

Sustainable Urbanization

# Paulson City Assessment Tool: Changsha Pilot Project August 2014



Xiangjiang River, Changsha © Steve Webel

*In partnership with:*

China City Development Academy

China Center for International Economic Exchanges

*With support from:*

Energy Innovation

Energy Foundation



## **EXECUTIVE SUMMARY**

As part of its Sustainable Urbanization program, The Paulson Institute has designed the Paulson City Assessment Tool (PCAT) to assist Chinese Mayors and other municipal leaders in determining their sustainability priorities. We have partnered with the China City Development Academy (CCDA), under the Chinese Ministry of Housing and Urban Development, the China Center for International Economic Exchanges, Energy Innovation, and the Energy Foundation to create the categories and criteria most useful to municipal leaders in developing their cities. The Assessment Tool is designed to help mayors and municipal leaders glean meaningful insight into how their city is performing on key domestic and international sustainability and livability measures. Armed with this information, mayors and key stakeholders can better prioritize how time, resources and efforts are allocated for maximum efficiency when building Cities of the Future.

The tool ranks data collected against national and/or international criteria in categories of urbanization such as transportation, urban planning, clean water, clean air, and so on. The tool builds on one designed by McKinsey & Company and used by the Inter-American Development Bank in Latin America. It assesses the data against a simple but effective “stop light” methodology, which places metrics in the green category for meeting or exceeding standards; the yellow category for falling within a certain bandwidth that merits cause for additional monitoring; and, the red category for indicators that necessitate immediate attention. Based on the green, yellow or red result, a city leader can see at a glance the areas of priority focus.

We have piloted the Paulson City Assessment Tool in two rapidly urbanizing cities: Baoding in northeastern Hebei Province and Changsha, the capital of south-central Hunan Province. After several months of interviewing local officials, collecting data from relevant bureaus, and using publicly available information, our findings on Changsha are compiled in the following report. The Baoding findings are issued separately.

## About Changsha

The capital of Hunan province, Changsha is transforming from an underdeveloped interior city into a fast growing urban center. The city is a driver of growth not only in the province, but also for the Central China region where it leads the central region's six provincial capitals<sup>1</sup> in growth. Located in the middle of the Yangtze River Basin, Changsha has a population of about 3.7 million people residing in six central districts and three peripheral districts.<sup>2</sup> Given its strong economic growth, Changsha is urbanizing rapidly and attracting a significant migrant community in search of job opportunities. It's population is largely concentrated in the central districts where the urbanization rate is about 90 percent, with the Central Business District of Furong claims 100 percent population density. However, when comparing the density rates to the worlds' most populous cities, like Japan, it is clear that the Changsha city area has the capacity to further urbanize, particularly if the city's infrastructure, systems, and urban planning keep pace.



Changsha's large investment in urbanization has led to a beautiful urban landscape.

The Paulson Institute opted to pilot the City Assessment Tool in Changsha after being invited to hold our annual provincial sustainability seminar there in 2012. Then Mayor Zhang Jianfei, who has since been promoted to Vice Governor of Hunan, was progressive in his approach to sustainable urbanization in Changsha and agreed that the tool would be valuable for him and his team. During the seminar, Mayor Zhang talked about the urgent need for incorporating sustainability into the city planning as Changsha was expected to grow from 3.7 million to 8 million people in the next decade.

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<sup>1</sup> The six central provincial capitals include: Hefei, Zhengzhou, Wuhan, Nanchang, Changsha, and Taiyuan.

<sup>2</sup> Six central districts include: Furong, Tianxin, Yuelu, Kaifu, Yuhua and Wangcheng (recently promoted to a district in 2011, so urbanization lags behind the other five). Three peripheral: Changsha County, Ningxiang District, Liuyang City. (Liuyang City, although called city, has the same administrative level as county)

## Our Findings

Changsha is facing challenges common to rapidly urbanizing cities worldwide: traffic congestion, industrial inefficiencies and high-energy consumption. As a result, the Paulson Institute and CCDA have focused our analysis and recommendations on five key sectors: Urbanization, Transportation, Public Green Space, Energy Consumption and Water Consumption. Based on the results of the Assessment Tool, we found that:

- Rising steadily, Changsha’s urbanization rate is higher than Hunan’s average as well as the national average. There are large variations in urbanization rates between the districts, with higher levels in the central, more urban districts stemming from the immigration of migrant workers leaving the rural districts in search of job opportunities. As such, this metric fell into the yellow category as an area of concern. We recommend that Changsha continue to identify ways to protect and support migrant workers and their dependents, as this influx is not likely to slow. Additionally, we recommend that the municipal government work with the peripheral district to initiate an “edge development” plan as these areas are losing population to the city center leaving them without sufficient labor in the agricultural sector.
- In the transportation sector, there have been significant efforts to make the public transportation systems more environmentally friendly, but Changsha’s transportation system will need further attention to ensure that it keeps pace with the urbanization. The city is experiencing serious traffic congestion as a result of insufficient road area per capita and the rapid increase in private auto ownership. There is also work to do in providing adequate pedestrian paths.
- The amount of public green space, although slowly increasing in Changsha, falls well below the national average. Total density has increased slightly, but in per capita terms, the amount of space has fallen significantly. Green space fell into the red category for immediate consideration. An urban center’s green space has a strong correlation with economic and tourism development. To address this issue, we recommend that Changsha implement building practices that include green space and create transit systems that allow for more movement – such a bicycle paths and pedestrian walkways – off of the roadways.
- Changsha has made significant progress in overall energy conservation. Energy consumption per unit of GDP in Changsha in 2011 was down a remarkable 22.52 percent compared with the previous year. Among regional counterparts, Changsha had the lowest electricity consumption per capita but held the highest residential electricity consumption per capita, indicating the need for emphasis on reducing

residential electricity consumption.<sup>3</sup>

- In the water sector, Changsha benefits from rich water resources due to nearby lakes and three main rivers: Xiangjiang, Liuyanghe, and Laodaohu. The city has made development of a sophisticated sewage treatment system a top priority and it now ranks above the national average in sewage treatment. However, per capita water consumption remains high. The city should explore alternate means to promote better water conservation, such as overhauling the water supply network, introducing water saving fixtures, and launching a civic education campaign.



Changsha's natural resources and environmental landscape need to be protected during rapid urbanization.

We found that Changsha is on a good path for quality, sustainable growth. The leadership demonstrates a dedication to sustainable urbanization and has made considerable progress in key areas, but faces some critical challenges that will require difficult decisions and innovative approaches. We hope that the Paulson City Assessment Tool report will provide another useful framework for the Mayor and Changsha officials to refine their planning and take the city to the next level.

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<sup>3</sup> Note that electricity consumption per capita includes manufacturing, agriculture, service, and residential consumption. Residential consumption is the total residential electricity consumption over the total population.

## I. ABOUT THE PAULSON CITY ASSESSMENT TOOL

The PCAT is based on the Rapid Assessment Tool developed for the Inter-American Development Bank by McKinsey & Company. It has been adapted for use in Chinese cities, based on input from the Paulson Institute, the China City Development Association, the China Sustainable Cities Initiative of The Energy Foundation, Energy Innovation: Policy and Technology LLC, the China Association of Mayors, the China Center for International Economic Exchanges, Tsinghua University's Architecture School, several corporations including Honeywell, and other experts and practitioners.

The Tool utilizes a “stop light” classification system to categorize the results of the city data. After collecting data for each of the indicators, the information is then compared to national and international standards, including:

- The city's current stage of development;
- Industrial planning targets and standards;
- Chinese and international sustainable urbanization metrics; and,
- Chinese metrics for culturally advanced cities, livable cities, and water-saving cities.

Areas falling far from the norm are placed in a red, or serious, category. Those areas within a certain range—which differ for each indicator—are in a yellow, or warning, category. And, those falling into the green category either meet or exceed the international or national standards.

This tool also enables its users to identify trends as they emerge. In some instances, situations may not yet warrant a red flag or warning label, but are trending in that direction. With collection of the right data and careful analysis over time, the tool can indicate positive or negative trends.

In Changsha, our team spent several months studying urbanization rates, transportation systems, public green space area, and energy and water consumption. Our data collection methodology included conducting interviews and collecting statistics from Changsha's Bureau of Communications, Water Resources Bureau, and the electric company. We have included the relevant data from 2011 in Appendix I. After collection, data was then analyzed for trends and classified into the stop light system. Finally, we worked with Chinese and Western experts to develop a series of recommendations based on international and domestic best practices that have proven effective in meeting or exceeding the key metrics.

## II. CHANGSHA CITY OVERVIEW

The city of Changsha is located in the central-south region of China and is the capital of Hunan province. Changsha is part of the Changsha-Zhuzhou-Xiangtan (CZX) city cluster located in the middle of the Yangtze River Basin that covers a total of 11,800 square kilometers. The city government has jurisdiction over 1,910 square kilometers encompassing six districts: Furong, Tianxin, Yuelu, Kaifu, Yuhua and Wangcheng.



With a population of 3.7 million, Changsha accounts for 51 percent of Hunan’s total population. Changsha is expected to experience a significant population boom in the next decade when it is expected to grow to a city of eight million. By comparison, only about 10 cities in the United States exceed a population of one million.

The population density statistics in Changsha demonstrate the city’s capacity to urbanize. In the city overall, density rates are approximately 600 people per square kilometer, and 1,911 people per square kilometer in the city proper – the lowest among the six provincial capitals in Central China. The Furong Central Business District has the highest density – as to be expected – at 12,376 people per square kilometer growing at a rate of nearly 1 percent annually. While almost double the overall density of the city, the rate is still lower than that of downtown Tokyo, one of the most populous cities of the world, which has 13,063 people per square kilometer. For a large city with a solid transportation infrastructure, 12,000 people per square kilometer is on the low side.

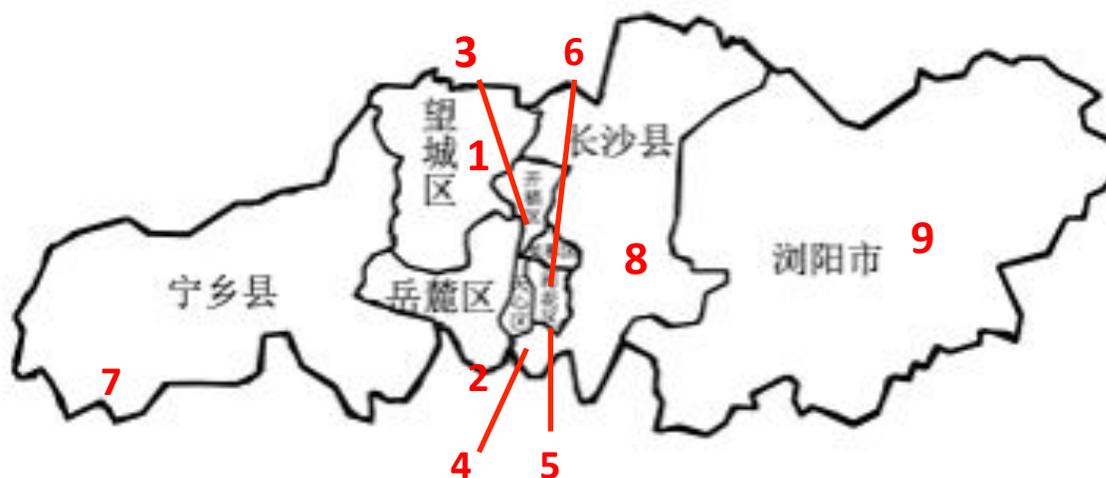
In terms of urbanization rates, Changsha has moved from the “rapid advancement” stage to the “stable” stage.<sup>4</sup> According to China’s urban development principles, 70 percent is the turning point from “rapid” to

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The urbanization rate is the percentage of the population living in urban areas: urban population (non-agricultural) / total population (non agricultural + agricultural).

“stable”. In 2011, the city’s urbanization rate reached 68.49 percent, an increase of 0.8 percent over the previous year. The urbanization rate of the central districts comes close to 90 percent, with the central business district of Furong reaching the “complete” stage at 100 percent. By comparison, China’s national average is 52.6 percent.

Urbanization Rates by County



1: Wangcheng 2: Yuelu 3: Kaifu 4: Tianxin 5: Yuhua 6: Furong 7: Ningxiang County 8: Changsha County 9: Liuyang City

Districts	Urbanization rate (%)
Furong District	100
Tianxin District	99.42
Yuelu District	84.37
Kaifu District	97.82
Yuhua District	99.03
Wangcheng District	47.57
Changsha County	51.92
Liuyang City	46.87
Ningxiang County	44.25

Much of the higher percentages in the central districts can be attributed to the influx of migrant workers into the city center where there are more job opportunities as a result of rapid economic growth. In fact, the “resident population” (those living in the city without legal registration) is far outpacing the “registered population” (those with a recognized *hukou* or a legal resident permit) in the central districts and counties, with the exception of the Wangcheng District, which was only recently upgraded from a county to a district in 2011 and has yet to match the development of the other central districts.

In the peripheral districts, the registered populations are still higher than the resident populations. For example, in Liuyang City and Ningxiang County both have 200,000 fewer resident inhabitants than registered. Yet we have seen a clear trend of outward population movement from the peripheral districts into the central districts. This has affected the agricultural sector, which is losing workers to the city center. Changsha will need to address bolstering the economy in the peripheral districts, or “edge development” as it is known, in order to keep people in these districts.

In terms of GDP, Changsha plays an important role driving growth in the region ranking second in overall GDP and first in per capita GDP among the six central provincial capitals. Further, the city has focused on quality growth, an issue important to President Xi Jinping who has promoted quality over quantity in the New-Style Urbanization Plan released earlier this year.

In 2011, Changsha’s GDP hit 562 billion RMB (US\$87 billion), an increase of an astounding 14 percent from the previous year, which put the city on par with Milwaukee, Wisconsin. The per capita GDP amounted to 79,244.64 RMB (US\$12,410) well above the average rate in China of US\$9,844. Changsha accounts for around 50 percent of Hunan’s provincial tax revenue, foreign trade, and business profits. Currently, the city ranks 18th in GDP and 27th in per capita GDP among Chinese municipalities, provincial capitals, and cities at the vice-provincial level. These rankings put them close to the median for all of China.



Changsha’s Meixi Lake International Cultural Center is not only a showcase of modern architecture, but also home to cultural spaces such as museums and concert halls, positioned to encourage pedestrian traffic.

The Changsha-Zhuzhou-Xiangtan (CZX) city cluster was recently recognized by the central government as a pilot region for resource-saving and environmentally conscious reforms. Changsha has been the leading force for environmental transformation in the region and has made remarkable progress both socially and economically. For example, in 2009 Changsha became the first city in China to prohibit free disposable toiletries, including toothpaste and toothbrushes, in hotels. This will save more than 2.4 million packages

and 10 million RMB (US \$1.6 million) per year. In 2011, Changsha issued the *Changsha Green Building Design Standards* and *Changsha Green Building Codes* and then initiated several successful pilot projects that have attracted 12.7 billion RMB (US \$2.1 billion) in investment over the last three years. As a result, one-third of Changsha's new buildings meet green building standards. *Changsha's 2012 Residential Energy Conservation Regulation Rules* made them the first in the country to propose that state-funded projects and large public constructions should implement at least one type of renewable energy and that new buildings under 12 floors must have a unified design and solar heat. In the same year, Changsha launched the "Green Subway" project, which aims to reduce subway energy consumption by 20 percent through better design and energy-saving technologies.

### III. DATA EVALUATION

Changsha is transforming from a smaller interior city into a fast growing urban center. Based on our analysis, the possible set of challenges Changsha may face includes greater traffic congestion, industrial inefficiencies and high-energy consumption stemming from rapid urbanization and industrialization. As a result, we focused on key sectors in which we anticipated these challenges: Urbanization, Transportation, Public Green Space, Energy Consumption and Water Consumption. The Paulson City Assessment Tool revealed the following trends:

#### Urbanization

Overall, Changsha had an urbanization rate of 68.49 percent in 2011, 23.39 percentage points higher than the province's average of 45.1 percent, and 17.22 percentage points higher than the national average of 52.6 percent. Changsha has the second highest urbanization rate among the six provincial capitals in Central China, and it falls in the upper 50th percentile among Chinese cities.



Changsha has recently broken ground to build the world's tallest skyscraper, Sky City, which will overtake Dubai's Burj Khalifa. Photo is an artist's rendering of the Sky City design, juxtaposed against the Chicago skyline.

As with many rapidly growing cities throughout China, there is an imbalance of population distribution among the districts. The central districts are around 90 percent urbanized (Furong District is at 100 percent). Migrant workers are concentrated in the central urban areas, leaving rural areas without sufficient labor for cultivation. Wangcheng District, Liuyang City and Ningxiang County – the three main agricultural areas – are below the national average. Because of the uneven rate and potential challenges related to incorporating a significant migrant population, currently about 500,000 people, we have placed the urbanization statistics in the yellow category as an area for further monitoring.

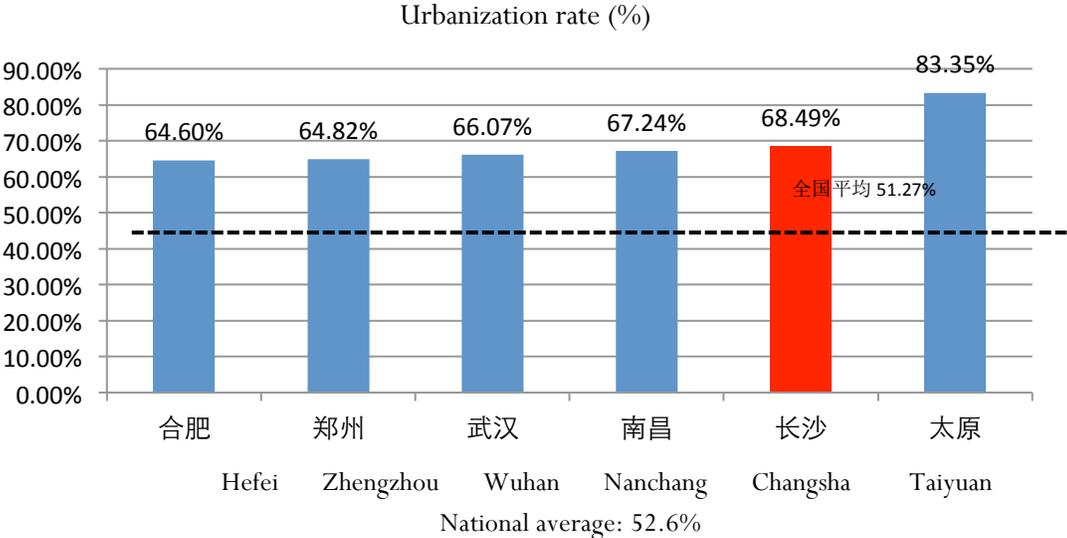


Fig. 1: Urbanization rate of the six provincial capitals in Central China

**Transportation**

While there have been significant efforts to make the public transportation systems more environmentally friendly, Changsha’s transportation system will need further attention to ensure that it keeps pace with the urbanization. The city is experiencing serious traffic congestion as a result of insufficient road area per capita and the rapid increase in private auto ownership. There is also work to do in providing adequate pedestrian paths.

Changsha had 2,173 kilometers of roads in 2011, ranking it second among the six central provincial capitals. Changsha has a total road area of 42.58 million square meters, of which only 8.46 million square meters (19.87 percent) are allocated to pedestrian paths. Zhengzhou, Hefei and Wuhan all have a higher percentage of pedestrian paths. The total mileage and road area of Changsha increased by 22.01 percent and 17.69 percent respectively compared with the previous year, while the pedestrian path area only increased by 0.36 percent. We have placed the road mileage and area statistics as well as the pedestrian path area in the yellow category for further attention.

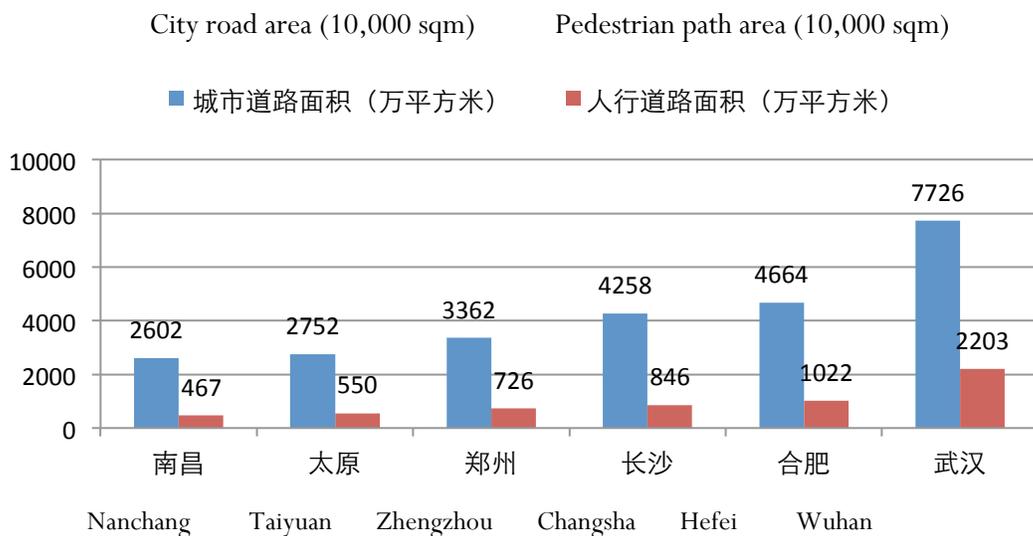


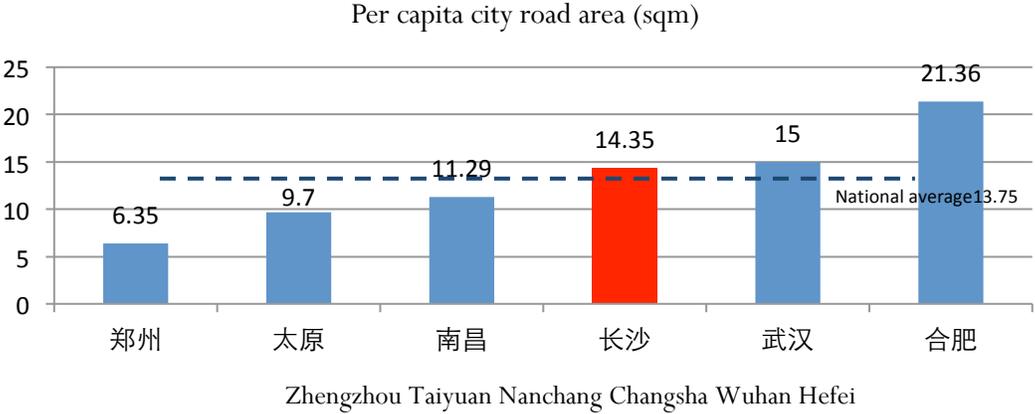
Fig. 2: Road area and pedestrian path area of the six provincial capitals in Central China

Changsha has a per capita road area of 14.35 square meters, slightly below the benchmark of 15 square meters set by the Scientific Assessment Standards of China for Livable Cities, yet slightly higher than the national average of 13.75 square meters. These statistics place Changsha third among the six central provincial capitals and in the middle among all Chinese cities. In 2011, the number dropped by 4.14 percentage points compared with the previous year, which places this metric in the red category as a trend that will need immediate attention. Cities with a low per capita road area are prone to traffic congestion.



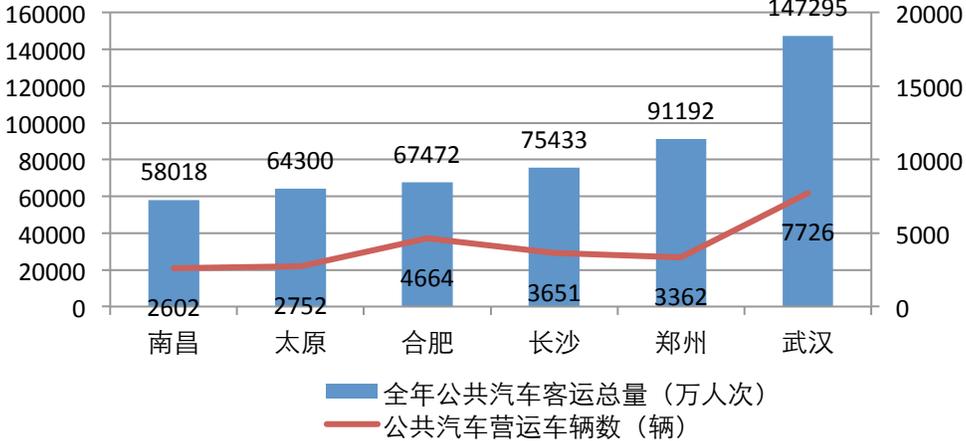
Despite an abundance of roads, Changsha suffers from heavy traffic and needs to encourage other transportation.

The road area statistics are further cause for concern when coupled with Changsha’s vehicle population. The number of vehicles has increased at an average annual rate of 20 percent over the past three years reaching one million vehicles in 2011 (marking a 25 percent increase over the previous year), which also places this metric in the red category. Drivers spend an average of one hour to travel five miles during rush hour traffic. However, the number of private cars per 1,000 people in Changsha is still lower than that of Taiyuan or Zhengzhou, indicating the likelihood of increasing motorization and more inter-city traffic. In order to facilitate inner-city travel, Changsha (especially the central districts with a high population density) should continue to improve public transportation systems.



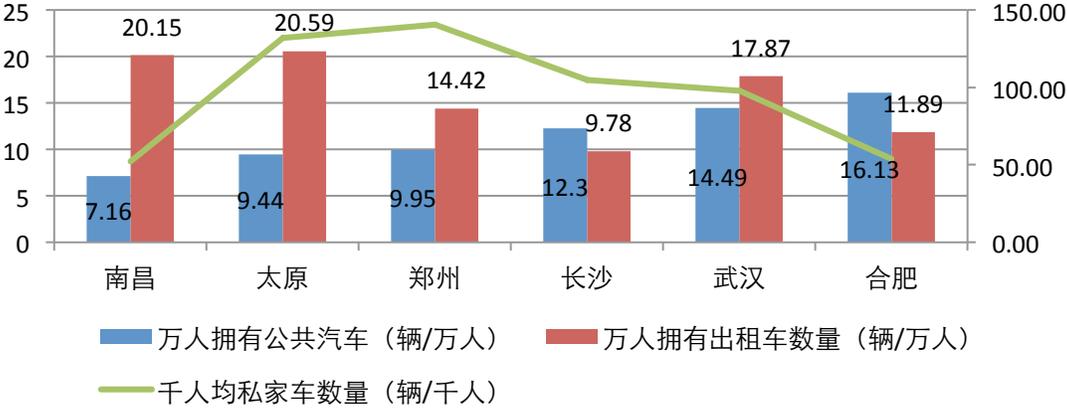
Zhengzhou Taiyuan Nanchang Changsha Wuhan Hefei  
 Fig. 3: Per capita road area of the 6 central provincial capitals

We also note stress on the bus system. A comparison between the annual number of passengers and the number of buses in operation suggests passengers per bus can be as high as 207,000 people per bus at times, which ranks Changsha below Hefei (145,000) and Wuhan (190,000). The yearly increase in passengers has outpaced the yearly increase in buses.



Nanchang Taiyuan Hefei Changsha Zhengzhou Wuhan  
 Total annual passenger throughput by bus (10,000 person times)  
 Number of buses in operation

Changsha has 12.3 buses per 10,000 people. While this number conforms to the benchmark of 12 set by the Scientific Assessment Standards of China for Livable Cities Category A, it represents a 16.38 percentage point drop from the previous year placing this statistic in the red category.



Nanchang    Taiyuan    Zhengzhou    Changsha    Wuhan    Hefei  
 Number of buses per 10,000 people  
 Number of taxis per 10,000 people  
 Number of private cars per 1,000 people

Fig. 5: Ownership of urban transit vehicles in the six central provincial capitals

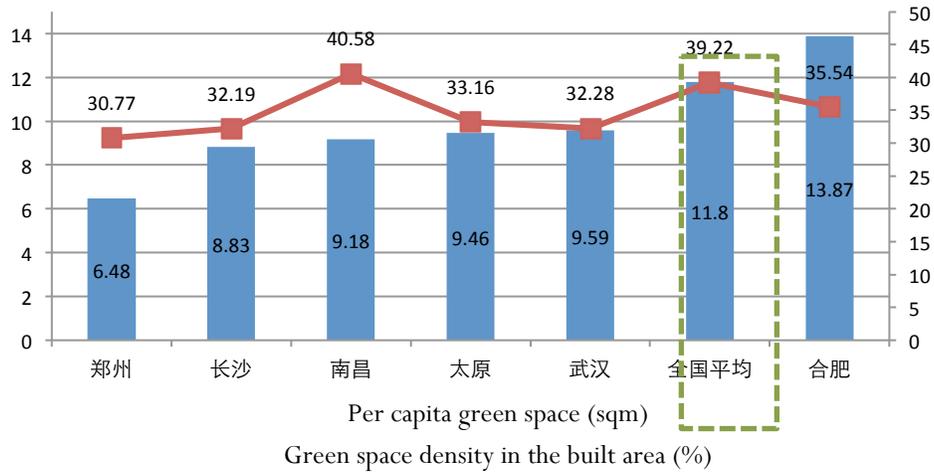
## Public Green Space

In 2011, the total density of green space in Changsha was 32.19 percent, marking a slight two percent increase over the previous year. However, in per capita terms, the green space fell 11.52 percent from the previous year to 8.83 square meters. On both counts, Changsha ranks second to last among the six central provincial capitals and falls well below the national average of 39.22 percent and 11.8 square meters respectively.



Changsha's public green space has increased due to introduction of projects such as Songya Hu, a man-made lake.

We have placed this metric in the red category for immediate attention. This decline is likely a result of annual increases in population density, most notably in the central districts and the development of these spaces. But, the loss of urban green space will result in a decline in the quality of life as well as exacerbating environmental problems if not addressed.



Zhengzhou Changsha Nanchang Taiyuan Wuhan Nt'l avg Hefei

Fig. 6: Urban green space in the six central provincial capitals

## Energy

In the area of energy consumption, Changsha has seen significant progress. In fact, we have placed all energy metrics in the green category. The only area we flag for improvement is in the residential usage category where their statistics are higher than their regional counterpart's. In 2011, energy consumption per unit of GDP was 0.65 tons standard coal per 10,000 RMB<sup>5</sup>, down a notable 22.52 percent from the previous year. Electricity consumption per unit of GDP was 383.1 kwh per 10,000 RMB, 19.18 percent less compared with the previous year and far below the national average of 1,364 kwh per 10,000 RMB. Changsha's energy consumption per unit of GDP is the lowest among the six central provincial capitals.

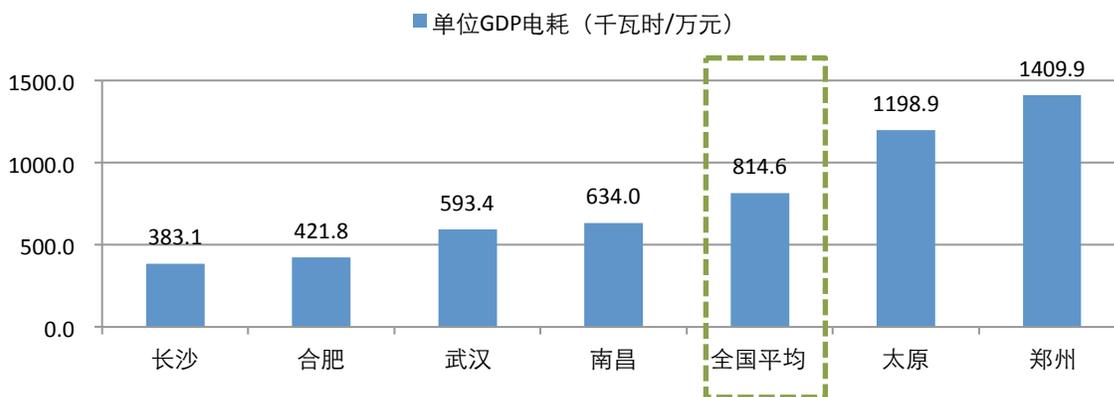


Fig. 7: Energy consumption per unit GDP in the six central provincial capitals

<sup>5</sup> Approximately US \$160.

Changsha’s annual electricity consumption per capita in 2011 was 3895.57 kwh, a decrease of 0.22 percent from the previous year. Annual residential electricity consumption per capita fell to 1406.97 kwh, a 1.23 percent decrease compared to the previous year. While Changsha’s electricity consumption per capita is the lowest among the six central provincial capitals, they have the highest residential electricity consumption per capita, suggesting that ongoing energy conservation efforts should place more focus on improving residential electricity conservation.

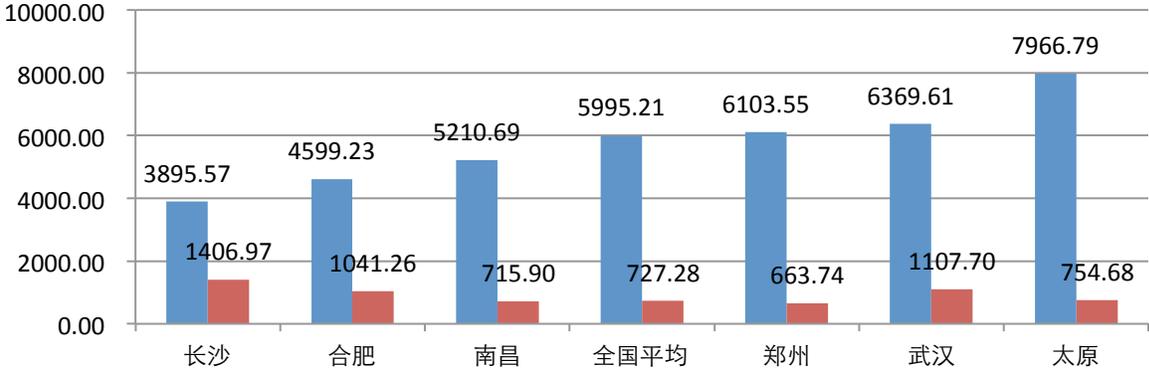


Fig. 8: Urban electricity consumption in six central provincial capitals

## Water

A city rich with water resources, Changsha has also made notable achievements in the water sector, particularly the development of a highly efficient sewage treatment system, which greatly reduces the environmental pollution caused by urban sewage. Changsha's domestic sewage treatment rate reached an impressive 94.35 percent, up 2.48 percent from the previous year. This statistic is far above the nation's 70 percent assessment standard for water-saving cities as well as the national average of 83.63 percent. Among the six provincial capitals, Changsha ranks second behind Zhengzhou. This metric is squarely in the green category.



Dumping of industrial waste has led to polluted rivers in Changsha.

Changsha's high rate of water consumption per capita, however, places it in the red category. The 2011 rate was 307.47 liters, down 15.59 percent from the previous year. This is a notable reduction, yet these rates remain far higher than the benchmark of 85 to 140 liters set by the Chinese Standards for Domestic Water Use by Urban Households.

## IV. RECOMMENDATIONS

The Paulson City Assessment Tool revealed that Changsha faces a current imbalance of population distribution with a higher concentration of migrant workers in the central urban area, leaving rural areas without sufficient labor for cultivation. We have flagged the transportation and public green spaces for immediate attention on several metrics. There have been significant efforts to green the public transit system, but capacity will need to increase to meet current and future demand. The city will also need to improve its livability by addressing the rapid reduction in green spaces. The PCAT further revealed

impressive water statistics, particularly for sewage treatment, and reasonable energy consumption overall but flagged high rates for residential electricity consumption. Based on these findings, the Paulson Institute and CCDA have developed a series of recommendations for the leadership of Changsha based on domestic and international practices that have proven effective.

## **Urbanization**

1. Focus on situation of migrant workers: As an economically and socially thriving city, Changsha will continue to face rapid influx of migrant workers. Already, there are about a half million migrant workers (in a city of 3.6 million) living primarily in the more urban central districts.

Changsha will need to consider how to develop the necessary infrastructure – and hukou reform – to support this growing population. There is a need for building affordable housing, concerns about “slum development” and to provide these workers --- and accompanying dependents – with adequate public services, including basic housing, social security, health, and schooling. These workers will need further assistance with assimilating into urban life.

We recommend both carefully tracking population growth for ongoing and future planning and conducting a public service needs survey for migrant workers. These assessments will help city leaders identify infrastructure and public service facilities needed to support this growing population.

2. Movement of migrant workers: With the exception of the central business district, the areas around Changsha are growing at a steady pace in the center but more slowly in the surrounding counties, which means that they still have additional capacity for population growth. Ideally, Changsha should aim for an annual increase in urbanization between 0.6-0.8 percent to avoid undue stress on current systems.

One of the biggest challenges of the movement of migrant workers is that the primarily agricultural based districts are left with the elderly population while the youth seeks job opportunities in urban areas. The three primary agricultural areas of the city – Wangcheng District, Liuyang City, and Ningxiang District – have experienced rapid development in agricultural modernization. But the modernization efforts have not been effective in retaining young workers which has created a capacity shortage in the agricultural sector.

Further, Chinese cities have used land sales as a major source of funding for the municipalities. Often is the valuable agricultural land on the near outskirts of the city, that are sold because of their appeal to developers in building industrial parks and needed residential housing for the influx of urban dwellers. This practice – leading to a decline in arable land -- has put severe pressure on the food supply in Changsha.

We recommend the municipal leaders continue to support these rural districts in their agricultural modernization and development, but also initiate programs that may support diversification of the peripheral or “edge” economies. It is important that they find ways to retain young workers in the

agricultural field, introduce means by which farmers can own their own land, and provide benefits – perhaps tax incentives – to encourage continued modernization and development of these rural districts. In addition, these areas will need better infrastructure and living facilities in order to retain the current population.

## **Transportation**

3. Improve transportation infrastructure and services: Changsha has seen rapid growth of private automobiles, yet the growth in public transportation and pedestrian paths has not kept pace. The number of public buses available in Changsha is about half that of Wuhan, a comparably sized city. Changsha should amp up the bus fleet and identify areas of the city for additional pedestrian and bike paths. In addition, Changsha has considered the introduction of more “green” public transportation. We highly recommend this step particularly as air quality is beginning to suffer from the increase in private auto ownership and the decline in green space.
4. Rationalize the public transportation system: The city will need to address gaps in the public transportation system and make several adjustments. One, the city should consider increasing the use of “green” public transportation means. Specifically, the public bicycle program should be expanded. Bicycle rental stations should be placed near bus stations and bus rapid transit (BRT) hubs to ensure that they are incorporated into the overall transportation plan and not just placed randomly about the city. There should be an effort to encourage pedestrian travel by increasing the number of pedestrian paths and giving precedence to pedestrians instead of automobiles.

## **Public Green Space**

5. Increase public green space: Changsha is falling behind the national average in per capita green space area and green space density. As the population grows in the central districts, per capita green space will continue to decrease due to urban encroachment. However, based on interviews conducted as part of our assessment, Changsha residents want to maintain urban green spaces, which they associate with a healthier and higher standard of living.

Increasing the city’s public spaces will require municipal leaders to regenerate parts of the city and increase the multifunctional design of buildings to create more public green space.

6. Build a transit system for pedestrians and cyclists: A comprehensive and conveniently designed non-motorized transit system not only encourages green transportation but also boosts a city’s tourism appeal with increased sightseeing, shopping and recreation options. For example, building a green pedestrian path along the Xiang River would provide residents and tourists alike with a commercial destination and a means of green transit. This is an area that attracts tourism in the city, but the high population density in this area makes it difficult for pedestrians to navigate the streets and cross the river. There is a combined commercial and sustainability opportunity here. And there are a lot more of these types of opportunities in the city of Changsha if the leadership will be creative in its planning.

7. Develop mixed-use neighborhoods and roadside commerce in residential communities: Mixed-use neighborhoods enable residents to do their shopping and errands without getting into their cars or taking public transportation. This greatly reduces traffic congestion and air pollution in a city.

Further, roadside commerce and outdoor markets, if planned properly, can enhance the character and livability of the city and promote interaction in the community. These markets also benefit the local agricultural community as most products are grown or produced locally.

## **Energy**

8. Promote residential electricity conservation: Changsha has the highest residential electricity consumption among the six provincial capitals that make up Central China. The city should consider embarking on a civic education campaign promoting electricity conservation and cultivating a sense of individual responsibility. They could also consider innovative pricing models for electricity as well that would deter wasteful use of energy.

## **Water**

9. Promote the use of water-saving methods: To reduce Changsha's rate of water consumption per capita, one recommendation is to strengthen public and residential water conservation facilities by implementing advanced water-saving fixtures, such as ceramic core water-saving faucets and dual-tank toilets. Changsha's regulators should be vigilant in setting high standards for these products and ensuring their installment and promoting their use. To ensure these products appeal to the general public, Changsha should ensure that they be easy to use, high quality, and water saving by controlling the appropriate level of volume and pressure.

In addition, the city should work with the local industry and agricultural leaders to introduce water saving methods in these industries. They are the largest users of water – as well as the largest source of water waste.

10. Increase the opportunities for water reclamation: Changsha is one of the leaders in its treatment of sewage, reaching not only the main city districts but also the surrounding areas. There are opportunities to promote water reclamation, however, in several aspects. Changsha's residential area waterways excelled in sewage treatment, but there is room for improvement in the construction of new residential area waterways, and promoting reuse of wastewater for landscaping.
11. Construct and maintain a quality water supply network: We highly recommend a concerted program to upgrade the water supply network in the city including: renovate water pipes, regular inspections for leakage, and rapid repair or replacement of unsound or old pipes.

Most cities in China suffer from leakage in their urban water supply network. On average about 15% of the water supply is lost to unsound pipes; far higher than the leakage rate of 3.3% in Japan and 7% in Europe.

The quality of the existing water supply infrastructure in Changsha's residential areas is highly uneven. Most of the old district water supply facilities are still being used even though updates are desperately needed. Pipe deterioration and damaged pipes are resulting in widespread water leakage which a major reason why the numbers are so high on Changsha's residential water usage. Changsha should install residential water meters and embark on a water pipe network renovation project as part of its overall infrastructure development program.

12. Promote water conservation through civic education: A low-cost and highly effective means of achieving measurable progress in residential water conservation is through civic education campaigns. Changsha could launch a campaign that includes establishing a community-based water conservation network, setting up free water-saving hotlines, and educating families on the importance of water conservation through advertisements and public service announcements.

# APPENDIX I

## DATA SUMMARY

The following is a summary of the data collected, our findings and recommendations. The numbers shaded in green suggest particularly encouraging data. Those in yellow denote there are potential causes for concern and those in red show a trend that requires immediate attention.

Categories	Indicator category	2010	2011	Change
Urbanization	Registered city population (10,000 persons)	650.12	656.62	0.99%
	Permanent city population (10,000 persons)	704.07	709.07	0.71%
	Population density of Furong District (persons/sqkm)	12277	12,376	0.81%
	Changsha's urbanization rate (%)	67.69	68.49	1.18%
	Urbanization rate of Furong District (%)	100	100	0
Transportation	Urban road mileage (km)	1781	2173	22.01%
	Road area (10,000 sqm)	3618	4258	17.69%
	Pedestrian path area (10,000 sqm)	843	846	0.36%
	Road area per capita (sqm)	14.97	14.35	-4.14%
	Annual bus throughput (10,000 person times)	101,303	106,159	4.79%
	Number of buses (gas/electricity) in actual operation at year end	3557	3,651	2.64%
	Buses per 10,000 people (number/10,000 persons)	14.71	12.3	-16.38%

	Taxies per 10,000 people (number/10,000 persons)	9.66	9.78	1.24%
	Private cars per 1,000 people (number/1,000 persons)	84	105	25.00%
Green Space	Green space as a share of built area (%)	31.57	32.19	1.96%
	Green space per capita (sqm)	9.98	8.83	-11.52%
Energy	Energy consumption per unit of GDP (standard coal/10,000 RMB)	0.826	0.64	-22.52%
	Electricity consumption per unit of GDP (kwh/10,000 RMB)	474	383.1	-19.18%
	Annual Electricity Consumption per capita (kwh/person)	3904.31	3895.57	-0.22%
	Annual Residential Electricity Consumption per capita (kwh/person)	1424.45	1406.97	-1.23%
Water	Daily water consumption per capita (liter/person/day)	364.24	307.47	-15.59%
	Sewage Treatment Rate (%)	92.07	94.35	2.48%

## APPENDIX II

# ORGANIZATION BACKGROUNDS

### **About The Paulson Institute**

The Paulson Institute is an independent, non-partisan center located at the University of Chicago. Our work is grounded in the principle that today's most pressing economic and environmental challenges can be solved only if the United States and China work in complementary ways.

With offices in the United States and China, and partners around the globe, we take a “think and do” approach. Our mission is to advance global environmental protection and sustainable economic growth in the United States and China, while fostering broader understanding between the two countries.

The Institute was founded in 2011 by Henry M. Paulson, Jr., the 74th Secretary of the Treasury and former chief executive of Goldman Sachs, to promote economic growth and environmental preservation in both countries through programs, advocacy and research.

### **About the China City Development Association**

China City Development Academy (CCDA) is a research and consulting institute focusing on China's urban development and urban-rural planning. Founded by the Chinese Ministry of Housing and Urban-Rural Development (MOHURD), it is one of the council members of China Center for International Economic Exchanges (CCIEE), a government think tank under the National Development and Reform Commission (NDRC). Supervised by MOHURD and NDRC, CCDA holds many qualifications, including Grade-A status for urban planning and tourism planning.