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Alex Evan Galbraith

The Red Dragon: Urban Sprawl in China

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Abstract

Low-dense, spatial distribution of land use in China can be attributed to urbanization. This thesis culminates by perforating the challenges associated with city growth as seen through the lens of urban sprawl. In China, the foundation for economic prosperity has been rooted in the industrial progression of its cities; however, the phenomenon of urban sprawl elucidates a myriad of negative externalities. Urban growth is the cause of environmental vulnerability in Shenzhen, road congestion in Shanghai, and air pollution in Beijing. In order for China to remain prosperous in the twenty-first century, it must address and find solutions to mitigate the effects of current and future sprawl.

Introduction

Winding from the Yellow Sea to the South China Sea is the Red Dragon's backbone – the Eastern Sea Coast of China. Its meandering shoreline connects Beijing, Shanghai, and Shenzhen with the pulse of millions of people. The Red Dragon is China's symbol for prosperity, fortitude, and its auspicious nature of becoming great, of becoming worthy of a global audience that will recognize China's responsibility, obligation, and dedication to its people. Red in Chinese culture signifies prosperity. In fact, during the Chinese New Year elders will give their younger generation a red envelope to bid good fortune on their future.

For the past two decades, good fortune has been evident as China has become the world's most rapidly growing economy. The recent rapid growth in cities like Shenzhen is the culmination of an ongoing transformative process that was instilled by Mao Zedong in the 1960s. The country has shifted from a predominantly poor rural economy to an industrialized and urban economy, from a government-planned economy to a market economy (which is evident through private ownership, central planning, and reduced government control over the economy today), and tried to develop a modern information economy (Jeckstein, 2011). Economic prosperity may come at the cost of other resources, however. As cities grow, there is a potential loss of green space, compromised air quality, and increased congestion. In these cases, the Red Dragon of prosperity, while beneficial, also comes at a cost.

This thesis expounds on the effects of urban sprawl as it affects human welfare in China, specifically in the cities of Shenzhen, Shanghai, and Beijing. The phenomenon of urban sprawl not only changes behavior, but also challenges current economic models that use urban development and industrialization as a means for increasing welfare. Operating under the assumption that states pursue economic development as a means of prosperity, the consequences associated with that development through urbanization are paradoxical because of the compromise in amenities that individuals value most (i.e. green space, clean air, etc.). The building of cities helps to create economic prosperity, but when amenities become too dissolved, we see a tipping point for human welfare.

In examining the development of each of the target cities, three factors emerge as having the greatest influence: 1) ecological vulnerability, 2) road congestion, and 3) air pollution. While each of these factors exists to some degree in each city, some are affected more greatly by a single phenomenon. This study will therefore focus on the following: 1) ecological vulnerability in Shenzhen, 2) road congestion in Shanghai, and 3) air pollution in Beijing. The next sections will describe the way(s) in which each factor has affected city dwellers and their urban amenities in the respective cities and identify current and future solutions to mitigate the effects of urban sprawl.

The Case of Shenzhen: Ecological Vulnerability

The idea of the Red Dragon emerged from Mao Zedong's vision in the 1960s, and it began with Shenzhen – China's fastest growing city. Without the rapid egression of Shenzhen as China's first Special Economic Zone, urbanization might not have spread to Shanghai or to Beijing, and the current economic status of China would be much different today. Shenzhen has experienced low-dense, spatial growth at an unprecedented rate, yielding a high concentration of commercial and industrial areas. As an area of land expands to accommodate population and economic growth, however, the direct result is a potential loss of green space. The effects of sprawl in Shenzhen include farmland depletion, environmental degradation, and rural population displacement, each of which can be attributed to the rapid growth of the city.

As population increases, a city can either grow up or grow out. As the term urban sprawl suggests, the issue is when there is too much growing "out" and too little growing "up." Sprawl largely demands a high level of economic activity in an area, and more land is allocated to accommodate sparser populations. Sprawl also allows denizens to live relatively long distances from destinations because of low travel costs (O'Sullivan, 2007). In general, more prestigious jobs yield higher wages and more income, which then make people demand more land. This low-dense development at distant locations over time has been a topic among Chinese policymakers within the past decade. Of the many factors contributing to urban sprawl, consumer choice demands scrutiny because consumers are capable of choosing (or not choosing) more land at the expense of other products (O'Sullivan, 2007). Consumer choice, in this case, has contributed to an imbalance between economic and ecological sustainability, which

has led to a more susceptible environment. The case of Shenzhen is an example of how the ecosystem can become vulnerable as a result of urban sprawl. In every city, the economy and ecosystem form a symbiotic circle – what affects one will affect the other. As China's population grows, officials must take action to form synergies between the economy and the ecosystem.

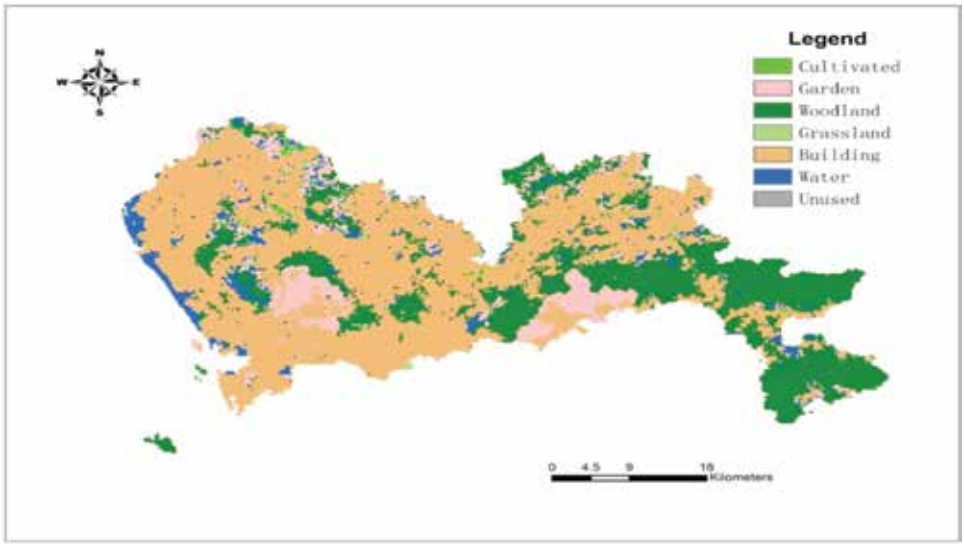
Shenzhen is located in the Guangdong Province, adjacent to the Pearl River Delta and surrounded by other major cities, such as Hong Kong, Macau, and Guangzhou. In the 1980s, the Guangdong Province served to pioneer China's modernization and reform. Shenzhen was established as China's first Special Economic Zone by China's premier – Deng Xiaoping – in 1979 to battle certain political and socioeconomic challenges (Bergsten, et al., 2009), and was freed from the strict Communist regime governing the rest of the country (Pearson, 1997). Special Economic Zones (SEZ) were extremely controversial to Chinese conservatives in the sense that they were similar to Export Processing Zones (EPZs) of the nineteenth century (Bergsten, 2009). However, these zones were beneficial to foreign investors because policy could be adapted to their needs. Within these zones, special tax incentives and preferential treatment with regard to land, raw materials, and foreign currency controls were granted to foreign investors. Special Economic Zone policies contributed to growth by bringing in technology and investment, and refrained from initially threatening the overall ability of the government to manage and to direct the economy (Buoye, 2002). The Special Economic Zone allowed for the pursuit of private enterprise without much interruption from the government (Pearson, 1997). As the decades have passed, the development of Shenzhen as a Special Economic Zone has surpassed any forecasted measure of economic indicator relative to any other area in China. Shenzhen was coined the "instant city" when, in the latter part of the 1980s, six cluster cities were constructed along three major highways. The clusters took full advantage of Shenzhen's long and narrow topography. The ten years following this led to unprecedented growth and urban sprawl, covering land equivalent to 11 islands of Manhattan in New York City (Jeckstein, 2011). Today, Shenzhen exists as the 23rd largest city in the world with 15 million people – more than Hong Kong (7.1 million) and Atlanta (4.7 million) combined (Worldpopulationreview.com, 2014). As the population has increased, land consumption has spread outwards, resulting in the loss of valuable green space.

In China, land is owned and allocated by the government on the people's behalf. Private land ownership does not exist; however, long-term land leases and ownership deeds exist in more developed urban real estate markets like Shanghai, Beijing, and Shenzhen. While the People's Republic aims to industrialize the east coast, the rural west is valued for its farmland and agriculture. Of particular interest is the transformation of agricultural land to industrial parks within a Special Economic Zone. Within Shenzhen, local officials are able to discount farmland and compensate farmers only for the agricultural value. Discounting farmland lures investors from firms to establish commercial and industrial use of land. Compared to the United States and Europe, the cost of transforming land is relatively low, and the time to construct infrastructure short (Bergsten, 2009). Land use in Shenzhen has six characteristics: 1) it must be approved by the Shenzhen government, 2) a leasehold system is established and a land-use fee is levied accordingly, 3) the owner must obtain a land-use certificate, 4) the government carefully maintains that land is used accordingly, 5) there is a time limit for development, and 6) land developers must bear the cost of environmental pollution (Wong and Chu, 1985). The planning strategies employed in the development of Shenzhen have been conducive for foreign investment in housing, industry, and tourism to maximize the use of land, despite the fact that the area of arable land has decreased over the past three decades (Wong and Chu, 1985).

Sustainable Development as a Solution

To track spatial distribution and expansion, many researchers use geographic information systems to observe and simulate land-use patterns and temporal dynamic changes over a period of time. Researchers at Peking University used GIS technology to simulate Shenzhen's land use in the year 2020 (Figure 1). Urban planners and researchers are able to draw conclusions regarding urban sprawl using GIS: 1) urban sprawl quality is high, 2) ecological benefits are low where urban sprawl has a high economic benefit, and 3) policies should be put in place as a safeguard for further development in Shenzhen (Zhang, 2013).

Figure 1. GIS of Shenzhen's land use by the year 2020.



(Source: Zhang, 2013)

When considering land allocation for commercial, residential, or industrial use, it is advisable to determine how to maximize local and natural resources. According to environmental economic theory, human welfare depends to a large extent on ecosystem services. This theory differs from standard neoclassical economics that might define growth as the production of goods and services (Daly and Farley, 2004). In Shenzhen's rapid development, ecosystem services had been sidelined as a means to an end to spur economic growth. At one time, Shenzhen had an abundant supply of firm and flat land that was appropriate for non-industrial use. The space near the city center had been allocated for industrial and commercial use to maximize profits. Due to rapid growth, and poor city planning, parks are next to lower socioeconomic neighborhoods and shopping areas are adjacent to industrially zoned areas. Despite its current state, urban renewal of Shenzhen can be achieved through sustainable development, or development without growth in terms of neoclassical economics.

One consideration in Shenzhen's current situation is population. If China's forecasted population is controlled at 1.4 billion by the year 2020, Shenzhen is predicted to have 800 million people. Its population saw the

most growth from 1994 to 1997, increasing by 236 percent, and from 2001 to 2005 quintupling its population since the 1980s (Jeckstein, 2011). The rapid increase in population at the former part of the century was followed by a dramatic increase in the demand for food, water, energy resources and facilities for waste. Officials acted hastily and, as a result, the ecosystem was ignored in an effort to expand economic growth. Rural areas were affected first. Farmlands were depleted until the 1990s, when farming became specialized within the city. Energy resources increased with larger commercial investment and use of Shenzhen's natural resources. In particular, the development of infrastructure created more roads, highways, and railways which increased congestion (Bao, 2013). Congestion poses a particular concern because of ozone-depleting chemicals.

Another factor that must be addressed is industrial development. In Shenzhen, congestion is most prevalent in freight flow patterns; the majority of goods manufactured in Shenzhen pass through Hong Kong for trans-shipment. Transportation by rail and road between Hong Kong and Guangzhou has been convenient; the Shenzhen Reservoir and the Xili Reservoir are able to provide an adequate and stable supply of water to the city. Shenzhen is a comprehensive economic zone, embracing tourism and manufacturing, as well as commercial and real estate development.

Overall, industrial growth has been the city's top priority since the 1980s (Bergsten, 2009). Industrial development in Shenzhen has been focused in three areas: a) the Shenzhen Special Economic Zone, b) the Shekou Industrial Zone, and c) industrial districts in other parts such as Kuichong, Buji, Longgang, Longhu and Songgang. The Shekou Industrial Zone has gained status as a separate entity and is managed by the China Merchants' Steam Navigation Co. Ltd. (CMSN) of Hong Kong. Shekou is located on the southwestern end of Shenzhen, and has been focusing on heavy industrial development such as ship breaking, steel refining and rolling, the production of oxygen, acetylene, boat paint and fiber glass, shipbuilding and marine engineering (Wong and Chu, 1985). This has also been the main contributor to a loss of valuable green space. In order for these three areas within Shenzhen to prosper in the future, policymakers must consider the role of sustainable development - "that is, qualitative improvement in the ability to satisfy wants (needs and desires) without a quantitative increase in environmental carrying capacity" (Daly and Farley, 2004).

The negative correlation between infrastructure and pollution in

Shenzhen has decreased in the past few years; nonetheless, government contracts with industries monitor the use of certain ozone-depleting chemicals in the production of consumer products. The integration of economic and ecological prosperity had been foreign until the introduction of China's 12th Five Year Plan in 2011. Since then, steps have been taken to create a steady-state subsystem that acknowledges a non-dualistic approach to growth. The idea of a steady-state system, according to Daly and Farley (2004), acknowledges the fundamental necessity of both economic and ecological boundaries - "the main idea...is to maintain constant stocks of wealth and people at levels that are sufficient for a long and good life."

Sprawl creates countless consequences for the environment, but present-day Shenzhen has learned to allocate what green space remains for preservation. Notably, Shenzhen has been labeled as the "City of Parks" with over 680 parks (English.sz.gov.cn, 2014). Greenways encourage more cyclists and reduce time spent driving, and urban gardening inspires the public to find value in green space. In fact, Shanghai and Shenzhen both exhibit examples of artistic and creative forms of green space. Since the population is so dense, it is difficult for individuals to find their own private green space. City planners instead use urban gardening as a means to create a sense of being a part of the environment by growing foliage on the sides of buildings.

In the last decade, Shenzhen officials have condoned courses of action that have helped create a steady-state subsystem to harmonize ecological needs with the growth of the economy. The choices that have made the difference in the twenty-first century are the city's systematic approaches to mitigating the externalities associated with urban sprawl. Notably, present-day efforts to control ecological vulnerability in Shenzhen incorporate measures of sustainable development to moderate the interdependent needs of the ecosystem and of the economy.

The Case of Shanghai: Road Congestion

Shanghai aims to be the world's international financial, trade, shipping, and economic center by the year 2020, according to its 12th Five-Year Plan (National People's Congress, 2011). Due to globalization of the economy and rapid urbanization in the past three decades, Shanghai has grown into a megalopolis, but not without costly externalities that shape the future of its city's amenities. Shanghai is the most important base for domestic and foreign trade in China – it has been the pumping heart of the

Red Dragon, sustaining China as a developing economy. The monocentric city model of urban economics can be a tool used to understand Shanghai's urban growth. The model acknowledges Shanghai's geographic area and renders reasons for its negative congestion externalities. In the future, government officials must take into consideration the market forces that have affected land use within Shanghai in order to pinpoint how to mitigate the effects of urban sprawl. Markedly, the expansion of a city is contingent upon variables like population growth, which ultimately impacts infrastructure.

In the 1980s and 1990s, the majority of Shanghai's residential, commercial, and industrial areas were at the heart of Puxi and Pudong, leaving recreational areas along the outskirts of the city. The main areas of Shanghai are separated by its main tributary source, the Huangpu River, which divides the city into Puxi (West) and Pudong (East). Puxi and Pudong are encapsulated by the Inner Ring of Shanghai – an elevated interstate system completed in 1994 and 2009. By 2012, all of the recreational area had been pushed beyond the boundaries of the Inner Ring, leaving only residential, commercial, and industrial use within the city. Currently, the city of Shanghai has a population of approximately 24 million, making it the world's largest city proper (Worldpopulationreview.com, 2014). By 2020, the population is predicted to grow to 26.5 million, with the majority of residents having migrated from other regions or provinces (watchchinatimes.com, 2013). The infrastructural impact of such an increase in population density means urban planners and policymakers must exercise control to match future demand. The city's conversion of land use has elicited a myriad of issues concerning population control, pollution, and, of particular concern, road congestion. Planners are using population growth and increasing land space as opportunistic mediums to control for congestion as Shanghai expands. Investment created by the Open Door Policy provided Shanghai with the finances it needed to create an integrated transport system supporting high volumes of carrying capacity. Over the next decade, planners and engineers will develop a more sophisticated transport system that can sustain its carrying capacity (Xiao and Gu, 2012).

Shanghai's current transportation system integrates several types of intermodal services to meet demand. Shanghai's total road network ranks number one in China, covering 12,000 kilometers with a density in the city of 184km/100km. Over 1,100 buses are available for surface transit, but

only “80% coverage of bus stops are within a 500 meter service radius in the city center” (Xiao and Gu, 2012). The urban rail network was also the first in China to reach over 400km. Today, fourteen metro lines have been established to reach all corners of the city (Figure 2).

(Source: Shanghai Metro, 2014)

Based on a 60 meter service station radius calculation, Xiao Hui and Gu Yu, two Directors of Urban Planning in Shanghai, attest that “one quarter of land in the city center area is covered by rail stations, directly serving 42 percent of all the population in the city center” (2012). The majority of the population makes primary use of the metro system and

surface transit as a means for transportation. As we have observed through the lens of urban sprawl, increasing traffic congestion puts pressure on the transport system's infrastructure. If there are more drivers using the road network, then congestion increases. If a congestion charge is implemented to curb the effects of congestion, the rail and surface transit systems will also expand. Either way, Shanghai must adapt to its urban development in order to meet future demand.

As many as 3.5 million drivers are predicted to use the road network in 2015. As the city expands, development plans look to build more intercity expressways, expand the railway system, and encourage more environmental policies to help mitigate the effects of 3.5 million drivers (Xiao and Gu, 2012). In August 2014, AutoNavi – a navigation service provider in China – released a traffic congestion report placing Shanghai ahead of Beijing as the most congested city in the country. Data was collected and analyzed from devices installed on taxis and transporters that recorded vehicle speed, location and driving direction. The "delay index" for Shanghai was 2.16, 2.1 for Hangzhou, and 2.09 for Beijing (Table 1). A reading of 2.0 indicates that one would spend twice as much time on a trip as on a normal day. In particular, the highways tend to become most crowded on Monday and Thursday mornings, and on Friday evenings when data shows a peak at 2.28 (China.org.cn, 2014). The cause of such congestion is an amalgamation of several factors, including population growth, the growth of consumerism in the middle class, and the rapid sprawl of the city.

Rank	City	Delay Index Extension	Average Trip Length	Average Travel Time (Minutes)	Average Trip Delay (Minutes)
1	Shanghai	2.16	10.58	29.26	15.73
2	Hangzhou	2.10	9.11	27.58	14.47
3	Beijing	2.09	11.39	31.56	16.44
4	Chongqing	2.07	8.73	21.75	11.24
5	Shenzhen	2.05	10.92	26.69	13.67
6	Guangzhou	2.02	11.33	26.31	13.30
7	Fuzhou	1.98	7.60	23.94	11.88
8	Shenyang	1.94	7.84	25.13	12.17
9	Chengdu	1.93	13.63	30.98	14.96
10	Nanjing	1.91	15.91	32.91	15.64

(Source: China.org.cn, 2014)

Shanghai saw drastic changes in its land use with the establishment of the Pudong Special Economic Zone in 1990. The establishment of the Pudong New Area (PNA) created clusters responsible for Shanghai's increased urban development. The area includes centers for industrial production, banking and investment, and imports/exports. In the short-run, the main benefits are being able to provide incomes to Chinese workers and revenues to the Chinese state, while the long-run benefit is to move from a labor-intensive economy to a capital-intensive economy. The Zhangjiang High-Tech Park (ZHTP) lies in the south of the PNA, and is mainly focused on the healthcare industry (English.pudong.gov.cn, 2014). The clustering of these various industries creates urbanization economies, which create larger, even more diverse cities. Shanghai's urban sprawl has not been completely detrimental, as it has encouraged labor pooling and labor matching. Firms are able to enjoy variance in worker skills, lower training costs, and more worker competition which tends to make workers more productive. Urbanization economies are also able to share knowledge among firms in the form of knowledge spillover. The primary feature of knowledge spillover is that the physical proximity of clusters leads to the exchange of knowledge between people, leading to new and improved ideas (O'Sullivan, 2007). As Shanghai and other cities in China become more international, these regions will become fertile grounds for fresh ideas and new products.

Growth in these areas of Shanghai has led to Shanghai's growing middle-class. As the majority of the middle class earns higher wages, they consume more. This means that more individuals have the capacity to purchase vehicles and other luxury items. In China, they call the growth of the middle-class the "China dream" coined after the "American dream." For example, imagine the American dream as an inflated American football. Both ends represent lower and higher socioeconomic status individuals, but the majority of the population is a part of the middle class. This example is analogous with the Chinese dream, however, unlike the "China Dream," the American football is deflating. Shanghai's GDP per capita in 2010 was 76,074 yuan ($11,238 USD) and has risen almost 20 percent to 90,749 yuan ($14,845 USD) in 2013 (Xu, 2014). In addition, individuals are beginning to make more, which will allow them to spend more of their disposable income.

Expansion as a Solution

In order for China's megalopolis to take advantage of being an international haven in the future, government officials must find solutions for the externalities associated with its increasing urban sprawl, such as congestion. As Xiao and Gu (2012) have contended, a more integrated transportation system should increase the capacity of Shanghai's road network, rail system, and surface transit. China's population in 2014 is predicted to rise to 1.4 billion and will continue to rise until mid-century. Urban planners can use the expansion of the city to breed fresh infrastructure ideas and to determine realistic steps towards finding solutions. Urban planners must take into consideration variables such as population when structuring the future of Shanghai's urban development. In particular, Shanghai's 12th Five Year Plan seeks to create three new main downtown areas by 2020 (Figure 3).

As depicted, the infrastructural changes will impact the entire district. To control its congestion issues now, Shanghai has not only begun placing limits on the number of vehicles on the road, but also has considered congestion taxes at peak travel times.

Figure 3. Shanghai's 2020 Development Plan.

(Source: Urban Development Plan, 2014)

In 2013, approximately 3 million vehicles were on the road in Shanghai. Government officials have taken measures, such as being the first to cap the number of vehicles distributed each year by auctioning license plates. The average price for a Shanghai plate soared to 75,000 yuan ($12,000USD) in 2013, roughly equal to the retail price of a mid-range sedan (Yue, 2014). In addition to Omega, Gucci, and Emporio Armani brands, license plates in Shanghai have also become a luxury item. When conversing with Shanghai denizens, the average person would consider buying a license plate as being equivalent to buying a house or getting married. Only the upper socioeconomic status individuals have tended to drive vehicles, but the growth of the middle class is changing that statistic.

During peak hours of the day, traffic in the Puxi and Pudong areas is in total gridlock. An increased amount of traffic means an increased amount of traffic pollution. Government officials seek to implement a congestion charge to mitigate pollution and reduce the number of drivers on the road. The city has also pledged to cut its PM2.5 rating by 20% by the year 2017. PM2.5 is fine particulate matter in the form of toxic organic compounds and heavy metals that stems partly from driving automobiles. Bloomberg News (2013) stated that Gao Yiyi, an official with the Shanghai Municipal Transport and Port Authority, has said, "Vehicles are a big reason behind the increase in PM2.5." Shanghai is similar to cities such as Beijing and Shenzhen, where traffic pollution is a main concern. Any implementation of a tax or charge would help to rectify a portion of the pollution problem.

According to standard neoclassical economics, as people's income increases so should their welfare and quality of life. People are able to use their income on products such as automobiles. In the case of Shenzhen, the city has become more vehicle-oriented as it has acclimated to higher energy consumption, congestion and pollution. While only a small percentage of Shenzhen's denizens are registered car drivers, the number of drivers per square foot is comparable to the number of taxi drivers in Manhattan, NY (Qi and Lu, 2008). Low-dense, spatial expansion generates longer travel times to destinations, which increases per capita consumption of petrol, contributing to air pollution. The ecological impacts are substantial, making green space more vulnerable. One way that the city has responded is to try to create an environment conducive for more cyclists. In the case of Shanghai, officials have created bike-sharing programs that encourage more citizens to bike instead of drive.

Both cities have pledged to cut the number of drivers on the road and have even shut down schools after three consecutive days of serious air pollution. In terms of air pollution, China is the world's biggest carbon emitter with smog levels that surpass World Health Organization recommendations by almost 40 times. Carcinogens in outdoor air pollution have been found to cause lung cancer and are linked to an increased risk of bladder cancer. Bloomberg News (2013) quoted Gao Yiyi on the situation:

> As part of its anti-pollution plan, Shanghai will focus on building infrastructure to promote the use of alternative-energy vehicles led by public transportation, consider raising emission standards and provide incentives to companies that use cleaner vehicles. […] The city also plans to introduce new environmental standards, expand the use of cleaner-burning energy in homes and companies, and close polluting projects.

Shanghai's pollution problem is bearable most days, but the issue is almost comparable to the air pollution in Beijing. As the world becomes more reliant on cities such as Shanghai, policymakers must find efficient and productive ways to mitigate these types of negative externalities.

The 2020 Shanghai Development Plan is strategic planning for the majority of issues to come as a result of urban expansion. Namely, if the congestion charge is implemented, more drivers will be off the road and will take other forms of transportation. The city already has a complex underground subway system consisting of fourteen lines. The 2020 development plan looks to expand fourteen lines to twenty-one (Urban Development Plan, 2014). As the subway lines push outside of Puxi and Pudong, the government also plans to develop new cities to help lessen urban sprawl within the Inner Ring. In particular, the three main new cities will be Jiading (Northwest Shanghai), Songjiang (Southwest Shanghai), and Luchaogang (Southeast Shanghai), with other towns spread throughout Shanghai that include Chengqiao, Baoshan, Qingpu, Minhang, Nanhui, Fengxian, and Jinshan. According to the 2020 development plan, these cities will follow the monocentric city model as a form of development with the heart of employment at the center of the cities.

The creation of these new cities should also include a public goods provision similar to the Puxi and Pudong areas with healthcare and education. The expansion plan should also detail more green space area locations. Within the Puxi and Pudong areas are public parks choked by a heavy population, which makes it difficult to find value in the space. Ur-

ban economics acknowledges that space such as the areas between houses and public spaces like parks are valuable; thus, it is important that the 2020 development plan establish more space to increase overall individual utility. With the expansion of these new cities, the increase in metro lines will help mitigate congestion within the Puxi and Pudong areas. At first, denizens who live outside of the Inner Ring will bear high transportation and commuting costs to and from work. The addition of subway lines will ultimately change people's commuting patterns, and expansion of Shanghai will mitigate the effects of congestion in certain areas of the district; nevertheless, the increasing population will push boundaries of the city to maximum carrying capacity.

As China's international metropolis, Shanghai must meet the challenges associated with further urbanization such as sprawl. Growth of population will place unprecedented impacts on infrastructure. Present-day measures are taken to control congestion, such as congestion charges and auctioning license plates, but the current physical structure of Shanghai's transportation framework is limited. With great anticipation, urban planners are investigating solutions that identify how to develop a more sophisticated, integrated transportation system as Shanghai expands. It is true – the economic prosperity of Shanghai exists to promote China's provisional growth; however, the Red Dragon cannot sustain itself without the beating of its heart. As Shanghai shifts from a monocentric to polycentric city, it must take these factors into consideration.

Case of Beijing: Air Pollution

Smog blankets the city – a haze dense enough that it blots out the sun. Pollution is undoubtedly the first impression visitors form of China. The head of the dragon – Beijing – has struggled with air pollution for many years. The majority of Chinese cities today exhibit poor air quality, however, Beijing is the most prominent case. As the Chinese capital, Beijing has an innate responsibility not only to its city, but also to the country. The very air inhaled by city dwellers is the same air that is killing them. The main factors, such as coal consumption by industrial parks and vehicles, make the city almost unlivable. The effects of sprawl in present-day Beijing are a result of the very urbanization that is supposed to catapult China into the future as the world's leading economy. In order to eradicate the smog, the government will need to implement and enforce stricter regulations.

China's first priority to alleviate air pollution will be spearheaded by a reduction in coal consumption by mills and factories. The end-goal is to encourage those facilities to move towards using more environmentally-friendly resources (Stanway, 2014). But, as society sees in global news today, the world's conversations on the development of alternative resources like nuclear power and the use of compressed natural gas require global cooperation are contingent upon appeasing international demand. Industrial markets such as aluminum, lead, and steel would need to be minimized to foster the growth of alternative energy resources. Air pollution undeniably affects economic progression, but even more importantly, has implications on human welfare. Within Beijing, vehicle pollution, industrial land use and "Yellow Dust," make the city nearly uninhabitable during the winter and spring seasons (Herskovitz, 2014). Before any qualitative analysis can be discussed, it is important to identify the historical trail of Beijing's urban land use patterns.

Located in northern China, Beijing is governed as a municipality under the national government, with 14 urban and suburban districts and two rural countries. It is surrounded by Hebei Province and is relatively close to Tianjin to the southeast. It is second to Shanghai in population and is China's political and educational center (Bjstats.gov.cn, 2014). Historically, change in land use began in the late 1970s when the Chinese government became concerned with food security. Similar to Shenzhen regarding farmland depletion, the government tried to regulate policies in Beijing by implementing a multi-phase plan to regulate land conversion. These included urban master plans to protect farmland while also increasing construction of urban areas. Following the Open Door Policy, urbanization took off. During these phases, land was allocated efficiently, but was not moderated accordingly – farmland was zoned, but construction plans would take precedence. The transitions were dependent on the government's balance between promoting urbanization with farmland protection (Zhang, 2012), but this balance was not achieved and instead resulted in the costly sprawl in Beijing today.

Sprawl in Beijing can be attributed to expansion of its infrastructure system as a result of spatial growth. Of particular interest is its system of ring roads that support its spatial structure. The pragmatic growth of cities almost always at first follows predictions of the monocentric model. The interstate network in Beijing follows the same pattern. Within the first

inner ring is the Forbidden City, which is surrounded by the Imperial City. The second ring is commercial area and the third is residential area. The remaining rings push the boundaries of the city to new construction and industrial land use. Notably, the fifth ring is planned to link ten scattered districts and the sixth ring is designed to connect multiple satellite towns (Hornsby, 2008). The prolific growth of the city is causing it to unintentionally move towards being a polycentric metropolis (Figure 4).

As with Shenzhen and Shanghai, Beijing has developed plans that are expected to encourage growth and reduce the effects of sprawl. The causes of Beijing's pollution problems are clear. The state's emphasis on growth makes pollution of secondary importance. Water in China is not potable; over one hundred cities are seriously short of water. Within the six rings of interstate, the water table under Beijing has become so low that the city is actually sinking. Trees have been cut down to open land for industry, which means that China is not only losing land to desertification but also to industrialization. As a result, there are an estimated 178,000 people that die from respiratory diseases each year due to pollution. In fact, the total cost of air pollution is 8 to 10 percent of the gross domestic product. To put it differently, the costs associated with pollution may be as large or even exceed total economic growth. The pollution problem is compounded by its reliance on coal – the main source of harmful particulate matter – and this causes the majority of the population to live in a dangerously polluted milieu (Buoye, 2002).

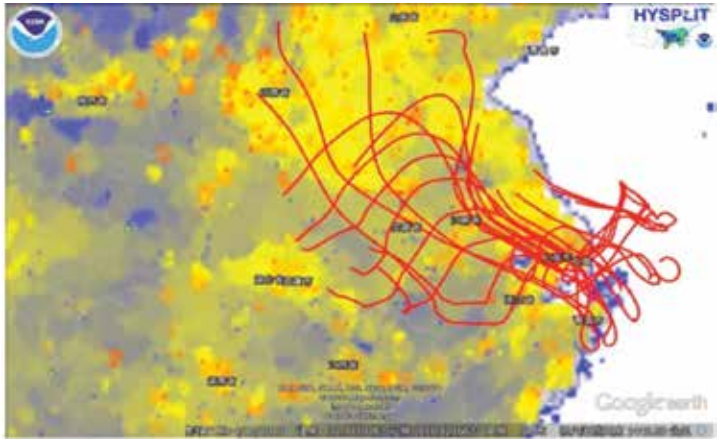
Figure 4. Beijing's Ring Road Network.

(Source: Kannaiyan, 2006)

The essence of Beijing's pollution problem involves both scale and growth. China is a global leader in carbon emissions. In terms of sulfur dioxide, Beijing's rate has already exceeded its environmental capacity, and is responsible for the acid rain that covers one-third of China's total land mass. According to Stephen Roach (2009), an economics professor at New York University, Beijing's problem is a part of China's macro system switching from pollution-intensive to more environmentally-friendly:

> The Chinese economy is heavily skewed toward exports and fixed investment. […] It is not sustainable from a macro point of view because it threatens to produce twin possibilities of a deflationary overhang of excess capacity and a protectionist backlash to open-ended exports. And it is not sustainable from an environmental point of view because the industrial-production-dominated growth model has a natural bias toward excessive carbon emissions.

With Beijing as China's political backbone, the city must move towards rebalancing these variables. In early 2013, Beijing witnessed unprecedented levels of PM – particulate matter – causing a public outcry to the government. On January 12th the Air Quality Index (AQI) reading was 755 – the charts nominally index a maximum reading of 500 (The Economist, 2014). The index is based on standards stated by the American Environmental Protection Agency (EPA). The AQI has a descriptive measurement from 'Good' to 'Hazardous'. An AQI score between 0 and 50 would classify as 'Good' while a score of 300+ would classify as 'Hazardous,' meaning that people may experience serious health effects (Aqicn.org, 2014). Industrial pollution, according to the Chinese Ministry of Health, has made cancer China's leading cause of death (Larsen, 2014), and factory mills and industrial areas in Beijing and Hebei Province contribute to this statistic. A 2013 geothermic land-satellite by the National Energy Administration reveals the wind patterns that carry pollution from coal-burning factories in northwest and northern China to cities such as Beijing and Shanghai (Figure 5).



(Source: HYSP landsat, 2013)

In addition to pollution from coal consumption and vehicle exhaust, Beijing and northern Asia witness a seasonal phenomenon known as "Yellow Dust" during winter and spring. Winds from Inner Mongolia and Kazakhstan kick up dry soil particulates from dust storms carrying them across northern Asia. They have even reached as far as Korea and Japan (Herskovitz, 2014). The scenario in Beijing is even more disconcerting because the dry soil particulates mix with pollutants from factory mills and industrial areas. The combination can cause serious health effects to those without proper breathing masks due to multiple toxins like sulfur and aluminum. Even though the natural phenomenon of yellow dust is difficult to protect against, its combination with China's already-polluted air poses an even greater risk to city dwellers.

If Beijing's pollution is to improve, the country of China must take measures to reduce its use of coal and natural resources for energy. Taking control of the pollution issue is not only a city issue, but must be addressed by the wider Chinese population. It is a rarity to see blue skies in Beijing or in other Chinese cities alone, but the government is showing encouraging signs that it is ready to tackle pollution.

Solutions

Forty percent of the 7 million people worldwide who died from air pollution in 2012 were from China (Bennett and Chen, 2014). Persistent air pollution has prompted the government and even entrepreneurs to take steps to identify solutions. For the national party and policymakers, this

means rethinking current economic models that rely upon heavy industry for a large percentage of gross domestic product. Recently, Beijing has either charged a maximum fine or shut down factories or power plants for their output of air pollution. This haunting statistic should drive Chinese officials to tighten environmental legislation. As Beijing continues to sprawl, the economic activity in the area will increase, but it should do so to sustain a steady-state subsystem similar to that of Shenzhen. Among the solutions are implementation of vehicle restrictions and placing standards on gasoline. Furthermore, a look at waste absorption capacity and a pollution tax might serve as potential solutions.

Of the myriad entrepreneur solutions, several have gained nationwide attention, including roof sprinkler systems (Kensley, 2014), wind tunnels (Meng, 2014), and electrostatic "vacuum cleaners" (Wan, 2014), all sharing the same objective — to remove smog particles from the air. From the air filters in people's homes to the facemasks worn on a daily commute, the number-one priority among city dwellers is personal safety. The government is committed to rectifying the issue; in fact, Beijing will allocate 760 million yuan (estimated 124.64 billion USD) to improve the city's air quality by 2017, says Mayor Wang Anshun (2014). Investment has gone into the creation of pressurized domes and will extend into the provision of cleaner factories. For example, the International School of Beijing has built a $5 million two-domed structure that encloses an outside recreational area where students can play (McKirdy, 2014). The pressurized dome is inspected multiple times during the day to ensure that particulate matter is absent. As CNN's Dayu Zhang (2014) commented, "Until the skies clear, life in the bubble seems surprisingly good."

Among other solutions is a pollution tax that the Beijing government would impose on mills or plants equal to the external cost it has on society. For O'Sullivan (2007), placing a buffer between a polluter and its potential victim is the easiest way to reduce exposure to pollution. However, the tax would need to be combined with a zoning measure. If not, the polluter would be free to migrate, increasing pollution in new areas. A combination of an industrial zone and a tax would reduce pollution to a socially optimal level to minimize exposure (O'Sullivan, 2007). According to O'Sullivan (2007), the tax would decrease pollution for two reasons: 1) the producer would decrease pollution as a means to avoid the pollution tax itself, and 2) the increase in the price of the product decreases total production. A tax would increase the relative attractiveness of the city, too,

because the air quality would improve.

Tradeable permits are another effective tool used by the Beijing government on heavy polluters. The permit takes a cap and trade approach not to impose a tax, which would reduce demand, but instead enforces a quota – a set amount of pollution that it will allow. The coal cap being imposed affects the entire country of China, not just Beijing. According to Greenpeace Asia, by the end of 2017, 12 of 34 provinces have included coal consumption targets in their master plans including Beijing. The majority of polluting plants are located in northern China, so the highest targets tend to be in those areas rather than in the Yangtze River Delta or the Pearl River Delta. These coal measures are predicted to result in a reduction in coal consumption by an estimated 350 million tonnes. Coal consumption has already dropped significantly compared to previous years (Table 2). As coal consumption has decreased, renewable energy like solar and wind capacity have both increased since 2012 (Li and Myllyvirta, 2014). These steps indicate fundamental changes in China's developmental models to curb air pollution.

Table 2. China's National Coal Consumption Growth Rate

Consumption Growth Rate	
Year	Coal Consumption Percentage
2003	19.20%
2004	17.50%
2005	10.60%
2006	10.80%
2007	5.60%
2008	3.70%
2009	7.40%
2010	9.50%
2011	9.40%
2012	2.80%
2013	2.60%
2014	3.01%

(Source: Li and Myllyvirta, 2014)

During the Asia-Pacific Economic Cooperation summit (APEC) held in November 2014 in Beijing, pollution control measures were implemented to dispel some of the smog. Blue skies were seen throughout Beijing, but the smog returned once the strict regulations were lifted. Officials were able to observationally validate that the restrictions imposed had worked; in fact, the government has stated that a more fundamental

approach will be taken to give Beijing permanent blue skies by the year 2030. Ten thousand plant operations in and around the city were stopped and an odd-even license plate scheme was implemented to reduce the number of vehicles on the road. However, these anti-pollution measures were deemed costly and not "sustainable," affecting 3 percent of the country's industrial output (Marin, 2014). Time spent in the next few months will allow the Beijing government to determine cost-effective ways to rid the city of smog.

Possibility is present – Beijing's smog problem is not irreversible. Clean air has multiple implications on daily life, the attractiveness of the city, and overall human welfare. New cases of respiratory illnesses will be reduced and those already diagnosed will have a chance at a healthier future. The future of Beijing and of China is contingent on the national party making daily life better as a result of clean, smog-free air.

Conclusion

The Red Dragon symbolizes the growth of China's East Coast through urbanization. Similar to a dragon, the head of China also relies on its heart and tail to survive. Chinese officials must recognize the undeniable interdependence of Shenzhen, Shanghai, and Beijing as they relate to the country's future. Shenzhen as China's first Special Economic Zone, Shanghai as China's international metropolis, and Beijing as China's political center, represent the urban venerability inspired by Mao Zedong to bring about economic prosperity. Understanding the undeniable interconnectedness of tier 1 cities like Shenzhen, Shanghai, and Beijing is pivotal to the country's future. More so, the state must learn from how these cities have grown and apply that knowledge to the expansion of tier 2 and tier 3 cities in the future. As cities emerge and continue to grow, what has been the normative mindset of the state will be challenged. It will challenge what it knows, what it has known, and what it can do. The consequentialist factors associated with low-dense, spatial growth along China's East Coast have perpetuated externalities that change how the state plans and builds its cities.

Each case represents a challenge of urban growth. With sprawl, we notice that the non-agricultural expansion of land makes the environment vulnerable. We are able to deduce that sprawl creates disharmony within cities bringing about congestion and challenging infrastructure systems. China's mindset for economic prosperity has been contingent on industrial

growth within cities which has created negative externalities such as smog congestion, and lack of green space. Planners, officials, and policymakers must be more forward-thinking to create more sustainable cities. Reconsidering industrialization as the single most important part of economic growth while working to create a steady-state subsystem to balance economic and ecological needs will create a more harmonious society. For the sake of the world, and itself, China must rebalance how it builds its cities: rather than rapid urbanization that spurred sprawl in the past, China's eye to the future should focus on sustainable urbanization that will carry it forward.

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