population centers is very high. Remote regions lag behind in health and educational services and perceive themselves as socially and politically excluded from mainstream society (de Haan and Maxwell, 1998).

3. Urban development in Nepal: trends and policies

The record of urbanization of Nepal began with the 1952/54 census (K.C., 1998). However, that census failed to set clear criteria for either population or settlement characteristics of urban centers. Instead, it assumed that ten towns were urban centers (*Sahar*) (Sharma, 1989). Four (*Lalitpur, Bhaktapur, Kirtipur and Thimi*) were located at the pe-

riphery of the capital city (*Kathmandu)* and the other five - *Biratnagar, Birjung, Janakpur, Nepalgunj, and Malangawa* - on the borders of the Terai, near the Indian border.

The 1961 census set the minimum population criterion for an urban center at 5,000+ inhabitants. Based on this criterion, 16 towns (*Biratnagr, Birjung, Dharan, Janakpur, Malngawa, Npalgunj, Matihani, Rajbiraj, Kathmandu, Lalitpur, Bhaktapur, Thimi, Kirtipur, Pokhera, Tansen and Banepa*) qualified as urban centers. In addition, six new towns were added to the urban centers' list - three (*Rajbiraj, Dharan and Matihani*) in the Terai and the other three (*Banepa, Tansen and Pokhera*) - in the Hill region.

The Town Panchyet (Town Council) Act of 1962 defined an urban center as a locality with no less than 10,000 residents. The 1971 census added the requirement that urban centers include permanent public structures, such as schools, administrative and judicial buildings and commercial facilities. Thus, five new towns (*Bhadrapur, Butwal, Sddharthnagar, Illam, and Hetauda*) appeared in the updated list of urban localities, while five others (*Matihani, Thimi, Kirtipur, Banepa and Malangawa*) were omitted from the list, as they failed to attain minimum population and lacked permanent public structures. Among the newly counted towns, *Bhadrapur, Butwal and Sddharthnagar* were located in the Terai, whereas *Illam, and Hetauda* were located in the Hill region.

In 1976, an amendment to the Town Panchyet Act 1962 reduced to 9,000 persons the minimum urban municipality population. The 1981 census identified 23 towns (*Mahendranagar, Dhangadhi, Birendranagar, Nepalgunj, Tribhuvannagar, Butwal, Siddharthnagar, Tansen, Pokhera, Bharatpur, Kathmandu, Lalitpur, Bhaktapur, Janakpur, Lahan, Rajbiraj, Dhankuta, Dharan, Biratnagar, Illam and Bhadrapur*) as urban settlements. Two of the seven new ones were in the Hill region and five in the Terai.

In 1981, the urban population reached 956,721 residents, i.e. 6.4% of Nepal's population. In 1987, HMG of Nepal granted urban center status to 33 municipalities. Between 1987 and 1990, 10 other municipalities (*Bidur, Damak, Dhulikhel, Dipayal, Inerewa, Jaleswor, Kalaya, Kapilbastu, Mlaangawa and Banepa*) received the status of urban centers. As of the 1991 census, 9.2% of Nepal's population was urban.

After the establishment of Multi-Party Democracy in 1990, the new Municipality Act (1992) and Self Governance Act 2055 (1999) classified municipalities into three categories - Mahanagarpalika (Metropolis), Upa-mahanagarpalika (Sub-Metropolis) and Nagarpalika (municipality). The new classification was based on the criteria of population size, total annual income and presence of basic urban amenities.

- *A mahanagarpalika* (Metropolis) should have at least 300,000 residents and an annual income of at least Rs 400 Million (about 5.2 million US dollars). It should also have electricity, running water, telephone lines, paved roads, hospitals and sport facilities and at least one university and a number of colleges. A *mahanagarpalika* should also be registered by the Municipal Corporation of Nepal.
- *An upa-mahanagarpalika* (sub-metropolis) should have at least 100,000 residents and a combined annual income of Rs. 100 Million (about 1.3 million US dollars). An *upa-mahanagarpalika* is also supposed to have electricity, running water, and telephone lines. All main roads should be paved. It should also have colleges and medical and sport facilities, and be registered as a municipality.
- *A nagarpalika* (municipality) should have least 20,000 residents (in the Terai) and 10,000+ residents (in the Hill and Mountain regions), and an annual revenue of at

least Rs. 5 Million (about 65,000 US dollars). It should have electricity, public transportation, running water, and communication facilities.

In early 1992, three new localities were promoted to the status of urban centers (i.e., *Gaur, Byas and Tulsipur*), followed by 22 others in 1997. They are: *Mechinagar, Khandbari, Itahari, Siraha, Bhimeswor, Ratnanagar,Tikapur, Panauti,, Pirthivinarayan, Lekhnath, Putalibazar, Waling, Baglung, Gulariya, Amargadhi, Kirtipu, Madhyapur, Banepa, Dasharathchand, Kamalamai, Narayan, Ramgram*. According to the 1992 Municipality Act and 2001 census, there was one mahanagarpalika (metropolis), four upamahanagarpalika (sub-metropolis) and 53 nagarpalika (municipality).

As Fig. 2 shows, the regional distribution of urban centers shifted between 1952/54 and 2001. Thus, the 1952/54 Census showed 5 urban centers in the Terai and 12 in the Hill region. By 2001, however, their distribution had become nearly equal: 29 in the Terai vs. 27 in the Hill.

A glance at Fig. 3A shows that the spatial distribution of urban growth in Nepal is very uneven: most growing centers are in the Terai, and, especially along the Indian border or along major highways radiating from major population centers (Kathmandu, Lalitpur, Biratnagar, Pokhera and Birjung) to the border crossings. Municipalities where telephone lines are in high supply are usually the most rapidly growing ones (see Fig. 3A-B).

<<< Figure 2 about here >>>

4. Research methodology

4.1 Study Area

Nepal is a landlocked country, situated on the southern slopes of the Himalayan Mountains, with the total land area of some 147,810 km^2. The country stretches over 885 km,

from west to east, and has a mean width of 193 km in the north-south direction (see Fig. 1). It is divided into three geographic regions - the Mountain, the Hill and the Terai (Fig. 1). The lowest altitude is 60 meters above sea level, in the Southern plain (Terai) and the highest altitude is 8,848 meters (Mt. Everest - the world's highest mountain) in the North. Rocks, barren mountains and hills cover about 77% of the land. The climate of Nepal ranges from the tropical heat of the Terai to the freezing cold of the Himalayas. The climate of the middle Hills, particularly in the Kathmandu Valley, is moderate, with warm summers and cool winters. The rainy season lasts from June to August.

Geographical studies highlighted the importance of urban centers in Nepal's economic development but failed to clarify the links between city location and socio-economic performance. Thus, the GIC (1984) study concluded that Hill towns were not growing because of limited economic resources. The New Era study (1986) showed that Hill urban centers acted as a hub of commercial services, supplying their hinterland with agricultural and other goods received from the Terai and from India. The CEDA report (1989) showed that the Hill towns belonged to the lower tier of the urban hierarchy while the Terai towns belonged to its upper tier.

Economists, political scientists and anthropologists also conducted urban studies. Erthur (1994) suggested optimal management of small towns and middle size cities, to maximize rural development. Mikesell (1988) examined, in the dependency perspective, the historical growth of a market town in western Nepal. The anthropologist Caplan (1975) studied an administrative center in far western Nepal showing the dependence of its economy and politics on cash infusion by the central Government. ICIMOD report (1986) suggested developing market towns to generate off-farm employment in the Hill.

Unlike all those studies, the present analysis focuses on the links *between location and socio-economic performance* of towns and cities in Nepal. Thus we attempt to determine whether the latter differs by location, e.g. by proximity to major highways, rivers, and major population centers, and by elevation or geographic region.

4.2 Data sources

The data used in this analysis were obtained from two major sources:

- *Population data* for 1991 and 2001 were obtained from the Central Bureau of Statistics, HMG of Nepal. They were used to calculate the population growth and per capita incomes of municipalities.
- *Socio-economic data* on municipalities (total income and expenditure; number of industries; number of telephone lines, total length of paved road, number of primary schools, etc.) were obtained from the Municipal Association of Nepal and the Ministry of Local Development, His Majesty Government (HMG) of Nepal. The data are based on FiMa report of GTZ/UDLE (German Technical Cooperation/Urban Development through Local Efforts), FY 1997/1999. Missing and vague data (e.g., number of telephone lines and industries) were verified through the concerned municipalities.

The descriptive statistics of the research variables are reported in Appendix 1.

Major rivers, highways, international borders, urban centers, regional and geographic divisions were digitized using the base map of Nepal (1:1,000,000) and the Nepal district map (1:50,000), obtained from the Survey Department, HMG of Nepal.[2]

The analysis of map data (i.e., the location grouping of municipalities and the calculation of average development rates) was performed in ArcGIS9 ©, using its two basic features – "spatial join" and "select by location" (Minami, 2001).

4.3. Location categories

The urban municipalities covered by the analysis (58) were grouped according to eight spatial criteria: distance to major population centers (DMPC); distance to the Indian border (DIB); distance to the Chinese border (DCB); distance to major highways (DMH); distance to major rivers (DMR); altitude (elevation above sea level - EL); development region (DR), and geographic region (GR) (see Appendix 2). In theory, the results may depend on the distance intervals used. Therefore, we analyzed natural breaks in a parameter's distribution (the Jenks method; see Minami, 2001), to minimize this source of bias. Minor adjustments were made, whenever necessary, to secure a similar number of municipalities per classification group. The latter condition was considered essential for subsequent statistical testing of inter-group differences.

We also ran a sensitivity analysis, to determine whether the results vary with the number of location categories used in the analysis, reflecting the phenomenon known as

[2] Although we used a low-resolution map (1:1,000,000) in this analysis, the accuracy of the estimates was determined by that of the map (+/- 1%) and that of the digitizing process (+/-0.5%). The resulting possible error of some +/- 0.5 km is not critical for distance intervals of tens of kilometers. It may be critical for distances to highways and rivers, but these were obtained from higher resolution maps (1:50,000) with smaller margins of error.

the 'modifiable aerial unit problem' (Griffith *et al.*, 2003). In general, test results (see Appendix 3), showed that the number of intervals did not substantially affect the outcome of the analysis. Nevertheless, to insure maximum result comparability we opted for the uniform *five-tier* grouping of municipalities, unless the number of location groups was predetermined by actual regional subdivisions, such as the three-tier division of the country into geographic regions (see Fig. 1 and Appendix 2).

An additional rationale for choosing particular classification factors and their distance intervals is outlined in some detail in the following subsections.

4.3.1. Distance from major population centers (DMPC)

Distance from major population centers, which also tend to be the major markets, affects the economic performance and growth potential of urban places. Those which are distant from such centers are economically weak and offer limited job opportunities (Fujita and Mori, 1996; Fafchamps and Shilpi, 2000). Urban municipalities were divided into categories by distance from major population centers (***Kathmandu, Lalitpur, Pokhera, Birgunj*** or ***Biratnagar***). The five location categories were: 0 – 15 km; 15-40 km; 40-75 km, 75-150 km, and >150 km (see Appendix 2 and Fig 1).[3]

As mentioned, natural breaks in the distribution and securing a similar number of municipalities in each location category were major considerations for municipality grouping. However, distance ranges were also taken into account. In the Terai and Hill regions, where the transportation network is relatively well developed, a 15-km distance

[3] In location studies, various distance measurements (aerial distances, road distances, access time, etc.) can be used. However, none is problem-free. Thus, aerial distances fail to reflect local topography, while access time may depend critically on seasonal weather conditions, etc. Road distances disregard road and service quality (see *inter alia* Portnov and Erell, 2001). The present analysis is based on aerial distances, which are easy to compare and measure, and this limitation is referred to in the discussion section below.

range may be practicable for daily commuting. Thus, a bus ride from the city of *Banepa* to the national capital *Kathmandu* (26 km) takes about an hour (Bajracharya, 1995). By the same token, a 15-40-km distance range (approx. 1-2-hour travel time, including waiting for the bus) may be practicable for *periodic* travel to major population centers, while a distance of more than 150 km may be nearly impracticable, even for infrequent travel.[4]

4.3.2 Distance from borders (DCB&DIB)

Proximity to the Indian border was expected to spur the socio-economic performance of Nepalese towns. There are historical, geographical, cultural, linguistic, ethnic, and family links between people in India and Nepal (Shresth, 2003). Moreover, the 1950 Treaty of Peace and Friendship secured an open-border regime and free population and goods exchanges between the two countries. Thus, municipalities near the Indian border had a comparative advantage *vis-à-vis* those located elsewhere. In contrast, proximity to the Chinese border may have no particular effect the socio-economic performance of municipalities, as it is a closed border. Based on proximity to border crossings, the municipalities were classified into five location categories (0 – 40 km, 40–70 km, etc.), with *similar numbers* of municipalities in each group (see Appendix 2).

4.3.3. Distance from major highways (DMH)

Highways play a crucial role in Nepal, due to their scarcity (poor infrastructure development) and to the combination of climate (monsoon rains) and topography fostering de-

[4] In contrast, in the peripheral areas of Nepal, where the transport network is undeveloped, a 20 km trip may take a whole day's walk. However, differentiating distances by region was found to be unfeasible.

pendency on all-weather roads. Proximity to highways reduces transportation outlays and facilitates commuting. As Sharma (1992) points out, in Nepal urban centers located close to major highways tend to grow rapidly.

4.3.4. Distance from major rivers (DMR)

Rivers are vitally important in Nepal: they provide fresh water at minimal cost, for both daily uses and subsistence agriculture. Building materials, like sand and stone, are also available at the river. Nearly 90% of Nepal's urban centers are located within five kilometers from a major river.

4.3.5. Altitude (AL)

High altitudes are not suitable for large-scale urban settlement, due to harsh climate and steep slopes (Fafchamps and Shilpi, 2000). According to altitudes, urban municipalities were classified into five groups (< 100 m; 100–200 m; 200–800 m; 800–1500 m, and 1500+ m), with approximately equal numbers of municipalities (see Appendix 2)

4.3.6 Development regions (DR)

Nepal is divided into five development regions - Eastern Development Region, Central Development Region, Western Development Region, Mid-Western Development Region and Far Western Development Region. These regions, established for administrative purposes, divide the country in the East-West direction (see Fig. 1).

4.3.7 Geographical regions (GR)

According to climatic and topographic conditions, Nepal is divided into three geographical regions - Terai, Hill and Mountain (see Fig. 1). The Terai is a fertile plain, in the south of the country. The Hill region, located in its middle, has undulating topography, small fertile valleys and historical old settlement. The Mountain region, in the north of the country, along the Chinese border, has little fertile land and is freezing in winter.

4.4. Dependent variables

Eight variables served as measures of urban center socio-economic performance:

- *Per capita income* and *per capita expenditure* [Rs] are important measures of local welfare, reflecting the overall amount of taxes collected and outlays on local services a municipality provides;
- *The number of shops* per 1000 residents is an indicator of business activity and socio-economic welfare. Small businesses are unlikely to survive in poor localities, due to the limited purchasing power of their residents;
- *The number of telephone* lines per 1000 residents is another important performance measure. While there may be a strong link between population welfare and telephone proliferation, it may not be clear-cut, due to the limited availability of telephone infrastructure in the periphery of Nepal.
- *Education* is a sensitive social indicator, considering Nepal's relatively low literacy level - less than 54% in 2003. In the absence of more suitable measures, access to education was measured by number of primary schools per 1,000 residents.

- *Population growth* is an intrinsic measure of urbanization potential. Rapidly growing centers may reach the threshold for the provision of higher services, thus becoming more attractive as migration targets.
- *The per capita length of paved roads* reflects a municipality's overall development, as good roads facilitate commuting, reduce transportation costs and enhance local economic activities.
- *Industries* provide income to municipalities and generate employment opportunities for residents.

There are two alternative ways of calculating a parameter's mean. The standard way, implemented in most GIS software, is simply averaging the rates observed in individual localities within a given distance band. This approach is somewhat problematic, as it assigns equal weights to different localities, irrespective of population sizes. In this study, we opted for "population weighted" averaging: first, a parameter's values were summed separately for each distance interval and then, they were divided by the total population for the distance band overall.

4.5 Test for significance of location differences

To compare the socio-economic performances of municipalities across location groups (see Appendix 2), a non-parametric (K-Independent Samples) test was performed. Analysis of Variance (ANOVA) is commonly used to test the significance of differences between groups (Coakes and Steed, 1997). However, this method assumes that the mean is a valid estimate of the center and that the distribution of the test variable is reasonably normal and similar in all groups. Since our preliminary analysis indicated that these as-

sumptions are not entirely met, we opted for a non-parametric test, which makes no assumptions about parameters' distribution, such as mean and variance (Coakes and Steed, 1997). The K-Independent Samples test uses a c^2-statistic to determine the degree of independence between group membership and the proportion of cases above and below the median. Statistically significant values of this statistic indicate that inter-group differences are unlikely to occur by chance. We used this test to determine whether socio-economic performance (as measured by population growth, locally generated incomes, infrastructure development, etc.) varies significantly with the location of municipalities.

4.6 Analysis of spatial association

Indicators of spatial association (such as Moran's *I*, Geary's *C*, $G_i(d)$ and $G_i^*(d)$) provide summary information about the intensity of spatial interaction between values observed in adjacent locations, thus helping to determine whether a parameter's values are arranged in space in a systematic manner. Such a distribution of values is known as "spatial autocollinearity" or "spatial association" (Cliff and Ord, 1981; Anselin, 1999).

In this study, the analysis of spatial association was used in two instances. First, we tested the regression residuals for spatial autocorrelation. The presence of such autocorrelation may lead to inefficient regression estimates if the method of Ordinary Least Squares (OLS) is used (Anselin, 1999). The test (see Table 4: z-Moran's *I*) indicated *no* significant spatial association of residuals, and thus we did not have to use more sophisticated analytical techniques, such as spatial lag models (SLMs).

In the second instance, the analysis of Local Spatial Autocorrelation (LSA) was used to detect "hot spots" in local spatial development. The Getis-Ord ($G_i^*(d)$) statistic, used to this end, is reported as standard normal z-values and calculated as follows:

$$G_i^*(d) = \sum_j^n w_{ij}(d)(x_j - \overline{x_i}) \Big/ (S_i \sqrt{w_i(n-1-w_i) \Big/ n-2}),$$

where n is the number of observations; d is the distance band within which locations j are considered as neighbors of the target location i; x_i is the value observed in location i; $\overline{x_i} = \frac{1}{n-1}\sum_j^n x_j$; w_{ij} is a symmetric binary weight matrix, whose elements take value 1 if locations i and j are neighbors and 0 otherwise, and $S_i^2 = \frac{1}{n-1}\sum (x_j - \overline{x_i})^2$.

$G_i^*(d)$ statistic evaluates each point within a network of sites, helping to determine the relationship between the values observed around the target point and the global mean (Getis and Ord, 1992).[5] This statistic is easy to interpret: a significant and positive $G_i^*(d)$ indicates that location i is surrounded by relatively large values (with respect to the global mean) – "peak-value clusters", whereas a significant and negative $G_i^*(d)$ indicates that location i is surrounded by relatively small values – "dip-value clusters" (ibid.).

5. Findings

5.1. Significance of location differences

Table 3 shows the results of the test of differences between the average values of development measures observed in different location groups of municipalities. Per capita in-

[5] The values of the Gi(d) index are sensitive to how the spatial neighborhood of a location (d_i or search radius) is defined. In the present analysis, different search radii (20 through 100 km) were tested. The results for the best performing spatial lag (d_i=50 km) are the only ones reported.

come, municipal expenditures, and road length differ significantly across nearly half the location groups covered by the study. In particular, the number of shops, telephone lines and schools exhibit significant differences across three out of the eight location groups analyzed. The most significant development differences are between access rings of the national capital, Kathmandu (see Table 3: DMT), major cities (DMPC) and development regions (DR). Across these location groupings, nearly all indicators used in the study show significant performance differences between municipalities situated at different distance intervals (probability of error < 5%). Significant differences in municipality development are also observed in most other location groupings: distance from Indian border crossings (income and expenditures of local municipalities); distance to major highways (annual population growth and number of schools); elevation (road length per 1000 residents), and geographic region (number of telephone lines and road length).

The most significant location-performance interactions, highlighted by the analysis, are discussed in some detail in the following sub-sections.

<<<<< Table 3 about here >>>>>

5.2. Inter-group comparison

Urban centers located in the first ring (DMPC1), within 15-km distance from major population centers, exhibit a relatively high level of economic development, as indicated by telephone proliferation, 77 telephone lines per 1,000 residents. In contrast, in the second and third rings (DMPC2 and DMPC3), urban centers have, on the average, 40 and 61 telephone lines per 1,000 residents, respectively. The last ring (DMPC4), located farther than 150 Km from major population centers, has only 28 telephone lines per 1,000 residents (see Fig. 4A). Notably, there are more telephone lines in the DMPC3 ring than in

the DMPC2 ring (see Fig. 4). This apparent discrepancy may have a simple explanation. Most urban municipalities of the second ring (9 out of 11) are small (25,000 residents, on the average) and located in the Hill region. While they are close to major population centers (Fig. 1), their access to these centers is impeded by rugged terrain and poor roads. In contrast, urban municipalities in the third ring (DMPC3) are mostly located in the plains of the Terai and enjoy easy access to major highways and Indian markets. Urban municipalities in this ring include major industrial and trade centers such as Bharatpur, Siddarthnagar, and Butwal, as well as Sunauli, the main trade gate from Nepal to India.

<<Figures 3&4 about here >>

Urban municipalities located in the Central and Western development regions have more telephone lines per 1,000 residents than municipalities located elsewhere – 79 and 66 telephone lines per 1000 residents, as opposed to 26-31 lines in the Far West and Mid West development regions (see Figs. 1&5). This is hardly surprising considering that all major population centers of Nepal are located in the Central and Western development regions, and enjoy easy access to the Nepalese-Indian border.

<<Figure 5 about here >>

The Central and Western development region municipalities are also leading in income and expenditures (see Fig. 6). Thus, the average income of municipalities in the Western region reaches Rs725 per capita (ca. US $10), whereas that of municipalities in the Far Western Development Region is three times lower – Rs240 or US$3.5 per capita. The explanation is rather straightforward: The Central Development Region leads in commercial activities, having three major population centers - Kathmandu, Lalitpur and Birjung. While the latter (Birjung) is Nepal's main trade gateway, Lalitpur and Kath-

mandu have religious and political importance and attract thousands of tourists every year. The Far Western and Mid-Western Regions are far from major population centers, provide less opportunity for economic activities and are unattractive to foreign visitors, due to harsh climate and poor roads. That the per capita expenditure of municipalities in the Western and Central regions exceeds by 30-40% their locally-generated incomes (see Fig. 6) also shows that centers in these regions enjoy preferential treatment from the central government, which covers or, at least, tolerates their budget deficits.

<<Figure 6 about here >>

5.3. Multivariate analysis

The population growth of urban localities in Nepal may be affected by factors unconnected to location. Furthermore, their effect may be undetectable by a simple non-parametric test. To test this hypothesis, stepwise multiple regression analysis was used to explain population growth rates of individual urban municipalities (see Subsections 4.3-4.4). The list of variables and the resulting model are reported in Table 4.[6]

<<Table 4 about here >>

As Table 4 shows, only four variables – *telephone proliferation, distance to major highways, distance to major rivers and location in the Eastern Region* – were filtered out by the stepwise regression as statistically significant ($P<0.05$). Fully in line with our initial hypothesis, the *rates of population growth* of municipalities decline with increasing distances to major rivers and highways ($B<0$; $P<0.05$) and increase with welfare levels

[6] The normality of distribution of the dependent variable is an important precondition for regression analysis. The Kolmogorov-Smirnov (KS) normality test confirmed that the distribution of population growth was fairly normal (KS $Z=0.558$; $P>0.915$). The linearity of the relationship between dependent and independent variables was also verified, and logarithmic transformation was applied, when required, to improve the model's fit and generality.

(as measured by number of telephone lines per 1,000 residents). In addition, in the remote and predominately rural Eastern Region of the country, population growth rates are much lower than elsewhere.

5.4. Analysis of spatial association

Analysis of spatial association (spatial autocollinearity) is a relatively new technique of geographic analysis, which detects the spatial patterns of a parameter's distribution. The Gi*(d) index of local spatial association (LSA) used in the study identifies clusters of localities with either abnormally low or abnormally high levels of development, e.g. "development hotspots" (see the methodology section).

The results of the LSA analysis for the two variables – population growth and telephone proliferation – are reported in Fig. 7 and Appendix 4. Fully in line with the results of previous phases of the analysis (testing for location differences and multivariate analysis), accelerated urban growth is found around the city of *Gaur* (see Fig. 7A), which combines all the major location advantages of the Nepalese urban system: location the fertile Terai, close to an Indian border crossing, along the major highway from Kathmandu, and near major rivers. Unsurprisingly, the abnormally slow-growing urban clusters (*Dasrathchand, Amargadhi, Ilam and Mechinagar*; see Fig.7A) are located at the east and west "corners" of the country sharing nearly all possible location disadvantages which an urban place in Nepal may ultimately display: remoteness from major population centers, rugged terrain, impeded access to the Indian border crossings, etc.

The extreme western *Amargadhi* cluster of towns also lags behind all other municipalities in the rate of telephone proliferation, while towns around Kathmandu and near the central Indian border crossing clearly lead the others (see Fig. 7B).

<<Figure 7 about here >>

6. Conclusions and policy implications

While Nepal is a small country, it is characterized by large frictional distances and enormous difficulties of access. Unsurprisingly, under such extremely unfavorable conditions, closeness to major infrastructures plays a crucial role in a locality's development, much more than in countries with milder topographies and better infrastructure networks. Thus, the development levels of urban municipalities differ significantly by location, and especially by distance from major highways and major rivers. Wealthy municipalities (as indicated by rates of telephone proliferation) also tend to grow faster than their less fortunate counterparts.

Thus, although a town's low level of development *may appear* due to the low human capital endowment of its population, disadvantages inherent to the town's location may, in fact, be the underlying cause: An isolated and peripheral town, lacking basic infrastructures, is an unattractive place to the young and educated, who are geographically mobile and can choose better situated communities. Peripheral towns, cut from national and neighboring markets, are also unattractive to private entrepreneurs. Thus, location-disadvantaged urban communities tend to lag behind, trapping inside those who lack the means of geographical mobility. The large location-associated differences in the development performance of Nepalese towns, lend support to this explanation.

After the revival of Democracy in 1990 and the subsequent policy change to urbanization and economic liberalization, the number of urban centers in Nepal has increased rapidly. However, the most rapid growth was observed in the Central Development Region. In contrast, the Mid-Western and Eastern development regions exhibit slow growth. Unsurprisingly, in regions where road networks are poor, urban localities grow slowly. Impeded access to all-weather roads and major population centers limits local opportunities for employment and education, fostering out-migration to rapidly growing urban centers in the central regions of the country. This process leads to population over-concentration in the latter, accompanied by depopulation of peripheral areas.

As this analysis indicates, access to major highways is a crucial determinant of municipality performance. Indeed, in the Mountain region, Eastern, Mid-Western and Far-Western development regions, poor road infrastructure, coupled with harsh climatic conditions, restricts economic growth and limits the number of tourists whose spending could foster the growth of the peripheries as it fosters the development of the centrally-located municipalities.

It would be simplistic, however, to assert that physical geography is the only determinant of municipality socio-economic performance. Informed governmental policies, a flexible border regime and openness of the national economy may play a crucial role. Incidentally, it may be that the sudden liberalization of Nepal's economy in the early nineties of the twentieth century has widened inter-regional differentials, embittering those left behind, such as the dwellers of the Mid-Western region, the breeding ground of the civil war afflicting Nepal since 1996. Under extreme physical conditions such as those of Nepal, a more gradual approach to liberalization might have been better and

some preferential treatment should have been given to the less developed parts of the country. In particular, it might have been desirable to invest more in linking underdeveloped peripheral regions to the center of the country, by developing the all-weather road network. Another type of such treatment would be to increase the support to municipalities in such regions. Due to scattered urban settlement in the country's periphery, the minimum criterion for municipality status (i.e., 5000+ residents and total revenue of Rs. 5 million) is hard to meet. Thus, localities become ineligible for government aid and have to limit the services they provide, which further fosters out-migration.

In general, Nepal should have a clearly formulated regional development policy supporting peripheral regions with physical infrastructure development and other tools. However it is questionable whether such policies can be pursued as long as the civil war in Nepal is ongoing (Bhurtel and Salim, 2005). In any case, follow-up studies are clearly needed to verify the validity of our findings and the long-term effect of the ongoing civil war may have on future urbanization trends in the country.

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Table 1: Urbanization rates in selected Asian countries

Country	Level of urbaniza-tion in%	Annual urban growth rate	Urban population in 1,000
Bangladesh	17.7	5.26	20,899
Cambodia	20.1	6.23	1,999
India	26.5	2.87	243,286
Maldives	38.7	3.97	65
Myanmar	25.8	3.27	11,774
Nepal	13.8	7.07	2,797
Pakistan	34.1	4.44	46,615
Philippines	53.1	4.21	35,175
Sri Lanka	22.1	2.20	4,009

Source: Skeldon (1998)

Table 2: Urban growth in Nepal from 1952 to 2001

Urban population,% of the national total	Urban population, residents	Number of ur-ban centers	Year
3.0	238,275	10	1952/54
3.6	336,222	16	1961
4.0	461,938	16	1971
6.4	956,221	23	1981
9.2	1,695,719	33	1991
14.4	3,227,879	58	2001

Compiled from: K.C. (1998); Ministry of Population and Environment (2002)

Table 3: *K*-test for significance of location differences (c^2 -values)

Indicator	Location groups								
	DCB	DIB	DMH	DKM	DMPC	EL	DMR	DR	GR
Annual population growth [percent]	8.00[c]	3.90	11.73[b]	2.40	1.98	0.90	4.35	3.01	0.07
Per capita income of municipalities [Rs]	3.33	15.68[a]	3.75	12.31[b]	9.01[b]	1.60	2.10	7.99[b]	2.32
Per capita expenditure of municipalities [Rs]	2.01	19.33[a]	3.75	9.31[b]	11.27[c]	0.47	5.18	7.99[b]	2.32
Number of industrial plants [per 1000 residents]	3.26	3.44	3.87	9.52[b]	8.45[c]	6.17	2.54	4.62	0.64
Number of shops [per 1000 residents]	3.81	4.16	1.21	15.96[a]	8.77[c]	1.83	2.81	10.37[b]	3.24
Number of telephone lines [per 1000 residents]	1.69	4.77	6.25	7.31[c]	9.47[c]	5.90	0.94	5.42	4.62[c]
Road length [km per 1000 residents]	1.59	1.30	1.82	7.75[c]	8.26[c]	10.88[b]	1.36	7.81[b]	6.61[b]
Number of school per 1000 residents	8.60[c]	4.28	11.38[b]	3.81	11.03[b]	0.50	4.88	4.53	2.07

DCB = Distance from the Chinese border;
DIB = Distance from the Indian border;
DMH = Distance from major highways;
DKM = Distance from Kathmandu;
DMPC = Distance from major population centers;
EL = Elevation above the sea level;
DMR = Distance from major rivers;
DR = Development region;
GR = Geographical region

[a] Indicates 0.01 significance level, [b] Indicates 0.05 significance level, [c] indicates 0.1 significance level

Table 4: Factors affecting population growth of urban municipalities in Nepal (method – Stepwise Multiple Regression; Dependent variable – annual population growth in 1991-2001 per 1,000 residents)

Variables	B[a]	Beta[b]	t[c]	Sig.[d]	V.I.F.[e]
	A. Significant variables (variables in the model)				
(Constant)	4.022		8.190	0.000	
TEL_PT	0.010	0.248	2.126	0.038	1.048
EAST_REG	-1.227	-0.368	-3.096	0.003	1.091
D_HIGWAY	-0.027	-0.393	-3.128	0.003	1.219
D_RIVER	-0.117	-0.305	-2.572	0.013	1.084
No of cases	54				
R^2	0.351				
F	6.775			0.000	
Moran's I[f]	-0.003				
Z-Moran's I[f]	0.094				

	B. Insignificant variables (excluded variables)				
	Beta In	t	Sig.	V.I.F.	Minimum Tolerance
POP_91	-0.193	-1.459	0.151	1.373	0.723
INC_PC	-0.225	-1.531	0.132	1.707	0.568
EXP_PC	0.115	0.703	0.485	2.026	0.486
F_SIZE	-0.183	-1.579	0.121	1.063	0.808
HOSP_PT	-0.181	-1.538	0.131	1.100	0.776
IND_PT	0.005	0.042	0.967	1.019	0.813
SHOP_PT	-0.083	-0.674	0.504	1.150	0.814
HOTEL_PT	-0.142	-1.199	0.236	1.088	0.818
ROAD_PT	-0.037	-0.309	0.759	1.076	0.790
SCHOOL_PT	-0.054	-0.441	0.661	1.119	0.794
CAMP_PT	0.102	0.804	0.425	1.244	0.801
D_IND	0.037	0.210	0.835	2.304	0.434
D_CHINA	0.119	0.730	0.469	2.013	0.491
D_KTM	0.006	0.049	0.961	1.130	0.809
D_CITIES	-0.034	-0.269	0.789	1.188	0.808
CENT_REG	-0.060	-0.462	0.646	1.279	0.766
WEST_REG	0.034	0.281	0.780	1.112	0.817
MWEST_REG	0.036	0.296	0.768	1.136	0.774
ELEVATION	-0.073	-0.604	0.549	1.115	0.773

Note:

[a] regression coefficient; [b] standardized regression coefficient; [c] t-statistic; [d] significance of t-statistic; [e] variance inflation factor (collinearity diagnostic); [f] Moran's I measure of spatial collinearity of residuals

TEL_PT=telephones per 1,000 residents;
EAST_REG = 1-Eastern Region, 0- elsewhere;
D_HIGWAY= distance to major highways, km;
D_RIVER=distance to major river, km;
POP_91=population in 1991, 1,000 residents;
INC_PC=per capita income of municipality, Rs (US$1=ca.Rs70);
EXP_PC= per capita expenditures of municipality, Rs (US$1=ca.Rs70);
F_SIZE=average family size, persons;
HOSP_PT=number of hospitals per 1,000 residents;
IND_PT=number of industries per 1,000 residents;
SHOP_PT=number of shops per 1,000 residents;
HOTEL_PT=number of hotels per 1,000 residents;
ROAD_PT=length of paved roads, m per 1,000 residents;
SCHOOL_PT=number of schools per 1,000 residents;
CAMP_PT= number of university campuses per 1,000 residents;
D_IND and D_CHINA= respectively distances to the Indian and Chinese borders, km;
D_KTM=distance to the Kathmandu city, km;
D_CITIES=distance to the closest major city;
CENT_REG=1-Central Region, 0-elsewhere;
WEST_REG=1-Western Region; 0-elsewhere;
MWEST_REG=1- Mid-Western Region; 0-elsewhere;
ELEVATION=elevation above the sea level, m.

APPENDIX 1

Descriptive statistics of the research variables

Variables*	N	Minimum	Maximum	Mean	SD
CAMP_PT	58	0.0	0.2	0.1	0.0
D_CHINA	58	25,999.9	215,657.6	115,847.9	42,554.6
D_CITIES	58	1.0	380,692.6	96,379.1	103,738.2
D_HIGWAY	58	23.5	75,729.0	28,021.0	21,202.5
D_IND	58	243.6	96,788.2	36,764.1	31,485.4
D_KTM	58	1.0	525,025.2	191,092.6	143,682.9
D_RIVER	58	59.1	15,376.1	3,848.4	3,719.2
ELEVATION	58	70.0	2,327.0	782.5	733.7
EXP_PC	55	192.2	1,950.8	621.5	400.4
F_SIZE	58	2.8	8.0	5.2	1.0
GR_9101	58	-1.5	7.8	3.5	1.9
HOSP_PT	58	0.0	0.4	0.1	0.1
HOTEL_PT	58	0.0	15.1	2.8	3.2
INC_PC	55	187.1	2,117.3	541.8	324.0
IND_PT	58	0.0	11.6	3.2	2.9
POP_01	58	11,521.0	671,846.0	55,653.1	89,625.8
POP_91	58	9,812.0	421,258.0	39,345.6	56,558.5
ROAD_PT	58	0.0	1.9	0.6	0.4
SCHOOL_PT	58	0.0	1.7	0.8	0.4
SHOP_PT	58	0.0	72.7	23.1	16.1
TEL_PT	58	0.7	158.1	45.3	36.9

*Variables are reported in the alphabetical order;
POP_01=Population size in 2001, residents;
GR_9101=Population growth in 1991-2001, percent;
For description of other variables, see footnote to Table 4.

APPENDIX 2

Location grouping and the number of municipalities in each group

Classification criterion/location group	No of municipalities	Classification criterion/location group	No of municipalities
Distance to Indian border, km (DIB)		Distance to major highway, km (DMH)	
<40.00	10	<10.00	13
40.00-69.99	13	10.00-19.99	14
70.00-89.99	12	20.00-39.99	12
90.00-99,99	11	40.00-49.99	9
≥100.00	12	≥50.00	10
Distance to Chinese border, km (DCB)		Distance to major rivers, km (DMR)	
<70.00	11	<1.00	11
70.00-99.99	12	1.00-1.99	11
100.00-134.99	13	2.00-3.99	15
135.00-149.99	9	4.00-4.99	8
≥150.00	13	≥5.00	13
Distance to major population centers, km (DMPC)		Development region (DR)	
<15.00	9	Central Region	20
15.00-39.99	11	Eastern Region	14
40-74.99	15	Far West Region	6
75.00-149.99	12	Mid West Region	6
≥150	11	Western Region	12
Distance to Kathmandu, km (DKM)		Geographic region (GR)	
<45.00	10	Mountain	2
45.00-124.99	12	Hill	27
125.00-189.99	14	Terai	29
190.00-299.99	11	Elevation above the sea level, m (EL)	
≥300.00	11	<100.00	12
		100.00-199.99	11
		200.00-799.99	13
		800.00-1499.99	10
		≥1500.00	12

APPENDIX 3

Sensitivity test for location grouping (response variable – road proximity; method - *K*-test for independent samples)

Indicator	3 Groups		4 Groups		5 Groups	
	c^2	Sign.	c^2	Sign.	c^2	Sign.
Annual population growth [percent]	3.853	0.146	10.783	0.013	11.731	0.019
Average per capita income of municipalities [Rs*]	0.567	0.753	0.642	0.887	3.752	0.441
Average per capita expenditure [Rs*]	2.301	0.316	0.924	0.820	3.748	0.441
Average number of industries [per 1000 residents]	1.989	0.370	0.144	0.986	3.874	0.423
Average number of shops [per 1000 residents]	0.305	0.858	0.679	0.878	1.207	0.877
Average number of telephone lines [per 1000 residents]	3.168	0.205	5.915	0.116	6.253	0.181
Road length [km per 1000 residents]	0.105	0.949	0.679	0.878	1.822	0.768
Average number of school per 1000 residents	9.747	0.008	11.275	0.010	11.382	0.023

* Nepalese Rupees (US$1=ca.Rs70)

APPENDIX 4

The values of the Gi*(d) statistic of local spatial autocorrelation of population growth and telephone proliferation by urban municipality (spatial lag – 50 km)

Municipality	Population growth			Telephone lines		
	Average annual rate, %	z-Gi*(d)	No of neighbors	No of lines per 1000 residents	z-Gi*(d)	No of neighbors
Amargadhi	1.18	-0.445	2	7.60	*-1.701*	2
Baglung	3.70	0.260	4	21.16	-0.051	4
Banepa	2.62	-0.695	8	128.26	*2.352*	8
Bhadrapur	1.93	*-2.209*	3	65.75	-0.421	3
Bhaktapur	1.81	-0.815	9	65.14	*2.178*	9
Bharatpur	6.34	0.996	3	76.82	-0.286	3
Bhimeswor	1.38	0.000	0	7.89	0.000	0
Bidur	1.34	-0.224	6	34.24	*2.786*	6
Biratnagar	2.88	-1.006	4	69.87	1.487	4
Birendra Nagar	3.66	-0.406	1	16.98	-1.229	1
Birgunj	6.30	1.255	3	94.20	0.370	3
Butawal	7.03	0.919	5	158.11	1.382	5
Byas	4.04	0.661	7	23.16	-0.602	7
Damak	-1.53	-1.582	5	26.96	0.607	5
Dasharathchanda	0.16	*-2.137*	1	11.91	-1.385	1
Dhangadhi	5.07	0.000	0	55.30	0.000	0
Dhankuta	2.11	-0.434	4	43.93	0.986	4
Dharan	4.34	0.147	5	90.28	1.145	5
Dhulikhel	1.74	-0.296	7	64.82	*2.583*	7
Dipayal Silgadhi	7.85	0.717	1	10.44	-1.414	1
Gaur	2.42	*2.061*	4	48.94	-0.110	4
Gulariya	5.02	0.463	2	10.28	-1.177	2
Hetauda	2.72	1.548	7	37.15	*2.123*	7
Ilam	2.30	*-2.209*	3	34.17	-0.421	3
Inaruwa	2.51	-0.345	5	53.92	1.583	5
Itahari	5.36	-1.247	5	102.59	1.355	5
Jaleshwor	2.19	-1.176	3	27.64	-0.612	3
Janakpur	3.56	-1.176	3	63.97	-0.612	3
Kalaiya	7.44	1.255	3	27.14	0.370	3
Kamalamai	7.04	0.284	3	12.66	-1.050	3
Kapilbastu	5.86	1.703	2	35.27	*2.554*	2
Kathmandu	5.95	-0.815	9	52.70	*2.178*	9
Khadbari	1.62	-1.252	1	13.33	-0.649	1
Kirtipur	3.03	-0.815	9	57.44	*2.178*	9
Lahan	4.54	-0.377	3	45.75	-0.965	3

Municipality	Population growth			Telephone lines		
	Average annual rate, %	z-Gi*(d)	No of neighbors	No of lines per 1000 residents	z-Gi*(d)	No of neighbors
Lalitpur	4.07	-0.815	9	149.31	*2.178*	9
Lekhanath	3.74	0.031	4	9.96	-0.761	4
Madhyapur Thimi	4.94	-0.815	9	84.77	*2.178*	9
Mahendra Nagar	3.03	0.000	0	36.26	0.000	0
Malangawa	3.07	0.133	4	34.72	-0.486	4
Mechinagar	3.22	*-2.209*	3	24.15	-0.421	3
Narayan	2.34	-0.406	1	10.53	-1.229	1
Nepalgunj	2.03	-0.016	1	41.82	-0.749	1
Panauti	2.72	0.373	8	9.95	*2.140*	8
Pokhara	6.40	0.062	5	120.69	-0.983	5
Pirithbinarayan	2.50	0.996	3	8.92	-0.286	3
Putalibazar	1.47	0.365	6	11.79	-0.671	6
Rajbiraj	2.53	0.034	3	46.44	-0.365	3
Ramgram	1.97	0.841	3	26.44	2.428	3
Ratnanagar	5.05	0.996	3	51.76	-0.286	3
Siddharth Nagar	3.32	1.319	4	101.34	*2.065*	4
Siraha	0.97	-0.783	3	11.16	-0.457	3
Tansen	5.02	-0.023	6	68.02	0.772	6
Tikapur	5.10	1.125	1	10.41	-1.362	1
Tribhuwan Nagar	4.85	1.004	1	31.05	-0.570	1
Triyuga	4.74	0.525	3	8.96	0.146	3
Tulsipur	4.95	1.004	1	30.24	-0.570	1
Waling	2.22	1.029	7	0.66	0.531	7

Figure 1. Geographic and regional divisions of Nepal

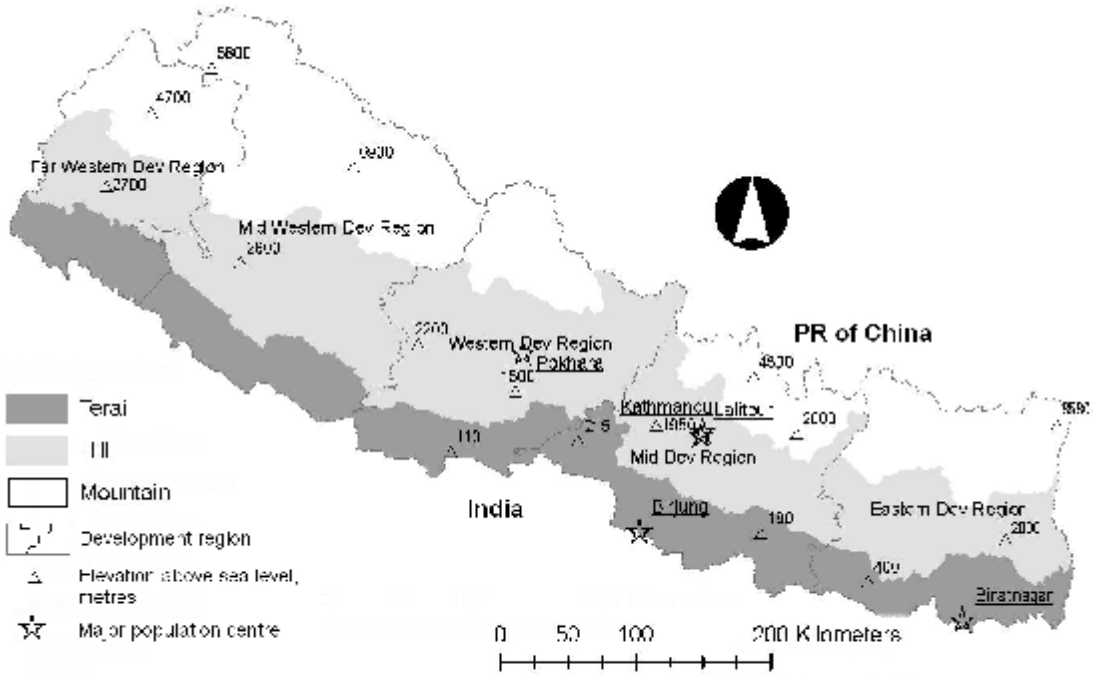
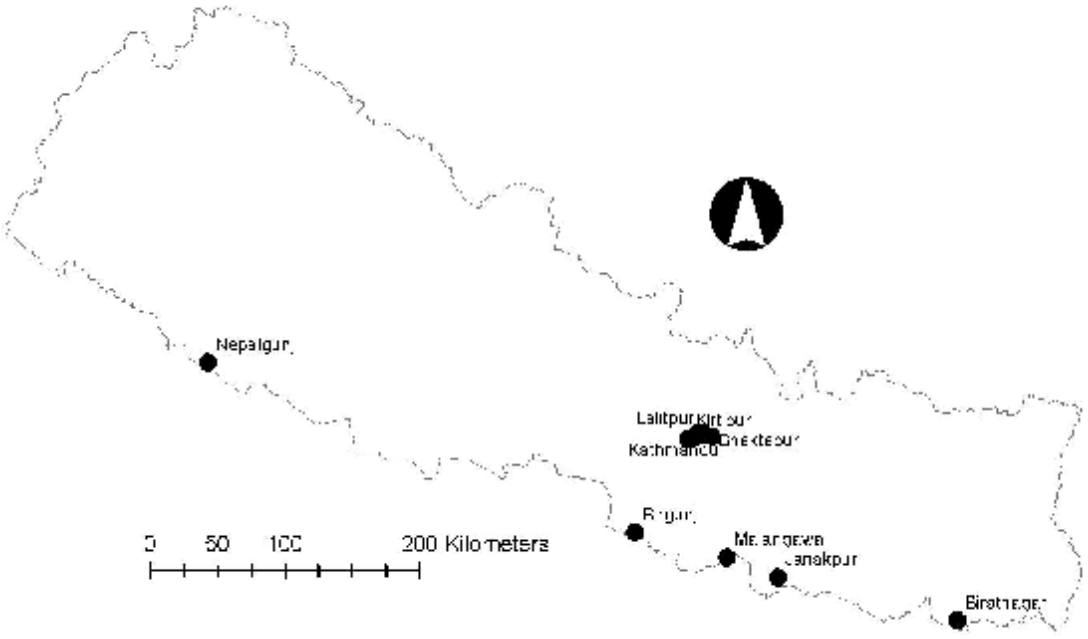


Figure 2. Urban centers of Nepal in 1952 (A) and 2001 (B)

A



B

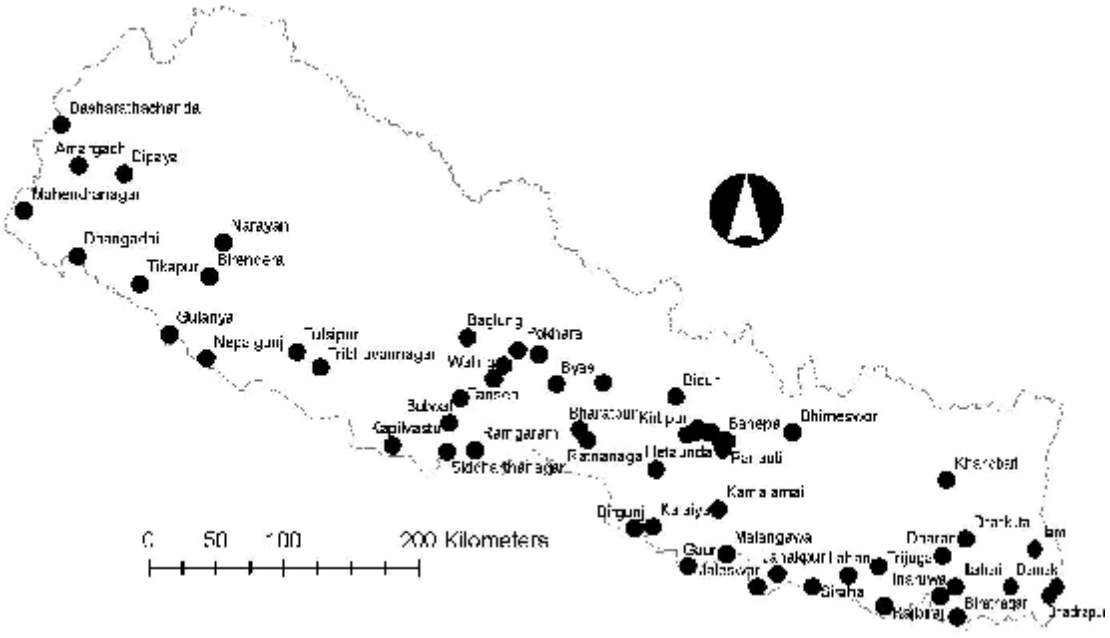
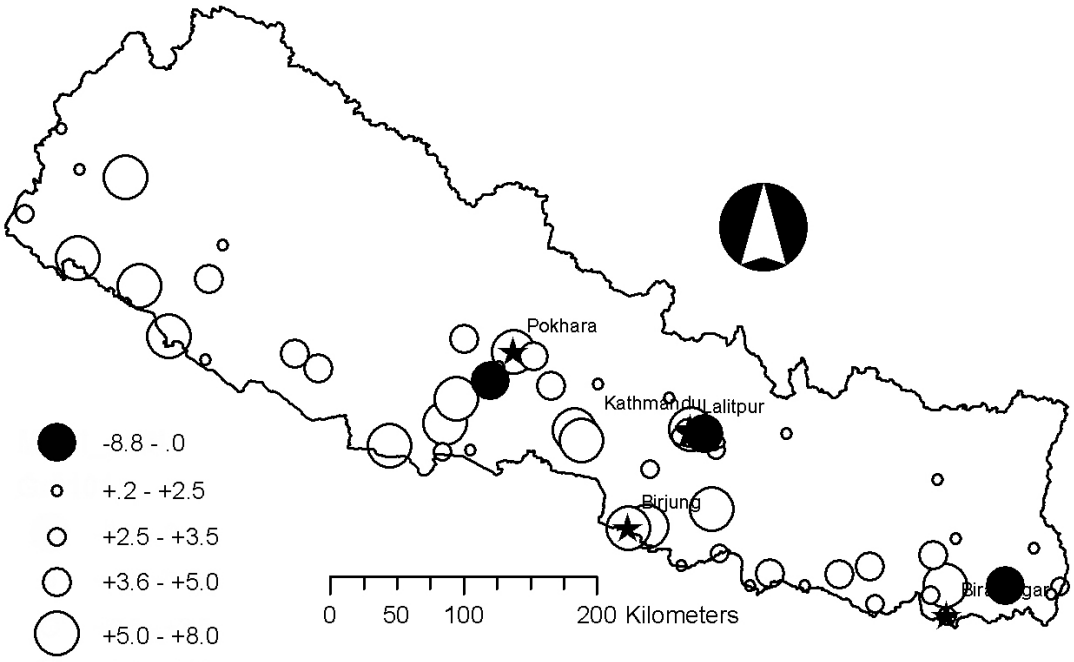


Figure 3 Population growth of municipalities in 1991-2001 (A) and rates of telephone proliferation (B)

A



B

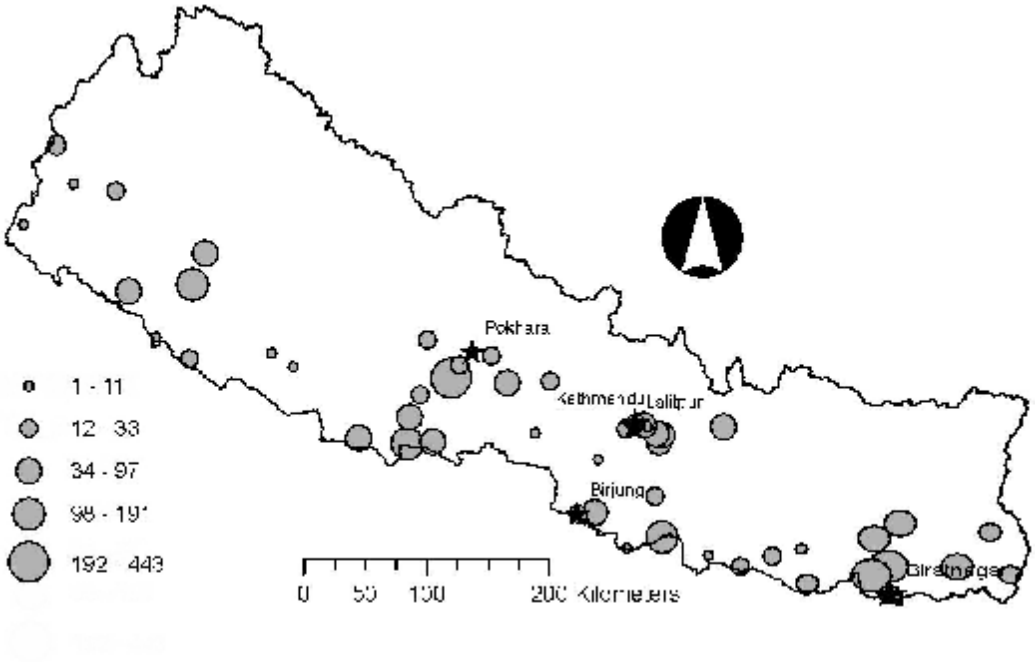


Figure 4. Average number of telephone lines as a function of distance from the major population centers

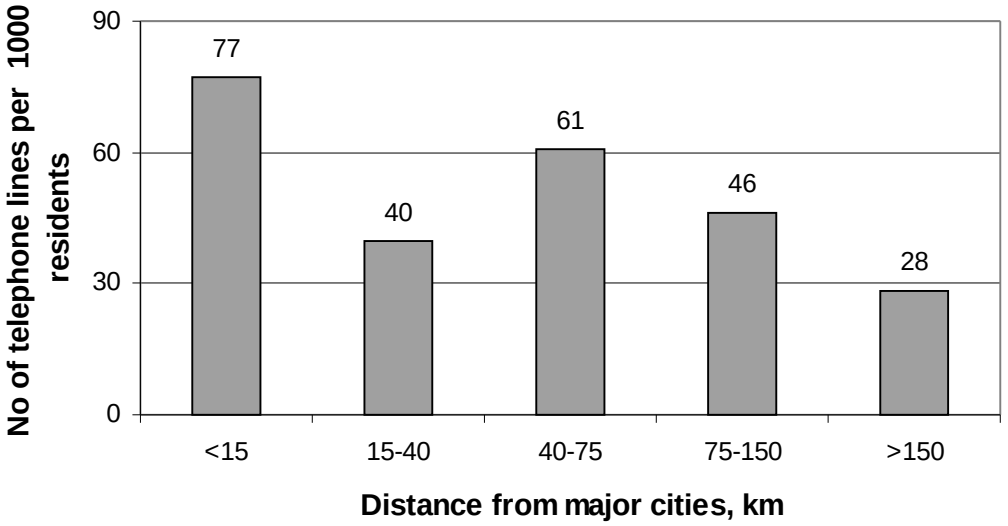


Figure 5. Average number of telephone lines by development region

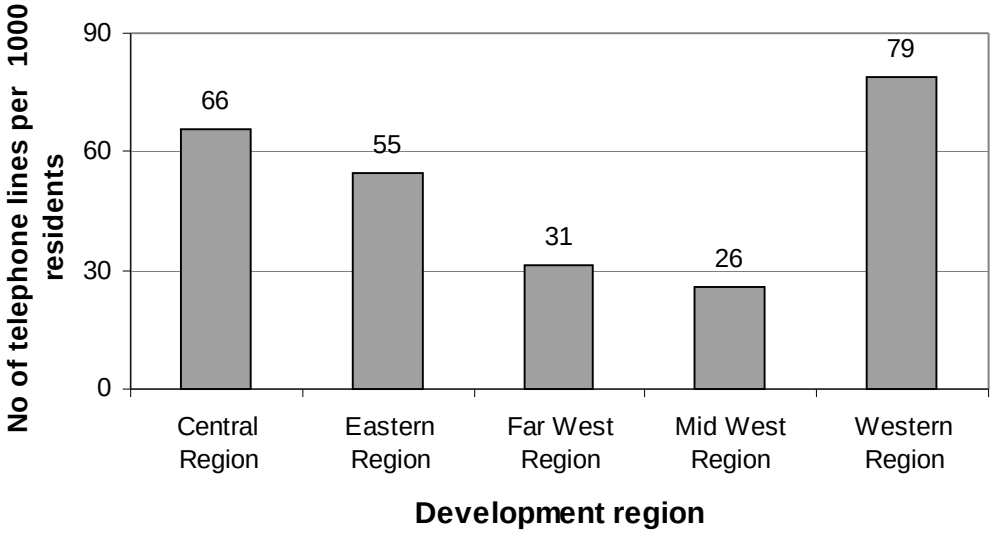


Figure 6. Average per capita income and expenditures of municipalities by development region

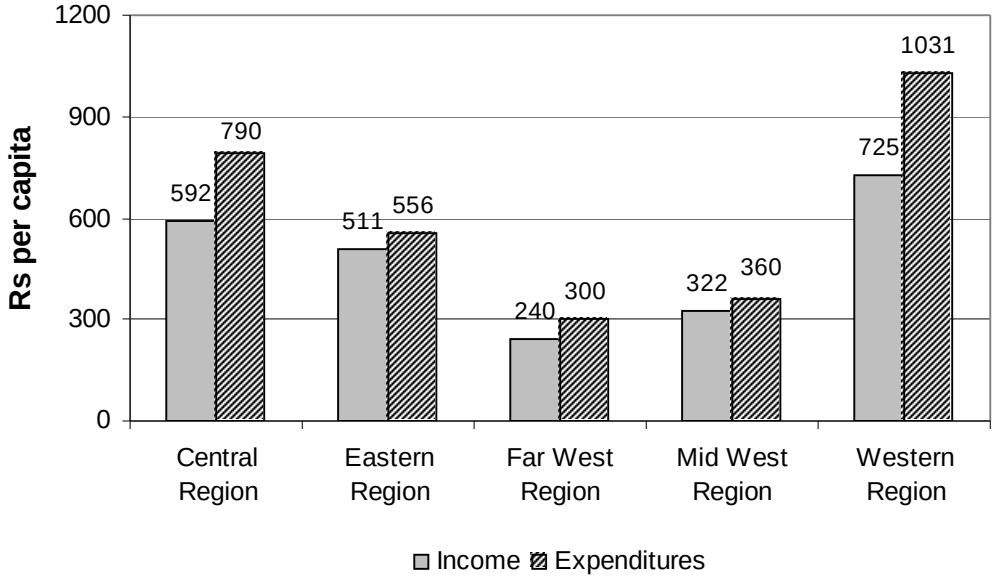
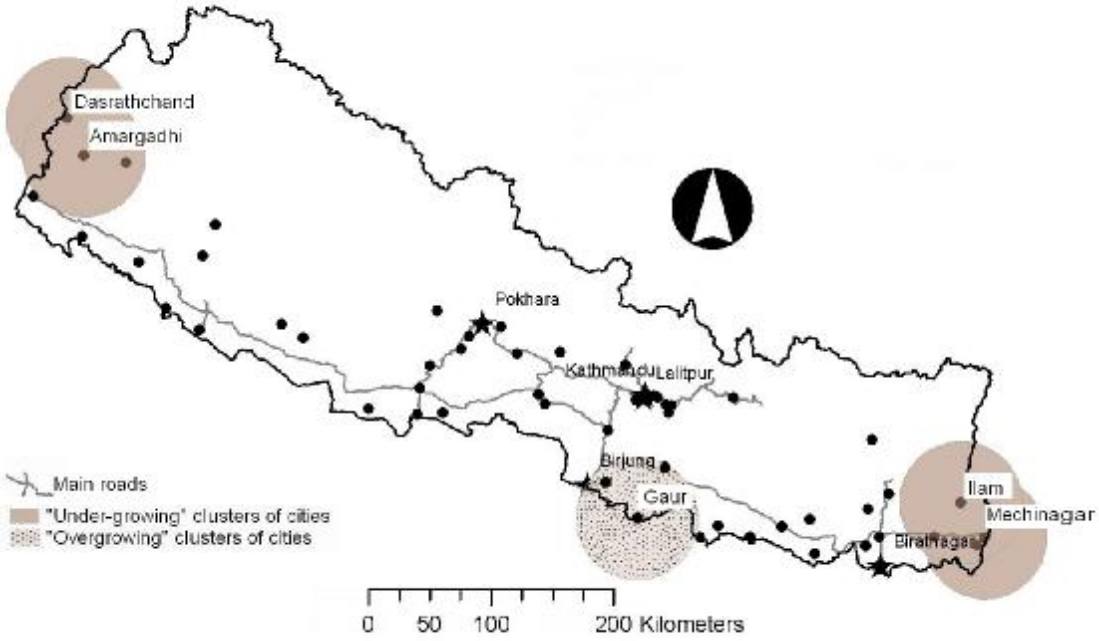
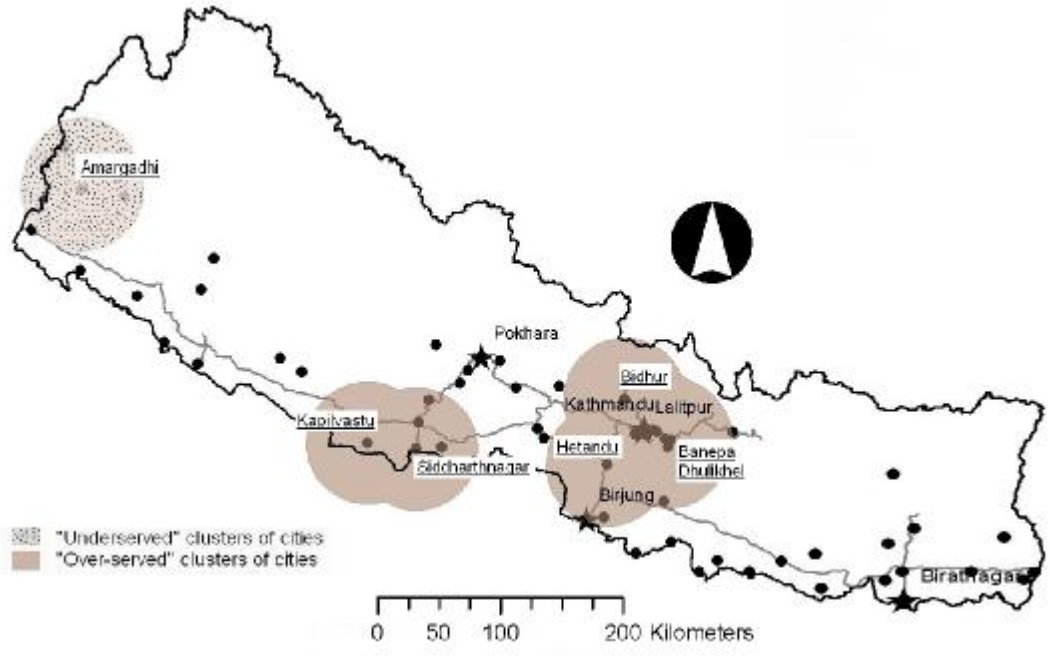


Figure 7. "Hotspots" of urban development in Nepal according to the annual rates of population growth (A) and telephone proliferation (B)



A



B