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# Big Data for New Industrialization and Urbanization Development: A Case Study in Chinese Cities

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**ABSTRACT**
Industrialization and urbanization are considered as interdependent processes of recent economic development. Innovations in technology and higher affordability of electronic devices have facilitated current age of big data. Use of digital data provided modern urbanization which is an essential element of industrialization and rapid income growth globally. Most manufacturing and service production is efficient when undertaken in urbanized areas where organizations can readily follow best practice in technology and management. Over the past three decades, China has achieved enormous economic growth, accompanied by a growing number of large cities. The purpose of this paper is to identify prominent issues relating influence of big data on modern industrialization and urbanization development in China as well as in other regions. The case study of China was taken to understand the advancement of big data on industrialization and urbanization enhancement. It was investigated that industrialization and the rise of the service sector appear to have influenced the growth of urbanization, but their role was relatively small when compared to the direct effects of economic growth. In the coming years, urbanization will become increasingly an opportunity as well as a challenge to the country's effort to sustain rapid growth and maintain effective development.

***Keywords*:** Industrialization, urbanization, big data, China

## I. INTRODUCTION

Digital devices have provided the industrial revolution of datacharacterized byan increment in the quantity and diversity of digital data resulting from thegrowing role of technology. Big data for development is to turning imperfect, complex, often unstructured data into actionable information.Industry is an important tool for technology enhancement and innovation.Study shows that manufacturing is the sector in which most research and development investment is undertaken. It is recognized that this type of investment has positive influence onproduction and contributing significantly to productivity growth fueling overall economic growth (Lavopa & Szirmai, 2012). It should be ensured to provide an environment-friendly and comfortable environment for residents in the city in the digital era, so that the city will have sustainable development. Furthermore, we should promote the construction of smart city to create a more intelligentization city. Such smart city will facilitate effective solutions every kind of issues arisen from traffic jam, population expansion and the processes of industrialization and urbanization. The acceleration of smart city construction and the development of big data industry are balancing.

Besides making industrialization inclusive, there is a need to respond to environmental concerns by increasingresource efficiency in production. For most industries the latter has also become a core determinant of economiccompetitiveness and sustainable growth. Since resource inputs represent an important cost of production forindustries, efficiency improvements can be asignificant lever for competitive advantage (SERI, 2009). The UN report suggests as one of the indicative goals tocreate jobs, sustainable livelihoods and equitable Growth (UNHLP, 2013). A quantum rise ininclusive and sustained economic growth is necessary to create employment, mainly for the youth, and reducepoverty.Economic growth can allocate individuals to collect the benefits that markets and entrepreneurs provide and to improve on their self-esteem. One of the measurement tools of urbanization is migration from rural to urban areas. There are two ways in which migration is measured. One is by household registration (or the *hukou* system in Chinese) whereby a rural migrant attains the urban status when he or she has gone through a legal process of having acquired an urban registration status (Huang, 2010). The correlation is so strong that urbanization is frequently used as aalternative for income across space and over time (Dittmar, 2011). In addition, there is a worthy circle between economic development and urbanization (Henderson, 2010; Duranton, 2013). As countries develop, people move out of the rural-based agricultural sector into the urban-based manufacturing and services sectors (Michaels, Rauch and Redding, 2012). While many developing countries have followed the typical

pattern of industrialization and urbanization, thereby achieving convergence in manufacturing (Rodrik, 2013), a different process seems to be taking place in a number of developing nations.

The purpose of this paper is to discover prominent issues relating influence of big data on modern industrialization and urbanization development in China as well as in other countries. The case study of China was taken to understand the advancement of big data on industrialization and urbanization enhancement. Regarding urbanization and income growth Bloom et al. (2008) pointed out that, "the economics literature is replete with references to urbanization as a natural concomitant of modernization and industrialization". Urbanization process itself, not just being urban, is often said to influence the efficiency of economic growth as well as the income distribution of a country (Henderson, 2003). The two usual channels associated with the positive economic contributions by urbanization are external scale economies and knowledge overflow. Scale economies can be achieved because urban centers are more efficient in job creation due to industrialization (Yuki, 2007). Provided the presence of non-agricultural activities in the rural economy, an unrestricted rural-to-urban migration may lead to a compression of the average income of both rural and urban dwellers (Fan and Stark, 2008).

## II. BIG DATA FOR DEVELOPMENT

Working with new data sources brings about a number of challenges. The significance and severity of those challenges will vary depending on the type of analysis being conducted, and on the type of decisions that the data might eventually inform. The interpretation of data is at the core of any research and evidence-based policymaking, but there is a general perception that new digital data sources poses specific, more acute challenges. It is thus essential that these concerns be spelled out in a fully transparent manner (Lavopa & Szirmai, 2012). The challenges are intertwined and difficult to consider in isolation, but for the sake of clarity, they can be split into three distinct categories: (1) getting the picture right, i.e. summarizing the data (2) interpreting, or making sense of the data through inferences, and (3) defining and detecting anomalies.Big Data for Development sources generally share some or all of these features:

(1) **Digitally generated:** The data are created digitally and can be stored using a series of ones and zeros, and thus can be manipulated by computers.

(2) **Passively produced:** A by product of our daily lives or interaction with digital services

(3) **Automatically collected:** There is a system in place that extracts and stores the relevant data as it is generated

(4) **Geographically or temporally trackable:** Mobile phone location data or call duration time.

(5) **Continuously analyzed:** The information is relevant to human well-being and development and can be analyzed in real-time.

Human behavior that can support the field of global development in three main ways:

1) **Early warning:** Early detection of anomalies in how populations use digital devices and services can enable faster response in times of crisis

2) **Real-time awareness:** Big Data can paint a fine-grained and current representation of reality which can inform the design and targeting of programs and policies

**3) Real-time feedback:** The ability to monitor a population in real time makes it possible to understand where policies and programs are failing and make the necessary adjustments.

The examples and arguments presented so far have all underscored the importance of contextualization in two corresponding ways.

1) Data context: Indicators should not be interpreted in isolation. If one is concerned with anomaly detection, it is not so much the occurrence of one seemingly unusual fact or trend that should be concerning, but that of two, three or more.

2) Cultural context: Knowing what is "normal" in a country or regional context is prerequisite for recognizing anomalies. Cultural practices vary widely the world over and these differences extend to the digital world. There is a deeply ethnographic dimension in using big data. Different people use services in different ways, and have different norms about how they communicate publicly about their lives.

The enticement to locate any correlations in big datasets must be kept in check to avoid misinterpretations and abuses, but there are many cases where correlations are relevant. In some cases, new data sources may reflect official statistics, offering cheaper and faster tools. Researchers have been estimating inflation by collecting and analyzing the daily price of goods sold or advertised on the webwith remarkable accuracy (Duranton, 2013). The key value-add of this method is that online prices can be obtained daily whilst consumer price indices in most countries are only published on a monthly basis. Thus, this approach may help detect inflation rate sooner than traditional methods, or offer new insights into the transmission of price fluctuations to various goods and areas. In addition, it is not just the size and speed but also the nature, the richnessof the information that many new data has great value. Fig. 1 shows the dynamics of the data

ecosystems. In many cases big data for development is not meant to replace or act as a substitute for official statistics, but to complement them by adding depth and degree.

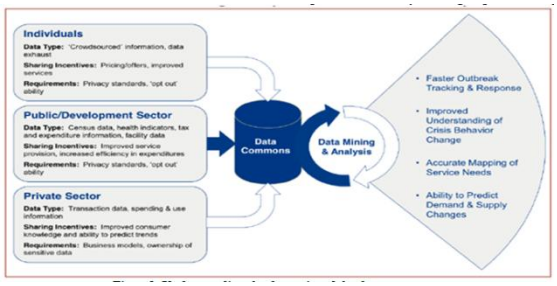


**Figure1. Understanding the dynamics of the data ecosystem.**

(Source: http://www3.weforum.org/docs/WEF_TC_MFS_BigDataBigImpact_Briefing_2012.pdf)

## III. EFFECTS OF INDUSTRIALIZATION AND URBANIZATION DEVELOPMENT: CHINA CASE

China is the most populated country in the world with slightly more than half of the population is stillliving in rural areas. Rapid urbanization and industrialization have significantly changed the land use and land cover pattern in rural areas, particularly those around the big cities in eastern China. Shandong Peninsula, a traditional agriculture area, also has witnessed rapid urbanization and industrialization and it has been undergoing rapid urbanization and industrialization for the past couple of decades. Urbanization percent had increased from 35.4% in 1990 to 50% in 2001 (Xu et al., 2009). Analysis of land use and land cover change in this area, particularly the change of agricultural lands, would assist better understand the interaction between Chinese government's policies and farmers economic interest (Qingshui et al., 2011). Chongqing municipal government endeavors to develop the big data industry and carry forward the construction of smart city. The people may have rich experience,and will benefit from big data. When China begins to develop in a 'modern' state, the construction of smart city will facilitate internationalization development, drive transformation of development mode and promote the adjustment of economic structure. Moreover, it deeply impacts and changes the production method and life style of people, leading to more scientific development, effective management, harmonious society and comfortable life of the city. Based on such an understanding, Chongqing lays an emphasis on the deep integration of big data processing with inland opening-up, industrial upgrading, urban management and services that benefit people, and conducts an active survey on the construction of smart city.

In the meantime, Chongqing is constructing application platforms for government affairs, people benefited information, credit system and social governance, which are connected to information isolated island to recognize resource sharing. A complete institutional rules and regulations will be established related to informatization, to understand the sharing of basic data, independent industrial management and controllable information security. In this connection, China has been witnessing rapid urbanization since the adoptionof economic reform and the open-door policy in 1978. In thepast 20 years, the number of small cities in China has increasedmore than 6 times, from about 3000 to 19,216. There are another 50,000 towns currently under development (Lu and Campbell, 2009). From 1980 to 2006, urban population percent had increasedfrom 20.6% to 43.9% (Chen et al., 2009). Gross domestic production (GDP) has also increased at an annual growth rate of 9.6%during this period, which is much higher than the world's averageof 3.3% (Hubacek et al., 2009). China ranks as the world'ssecond largest economy in terms of purchasing power parity in2010. Significant changes have taken placed in agricultural land use inChina due to urbanization and industrialization (State StatisticalBureau, 1978–2008). Nevertheless, most current studies mainly focuson land use and land cover change (Doygun et al., 2008; Yin et al.,2010). Change in the agricultural land use and interaction between government polices and farmer's economic interests were rarelydiscussed.

Ensuring sustained, inclusive and sustainable growth through industrial structural transformation requiresinvestments in economic and other infrastructureas follows:

- Information and communication infrastructure, including broadband infrastructure- the informationsuperhighways on which the global digital economy is being built
- Energy and piped gas, piped water supply, sanitation and sewerage, and solid waste collection and disposal
- Roads and major dam and canal works for irrigation and drainage
- Other transport sectors-urban and interurban railways, bus rapid transit and other urban transport, ports andwater ways, and air transport
- Infrastructure for health care, education and skills development, etc.

**3.1 Rapid Urbanization and Industrialization in China**

Urban areain China significantly expanded from 37,469 ha in 1978 to 176,257 ha in2006. The annual rate of change is 3.6% between 1978 and 1999and markedly boosts up to 27% in the period from 1999 and 2006.This period also witnessed a rapid GDP increase, from ¥ 0.7 billionin 1978 to ¥ 6.9 billion in 2006. The development of industrialization, and urbanization increased the rigid demand of grain. The reduction of arable land, the lack of water resources and other reasons impacts the food production. Ceng (2012) believe that industrialization promotes urbanization, and it increases the industrial use of grain. The industrialization level of China has been leading up the level of urbanization, and agricultural modernization. But with the development of industrialization, the balanced development between industrialization and agricultural modernization strongly becomes the focus of concern. A number of studies on Chinese urbanization process have examined the size distribution of cities, growth city population, and growth in city numbers (Henderson and Wang 2007).The general judgment on Chinese urbanization by economists is quite positive. A number of empirical studies find a strong association between GDP growth and urban spatial expansion (Deng et al. 2008; Ho and Lin 2004). A natural topic is the effect of urbanization on land values. Urbanization was found to improve the value of urban land and the budgetary strength of the local governments (Lichtenberg and Ding 2009). It is common knowledge among China academics that the Chinese urbanization process has a set of very unique features. Canning et al. (2008) observed "a person can become 'urbanized' while standing still." The *hukou* system is highly discriminatory against rural *hukou* holders. Naughton (2007, p. 129) compares Chinese rural migrants to undocumented Mexican migrants working in the United States.

While the central government has since 1994 reclaimed a substantial share of the tax revenues generated and consequently all industrial enterprises regardless of ownership, local governments have been assigned the exclusive right over an increasingly important tax category, viz. the business tax. This tax has been a driving force in China's urbanization process,as nearly half of these revenues are generated from the construction and real estate sectors. Furthermore, since urbanization helps spur local GDP growth, it also enhances the career prospects of local officials (Xu, 2009). In sharp contrast to all other formerly centralized economies where specialization and monopoly is an outstanding feature, China had never organized its economy in a highly centralized manner even in its primedays as a command economy (Naughton, 2007).

Decentralization does not always create strong incentives to regional officials for regional economic growth, hence the intriguing question is what makes China differentin providing strong incentives to regional officials for economic development, and is there empirical evidence to bear upon the effectiveness of a decentralized regional economic operations nested within a hierarchy of centralized control. The benefit of pursuing an urbanization strategy is by no means confined to being the sole residual claimant of the business tax. By converting farmland for a variety of development projects local governments are able to both collect fees (*fei*) associated with land conversion and, even more lucratively entitle to a land conversion income (*tudi churang jin*) an income stream over which it has been assigned exclusive rights by the central government.

**3.2 Variations in Agricultural Structure**

The area of barren land decreasedin China from 1978 to 1999. The most possible reason is that during thisperiod some farmers converted barren lands into agriculturallands to increase agricultural production. By contrast, barren landincreased from 1999 to 2006 primarily because some arable landswere abandoned. Most of these new barren lands are found on theperiphery of urban areas. Obviously most of them were confiscatedby government to meet the increasing demands for more built-upland due to the urbanization and industrialization.Urbanization and industrialization in China was still at a relativelylow level from 1978 to 1999. Maintaining and improvinggrain production was the prior task for the government. Chinesecentral government issued many polices to insure high enoughgrain production to meet the increasing demands. China's industrialization, urbanization, and agricultural modernization process has a certain impact on food security, based on the empirical analysis of the correlation of the industrialization, urbanization and agricultural modernization (Li and Zeng, 2014). It is considered that the industrialization and agricultural modernization has a positive effect on improving the level of food security, while the urbanization does the conflicting.

**3.3 Scientific Development of Urbanization**

China's urbanization has been increasing rapidly. Development of urbanization influences food security. However urbanization is unavoidable. China has a large population, especially the rural population. Urbanization will

still maintain a certain growth rate. Promoting scientific development of urbanization and reducing the threat of urbanization on food security is the problems to be solved. Initially, make scientific plans to strictly protect arable land. People must strengthen land using, improve land utilization levels and protect arable land. Further, reinforce the construction of small towns. It can attract urban rural reflux to raise the level of employment, income and living standard in small towns. The increased gap between urban and rural income levels is the root cause of the rural population to urban inflow. Guiding the population back hand can protect agricultural population and alleviate the pressure of urban sustainability. Besides this, improve the social security system in rural areas, so that rural and urban can both enjoy the same social security. Guarantee the basic livelihood of the rural so that farmers can grow grain without pressure. This study follows Au and Henderson (2006) and takes as given that the Chinese urbanization process occurred under two prominent institutional conditions. One is the persistence of the *hukou* system and the other is the government ownership of all the land assets.

There are two questions that motivate this study. First, whether urbanization has not just benefited the fiscal position of the local governments as documented by Lichtenberg and Ding (2009) but also the financial conditions of the average Chinese households (either of rural migrants or *hukou* residents). The findings show that the *hukou* urbanization has actually a negative effect on urban household income growth or its level. This would be consistent with the view that urban *hukou* embodies a substantial rent and thus a relaxation of the *hukou* system would have the influence of dissipating some of this rent. This may be the reason why the Chinese urbanization has not been substantially about relaxing the *hukou* barriers. This is a clue that the *hukou* urbanization, as imperfect as it is, may move in a directionally similar fashion as the rural labor migration.

The Chinese government needs to address the twin problems of protecting farmers' property rights as well as halting the unabated loss of arable land in its reforms ahead. Lucrative revenues have to be set against the exceedingly low costs of land conversion incurred by regional governments. For instance, Zhou (2007) finds that compensations incurred by a county government in Zhejiang Province accounted for an extremely tiny fraction, 1.59%, of the selling price.

### 3.4Distinguishing Features of China's Urbanization

Several typical features of China's urbanization, compared to other countries, help reveal the key urban policy issues facing the country in the coming decade.

**Large and Growing Urban-Rural Income Gap:** Through the *hukou* system and other policies, China has maintained a strict separation of the urban and rural sectors, making rural-urban labor mobility more difficult than in other countries. The strict separation of the urban and rural sectors has made income inequality in China the highest in Asia today.

**Too Many Cities, Too Few People:** In the 1990's, China's urbanization was highly contained within regions and provinces, with relatively little long-distance migration compared to other large countries such as Brazil and the USA. Half of China's increased urbanization simply involved the reclassification of rural areas as cities. Most cities in China have too low populations to properly exploit the scale benefits of clustering local economic activity, thereby limiting urban productivity gains and economic growth.

**Economic Structure of Cities:** Compounding the problem of under-sized cities is insufficient concentration and specialization of individual industries in cities. This configuration is inherited from the central planning era which favored the production of a wide range of manufactured products in most cities, often at an inadequately small scale.

**Comparative Rate of Urbanization:** Urbanization in terms of both the physical expansion of cities and the growth of population living in them has been an important feature of China's remarkable economic transformation (Fig. 2). China's urbanization over the last 20 years is unprecedented in complete magnitudes of people involved. Still, China's annual rate of urban population growth, at about 3.5 % per year is well below the 5-6% rates typically experienced by other developing countries during their periods of rapid economic growth. Fig. 3 shows urban-rural differences by regional degree of urbanization in China.

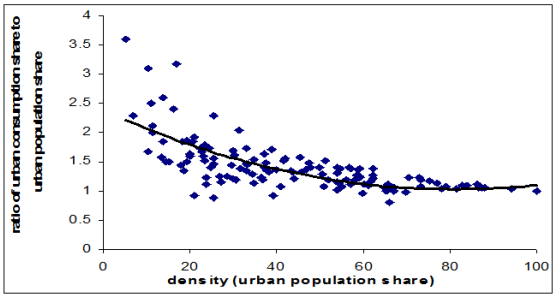


**Figure 2.Urban-rural inequality by degree of urbanization.WDR (World Bank, 2013)**

**Philippines, 2000 China 1999 & 2006 India, 1983 & 1994**

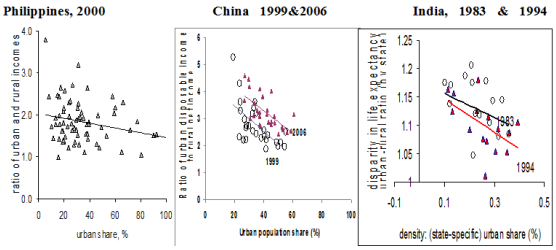


**Figure 3. Within country urban-rural differences by regional degree of urbanization,WDR (World Bank, 2012)**

Fig. 4 presents that capital allocations remain hugely slanted towards cities at the top of the urban hierarchy. This is not direct evidence of costly discrimination as it is not identified the rates of return on such investments but the magnitudes of the various differentials are reminiscent.

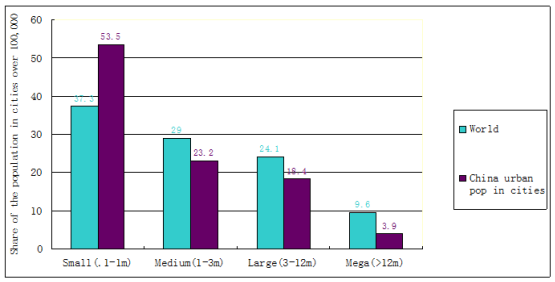


**Figure 4. Share in urban population of each city size category: World vs. China, 2000**

From the last column of Table 2, smaller cities are much more heavily industrialized and industry is much more capital intensive than services. The rate of return to capital in the tertiary sector in China is low compared to the industrial and agricultural sectors. Bai et al. (2006) calculate that the return to investment in the tertiary sector is a 1/3 to ½ that in the other two sectors. Table 2 indicates that capital investment in provincial levels cities is 5-fold that in county cities and double that in other prefecture level cities. The overall spread for FDI is less, but the gap between provincial level cities and others is very large. The favouritism of provincial level cities may be a little over-stated since the per capita numbers are based on the *hukou* population. But the exclusion of migrants applies to all cities, and it isn't clear how the relative shortfalls in total population differ across the urban hierarchy (Table 3).

**Table 3. Where capital investment goes (Source: Urban Year Books (China: Data Online)**

| | **Total FDI (US$) per capita (*hukou* population): 2002-2007** | **Total investment in fixed assets (¥) per capita: 2002-2007** | **Share of second sector in GDP 2007** |
|---|---|---|---|
| **Provincial level cities (4)** | 3850 | 122,500 | 42% |
| **Provincial capital (26)** | 2060 | 98,900 | 44% |
| **Other prefecture level cities (238)** | 1570 | 64,000 | 56% |
| **County-level cities (367)** | 980 | 24, 400 | 54% |

Numbers for prefecture and above level cities are for urban districts.

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**Table 4 indicates arriving at good growth numbers is difficult. The entire province can be losing population while urban areas grow at high rates and official numbers from the UN cover the reality. Because of favouritism, a few urban areas in China now may face the prospect of over-population.**

**Table 4. Urban Growth in China based on 2000 and 2005 Census**

| | Total pop. [cities and towns] 2005 millions | Annual growth rate ('00-'05) | Migrant pop. Out- [in] side province 2005 millions | Annual migrant growth (outside) ('00-'05) | Annual UN city growth rate ('00-'05) | Annual pop growth, cities and towns ('00-'05) |
|---|---|---|---|---|---|---|
| Beijing | 15.3 [12.8] | 2.5% | 3.4 [2.3] | 6.6% | 1.9% | 4.1% |
| Shanghai | 17.7 [15.8] | 1.6% | 4.6 [2.4] | 8.1% | 1.8% | 1.7% |
| Chongqing | 27.8 [12.7] | -1.7% | .35 [1.9] | -2.6% | 1.1% | 4.9% |
| East region (rest) | 509 | 0.8% | 33 [45] | 4.2% | | 4.6% |
| Central region | 441 | 0.4% | 3.4 [30] | -2.2% | | 5.0% |
| West region (rest) | 261 | 0.7% | 3.5 [15] | -5.5% | | 4.7% |

In conclusion city management includes the following factors as shown in Table 5.

- Redefine the role of mayors
- Restructure urban finances

- Reforming the urban administrative hierarchy

**Table 5. Distribution of large cities by major geographic area, 1950-2015**

| Region | 1950 | 1975 | 2000 | 2015 |
|---|---|---|---|---|
| Distribution of the world's 30 large cities | | | | |
| Africa | 1 | 1 | 2 | 3 |
| Asia | 7 | 14 | 16 | 15 |
| Europe | 12 | 6 | 3 | 2 |
| Latin America | 4 | 4 | 6 | 6 |
| North America | 6 | 5 | 3 | 3 |
| Oceania | 0 | 0 | 0 | 0 |
| Number of cities with at least 1million population | | | | |
| Africa | 2 | 8 | 35 | 63 |
| Asia | 27 | 86 | 194 | 288 |
| Europe | 20 | 47 | 62 | 60 |
| Latin America | 7 | 21 | 49 | 73 |
| North America | 14 | 31 | 41 | 51 |
| Oceania | 2 | 2 | 6 | 6 |
| **Total** | 72 | 195 | 387 | 541 |

## IV. BIG DATA FOR FRESH WATER, WASTE MANAGEMENT AND CLIMATE CHANGE

In the wake of urbanization, climate change and industrialization, big data is driving new ways to resolve old issues in water management. Using sensors to collect data in the field is not new, but the amount of data, and the speed and frequency of which it is available, as well as the ability to integrate it all together, is providing a proliferation ground for regional, national and even global innovation. Sensors can provide researchers with data on everything from the impact of seismic activity and climate change to the most subtle changes in marine biology. With real-time data access and control over instruments, an extension of the internet is provided over the oceans. There is no limit to where sensors can be located and managed. Anybody in the world can access it and use it to make sustainable decisions. Capturing and sharing real-time data is a way to add commercial value to science, something that has been a stumbling block for researchers. Possible benefits include improved marine safety for port authorities, or greater protection for populations at risk from geohazards such as tsunamis and other factors. Watershed touches water for all uses, including agriculture, industry, ecosystems and municipalities. Urban growth is demanding more water and better management of it. However, many surface water bodies are getting to the limit of how much we can take. Strong monitoring of quality, quantity and impact on ecology play a pivotal role in helping decision makers assess the need for infrastructure upgrades or replacement. Long-term environmental sustainability requires an understanding of how water cycles work on a much larger scale than anticipated before. Information is needed for people to make decisions at that scale. One of the challenges in water management is being able to demonstrate technologies and processes in a real environment to provide a business case for commercialization. Since the data became public domain, interest in collecting watershed scale data has been strong. Whether oceans, rivers or lakes, better processing and sharing of information around the water domain ultimately translates into making better use of natural resources. Better utilization of water has been a key global concern for years. The ability to integrate information systems means highly capable manpower are less burdened by manipulating data and more focused on higher value analysis and product innovation.

## V. CONCLUSION

Modern economic development has been associated with industrialization and urbanization. The rapid rise of urbanization coincided with industrialization that took hold and grew over the course of the nineteenth century. One of the most important developments associated with industrialization is the rise of the labor market. It is important that emphasis on economic growth as a driver of development accompanies emphasis on the social dimension of development. Development is a major source of human fulfillment and freedom. It satisfies the need for being creative and contributing to society through inventing, designing, building and working on products and services. It also often satisfies needs for social interaction and learning as the knowledge required for production is generated collectively in organizations through communication and exchange of views. In this study the case study of Chinese cities are taken. The land use and land cover change in China was strongly controlled by the government policies and farmer's economic interest under rapid industrialization and urbanization. If urbanization has increased China's production capacity but without increasing the consumption of the rural migrant workers or the income of the Chinese urban and rural *hukou* population, urbanization may very well lead to a decline in the consumption and GDP ratio. This analysis suggests that the right way to move Chinese economy away from its current high dependency on export market is to implement institutional reforms, such as abolishing the *hukou* system and privatizing land ownership. This paper contributes to generating exchanges, debates and interest among a wide range of readers to advance big data for development in the twenty-first century.

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