THE IMPACT OF LAND USE FEATURES AND TRANSPORT ACCESSIBILITY IN THE OCCURRENCE OF CRIME IN A UNIVERSITY CAMPUS

Alice Ross T. Morta, Lund University, SE-223 62 Lund Sweden

Jun T. Castro, University of the Philippines Diliman, Quezon City 1101 Philippines

ABSTRACT

Several research works have shown that land use variables and the presence of escape routes significantly contribute to criminal activity in cities. Commercial and mixed use zones are particularly vulnerable to crime, as those areas with major intersections and heavy foot and automobile traffic. This study investigates whether such factors – land use and accessibility – are also important determinants of crime at the micro scale, particularly in a university campus. The site chosen is one of the biggest university campuses in the Philippines, where over the years users have suffered from problems of theft and robbery.

In the study, Geographical Information Systems (GIS) and Kernel Density Estimation were used to identify campus crime concentrations (also known as hot spots) and relate these with land use features. Multiple Centrality Assessment (MCA) was then performed to examine street network. Values for degree and closeness centralities were calculated and plotted on digital maps to see whether the more “central” (i.e., connected) street segments are those that are more prone to crime.

Our results support the conclusions made from macro-level analyses. First, land use contributes to the possibility of crime in a campus setting. Land use influences the intensity of use of a particular place, with high user density denoting more potential targets for offending. But changes in land use on campus are not necessary; for one, there are no “negative” land uses that encourage or host risky behaviors. Instead, it is recommended that the problem be addressed using mechanisms like space design and surveillance that reduce the vulnerability of campus users to crime.

Second, access opportunities are related to campus crime. Areas with high concentrations of crime are directly connected to public transport routes and are in close proximity to major intersections. Both features open up opportunities for offenders to easily reach target areas

and escape from them. The novel use of MCA in the study showed that the availability of public transport, in fact, makes up for the poor centrality of street segments near or in high-crime areas: the biggest hot spot on campus is characterized by low centrality and high public transport accessibility. But based on GIS-generated scenario, limiting transport accessibility would have an unfavorable effect on the achievement of land use objectives on campus. Hence, measures that address user vulnerability to decrease the number of potential targets or victims are indeed more suitable.

1. INTRODUCTION

The objectives of the study are straightforward: (1) examine if land use and transport accessibility create conditions for crime in a university campus as they do in significantly larger areas and (2) if indeed valid, draw up preventive measures that are particularly suitable for the chosen site. The premise that land use and accessibility could have some influence on the safety of a place was based on conclusions derived from studies of cities, residential neighbourhoods, and commercial districts. Hence, what is new in this work is the analysis of how the two variables relate to crime in a place much smaller than those used in other studies.

The UP Diliman campus was selected for a couple of key reasons. First, the authors are already familiar with the area which is essential in facilitating data collection. Second (which is more important), a systematic analysis of crime in the university has never been done, despite persistent concerns of users about their safety on campus. In 2005, a number of measures were installed to address, for instance, inadequate and inappropriate lighting around the campus at night, and the openness of the campus to non-academic users, without investigating whether these factors were mainly accountable for crime. As a result, the administration managed to lower the incidence of crime in 2006 but by the next year faced a sharp increase in the number of offences. It was clear therefore that defining solutions around mere presumptions is not very effective. (In fact, in the course of the study, it was found that most cases of theft and robbery happened in the early afternoon, and not, as widely presupposed, during the evening.)

The study revealed that offenders in a micro-space operate almost in the same fashion as they do in a larger space, especially when land use and accessibility are taken into account. But similar as these two environments may be, large-scale solutions that can be adopted in cities were found unsuitable for a campus setting. Thus, in the paper, one will read about doable, practical, and direct measures to enhance safety for campus users. Such approach is particularly relevant to an educational institution that operates on limited public funds, which makes expenses on non-academic items like security difficult to sustain. Furthermore, it can serve as a basis for gauging the appropriateness of existing preventive measures, and for assessing whether future development plans can strengthen or weaken safety and security on campus.

2. BACKGROUND LITERATURE

Many researchers have examined how and why crime occurs, especially as it relates to the physical environment. The link between the two is not new. Medieval and classical cities found refuge in defensible space, long before the term was even coined, which can be observed in the way they walled their communities and placed few entry gates. Cities in the 18th and 19th century modified their built surroundings as part of major crime control efforts (Dhiman, 2006). In London and Paris, street lighting was introduced to reduce crime on the streets (Brantingham and Brantingham, 1993). In 1942, before the age of computer-aided crime mapping began, Shaw and Mckay along with their contemporaries analyzed "strong and lasting correlations among crime locations, offenders' residences, inner-city areas, non-white populations and urban poverty" (Schneider, 1988).

Several variables were associated to crime in cities but two of such variables particularly stood out: land use and accessibility. An early work noted that the commercial district is more vulnerable to crimes against property than areas far from the city center (DeFleur and Quinney, 1966). Another study showed that excessive commercial activities in a very small area can generate crime (Seville, 1998). Much later works proved that commercial land uses do have strong consequences on crime occurrence (Baran *et al.*, 2006; Morta, 2008), and even more so if the areas are accessible (Davison and Smith, 2003). In residential neighbourhoods, layout and land use likewise contributed in many housebreakings (Landman and Lieberman, 2005).

The easy access to and escape from places has an impact on criminal activity as well (Poyner, 1983; Taylor, 2002), especially where intersections are present. Corner houses were observed to have been burglarized more than those in the middle of the block (Hakim *et al*, 2000) while bus stops in intersections experienced more crime (Loukaitou-Sideris, 1999). In South Africa's major cities, many robberies and hijackings took place at isolated intersections (Landman and Lieberman, 2005). The kind of intersection also has an impact on crime rate. T sections were observed to be most accessible to offenders; L sections, less accessible; and cul-de-sacs, the least accessible (Rubenstein *et al*., 1980). Accessibility is crucial to offenders because they need areas where they have the best possibility of escape when confronted by a potential threat (Felson, 1987). Thus, apart from intersections, places with heavy automobile traffic recorded higher victimization rates (Rubenstein *et al*., 1980; Clontz *et al*., 2003).

Not many studies have been conducted to explore the influence of the built environment on campus crime, and in those that did, land use and accessibility were never discussed (Fisher and Nasar, 1992; Day, 1999; Fernandez, 2005). It was only Long and Baran's work in 2006 that noted the presence of highly connected streets as a factor in the occurrence of crime on campus. However, they concluded that land use variables are not important in analyzing crime in this setting. The researchers too observed that outdoor crimes on campus were committed close to buildings and roads where there was greater movement and more potential victims. Crime then is more likely to happen in places where there is a number of

potential victims, and where physical features make it easy for criminals to commit crime (Rhodes and Conly, 1981; Loukaitou-Sideris, 1999). These characteristics are known respectively as target attractiveness and spatial attractiveness.

3. DATA AND STUDY AREA

Lying on 493 hectares of land, UP Diliman is the flagship campus and largest constituent university of the UP System (Figure 1). It offers the most number of graduate and undergraduate courses among all universities in the Philippines, with 23,327 enrolled students as of November 2008.

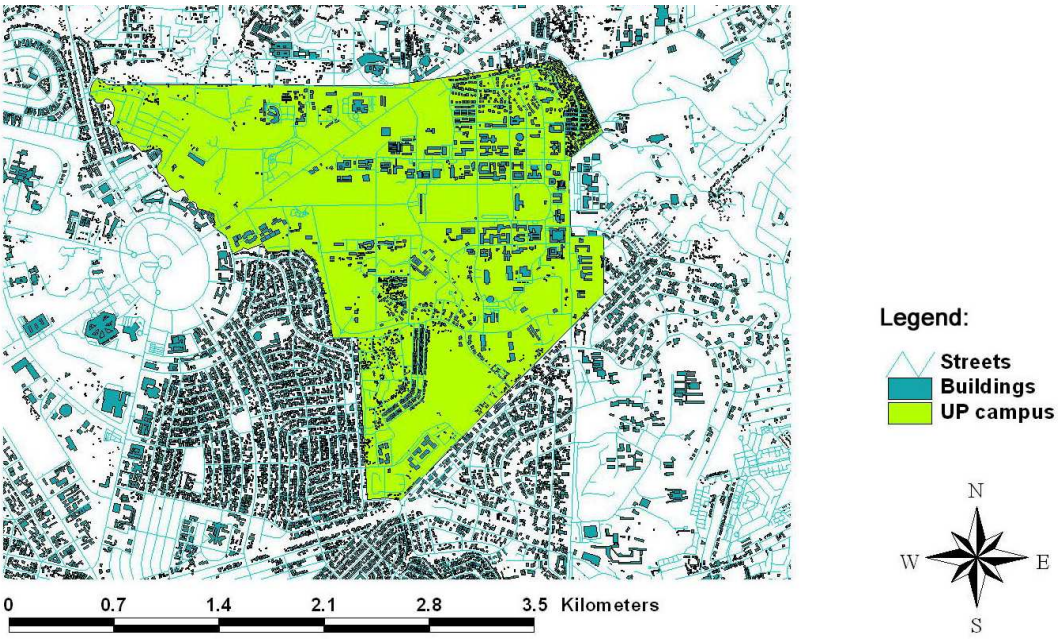

Figure 1 - UP Diliman campus and its boundaries

The university possesses peculiar structural characteristics that, at times, it has been likened to a “mini city.” First of all, while other university campuses in the country belong to only one barangay, the jurisdiction over UP Diliman is shared among eight different ones. The barangay, much like a district or a village, is the smallest administrative division in the Philippines, and a group of barangays compose a city or municipality. Second, there are three major roads that directly pass through the campus: two are national roads and one is a city road. Third, it is the only university in the Philippines (and perhaps even in the world) that has its own police force – the UP Diliman Police - whose primary mission is to secure university property.

Police records show that a total of 268 crimes against property were committed on campus from January 2006 to July 2008 (Table 1). Of these, 205 were from theft and 63 were from robbery. If the estimated total population on campus was 55,039 in 2006 and 55,213 in 2007,

then this means that for the two reference years, 0.16 percent and 0.24 percent of the population was affected by crime, respectively. The total population is comprised of students, on-campus residents (faculty, staff, and their families), and informal settlers.

Table 1. Number of Property Crimes, UP Diliman, 2006 to mid-2008

Type of crime	*2006*	*2007*	*2008*	*Total*
Theft	61	104	40	205
Robbery	26	29	8	63
Total	87	133	48	268

4. METHODOLOGY

Geographical Information Systems was utilized jointly with Kernel Density Estimation and Multiple Centrality Assessment to analyze spatial data.

4.1 KERNEL DENSITY ESTIMATION

The location of hot spots on the map was identified using Kernel Density Estimation (KDE). Each crime was given a Gaussian probability function with a waist, σ, which means that a crime at a map position *x* and *y* would have 67 percent probability of occurring within a radius of σ/2 from *x* and *y*. The addition of the probability distribution of all crimes results in the equation,

$$KDE = \sum_{n=1}^{N} \exp\left[-\frac{(x-u)^2 + (y-v)^2}{2\sigma^2} \right] \quad (1)$$

where *N*: total number of crimes
u: location of the crime event at the *x* coordinate in the map
v: location of the crime event at the *y* coordinate in the map.

This method is similar to a Gaussian probability function being convolved with crime events distributed at different positions (Figure 2). In the convolution theorem, the inverse Fourier transform of the product of the Fourier transforms of the factors is the convolution of the factors (Goodman, 1968). In mathematical terms,

$$h(x,y) \otimes g(x,y) = \Im^{-1}\{H(\xi,\eta) * G(\xi,\eta)\} \tag{2}$$

$$= \Im^{-1}\{\Im\{h(x,y)\} * \Im\{g(x,y)\}\}$$

where $h(x,y)$ and $g(x,y)$: factors in the Cartesian plane
$H(\xi,\eta)$ and $G(\xi,\eta)$: factors in the Fourier plane (k-space)
$\Im$ and $\Im^{-1}$: inverse operators that transform the factors from the Cartesian plane to the Fourier plane and vice versa.

The power spectrum of the convolution displays the KDE:

$$KDE = \left|h(x,y) \otimes g(x,y)\right|^2 \tag{3}$$

The brighter areas in the generated images represent those places with high crime concentrations, and conversely, the darker areas have less or no crime (Figure 2). Areas where crime is most concentrated are called hot spots.

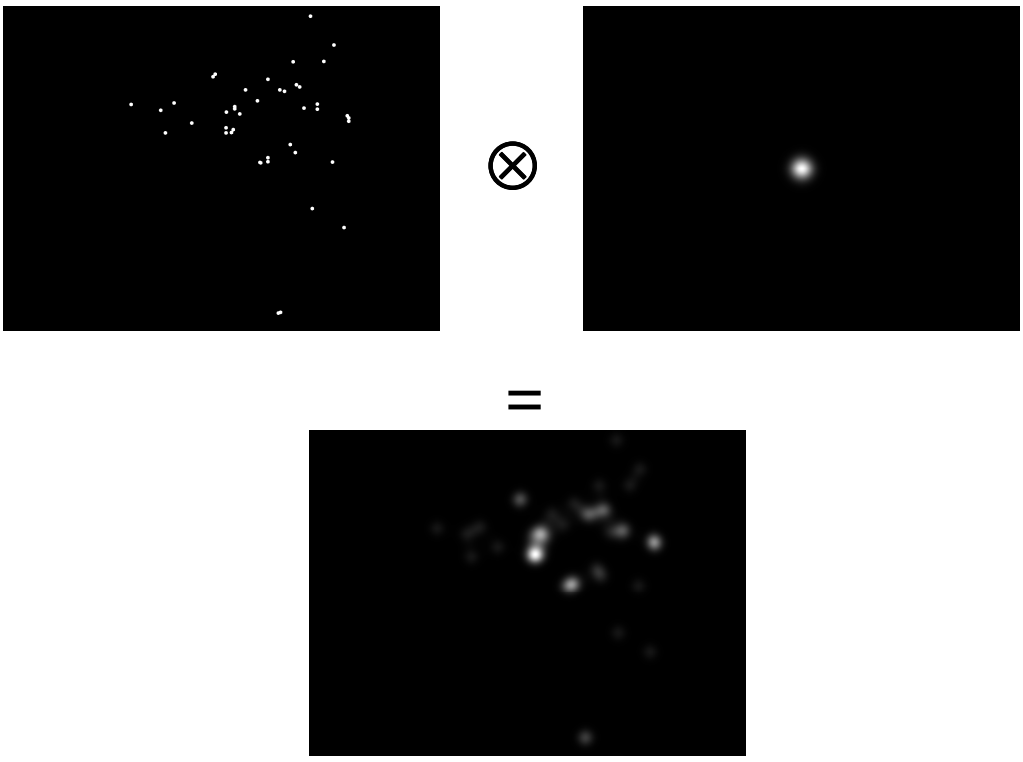

Figure 2 - GIS Crime Map Convolved with a Gaussian Function and its Result

4.2 Multiple Centrality Assessment

Multiple Centrality Assessment (MCA) was performed to investigate if crime is influenced by street network on campus. MCA is based on urban design principles and the physics of complex systems, and uses the graph theory to model relationships between vertices and edges (Technology, Space and Place, 2008). The first are also known as nodes, and the second as connections between nodes. In a nutshell, MCA measures how important a node is relative to other nodes in the same graph This measure is called centrality, which in different disciplines, is also referred to as accessibility, proximity, integration, and connectivity (Porta *et al.*, 2006).

There are six types of centrality. Closeness centrality measures how close one node is to all other nodes along the shortest path. In degree centrality, the important nodes are the ones with the most number of ties with other nodes. For betweenness centrality, a node is central if it lies between many other nodes, in the sense that it is traversed by many of the shortest paths connecting pairs of nodes. Straightness centrality measures how much different the real paths that connect each node to all other nodes are from a straight path. With information centrality, a node is important if it affects the efficiency of the whole network when that node is taken out. Finally, Eigenvector centrality calculates the importance of the node based on the importance of the other nodes to which it is connected.

This work focused on closeness centrality as it seems to be most appropriate for the chosen site. Closeness has a meaning on systems whose boundaries are clearly physically determined, like in the case of islands, gated communities or, as in this study, school campuses (Porta, personal communication). As closeness is always meaningful locally, it is best analyzed with betweenness (Porta, personal communication). However, due to constraints in resources, betweenness centrality was no longer investigated and closeness centrality became the sole basis for analysis.

In calculating centrality values, map intersections were translated into nodes while streets were translated into edges. The map becomes a set *G* where all the nodes are elements with a total number *N*.

Closeness centrality was computed as:

$$C_i^C = \frac{N-1}{\sum_{j \in G, j \neq i} d_{ij}}, \quad (4)$$

where *C*: Closeness Centrality
i: node whose centrality is being measured
d_{ij}: distance from node *i* to node *j*
and node *i* is not similar to *j* and is an element of *G*.

It should likewise be noted that only local C^c (i.e., the value is calculated for a certain distance from node *i*) and not global C^c (i.e., the value is calculated for all the nodes *j*) was used. Local closeness centrality was measured using a distance of not more than 500 meters from node *i*.

5. RESULTS AND ANALYSIS

The case of UP Diliman supports the idea that offenders consider the target and spatial attractiveness of potential crime locations. By looking closely at land use and accessibility, it was found that certain places indeed make the campus attractive to offenders in both aspects.

5.1 CRIME AND LAND USE

The campus land use plan, designed in 1994, includes 10 land use types. These are: academic units, campus core, commercial development, community services, dormitories, faculty and staff housing, other parks and major open spaces, protected forest area (arboretum), R&D services, and Technology Park (Figure 3).

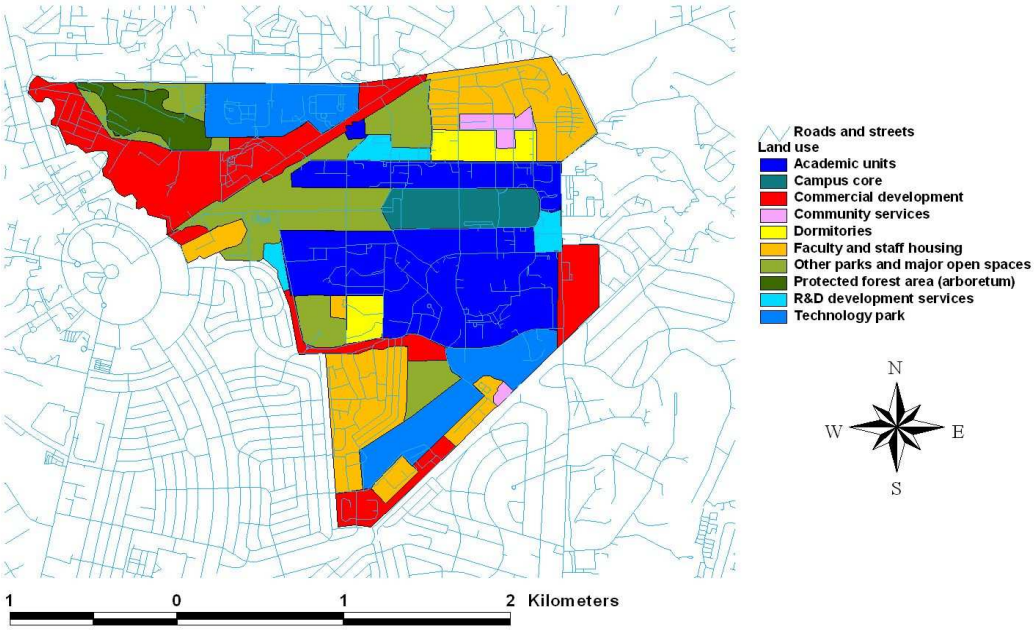

Figure 3 - Land Use Map

Only 218 of the total 268 cases could be plotted on the land use map as the remaining cases had, for example, unreported or vague locations. Roughly 44 percent of such plotted cases occurred in areas allocated for academic units, that is, when crime volume is taken into

account (Table 2). However, when examined using crime density (computed as crime volume over land area), land allocated for community services appeared to be most crime-prone. Crime density and not crime volume was used in the analysis. With crime density, crime events are analyzed in relation to the size of the place of occurrence; hence, the danger of seeing larger places as more crime-prone is eliminated.

Table 2. Crime Volume and Crime Density by Land Use (2006 to mid-2008)

Land use	*Crime volume*	*Total land area*	*Crime density*
Academic units	95	1243462.382	0.007639958
Faculty and staff housing	33	830239.252	0.003974758
Dormitories	24	172563.649	0.013907912
R&D services	18	118417.659	0.015200436
Commercial development	6	923045.138	0.000650022
Community services	21	70261.223	0.029888464
Protected forest area	2	162418.816	0.001231384
Other parks and major spaces	4	745242.884	0.000536738
Technology park	3	591520.366	0.000507168
Campus core	12	248798.455	0.004823181
Total	218	5105969.824	0.004269512

The relationship between crime and land use was determined through normalization and graph comparison. Normalized crime density was computed as the quotient of the quotient of the crime volume and the land area of the particular land use, and the quotient of the total crime volume and the total land area. It is clear in the resulting spider plot, presented below, that certain land uses consistently exhibited high densities of crime across the three-year period (Figure 4). This is particularly evident in lands for community services and dormitories.

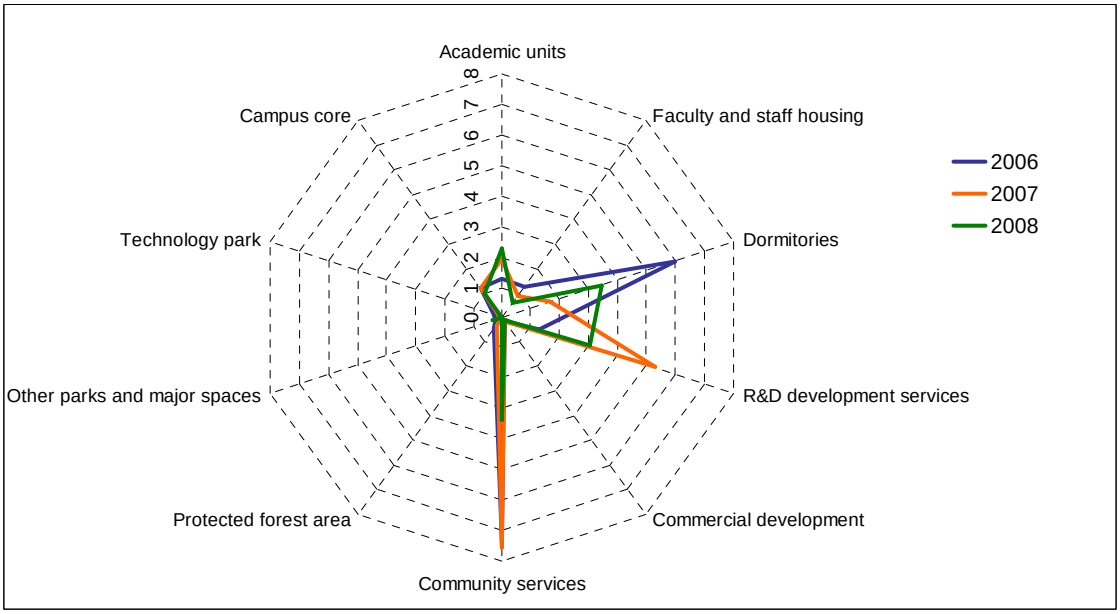

Figure 4 - Normalized Crime Densities by Year and Land use (2006 to mid-2008)

Another way of looking at this relationship is by means of hotspot analysis. A hot spot is an area of concentrated crime where people have a higher than average risk of victimization (Eck, 2005). Five hot spots were identified on campus for the period 2006 to mid-2008 (Figure 5). They are: (1) the Catholic Chapel and its vicinity, (2) the Faculty Center (FC), College of Arts and Letters (CAL) and its vicinity, (3) the College of Engineering and its vicinity, (4) Palma Hall, and (5) Vinzon's Hall and its vicinity. Put together, these hot spots constitute 28.4 percent of the plotted cases of theft and robbery from 2006 to 2008. Thirty cases happened at the Chapel area alone, making it the biggest hot spot on campus. Its vicinity encompasses other buildings found at the community service area, and student dormitories south of the Chapel. Hence, consistent with the results obtained from normalization and plotting, lands for community services and dormitories are indeed most prone to criminal activity. But why is it so?

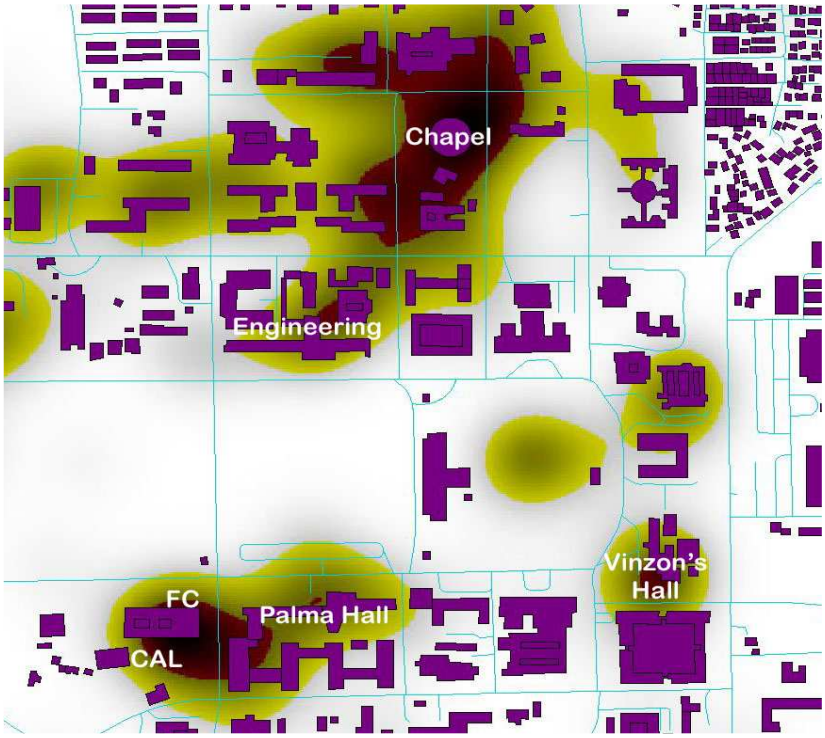

Figure 5 - Location of Overall Hot Spots (2006 to mid-2008)

5.1.1 Land Use and its Relationship to Crime

The community service area is where institutional buildings like the Center for Health Services and Catholic Chapel are located (Figure 6). At the same time, it is home to major commercial entities on campus like a cooperative-run grocery, commercial bank, and a building known as the Shopping Center. The fact that it has high commercial activity could explain why theft and robbery is frequent in this part of the campus. In literature, many researchers have written about how commercial areas attract criminals, and how the availability of potential victims and hot commodities in these places could account for it.

Joint to high commercial use in the community service area is low informal or natural surveillance. This adds to the vulnerability of the place because then it becomes a critical intensity zone. The term was coined by Angel (1968) to refer to a situation whereby when the intensity of land use increases, the number of potential victims increases sufficiently to attract the attention of potential offenders, but there are not enough witnesses. With its institutional and commercial functions, the community service area invites a host of users, especially during the day when the buildings are open. (In fact, only 14 percent of the reported crimes in this area occurred during the evening.) The area enjoys constant use and high volume of human traffic but, at the same time, movements are all directed inwards; i.e., activities in the area are mainly done indoors. This imbalance provides opportunities for crime, making the area inviting not only to legitimate users but also to potential offenders. Police records reveal an almost equal number of outdoor crimes and indoor crimes, and this suggests that criminals target parking spaces which by design are not expected to have people staying in it

for a long time. These on-street parking lots also do not benefit from natural surveillance, and this will be discussed in detail later on.

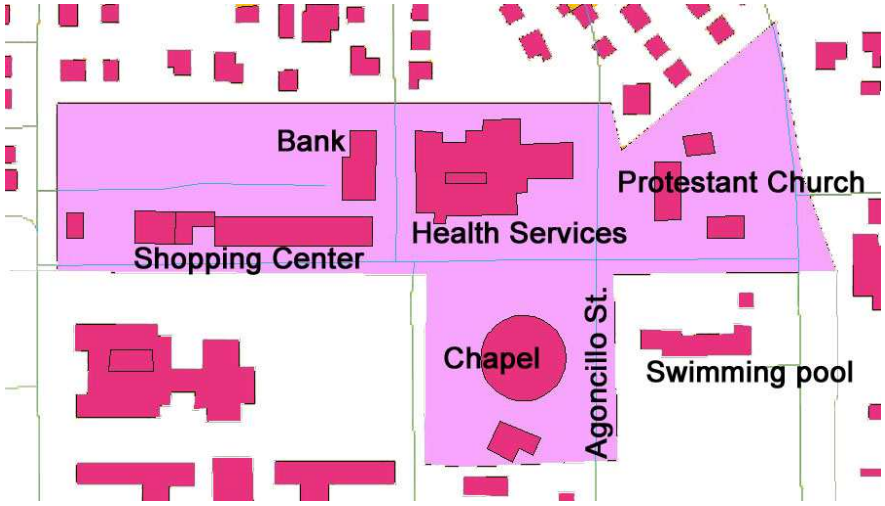

Figure 6 - Key Buildings in the Community Service Area

From some such parking spaces, crime could have spilled over to student dormitories, the second most popular target for offending. But studies abroad have shown that dormitories do exhibit propensity to attract offenders regardless of their proximity to crime-prone regions. Resler (1999) observed that the "highest concentrations of campus crimes occur both in and around student dormitories," for reasons like density and routine activity. The latter, taken from Felson and Cohen's theory, stresses how one's daily routine activities can influence the likelihood of victimization. Indeed, dorms can be appealing to offenders because of the amount of valuable items often left unattended by students. Dormitories in UP Diliman, too, seem to be no different from buildings in the community service area when viewed from Angel's premise. Theft in dorms is usually committed in bedrooms such that, despite intensity of use, it is difficult to have witnesses to crime.

Thus, in contrast to what Long and Baran (2006) concluded, these observations demonstrate that land use variables can be important in the analysis of campus crime. In UP Diliman, the most crime-prone land use types are those which in previous studies were said to have the potential to attract or generate crime. This is because they provide criminals with a number of desirable targets. There are also not sufficient witnesses to crime even if there is intense use.

Notwithstanding unfavorable conditions, land use changes on campus are not recommended. UP Diliman has a good land use mix because adjacent land uses are compatible. Having a community service area near student residence halls, and faculty and staff housing supports the need of primary campus users for services in health, nourishment, recreation, and spirituality. In return, the presence of dormers and residents creates a lively atmosphere for business and basic services. This also justifies why stores and small businesses should not be removed from the area, even if commercial activity is likely to draw

the attention of offenders. Crime prevention, after all, is not the only objective of land use planning (Taylor and Harrell, 1996).

Second, land uses which exhibited high crime density are not "negative" land uses. For example, commercial activities at the Shopping Center do not encourage alcohol consumption, gambling or other behaviors that invite crime. In student dorms, there are policies and what John Eck (2005) calls "place managers" to ensure that behaviors are kept at desirable levels.

Third, the land use mix at the community service area can decrease user isolation. The use of the Chapel is largely time-dependent: a good number of people are present during the celebration of the Holy Mass, and the number instantly thins out as soon as it is over. Quite the opposite, the Shopping Center is occupied throughout the day and until around 8:00 p.m. Having an active commercial place should make it safe for people to go to the Chapel during non-mass hours.

Most important of all, while crime appeared to be related to land use by virtue of user density, the situation is exacerbated by some other factor: space design. Mechanisms like fencing and landscaping may serve to enhance safety but if improperly located or are overused, they can do more harm than good. The environment around the Chapel is a perfect example. One of the streets where mass-goers park their cars lies opposite the huge wall enclosure of a swimming pool. The pool is right beside a vacant lot. There is a commercial arcade which, in the past had eateries and other small stores, but in recent years has been empty. On the other side of the Chapel is another on-street parking area. It is located parallel to a solid-fenced land reserved for future development. The Chapel itself is surrounded by trees and tall shrubs, making it more difficult for mass-goers to see their parked vehicles. The streets in front of dormitories are dotted on the side by buildings with closed windows and open, unused front lawns. These streets, including those around the Chapel, are exceptionally vulnerable to outdoor crime.

5.1.2 Land Use-Related Measures to Prevent Crime

Because improper design worsens safety conditions in the affected land uses, the University can undertake redesigning solutions or space revamping to address the problem. But it would be complex and expensive. Services would be disrupted and temporary relocation of existing users has to be provided. This is if people do agree to major design changes, which can be determined only after a long process of consultation and discussion.

A cheaper, easier alternative to redesigning space is the addition of complementary uses to promote natural surveillance (Wekerle and Whitman, 1995). In areas prone to outdoor crime, activities can be promoted on unused spaces by locating benches or small gathering areas for students or other regular users. Small food booths or kiosks may be placed in spots

facing parking lots to allow natural surveillance. Needless to say, these should be subject to regulations in terms of how and when they can be used.

Increasing activity should consider existing uses above all. For instance, a more permanent solution to generating activity near the Chapel is the revitalization of the commercial arcade. With proper management, the place has a huge potential for activities that support the existing land use. It can create more dining options, especially during lunch time when the Shopping Center is packed. At noon, a mass is held too at the Chapel. Thus, not only will this enhance natural surveillance at a time when most needed but it will also create a complementary use near the Chapel: a less crowded eating place for mass-goers. Finally, revitalizing the commercial arcade can ease the intensity of use at the Shopping Center, which should facilitate formal and informal surveillance.

On lands with dormitories, creating more sitting areas for students in front of residence halls can improve natural surveillance of streets. But these must be kept clean and maintained. Benches that are broken, badly painted or full of graffiti denote low supervision or disregard for law and order. This creates the impression of a place that is open to crime. Similarly, appropriate signage must be in place to notify unauthorized users that they are unwelcome in these facilities. Signage not only controls natural access to these places but also reinforces territoriality. It makes potential offenders think twice because in places where territorial cues are present, people are likely to be cautious of strangers and willing to intervene during a crime.

Aside from generating activities, proper design and maintenance of landscape can help create safer places. Effective sightlines of the streets from the Chapel can be created if plants are not too high. Trees must be trimmed if impeding on the view of the street. There are many ways by which the Chapel can keep a dense and lively garden while allowing users to still see their surroundings and be seen.

Strengthening formal surveillance can likewise counter low informal or natural surveillance whether indoors or outdoors. People are discouraged from committing crime in areas where there is a reality or perception of supervision. In this sense, it helps to reinforce security patrolling in and around buildings, and the visibility of the police and supplemental patrols in outdoor places prone to crime.

It would be interesting to note that two key buildings in the community service grounds are extremely accessible even to non-legitimate users of the campus: both the Chapel and Shopping Center have unregulated natural access during opening hours. On-street parking areas around the Chapel, too, have uncontrolled use. Would natural access control then be effective in discouraging criminals? Not as much in UP Diliman, so it seems. Student dormitories have security guards posted in the lobbies yet they are still popular targets for crime. Hence, the incidence of indoor crime in these entry-regulated spaces suggests that offenders could have been users with legal access to these buildings. A similar discussion on this can be found on page 19.

Thus target hardening seems more rational, especially in deterring indoor crime. Putting locks on doors is important especially in dormitories, though it is equally important that users develop a culture of safety awareness. Locks on doors are completely useless if dormers leave doors ajar anyway, thinking that a minute or two away from their rooms would not hurt. Such users can cause more crime by encouraging more people to participate in the crime and by helping offenders become more efficient (Felson and Clarke, 1998).

5.2 CRIME AND TRANSPORT ACCESSIBILITY

The preceding section pointed out how a university campus is comparable to a macro-space in as far as land use is concerned. Its most crime-prone land uses are also those with high user density, which indicates target attractiveness. But will the same results hold true for transport accessibility on campus? This section will give the answers.

Because it is logical for an offender to choose street segments that are most central, nodes having high centrality values are likely to be more crime-prone. After all, high street centrality denotes more likelihood for the offenders to reach target places and escape from them. A study noted the presence of highly connected streets as a factor in the incidence of property crimes on campus (Long and Baran, 2006). It reported that offenders on campus search for two kinds of opportunities: a large number of potential victims, and areas that provide opportunities for escape.

But a hotspot map overlaid with the closeness centrality map shows that crime in UP Diliman is negatively associated to closeness centrality: four of the five hot spots are characterized by streets with low closeness centrality values (Figure 7). The hot spots at FC/CAL and the Chapel in which crime counts are higher are located on streets that exhibit low centrality. The streets around Palma Hall and the College of Engineering hot spots have low to medium centrality values. The assumption that high centrality is related to high crime incidence proved to be true only in the Vinzon's Hall hot spot.

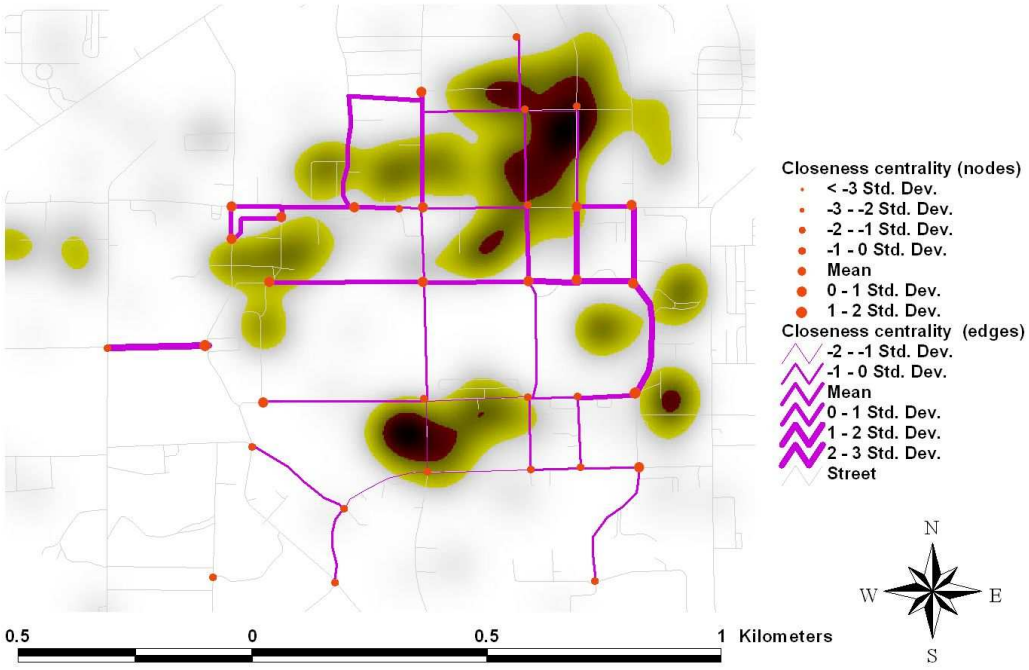

Figure 7 - Closeness Centrality Values

5.2.1 User Density and Transport Accessibility

It appears that criminals on campus are indeed concerned about the target attractiveness of crime locations: all of the identified hot spots exhibit high intensity of use. It has already been noted how the Chapel area, where the Shopping Center and other commercial establishments can be found, attracts legitimate users on a regular basis. The College of Engineering is the largest college in UP Diliman. Palma Hall houses the College of Social Sciences and Philosophy, the second largest college, and the College of Science, the third largest college. It is also where many of the General Education classes are held. The FC/CAL hot spot sits in close proximity to the Palma Hall. In short, all five areas have exceptionally large numbers of potential victims.

In contrast, places with low crime incidence do not have dense populations, even if they are more central. The area around the University Avenue could have been a hot spot since the node near the iconic Oblation sculpture at the campus entrance showed the highest centrality value; ergo, it provides the best route for escape. Nonetheless it was not attractive enough for offenders possibly because, to begin with, there are no sufficient targets in the area. As such, the few crimes reported here did not create a hot spot.

If accessibility is important for offenders to reach potential targets and to escape from the scene of the crime after, then why are the least central sites on campus most attractive to offenders?

The answer lies on transport accessibility, which mainly accounts for the spatial attractiveness of hot spots. Public transportation makes up for what were otherwise poorly

connected target areas for crime. Campus hot spots are directly connected to jeepney routes and this breaks down limits to criminal escape (Figure 8). The jeepney is the chief mode of public transportation in UP Diliman, and the biggest hot spot on campus – the Chapel area - is cut by a jeepney route. Street segments within this site are characterized by low centrality values but transportation allows easy access to and escape from it.

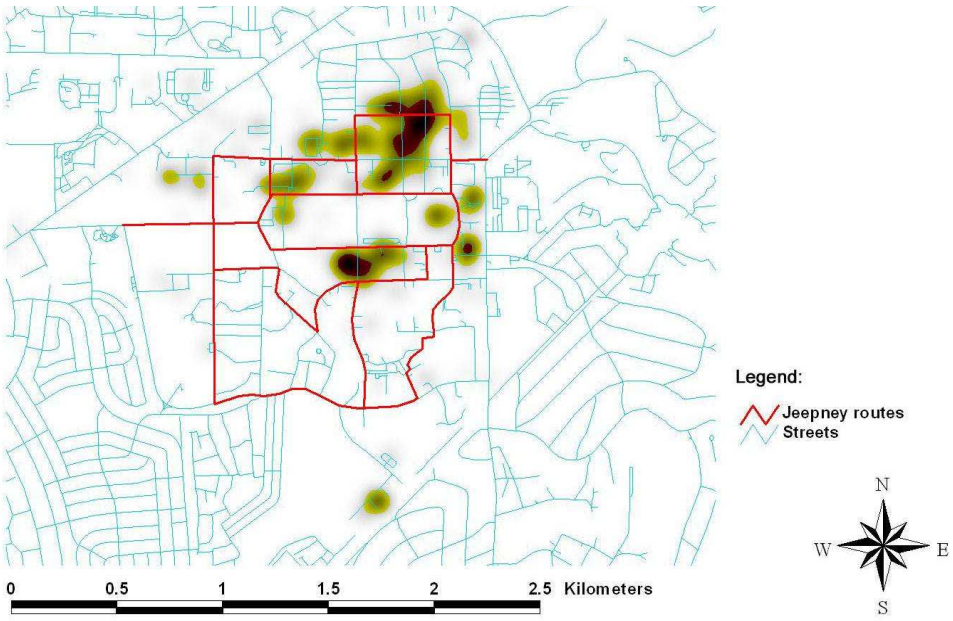

Figure 8 - Hot spots and jeepney routes

Although there is no data (from police records or elsewhere) on how offenders come close to targets and how they escape, it is safe to assume that this is carried out chiefly via two modes. The first is by public transportation specifically jeepneys. Because a majority of the offences recorded were petty crimes, it is least likely that they would have been committed by organized groups with large resources such as get-away vehicles. Not that these vehicles were necessary for the types of crimes committed in the first place. Records show that almost 55 percent of stolen properties were small, portable items: mobile phones, laptops, jewellery, cash, side mirrors of vehicles, and car plates. These articles could very easily be kept in ordinary bags and transported by offenders using public utility vehicles, without raising a hint of suspicion from people around.

That said, the second most possible mode of access and escape is by foot. Carrying only small articles, offenders can conveniently make use of foot paths around the campus that are directly connected to or are near the main roads. Furthermore, as Figure 8 shows, all hot spots on campus are located from 0 to about 100 meters away from intersections of streets, thus opening up escape routes. This observation is coherent with the results of previous studies in which the incidence of crime was found highest along intersections. Some would probably argue that intersections are inherent in the physical layout of the campus such that any point on the street network could in fact be prone to criminal activity. Being so, the proximity of hot spots to intersections has little to do with crime. However, based on the estimated distance of the center of the hot spot to the nearest intersection, it appears that the

size of the hot spot is inversely proportional to its proximity to an intersection. The biggest hot spot has the shortest distance to the nearest intersection and the smallest hot spot has the longest. The Chapel hot spot is directly traversed by two main intersections on campus. Moreover, these hot spots are all characterized by their closeness to T sections, which are said to be most accessible to criminals (Rubenstein *et al*, 1980).

5.2.2 Transport Accessibility-Related Measures to Prevent Crime

Can the situation be eased by limiting transport accessibility or allowing jeepneys to pass only through low density areas? In short, can the hot spots be made less spatially attractive? Unfortunately, it is not as simple as it sounds. Measures like re-routing might discourage potential offenders but it will also lead to inconvenience of primary and legitimate users of the campus. The map below shows what would happen if the jeepney route is disconnected from high-density, high-crime land uses (Figure 9). A majority of dormitories would be made less accessible, and way less so for buildings in the community service area. On top of this, the accessibility of the residential area for faculty members and staff would be tremendously disturbed, as it is easily reached via public transport passing mainly through dormitories and community services.

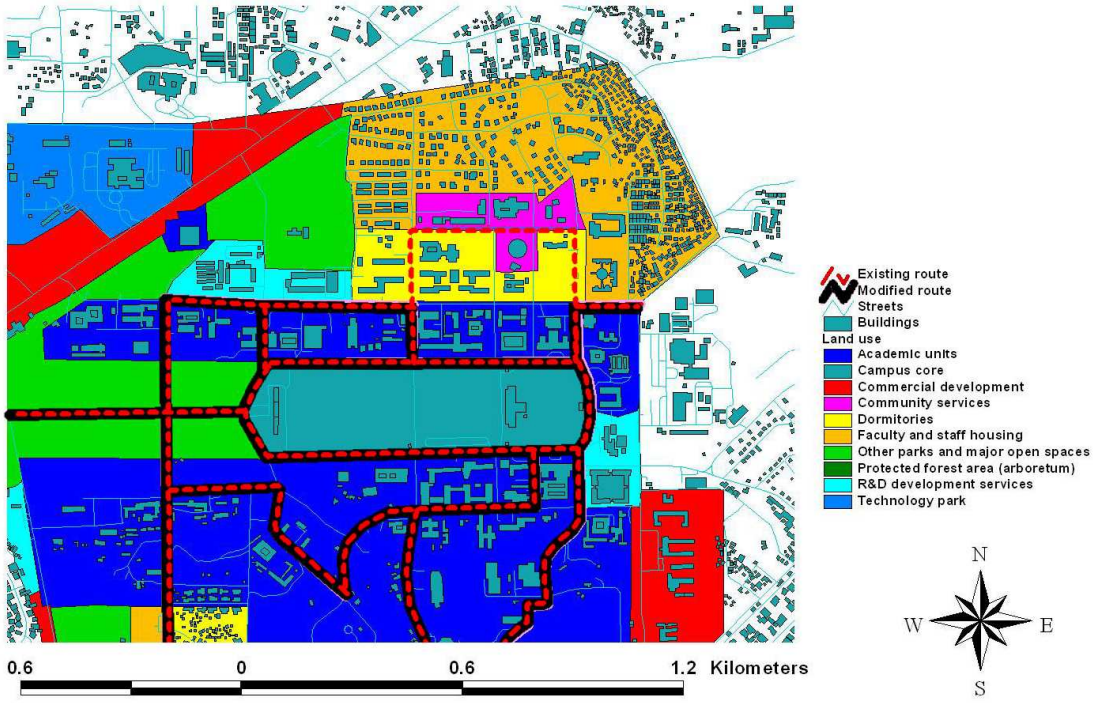

Figure 9 - Existing jeepney route versus modified route

So although the finding is generally similar to those in macro-level studies – that is, transport accessibility is an important variable in crime occurrence - it is interesting to note that traffic-related solutions which work in big spaces do not necessarily find themselves suitable in smaller ones. In such big units like cities where land use and layout are more complex, there

is more room to implement changes in traffic patterns in a way that will not upset the whole system.

Another problem with measures that limit accessibility is the lack of evidence on the mobility of offenders. Do they move around the campus in search of new targets? In three of the five hot spots, indoor crime exceeded outdoor crime in volume, and many of the buildings here are restricted to outsiders. This suggests that offenders could actually be regular and legitimate users of a place who just happen to find the perfect opportunities to commit crime. After all, crime does not need hardened criminals; it just needs an opportunity (Cohen and Felson, 1979).

There is reason to suspect offenders to be mobile, however. According to behavioral geography theory, offenders tend to commit crime in places near their residence or place of work, and this was seen in the case of UP Diliman. Of the 36 suspects who were apprehended, 11 resided within the campus and13 lived within the city. Because of the small number of property crimes solved, surely it would be difficult to make definitive statements on whether threat to campus security is internal or external. What is clear, though, from available data is that most suspects are residents of the city to which the university belongs. This is consistent with the findings of other studies that offenders tend to commit crime in areas not far from their homes (Brantingham and Brantingham, 1981; Ratcliffe, 2003) because of less travel cost and familiarity with escape routes (Dhiman, 2006).

This does not automatically mean of course that offenders come from the University grounds as some of the streets on campus also serve as public thoroughfares to reach adjacent areas. Plus, as mentioned in the earlier pages, the campus is cut by three major roads which are used by both private and public vehicles.

Long and Baran are correct in their observation that offenders look for a good supply of victims and opportunities for escape, or what has been described in this paper as target and spatial attractiveness. But this study showed that the latter may not always be provided by street design. In UP Diliman, it appears that the spatial attractiveness of hot spots lean on the availability of public transportation.

With measures against spatial attractiveness out of the picture, the best step to address crime on campus is to work on reducing the vulnerability of campus users. This is especially relevant knowing that target attractiveness also invites offenders. Strengthening periodic building patrols during identified peak hours of crime, or implementing policies that regulate use of crime-prone places can help decrease the number of potential victims. Other such measures have been cited in the section on land use.

It also helps to take into account the assumptions on the possible modes of access and escape used by offenders. With public transportation, though it is impossible to identify who among commuters are likely to be offenders, there are some ways to discourage people from committing a crime. Signs on jeepneys that persuade people to immediately report crime to

the police, or posters with pictures of recently caught offenders give people clues on – or at least the impression of - how tight security is on campus. As for the other option, which is going on foot, the university could benefit from more frequent patrolling around the campus, and from permanently closing unused, unnecessary foot paths and access points.

Finally, the administration should give some thought on relocating the UP Diliman Police Headquarters, as its current location is far from areas frequently distressed by crime. Using straight line distance, the police station is approximately 343 meters from the center of the hot spot nearest it (Figure 10). This huge spatial gap can boost the confidence of criminals that pursuit and apprehension can be avoided, another feature that adds to the spatial attractiveness of hot spots.

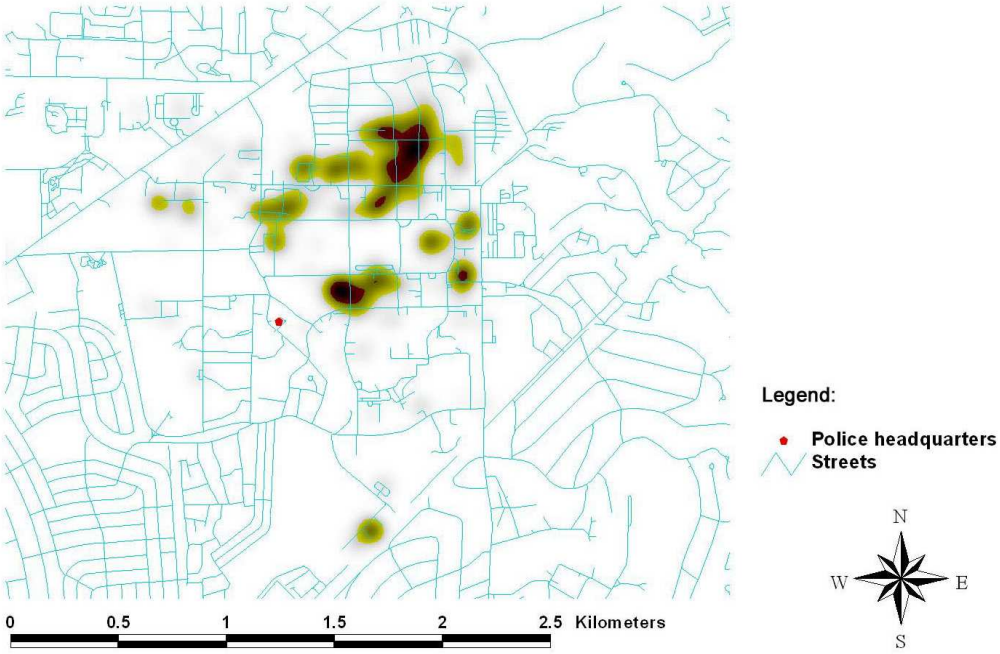

Figure 10 - Location of the police headquarters

6. CONCLUSION

Land use can influence the occurrence of crime in a university campus, especially when the type of land use has high density but not enough witnesses to crime. In UP Diliman, such target attractiveness is particularly seen on lands for community services and dormitories. Community services also provide a mix of institutional and commercial activities, and in literature, the latter is generally regarded as attractive to offenders.

Street centrality appears to be negatively related to crime; the lower the value, the higher the crime volume. In fact, only one of the five hot spots on campus fits that conclusion. The others lie on street sections with either low or average centrality. However, transport

accessibility compensates for the poor centrality of segments, making them spatially attractive to offenders.

These findings on land use and accessibility show that a micro-space like a university campus is similar to a macro-space: both variables can be significant factors for crime. But the approach to solving safety problems on campus is different from one that is suitable to cities, like a change in land use or traffic patterns. Simple measures to break down target attractiveness rather than spatial attractiveness seem more appropriate. In other words, it is best to address foremost the vulnerability of potential targets to criminal activity.

This study is an attempt to stimulate research-based discussions of crime in the Philippines because such are still wanting. Although the focus was on a small community, the methods used can be applied to districts and cities. The importance of small spaces in crime prevention should not be underestimated as well. After all, when small communities work for their own safety and security, the bigger community always benefits from it.

REFERENCES

Angel, S. (1968). Discouraging crime through city planning. Working Paper No. 75, Center for Planning and Development Research, University of California, Berkley.

Baran, P., W. Smith and U. Toker. (2006). Conflict between space and crime: exploring the relationship between spatial configuration and crime location. Paper presented at EDRA37, Atlanta, U.S.A.

Clontz, K. A., J.G. Mericle, and M. Maskarinec. (2003). On the road again: crime and major transportation routes. Paper presented at the 23rd Annual ESRI International User Conference, San Diego.

Cohen, L. and M. Felson. (1979). Social change and crime rate trends: a routine activity approach. Am. Socio. Rev., 44, 588-605.

Davison, E. L. and W.R. Smith. (2003). Exploring accessibility versus opportunity crime factors. Sociation Today, 1.

Day, K. (1999). Strangers in the night: women's fear of sexual assault on urban college campuses. J. Archit. Planning Res., 16, 289-312.

De Fleur, M. and R. Quinney. (1966). A reformulation of Sutherland's differential association theory and a strategy for empirical verification. J. Res. Crime Delinquency, 3, 1-22.

Dhiman, D. (2006). Identifying the relationship between crime and street layout using Space Syntax Technology. M. A. thesis, School of Planning, University of Cincinnati.

Eck, J. (2005). Crime hot spots: what they are, why we have them, and how to map them. In: Mapping Crime: Understanding Hot Spots. U.S. Department of Justice Office of Justice Programs, Washington, D.C.

Felson, M. (1987). Routine activities and crime prevention in the developing metropolis. Criminology. 25, 911-931.

Fernandez, M. (2005). Crime prevention and the perception of safety in campus design. M. A. thesis, School of Landscape Architecture, Louisiana State University.

Fisher, B. S. and J. L. Nasar. (1992). Fear of crime in relation to three exterior site features: prospect, refuge and escape. Environ. Behavior, 24, 35-65.

Goodman, J. (1968). Introduction to Fourier Optics. McGraw-Hill Inc., New York.

Hakim, S., G. Rengert and Y. Shachamurove. (2000). Knowing your odds: home burglary and the odds ratio. Working Paper 00-14, School of Arts and Sciences, University of Pennsylvania.

Landman, K. and S. Liebermann. (2005). Planning against crime: preventing crime with people not barriers. SA Crime Quarterly, 11.

Long, Y. and P. K. Baran. (2006). Spatial configuration and actual crime locations in a university campus setting. Paper presented at EDRA37, Atlanta.

Loukaitou-Sideris, A. (1999). Hot spots of bus stop crime: the importance of environmental attributes. J. Am. Planning Assoc., 65.

Morta, A. R. (2008). Spatial analysis of crime incidents in Marikina City. Unpublished manuscript.

Porta, S., P. Crucitti and V. Latora. (2006). The network analysis of urban streets: a primal approach. Environ. Planning B: Planning and Design, 33, 705-725.

Porta, S., P. Crucitti and V. Latora V. (2008). Multiple Centrality Assessment in Parma: a network analysis of paths and open space. Urban Design Int., 13, 41-50.

Poyner, B. (1983). Design against crime: beyond defensible space. Butterworths, London; Boston.

Resler, L. (1999). Campus crime at the University of Texas at Austin: a spatial and organizational approach using GIS. Workshop paper, University of Texas at Austin.

Rubenstein, H., C. Murray, T. Motoyama, W. V. Rouse and R. M. Titus. (1980). Link between Crime and the Built Environment: The Current State of Knowledge, Vol. 1. National Institute of Justice, Washington.

Schneider, J. (1988). Review: toward an environmental view of inner-city crime. Law and Soc. Rev., *22*, 1023-1026.

Taylor, R. (2002). Crime Prevention through environmental design: yes, no, maybe, unknowable, and all of the above. In: Handbook of Environmental Psychology (R. Bechtel and A. Churchman, eds.). John Wiley and Sons, New York.

Taylor, R. and A. Harrell. (1996). Physical environment and crime. Research report, National Institute of Justice, Washington, D.C.

Spotting spatial hotspots: centrality. In: Technology, Space & Place, Nov. 2008, 37.

Wekerle, G. and C. Whitman. (1995). Safe Cities: Guidelines for Planning, Design and Management. Van Nostrand Reinhold, New York.