Megacities Sustainable Development and Waste Management in the 21st Century

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Abstract

The purpose of this paper is to present the challenge of waste management for the emerging megacities of the developing world and transition countries and to outline major issues that have to be further elaborated in order to create sustainable patterns in waste management.

Megacities face tremendous environmental challenges and threats for human health. In this framework the role of waste management is becoming more and more crucial both for the daily life as well as for the long to medium term sustainability of megacities. The challenge of a successful waste management in megacities is one of the most demanding for public authorities and the waste management industry.

This paper outlines some of the major characteristics of megacities that substantially affect waste management activities like their rapid growth, the symbiosis of wealth and poverty, the role informal economy, governmental and institutional issues and their role in the globalization process.

Then it focuses on how the characteristics of megacities create certain conditions and implications for waste management depending on the megacity growth profile.

Special importance is given to the role of the informal sector and the experiences related its integration to waste management systems. While there is no certain way for a successful waste management approach, there are things that must be avoided and they are presented in a Failure Receipt. Also, some generic suggestions are made on how to increase the possibilities of a successful approach.

Finally, it is proposed a view and certain questions that must be answered in order to understand how sustainable waste management can be created within the triangle megacities – globalization – waste management.

1. Introduction

21st century is already and will be much more a century of radical changes. Economic power and global production centers are already moving to Asia. Population is expected to grow more or less by 50% until 2050 [1]. The vast majority of this increase is expected to be in the current developing countries.

Global Gross Domestic Product is also expected to be quadrupled until 2050 [2]. At the same time 21st century is already characterized as the first Urban Century in the history of human species. After 2007, the majority of the human population is already concentrated in urban areas. According official reports [3], by 2007, 3.2 billion people

— a number larger than the entire global population of 1967— live in cities. From the 3 billion increase of the population expected until 2030-2040, 60-65% will be realized in urban and metropolitan areas. By 2050, an estimated two-thirds of the world's population will live in urban areas, imposing even more pressure on the space infrastructure and resources of cities, leading to social disintegration and horrific urban poverty.

Megacities are a product of the continuous urbanization process. A megacity is usually defined as a metropolitan area with a total population in excess of 10 million people. Megacities can be distinguished from global cities by their rapid growth, new forms of spatial population density, and both formal and informal economy, as well as poverty, crime, and high levels of social fragmentation. A megacity can be a single metropolitan area or two or more metropolitan areas that converge.

The number of megacities is increasing [4] worldwide: 1950: 2, 1975: 4, 2003: 21. By 2015, there will be 33 mega-cities, 27 of them in the developing world. Two third of them are situated in developing countries, especially in South-East-Asia. In 2003 already 283 million people lived in megacities, 207 million of them in developing countries, more than 171 million in Asia.

Megacities population is estimated to increase by 280.000 people per day [4]! In the year 2015 the total population of megacities worldwide [5] will be about 359 million and the future rate of growth will be high, as the development of Jakarta, Delhi, Dhaka and Karachi have shown. Their population tripled between 1975 and 2003. According UN estimation [3] concerning the number of megacities in 2015, Tokyo (36.2 mill. inhabitants), Bombay (22.6), Delhi (20.9), Mexico City (20.4) and São Paulo (20.0) will be the worldwide five biggest megacities each with much more than 20 million inhabitants.

Although cities themselves occupy only two percent of the world's land, they have a major environmental impact on a much wider area. Mega-cities are likely to be a drain on the Earth's dwindling resources, while contributing mightily to environmental degradation themselves.

Megacities face tremendous environmental challenges and threats for human health. In this framework the role of waste management is becoming more and more crucial both for the daily life as well as for the long to medium term sustainability of megacities.

The challenge of a successful waste management in megacities is one of the most demanding for human societies and especially for the waste management industry. To respond to such a challenge it is important, first of all, to have a better understanding of megacities and emphasize at their particularities that really affect waste management.

2. Understanding megacities

Megacities can be categorized in three different categories [6]: **Emerging, Transitional** and **Mature** cities, depending on their stage of economic and social development.

Emerging megacities tend to be characterized by high growth rates driven by migration and natural growth, much of which occurs in informal settlements not

served by the installed base of infrastructure and services. **Transitional Megacities** have often developed mechanisms to more effectively manage dynamic growth, and may be seeing a slowing of annual growth rates. Transitional cities have similar infrastructure challenges as compared with Emerging cities but are better able to respond financially and organizationally. **Mature Megacities** have much slower growth rates than both Emerging and Transitional megacities, at around 1% on average. In some of these cities, the population has stagnated or is shrinking. Mature megacities also have older population profiles. They exist in countries that are typically around 75% urban.

Mature megacities often face the problem of maintaining their infrastructure and adapting it to their changes. On the other hand in emerging and transitional megacities the main challenge is usually the delivery of infrastructure which is always much slower than the city's growth. As a consequence the challenges for waste management in mature megacities are completely different than in emerging and transitional megacities.

Below, the analysis concerns mainly the emerging and transitional megacities and their characteristics that affect waste management.

2.1 Dynamics and growth

Three issues are very important for waste management: population growth, economic activities and spatial growth.

Megacities have phenomenal growth rates [7]. Bangkok, for example mushroomed from 67 km^2 in the 1950s to 426 km^2 in the early 1990s and Beijing has more than tripled in size over the last four decades. Every day thousands of people move to each of the megacities from the surrounding rural areas of the country. This tremendous influx often undermines Local Government's best efforts to provide adequate services to the inhabitants of the cities.

Emerging and transitional megacities often represent the most dynamic economic growth of their countries. It has been estimated that the urban areas of the developing world, which contained some 30 percent of the total population, contributed to nearly 60 percent of the total GDP at the turn of the century [9]. Johannesburg, for instance, is the economic engine not only for South Africa, but also it generates some 10% of the GDP of the entire African continent. Dhaka provides roughly 60% of Bangladesh GDP, Mexico City 40%, Buenos Aires 45% [6] etc.

It is mentioned [10] that the most rapid growth of urban centres is taking place in the economically weakest countries and regions. A high birthrate combined with an increasing migration from the rural areas that is reinforced by the so called "push-factors" (unemployment, low standards of housing and infrastructure, lack of educational facilities) and "pull-factors" (economical opportunities, attractive jobs, better education, modern lifestyle) leads to this very dynamic growth process.

As a result of population growth and GDP / capita improvements [11] waste quantities are rapidly increasing while different waste streams are continuously appear or disappear depending on the economic activities that are developed or declined.

An issue of global interest is the expected increase of organic fraction of waste in megacities. It has been estimated [12] that, globally, urban food waste is going to

increase by 44% from 2005 to 2025. During the same period, and because of its expected economic development, Asia was predicted to experience the largest increase in food waste production, of 278 to 416 million tons per year. If present waste management trends are maintained, landfilled food waste was predicted to increase world CH4 emissions from 34 to 48 million tons and the landfill share of global anthropogenic emissions from 8 to 10%.

Spatial growth is also very important for waste management services. It has been suggested [13] that spatial growth and Urban Change depends on the interaction between five drivers of growth namely randomness, “historical accidents”, physical constraints, natural advantage and comparative advantage. In that view, city growth can only be studied and understood using tools and theories suitable for “far from equilibrium” systems, like the complexity framework of analysis. Another consequence is that future expansion cannot be predicted but only simulated using models suitable for epidemics and diffusion.

Three common trends can be noted [13] regarding the spatial dynamics of megacities: a. the decline of historical centers or core – cities b. the emergence of edge cities that compete or complement with the functions of the core- city and c. the rapid suburbanization in the periphery.

Several megacities appear to have reached their physical and managerial limits and others will do so sooner or later. When megacities run out of space, urban land prices become prohibitively high, leading to intensification of land use with development of more high-rise buildings and underground space. The skyscrapers of old and new world megacities demonstrate that megacities operate not in two dimensions, but in three.

As a consequence of the character of megacities spatial growth, the land required for waste management activities e.g. transfer stations, recycling centers, waste treatment or disposal facilities is always too difficult to be found and acquired in time, thus creating an additional barrier to infrastructure delivery.

2.2 Poverty and slums

A particular feature of megacities is the symbiosis of two extremes in the same shell. On the one hand there are highly sophisticated parts, modern industries and technologies, five star hotels, financial and commercial institutions, research centres, etc. On the other hand there is an expanding poverty, huge socio-economic differences, dangerous living conditions and a dynamic informal sector. These informal areas make up some 30 to 50% of the population.

It must be noted that those two parts are not clearly separated but most of the times they are combined economically, socially and even spatially: there are a lot of glamorous neighborhoods in megacities that are in direct contact or at a very small distance with slums and informal areas.

Poverty may be less extreme in the more developed cities, but social problems are still very important. The OECD’s report [14] on competitive cities notes increased socio-economic inequalities even in some of its most dynamic metropolitan regions. It points to large and persistent pockets of unemployment: about one-third of the 78 metropolitan regions covered in the OECD report have above average national unemployment rates, and between 7-25% of populations live in deprived neighborhoods that often have reduced access to public infrastructure and services.

The report concludes that poverty and social exclusion lead to significant costs including high levels of criminality (on average 30% higher in urban areas than the national level).

Collection frequency and coverage in slum areas is remarkably lower comparing to non-slum areas [15] and in some cases less than 10% of the slum households receive a waste collection service.

Consequently, there are a lot of different city parts (patches) where waste management services could not be the same or even similar. The different road and infrastructure networks (if there are such networks), the existence of areas where not even access is provided to collection vehicles, the different social and living conditions, the huge inequalities in terms of income per capita create a mega - patchwork for which the typical collection routing and the uniform approaches that work in developed megacities are not suitable for planning procedures.

2.3 Governance and institutional problems

Metropolitan governance has become increasingly complex as cities have morphed into agglomerations combining multiple administrative organizations and jurisdictions. This has led to calls for a complete reassessment of urban governance but still there is considerable debate [6,8] about the best practices and the solutions required for the unique circumstances and needs of each city.

The incredibly rapid growth of megacities causes severe ecological, economical and social problems which must be handled under the condition that almost over 70% of the growth [16] currently happens outside of any formal planning process.

For many megacities, inadequate representative governance inhibits spatial planning, building control, the delivery of services (such as water supply, sewage disposal, energy distribution and waste management), and the establishment of general order (including security and disaster prevention). Existing administrations and their organisational structures may have been outgrown by the rapidly expanding city and may simply be unable to cope with the huge scale of their new responsibilities. In addition, of course, informal processes and activities can take on an important role in the development of megacities.

As a result, due to the significant dynamics of megacities, urban planning and public infrastructure provision tends to be reactive [17] rather than a guide to development.

OECD identified three main obstacles [14] to effective governance which are:

- An extensive fragmentation of administrative jurisdiction;
- Strain of the financial and fiscal abilities of local municipalities in metropolitan areas; and
- Lack of transparent, accountable, decision-making processes.

UN – Habitat World Urban Forum 2001 recognized that the effectiveness of a city waste management system and the cleanliness of the city are useful indicators of good governance. On the other hand, the suitability and effectiveness of the services provided to slums and poorer populations is a measure of the successful management of urban poverty as well as the health risks derived by inappropriate waste collection [15].

Financial issues are a great challenge for emerging and transitional megacities. Solid waste management represents 3 – 15% of the cities' budget and 80-90% of it is spent for waste collection, although coverage rates remain relatively poor [15]. Any effort for improvement will substantially increase the costs for waste management and probably new tariff systems will also be required.

A problem that is usually a barrier for planning in waste management issues is related to the quality and availability of the information required. There is a need [10, 16] for an information infrastructure that provides "megacity managers" with the information required to manage such sustained development. New tools, techniques and policies are required to baseline and integrate the environmental, economic and social factors associated with megacities, to monitor growth and change across the megacity and to forecast areas of risk – all within shorter timeframes than previously accepted.

Typical procedures of providing master plans of waste management for such megacities are too static to include their growth and complexity.

Last but not least, it is broadly recognized [18, 7, 10] that the co-existence of several authorities (on neighborhood, local, municipal and metropolitan level) with similar or even identical responsibilities about waste management makes the task of coordination or competition between them actually more difficult that the waste management solution required.

2.4 Megacities and globalization

Megacities are increasingly becoming the interface of a country with the globalised economy and culture, rather than being closely connected to the surrounding rural hinterland as was often the case in the past. They are hubs in super-national complexes in several ways [6, 8,10]: in terms of water, energy, waste and material fluxes, as well as in terms of socio-economic and political developments, and environmental and security considerations.

In that way, megacities are also part of the global network of waste trafficking.

Megacities are also foci of global risk [19]. They are increasingly vulnerable systems because they often harbour pronounced poverty, social inequality and environmental degradation, all of which are linked together by a complex system supplying goods and services. Megacities are particularly vulnerable to natural disasters because [19] their scale and geographic complexity make it difficult to provide the lifeline and transportation infrastructure necessary for risk reduction. Many mega-cities are usually located in geographically hazardous locations such as coastal areas or seismically active zones, making them susceptible to floods, windstorms, wild fires, earthquakes, tsunamis, and volcanoes.

Megacities' massive environmental "footprint" can act as both a trigger and an indirect effect of a disaster situation. In other words, because they require so much energy, food, water, and dispose of so much waste, mega-cities' urban ecologies can exacerbate a natural hazard.

For all those reasons megacities have been characterized as Global Risk Areas [21] for both natural and man-made hazards, including the health problems that might be created by inappropriate waste management systems.

In this view, the importance of health problems that are related with waste management is becoming of global interest. Waste management services and facilities are planned and operated locally but the demand for a safe waste management in each and every Global Risk Area cannot be left to local authorities. It has been mentioned [22] that demands for city infrastructure in the context of globalization might generate local – global conflicts that require new institutions for solutions.

3. Megacities and waste management

Table 1 presents the basic remarks that are related to waste management in megacities, as they have already been presented in previous paragraphs. For simplicity purposes megacities are presented in two categories namely Emerging - Transitional and Mature ones.

Table 1: Differences between Mature and Emerging – Transition Megacities Regarding Waste Management

Characteristics	Emerging – Transitional Megacities	Mature Megacities
Growth	Faster economic and population growth Younger populations Spatial growth cannot be predicted Waste quantities will increase for many years More organic fraction is expected Land is almost not available	Stabilized economic and limited population growth Aged populations Decline of traditional city centers Suburban spatial growth Waste quantities might be reduced Land has been occupied by current infrastructure
Poverty	Extended slams Restricted access to big areas Collection coverage between 10-70% Informal sector involved in waste management Health risks are still serious	Slams are more controlled and limited Waste management is organized and delivered in certain patterns Collection coverage goes up to 100% Environmental protection and aesthetics are important
Governance	Lack of information for planning – almost impossible to get it Multiple authorities with similar responsibilities Infrastructure delivery and increasing capacity is a key-issue Financial cost will be substantially increased as waste management services will be better	There are plans in place Waste management authorities with more clear responsibilities and limited overlaps Infrastructure maintenance and upgrade is a key-issue Financial cost is already relatively high and efforts are made to reduce it
Globalization	Global nodes Global Risk areas Waste trafficking problems	Global nodes Recyclables exported to emerging – transitional megacities

Regarding waste management, other major differences between industrialized and developing countries and cities have been mentioned [23] including availability of capital and labor, physical characteristics of cities, waste composition and informal sector participation to waste management activities. The last one has special importance for any effort to resolve the waste management problem in emerging and transitional megacities.

3.1 The role of Informal Sector

The role of informal sector in waste management, especially in collection of garbage and recycling is very important in many megacities. It has been noted [23] that in Latin America and Asia up to 2% of the population of megacities are involved to waste management activities.

The main field of activity of the solid waste informal sector is recycling and recovery of materials. This activity diverts a lot of materials from disposal, and supports livelihoods for millions of poor people. There are cases [14] where informal recyclers divert 15-20% of the city recyclables.

Informal sector activities are completely within the private sector. As such, they contribute to moderating the overall (public) costs of management of solid waste and recyclables at no or negligible cost to local authorities; informal actors lower remarkably the quantities of wastes to be handled and reduce the cost burden to solid waste authorities. So in most emerging megacities informal recycling is a "survival activity" for hundreds of thousands of people which in some cases provides people an income by far better than the minimum one [24]. Informal sector has also been involved in waste collection, with a certain fee, but even in those cases the primary economic motivation is related to the income they can make from recyclables.

The attitude of public authorities and formal waste management sector to informal recycling is often very negative regarding it as backward, unhygienic and generally incompatible with modern waste management systems. On the other hand it has been noted [25] that it would be ironic to eliminate already existing and well performing recycling systems trying to apply the waste hierarchy framework.

The story of Cairo [26] is an emblematic one regarding the failures to modernize waste management and it has failed just because the actual role and contribution of informal sector was completely underestimated or ignored both in collection and recycling activities.

As it has been mentioned for Cairo [27] "Traditional waste management systems are embedded in realities which are too complex for official, conventional systems to understand. They are socially constructed and thus also difficult for engineers to understand… (Informal systems) are market based and derive from knowledge and information about popular market and trading systems…They achieve the highest recycling rates and generate employment for significantly higher numbers of people than official systems do…The question posed to waste manager of cities therefore should be: how can we give these people …their rightful place in a more efficient system to serve the city, the economy of the poor and the environment?"

A major challenge is to change the political attitudes and the public policies to informal sector. The same is also true for the waste management industry [25]. It is becoming increasingly evident that incorporating informal recycling and collection systems into formal waste management operations and procedures can bring substantial economic, social and environmental benefits. Strategic Planning needs to document, understand and build on existing informal systems [25,28,29] because all the experiences demonstrate that it will be more expensive and less effective to build a new formal recycling system ignoring the already established one. Of course this is neither an easy nor a simple task. But it seems that there is no alternative.

3.2 About technologies and systems applied

It has been mentioned [23] that conventional technological approaches to waste management are not working in emerging and transitional megacities because they involve imported solutions that are centralized, bureaucratic and suitable for different socio-economic conditions and so the possibility of decentralized models must be examined.

In most of the cases those conventional solutions are promoted [15] by international donors and aid programs in an effort to export “Western type” technologies. A usual way of such a promotion is the adaptation of certain environmental and technical standards as a condition for funding.

Another approach [31] explains the technological evolution of waste management systems with the Change Ring model. According the Change Ring model, GDP/ capita is the dominant driver for SWM changes and historically at each GDP level several different SWM systems may correspond. In other words technologies applied are clearly driven by GDP growth but framed by the ring of History, Policy and Know How. The practical suggestion is that [31] “…Instead of waiting for the GDP growth, the Change Ring indicates that pushing Policy measures, Know How development and History - Culture utilisation in their limits, changes in SWM are possible”.

It is very difficult to find out conclusions of general importance from the different technological systems applied in different megacities. But it is substantially easier to outline conclusions from the negative experiences [15, 18, 23, 25, 27, 30, and 31] that exist and provide a “Failure Receipt” that has to be avoided.

The components of the “Failure Receipt” are presented in Table 2. They are presented categorized according the different practical aspects of waste management, namely planning, financing, institutions, collection, recycling, treatment and disposal.

Table 2: The Failure Receipt Components categorized in practical aspects of waste management

Aspects	Do not (Failure components)
Planning	Copy Master Plans with solutions from other cities Design for a radical transformation but for realistic improvements and steps Provide too many priorities Wait for a complete set of data Ignore or underestimate the role of informal sector Give priority to central facilities only Ignore the solutions required to slams where health risks are serious Forget the need to control waste generated as soon as possible Make plans without broad participation and interaction of all stakeholders Forget that the only sustainable solution is based on capacity building of the involved authorities and personnel Forget that Master Plans are becoming old before they get completed if the growth is too fast Underestimate the need for pilot efforts that will provide evidence for future steps
Financing	Wait for the donors Spend donor funds without creating the right framework for their utilization Examine only the investment and direct costs – check also the operational and hidden costs of any proposal Charge uniform tariffs Spend only for new infrastructure and not for small improvements Ignore the cheap solutions provided by informal sector Ignore the dynamics and structure of informal market Ignore the dynamics and structure of local waste management market
Institutions	Let responsibilities overlap between a lot of different authorities Ignore the need for coordination Ignore the importance of community participation Wait for new regulations to resolve the problems Copy regulations from other countries without examining their practical suitability Create bureaucratic systems that are inflexible to react
Collection	Import vehicles and equipment without examining where and how they are going to be used

	Provide uniform solutions to different patches of the city Ignore local private sector and practical solutions that are working Ignore the contribution of informal sector in certain patches
Recycling	Create formal systems in direct competition with informal ones Forget that “recycling for living” is more effective than “recycling for the planet” Ignore the organic fraction recycling and recover procedures
Treatment and disposal	Wait to occupy the land required Put all efforts to establish a central facility Design just one and only final destination for all waste Import technologies just because they are subsidized Tender without ensuring informal sector reactions Tender pharaonic contracts “one in all” Underestimate the importance of gradual improvements in landfills Underestimate the benefits of low cost technologies

It is important to notice that avoiding the Failure Receipt does not automatically mean that decisions and choices are successful and suitable but at least the possibilities for a big failure are reduced.

On the other hand, there are certain issues that can really be suggested in order to create a framework for a successful waste management approach in megacities. But those issues are just some generic components that also do not guarantee successful waste management solutions but they can increase the possibilities for that. Some of the most important are:

- Megacities should develop an overall Strategic Urban Waste Management Plan that prioritizes areas of the city that are most vulnerable and require on-going monitoring and proactive intervention. These priorities should be decided locally through an environmental planning and management process to ensure that the issues are pertinent to specific parts of the city rather than simply applying generic, city wide issues. This will result in a patchwork of different information collection and analysis requirements across the megacity – quite different from a consistent, city wide data gathering exercise. The rate of change in portions of the megacities also varies significantly. Therefore, priorities for data collection could also be focused on those areas of the megacities with the highest growth patterns. Finally, the Waste Management Plan will be a mega - patchwork that reflects the complexity of the city and the different socio-economic conditions.

- The starting point of improvement is the analysis of the current successes and failures of the existing system, of the strong and weak points of it. Always planning for gradual improvements is a better and more effective way to upgrade waste management than planning for a substantial shift to another level suitable for other socio-economic conditions. That also provides the opportunity of a trial – error approach without serious risks.

- Megacities do not have the luxury to wait for waste management solutions. The rapid growth of waste production pushes hardly to systems and plans that combine, from the very first day, waste prevention and recycling programs with infrastructure delivery. So even if new infrastructure is delayed or canceled, successful recycling initiatives, including the organic fraction of waste, will provide a medium to long term relief of the waste management systems.

- Integrating the informal sector within waste management systems, analyzing and supporting the local informal and formal markets dynamics, creating initiatives to combine employment in slams with recycling and collection and changing the attitudes of public authorities and waste management industry against the informal sector is certainly a component of a successful approach.

- Put special emphasis on creating a core of responsible officers that will have the capacity to understand and propose suitable solutions instead of “buying” expensive and sometimes non-customized studies. Invest in training people in order to adapt and adopt suitable solutions.

- Create metropolitan authorities to coordinate activities and try to keep legal responsibilities as clear as possible, without overlaps. Try to create representative waste management platforms to share the responsibilities with all the stakeholders involved.

- Defining land uses and occupying land for waste management facilities and activities as early as possible is a must as the rapid growth will be adapted around those pieces of land.

- Examine the possibility of underground developments to reduce logistics’ costs and create space in convenient locations. Sometimes the savings from logistics are substantial and they can be used to subsidize underground transfer stations or treatment units.

- As health risks are too crucial and present in slam developments, the possibility of epidemics due to inappropriate waste management is not negligible and represents a risk for the whole megacity or even worst a global one. Thus emergency response planning is required in relation with waste management activities and must be prepared as soon as possible.

4. Instead of conclusions

Megacities are too complex systems and their waste management cannot be easy and simple. In fact, waste management solutions will be always late comparing to the fast population and economic growth of emerging and transitional megacities. Since this growth cannot be modeled, any waste management plan will be temporary and static. So what is really important is to develop certain patterns that will reflect the rapid changes of the city and support the decision makers to adapt waste management to the emerging changes.

It would be wrong to assume that megacity growth is automatically bad for the environment. It is obvious that a city with 20 million people will have a large environmental impact, but it is less clear whether that impact is bigger than if the same number of people lived rurally [6]. Certainly there are those who argue that clean, modern cities, where dense living enables resources to be consumed efficiently, provide an environmentally sustainable model for the future.

Megacities are ideal places for social, Earth, environmental and medical scientists to investigate the impact of socio-economic and political activities on environmental change and vice versa, and to identify solutions to the worst problems. For these reasons, megacity research has the potential to contribute substantially to global justice and peace – and thereby prosperity [19].

The challenge of globalization is also a great one. Megacities, as global junctions, offer a multitude of potentials for global transformation. Due to their wide range of available human resources and globally linked actors, megacities are considered to be potential "innovative milieus" [32]. For example, improved sustainability can be achieved by decreasing the "drain on land resources", by using resources very efficiently (recycling and regeneration), efficient hazard prevention, and sufficient health care. This is why research has to focus on the triangle megacities – globalization - waste management. There are a lot of questions that must be answered and here are just some of them, as a starting point.

Can megacities create sustainable patterns for their waste management?

Is there a way to manage the increasing complexity of their waste management systems?

How globalization affects waste management in megacities?

Is there a global demand for waste management infrastructure in megacities or it is a local problem?

Is there any connection between the “openness” of the megacities and the waste management systems and technologies - infrastructure applied?

How waste trafficking will be separated from resource management?

What can we learn from complexity science regarding waste management planning?

What are the global risks from inappropriate waste management?

How can globalization be combined with informal sector in place?

What are the conditions for more successful international aid and donations?

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