

**Remote Sensing, GIS, & Peri-Urban Settlements:
The Case of *Ger* Districts in Ulaanbaatar, Mongolia**

By

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A Thesis Submitted to

Saint Mary's University, Halifax, Nova Scotia
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Arts (Honours) in International Development Studies.

April, 2015, Halifax, Nova Scotia

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Date: April 30, 2015

Acknowledgements

I would like to thank my thesis supervisor, Dr. Anthony O'Malley, for his lectures on urbanization in the International Development Studies seminar at Saint Mary's University that inspired my interest in this field of study. Without his broad knowledge, thoughtful guidance and seemingly endless patience, I would never have finished my research and written this thesis.

The Smith Family (Todd, Baaska, Alex and Tony) welcomed me into their home in Ulaanbaatar, Mongolia. Their kindness and generosity were emblematic of this wonderful country, and I am deeply indebted to them for sharing with me their passion for Mongolian culture.

Finally, I would like to thank my parents, Rea and John Shaw. Without their encouragement and support, I would not have been able to return to university to pursue my interest in international development.

Thank you all.

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Abstract

The world is at the brink of an urban crisis. Several hundred million poor people will be born in nations throughout the global South by the middle of the century, mostly in impoverished urban communities in less developed countries unprepared to provide the kinds of social services and infrastructure needed for growing populations. A particular pattern of urban growth – peri-urbanization – has emerged since the post-war development project began, yet it remains a poorly understood process. A pervasive lack of baseline data concerning peri-urban population continues to preclude equitable and inclusive urbanization, leading to what the United Nations describes as the global Urban Divide. This thesis will suggest that Remote Sensing and Geographic Information Systems offer the potential to ensure communities in the global South have the kinds of fundamental baseline data needed to tackle the Urban Divide. Generating these baseline data and mapping the world’s ‘forgotten places’ should be seen as a powerful way to change the conversation about urban inequality and marginalization. The effects of the urban crisis can be greatly mitigated for the world’s most vulnerable people only if their voices are heard and their existence is acknowledged.

April 30, 2015

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Section I

Introduction

The world is inexorably—and irreversibly—urbanizing. More than half its population lives in urban areas, and the United Nations (2014) projects that another 2.5 billion people will be born or move into towns and cities by 2050. The profound implications of this transition represent the greatest challenge for equitable human development in the 21st century.

Normative discourse on urbanization associates this process with the promise of development through empowerment, security and prosperity. After all, urban environments have long been seen as the centers of – and catalysts for – trade, industry, education, commerce and employment, a view endorsed by UN-Habitat (2013), which describes them as places which “...provide the best opportunities to improve livelihoods” (p.9). Yet for so many people, especially those in less developed countries (LDCs) where almost all projected growth will occur, urban life increasingly presents very few realistic opportunities. Davis (2006) offers a sober (if somewhat dystopian) vision of urban life for hundreds of millions of people when he observes that “...much of the twenty-first-century urban world squats in squalor, surrounded by pollution, excrement, and decay” (p.19).

The gap between urban *promise* and *reality* is symbolized in what UN-Habitat (2013) terms the ‘urban divide’, a phrase that quite accurately defines the socio-economic chasm dividing those for whom the city offers a secure future and those for whom it does not. This metaphor is sharply manifested by the burgeoning slums and impoverished peri-urban

settlements which mushrooming around the world's town and cities, most notably in the global South.

To better understand the future trajectory of urbanization, the structures and conditions that created and sustained the urban divide must be better understood. This is essential if informed policies aimed at addressing urban poverty – and its worst pathologies, the miasmic slums and squalid peri-urban settlements of LDCs – are to be effective. However, the urban divide resides not just in census data and quality-of-life indicators, but in the crowded streets of Mumbai and Kinshasa, where the contrasts of urban reality are evident everywhere. In cities like these, squatters and inhabitants of shantytowns live a precarious existence in the shadows of gleaming office towers and modern expressways. The jarring dichotomy of urbanization is evident to the visitor through an airplane window on final approach to any number of cities in the developing world.

While such disparity symbolizes the urban divide, it also offers important clues. The kind of socio-economic contrasts that divide the rich from the poor also have more tangible attributes. Like anywhere else on earth, Mumbai and Kinshasa have perceptible qualities that change over time – or, in the language of geographers and urban planners – they have spatial and temporal characteristics. Satellite-based (and to a certain extent, aircraft-borne) observation and measuring technologies collectively known as remote sensing are used for a wide range of scientific applications requiring spatial and temporal observations. From the study of ocean currents and geological activity to environmental research, remote sensing platforms were later optimized for applications useful for the study of anthropogenic environmental changes, including urbanization and urban growth. Along with remote sensing technologies came increasingly powerful methods of storing analyzing, and visualizing the data they gather (often in the form of maps), known as

Geographic Information Systems (GIS). Perhaps the most widely-known of these is America's Landsat program, which has not only gathered data of incalculable scientific importance, but also captured the public imagination with stunning images of earth from space. By providing a synoptic overview of complex, evolving and large-scale phenomenon – such as tsunamis, rainforest clear-cutting, or urban 'sprawl' – data gathered by Landsat have indelibly shaped public understanding of historical events and environmental transformations shaping the world.

There is now a broad-based consensus that remote sensing and GIS solutions offer enormous potential for better understanding the complex spatial and temporal attributes of urbanization. When used as a means for better managing urban development in the developing world by supporting decision-makers with powerful analytical tools, these methodologies offer the opportunities to address important aspects that frequently accompany urbanization: poverty and socio-economic marginalization.

The first part of this thesis will use a literature review to frame the aporia between possibility and reality in the cities of the global south, looking first at the historical causalities of chronic urban poverty and marginalization, and then at how they threaten to undermine what progress has been made in human development since the advent of the post-war international development project. Several important themes – including the failures of modernization and neo-liberal globalization to deliver equitable economic growth, urban bias (followed by an even stronger rural bias), the prevalence of unmapped communities, and rural-urban migration will be considered in the context of urbanization in the global south, as will previous efforts by governments and non-governmental organizations (NGOs) to help bridge the 'urban divide'.

The literature review will also consider the strengths and weaknesses of RS/GIS projects and partnerships, including a meta-analysis of hundreds of projects all over the world, to

determine if advocating their wider use in the developing world is appropriate. These findings will be the foundation of my assertion that while international collaboration is an important departure point, LDCs must develop independent capabilities to ensure data is used in their best interests.

Having established that a strong case can be made for applying RS/GIS solutions in LDCs, I will turn to a nation that exhibits some of the most seemingly intractable symptoms of mismanaged urbanization: Mongolia. To evaluate the potential of such methodologies to promote equitable and inclusive social development, my empirical section will use the city of Ulaanbaatar, Mongolia as a case study. Emblematic of both the great challenges of urbanization in the developing world and also of the opportunity to make meaningful improvements to the lives of marginalized people, this city will be used as a model to highlight the importance of gathering data on human settlements.

Despite the frequently appalling prospects of life in slums, a good deal of recent discourse in the field of urbanization and development suggests that such places offer governments and NGOs realistic opportunities for improving the lives of huge numbers of the world's poorest and most marginalized populations. That is to say, getting urbanization 'right' affords the promise of improving the welfare of more people than any other single focus of investment and policy. How governments implement urban policies to address the challenges faced by cities beset by the urban divide is an absolutely central issue of human development in the twenty-first century. However, as UN Habitat (2004) concludes, "most government intervention in the last 30 years has increased, rather than decreased, poverty and slums" (p. 3).

This thesis will argue that one of the key reasons government intervention has utterly failed is to a very important extent attributable to the lack of reliable and intelligible presentation

of the complex and rapidly evolving urban fabric in LDCs. In some cases, communities in the global South remain partially or entirely unmapped, meaning that large populations of the world's most vulnerable people live in 'forgotten places'.

I will argue that by providing the kinds of baseline data on urban and peri-urban areas that are fundamental to informed urban planning by municipal authorities and policy-makers, the spatial and temporal evolution of towns and cities can be understood and thus managed in a more equitable, efficient, and inclusive way. The use of GIS and satellite-based sensing platforms – which have been used by urban planners in the West for decades – now offer a cost-effective and highly effective way of gathering, organizing, and presenting these data. By evaluating the use – and potential – of such solutions in a city in the developing world that manifests some of the worst symptoms of urbanization, this thesis will argue that the 'urban divide' in the developing world could be narrowed by the implementation of remote sensing/GIS initiatives.

The research question guiding this thesis is:

How can Geographic Information Systems (GIS) be used to provide baseline data on peri-urban slums to support equitable urban planning in less developed countries?

Thesis Statement:

I will be arguing that RS/GIS has a critical role to play in providing much needed baseline data on peri-urban settlements in developing societies, allowing urban planners to access data so to systematically raise the standard of living of peri-urban inhabitants. However, it is imperative that communities participate in the collection and dissemination of baseline data as part of broader cooperation in national urban planning policies.

Section II

Literature Review

i. Urbanization and Development

Debate surrounding urbanization in the developing world parallels general themes extant in overarching international development discourse. Perspectives associated with contemporary debate about modernization, post-colonialism, neo-marxism, neo-liberalism, and post-development theory are embedded throughout the literature and discussion under consideration here, as are evolving conceptions of social capital, participatory development and synergies between state and society. Academics and practitioners naturally emphasize disparate historical causalities and theoretical frameworks in their development analyses, and while important they are somewhat marginal to the discussion at hand. The fact is that however one approaches the causes behind the ‘crisis’ of urbanization in LDCs, its effects are clear and beyond dispute. The real question is what to do about it. This literature review, after interrogating the main streams of discourse and research, will point to some inherent possibilities.

Origins of the Urbanization Crisis

While a detailed exegesis on modernization, industrialization, and urbanization are beyond the scope of this thesis, it is useful to begin with a general summary of how and why the crisis of urbanization emerged in the second half of the twentieth century. Broadly stated, it can be argued that beginning in the 1950s there was a push towards modernization and industrial development in the global South in tandem with unprecedented urban growth in the same regions (see for example Davis, 2006). It is important to parse out the causes and implications of these

two developments to understand how they are related, and to determine whether economic growth is a determinant of urbanization or if the reverse is true.

While the correlation between urbanization and economic activity has long been observed, the kind of globally-integrated economic growth attempted in post-colonial Africa, Asia, and Latin America was predicated on new Western development models, including the infamous Rostovian model of modernization. This model was predicated on taking advantage of the availability of cheap labour and primary resources, as well the economies of scale offered by centralized production and urban hubs, to mimic the industrialization of Europe and North America. The prospect of better livelihoods anticipated during this industrial ‘take-off’ impelled migration from rural areas (which then constituted the vast majority of populations in LDCs), where labour-intensive agrarian production and raw resource extraction provided a huge pool of labour eager to improve their prospects. However, the anticipated modernization and associated industrialization in the urban locale largely failed to materialize during the 1950s, 60s, and 70s. This left vast populations of principally rural migrants marooned in conditions of extreme and relative poverty in LDC conurbations, typically clustered in slum settlements on the outskirts of large towns and cities.

While the stream of migrants gravitating towards towns and cities in search of a better life is as old as civilization itself, what changed in the global South was the extent and strength of this pull in the last six decades. Indeed, at the beginning of nineteenth century, less than two per cent of the world’s population lived in towns or cities (UN-Habitat, 2015). But it wasn’t until the mid-twentieth century that the scale of urban deprivation hinted at the impending crisis that has since unfolded, vastly out-scaling the relatively modest economic growth that impelled waves of urban migration in developing economies in the first place. Today, almost all projected

future growth in urban populations will occur in the low- and middle-income nations of Africa and Asia (UN, 2014), in countries and regions least prepared to absorb the huge influx of urban residents. But while the vast majority of urban growth will occur in the global South, Martine et al. (2008) point out that so too will most of the world's economic growth, an important fact that must be remembered in debates about how future urban growth will be managed.

Modernization Theory

While town and cities – the dynamos of economic growth – symbolize the prospect of a more prosperous future, the reality of life in the global South's cities for most people has proven to be less enticing. So why do people keep coming? According to classical economic models, the primary driver of rural-urban migration is higher wages (Spengler & Myers, 1977), and migrants tend to base their decision on a “comparison of rural and urban opportunities” (Gugler, 1997, p. 43), widely referred to as the push/pull effect. Proponents of Modernization Theory in any case argue that industrialization and associated urbanization are a prerequisite for economic growth, and encourage (indeed advocate incentivizing) large-scale rural-urban migration to ensure a ready supply of labour. Whatever the apparent cause, “[t]here is a general consensus among economists and urban scholars that urbanization plays a positive role in social and economic development” (Tacoli et al, 2008, p.37).

This consensus is new, and represents a reorientation of theoretical approaches to urban studies. Bazoglu (2011) points out that in the 1970s, when the tremendous demographic shift to urban centres in the developing world became evident, there was significant contestation among development practitioners, governments, and stakeholders about what to do. She asserts that those who opposed unmitigated urbanization (on the basis that they invariably led to slums,

crime, and pollution) at first greatly outnumbered those who embraced the economic advantages supposedly afforded by large numbers of migrant workers.

Corbridge and Jones (2010), note the “apparent bias in favour of urban-industrial models of development” (p.243), and find in the work of W. Arthur Lewis (1954), Hans Singer (1950), and Raoul Prebisch (1950) the origins of discourse that justified – indeed embraced – the push for economic growth predicated on the clustering effect of labour capital and trade in cities throughout South America, Africa, and Asia. Their analysis also identifies a common thread throughout these early (and tremendously influential) development thinkers, namely that economic growth in the West appeared to be predicated on similar historic causalities, and thus they should be replicated throughout the Third World in order to stimulate comparable growth.

The central flaw of this approach is representative of the broader fallacious tenets of Modernization Theory, which were exhaustively addressed in a wide body of subsequent development analysis. Comparisons between North/South urbanization since 1950 reveal how the challenges faced by developed nations were completely different to those faced in the newly-defined “Third World”. The most important distinction is that while nations in Western Europe and North America urbanized and developed over several centuries, the developing world is “...facing a larger absolute task of urbanizing more people within a shorter period of time than did developed countries” (Beier et al., 1977, p.366). Watson (2008) endorses a similar perspective, noting that approaches to urbanization and development originating in the developed world are predicated on assumptions that neither apply to the developing world today nor are any longer valid in the West (p.2272). Davis (2010) characterizes the early post-war period in the global South as “a regime of relatively slow, even retarded growth [followed by] abrupt acceleration to fast growth in the 1950s and 1960s” (p.51). He correlates this rapid urban growth

with two distinctive phenomena in the developing world: the emergence of mega-cities, and the beginning of large-scale slum settlements on the periphery of urban locales. The genesis of today's urban crisis can be traced to the emergence of these distinctive forms of urban agglomeration in the developing world, neither of which have any precedence in post-industrial Europe or North America.

Dependency Theory

While the failure of the classical modernization paradigm to deliver economic prosperity remains evident throughout the global South today (the model having now been supplanted by the equally problematic neo-liberal reform agenda), subsequent thinkers noted that the problem was not so much the conditions that drive economic growth, but more how they were integrated into the increasingly global exchange of goods and services. These issues are of course rooted in the legacy of colonial rule and post-colonial economic development, both of which deserve greater consideration than be given here. However, Davis (2010), in tracing the origins of urban poverty in the former British Empire, gives an excellent summary of how urbanization was strictly regulated in the African colonies for fear that “city life would “detritalize” Africans and foster anticolonial solidarities” (p.51). It could be argued that the legacy of this and other similarly egregious measures to prevent urban organization further undermined the conditions for industrial ‘take-off’ in the post-colonial era, when colonial officials were simply replaced by new agents of structural oppression and exploitation.

Proponents of what became known as Dependency Theory saw historical causalities – rather than the lack of ‘take off’ conditions – at the root of their economic dependency. In Latin America, for example, Galeano's (1997) populist and often incendiary writings appealed greatly to the exploited peoples of former empires. He argues that Europe and North America are simply

the ‘winners’ of global economics. Not only did Latin America (and by inference other colonial regions) lose in the development of global capitalism, but their loss was (and indeed remains) a necessary condition of others winning. As he says, “our defeat was always implicit in the victory of others...” (p. 2).

Beyond dependency theory, other debates on development (be it under the umbra of economic growth or human development) framed discourse in terms of rural and urban livelihoods. Emphasis subsequently alternated between focusing on agrarian populations and finding ways to deal with the reality of an irreversibly urban world, an approach now increasingly endorsed by organizations like the World Bank and the UN. However, the evolution of this discourse has profoundly shaped the way urbanization and urban growth have been (and indeed continue to be) approached by governments and academics in the last several decades, so these disparate attitudes must be explored in some detail.

Urban Bias Theory

Despite the explosive growth of urbanization and urban poverty, in many developing countries the general focus on rural development has proven resilient. Informed in part by analysis offered in urban bias theory (UBT), advocates of rural development point to urban poverty as a symptom of imbalanced economic development, a problem that could be mitigated by incentivizing rural industry. This, they argue, would in turn curb and even reverse the tide of urban migration. This approach remains a pervasive current of development discourse today, and discussion around the perceived socio-economic disparity between rural and urban populations continues to be framed in the often highly-changed political and ideological terms it employs.

Gugler (1997) offers a useful analysis of the origins urban bias theory, describing how its adherents have argued that prosperous cities emerge not because they are the primary drivers of economic development, but because capital and investment are diverted by governments and policy-makers who institute preferential policies that focus on centralized administration and service provision. More recently, Corbridge & Jones (2011), in their consideration of Michael Lipton's influential papers on urban bias in the 1960s, argue that UBT fails to account for the alarming scale and growth of urban poverty (p.245), a damaging critique of a theory that seeks to remedy inequality. This central point is supported by Patino & Duque (2011), who conclude that intra-urban inequality now vastly surpasses rural-urban inequality. While Corbridge & Jones (2011) acknowledge some validity in Lipton's arguments – for example that government spending on healthcare and education in rural areas is often drastically lower than in urban areas – they add that such issues can be addressed “... without resort to a generalized model of the exploitation of the countryside by the city” (p. 246).

Also addressing the issues around rural-urban migration and poverty, Tacoli, et al. (2008) suggest that because a link between rural-urban migration and urban poverty has never been substantiated, efforts to focus on – let alone curtail – rural-urban migration are misplaced, and perhaps counterproductive. While they acknowledge that migration stems from shifting economic circumstances in urban and rural areas (as stated, the push/pull effect) they cite research that demonstrates that most urban growth today is from population growth, and not migration from rural areas (p.50). So while there are valid arguments and issues addressed in UBT, they can and should be addressed without resorting to a misleading urban-rural bifurcation. Corbridge & Jones (2011) argue, “... it is thus prudent to retain the provocation set out by

Lipton's model (location matters for welfare), while avoiding reference to urban bias either as a social fact or as a pathology that always needs correction" (p. 246).

Indeed, after three decades of emphasis on making rural living conditions the focus of LDC development in order to stem rural-urban migration, the enormous proliferation of projects aimed at improving rural livelihoods, and the general dominance of rural development problems in development discourse and practice, have led to what might be termed a "rural bias". But as Corbridge & Jones conclude, it "...makes little sense to choose between UBT and what might be called its opposite" (P. 246). Therefore, attention must turn away from entrenched discourse on the origins of urban growth, and instead focus on its effects.

ii. Slums and Peri-Urban Development

The false dichotomy between rural and urban bias is particularly apparent when we consider how urbanization has evolved from a simple rural-urban binary to something much more complex. Urbanization in the global South over the past several decades has been characterized by an emerging form of hybrid urbanization that defies the rural-urban paradigm, described by Davis (2006) as the "hermaphroditic landscape" (p.9). While the German urbanist Thomas Sieverts used the word *Zwischenstadt* (meaning in-between city), the conventional term used by the UN and others (via the French word *périurbanisation*) is 'peri-urbanization'. This poorly-understood environment, argue Ravetz et al. (2013), has now become "...the dominant urban form and spatial planning challenge of the twenty-first century" (p. 13).

Up to this point, this thesis has used the word 'slum' to describe the untenable living conditions experienced by inestimable numbers of people in the developing world. Similar living

conditions, as will be explicated later, exist in areas increasingly known as peri-urban. While both terms define forms of problematic human settlement, they are not interchangeable. Since this thesis investigates problems and solutions at the nexus of human development and urban/geographical sciences, definitions inevitably betray different approaches. When discussion here is development-oriented, the term ‘slum’ is used for qualitative analysis, while ‘peri-urban’ is used to describe human settlements (which may not necessarily be slums) with distinctive geographical attributes in addition to socio-economic indicators. For a more detailed version of this important discursive point, see Simon (2008).

Another important disambiguation must be also made with the term ‘suburban’, which refers to patterns of residential habitation on the fringes of cities. Suburbs – initially a peculiarly American form of urbanization – tend to be bedroom communities from where urbanites typically commute to jobs in downtown business districts. Mieszkowski & Mills (1993) summarize the primary drivers of suburbanization in the American context as being a combination of social and economic factors, including the ‘flight from blight’ associated with postwar urban expansion, coupled with massive transportation and mass transit projects across the United States. While the ‘suburb’ is an interesting form of settlement in its own right, it is not to be confused as an aspect of peri-urbanization. As a type of urbanization essentially unique to the post-industrial Western world, it is irrelevant to the present discussion and must be dismissed entirely.

Definitions of peri-urban spaces betray the numerous and contestable issues associated with their development, and the literature reflects this. One successful definition, perhaps owing to its generality, comes from a widely-cited paper, where Webster (2002) puts forward the following: “The term peri-urbanization refers to a process in which rural areas located on the

outskirts of established cities become more urban in character, in physical, economic, and social terms, often in piecemeal fashion.” (p.1)

In a subsequent survey of peri-urbanization in East Asia, Webster et al (2014) revisit the definition more than a decade later, and confirm that it has held fast primarily because it underscores the significance of ‘process’ and ‘transition’ (p.316). The authors attribute the disparate characteristics and patterns of peri-urbanization to levels and forms of economic development in individual cities and regions, which inevitably result in different forms of development. In search of a broader peri-urban typology, Drescher & Iaquina (2000) warn of the tautological aspects of adhering to a rigid definition that links concepts of rural and urban identity to geographical location. Instead, they offer an understanding that peri-urban spaces should be seen as part of the “rural-urban spectrum,” since while proximity to urban centres may help define aspects of peri-urban spaces, it ignores important qualitative social aspects that accompany this urban evolution (p.3).

Slums

Poor neighbourhoods have been a part of the urban experience for millennia, but they really only rose to prominence in post-industrial Britain, France, and America, where the scale and degree of urban poverty defined what we now call slums. Vale (2007) chronicles the emergence of what he describes first truly modern slum: the Five Points district of Lower Manhattan. In Britain, the same kind of crowded tenements, filthy streets, thick smog, violence and crime appear as the backdrop in many popular Charles Dickens novels, while Karl Marx described the housing in the slums of Manchester as “cattle sheds for human beings” (Marx, 1978, p.582). The living conditions among the working class in nineteenth century England witnessed by Dickens – and especially Marx – informed a new social and political consciousness

in Europe and far beyond, the influence of which can hardly be overstated. While the most insidious symptoms of slums described by Dickens and Marx have arguably been mostly addressed in Western Europe and North America, they are now felt most acutely in the crowded streets of cities in LDCs.

In the West, urban planning has for the last two centuries accompanied economic and industrial development. While attentions by early urban planners and municipal authorities were often heavy-handed and used to exclude and marginalize the poor, progressive thinking (which can be traced to growing class consciousness) has drastically altered this approach. Today, cities in the West place enormous emphasis and allocate huge investment and resources on shaping healthy urban growth to facilitate the steady flow of goods and services. Large cities are dependent on networks of efficient and reliable urban infrastructure, such as roads, public transit, waste management, potable water, and public services in education, law enforcement, and healthcare to name but a few. From central planning offices designing rail networks for future generations to local building codes and municipal bylaws, almost every aspect of urbanization is regulated, monitored, and enforced. This is not the case in the developing world. The absence of such oversight is the genesis for slums, peri-urban settlements, and other forms of informal settlement. And the lack of concerted urban planning in LDCs, warn Webster et al. (2002), increasingly results in profound and human suffering and widespread social destabilization. So, the question is: are slums and informal peri-urban settlements forms of urbanization that will 'evaporate' from better urban planning and funding in developing nations, as has largely been the case in the West? Or, does their prevalence allude to something new?

Bolay (2006) argues the ubiquity of slums among even modestly-sized towns in LDCs today points to new era in urban development. Not only are they manifestations of poverty,

urban deprivation, and poor urban planning, their ubiquity suggests they are now “... a crucial element of contemporary urbanization” (p. 284). The slum is here to stay, and its peri-urban form suggests it is evolving with shifting patterns of human development. Neither urban nor rural, peri-urban settlements exist in the vague and protean spaces between town and countryside. As with more established forms of slum settlement, the peri-urban slum is characterized by poverty and marginalization, existing in defiance of planning authorities and municipal boundaries. Peri-urban slums differ vastly in form, yet they tend to define the shifting and vague boundary between city and countryside. And increasingly, as Bolay asserts, they typify urban growth in the developing world. Classical definitions of ‘rural’ and ‘urban’ are now unstable to the point of being almost devoid of meaning, no longer useful to planners and municipal planners faced with shifting and ambiguous boundaries of urban, peri-urban, and rural spaces. This is was not the case in Europe and North America in the nineteenth and twenty centuries, where the urban and rural experience were clearly differentiated.

What to do about slums and peri-urban settlements is one of the most urgent questions in international development today, and urban planners in LDCs have the unenviable task of finding answers to this complex problem. And whereas urban planning has historically been an issue of central importance to national governments, the advent of neoliberal reforms and market-based solutions have shifted this role over to the purview of municipal authorities, who are encouraged to work with private sector partners to develop local solutions. The documented failure of this model private-sector/municipal partnership has now shifted the importance of socially-equitable urban planning back into focus, with municipal authorities and planners looking for better answers. This is especially evident when it is understood that the rural/urban model is no longer relevant, and new conceptions of urbanization must be established. Clearly,

as the title of a recent UN-Habitat report suggests, it is *Time to Think Urban*. Stakeholders at every level need to identify ways to deal with the inexorable path of urbanization and growth, and ensure that resources are in place to accommodate billions more people over the next three decades. How the world prepares for this new reality “...will be the key to our very survival and prosperity” (UN-Habitat, 2013, p. 8).

Characteristics of Slums

The tentative definition of ‘urban’ in many countries alludes to the persistent (and often opaque) problem concerning the systematic exclusion of vulnerable populations, a matter often at the root of systematic discrimination faced by slum populations around the world. Even more elusive are ‘slums’ and ‘informal settlements’, the definitions of which vary by place and time, making even the most generalized assessments highly contestable. As mentioned, this thesis will use the term ‘slum’ to define the socio-economic characteristics of urban slums, informal settlement, and peri-urban areas, and defer to UN-Habitat’s definition that is now almost universally adopted:

UN-Habitat defines a slum household as a group of individuals living under the same roof in an urban area who lack one or more of the following:

1. Durable housing of a permanent nature that protects against extreme climate conditions.
2. Sufficient living space which means not more than three people sharing the same room.
3. Easy access to safe water in sufficient amounts at an affordable price.
4. Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people.
5. Security of tenure that prevents forced evictions

(UN-Habitat, 2011)

Slums and informal settlements are not just some kind of urban pathology. They are communities of people who can and must have a say in their own futures. Bolay (2006) asserts that it is essential that urban planners and municipal authorities include (rather than systematically exclude, as is so often the case) the inhabitants of slums in ways that represent their own agency in decision-making. He points out that the ‘technocratic’ approach of governmental urban planning is often incongruous with reality on the streets of slums in the developing world, alienating places which are often “...hothouses of cultural creativity, economic invention and social innovation” (p. 286). He argues that it is possible for stakeholders to find the right balance, and that it is possible to adopt policies and practices that foster equitable and sustainable communities within cities (p. 294).

He points out that approaches at the local, national, and international level are beginning to evolve from clumsy and often brutal attempts to tackle slums, where mass evictions and wrecking balls are the blunt instruments of short-sighted and market-driven approaches. One of the characteristics of slums as defined by UN Habitat – insecure tenure – has all too frequently the only justification needed to dismantle whole communities defined now only by their ‘illegal’ tenure. In China and India, this remains a highly charged issue, with clashes between slum dwellers and municipal authorities an almost daily occurrence. While often in the pretense of being for the construction of new social housing projects, Bolay characterizes such approaches as oppressive and draconian. They are, he says, little more than coercive and deceptive attempts at conforming “undesirable dwellers (migrants and other social ‘undesirables’) to an assimilating view of the urban populations” (p.285). Bolay proposes a more socially-informed and progressive model of consolation and collaboration, where municipal stakeholders adopt a facilitating role, providing essential services to slums while coordinating policies and initiatives

to rehabilitate – rather than destroy – slum neighbourhoods. His assertions allude to the discursive shifting of roles and responsibilities being negotiated in the urban sphere around the world today.

Slums and Peri-urbanization in the Global South

Cities in the global South are beset by a chronic lack of good governance that ensures the equitable provision of public services, key indicators of human welfare. And for this reason, a good deal of the urban population in the developing world live in areas that must – based on UN-Habitat’s definition – be considered slums. These characteristics not only exacerbate the economic challenges faced by developing countries, but also collectively define the daily challenges faced – in various degrees – by most of the world’s people, who must struggle with the effects of chronic poverty and inequality every day. Although the extent and magnitude of slums vary considerably from place to place, this thesis necessarily must describe conditions in the most general terms. For a more in-depth evaluation of the unique slum characteristics of slum settlements in different countries, refer to UN-Habitat’s (2003) Annex 2, which examines the local characteristics of slums in 30 countries in the developed and developing world.

To better understand the consequences of the lack of government or public sector intervention, it is useful to look a little closer at how discourse on slums is presented. Saunders (2010) argues that the world’s slums and shantytowns represent not the failure of cities to incorporate new migrant arrivals, but rather concentrations of humanity that – with well-managed government policy and investment – represent a dynamic addition to vibrant, prosperous cities. His perspective mimics the optimism of such migrants themselves, and focuses on the hope that slums are a transitory stage of urban growth that can regenerate and blossom, much like the Five Points slum of Manhattan, now home to most of Little Italy and Chinatown.

Saunders' vision brings to mind other examples transformation, for example Seoul, South Korea. After the Korean War, it was little more than an impoverished city of ruins surrounded by vast squatter camps. Yet 50 years later, Seoul ranks near the top of the Globalization and World Cities Research Network's renowned list of Global Cities.

However, Davis (2006) observes that in developing world cities, hope is all but extinguished by the apparent reality of life in the vast, impoverished metropolis. In this seminal work, he traces the historical and existent factors that conspire to prevent cities like Lagos, Kinshasa and Dhaka from metamorphosing in such ways. While he suggests the explosive growths of slums and urban poverty were not an inevitability *per se*, most efforts to promote equitable social development amounted to little more than "drab adaptations of modernism" (p.61). He contends that ambitious programs led by the former colonial empires, Soviet regimes, the UN, and the World Bank collectively amount to little more than empty promises.

Whichever perspective is more useful, these two views illustrate the dissonance between promise and reality, highlighting what has been already been described by the UN as the 'urban divide'. Beyond being a metaphor to illustrate the gap between rich and poor, this concept – says UN-Habitat (2010) – provides a theoretical framework that brings into focus the desperate plight of slums dwellers excluded from the benefits of urban life. In this report, it describes the two sides of the urban divide as a binary of "inclusion/exclusion, integration/marginalization, wealth/poverty, equality/inequality, formality and informality," (p. 221), terms that delineate the rich from the poor, the tenants from the squatters, and the workers from the beggars. As suggested, while these binaries were conventionally thought to reside in the rural/urban divide, they are increasingly seen to represent the aporia between intra-urban populations. By finding a way to close these gaps (echoed in the realities and possibilities presented by Saunders and

Davis), nations around the world could avoid the kind of dreadful social costs and political instability that UN-Habitat warns lie ahead if comprehensive measures are not taken to promote human development in urban settings.

So, what exactly would these measures look like? Davis (2006) touches on a key idea when he points out that until quite recently, few researchers or institutions had made any real concerted effort to gauge the extent of the slums on a global scale, “nor, of course, has anyone yet attempted a modern historical overview of the global pattern of informal settlement” (p.50). Based on established evidence of the importance of gathering spatial and temporal baseline data to better understand the dynamics of peri-urbanization, coupled with emerging evidence that remote sensing and GIS applications offer great promise for urban studies, this thesis will argue that sustainable and equitable urban growth is contingent upon the availability of reliable baseline data on which to base future urban planning and policy.

iii. Remote Sensing/GIS

Cities, especially those in the developing world, have been described by a number of researchers as inherently chaotic, complex spaces (see for example Bolay, 2006). To better understand them in human terms, governments and development agencies need to make better sense of this complexity and apparent chaos by gathering data. Historically, the most common methodological approach to quantify and qualify urban spaces has been the census, but inherent limitations reveal serious flaws that undermine their utility in getting a perspective on shifting slums and peri-urban settlements. While censuses do collect valuable socio-economic data, they cannot be relied upon to provide a comprehensive, objective picture. To illustrate this, one can

look at an official map of any large city in the developing world, and note that it most likely ignores the peri-urban settlements that surround the city. The labyrinthine alleys and dirt roads absent in the ‘grey area’ of official maps contain hidden residents who might represent up to half of the population of the city. As McGranahan & Satterthwaite (2014) point out, in the developing world census collection of urban and rural population estimates only happen every ten years or so, and in times of natural disaster and conflict, they don’t take place at all (p.4).

UN-Habitat (2003) reports that “...slums are habitually put aside from the established routine collection of data by national statistics offices and the statistics institutions” (p.6), and as a consequence data relating to them are often either not disaggregated from general data, or not gathered at all. Given the inherently subjective, frequently arbitrary, and often politically-charged nature of census collection and map-making, coupled with normative discourse predicated on the understanding that urban planning must be inclusive and integrated, policymakers must adopt a more inclusive approach. The question, as Pfeffer et al. (2011) put it, “is how to elicit such knowledge [so that it is] both inclusive as well as efficient” (p.235).

Although defining some areas as ‘slums’ is a controversial issue in some countries (as will be discussed later), there is no doubt that the residents of these areas must contend with many of the symptoms UN-Habitat uses to classify them as such. In some places, as much as half the entire population of a city live in areas not mapped – let alone properly serviced – by municipalities. That is to say slums and peri-urban settlements, defined by their ‘informal’ status, are quite simply ignored. There is an alarming consistency in this kind of scenario all over the world. The glittering façade of incredibly wealthy cities like Dubai, for example, hides a dark secret. Here, tall, colourful fences lining the desert highway on the outskirts of town obscure

squalid shantytowns inhabited by hundreds of thousands of migrant workers. These settlements do not appear in Dubai's government maps either.

Montgomery (2008) argues that another limitation to understanding urbanization on the basis of government census data (and the extent to which it is actually collected), is the lack of data on spatial and temporal characteristics. He notes such data are essential for understanding the dynamics of urbanization, especially for understanding the rate and distribution of migrants (p.32). He concludes the lack of spatially-disaggregated data in conventional census data collection as a "... long-standing and serious flaw in the urban demographic record" (p.32). An important corollary is that while conventional census data may offer a reasonably accurate snapshot of a particular place and time, without spatial and temporal data, it offers little insight into the processes of urbanization itself. As Seto et al. (2014) note, it is precisely these processes that will hold the key to understanding how urbanization and urban growth will play out in the coming decades.

Using a working definition of slums and informal settlements, a general understanding of their socio-economic attributes, and an acknowledgement of the profound stress urban and peri-urban slums place on cities and society as a whole, governments must begin to take full account of the global urban crisis. They must do this using methodologies that define the spatial and temporal dimensions and other physical characteristics of urban areas, with a view to providing comprehensive data necessary for effective policy formation. As stated here, the use of remote sensing data coupled with GIS software analysis is a methodological approach supported by considerable evidence in the literature. Jhavar et al. (2012), for example, concluded that to finally begin to address the problems associated India's rapid, it is "... fundamental for policy-makers to incorporate remote sensing into urban planning and management" (p. 53).

The general overview of RS and GIS tools and methodologies under consideration here does not require the kind of interpretive debate inherent in the various fields of the social sciences, since by and large we are dealing with data generated by technological systems. To the extent that remote sensing and GIS case studies are to be evaluated, interpretation and extrapolation will be limited to more general findings and conclusions on their utility in first defining slums and peri-urban settlements, and then in constructing synoptic data-rich visual references. Therefore the scientific rigor of literature used in this section will be taken at face value. The transferability of highly scientific and technical findings published in geographic and geospatial research to complexly politicized urban planning practice highlights an obvious weakness in the approach of this thesis. However, my research question focuses on the utility of remote sensing/GIS baseline data as a potential source of important information for urban planning; what urban planners actually do with this baseline data when it is made available is the subject of further research.

Applications of RS/GIS

A useful introduction to the terms ‘remote sensing’ and ‘GIS’ widely cited in textbooks and introductory passages in academic papers comes from Campbell (2007), who described the concepts as “...the practice of deriving information about the earth’s land and water surface using images acquired from an overhead perspective, by employing electromagnetic radiation in one or more regions of the electromagnetic spectrum, reflected or emitted from the earth’s surface (p.6).” In the interest of concision, he concedes a generalization can be made by saying that remote sensing platforms gather data, while GIS are ways of sorting and analyzing the data gathered by these sensors.

The tall boundary fences and grey areas on city maps, which I have described as ways to segregate, isolate, and marginalize populations, are no obstacle for satellite platforms, which allow us to peer across the ‘urban divide’. While satellite-based sensors (as well as the associated methods of collating and interpreting the data they gather) have been used to study the earth's surface for some time, they remained in the hands of specialized users even as the Cold War ended and scientific applications of remote sensing came into the public sphere.

Patino & Duque (2013) note that the availability of remote-sensed data has increased exponentially while costs have dropped – or in the case of new open-source data – completely disappeared (p.2). Governments and commercial interests have launched new satellites, including Landsat MSS, Landsat TM and ETM+, SPOT, Ikonos and QuickBird, bringing hyper-spectral data within reach of thousands of researchers and technical users. In tandem with the increasing availability of remote sensing imagery came relatively affordable GIS software, allowing researchers to analyze the steady flow of satellite data and compile data-rich maps. As specialized uses of remote sensing and GIS data opened the door to different fields of study, urban planners – usually based in research centres in Europe and North America – applied these tools to transform urban planning policy and practice close to home. The advent of public domain high-resolution satellite data in tandem with specialized and increasingly user-friendly open-source GIS programs, these methods of studying the earth from above are now available to competent computer users everywhere. This last development is especially significant vis-à-vis the potential for widespread application of these solutions to address urban development problems in the global South.

RS/GIS Solutions for Urban Planning

Arguing that enabling municipal policy-makers to visualize cities in geospatial terms is vital, Bhatta (2006) cites a growing consensus among researchers and urban planners that understanding the spatial and temporal characteristics of urbanization is of fundamental importance, since as we have concluded, future management of slums and peri-urban settlements is contingent upon understanding processes of spatial and temporal urban change. However, Montgomery (2008) finds that only a few developing nations are taking steps to implement the gathering geographically-coded data, and "... fewer still make any systematic effort to place the... data in the hands of local planners and policymakers," the majority of whom – he points out – continue to operate without the use of spatial data (p.32).

Some promising findings come in the wake of research that seeks to combine GIS analysis with input from the people it aims to support: local leaders in inner city and peri-urban slums. Pfeffer et al. (2011) offer insight on how GIS-based research methodologies can complement (rather than replace) locally-embedded knowledge. In a project to generate a better understanding of urban inequality in four cities in India (Mysore, Hubli–Dharward, Kalyan and Mira–Bhayandar), they conducted workshops to introduce the basic principles of GIS data collection to community leaders and elected officials. The authors conclude that participants "found it useful to see the spatial perspective of governance issues" (p.246), which they say provided leaders in a more multi-faceted understanding of complex urban problems. However, the researchers point out that a good deal more research will be needed before the utility of this hybrid model of local engagement and urban planning could be determined.

There remains some uncertainty on the issue of the compatibility of remote sensing and GIS applications in the urban context where identifying subtle geospatial indicators are

fundamental for the accurate delineation of slums within the broader urban fabric. Bhatta (2006) highlights some of the challenges in differentiating data values collected by satellite platforms. Leaning on the widely-cited findings of Jensen and Cowen (1999), he similarly concludes that remote sensing and GIS were well suited for detailed study of urban environments, although “... the spatial and spectral heterogeneity of urban environments” (p.49), provide a significant challenge.

However, a report from the *Center for International Earth Science Information Network* (CIESIN) (2014) found that the advent of satellite sensors with improved spectral, spatial, and temporal resolution – coupled with data processing software optimized for distinguishing subtle variations in the urban environment – offered new hope in this area. Similar findings are offered by Patino & Duque (2013) observe that increased spatial resolution of both public and commercial satellite data make highly detailed surveys of urban areas possible, allowing users to distinguish minute variations and features in the urban environment that help in the delineation of slum and marginal human settlements. CIESIN (2011) demonstrate that high-resolution data enable users to classify small buildings, tarpaulin roofs, sheds, dirt paths, small open spaces, livestock pens, gardens, and other features typical of informal and slum settlements.

Adoptions of RS/GIS

Although the complex, heterogeneous nature of urban and peri-urban areas present significant challenges (and often reveal the limitations of various sensors), Patino & Duque (2013) find that interpretation of satellite-derived data provides reliable sources for the detection of “...urban deprivation hot spots, quality of life index assessment, urban growth analysis, urban population estimation and urban social vulnerability assessment,” (p. 1) all of which are essential indicators for urban planners in developing nations. Patino et al. (2013) contend that while many

government agencies and research organizations have adopted GIS initiatives to study the dynamic processes of urbanization, more research is needed to consolidate evidence of the utility of satellite data in efforts to clearly define the often muted characteristics of urban spaces.

Until LDCs have the capacity to operate independent GIS projects, organizations like CIESIN can play an important interim role. Montgomery (2008) advocates initiatives such as the Global Rural-Urban Mapping Project (GRUMP) as a resource for international collaboration that helps build capacity but also yields immediate, useful results. The author cites a GRUMP-initiated mapping project in 2007 that worked with coastal communities around the world to determine areas most vulnerable to extreme weather associated with climate change as evidence of this dual role. GRUMP's online database also offers comprehensive analysis of a wide variety of themes – from access to healthcare to natural hazards to road infrastructure – for every country on earth. Their geospatial analysis of urban land cover (based on remote sensing data of nighttime light patterns) led to a series of maps that delineate urbanization at the national, regional, and global level, providing a wealth of data-rich sources for urban planners everywhere.

The World Bank (2015) is another example of an international organization turning to remote sensing/GIS solutions to make sense of the complex processes of urbanization. Compiling geospatial data on urbanization in East Asia that revealed apparent patterns of urban expansion and inter-connectedness, it proposes that its geospatial approach “offers a blueprint for research to help governments and urban planners ensure the population shifts from rural areas to cities contribute to poverty reduction and boosting shared prosperity” (World Bank, East Asia's Changing Urban Landscape, 2015).

The Urban Remote Sensing and Slum Mapping project, a research initiative by Columbia University's CIESIN project in partnership with UN-Habitat, is mandated to specifically address the lack of up-to-date data showing the extent and characteristics of slums around the world, with a focus on slum population and growth estimates. In a joint statement, it said that gathering accurate spatial and temporal baseline data on slum populations was the essential starting point for strategic planning to meet the challenges presented by formidable urban growth projected by the UN, adding to the chorus of similar findings from other researchers and organizations cited here. Patino & Duque (2013) note the lack of a consistently accurate slum detection model, a problem they also attribute to data gathering in complex, amorphous, and heterogeneous urban environments. They find that very high (spatial) resolution sensors have been used extensively in Western cities, and while these methodologies should – in theory – be transferable to cities in LDCs, it has not been investigated with any serious rigor (p.6). The authors note a “research gap in slum detection from remote sensing that must be filled to develop a method applicable worldwide that takes advantage of the similar appearances of slums all over the world” (p.7), noting the challenges of detecting poorly understood forms of urbanization in peri-urban environments.

Technical Considerations

In GIS projects to study deforestation and land use, there is a wide body of research indicating that lower spatial-resolution images may be complemented by the overlapping use of other spectrum bandwidth data. To detect vegetation, panchromatic (visible light) spectral data can be enhanced by using near infra-red spectral data, which highlights the presence of organic matter when converted for image analysis. While there may be some applications for such data in

the urban context, Jensen and Cohen (1999) contend that when it comes to interpreting data collected from urban areas, the availability of high spatial resolution images was far more important than spectral resolution (p.612).

This has significant implications for GIS users in the developing world who might lack the kind of expertise found in established research organizations in the West. Spectral bands, groups of electromagnetic wavelengths detected by a particular sensor, require considerable technical expertise to analyze and extract useful data. However, since panchromatic imagery is sufficient for the most important remote sensing data applications in urban environments, there is less need for extensive training in multi-spectral image processing. This being the case, Jensen & Cohen (1999) assert that image analysis of urban landscapes can focus on “tone, color, texture, shape, size, orientation, pattern, shadow silhouette, site, and situation of objects” to extrapolate the kinds of data and analysis most useful to urban planners and researchers (p. 614). Fugate et al (2007) later confirm these findings, stressing again that while slums and peri-urban settlements have unique attributes that can be identified from satellite imagery, suitable spatial resolution is essential if slum-detection is to be precise and unambiguous.

Identifying Patterns of Urbanization

Saxena (2013) avoids the more technical aspects of slum-detection by instead incorporating a broader perspective of human settlement. Rather than focus on distinguishing the tin roofs and narrow alleyways of slums from the broader urban mosaic, she suggests urban planners instead adopt a broader and more abstract imagining of what she terms ‘fringe areas’, which she defines as the vague spaces between town and city centres characterized chiefly by contestable land use (p.1). In her approach, the spatial characteristics of slums – which differ

greatly from other forms of informal settlements within extended metropolitan regions – highlight differences, rather than similarities, among various marginalized urban populations. Saxena’s analysis also stresses the need to identify urban zones as incorporating a broad range of inter-related regions, and while they may have different spatial characteristics, they are similar in how land is used, characterized by the “haphazard development of slums, unauthorized colonies, piecemeal commercial development, intermix of conforming and non-conforming uses of land coupled with inadequate services and facilities” (p.3).

Maktev et al. (2005) suggest that to better shape these kinds of unplanned settlements, planners must be presented with data that helps them visualize how they are developing. Stressing the importance of temporal resolution, they insist such data must be “...up-to-date and accurate... at regular intervals of time” (p. 658), so planners can identify emerging patterns in urban density across space and time. The authors again single out government authorities for not working with developers and urban planners to avoid this kind of haphazard and short-sighted construction, and conclude that a lack of integration and inter-agency cooperation is the single greatest obstacle to sustainable urban development, especially in developing LDCs (p. 659).

Noting the lack of clear, practical indicators of urbanization that might offer planning authorities a reliable benchmark for measuring and monitoring dynamic urban patterns, Yeh & Li (2001) offer interesting solutions for studying evolving cities on a larger scale. Using conventional RS/GIS techniques to identify patterns of spatio-temporal urban distribution in Guangdong Province, China, they were able to track and map two indicators of urbanization: the density of land use and distances between settlements and town centres/major roads. They clearly identify distinctive instances of low-, medium-, and high-level peri-urban and urban sprawl over a period of 10 years. Interestingly, while the authors hoped their findings might be

useful for identifying rapidly evolving urban areas, their research (conducted in the early 1990s) happened to encompass what has since become the largest and most populous urban agglomeration in the world: the Pearl River Delta metropolitan area.

For an even broader perspective of global land use/land cover patterns, Seto et al. (2011) use a meta-analysis of 326 projects based on using remote sensing data to map changes to urban and rural landforms. The authors suggest that the strength in this approach is that it would detect similar and disparate characteristics and patterns evident in specific case studies to highlight broader attributes. This analysis is germane to this thesis in several regards. Firstly, these findings linked urban growth in Europe and North America (as well as in parts of China) to GDP growth, whereas in India and Africa urban expansion clearly correlates to population growth. A World Bank (2015) report, based on data derived from spatial analysis of urban areas in East Asia, confirmed these findings, finding “a direct link between urbanization and income growth” (World Bank, East Asia’s Changing Urban Landscape, 2015). At the global level, Seto et al. identify four key determinants: “international capital flows, the informal economy, land use policy, and generalized transport costs,” meaning overall patterns of urbanization are intimately linked to localized factors that make a comprehensive model difficult to establish (p.7). This is another instance that supports the contention in this thesis that individual nations (especially in the developing world) must develop independent remote sensing/GIS capacity.

As the analysis of Seto et al. (2011) reveals, patterns of urbanization are intrinsically linked to local factors, and therefore – in the absence of a general model of urbanization – local urbanization must be studied to understand local outcomes. That is to say, while data offered by organizations like GRUMP can offer an excellent overview at the national level, it is important that this is accompanied by research at the city-level to ensure municipal authorities have the

kinds of synoptic perspective they need to enact suitable policies. While Montgomery (2008) argues that much more research is need to determine the best forms of guidance for policymakers in any given locale, Mahesh et al. (2013) conclude that remote sensing and GIS practitioners can already “...provide accurate, orderly and reliable information for planning and management of a town or city” (p.42) in any context.

It is clear that there exists in the literature a wealth of evidence demonstrating that baseline data gathered by remote sensing platforms can be analyzed and rendered using GIS software programs to identify and make intelligible the spatial and temporal dimensions of human settlement vital to understanding the dynamics of urbanization. Therefore it can be inferred that possible limitations with this approach lie not with technical considerations, but rather with the government agencies and organizations that are presented with these baseline data. That is to say that the success of RS/GIS projects to gather baseline data is contingent on policymakers and urban planning authorities, who must take steps based on the evidence they are presented. In this respect, cooperation between researchers and government agencies is paramount.

RS/GIS Partnerships

Perhaps attributable to it remaining a somewhat new development in the field of urban planning (especially in LDCs), there remains a paucity of research concerning the use of independent remote sensing and GIS technologies in the developing world. To the extent that this is because studies have not been done or the possibility that these applications are not yet widespread remains unclear. However, instances of technical partnerships offered by groups like

GRUMP and CIESIN offer some insight into the wider use in the developing world, now and in the future.

Another such initiative is the United Nations Institute for Training and Research (UNITAR), an agency of the United Nations System tasked with technical cooperation with students, academics, and technicians in the developing world. While it appears much of the outcomes of these partnerships have again not been widely cited in peer-reviewed literature, the UNITAR Operational Satellite Applications Programme (UNOSAT) has published numerous documents on its technical cooperation and capacity building projects in LDCs. With a mandate of providing expert image analysis and GIS mapping data to relief and development organizations, including governments and agencies in the developing world, UNITAR serves both as the UN's primary remote sensing office tasked with gathering data in humanitarian disasters and in enabling partner nations develop their own monitoring systems. UN-Habitat, an organization that frequently advocates the use of RS/GIS solutions for urban planning, published a comprehensive 'how-to' manual for establishing municipal GIS projects. The Systematic Land Information and Management manual (2008) was compiled to help municipal authorities in the developing world collect and manage data to with the aim of improving effective urban management.

There are also examples of personal initiatives to use GIS solutions to foster innovative ways to improve living conditions in peri-urban/slum settlements without directly involving municipal/government agencies or international partners, at least at the outset. Rosario C. Giusti de Pérez, an urban planner committed to improving the *barrios* of Venezuela (where over half the nation lives in slums), does just that. She notes that her GIS models help visualize the networks of complex social and economic relations that define these communities, making order

of what may appear ‘informal’ and ‘chaotic’ to planning authorities. By representing the inherent strengths of these *barrios*, she says discourse shifts from redevelopment and resettlement proposals to ideas that build capacity and reinforce sustainability in existing neighbourhoods. Presented with easy-to-understand GIS models, she says planners and community leaders start to ask better questions, like: “What would happen if we put a concrete fascia on the slope? How can we run sewers into this area? Where is the best location for an elementary school?” (ESRI Best Practices, January 2011, p.21). Pérez remarks that discussion like this is a way of ‘changing the conversation’ about slums and development, and incorporates important concepts like participatory development and stakeholder engagement into new urban planning discourse.

The Danger of Cooptation

As Brotton (2012) points out, any attempt to depict geographic even the most objective information in the form of maps results in information that may be manipulated, meaning the cartographic process is a form of what he calls “managed reality” (2012, p.8). He notes that since the age of Ptolemy, cartographers have always appropriated the ‘reality’ depicted on maps for political and economic motives, and the case made here for mapping ‘forgotten places’ must consider the danger of being co-opted. In a sense, the inclusion of baseline data of under/un-mapped communities represents a step towards the formalization of relations with state authorities, and in the case of autonomous indigenous communities, this is not necessarily advantageous. However, the methods of baseline data collection and GIS analysis discussed here are those grounded in the principles of participatory development. While there may well be evidence that RS/GIS projects have been used to dispossess people from the space they inhabit, this thesis will focus on how communities can use them to improve living conditions, especially

with respect to community-municipality urban planning in the urban centres in developing societies.

In the absence of evidence to the contrary, it may be tentatively concluded that the use of RS/GIS in the global South, with the exception of a number of technical partnerships, remains limited, despite evidence of the formidable potential of these methodologies in delivering important baseline data on slum and peri-urban development. Since part of the goal of this thesis is to underscore the advantages offered by remote sensing/GIS in individual developing nations, we will now turn our attention to a country that exhibits all the problems – and opportunities – of urbanization in the global South: Mongolia.

iv. Urbanization and Development in Mongolia

Mongolia has since the early 1990s experienced radical social, economic, and economic changes that have profoundly reshaped the fabric of Mongol society. Within weeks of the fall of the Berlin wall, the world's second officially Communist nation began to institute reforms, and "citizens from all parts of Mongolia started demonstrating for multiparty elections, transparent governments, human rights, and private property" (Sabloff, 2010, p. 86). As in other post-Communist nations, the transition to a market-based economic system was difficult, and there were widespread shortages of food and fuel in the following years. A mineral boom in the last decade or so has brought considerable attention – and international investment – to Mongolia, although recent developments (including stalled profit-sharing agreements with mining giant Rio-Tinto) have hurt the reputation of what is nonetheless one of the fastest-growing economies in the developing world.

The shift to permanent urban habitation in Mongolia is relatively recent. While in 1950 only a small fraction of the nation lived in urban areas, that figure has now tripled and continues to grow. Chinbat et al. (2006) note that while Ulaanbaatar took form as a settlement in (known as Urga) in 1639 and became a permanent town in 1778, it wasn't until 1954 that any sort of evidence-based planning and decision-making took place, largely the result of Soviet intervention. Although the end of the communist era is often cited as the catalyst for urbanization in Mongolia (eg. Byambadorj et al., 2011), this is somewhat deceptive summary. In fact, rural-urban migration temporarily slowed in the immediate aftermath of the fall of the communist government, in part because of efforts to curtail urban migration. Unicef (2003), in a review of post-reform migration and urbanization in the capital in the 1990s, does ascribe some of the migration to market reforms in the wake of democratic reforms. Firstly, market-oriented policies drove up prices for electricity and medical care, forcing some homeowners – particularly in smaller towns and cities – to sell their modest houses or apartments and move to the capital to seek better opportunities (p.8). Aggravating rising costs of living, mass layoffs at state-owned enterprises drove others to UB to find work. A final factor that can't be blamed on the government was a series of particularly harsh winters, known as 'dzuds' in Mongolia, killed off huge numbers of livestock, leaving tens of thousands of herders with no alternative but to look for work in the capital.

Much of the literature under consideration here concerns the plight of Mongolians who to various extents are shifting from a nomadic herding lifestyle to an urbanized existence. Upton (2010) provides an excellent summary of what she describes as the “diverse discourses of rurality, nature and modernity” in post-collective Mongolia (p.865). Exactly how this

‘reconstructed’ form of nomadism will continue to evolve on the steppe remains unclear, but she argues that it represents a step forward from Soviet-era policies of social coercion and conformity (p.865). Evidence of donor projects in Mongolia, summarized by Upton (2008) in an earlier paper, are shown to focus on rural nomadic populations, and external development agencies have largely supported efforts to reduce poverty and improve environmental management in rural areas. She argues that while building social capital and promoting collective action in rural communities is presented by development practitioners as the best development model, there is growing evidence that such efforts may actually entrench inequality by creating conditions that actually exclude parts of small communities (p.176). Until the dynamics of inter- and intra-community participation in Mongolia are better understood, further interventions of this sort are unadvisable, she concludes.

Beyond dispute, however, is the fact that many of the recent settlers in urban areas are nomads now abandoning the traditional Mongolian livelihood of herding livestock on the vast, grassy steppe that characterizes the rural Mongolian landscape. A Save the Children (2013) report on the social effects of this transition characterizes ‘pastoralist drop-out’ in Mongolia over the past two decades as a profound transformation of rural community life, and suggests this “...increasingly apparent and problematic shift is sure to have lasting implications for Mongolian society” (p.4). However, unlike the typical push/pull effect described in developing nations (where prospective migrants evaluate reasons to stay or move to urban areas), Save the Children posits that rural-urban migration is not correlated to perceived economic opportunities in the city. This trend is one driven by desperation, a process of “...long-term, slow-onset stress migration, resulting from a lack of viable livelihood options in rural areas” (p.4). The ‘push’ of Mongolian urbanity clearly represents a radical social and cultural shift as well as a profound urban

demographic change impelled by deteriorating rural prospects. Yet despite its unique characteristics, urbanization in Ulaanbaatar (which is the only major city in Mongolia) has one thing in common with every other urban centre in the developing world: the urban divide.

One singular characteristic of the urban built environment in Mongolia is the traditional family dwelling known as the *ger*, which will be described in more detail in Section 2. Owing to their suitability to the Mongolian climate (where temperatures range from +30 C in summer to -40 C in winter) and portability, nomads can simply move around the countryside and on the outskirts of towns according to season. While *gers* have appeared on the edges of UB since its founding, they tended to be impermanent villages, often appearing while nomads waited out the winter on the steppe. Semi-permanent *ger* districts also constellate around the city, and while these populations were able to take advantage of goods and services provided in the urban context, they tended not to fully integrate with urban populations (Unicef, 2003).

In stark contrast to *ger* district urbanization, from a distance Ulaanbaatar's modern skyline looks much like any other city. Tall glass office towers line the broad boulevards laid out by Soviet town planners in the 1950s and 60s, who also left behind thousands of low- and medium-rise concrete apartment blocks. This part of the city was largely shaped by Moscow's State Institute of Urban Development and Investment, known informally as the Giprogor ("progress") Institute, during the Soviet era. Byambadorj et al. (2011) suggest that the streets and skyline of Ulaanbaatar are a manifestation of the "capacity of the state to control land ownership" (p.21) during communist party rule, resulting in a city where conceptions of communist ideology took priority over practical concerns. One folly of this type of planning is a huge Soviet-built (and still operating) coal-fired power plant that heats water for the city's aging central heating system. Moscow planners arrived one summer and chose a site far to the west of the downtown, noting

the winds that blow in from the east. However, they failed to account for a shift in prevailing winter winds, and for 40 years the inhabitants of the city have had to live downwind from chimneys belching out thick coal dust.

The resource boom of the early 2000s brought considerable prospects for foreign investment, and developers rushed to cash in on the increasingly speculative real-estate market. Japanese, Chinese, Russian, and South Korean developers continue to develop gated communities of townhouses and luxury apartment complexes apparently at their whim. The urban landscape is disjointed and fractured, clearly lacking any planning or regulatory oversight, and allegations of widespread corruption and kickbacks appear almost daily in the local press. The US Embassy in Mongolia claims it has thorough documentation of corruption and general opacity in government affairs as, which it says both “...undermined government efficiency and public confidence” (Human Rights Report on Mongolia, 2013). The overall effect is the reinforcement of an urban divide that separates the paved streets and centrally-heated concrete towers of Ulaanbaatar from and the ramshackle patchwork of peri-urban *ger* districts surrounding the city and clinging to its outer hillsides, the features of which will now be described.

v. Peri-Urban Settlements in Mongolia

Ulaanbaatar home to roughly half of the nation’s 2.9 million people, has naturally been the focus of the recent transformation throughout Mongolian society. The rubric of slum/informal settlement classification (based in part on security of tenure as established by UN-Habitat), has been problematic in Ulaanbaatar, particularly in how it relates to *ger* districts. In part because of the proud cultural association Mongolians have for their iconic homes, describing

ger districts in terms associated with slums does not sit well here. Byambadorj et al. (2011) noted that a 2007 UN-Habitat Mongolia report on informal *ger* settlements did not use the term ‘informal settlements’ in Mongolian translation, which they noted was “... an important discursive position as the *ger* districts of Ulaanbaatar fail to meet many of the criteria used for informal settlements” (p. 167). They go to conclude that the term offends Mongolians, who object to its use. Although this is a useful insight, the authors forget that UN-Habitat defines slums as having *one or more* of these criteria.

Choi (2012) describes *ger* areas as both “...historically unique assets embedded in Mongolia as well as urban squats in need of redevelopment” (p. 121). Byambadorj et al (2011) provide an inventory of the major challenges faced by municipal authorities seeking to deliver essential service to the residents of the city, particularly those living in *ger* districts encircling the city. They single out the lack of paved roads, public transportation, and provision of employment as particularly problematic.

Urbanization in Ulaanbaatar exemplifies the complex nature of peri-urbanization laid out by Webster (2002) and Iaquina & Drescher (2000), especially in terms of the transformations and processes driving social and economic change. *Ger* districts are inherently ill-defined and ever-changing. There are no addresses or even street names (or even real streets in the conventional sense) in these areas, making even basic census data collection extremely difficult and inaccurate. As a result, “...those managing the city have faced significant information deficits when making decisions on how to invest their limited public resources” (In Asia, 2014).

But as Unicef (2003) notes, the economic pressures on nomadic families that worsened in the 1990s has led to strife in the *ger* villages. With finite space in the open flatlands surrounding the city, migrants began erecting *gers* in marginal areas, including flood-prone marshes, steep

hillsides, and areas lacking even basic infrastructure such as roads (p.8). And unlike historic times of hardship on the steppe, the migrants aren't leaving when the snows melt.

The advent of land reforms and privatization of property under the 2003 New Constitution have led to inevitable conflict, and tenure remains a divisive issue in Mongolia today. One particular government reform is blamed for growing conflict around tenure. Municipal administration in Mongolia consists on a complicated series of districts and sub-districts, and until recently land administration was handled at the '*khoro*' (sub-district) level, a highly localized level of governance familiar to every Mongolian. However, in 2001 responsibility for settlement and tenure was moved to the purview of much larger District Authorities, resulting in what Unicef (2003) describes as complex and expensive bureaucratic procedures. Their report notes that most migrants either don't know how to navigate the much more formal procedures, or don't have the money to file for residency status. The result is vast numbers of 'unofficial' residents, whose official status excludes them from most forms of employment and state education (p.9). And when disputes over land erupt, as is the case with 'squatters' all over the world, residents have no legal recourse or financial support when they are evicted. These 'unofficial' residents are known to experience prolonged adjustment times as they transition from nomadic herders to urban workers. Save the Children (2013) observes that households that relocated to ger districts following the harsh winter to 2000-2001 (that killed off many livestock herds on which they depended for livelihood) had over a decade later not found any source of dependable income or employment (p.12).

The United States Embassy (2013) human rights report on Mongolia finds troubling evidence to substantiate this. In Mongolia, land that isn't fenced off or in active use can be 'lawfully seized' by any citizen who wishes to stay on it. And while the evictions of residents on

land (even if it is leased) is illegal (Criminal Code of Mongolia, Article 137, p.75), the report found evidence that unlawful evictions take place routinely both in UB and in the countryside. So while there are provisions in Mongolian law to protect ‘squatters’ and inhabitants of ‘informal settlements’ like *ger* districts, the issue is mired by a lack of transparency and corruption. The report also presents the perspectives of landowners, who similarly complain about vague property rights, arbitrary enforcement, and general uncertainty as to when legal contracts can and will be upheld (Human Rights Report on Mongolia, 2013).

Beyond the legalities of tenure that (illegally) marginalize and exclude them, *ger* districts are also blamed for Ulaanbaatar’s serious air pollution. Heating *gers* in the world’s coldest capital generates thick, brown smog, and the government has linked this to human health concerns, noting the high rates of respiratory distress and chronic environmental illness. Whereas dung is often burned in the steppe, cheap, low-grade coal briquettes are burned in the city, and according to a 2009 World Bank special report on *ger* stove use, it contributes as much as 70 per cent of overall air pollution in Ulaanbaatar (p.18). For the eight-month autumn and winter period when stoves are almost continually lit, the report described airborne particulate as a “serious health hazard” (p.5).

Perception

There seems a temptation in much development discussion to resort to a facile discourse of modernity/tradition in developing nations. Such simplifications obfuscate more subtle and revealing truths about social and economic development, and this is especially the case in Ulaanbaatar. The urban divide in Mongolia is not a simple binary described by the gaps between rich/poor, urban/peri-urban, apartment/*ger*, modernity/tradition. In many cases, Mongolians choose to live in *gers*, preferring them to leaky, draughty, and mold-ridden Soviet apartment

buildings. In the small fenced-off plots of land on which *gers* are erected, families often build brick-and-mortar structures and install modern kitchens, bathrooms, and living spaces.

Social perceptions in Mongolian society, as far as can be ascertained in the English-language literature, do not clearly discriminate in such ways either. Despite this, even well-meaning articles (almost invariably by non-Mongolians) lose this distinction, and assume Mongolians frame the urban divide in the same way. In one example, an otherwise well-written and sensitive article about *ger* districts begins like this:

“Often brushed off as shanty towns and slums that have to be replaced with apartment complexes to reduce pollution, the *ger* districts are mostly viewed as an ugly backdrop to Ulaanbaatar that have to be removed” (*Nomads to Migrants...*, 2012)

While the peri-urban *ger* districts of Ulaanbaatar clearly exhibit the symptoms of slums, it is essential to think of them as communities imbued with rich cultural tradition, strong social agency, and economic innovation, attributes described here previously by Bolay (2006).

Redeeming itself after the inaccurate simplification in its introduction, the article links to a short film by the author documenting the life of *ger* district resident Begzsuren Jamsranjav. In an interview, he describes how he doesn't want to be part of the consumerist lifestyle that comes with living in an apartment in the city centre. Such lifestyles, he says, are “against nature”.

Although he describes the problems of living in a *ger* district (including the lack of sanitation, potable water, pack of wild dogs, and air pollution), he asserts that they can be overcome through thoughtful and creative improvements and innovations both by the government and by educating local people. Summarizing his life, Jamsranjav says: “I'm proud to live here. It's the perfect life for a Mongolian” (*Ger Necessities*, 2012).

vi. Peri-Urban Settlements, Urban Planning, and RS/GIS in Mongolia

In a major report on infrastructure and urban planning, The World Bank (2007) concluded that Mongolia was in urgent need of a comprehensive review of its planning policies. It noted that while planning regulations were highly restrictive in some areas such as the central business district, there was no evidence of any semblance of planning or policy in peri-urban *ger* areas (p.77). This evaluation confirms previous findings (outlined here) that the lack of planning – especially in marginal and peripheral urban spaces – is a key attribute of urbanization in the developing world.

In a section focused on Ulaanbaatar itself, the report describes generally weak planning by municipal authorities, and singles out the 1998 Urban Development Law as being particularly flawed. The law, the World Bank asserts, results in excessive zoning for heavy industry, while weak power infrastructure has led to increasingly frequent brownouts and sometimes complete blackouts (p.67). In *ger* districts, the report identifies water, drainage, public transportation facilities, and road networks as being the most urgent priorities, noting that government services (such as waste management) are essentially impossible without basic infrastructure. It should be noted, however, that as a developing nation with limited capital resources, Mongolia relies on external donors and investment projects for infrastructure development. Accordingly, the report suggests that as the economy grows, it was contingent on the government and state-owned enterprises to play a greater role in securing financing (World Bank, p. 21).

Byambadorj et al. (2011) attribute some of the blame for Ulaanbaatar's poor infrastructure to a series of four master plans issued by the central government between 1954 and 1986 that failed to anticipate the kind of urban growth the city has experienced (p.171). They make a fair assertion that it would not have been possible to see that land reform and privatization under market-oriented policy would transform the city. In the aftermath of the revolution that ended centralized rule, the authors describe the period of 1990 to 2002 as being a period when "...there was, in essence, no regulation of urban planning" (p.171).

Describing the tension of trying to formulate a master planning process in the midst of evolving land reforms, Byambadorj et al. (2011) see a central challenge that threatens to undermine hope of progress in the *ger* districts. The formalization of property rights, enshrined in reformed planning law, stands at odds with peri-urban settlement around the city. Since these communities defy the strategic vision of Ulaanbaatar's planners and developers, municipal authorities are now trying to challenge the legal legitimacy and permanence of these areas (p.173). Responsibility for the city's land administration and urban planning, until recently, fell under the purview two separate offices: the Land Administration Department (at the Ministry of Environment) and the Urban Planning Department (under the Ministry of Construction and Urban Development). Although they were merged in 2008, the authors note a distinctive lack of cooperation, and "little interaction over issues associated with the identification of joint objectives, strategies and policy implementation" (p.174).

In Ulaanbaatar it is evident that just as the 'informal' and marginalized inhabitants of the *ger* districts are seeking greater support and autonomy, the government is working to establish techno-managerial solutions for land allocation and urban planning. This process is

perhaps an example of what Watson (2008) describes as the ‘conflict of rationalities’. She frames this kind of conflict as being between the rationalities of government/administration and the rationalities of survival of the poor and dispossessed (p.2272). Ariunaa Norovsambuu, a Mongolian representative from the Asia Foundation, in an interview that highlights government efforts to ignore and marginalize the *ger* districts, says that they are “not officially considered to be part of UB,” but that municipal authorities had underestimated both their scale and ubiquity on the capital’s urban landscape (Mongolia puts Shantytowns on the Map, 2014). Faced with evidence that these areas are now home to more than half the city’s population, attitudes are now changing. This shift is due, in no small measure, to new perspectives offered by the advent of at least one high-profile remote sensing/GIS project.

Remote Sensing and GIS in Mongolia

Ganzorig (2002) argues that as a large expanse with relatively little evidence of anthropocentric activity, Mongolia offers an ideal place to gauge global environmental change. And while he suggests that remote sensing and GIS solutions are already “...essential tools for economic development... and planning” in Mongolia, he offers no examples of their use (p.31) in urban contexts. The four studies he cites all concern ecosystem management, conducted over the grassy steppes and lowland forests of Mongolia.

Chinbat et al. (2006) observe that while UB has undergone tremendous growth in the last 15-20 years, there is an almost complete lack of research on resultant urban change in the capital. Although Amarsaikhan et al. (2001) and Amarsaikhan et al. (2005) did conduct

multi-spectral image analyses of the city, Chinbat et al. assess their findings as generalized and lacking in spatial analysis that disambiguates land use and land cover. Their objective was to detect changes to the central business district (CBD) between 1990 and 2002 using data from the SPOT 5 and Quickbird satellite-based remote sensing platforms. Although their conclusions offer a practical synopsis (namely that considerable parts of the CBD were already developed to maximum capacity), of real significance is this first step in linking urban planning and “modern urban geographical theory and methodologies” in Ulaanbaatar (p.1). Until now, they conclude, Mongolia has not used this kind of remote sensing and GIS analysis conventionally used to study cities in developed countries (p.1).

Chinbat et al. (2006) describe the most spatially characteristic changes observed between 1990 and 2002 as being the explosive growth of the ger areas in addition to the “formation of satellite nodes with clusters of commercial functions” (p.2), a finding that correlates with Drescher & Iaquina (2000) already mentioned conception of the “rural-urban spectrum” as an emerging feature of peri-urban hybridization.

In the empirical section that follows, I will present data on urbanization and development, slums and peri-urbanization on a global scale. Then, using a case study on Ulaanbaatar, I will revisit these themes in the context of Mongolia. These data will not only reinforce assertions made in the literature review, but also form the basis of my analysis in Section 3 of this thesis, where I will comment and make several recommendations in light of findings and data presented here.

Section III

Empirical Data

i. Urbanization and Development

Since it is the purpose of this thesis to interrogate the problem of gathering baseline data in support of urban planning in the developing world, it is important to get a sense of the scale of global urbanization and urban growth over the past several decades. After looking more closely at the prevalence of slums and peri-urban areas in the developing world, this section will also provide an overview of the extent of remote sensing and GIS projects around the world.

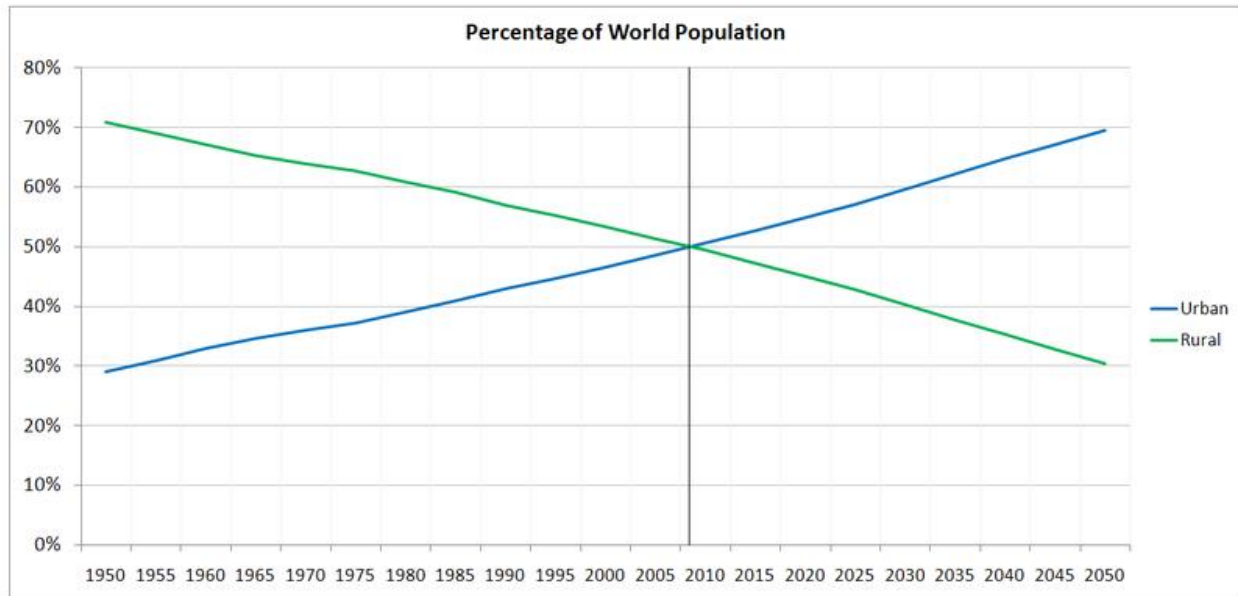
Following some introductory information about Mongolia, salient data will be used to provide a brief overview of that nation's economic development and the course of urbanization. The final section of the data section, in the context of peri-urban settlements in Mongolia, will present evidence of the extent of remote sensing/GIS applications relevant to urban planning and human settlement in the nation's capital, Ulaanbaatar.

The Demographic Shift and Population Growth

As outlined before, urbanization is driven by two key factors: migration and demographic change. Therefore data on these two factors are key to understanding both the validity of approaches examined in the literature review, and for subsequent analysis in the final section of this thesis.

Figure 1

Global Urban and Rural Demographics



Data Source: United Nations, <http://esa.un.org/unup/p2k0data.asp>

Source: UN (2009)

Demographic Milestones

On Sunday, 30th October 2011, the world celebrated the birth of the baby Danica May Camacho in Manila’s Jose Fabella Memorial Hospital. The Guardian ran a front-page story about this child, “one of several children around the world who will symbolically represent the global population milestone” of being the seventh billion human alive today (The Guardian, World’s ‘seven billionth baby’ is born, 2011). But at some point four years earlier (See Figure 1), another symbolic (albeit less ‘cute’) milestone was reached: the world became a primarily urban place. Although it hardly gained notice in the public imagination, 2007 was the true watershed moment in human demographics of the 21st century.

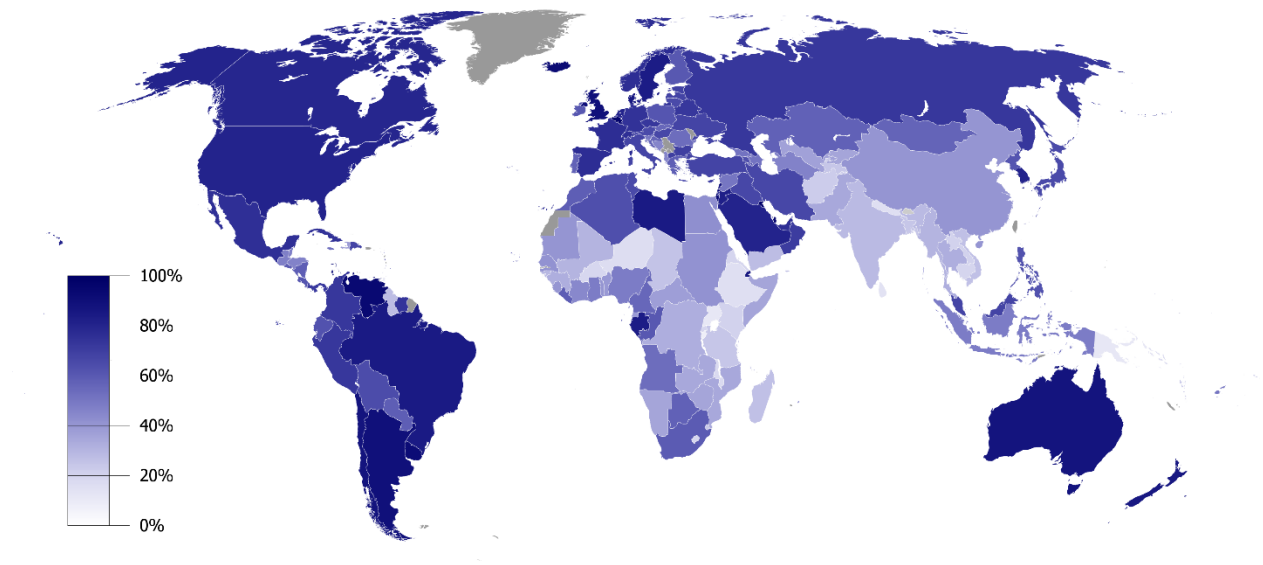
Today, about 82% of North Americans live in urban areas, while Latin America and the Caribbean (80 per cent) and Europe (73 per cent) are also heavily urbanized (UN, 2014). However, most people in Asia and Africa (with urbanization rates of 40 per cent and 48 percent, respectively), still live in rural areas (See Figure 2). But this is changing. Although all regions of the world will continue to urbanize, the rate of urbanization in Africa and Asia is projected to far outstrip urban growth elsewhere. The UN (2014) reports Africa is expected to see urbanization rates reach 56 per cent by 2050, while Asia will become 64 per cent urbanized in the same period. Coupled with the fact that virtually all the world's anticipated population growth will also occur in Africa and Asia (UN 2014), this represents an enormous challenge for the people of these continents. Not only must cities accommodate a relative shift in demographics from migration, but additionally they must face the prospect of enormous absolute growth in population as well. Adhering to the benchmark years of 1950 and 2050 used in this thesis, the UN (2007) reports that the ratio of rural to urban populations will reverse, from 30:70 in 1950 to 70:30 by 2050. Highlighting urban growth rates in large cities in the global South is the fact that Lagos (Nigeria), Kinshasa (Democratic Republic of Congo), and Dhaka (Bangladesh) are each roughly 40 times larger today than they were in 1950 (Davis, 2006, p.2).

The case of Asia illustrates this enormity of this challenge. Although, as mentioned, Asia still has a modest 48 per cent urbanized population, it already represents more than half (53 per cent) of the world's urban dwellers (UN 2014). Since almost all future popular growth will take place in LDCs, Asia – together with Africa – must find a way to add 90 per cent of the 2.5 billion people expected to be living in urban areas by 2050. Three countries stand out as global 'hot spots' of urbanization. Almost two fifths of the 2.5 billion new urban dwellers expected by 2050 will live in the towns and cities of India, China, and Nigeria. The UN's (2014) *World*

Urbanization Prospects report indicates that India will add over 400 million urban dwellers, while China should expect another 300 million and Nigeria an additional 212 million over the next 35 years. The corollary of these statistics illustrate the staggering challenges facing nations already involved with complex socio-economic changes. A summary of global urbanization is presented in Figure 2.

Figure 2

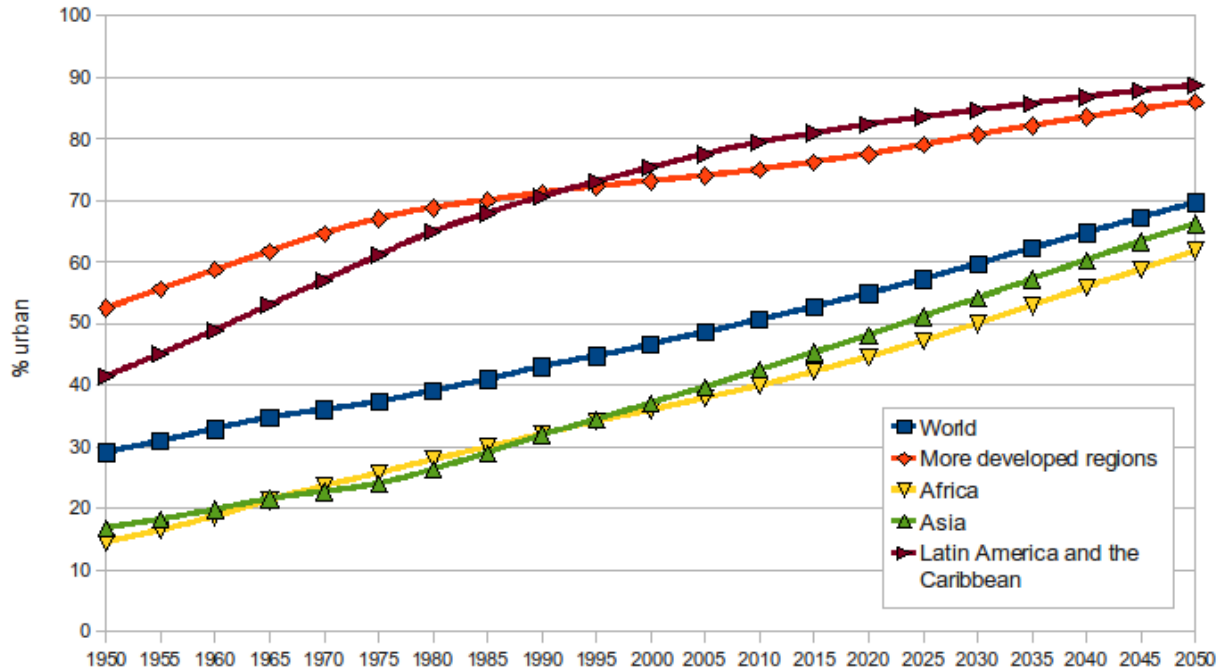
Global Urbanization Rates



Source: UNICEF, 2008

Figure 3

Global Urban Growth, 1950-2050



Source: UN World Urbanization Prospects, 2007

Migration

There is some evidence, according to McGranahan & Satterthwaite (2014), that rural-urban migration, as discussed in the literature review, may not be as simple as presented so far. The typical perception that individuals or families simply migrate to towns and cities (where they either stay or pack up and go home) is misleading. Citing recent research, they show that groups may actually regularly “span the rural/urban divide as part of their livelihood strategies” by moving back and forth, “revealing a much more complex and circulatory patterns” (p.16). As a consequence, rural-urban linkages in the developing world are probably much more intricate and intertwined than commonly believed, and this must be considered an interesting subject of future research.

Uncertainty in Population Growth and Urbanization

With the publication of *World Population Prospects: the 2012 Revision*, the United Nations asserted that the current world population of 7.2 billion is expected to reach 9.6 billion by 2050. While the report notes that populations in the developed world will stabilize (at around 1.3 billion) over the next few decades, the 50 or so least developed nations are expected to almost double in size. This represents a doubling to 1.8 billion over the same period (un.org, 2013).

Karen Seto, in a presentation at the Woodrow Wilson Center in 2009, cites a 2007 UN graph (Seto, 2009, p.2) on population growth uncertainty suggesting the statistical variability for 2050 population forecasts ranging from 7.8 billion to 11.9 billion (the high figure, a constant-fertility variant, is unlikely to be accurate given that fertility rates always decline as urbanization increases). While debate over population projections is ancillary to the main issues here, the extreme variability in basic data such as these illustrate the troubling inconsistencies in data that beset demographers and urban planners from the outset. On the subject of demographics and population statistics, Cohen (2004) citing the latest *World Population Prospects* report, adds an admonitory tone to discussions about the significance of these data. Although he describes such projections as important indicators in some contexts, he warns that they can be misleading, adding that “there is a great deal of misunderstanding and misreporting about what these data mean and how they should be interpreted” (p.23). Because there remains wide statistical variability and general uncertainty about the exact scale of future urban growth, he suggests the world instead focus on the profound challenges represented by even modest growth projections. Adding to the chorus of dire predictions from urban thinkers and groups like UN-Habitat, Cohen concludes that the outcome of entire national development strategies, not to mention the stability

of nations and regions, depends on “how well local authorities are able to respond to this challenge” (p. 49).

This final remark is a telling one. It is interesting to note that the incredible burden – indeed the social and political stability of nations – rests not with central governments, but with local authorities. This seemingly innocuous statement betrays one of the most problematic dimensions of global urbanization. This process, which is changing the face of the planet, largely falls to the purview to municipal planners in towns and cities in the developing world. Equitable urban planning to accommodate this change is, therefore, contingent upon the adoption of informed policies and practices by municipal authorities, including – as this thesis asserts – the use of accurate and timely baseline data gathered and interpreted using remote sensing and GIS solutions.

A common feature of discussion about future urbanization is the “mega-city” and “urban agglomeration”, usually defined as urban centres with in excess of 10 million inhabitants. By 2030, the UN (2014) predicts the world will have at least 41 mega-cities, dramatic manifestations of what the future may hold. While historically cities like London, New York, and Seoul have defined the largest metropolises, most new additions have been in the global South. With an astonishing population of 38 million living in the greater metropolitan area, Tokyo represents a vision of efficiency, social cohesion, human development, offering a secure and prosperous future for almost every one of its inhabitants. The second largest urban agglomeration, Shanghai (with 23 million people), reveals the ongoing socio-economic experiment that is China. With seemingly contradictory elements of strict Communist policies to control rural-urban migration (under the *hukou* system) alongside free-market reforms, the city defines a nation in transition. Here millions of people have been lifted out of poverty (leaving millions more in the shadows)

during a period of economic development unparalleled in history. However, with populations in the region of 21 million, Mumbai, São Paulo and Mexico City highlight the grim prospects of cities in LDCs, where the ‘urban divide’ remains a stubbornly pervasive reality. The future for the people of Mumbai, São Paulo and Mexico City is intrinsically tied to the slums and peri-urban settlements that largely define them.

Despite all the attention these huge cities attract, they account for a modest share of the world’s urbanites. As of 2014, megacities are home to less than one eighth of the world’s urban population, while the denizens of towns and cities with populations under 500,000 represent roughly half of the world’s urban population (UN, 2014).

ii. Slums, Peri-urbanization and Development

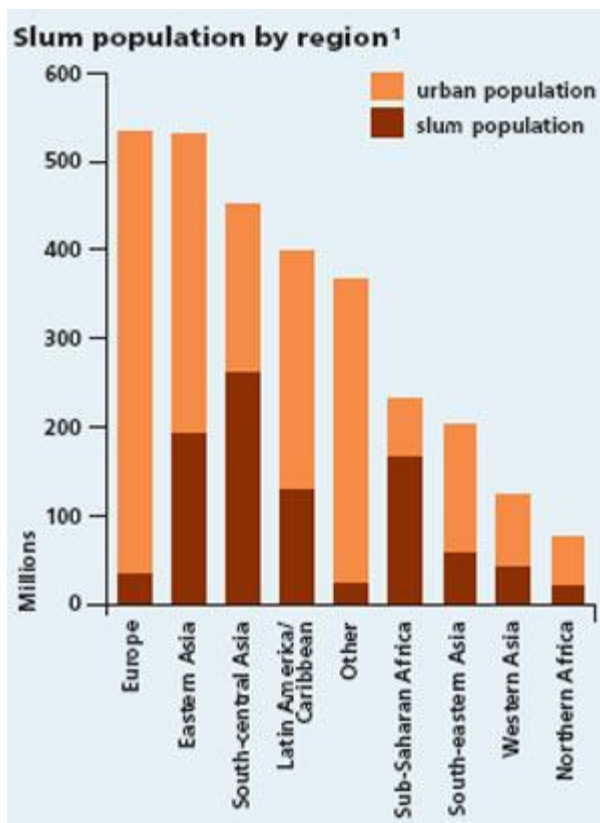


Figure 4

Slum Population by Region

Source: Global Urban Observatory, UN-Habitat, 2003

Davis (2006), estimates there are at least 200,000 separate slum settlements around the world, ranging in size from several hundred to well over a million people (p.26). Citing UN-Habitat statistics, he notes that some cities – and indeed some nations – include urban regions that are

almost exclusively slums. Ethiopia tops the list, with an estimated 99.4 per cent of people inhabiting slums, with Chad, Afghanistan and Nepal all well above the 90 per cent mark. Mumbai has the dubious distinction of encompassing the largest overall slum population with more than 12 million, while Karachi, Lagos, Cairo , Kinshasa-Brazzaville, Sao Paulo, Shanghai, and Delhi lie close behind (p.23). Asia accounts for 60% of the world's slum-dwellers, while Africa (20%) and Latin America (14%) account for virtually all the rest.

While UN-Habitat (2012) estimates that in the developing world nearly 45 per cent of urban populations live in what it classifies as slum households (see Fig. 4), untold more families live in the peripheral 'grey areas' surrounding urban settings, already described here as peri-urban settlements. Webster et al (2013) note the lack of reliable statistics on urbanization in smaller cities (those with populations under 500,000), but using the UN's projection that East Asia alone will add nearly 400 million to its population in the next 15 years, they estimate that 120 million of them will live peri-urban areas.

McGranahan & Satterthwaite (2014) point out that it is important to distinguish between urbanization and urban growth, or more specifically, what they term "urban spatial expansion" (p.15). Noting that while the rate of urbanization is growing on a global scale, the density of the built environment has been declining (at a rate of about 2 per cent per year between 1990 and 2000), in part due to the growing prevalence of peri-urban settlements (p.15). Further evidence of this can be inferred from the fact that urban land cover has grown at about twice the rate of population growth, a fact that the authors say further underscores the significance of peri-urbanization in the broader context of urbanization (p.15). This fact also alludes to the inherently more complex face of urbanization than implied by conventional rural/urban differentiation. Webster et al (2013) offer a quantitative look at this conversion of rural to urban land. While

reiterating that the rise of peri-urban settlements results in an overall decline in urban density on a global scale, they calculate that growing urban spaces will convert more than 700,000 square kilometers of rural land to urban use between 2000 and 2030. They project over 70 per cent of this will take place in the global South, where peri-urban settlements will account for almost all land conversion (p.2). This correlates with data presented here that shows that most demographic growth will take place in the slums situated in the global South.

Although we have already dismissed slum clearance as an oppressive and counterproductive measure, there are some useful data to reinforce this position. UN-Habitat (2005) estimates that the cost of evicting and clearing slums (as a means of ‘dealing’ with urban poverty) is up to 10 times more than supporting existing settlements. In 2000, notes du Pleiss (2005), nearly one million people evicted from the slum district known as Rainbow Town in Port Harcourt, Nigeria, while in Beijing an estimated 300,000 lost their homes to make way for the 2008 Olympic Games. Despite evidence of the terrible social costs incurred through dispossession of land and slum clearance, this trend continues unabated. This being the case, the call for more progressive intervention grows ever more urgent.

iii. Remote Sensing and GIS

The 2015 report from the World Bank, cited earlier in the literature review as being indicative of the emerging role of remote sensing and data presented using GIS software, is evidential of the acceptance this approach is finding. Whereas earlier results from research (in this case on urbanization in East Asia) may have downplayed its research methodology, in this instance the sub-head starts out with: “New World Bank data compiled through satellite imagery and geospatial mapping provides better understanding of East Asia’s accelerating urbanization” (World Bank, 2015). The report presents findings that underscore the advantages of remote

sensing/GIS presented in this thesis, and in some cases attributable to these solutions. For example, it found that urban growth tended to cross administrative boundaries, a fact difficult to prove without temporal and spatial data.

One problem concerning GIS application in the Global South that appears throughout literature originating in developing nations is the lack of long-term commitment to partnerships. For example Nkambwe (2002) examines the challenges of developing a GIS-based land management system in Botswana, and while he found pilot projects in partnership with foreign universities revealed the potential of spatial databases in that country, he concludes that they “have been done in isolation without relating them to an overall effort” (p.145). Simply put, international cooperation needs to be more than an introduction to remote sensing and GIS technologies. It must be part of ongoing effort of capacity building aimed at founding a global network of independent research posts.

iv. (a) Country Profile: Mongolia

Figure 5

Location of Mongolia



Source: freeworldmaps.net (2015)

Historical Overview

Although Mongolia has a remarkably long and eventful history – including such figures as Chinghis Khan (whose Mongol Empire stretched from the Sea of Japan to Arabia) and Kublai Khan (who ruled most of China as emperor of the Yuan Dynasty) – the history of modern Mongolia begins with the fall of the Qing Dynasty in 1911 and the subsequent Mongolian Revolution the same year. The Bogd Khaanate (1911-1924) saw the installation of a theocratic “Holy Ruler,” who ruled the new nation during a turbulent period of maneuvering (and intermittent occupations) by Chinese and Russian Tsarist forces. Following the Mongolian Revolution of 1921 – and with the backing of now Soviet Russian forces – the final remnants of Russian White Guards and Chinese forces were driven out of Mongolia. After several years of internal power struggles (and the death of Bogd Khaan, who was by now in any case only the nominal head of state), the Mongolian People's Republic was proclaimed at the end of November 1924. The communist Mongolian People's Revolutionary Party (later the Mongolian People's Party) led the nation for the next 70 years, and close political and economic ties maintained with the Soviet Union largely defined the nation’s development and geopolitical outlook in the 20th century.

The final – and by far the most consequential – development in modern Mongolian history was the collapse of the Soviet Union, which almost immediately catalyzed the largely peaceful democratic Mongolian Revolution of 1990. Although the Mongolian People's Party won the first election, sweeping constitutional and economic reforms were introduced from the outset, aligning the nation with neo-liberal market policies and broad-based democratic reforms.

The geography and natural history of Mongolia have also profoundly shaped its culture and history. Wedged between Russia and China in northern Asia, Mongolia covers an area of just

over 1.5 million sq km, making it roughly the size of Alaska. With little arable land and a harsh desert/continental climate with enormous seasonal temperate variations, its vast grassy steppe has supported nomadic pastoralists for millennia. To this day, the customs associated with nomadic livelihoods inform almost every aspect of Mongolian life.

The Economy: ‘Minegolia’

The World Bank (2015) classes Mongolia as a lower middle income nation, with a 2013 Gross Domestic Product (GDP) of \$11.52 resulting in gross national income (GNI) of \$3,770 per capita for the same period. The WB’s Global Poverty Working Group reports that the proportion of Mongolians living at the national poverty rate dropped abruptly at the height of this economic growth, from close to 40 per cent in 2010 down to just over 27 per cent in 2012, indicating that rising national income has indisputably had a positive effect on the nation as a whole. While the UNDP’s Human Development report for 2013 ranks Mongolia in the middle of the world’s Income Gini coefficient scale at 36.6 (with a modest global Human Development Index rank of 103), the World Bank warns that “significant regional disparities prevail” (World Bank Data, 2015).

Mongolia has experienced blistering economic growth over the past few years. According to statistics released by the National Statistical Office of Mongolia (2015), annual growth in national Gross Domestic Product (GDP) for 2011 was 18.2 per cent, while 2012 saw 12.3 per cent growth, 2013 had an increase of 12.8 per cent, before the indicator dipped in 2014 to 7.0 per cent. The WB Global Economic Prospects forecast projects GDP growth to settle at around 6.0 per cent for the next several years. Accounting for a rising share of GDP is the nation’s booming mining industry, which has doubled in the past two decades to a figure of 20 per cent today (World Bank Data, 2015), earning the nation the sobriquet “Minegolia”. The nation has been

unearthing coal, copper, and gold at breakneck speed, spurred on by rising prices on global markets.

The largest project, Oyu Tolgoi (Mongolian for Turquoise Hill) is run as a partnership between Rio Tinto and the Mongolian government in Ömnögovi Province, deep in the Gobi Desert. The dual underground/open-pit mine, which could produce around 450,000 tonnes of copper and 330,000 ounces of gold a year from a deposit the size of Manhattan, was touted as one of the three richest deposits in the world (Bowler, BBC, 2013). However, the project has generated controversy from reports of its environmental damage to the social impact on nomadic herders who rely on clean water for goat herds. Former Rio Tinto geologist Sanjaasuren Oyun, who is now the Mongolian Minister of Nature and Green Development, said in an interview that “because we were pretty desperate to get the economy going, to get some income and jobs, and budget growth, we more or less overlooked environmental standards” (Financial Post, 2013). The greatest hurdle, however, has been disputes clashes between Rio Tinto and the government over operating costs, which threaten the future of the entire project and led to long delays in production.

While growth in the mining sector has the potential to drive economic growth in Mongolia, Jacob (2013) warns of apparent signs of so-called Dutch Disease, the dreaded “resource curse” scenario where the economic growth is excessively tied to exports of primary resources. The author cites statistics revealing that the mining industry already accounts for almost 90 per cent of Mongolia’s total exports. Another key factor in the future of the all-important mining sector is public sentiment surrounding foreign investment, on which the investment-hungry nation still depends. A World Economic Forum report cites a 2013 national survey that found that 60% of Mongolians believed that mining projects should be majority

owned by Mongolian interests, while another 25% responded that they should be fully Mongolian-owned (World Economic Forum, 2014, p.7). Political maneuvering to align interests with 85 per cent of the voting public has played a role in at least the perception of hard-ball negotiations with potential investors.

Plichta (2015) determines that Mongolia, as a poor but energy and mineral-rich economy wedged between the geopolitical ambitions of resource-hungry China and Russia, has struggled to balance long-term development with short-sighted FDI schemes. Because of its reliance on foreign investment, the nation has exposed itself to enormous influence from interests that “that have very little concern for the welfare of Mongolia or its inhabitants” (Plichta, M. *Mongolia: Between a Rock and a Hard Place*, 2015). Oscillating between the pull of Moscow and Beijing has seriously undermined its autonomy in the region, he concludes.

Economic Vulnerability

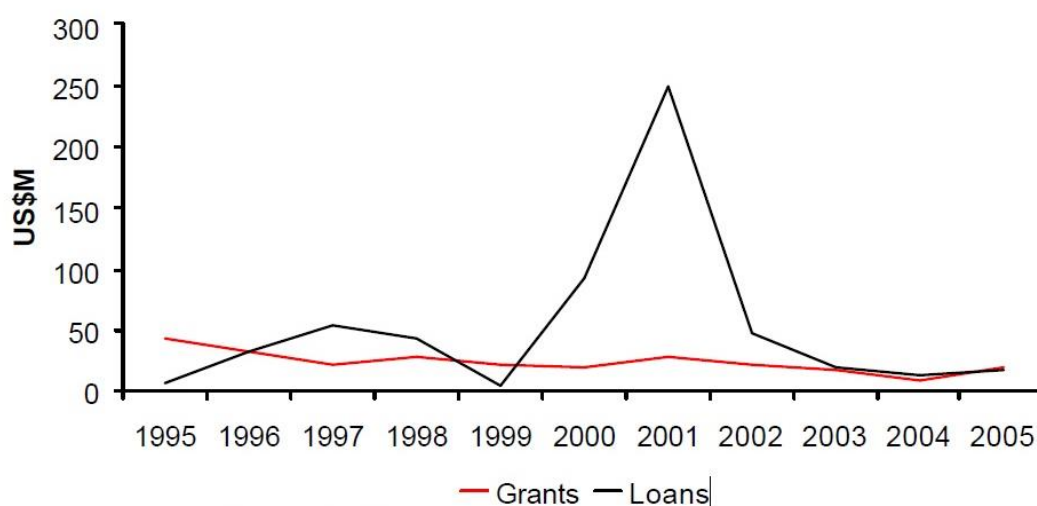
Although rural-urban migration remains poorly understood in Mongolia, one recent event is thought to have spurred migration to the city in unusually high numbers in the winter of 2009/2010. Following an unusually dry summer that yielded little vegetation on the steppe, Mongolia experienced its harshest winter in over three decades. Known as a ‘*dzud*’, the extreme winter phenomenon was responsible for the loss of an unprecedented 5 million horses, yaks, camels, sheep, and goats – the traditional livestock of the country’s nomadic herders, representing an overall loss of about a tenth of the herds (The Economist, Bitter Toll, 2010). Although they are known to happen every several years, the years 2000, 2001, and 2002 were all considered *dzuds*, and environmentalists have linked the unusually frequent – and harsh – examples as evidence of climate change. The financial losses incurred by more than half a million herders, especially painful in light of the restructuring to a privatized model of herding in

the post-Soviet era, was a catalyst for many herders to move into the city in search of more reliable sources of income.

iv. (b) Urbanization and Development in Mongolia

Figure 6

Loans and Grants to Infrastructure

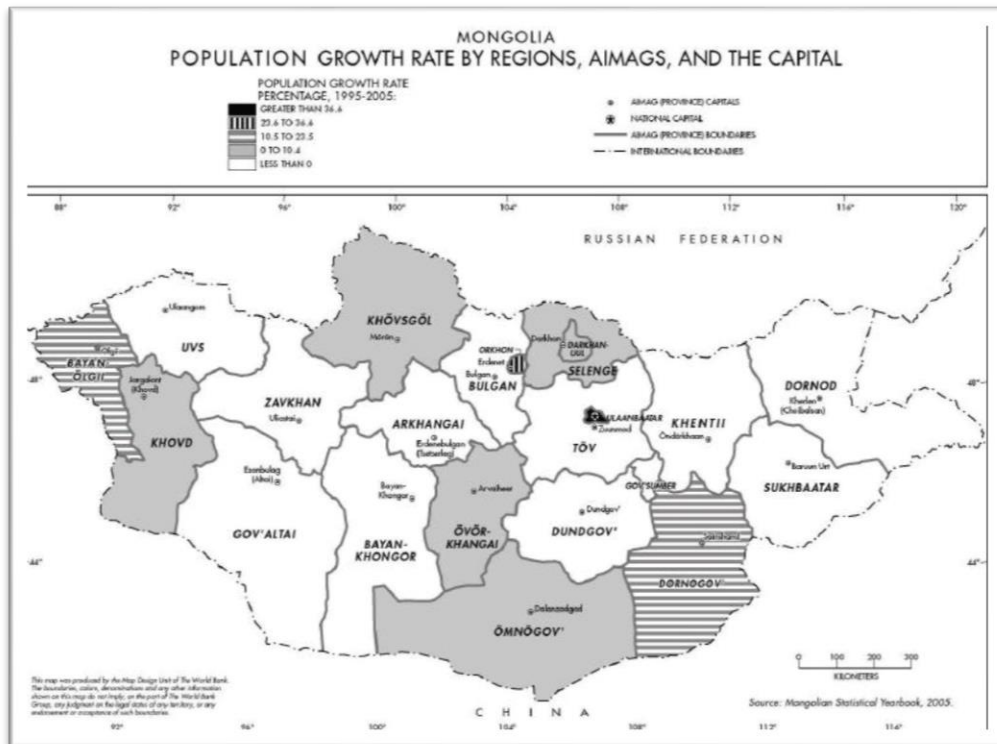


Source: Mongolian Ministry of Finance, 2007

The shift to urban habitation in Mongolia has been relatively recent. While in 1950 roughly 20% of the population was classified as urban, that figure reached 65% today and is projected to exceed 85% by 2040 (UN Population Division, 2012). Over 57% of total population now lives in the capital city. The year 1990 marked a levelling-off of rural-urban migration for a decade (at 55%), before the upward trend resumed in 2000 onwards (UN Population Division, 2012). This, according to some sources, was attributable to a series of government measures to restrict internal migration. It is worth mentioning that besides Ulaanbaator, the nation's capital, the only urban areas in Mongolia with populations exceeding 50,000 are Erdenet and Darkhan, with

populations of 90,000 and 75,000, respectively. Although a comparative analysis between these other cities and Ulaanbaatar may offer some insight, this is beyond the scope of discussion here. However, according to data from the World Bank (2007), the central area of Mongolia (south of Ulaanbaatar) is experiencing significant growth, largely attributable to this being the main area of large-scale mineral extraction activities.

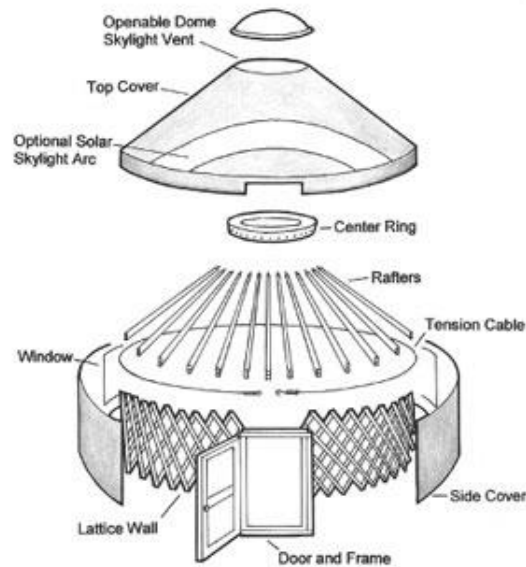
Figure 7
Mongolian Urban Growth Rates by Region



Source: World Bank, 2007

Figure 8

The Mongolian Ger



Source: Yurt New Zealand

Discussion about urbanization in Mongolia is impossible without a description of its most distinctive structure, the *ger*. The nomads of Mongolia have for thousands of years used these distinctive dome-shaped shelters. Often known by the Turkic word “*yurt*” in the West, it consists of a lightweight wooden frame (a circular crown supported by steam-bent curved ribs and a collapsible lattice) that can easily erected and dismantled by a group of two or three people. Covered in a thick yak-felt layer and a weatherproof outer layer made of canvas, a portable iron stove and central chimney stack (fueled by readily available dried dung or cheap local coal) provides heat for cooking and warming the enclosure, which can be cooled in the warmer months with a ceiling vent. Gers are typically enclosed (along with vehicles and livestock) in a fenced-off plot of land called a *hashaa*. These portable structures, which has proven to be a singularly versatile structure perfectly suited to nomadic lifestyles, are also closely associated with the

nation's cultural identity. They are almost invariably decorated with ornamental carving and painted decoration symbolic of the nation's Yellow Hat (Tibetan) Buddhist and shamanistic spiritual beliefs, as well as decorations and embroidery indicative of clan and kinship. Most Mongolians (including those with apartments in the city) either lives in a *ger* or maintains one somewhere in the *ger* district or the countryside.

v. (b) Peri-Urban Development in Ulaanbaatar, Mongolia

Ulaanbaatar is situated in a wide valley surrounded by tall hills, with several small rivers meandering through the downtown core. Administratively, the city has a Byzantine system of districts and sub-districts. It is divided into nine *düüregs*, six of which encompass the central urban areas of the city while the remaining three include the peri-urban *ger* districts. Each *düüreg* is subdivided into sub-districts known as *khoroos*. A total of 87 of the 132 *khoroos* are predominately *ger* areas, and collectively (if somewhat anachronistically) known as the *ger* districts. These districts are home to 61% of Ulaanbaatar's population (Byambadorj et al., 2011), most of whom "... live without access to basic public services like water, sewage systems, and central heating" (In Asia, 2014b). At the most local level, each *khoroos* is in turn divided into micro-districts known as *khesegs*. As Chuluunbaatar et al. (2014) describe, there is very limited data on demographics or public service provision in primarily *ger khoroos*, and local consultation/participation in decision-making and planning matters is similarly absent. Until very recently, the only source for data has been the national census, which was last conducted in 2011. Some of the main findings are now presented below.

Census Data and Household Survey Findings

Recent figures from the National Statistics Office (2012) illustrate the scale of problems associated with urbanization in Ulaanbaatar. Between 2007 and 2011, the number of households in the *ger* districts grew by 36 percent or 43,990 households. A household survey conducted in 2011 found that roughly 40 per cent of households in these districts live in *gers* enclosed by a *hashaa*, while another 40 per cent also has a single- or double-story brick structure on the same plot. A smaller number, around 14 per cent, had both a fully-functioning *ger* and detached house. Also of interest were estimates of coal consumption in the peri-urban districts. Individual *ger* households in 2011 were estimated to burn a staggering four tons of coal each year, while detached homes burned almost 5 tons and those equipped with low-pressure boilers (for heating) used 6.3 tons per year. The bureau reports that it counted over 184,000 separate family households in the *ger* districts. Around 80,000 of them live exclusively in a *gers*, while the remaining 100,000 families have secondary structures or houses within their *hashaa*.

Save the Children (2013), in their own survey, found that most *ger* households struggled to meet even the basic necessities of life. Most homes had at least one unemployed parent looking for work, and many found the cost of primary school education to be prohibitive. Almost all families in the *ger* districts they surveyed say they rely on family allowance or other forms of social assistance to survive, it reports. A report by The Guardian noted that the unemployment rate in *ger* districts exceeded 60 per cent, more than triple that of the downtown “apartment” city (The Guardian, 2014).

The National Statistics Office (2012) also notes that the ‘modern’ *khoroos* are growing at a substantial rate as well. It reports that almost 123,000 families now live in rented/owned apartments, and that the number was growing at a rate of over 5,000 per year over the past five

years. These families represent the lion's share of the estimated 55 per cent of households relying on the municipal central heating system, which pipes pressurized hot water through a network of rusty pipes that crisscross the city. Between 2000 and 2011, the bureau reports that 53,000 new apartment units were constructed, putting further strain on the Soviet-era heating infrastructure.

In a report on the census bureau findings, Chilkhaasuren & Baasankhuu (2012) conclude that despite strong increases in monthly salaries in the private sector and evidence of economic development in UB, human development in the capital district was hampered by factors including air pollution, environmental degradation, and limited access to social support and public services. They stressed the importance of improving infrastructure delivery, particularly the need to provide electricity and potable water to the outlying *ger* districts.

Evidenced here are the main aspects of an urban problematic that undermines socially-inclusive and equitable development in Ulaanbaatar, and by extension, Mongolia. I have shown that the nation's geography, climate, history, and culture (coupled with global trends of liberal market economics, financial deregulation, population growth, and urbanization) conspire to lead it towards one of the most challenging paths of human development. That is to say, Mongolia's unique and seemingly imponderable characteristics and problems position it to be the perfect place to understand the potential of technological and policy-oriented solutions to improve equitable urban planning in that nation – and hint at possibilities for similar solutions elsewhere.

The disjointed nature of urbanization in Mongolia – highlighted by the uneven provision of infrastructure and delivery of public services in its capital – is widening the 'urban divide' in this country. This is also evident in the data collected by the census bureau that reveals that vast numbers of the city's urban inhabitants live a marginal and precarious existence. These findings reinforce the assertion that new and creative approaches to equitable urban development are

urgently needed. And as the World Bank (2015) concludes, “requires a new model of metropolitan governance.”

vi. RS, GIS, and Peri-Urban Development in Ulaanbaatar

The World Bank (2007) reports Mongolia’s ambitious plans for development look more like a “wish list” than workable future plans (p.21). As emphasized here, the nation needs to see integrated multi-agency cooperation founded on the analysis of reliable baseline data, but as evidenced by Chinbat et al. (2006), the use of such solutions remain in their infancy in Mongolia.

As the Asia-Pacific Regional Space Agency Forum reports, Mongolia’s National Remote Sensing Center was established in 1991 to facilitate international cooperation under the auspices of the UN Regional Space Application Programme. While the only official document available (in English) that outlines its role provides a long list of partners within the government (including the now-merged Land Management Agency and Infrastructure Development Ministry), there is little evidence of what has research has resulted from such cooperation in the area of urban studies. This paucity of data may be attributable to the lack English-language publications, but this seems unlikely, given that the government publishes all important reports in English as well as Mongolian. Its mandate to “coordinate all activities related to remote sensing in Mongolia aimed at developing local capability” may simply be part of another wish list.

In terms of capacity building, a promising development is the Earth Observation Laboratory established in 2012 at the Mongolian University of Science and Technology. Although, once again, there is little evidence of research, the lab reports it has started education,

research and scientific initiatives. All remaining evidence of RS/GIS projects in Mongolia appear as part of international partnerships focused on resource extraction, environmental monitoring, and grassland coverage, as well as research based on monitoring climate change and meteorological activity. Tsolmon (2006) offers a more detailed look at the activities and capabilities of remote sensing/GIS programs in Mongolia, noting their chief use in environmental and natural disaster mitigation applications and resource management (particularly mining). He observes that there are four groups engaged in this area of research: government agencies, universities, the private sector, and international NGOs. He highlights what he considers the main obstacles in the application of these solutions in Mongolia: a lack of intuitional awareness of the capabilities of RS/GIS, and the poor use of what assess are already in place. However, he says steps are being taken to address these problems, suggesting that training programs (led by the Research Center for Geophysics at the National University of Mongolia) in tandem with collaboration with a growing network of research organizations would strengthen capacity in the near future. Noteworthy, however, is the lack of mention of existing or future plans to specifically address urban land use/land cover analysis.

vii. Case Study: Urban Services Project for the Ger Districts of Ulaanbaatar

With limited evidence of concerted efforts to monitor the temporal and spatial development of Ulaanbaatar (the only notable exception being Chinbat et al., 2006), a new project led by the Asia Foundation offers great hope for remediation. In many respects, this initiative bears some resemblance to the urban inequality project in India by Pfeffer et al. (2011) outlined earlier in the literature review. Noting that municipal authorities face a serious lack of information to inform the process of resource allocation, the Urban Services Project for the Ger

Districts of Ulaanbaatar (USP) was launched to provide crucial baseline data on the *ger khoros* for government agencies, local and international NGOs, and community leaders. Known locally as the Community Mapping Project, GIS specialists working with open-source remote sensing imagery worked with government representatives from the mayor's office, the planning office, as well as community leaders at the *kheseg* (micro-district) level to map and analyze all the *khoros* in the five main *ger* districts.

The Asia foundation says the resulting online and interactive maps – which present data on five key municipal service indicators (healthcare, fresh water, education, safety, and transportation) are bringing local leaders and community activists face to face with municipal authorities to discuss infrastructure, governance, and public services in these districts. The maps provide a basis for the exchange of “clear ideas for the prioritization of resources and investment,” it says (Asia Foundation, 2013). By bringing GIS specialists together with local leaders, the synergy between technology and embedded knowledge allows for the collection of rich baseline data. Because community participants are able to identify each and every water kiosk or health clinic in their neighbourhoods, the mapmakers were able to compile a comprehensive spatial analysis that highlights the availability – or lack – of public services in the *ger khoros*.

The Foundation also reports that even as the maps were being initially analyzed, participants reported that by seeing the ‘bigger picture’ at the *khoro* level, they could better understand how different parts of their communities were integrated. As a result, they immediately identified the need to develop stronger relationships with adjacent areas and to broaden communal cooperation.

While this project is a remarkable resource for *ger* district residents, government agencies, and NGOs, its real success can be measured in one simple but telling fact. In late 2013, a detailed map generated by the Community Mapping Project was submitted to municipal authorities, who subsequently explicitly listed the five *ger* districts in the official municipal budget for the first time. This single remote sensing and GIS project quite literally put an absent and marginalized 746,766 people on the map.

Section IV

Analysis & Discussion

The results of the Urban Services Project for the Ger Districts of Ulaanbaatar case study offer evidence of the potential for RS/GIS projects to catalyze meaningful urban change in developing nations such as Mongolia. It demonstrates that by engaging local communities and bringing together research specialists and local stakeholders, a single RS/GIS project was able to do what decades of advocacy could not: put a marginalized community on the map where it belongs. While innovative, this approach is not novel. It is grounded in a growing body of evidence that shows that if meaningful changes for populations of urban poor all over the world are to be made, then old ideas of development need to be replaced with more creative and evidence-backed solutions founded on the inherent strengths of slums and peri-urban communities. No longer systematically excluded by municipal authorities, the problems faced by the people living in the *ger* districts can be tackled in earnest. Having identified gaps in service provision, urban planners and government officials can begin to remedy issues such as the lack of sanitation facilities, public utilities, transportation infrastructure, and waste management – all of which were identified in the project. This is an example of what Rosario C. Giusti de Pérez describes as ‘changing the conversation’ about slum development. It represents a move away from private property developers, bulldozers and evictions and towards stakeholder engagement, pro-poor policies, and strengthening vibrant communities.

This conversation can only take place if it is indeed a reciprocal forum where the voices of marginalized and excluded people living in ‘forgotten places’ are acknowledged and addressed. As this case study illustrates, these voices are heard when the grey areas on municipal maps are filled in, providing government policy-makers with undeniable evidence of the

existence of dynamic communities in their midst. Mindful of Brotton's (2012) description of the 'managed reality' of geographic space, it is essential that the reality portrayed by RS/GIS projects is managed by these communities themselves, ensuring that such efforts strengthen – and not undermine – their negotiation of formalized urban integration. The success of projects like Ulaanbaatar's community mapping project must be measured by the benefits they bring about for concerned populations. Although this particular project is very recent, all initial indications point to the transformative effects of formalized urban integration.

To trace the origins of this approach, the reader will recall that my literature review began with a survey of the drivers of development and urbanization. This included an overview of the major debates and discursive perspectives concerning the emergence of an urbanized world, revealing that marginalized communities like the *ger* districts are increasingly the norm – rather than the exception – in the global South. I concluded that the future of these communities represents the greatest challenges – and opportunities – for human development in the twenty-first century. I reviewed evidence, supported for example by Tacoli et al. (2008), that cities – as centres of employment, education, healthcare, and other socio-economic advantages – do indeed offer the best prospects for positive human development. And with insight from Bolay (2006) and Saunders (2010), we see that not only does the city have something to offer migrants, but the benefits are reciprocated. As both assert, new 'arrivals' bring creativity and innovation to their urban communities. The seed of community mapping projects like this lies with the understanding that the lives of rural 'arrivals' are just as important as their settled urban counterparts.

This being the case, the continued prevalence of Urban Bias Theory remains a problematic dimension of urbanization research and development practice. Since it is now clear

that urbanization (and in particular peri-urbanization) are both the dominant forms of human settlement and primary challenges of spatial planning today (Ravetz et al., 2013), the persistent focus among development practitioners and NGOs remains a distraction from the key challenges of the new century. We have seen how the rural-urban divide has been supplanted by intra-urban inequality. If it is the intention of development advocates to improve the living conditions of the world's poorest and most marginalized communities, they must turn their attention to the sprawling cities of LDCs. They must look to not only the slums and peri-urban settlements, but also at the complex social and economic interactions at the boundaries of the rural/urban spectrum. And as this thesis asserts, the only way to understand the complex spatial and temporal dimensions of shifting urban and rural contexts is by the collection of baseline data coupled with GIS analysis. As discussed in the literature review, the kind of synoptic overview offered by RS/GIS is the only way to make intelligible the emergence of new patterns of social, political, and economic space.

The data I have presented on global urban and demographic growth, as well as urban and demographic growth in Mongolia, support the findings of Corbridge & Jones (2011), who argued that Michael Lipton analysis of 'urban bias' vastly underestimated scale of urbanization in the last 40 years. Even the most modest demographic estimates presented in the data section would result in almost unimaginable urban poverty, and so the continued focus on rural poverty is clearly misplaced. Lipton was right in one important regard; location *does* matter for welfare. But, as the evidence has shown, the question no longer concerns the rural-urban paradigm. The location that 'matters' resides in the urban divide. The data show that it really is 'time to think urban'.

The demographic data presented in the empirical section also reveal the urgency of beginning to address these challenges now. As I have shown, most of the urbanization and population growth projected for the next 35 years will happen in the places least prepared to adapt to them: Africa and Asia. While the relative urban populations of these two continents remain lower than in the global North, this is changing very quickly. The urban divide in Africa and Asia will be the focus of new economic, political, and social development in this century. If patterns of peri-urban development continue unabated, the cities of the developing world will become islands surrounded by an ocean of hundreds of millions of marginalized and disaffected poor people. The prosperity and indeed stability of developing nations depends on how leaders address the urban crisis.

In my review of the origins of the urban crisis, I looked at the rising tide of urban-rural migrants beginning in the 1950s. Reviewing well-established literature on mid-century urbanization in LDCs, I was able to clearly correlate the emergence of an urban crisis with – to borrow a phrase from Davis (2006) “drab attempts at modernism” – throughout the global South. We saw how emerging nations were – by a combination of historical and structural causes – destined to be the ‘losers’ of global economics. Of course, as shown in the literature, by the time the influx of rural-migrants arrived in search of opportunities their fate was sealed. The origins of vast unplanned, informal communities are populations of marooned migrants. Their slums were simply a manifestation of their formalized marginalization and exclusion from the economic, social, and political benefits of urban life. Obviously this thesis cannot solve the imponderable problems of international development in the twenty-first century. But by surveying what Walter Benjamin has called the wreckage of history, we can see that progress in urban development will

not come from more ‘drab attempts at modernism’. This thesis has shown that in the debris of the history of urbanization lies the true origin of the urban crisis: formalized exclusion.

I have advocated the use of remote sensing and geographic information systems to address this kind of exclusion. By peering over the walls that separate informal peri-urban communities and slums, remote sensing imagery provides incontrovertible evidence of excluded communities. Satellite imagery helps us ‘find’ the forgotten places, and GIS provides a way of understanding the past, present, and future of the people who live in them. Based on findings from McGranahan & Satterthwaite (2014) and UN-Habitat, I have shown that slums are not simply overlooked by municipal authorities. They are systematically and willfully ignored, dismissed as transitory forms of urbanization, and excluded from the formal policy-making process in many – if not most – nations in the global South. I have also shown that in cases where such exclusion is not intentional, there exist too few resources to adequately account for them. Either way, their existence must be first acknowledged before anything can be done before measures to address equitable urban planning can be implemented.

My analysis of the findings of RS/GIS researchers and practitioners vis-à-vis the suitability of such methodologies in the peri-urban/slum context reveals promising conclusions. Of particular note is the findings of Jensen & Cohen (1999), which show that the spatial attributes of even the most heterogeneous urban area are best resolved by high-resolution panchromatic (essentially visible light) imagery, precluding the need for highly technical multi-spectral analysis. This has important implications for my thesis. It means that RS/GIS projects can be undertaken using the least expensive, most accessible, and most accessible forms of image gathering and analysis. Historically, even the most basic forms of RS/GIS research has involved the kind of complex computer software and technical expertise only found in

specialized research labs. However, the advent of open-source software (for example Q-GIS), public domain satellite imagery (for example LandSat imagery), and extensive training resources available online means that competent users anywhere have the opportunity to develop proficiency in RS/GIS methodologies. This is an important development that warrants further research. In the meantime, the advent of free software and public domain imagery and data means the final barriers to at least basic analysis of urban areas in LDCs have been removed. One remaining challenge is to demonstrate the great potential for these methods to be used in the service of marginalized populations and unmapped communities.

I have examined discussion and evidence of RS/GIS capabilities in the global South, and all evidence suggests that despite the enormous potential to support urban planning, they remain chronically underutilized. An in-depth look at why this remains the case would be an interesting area for further research. However, the example of inter-agency cooperation in Botswana (Nkambwe, 2002) offers insight. Nkambwe's remarks about short-term projects that do nothing to support the broader objective of developing stand-alone capacity in LDCs are significant. This may well be symptomatic of other international development partnerships which simply 'wind up' when funding runs out or when preliminary objectives are met. Implicit in such cases is the fact that long-term, sustainable development comes only when local capacity is strengthened. So while international cooperation offers a departure point for RS/GIS initiatives in developing nations, it is clear that the work of groups like UNITAR – which work to establish and support long-term capacity building in LDCs – are paramount.

Section VI

Conclusions and Recommendations

The Urban Services Project for the Ger Districts of Ulaanbaatar, summarized here in the case study, is illustrative of the potential for RS/GIS to support equitable urban planning in less developed countries. It demonstrates that the lack of baseline data concerning a marginalized population – in this case formerly nomadic population of herders in Mongolia now residing year-round in the capital city of Ulaanbaatar – was an impediment to their inclusion in municipal affairs. We saw how the *ger* districts (as any number of peripheral communities in the developing world today) were deliberately excluded from the benefits of urban life. The Urban Divide, the United Nation’s conception of intra-urban marginalization, represented a profound chasm between the ‘legal’ residents of the city and their ‘informal’ neighbors, who lived in one of the world’s ‘forgotten places’. This divide was manifested in every aspect of life, from educational opportunities to healthcare provision to employment prospects. However, the inhabitants and leaders of the *ger* districts came together with RS/GIS specialists to put their communities on the map, and to have their voices heard. They generated the kinds of baseline data that not only formalize their existence, but offered solutions to how their living standards could be improved. In short, the community mapping project was an act of empowerment that challenged authorities to act, an expression of agency, and a negotiation of political capital.

While Davis (2006) offers a glimpse of the nightmare that may follow if the “Planet of Slums” is a vision of the future, Saunders (2010) conception of the “Arrival City” may be a more accurate imagining if Ulaanbaatar is any indication of possibilities. In the era of neo-liberal globalization, we cannot wait for governments to come to the aid of the victims of economic exclusion, however innocent they may be. The voices of urban poor and the inhabitants of

forgotten places must be heard. Their ‘informal’ status must be renegotiated, and they must resist the tide of eviction and exclusion. And as this thesis suggests, generating baseline data using remote sensing and geographic information systems is a good place to start.

The final great challenge to putting slums and peri-urban communities on the map and back on the urban development agenda is ensuring that action is taken by relevant authorities. As the UN (2014) put it, sustainable urbanization in the developing world is contingent upon “competent, responsive and accountable governments charged with the management of cities and urban expansion” (p.18). Pervasive forms of neo-liberal governance are not compatible with the kind of oversight this requires, nor are market-based land-use models. To ensure equitable policies concerning urban planning are implemented, governments in the global South must adopt integrated approaches to pro-poor urbanization. To ensure institutions can adapt more innovative approaches to urbanization and urban governance, the municipal, provincial, and national institutions charged with planning must define the path future urban growth.

Managing urbanization using remote sensing is not technocratic approach to urban planning. At its root, inclusive planning is a matter of rights and socio-economic equality. The process of putting forgotten places on the map advocated here is not a way of simply formalizing land use or tenure. Rather, it is a way of establishing legitimacy to ensure basic services are provided across the spectrum of rural, peri-urban and urban communities. Without this legitimacy, communities are powerless in face of urban ‘progress’ and development. Further ‘drab attempts at modernism’ will not solve the coming urban crisis. But by using remote sensing and geographic information systems to ‘manage reality’, communities in the global South can lead the conversation about slums, marginalization, and exclusion. This new negotiation of rights

and socio-economic equality is an inherently a question of political space, and it is time for the world to join the conversation.

Section VI

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