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REMOTE SENSING, GEOGRAPHIC INFORMATION SYSTEMS AND SHANNON'S ENTROPY: MEASURING URBAN SPRAWL IN A MOUNTAINOUS ENVIRONMENT

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ABSTRACT:

Urban sprawl, or the unplanned and uncontrolled spreading out of built-up areas, causes problems in the allocation of basic needs and increases risk to life and property in the face of disasters. The integration of remote sensing and geographic information systems is used in adopting Shannon's entropy to measure urban sprawl. Shannon's entropy is an index used here in quantifying the degree of dispersion or concentration of built-up areas. This study in the mountainous city of Baguio in northern Philippines shows that together with remote sensing, geographic information systems and photogrammetric techniques, built-up concentration can be identified and quantified from time series of aerial photographs and satellite images; this facility can assist in monitoring the growth of built-up areas and in drafting measures and policies to address urban sprawl's imminent effects.

1. INTRODUCTION

1.1 The Problem with Urban Sprawl

Urbanization is needed for development (Bekele, 2005). However, growth and spread of built-up areas that come with urbanization can become uncontrolled and irregular over time, such that isolated tracts of land are encroached upon. This is known as "urban sprawl" (Yeh and Li, 2001 p.83; Mujtaba, 1994 p.2) and such is detrimental to the efficient functioning of developed areas. Cities become congested due to overpopulation, and resources become limited in catering to the different needs of the people. Moreover, urban sprawl presents greater risk and damage to life and property in the occurrence of calamities and disasters. It endangers the living condition of inhabitants and puts ecosystems in jeopardy by compromising biodiversity (Yeh and Li, 2001). Thus, urban sprawl studies are done to help monitor the spread of built-up areas and quantify the sprawl in order to determine the trend, the extent, and avert the associated complications (Yeh and Li, 2001; Sudhira *et al.*, 2004; Jat *et al.*, 2007).

1.2 Urban Sprawl Studies

One of the measures commonly used due to its robustness in urban sprawl measurement is Shannon's entropy (Yeh and Li, 2001); it is an index that determines the distribution of built-up as a function of the area of built-up within a defined spatial unit (Jat *et al.*, 2007). It characterizes the pattern – dispersed or concentrated – of built-up over time that can help officials to identify which area is being used inefficiently (Yeh and Li, 2001). Moreover, entropy values can be factored into the analysis of risk as a component of vulnerability in the risk equation: *risk = hazard x vulnerability* (Castellanos-Abella, 2008). Entropy gives the distribution of the loss to the built-up, which signifies population and property.

Previous studies that use Shannon's entropy take into account the horizontal spread of built-up on a given area (Yeh and Li, 2001; Jat *et al.*, 2007). However, as time progresses, people begin to develop residences vertically, constructing structures of several storeys high in order to maximize available habitable space especially in mountainous regions (Reddy, 1996). This makes the risk per unit of space more acute. Thus, both horizontal distribution and vertical growth need to be measured to determine the full scope of the implications of urban sprawl in the affected area.

Entropy calculation is based on area computation; this is best facilitated by the integration of spatial measurement facility correspondingly offered by remote sensing (RS), geographic information system (GIS) and photogrammetric techniques (Sudhira *et al.*, 2004; Ayhan *et al.*, 2008). Satellite images and aerial photographs provide data about the physical state of an area at a given time. Remote sensing facilitates image enhancement and classification; photogrammetric techniques, particularly stereo-modelling, enable the determination of heights and elevations. On the other hand, GIS enables proper storage, retrieval, and display of spatial data, as well as provide spatial analysis functions and area computation. The combination of these tools provides the essential data in computing for Shannon's entropy in growth areas; thereby check on emerging trends that may require immediate attention.

1.3 The Study Area

In this study, we apply the principle of Shannon's entropy to measure urban sprawl phenomenon in the highly urbanized mountain city of Baguio, located in the Province of Benguet in the northern Philippines (see Figure 1).

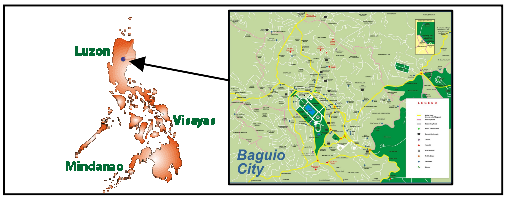

Figure 1. Location Map of Baguio City (Philtravel Center; CLUP)

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Baguio is a plateau at 1400m altitude whose limited land area was originally designed for 30,000 people (MTDP 2005-2010); but the 2007 census shows that it is now actually housing some 301,926 inhabitants (NSO 2007). Baguio City is the Philippine's "Summer Capital" as its temperature is generally 8-10°C lower than those of the lowlands. Baguio City's cool climate attracts settlers such that whole mountainsides have developed into housing projects. With its limited space, high-rise structures are dominating Baguio City's landscape. This poses a big risk to its inhabitants due to its steep terrain, for being traversed by the northern splay of the Philippine Fault Zone, and for being in a wet region; Baguio City holds the world record for a 24-hour rainfall at 1,200mm (Jennings, 1950). With such confluence of environmental characteristics, Baguio City is highly prone to landslides (Orense, 2003).

Figure 2. Urban Sprawl along the Slopes of Baguio City (LCVerzosa, 2009)

To capture both the horizontal and vertical configurations of urban sprawl in Baguio City's mountainous landscape, this paper reports about the integration of remote sensing, GIS and photogrammetric techniques in conjunction with Shannon's Entropy to quantify the developed areas over time. We hope that this combination of technologies and procedures can realistically illustrate the spread of development in Baguio City and help its local government to effectively monitor and plan to mitigate the possible effects and implications of urban sprawl to its community.

2. METHODOLOGY

2.1 Shannon's Entropy: *Horizontal* and *Vertical* Entropy

Shannon's entropy originated from information theory as a measure of uncertainty of conveyed information over a noisy channel (Jat *et al.*, 2007; Bailey, 2009). The larger the value of Shannon's entropy, the higher is the uncertainty of information conveyed (Bailey, 2009). High entropy is the most probable yet least predictable state that leads to disorder. The same is true for urban sprawl. Thus, Shannon's entropy is convenient in measuring urban sprawl (Yeh and Li, 2001).

In urban sprawl, Shannon's entropy is the measure of the degree of dispersion or concentration of a random geographical variable, i.e. the built-up. It is given by (Yeh and Li, 2001):

$$H_n = \sum_i^n p_i \log(\tfrac{1}{p_i}) \tag{1}$$

where p_i is the probability or proportion of occurrence of a phenomenon in the i^{th} spatial unit out of n units, and thus, is given by:

$$p_i = x_i / \sum_i^n x_i \tag{2}$$

where X_i is the area of built-up at the i^{th} unit.

Entropy values range from a minimum of 0 – representing a concentrated pattern, to a maximum of *log n* – denoting a dispersed distribution. The value of *log n* is significant as it can be treated as a critical limit or threshold to the expansion of an area. *Log n* can be computed for any region; and every year, the entropy value can be monitored and compared to the previous in order to avoid reaching the threshold. Thus, planners and local officials would be able to have a scientific and quantifiable description of the urban situation for drafting policies that take into account threshold value.

When entropy values for succeeding years are investigated, the progression of a random geographic variable – the sprawl of built-up can be monitored. Increasing entropy values would indicate continuous dispersion with built-up highly occurring. Decreasing values would signify that an area is becoming less fragmented and homogenously covered, thus, further occurrence of built-up is less likely to happen.

Equations (1) and (2) above are used to calculate both *horizontal* and *vertical* entropies. The difference lies in determining the area of built-up, x_i, to be considered. *Horizontal* entropy describes the horizontal spread of the built-up area; thus, it accounts for the plane area of the built-up. On the other hand, *vertical* entropy evaluates the vertical development or the rise of building structures; thus, the aggregated floor area of the built-up is computed. In this case, x_i is given by:

$$x_i = (\text{number of floors}) \times (\text{area of the building footprint}) \tag{3}$$

where the number of floors is a function of the building height and the standard floor height.

Table 3 shows the three possible levels at which the Entropies can be computed in this study.

LEVEL	SPATIAL UNIT
City	*Barangay* (village)
Barangay (village)	*Purok* (neighbourhood)
Purok (neighbourhood)	Building

Table 3. Levels of Entropy Computation

For this study, *horizontal* entropy is computed for: (1) the entire city of Baguio using a series of available Landsat images from 1979, 1989, 1992, and 2002 in order to investigate and illustrate the trend and extent of horizontal development with population increase; (2) the *barangay* (village) level, and, (3) the *purok* (neighbourhood) level of Barangay Cresencia Village, one of the severely affected *barangays* during a recent typhoon, Typhoon Parma of October 2, 2009.

Computation of *vertical* entropy at *purok* level of Barangay Cresencia Village is also done in order to investigate the increase in high-rise buildings and analyze its relationship with the *horizontal* spread. Aerial photographs from 2003 are used to determine building heights.

2.2 Data and Software Used

Table 4 shows the available data which are utilized for this study. The Landsat images provide a time series analysis on the spread of built-up areas, while the aerial photographs are interpreted to yield the extent and to determine building heights in the developed areas. Identification of these built-up areas is essential in locating those where the population is concentrated. Kawamura (1971) similarly showed how changes in urban growth are monitored using a series of aerial photographs.

DATA	SOURCE
Landsat Images (1979, 1989, 1992, 2002)	USGS GLOVIS
Aerial Photographs (2003)	F.F. Cruz and Co.
Barangay Boundary Map	Reclaim II Project
Topographic Map	National Mapping and Resource Information Agency

Table 4. The Gathered Data

Satellite image enhancement and classification are done with ENVI 4.3®, while ERDAS-Imagine® is used for stereo-modeling of the aerial photographs. Spatial analysis and area computation are done using GIS software ArcGIS 9.3®.

2.3 Flowchart of the Methodology

Figure 5 illustrates the methodology we developed that combines photogrammetric and digital image processing techniques to delineate and estimate the extent of urban growth areas. GIS is also used in visualizing the spatial spread and distribution of developed areas. In turn, the quantified built-up areas from the aerial photographs and satellite images are used to compute Shannon's entropy.

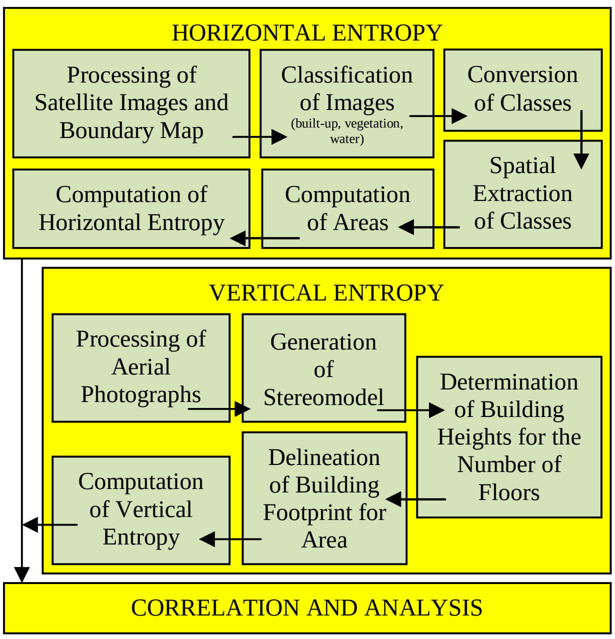


Figure 5. Methodology in the Measurement of Urban Sprawl in a Mountainous Environment

3. RESULTS AND DISCUSSION

3.1 Horizontal Entropy: Baguio City

From the temporal *horizontal* entropy values, all of which are near log N, and the corresponding *barangay*-built-up images of each year (see Fig. 6), it can be seen that the pattern of built-up area manifest a dispersed distribution from the city center (Barangay Kisad-Legarda). The high values of HE also indicate that the city is approaching log N (7.01), which is the critical level of expansion of built-up. However, from 1992 to 2002, there is a significant drop in entropy (from 6.04 – 5.79); this indicates that due to the rapid growth, the area has become homogenously covered by built-up, the space has become very limited and built-up areas have become concentrated within the city limits. However, in Figure 7, a population census from 1995-2000 (NSO, 2007), shows yet an increase from 226,883 to 252,386 (10% growth). This yields a higher population density that, without a corresponding built-up spread, is a sign of vertical development; the people are building high-rise residences. Such a trend necessitates the investigation of *vertical* entropy.

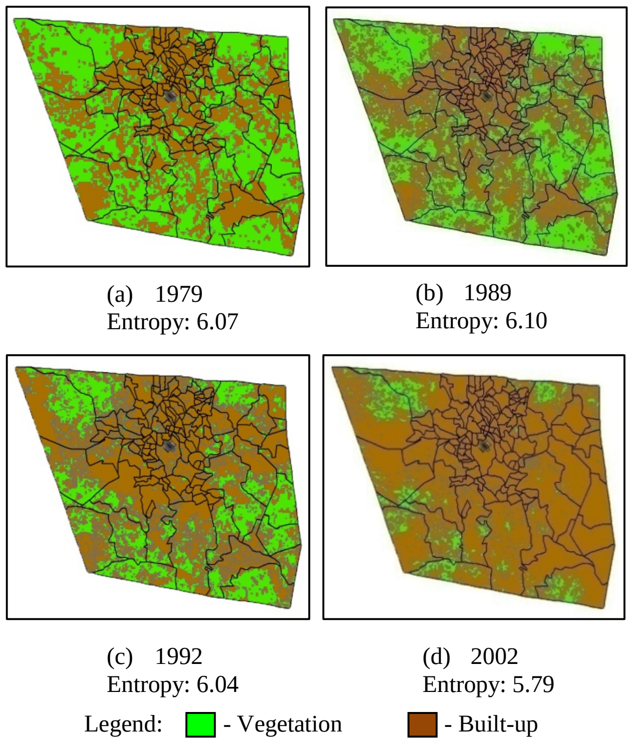


Figure 6. Series of Satellite Imagery and Corresponding Entropy Depicting the Spread of Urban Growth in Baguio City from 1979 to 2002

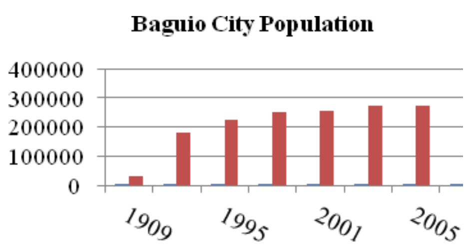


Figure 7. Baguio City Population from 1909-2007 (NSO, 2007)

3.2 Horizontal and Vertical Entropy: Barangay Cresencia Village

From the *horizontal* entropy value (HE) of the whole Cresencia Village in Table 8, it can be seen that this *barangay* has high entropy indicative of sprawl and availability of space where built-up areas may further establish. In the same way, the high *vertical* entropy value (VE) of this *barangay* signifies that built-up, in reality, is more than what is being shown in the horizontal dimension. It reflects a larger dwelling area, as well as population concentration. Thus, the two values would indicate the magnitude of the risk in the event of a disaster or calamity. This analysis is further established in the *purok* level (see Table 9), whose entropy values are near the threshold value.

With the computed *purok* entropy values, an entropy map can be generated using an entropy matrix for a given hazard. As an example, consider the entropy matrix for landslide risk in Figure 10. Entropy values are classified as high or low depending on their nearness to log N (Jat et al., 2007). An entropy value is high when it is nearer to log N, and vice versa. From this matrix, the HE and VE of the *puroks* of Brgy. Cresencia Village are classified and the resulting entropy map is generated in Figure 11. Entropy maps are useful in visualizing the risk corresponding to the horizontal distribution and vertical growth of built-up.

	HE	VE	N (*puroks*)	LOG (N)
Cresencia Village	1.73	1.68	4	2

Table 8. *Horizontal* and *Vertical* Entropies of Barangay Cresencia Village

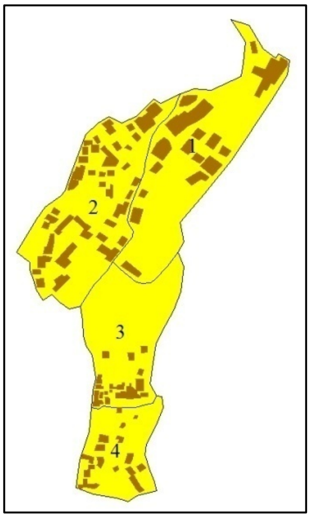
PUROK	HE	VE	N (building)	LOG (N)
1	4.24	3.96	22	4.46
2	5.64	5.43	58	5.86
3	4.05	4.00	21	4.39
4	3.93	3.76	18	4.09

Table 9. *Horizontal* and *Vertical* Entropies of the *Puroks* in Barangay Cresencia Village

VE	*High*	**HIGH RISK** (Concentrated, High Rise)	**RISKY** (Dispersed, High Rise)
	Low	**RISKY** (Concentrated, Low Rise)	**LOW RISK** (Dispersed, Low Rise)
		Low	*High*
		HE	

Figure 10. Entropy Matrix for Landslide Risk

The entropy map in Figure 11 shows that for a landslide risk, the puroks of Brgy. Cresencia Village are classified as risky areas composed of dispersed high-rise buildings.



Legend: - High HE, High VE (dispersed, high rise)
- Built-up

Figure 11. Entropy Map of Barangay Cresencia Village

3.3 The Aftermath of Typhoon Parma

Baguio City experienced severe casualties when the tropical storm Parma hit the city in October 2, 2009. Major landslides and high flooding were experienced in conjunction with the heavy rainfall that reached an average of 927.8 mm on that day (Gonzales, 2009). At the height of the typhoon three major roads going to and from Baguio were closed because they were impassable due to landslides in the area (Mananghaya, 2009). Figure 12 shows snapshots of some of the affected barangays.

Figure 12. Top: Flooding at the City Camp
(L – Noel Godinez, R – Brenda Dacpano; www.nordis.net);
Bottom: Landslide at Cresencia Village
(L – www.daylife.com, R – Danny Durante)

Tables 13 and 14 show the effects of the Typhoon Parma from October 2 – 13, 2009. The reported incidents occurred in different areas of Baguio City such as Brgy. Cresencia Village, Kennon Road and Bokawkan Road.

REPORTED INCIDENTS	NUMBER
Eroded Riprap	25
Soil Erosion	39
Flood	41
Landslide	58
Vehicular Accidents	1
TOTAL INCIDENTS	*164*

Table 13. Summary of Incidents (Pepeng Report, 2009)

Id	BARANGAY/ROADS	Evacuated Inhabitants	Missing	Deaths	Injured
1	Irisan	196	1	15	10
2	Pinsao_Proper	50		2	
3	Pinsao_Pilot	50			
4	Fairview	80			
5	San_Luis_Village	7			
6	Dominican_Hill_Mirador	12			
7	Sto._Rosario	47			
8	Quirino_Magsaysay_Upper	22			
9	Rock_Quarry_Upper			2	
10	Rock_Quarry_Middle			2	
11	Quirino_Magsaysay_Lower	557			
12	City_Camp_Proper	125			
13	Rock_Quarry_Lower	152			
14	City_Camp_Central	256			
15	Queen_Of_Peace	144			1
16	Camp_Allen	90			
17	Cresencia_Village			23	5
18	Gen._Luna_Upper	20			
19	Kias	26			
20	Atok_Trail				2
21	Loakan_Apugan			1	
22	Mines_View	6			
23	Brookspoint			1	
24	Bayan_Park_East				1
25	Aurora_Hill_South_Central				1
26	Bayan_Park_Village				1
27	Aurora_Hill_North_Central				1
28	Bayan_Park_West				1
29	Aurora_Hill_Proper				1
30	Lourdes_Subd_Extension	100			
31	Marcos Highway			4	1
32	Kennon Road				2
33	Kitma			8	

Table 14. Summary of Casualties (Pepeng Report, 2009)

Table 14 shows that Barangay Cresencia Village registered the most number of casualties during the recent typhoon. This reflects the high entropy values in Table 8, which was computed based on a set of 2003 aerial photographs. Therefore, these 2003 estimates, and whenever data is available to compute for the entropy of the succeeding years, would have served as signs that point to the high risk *barangays* in the city; the local government can then focus on high risk *puroks* in each *barangay*. In essence, a more strategic disaster preparedness plan could have been drafted.

The growth of built-up in Baguio City has become uncontrolled over the years, even with its policies that aimed at preventing congestion (CLUP, 2002-2008). The consecutive entropy values over a given period would suggest both the horizontal and vertical patterns of growth of the built-up; thus, better estimations of further growth could be seen and properly addressed in future policies.

In the light of the recent typhoon casualties and damages, the city council of Baguio City saw the need to draft resolutions and ordinances that would answer the city's lack of proper housing policies, disaster preparedness plans and rehabilitation measures. An ordinance is now being proposed for the creation of the City Housing and Resettlement Office to facilitate the "proper formulation, implementation and monitoring of housing and resettlement programs and projects in the city" (Refuerzo, 2009a). This study on the integration of remote sensing and geographic information systems in adopting Shannon's entropy to measure urban could help in giving a quantitative and scientific approach to site selection for housing and relocation projects.

The flooding that occurred at the City Camp Lagoon has been attributed to trash that clogged the sinkholes in the underground water channel (Refuerzo, 2009b). In this case, entropy values, which also reflect population concentration in the area, could have served as estimates of the number of people that will be affected during a flooding incident. The values can also suggest the amount of solid waste that are produced; and which potentially clog the drains when typhoons occur.

The death toll and infrastructure damage brought by Typhoon Parma prompted the Baguio city government to focus on areas found to be geologically hazardous, and to create a wholistic disaster management plan (Refuerzo, 2009c). The *horizontal* and *vertical* estimates of Shannon's entropy reflect the built-up area and population situation of the city; thereby, providing a comprehensive approach to prevent further casualties in the face of natural calamities.

4. CONCLUSION

Integration of photogrammetric, remote sensing, and GIS techniques facilitates delineation, tracking down and monitoring of urban development. RS provides pattern recognition techniques to classify land cover based on their spectral characteristics on satellite images. GIS enables the proper handling of databases necessary for the integration of data from different sources. Photogrammetric techniques for measuring building heights in estimating the vertical population concentration is also sufficient in providing the necessary data for computing Shannon's entropy equation. Entropy values are obtained and this demonstrates how it can be implemented within a GIS to facilitate the measurement and visualize the extent of urban sprawl.

This study shows that entropy is a good indicator in identifying and monitoring land development—that is, dispersion and concentration of built-up areas. Compactness of development (indicated by low entropy) is a sign of vertically built development in the light of continuing increase in population. This imply that high population concentration is being exposed to Baguio City's geologic hazards such as earthquakes and landslides, and more recently, flooding hazards. Moreover, the high values of Shannon's entropy indicate that the city is precariously approaching its critical level. Such a situation is important to keep track by the city government; in this way, safe urban development can be planned.

REFERENCES

Ayhan, E., Erden O., Gormus, E.T., 2008. Three dimensional monitoring of urban development by means of ortho-rectified aerial photographs and high-resolution satellite images. *Environ. Monit. Assess.*, Vol. 147, Nos. 1-3, pp. 413-421. http://www.springerlink.com/index/A7U5443530663M04.pdf (accessed 20 July 2009).

Bailey, K.D., 2009. Entropy systems theory. *Systems Science and Cybernetics*, Eolss Publishers, Oxford, UK, pp. 152-169. http://www.eolss.net/ebooks/Sample%20Chapters/C02/E6-46-01-04.pdf (accessed 1 December 2008).

Bekele, H., 2005. Urbanization and urban sprawl. http://www.kth.se/polopoly_fs/1.21420!294.pdf (accessed 2 December 2008).

Castellanos-Abella, E.A., 2008. Multi-scale Landslide Risk Assessment in Cuba. *ITC Library Academic Output 2008*. http://www.itc.nl/library/papers_2008/phd/castellanos.pdf (accessed 1 March 2010).

CLUP. 2002-2008. Baguio City Comprehensive Land Use Plan. Baguio City, Philippines.

Gonzales, M.A., 2009. More landslides feared in Baguio amid non-stop rains. *GMANews.TV*, 7 October 2009. http://www.gmanews.tv/story/174056/more-landslides-feared-in-baguio-amid-non-stop-rains (accessed 10 October 2009).

Jat, M.K., Garg, P.K., Khare, D., 2007. Monitoring and modeling urban sprawl using remote sensing and GIS techniques. *Int. J. Appl. Earth Observ. Geoinform.*, Vol.10, No.1, pp.26-43. http://linkinghub.elsevier.com/retrieve/pii/S0303243407000335 (accessed 8 February 2008).

Jennings, A.H., 1950. World's greatest observed point rainfalls. *American Meteorological Society.* Vol. 1, No. 70, pp. 4-5. http://docs.lib.noaa.gov/rescue/mwr/078/mwr-078-01-0004.pdf (accessed 20 November 2009).

Kawamura, J.G., 1971. Automatic recognition of changes in urban development from aerial photographs. Transactions on *Systems, Man, and Cybernetics,* Vol. 1, No. 3, pp. 230-239. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4308290 (accessed 20 July 2009).

Mananghaya, J., 2009. Northern Luzon towns isolated. *Philstar News Service*, 12 October 2009. http://www.philstar.com/Article.aspx?articleid=513366 (accessed 12 October 2009).

Mujtaba, S.M., 1994. Land use and environmental change due to urban sprawl: A remote sensing approach. New Delhi: Daya Publishing House.

MTDP, 2005 – 2010. Baguio City: Medium Term Development Plan 2005 - 2010. Baguio City, Philippines.

NSO, 2007. National Statistics Office: 2007 Census of Population. Manila, Philippines.

Orense, R.P., 2003. Geotechnical hazards-nature, assessment and mitigation. The University of the Philippines Press, Diliman, Quezon City, p.510.

Pepeng Report, 2009. Baguio City: Summary of Incidents Related to Tropical Storm Pepeng as of October 13, 2009. http://www.baguio.gov.ph/documents/pepengreport_oct13.pdf (accessed 10 November 2009).

Reddy, K.N., 1996. Urban redevelopment: a study of high rise buildings. http://books.google.com.ph (accessed 9 July 2009).

Refuerzo, A.P., 2009a. Creation of housing office urged. *News and Events*, 20 November 2009. http://www.baguio.gov.ph/index.php?q=content/creation-housing-office-urged (accessed 9 December 2009).

Refuerzo, A.P., 2009b. P1.5 million proposed for installation of screens to prevent flooding at city camp lagoon. *News and Events*, 20 November 2009. http://www.baguio.gov.ph/index.php?q=content/p15-million-proposed-installation-screens-prevent-flooding-city-camp-lagoon (accessed 9 December 2009).

Refuerzo, A.P., 2009c. Pepeng experience highlights need to address high risk areas, wholistic disaster management plan. *News and Events*, 19 October 2009. http://www.baguio.gov.ph/index.php?q=content/pepeng-experience-highlights-need-address-high-risk-areas-wholistic-disaster-management-plan (accessed 9 December 2009).

Sudhira, H.S., Ramachandra, T.V., Jagadish, K.S., 2004. Urban sprawl: metrics, dynamics and modeling using GIS. *Int. J. Appl. Earth Observ. Geoinform.*, Vol. 5, No. 1, pp. 26-39. http://linkinghub.elsevier.com/retrieve/pii/S0303243403000230 (accessed 11 November 2008).

Yeh, A.G.O., Li, X., 2001. Measurement and monitoring of urban sprawl in a rapidly growing region using entropy. *Photogr. Eng. Remote Sens.*, Vol. 67, No. 1, pp. 83-90. www.asprs.org/publications/pers/2001journal/january/2001_jan_83-90.pdf (accessed 11 November 2008).

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