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Mumbai's urban metabolism and the role of waste management through informality

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Mumbai's urban metabolism and the role of waste management through informality

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Abstract. As cities in the Global South continue their expansion, waste increases accordingly as a by-product of urban life. Although public authorities tend to aim to deal with disposal through formal waste management (municipal or private contractors), this often proves to be insufficient to deal with the volume of waste and to cover all areas of the city. Hence these systems are usually paralleled by informal solutions that in turn provide important ecological and economic contributions to the city and its inhabitants. Informal waste management takes place through a network of actors that collect and/or transform waste in order to sell it, using discarded material as a resource for the creation of recycled goods. Nonetheless, the recognition of the contribution of the informal sector and its actors is often lacking, with little emphasis on the benefits generated by informal waste pickers and the related industries. Through the paper, I analyse the role of informal waste management in the urban metabolism of Mumbai, India. The paper aims to identify the contribution of the informal sector in managing waste by determining: a) what role does informal waste management play in improving urban ecological sustainability and resilience?; b) how does informal waste management respond to historical transformations of urban nature?; c) what forces govern distributional flows of urban transformations and how can these be negotiated by informal waste management actors? The paper concludes by drawing lessons on how understanding the value of informal waste management can relate to the evolution of Mumbai into a just and sustainable city through urban planning. In fact, in a world of scarce resources and increasing income disparity, it is important to understand the contribution of informal waste management in order to improve urban sustainability, not only from an environmental perspective, but also in terms of livelihood and wellbeing for all citizens.

Content

List of images

Acronyms

ALM	Advanced Locality Management
CBO	Community Based Organizations
CRZ	Costal Regulation Zones
DRP	Dharavi Redevelopment Plan
FORCE	Forum of Recyclers Communities and Environment
FWM	Formal Waste Management
ICT	Information and CommunicationsTechnology
IWM	Informal Waste Management
MCGN	Municipal Corporation of Greater Mumbai
MFWM	Municipal Formal Waste Management
NSDF	National Slum Dwellers Federation
OCG	Organised Criminal Groups
SAS	Slum Adoption Scheme
SMS	Stree Mukti Sanghatma
SPARC	Society for the Promotion of Area Resources
WM	Waste Management

1. Introduction

'Bombay is the postmodern city par excellence, where past, present, and future collide and fragment, where the local and the global and everything in between mix together in a heady masala all the city's own. The most astounding contrasts meld into combinations that are impossible to decode.'

Kamdar, 1997

1.1 The issue of waste: problem or resource?

As cities in the Global South continue their expansion, by-products of urban life - namely waste water and solid waste - consequently increase in parallel (Smit and Nasr, 1992 in Satterthwaite 1999). So far, in order to deal with waste accumulation, there has been a tendency for public authorities to aim to replicate waste handling procedures of the Global North. This occurs despite the evidence that these might not be adequate to serve all citizens equally and to ensure environmental sustainability (UNCHS, 1996, in Satterthwaite 1999, Sharholy et al, 2008). Moreover, in many instances insufficient credit is given to those who contribute to waste recovery pertaining to the informal sector. Although waste is known to be a source of concern for cities in terms of health implications, environmental degradation and costs to society (Sudhir et al. 2003), in recent years there has been a paradigmatic shift towards considering refuse as an unused resource to take advantage of. This acknowledgement has been termed "resource recognition" (Furdey, 1992). Interestingly, the actors in informal waste management (IWM) have traditionally practised resource recognition as an inherent part of their activity. In a world of scarce resources and increasing income disparity, it is important to understand the contribution of IWM in order to improve urban sustainability, not only from an environmental perspective, but also in terms of livelihood for all citizens.

1.2 Research questions

Through this work, I aim to identify the contribution of IWM in the city of Mumbai through the lens of the urban metabolism in order answer the following research questions:

- What role does IWM play in improving urban ecological sustainability and resilience?
- How does IWM respond to historical transformations of urban nature?
- What forces govern distributional flows of urban transformations and how can these by negotiated by IWM actors?
- How does this relate to the evolution into a just and sustainable city through urban planning?

The urban metabolism theory will be understood as the body of knowledge exploring the flux of tangible and intangible resources between the city and its external environment, its transformations through the urban space, and the dynamics and structures that influence and determine these fluxes.

1.3 Research structure

I shall present a brief overview of IWM in **Chapter 2**, followed by a review of academic literature on urban metabolism in **Chapter 3**, in order to construct a layered notion of urban metabolism that will guide our analysis. **Chapter 4** introduces the case study of Mumbai and Dharavi as a recycling hub, while **Chapter 5** applies the layered construction of urban metabolism to the case study, encompassing an ecosystem analysis, along with dialectical views on historical, distributional and governance processes which affect the transformation of nature. This leads us to **Chapter 6**, where I conclude on lessons learned for sustainable and just urban planning with respect to IWM, with specific reference to Dharavi's future.

1.4 Methodology and limitations

The methodology consists in research through secondary data based on work on IWM systems in India and internationally, and writings on Mumbai and Dharavi. My lived experience in Mumbai and the visits to Dharavi have guided my understanding of the issue. Email correspondence with Vinod, the head of the Dharavi Project, helped elucidate some points that were not clear in the literature. Additionally, Boo's work Behind the Beautiful Forevers (2012), a fictional novel based on years of sound research and interviews with waste collectors in Mumbai, provided an insight into daily lives of waste-pickers. In terms of limitations, parts of the reality of IWM in Mumbai remain undocumented or poorly documented, such as small waste-picker organisations or waste mafia.

2. Overview of informal waste management and recycling

Waste management (WM)[1] is defined as the collection, transport, disposal and processing of waste, and is composed of informal and formal practices (Sudhir et al, 1997). IWM can refer to the occupation or industry, and involves the collection, sorting and selling of the valuables for recycling, including plastic, glass, paper, metals (Wilson et al, 2006). Formal waste management (FWM) encompasses municipal solid waste management (MSWM) and private contractors. Typically, while for formal refuse workers there is no inherent value in waste, but rather in the service of clearing, for scavengers[2] waste is valuable and ensures profits on which they depend on for survival (Moreno-Sanchez and Maldonado, 2006). There are various exceptions to this: municipal workers often sell waste to scavengers or strip waste of valuables after collection (Nas and Jaffe, 2004). In fact, the two systems are in reality interlinked through dynamic interactions and tensions, especially over the access to waste and contracts (Samsons, 2009). Processing recyclables is also part of WM, involving the transformation of refuse into new useful forms.

IWM is prevalent in most – probably all – developing countries[3], as Nas and Jaffe (2004) put it, "as long as poverty and garbage exist in combination, scavenging systems are likely to prevail". In his work on scavengers, Medina (1997) compiled a list of commonalities he found in different communities of waste-pickers, such as: low social status, typically migrant origin, scavenging as an adaptive response to chronic poverty, the supply of raw materials to industry and the use of organic waste for fertilizers. Nas and Jaffe (2004) criticise this list for concealing significant variations across countries and cities, in accord with DiGregorio's (1994:1 in Nas and Jaffe, 2004: 339) statement that there are only two common traits in IWM systems: "recognition of waste as a resource and a varying degree of social opprobrium".

There is a widespread perception of IWM as an undesirable and backward practice undertaken by unworthy citizens, which puts to shame cities aiming to modernise (Wilson et al, 2006). This vision has been found to be empirically incorrect (Nas and Jaffe, 2004), as IWM brings important contributions to the city, and actors in IWM have proved outstanding ingenuity, flexibility and capacity for innovation in challenging circumstances (Wilson et al, 2006).

In the following chapter, we shall review the urban metabolism theory in academic literature, before explaining how we conceptualise this notion in the elaboration of the framework to our study.

NOTES TO CHAPTER 2

1 Liquid waste management is excluded in this paper.

2 Also referred to as waste- or rag-pickers. In this context, the word scavenger is used as a non-derogatory term.

3 Also exists in the developed world.

3. Literature review and analytical framework:

3.1 Urban metabolism and its variations through the literature

The concept of urban metabolism[1] has been applied since the 19th century to analyse how tangible and intangible flows interrelate to shape urban dynamics. In recent years, urban metabolism featured in different academic currents, each providing a distinct meaning to the concept and accordingly developing new ways of understanding nature and cities. The mainstream view of urban metabolism pertains to the school *industrial ecology,* whereby material and energy flows are studied in order to design technological solutions to minimise resource inefficiency (Barles, 2004, in Rapoport, 2011). Nonetheless, as this view is too reductionist for our scope and over-reliant on technology[2], we shall explore alternative conceptualisations of urban metabolism[3], distinguishing between *functionalist* and *dialectical* explanations (Castan-Broto et al. 2011).

Functionalist views: urban metabolism as conducting the functions that reproduce the city

a. City as an ecosystem[4]. This vision is the most loyal to the biological definition of metabolism, and is mainly used in the field of *urban ecology* - understood as "the ecology of cities" – which is concerned with "how the aggregated parts sum, that is, how cities process energy or matter relative to their surroundings" (Grimm et al, 2000). It conceptualises the city simultaneously as a system and as a natural entity (Marcotullio and Boyle, 2003). Based on this concept, the normative implications involve the application of urban planning and design as a means to replicate natural mechanisms as models ensuring ecological sustainability (Girardet, 2008, Newman and Jennings, 2008). Just as in nature nothing goes to waste, as what is discarded by one organism becomes a source of energy for another through biological, chemical and physical processes (Garner and Keoleian, 1995), cities should function so that matter is transformed from its previous state into a reusable form, ensuring circularity. Nonetheless, the notion of optimised order and balance is challenged by urban ecologists supporting ideas linked to complex system theory (Alberti 2009 in Rapoport, 2011). Complex systems are defined as systems made up of interconnected parts that as a whole present emergent properties which are not apparent when observing individual parts (Marcotullio and Boyle, 2003). Since urban systems are considered to be complex, scholars argue that to reach sustainability of metabolic functions, urban planners should not aim to identify and reach ideal indicators ensuring equilibrium, as this might not appropriately consider emerging properties. Instead, a holistic approach should be adopted to design an adaptive system, building *resilience* to inevitable shocks in the social and ecological sphere to maintain integrity as an organised entity (Kay, 1991, Marcotullio and Boyle, 2003). In fact, complex systems have the ability to re-organise through an intricate array of *feedback* mechanisms, creating spontaneous interactions between all parts to regulate the responses to stress. Nonetheless, if confronted with excessive strain, the whole system in its present form faces the threat of collapse (Lovelock, 1979). Concerns have emerged as to whether the ecosystem theory approach is over-reliant on scientific knowledge and on biological exchanges, ignoring other aspects of urban life, such as the social and historical context (Gandy, 2004, Swyngedouw, 2006, Evans,2011).

b. Optimising the economic versus environmental relation: The concept of urban metabolism can be used to understand depletion of resources through commodification and monetisation, but also to establish the functional economic efficiency of the city in ecological terms (Niza et al, 2009). The normative objective is to increase efficiency by reducing environmental degradation per economic unit. This mainly concerns *industrial ecologist* and *ecological economists*, and raises important questions relative to the relationship between growth and depletion. In fact, while certain scholars claim that economic growth can occur without environmental strain (concept of *dematerialisation* or *decoupling*, Buttel, 1997; Dunn & Steinemann, 1998 in Rapoport, 2011), lifting the poor out of poverty over time as benefits from development "trickle down" (Kuznets Curve), others believe economic growth itself drives depletion (Czech & Daly, 2004)

Dialectical views: urban metabolism as a mutually constructive conception of relations between nature and urban society

c. Resignifying the city: social, technical and ecological relationships: *Urban political ecologists*, such as Heynen, Kaika and Swyngedouw (2000, 2003, 2004, 2006), have developed models including additional layers of urban life, such as political and social processes. This entails the resignification of nature as the core building ma-

terial of the urban tissue - driven and modified by different forces in the city (social, technical, economic, ecological). It allows a shift away from dualistic visions based on a human-nature divide (Harvey, 1996, Smith, 1984), giving new meaning to the process of urbanisation in relation to the ecological realm. In this view, nature is metabolically transmuted through the urban space through historical processes (Kaika & Swyngedouw 2000, Gandy, 2005). Urbanisation is described as a dynamic "social process [...] transforming and reconfiguring nature" (Swyngedouw, 2006:35), echoing Harvey's (1996:186) famous statement by which "there is nothing inherently unnatural about New York City". All human activity is integrated within biophysical processes; thereby nature and society intrinsically exert reciprocal influence on each other, creating a state of perpetual movement producing new forms of "metropolitan nature" (Gandy, 2004). It is a politicised, as opposed to functional, vision of the city, rejecting the view of nature as "a cyclical dynamic alterable through technological modifications" (Gandy 2006:64), but rather as matter transformed through social re-organisation and struggle. Hence, by exerting power over ecological and social flows, humans are active actors in the evolution of the city (Zimmer, 2010), shaping urban space in accordance with "drives, desires and imagination" (Castán Broto et al., 2012). Such approach uncovers the significance of urban infrastructure and technological networks as life-support systems in a "cyborg" city – a hybrid between machine and organism (Gandy, 2006).

d. Urban flows and the production and reproduction of inequality: *Political ecologists* are concerned with the creation, distribution and reproduction of inequalities throughout the city, and the structures that organise these socio-environmental flows (Graham & Marvin, 2001, Coutard, 2008). Agyeman (2005) stresses the impact of unequal distribution of benefits and damages of environmental resources in terms of environmental justice, although this movement concentrates more on praxis and specific instances, as opposed to political ecologists whom present a heavier critique of the system producing inequalities (Swyngedouw and Heynen, 2003). Biel (2006) bases himself of Prigogine's concept of the "dissipative structures" by which, within a system governed by the rules of thermodynamics, under the capitalist mode of production some entities, described as the *core*, draw excessive resources from other milieus, the *periphery* – depleting *exergy*[5]- to maintain order locally, and exporting chaos elsewhere in the form of *entropy*[6]. On the basis of the unequal power over the circulation of resources, the core has the ability to reproduce and reinforce this pattern through positive feedback processes of accumulation. The core represents the social realm that benefits from local order-building, whereas the periphery represents the two levels of dissipation: the social system, and the physical realm (c.f. Annex 2). The focus is on the interaction between the domination of nature and humankind and other uban dynamics (Keil and Bourdeau 2006, Biel 2006). While most applications are elaborated as part as *world system theory* (Hornborg, 1998; Biel, 2006), the core/periphery model remains transferable to the metabolic flows within the urban context.

e. Governing urban flows: This body of literature is concerned with how urban flows are governed and by whom. This is an important question with respect to planning, provision and use of infrastructure, housing, industrial plants, public buildings, etc. as decision-makers and users shaping the built environment guide the direction of tangible and intangible urban flows. Nonetheless, "not all actors can mobilise metabolisms in the same way" (Zimmer, 2010:350). Elites, powerful groups and institutions tend to be the most influential (Swyngedouw & Heynen 2003) and might put at risk longstanding socio-economic systems set up by other citizens. Nonetheless, marginalised actors also have a stake over urban flows, and their daily practices have strong regulatory power that could overturn imposed schemes (Allen et al., 2008, Bulkley et al. 2011). The governing of urban flows also involves *governmentality:* the means employed to make a population governable, such as the socio-psychological production of subjectivities and discourses determining relational imaginaries between stakeholders (Petersen, 2003, McFarlane, 2008b, Buitrago, nd). Martínez Alier (2009) argues that variations in the configuration of the metabolism can result in the re-organisation of urban governance. This can materialise in hybrid arrangements between public, private, and community systems (Allen et al, 2008). Biel (2006) describes two types of re-organisation through *emergence*[7]: co-opted emergence by the prevailing peripheral forces which negotiate a situation of stability with the core, shifting entropy downwards to lower strata, or uncontrolled emergence, which could be constructive or destructive and puts to risk the existing core/periphery structure.

3.2 Urban metabolism: which conceptualisation is most appropriate?

Most interpretations of urban metabolism carry a degree of relevance for our case study of IWM in Mumbai. However, some are more useful than others. We shall evaluate their appropriateness to construct an adequate framework for this analysis.

a. The City as an Ecosystem: This notion has the advantage of delivering a rich analysis of the intricate web of interrelations within the city and among its human and non-human parts, uncovering the functional role of IWM (Grimm et al, 2000, Newman and Jennings, 2008). The analogy with biological systems is relevant to the circularity in resource recovery, while posing the question of adaptive resilience at different scales. The two normative concepts have strong implications for sustainable city planning and for what should be prioritised: closing the

ecological loop and/or ensuring sufficient space for resilience building. The limitation of this model lies in the insufficient political and social dimension.

b. Optimising the economic versus environmental relation: The economic efficiency of different WM systems is an interesting dimension in evaluating costs and benefits of urban planning alternatives. In fact, for the same amount of waste cleared, what are the financial implications for different models? In addition, economic growth enabled through urban centres has become central to modern Indian culture and aspirations (Nikelani, 2009), as Mumbai diverts resources from across the subcontinent to produce further wealth - nonetheless raising questions concerning the economic efficiency of producing wealth by fuelling pauperisation in parallel. Although economics is indisputably at the heart of the issue, we need an expanded this framework to incorporate all aspects of urban life.

c. Resignifying the city: Mumbai has been a locus of multiple forces, patterns and drivers of urban transformation. Hence, a *historical-materialist* analysis of metabolic processes is particularly appropriate, offering a new understanding of the issue of waste as a means to respond to social, economic and technical and political shifts transforming nature to its complex current form.

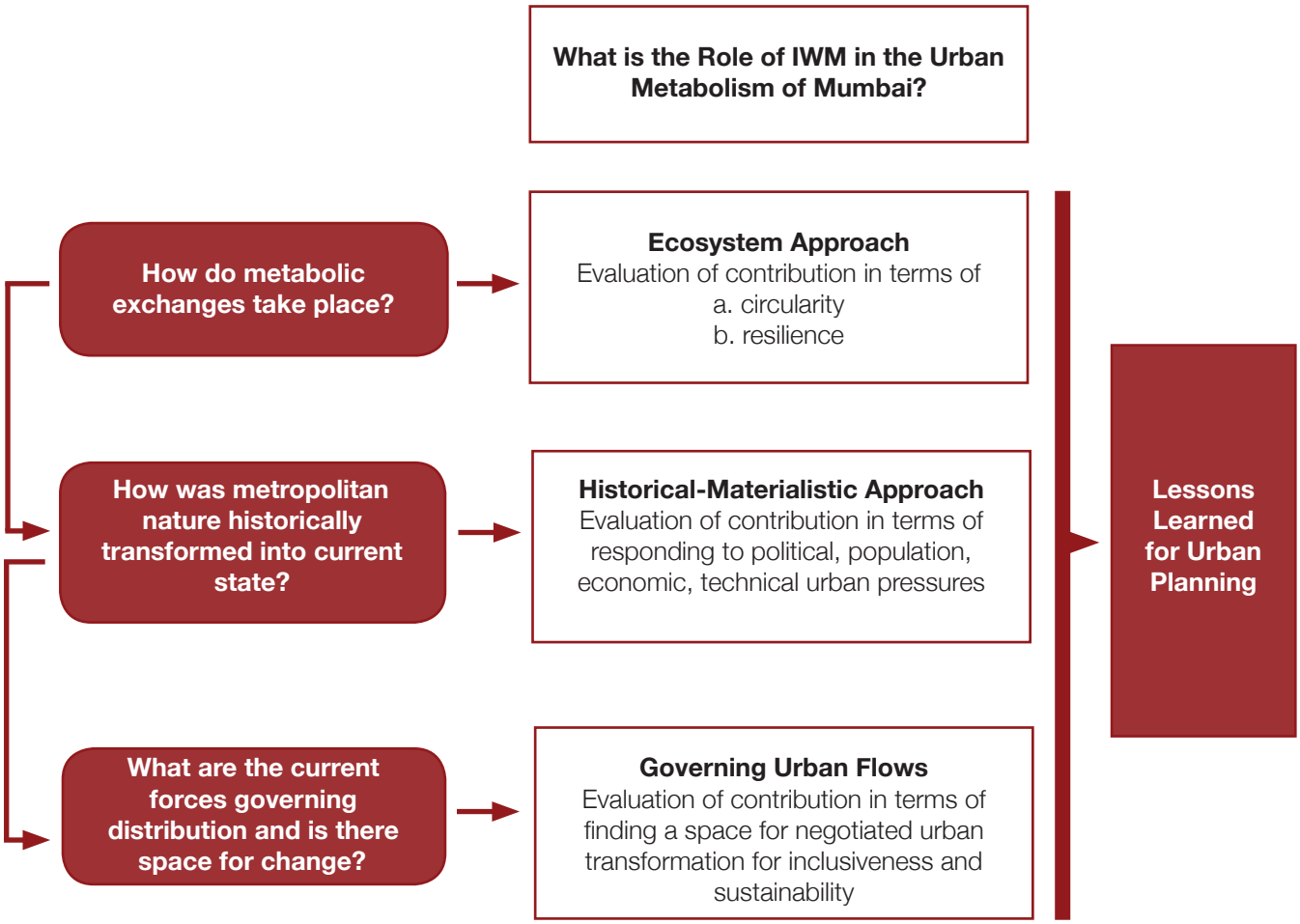
d. Urban flows and the production and reproduction of inequality: In a city where income and social disparities reach staggering levels, there is an essential need to uncover patterns of inequality reproduction. IWM is a clear example unequal distribution of environmental costs and benefits. A core/periphery analysis has the propensity to reveal processes of accumulation.

e. Governing urban flows: Uncovering the governance of everyday practices in IWM is central to the understanding the role of IWM in the metabolisation of flows. Authorities and urban elites have tended to ignore local economies of the poor without deepening their understanding of their contribution in the city, rejecting and disrupting existing practices through privatisation, slum clearances, relocation and redevelopment (Mukhija, 2003, Burra, 2005, Wilson, 2006). On the contrary, this conceptualisation allows us to go beyond established sources of urban control, to consider how governmentality is achieved by actors of IWM, and to contemplate proposed models that can result mutually beneficial arrangements with other participants of urban transformation.

3.3 A layered analytical framework

What this breakdown underlines is that there are many layers of metabolisation in urban areas, carrying multiple implications for planning and design. For the purpose of this paper, I shall adopt a framework that combines the functional conception of the city as an ecosystem and different aspects of dialectal interpretations of urban metabolism. Guided by these different notions of metabolic flows, I aim to unpack different layers of the role of IWM in the city through a progressive analysis of Mumbai's case study (c.f. Figure 3.1.). Firstly, I will assess the function and structure of IWM as an ecosystem to evaluate whether the industry can approximate a closed-loop system or an adaptive model of resilience. Secondly, I shall pursue a dialectical route to answer the following questions: according to a historical-materialist approach, what processes of transformation of metropolitan nature has IWM evolved in accordance to? How has the industry responded to deficiencies in planning? Thirdly, what is the current process reinforcing the distribution of governance over human and physical resources? Who has a stake in re-modelling the urbanscape and how can this evolve? In conclusion, in the light of the observed flows, what are the lessons learned for urban planning contributing to the creation of a just and sustainable city?[8]

Figure 3.1: A Layered analytical framework



NOTES TO CHAPTER 3

1. Biological definition: set of reaction by which, in an organism, living organised substance is produced and maintained, and energy is made available to the organism through transformation (Saunders, 2007)
2. Critique by Gandy, 2004, Moffatt & Kohler 2008, Barles, 2010 in Rapoport, 2011
3. Categorisation adapted from Rapoport, 2011
4. Ecosystem: area containing "interacting biotic and abiotic elements and that interacts with [its] surroundings" (Grimm et al., 2000:574)
5. Exergy: potential available stock of energy, finite fuel c.f. Annex 1
6. Entropy: 'low-ordered, chaotic state' c.f. Annex 1
7. Self-creation of order" (Biel, 2006)
8 Discussions concerning the importance of infrastructure will emerge at various stages of the analysis.

4. Case study: informal waste management in Mumbai

4.1 Mumbai and the issue of solid waste management

Mumbai[1] is the country's largest metropolis, with a population of approximately 12.5 million people residing in Greater Mumbai, and the highest density, standing at 21,000 inhabitants per square kilometre (Census of India, 2011). Despite many infrastructural constraints and income disparities, Mumbai is a major centre for economic growth. The economy is predominantly tertiary (Urban Age, 2009), including large and small businesses in the formal sector (finance, ICT, consulting, tourism, etc.), and a bourgeoning informal sector (street-vendors, hairdressers, car repair, etc.). Many linkages exist between the two (BUDD, 2009) (c.f. Annex 3).

As a result of increased population, wealth and consumption, the city is struggling to manage large volumes of waste and associated costs (Mahadevia et al., 2005). In fact, overall generation of solid waste in Mumbai is around 6500 tons per day at a cost of US$125 million (MCGM, 2007). MSWM is under the responsibility of the Municipal Corporation of Greater Mumbai (MCGM), which has the mandatory duty to maintain a clean and healthy environment (Mahadevia, et al., 2005). To tackle the increasing burden of waste, the MCGM has so far considered several options: increase landfill capacity, adopt new technologies (UV radiation for plastic disintegration, energy recovery from biomass), mandatory waste segregation at source, waste minimisation promotion, and community involvement (Mahadevia, et al., 2005). In parallel to FWM, the informal sector actively taps into the "waste economy" (Furedy, 1992). The MCGM estimates a total of 50,000 to 60,000 street and dumpsite rag-pickers, along with 80,000 to 100,000 door-to-door waste collectors[2] and recycling workers in the city (Modi et al 2002 in Mahadevia, et al, 2005), mainly residing and working in slums. To understand the structure within which IWM takes places, let us further explore the social and spatial composition of Mumbai.

4.2 Slums in the city

With housing and employment shortages, a large share of Mumbai's inhabitants resides in slums[3]. Das (2011) estimates a slum population of 7.5 million inhabitants, accounting for 60% of the population, and total slum land area at 42.30 square kilometres, equivalent to 9% of Mumbai's territory. It must be noted that slums do not only house deprived members of society, but also many civil servants, university graduates, low-level white-collar workers whom lack affordable alternatives (Burra, 2005), and owners of profitable businesses within the slum (Sharma, 2000). However, many slum dwellers live in dire conditions characterised by environmental pollution, infrastructural insufficiency, staggering poverty, and high density (Karn et al., 2003). Slums are often in risky locations (flood prone areas, along railway tracks, coastal zones), where MSWM is not carried due to the inability of municipal trucks to circulate within clustered, unpaved roads, or in some cases due to their illegal status (Sarholy et al, 2007). In fact, only 12% of the MSWM budget is dedicated to slums (Davis n.d. in Mahadevia, et al., 2005). Despite constraints, many slums are vibrant industrial and commercial areas (Sharma, 2000, BUDD, 2009), including nuclei of scrap dealers, stockists and recycling plants around which IWM gravitates. One of the main hubs is the famous slum of Dharavi.

4.3 Dharavi – a hub for the recycling industry

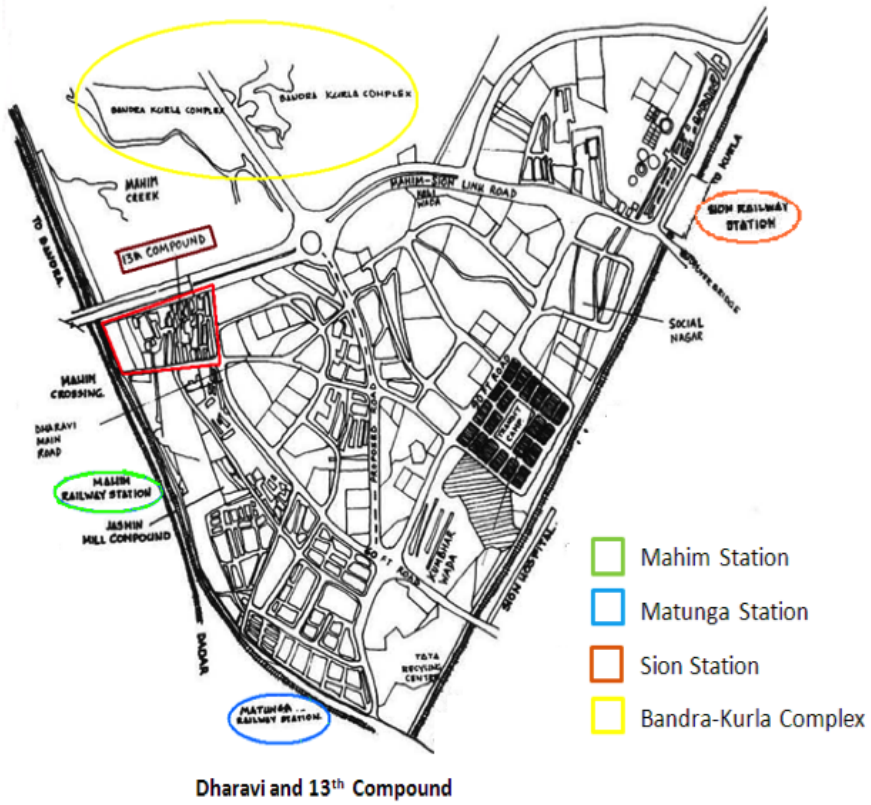
While our main scale of analysis remains the city of Mumbai, the case of Dharavi is analysed as a stark illustration of debates around urban restructuring, while hosting one of India's main recycling hubs (KRIVA and SPARC, 2010). What happens to Dharavi could become a model replicated throughout India and other cities of the developing world.

With a population of approximately one million inhabitants, Dharavi is considered the largest slums in Asia (BUDD, 2009). Although it was once a fishermen village bordering the city, it is now situated at the heart of Mumbai, serviced by three train stations on two lines, and close to the Bandra-Kurla Complex[4] (Sharma, 2000) (c.f. Figure 4.3.). In terms of recycling, it boasts and estimated 700 small and large establishments dedicated to recycling plastic, employing 5000 people (KRIVA and SPARC, 2010), and many more recycling other materials. A large number of recycling plants are licensed, but unofficial employment practices and reliance of waste-pickers inherently links them to informality (Sharma, 2000). According to the National Slum Dweller Federation in 1986 the annual turnover from recycling plastic was US$5 million, and

has probably increased considerably (KRIVA and SPARC, 2010). Most recycling plants are located in '13th Compound', one of the busiest areas of Dharavi (c.f. Figure 4.3.) (Raborn, 2009).

The value of the land has drastically increased over the years, attracting the attention of local authorities and private developers. Following the wave of the enthusiasm engendered by "Vision Mumbai", a report by the McKinsey (2003) inciting to transform the state's capital into a *world-class city*, radical plans were designed for the area. The Dharavi Redevelopment Plan 2004 (DRP), produced by the private real estate developer Mukesh Mehta, envisioned total reconfiguration through the construction of high rise buildings, half of which hosting high-end businesses, and half for residential use, mostly to resettle slum dwellers (BUDD, 2008, c.f. Annex 4). The project would be financed entirely by private developers, which is appealing for municipal authorities that would not have to provide funds. Nonetheless, the DRP is highly controversial: numerous concerns rose as to whether the rights and livelihoods of citizens were taken into account. The DRP conceptualises Dharavi as a residential area, negating its thriving industrial and commercial nature as little thought is put into employment opportunities for the urban poor (BUDD, 2010). There is limited understanding of the implications at the city scale in terms of economic and environmental costs, as activists describe Dharavi as the "green lung stopping Mumbai choking [...] on its own waste" (McDougall, 2007). It currently supports thousands of people involved in IWM in the slum and beyond, contributing to Dharavi's estimated annual turnover of US$650 million (BBC, nd). Charles Correa, an internationally renowned architect claims "there's very little vision with this plan, [it's] more like hallucinations." (McDougall, 2007).

Figure 4.3. Location of the '13th compound' within Dharavi. Source: People's Map by NSDF in Sharma, 2000 adapted by author



Dharavi and 13th Compound

NOTES TO CHAPTER 4

1. Mumbai was called Bombay until 1995. We will use both names according to the historical period.
2. Commonly denominated kachrawala, kedabiwala, raddiwala, or bhangarwala, partially depending on materials collected.
3. Statutory definition: Slum Area (Improvement and Clearance) Act of 1956: "areas where buildings are unfit for human habitation; or are […] detrimental to safety, health or morale" (Karn et al. 2003). Nonetheless, not all slums are illegal, as many have been legitimised.
4. The 'new' Central Business District.

5. Informal waste management in Mumbai through the lens of urban metabolism

Rationale: In the light of the difficulties for the MCGM to deal with waste and urban poverty, it is important to explore existing systems that found solutions to these issues, and learn to incorporate them in urban planning. Wilson (2006) identifies the first step towards the inclusion or support of IWM by authorities as the recognition of economic, environmental, social value. For this reason, I shall uncover the importance of IWM networks across the city, using a layered notion of urban metabolism to examine the case of Mumbai's IWM industry with specific reference to Dharavi. This will lead on to the elaboration of lessons learned for sustainable and inclusive planning.

5.1 The city as an ecosystem:

Informal waste management as an ecosystem imitating natural circularity

The ecology of cities is concerned with how cities as an ecosystem process energy or matter relative to their environment through defined functions and structures (Grimm et al., 2000). To understand the interactions between the city and its surroundings in terms of WM, we need to observe the flows of material that then become waste. Resources are extracted and processed around the globe, and enter Mumbai's economy where they are passed down from wholesalers to retailers and eventually sold, used and discarded by consumers (c.f. Figure 5.1.). This now enters the waste system, which function is to dispose or transform waste. Recycled goods will re-enter the local or global economy, without the need for extraction of new materials (c.f. Figure 5.1., KRIVA and SPARC, 2010). At the city scale, we find four main stages of WM: collection, transportation, sorting and processing. The structure is the following: in the FWM system, waste from collection points (streets, municipal bins) is brought to two transfer stations - Mahalaxmi and Kurla – which serve as intermediary stop before landfilling, or directly to the dumping grounds - Deonar, Mulund, and Kanjurmarg (c.f. Annex 5). Within the informal system, collectors gather waste from transfer stations and dump-sites (*dumpsite waste-pickers*), or from municipal bins, streets (*street waste-pickers*), households, businesses or industries (door-to-door collectors[1]) (Wilson et al., 2006). Waste in then transported to hubs such as Dharavi or Sakinaka (KRIVA and SPARC, 2010, Boo, 2012, Annex 5).

At Dharavi's scale, roughly sorted waste is brought to the '13th Compound' by collectors in containers or bags, and are subsequently sold to retailers and wholesalers. (Chikarmane and Nayaran, 2009). In the successive steps, workers are lined up and surrounded by waste to be thoroughly sorted in different recipients. Sorted material is shifted to recycling plants within Dharavi for processing.

In terms of functioning as an ecosystem, imitating the transformation of outputs into inputs and building a closed-loop system, the IWM sector is effectively dedicated to perform precisely this function. Discarded waste re-enters the system after undergoing a process of transformation and metabolisation into a new useful input (Scheinberg, 2001 in Wilson et al, 2006). The biologist Maturana describes the *organisation of living things* in Marcotullio and Boyle (2003:52) as a "network of production processes in which the function of each component is to participate in the production or transformation of the other components in the network. In this way the entire network continually makes itself." In IWM, as each component effectively participates in making the recycling industry work and replicate itself. Each stage is beneficial for the member dealing with it, providing him/her with a form of energy or input – income, materials or consumption. New products might re-enter the system as discarded items. Hence waste is transferred throughout the system in a circular manner, cleaning up the environment and keeping the living organism from suffocating, ensuring sustainability. In contrast, in FWM disposal occurs through landfilling following a linear model (Sharholy et al., 2008). Mumbai's landfills bring about significant problems derived from the unsanitary disposal in terms of environmental pollution, toxicity, damage and discomfort to the surrounding community, and health and fire risks for those operating on the grounds (Kaushal, 2012). Some waste-to-energy and composting technology has been introduced (Kaushal, 2012), but the scale of unproductive waste remains significant.

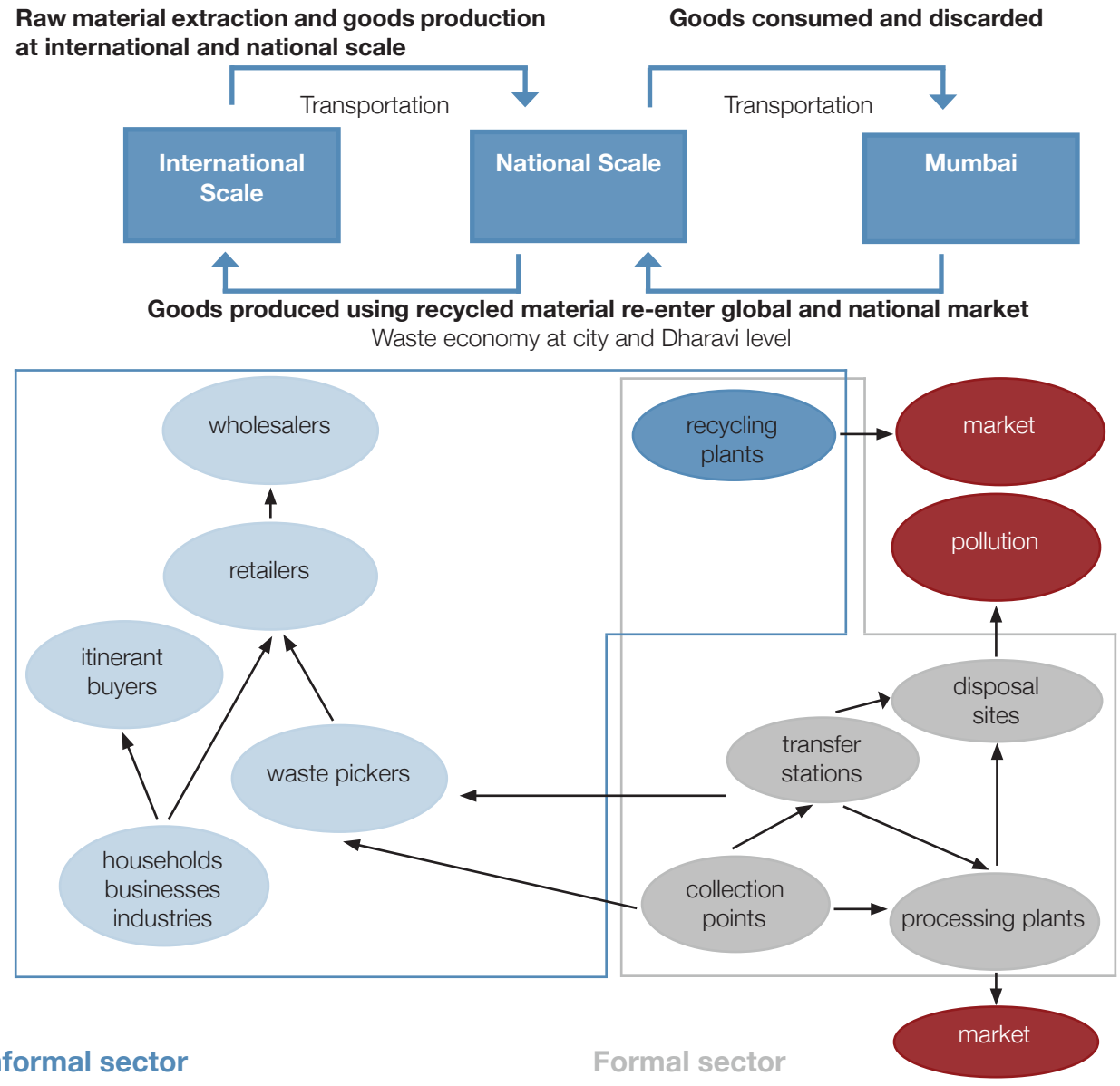
The IWM industry processes about 60% of Mumbai's recyclables (Sharholy et al, 2008, Dell, nd), hence contributing to sustainability by decreasing resource depletion through a closed loop system[2]. Nonetheless, the question remains whether this system is resilient enough to absorb shocks that threaten its sustainability both at local and city level.

Informal waste management as an ecosystem building resilience

Complex system theory stresses the idea of integrity to describe an ecosystems organisation, which refers to a "sense of a whole" (Kay, 1991:483). Integrity is achieved if a system is able to maintain its organisation despite changing conditions, encompassing the idea of resilience. These changes can be internal [i.e. *functions and structure*], or external [i.e. *environment*] (Kay, 1991). In a world of perpetual and rapid change, resilience is achieved through the capacity to adapt. We shall analyse the ability of IWM to self-organise in response to changes in (a) composition and (b) volume of waste[3].

In terms of (a), after initial difficulties in recognising, categorising, and finding uses for new materials, the industry adapts swiftly to absorb additional resources. The recognition of material by waste-pickers requires techniques such as biting, snapping, smelling, tapping on the material (Boo, 2012), forming a capital of tacit knowledge (Wilson et al, 2006). The rise in hybrid materials makes material recognition increasingly complex, as recycling plants only want pure materials (Boo, 2012). If the identification is incorrect, problems arise at recycling stage. This constitutes a negative feedback, which will continue until sorters learn to recognise the new material and recyclers develop new ways to utilise it. A positive feedback system will allow the trader to keep

Figure 5.1. Structure of the ecosystem: circulation of goods and waste at the international, national and local scale. Source: Graph by author, adapted from Sudhir et al.1995



using this technique insofar as the material remains the same. Change in composition can be beneficial, such as the shift towards plastic, which is now Dharavi's main activity (Gupta et al, 1998). The contrast is striking if compared to lags in technological development or adoption in FWM systems. Western inspired technological choices might not be suited for the composition of waste in the city. In fact, waste in India has a higher organic component, while Western technology is developed predominantly for dry waste (Naf and Jaffe, 2004). Since waste composition changes rapidly, even if the initial trucks and plants are well suited, they soon become inadequate, involving high replacement costs.

With reference to (b), MSWM increasingly struggles to cope with the growing quantity of waste to collect and dispose of, and associated costs. In contrast, waste expansion creates a parallel reaction in IWM in employment and profits. The tenfold increase in plastic in India between 1986 and 1995 was met by the mushrooming of recycling plants which process up to 80% of the plastic in circulation (Gupta et al. 1998) Flexibility is embedded in the fact that in IWM waste is correlated with profits rather than with costs, permitting re-investment (positive feedback). While on the long-term waste increases might over-saturate the system - supply and demand mismatch, unavailability of space for development of the industry - IWM is certainly more flexible compared to FWM. For example, having limited space in densely populated settlements is a constant constraint, but the recycling industry ingeniously found ways to "cut out" extra space e.g. working and living in the same room, drying plastic pellets on rooftops, adding extra floors (Reality Tours&Travels, 2010). In FWM, space for landfilling is rapidly being used up, and finding a new place to accommodate Mumbai's waste is problematic[4]

We have seen that the informal sector has a strong propensity for adaptability and self-organisation, offering a reliable service to the city. Failures in the FWM sector can be mitigated by the availability of another functioning network. Additionally, by clearing more waste than in the absence of IWM, the city is more resilient to environmental adversities such as flooding, as drains are less clogged by uncollected waste (Wolfe and Mahadevia, 2008).

Currently, integrity is achieved since Mumbai runs despite the large amounts of waste, but how would the city cope if IWM was reduced? Lovelock (1979) claims that if exposed to excessive strain, self-regulating organisms face the risk system failure. From a functional perspective, if recycling plants are eliminated from Dharavi, a central node in the IWM network, the market for scrap materials will undergo significant down-sizing, reducing the overall turnover from waste-picking. If scavengers do not have industries to provide for or commuting time and costs to new markets are prohibitive, less waste will eventually be collected, making Mumbai vulnerable to floods, disease transmission, environmental pollution, etc. In the long term, this could translate into urban ecological collapse. Hence, the ecosystem analysis has highlighted the role of IWM in increasing resilience at local and city level.

While this conceptualisation remains useful, an explanation is needed as to how the system of urban flows described above came into being. For this we move onto a historical-materialist political ecology analysis.

5.2 A historical-materialist approach to informal waste management

By envisaging the city as a by-product of historical processes (Smith (1997), Appadurai (1997) in Banerjee-Guha, 2002), we illustrate certain political, economic, population and technical trends that have driven the drastic transformation of nature. While IWM and its actors are often seen as adding onto urban problems, this analysis uncovers how IWM reflects the inadequacies in urban planning itself and is in fact an adaptive response providing effective solution in a context of institutional insufficiency.

We analyse the transition from a post-independence 'national' phase to the current 'global' phase with respect to increase in income disparity and unemployment, increase waste production, population pressure and urban planning failure.

Shifts in ideology and objectives of urban planning

With the advent of independence in 1947, the Indian government took a strong stance in re-acquiring direct political and economic control, and sealed itself behind protectionist policies. This marks the entry in the "modernist" phase (Harris, 2004), where nationalisation, state regulation and economic autonomy become the dominating rationale. Hence, the planning and management of urban nature moved away from British interests and discourses, and were subjected to national objectives. Bombay was to serve as a centre of growth, especially through industrial production, while financial resources and administrative power were to be redistributed across the country to promote inter-regional equalisation (Harris, 2004). Within the city, Nehru's progressive nationalism attempted to create "a planned and just city providing opportunities and services for all", through infrastructure, housing and industrial rationalisation (McFarlane, 2008b:483). Public space was to consist of "benign, regulated places, clean and healthy, incapable of producing either disease or disorder" (Chakrabarty, 2002: 77 in Mcfarlane, 2008a:31).

Nonetheless, overtime it became apparent that national strategies failed to ensure economic stability, with growth rate fluctuating between +7% in 1975 to -7% in 1979 (World Bank, 2014a, c.f. Annex 6 Graph 1). By the 1980s, India was on the verge of a drastic shift towards market deregulation, bringing about significant metabolic changes. Liberalisation policies were progressively introduced in the 1980s, with the promise of prosperity, and reinforced in 1991 through the New Economic Policy (Grant and Nijman, 2002). Inter-regional distribution policies gave way to resource concentration in urban hubs, as cities were re-envisaged as focal nodes in global economic networks. Bombay was projected to play a major role in India's strategy due to its inherited capacity for trade (Shaw, 1999, Banerjee-Guha, 2002, Nikelani, 2009). In fact, colonial authorities had designed the city to serve Britain's trading interests across the Empire, bestowing the city with infrastructure creating a junction between maritime and land routes. Trade, storage and distribution were paralleled by docks, warehouses and railway terminals (Grant and Nijman, 2002).

In 1995, the city was endowed with a new name and a new urban master plan: the Mumbai Metropolitan Plan, whereby Mumbai was to specialise in high-end services and export-oriented industries to become a global "mega city". This occurred despite the acknowledgement of insufficient infrastructure capacity (Banerjee-Guha, 2002). To enable this process, transformation of metropolitan nature would no longer occur through state-controlled allocation of resources and space. Instead, the production of urban tissue became increasingly fragmented though market mechanisms (Swyngedouw, 2004 in McFarlane, 2008b). For instance, private investment was preferred to public budgeting in infrastructure financing (Banerjee-Guha, 2002). Zoning was determined by commercial prospects rather than public needs, as provision of housing and infrastructure for the poor declined as land was sold to private builders. Coastal Regulation Zones (CRZ) protecting environmental stability were modified to allow the construction of hotels and entertainment venues (Banerjee-Guha, 2002). As a result of deregulation policies, Mumbai achieved an outstanding level of global economic interconnectedness, becoming a space no longer hostile to foreigners, but welcoming their economic presence, triggering economic growth (Grant and Nijman, 2002. c.f. Annex 3, Annex 6). Mumbai regained its historical role as a passageway of global activity, connecting markets through sea, air, freight, road networks, and financial services. Mumbai's International Airport was nicknamed the "New Gateway of India" (Boo, 2012).

Urban resources and space

Sassen (1994, in Shaw, 1999) observes two processes driving the transformation of global cities: a. *centralisation* through the concentration of economic activities in specific functional areas, and b. *decentralisation* through the displacement of people and low-skilled jobs to the peripheral areas. These processes resulted in divisionary structures within the urban space, embodied in the rise of two cities: the formal - with commercial areas and modern residential neighbourhoods; and the informal - characterised by informal sector activities, and decaying housing. Centralisation can be seen in the concentration of high-tech activities, due to sector's reliance on innovation, human capital, and agglomeration economies (Shaw, 1999). Finance and corporate activity replaced Mumbai primary and secondary sectors (Banerjee-Guha, 2002), occupying the land freed from the closing of old cotton mills, along with telecom services, advertising agencies and commercial businesses (Baria, 1998, in Shaw, 1999). Infrastructure, especially "productive infrastructure"[5], including MSWM, was focalised on servicing business and residential areas, at the expense of "social infrastructure"[6] . In terms of decentralisation, between 1980 and 1998 employment in manufacturing fell by 32% (Banerjee-Guha, 2002), creating structural unemployment and loss of the housing in the industrial areas. As these areas were redeveloped, they became unaffordable for the poor, driving many towards the outskirts.

Consumption and waste generation

The impact of these dynamic transmutations on metabolic flows was of drastic in magnitude and speed. Global integration translated into a rise of consumerism, made possible by the increase in overall imports, income, living standards and aspirations (Sharloy et al., 2008). Mazumdar (2007 in McFarlance, 2008b) illustrates this by observing India's most influential sector, indicator and determinant of cultural norms: the Bollywood film industry. Modern family films as evoke images of modernity as "rooted in an explosion of new kinds of high-end design, advertising, and commodity circulation", where "glamorous, globally aware individuals" are the actors of modern consumer cosmopolitanism (McFarlane, 2008b:489). New aspirations are predominantly inspired by Western lifestyles (McFarlane, 2008b), including the habit of generating large amounts of inorganic waste through households, hotels, entertainment venues, airports, and offices. Waste had been a problem in the city ever since colonial times, where filthiness had been declared to be the worst of Bombay's "many Evils" (Leith, 1864: 36 in McFarlane, 2008a:10). However, in recent years waste production has been growing at an unprecedented rate. In fact, Indian cities currently generate 8 times more waste than in 1947 (Sharloy, 2008). Nonetheless, waste production is not uniquely driven by wealthy classes, but also by the pressure from millions of new urbanites.

Population pressure

Urban prosperity attracted two types of migrants: entrepreneurs[7] and labourers[8] (Kamdar, 1997). In terms of regional migration, deteriorating conditions in rural Ma-

harashtra due to the inefficiency of inter-regional policies during nationalisation and their brutal removal provoked an unprecedented exodus towards the perceived abundance of employment in the State's capital (Desdara, 1994). Similar patterns extended to other impoverished areas across India and South Asia, facilitated by community ties with Mumbai's established migrants (Kamdar, 1997). Mumbai represented "India's America", where people had a chance to change their fate. Here, issues of caste, class, gender were attenuated and could be overcome (Kamdar, 1997). Nonetheless, as the city proved itself incapable of housing all its new inhabitants, migration led to the expansion of informal settlements.

Urban planning - the weak link:

Urban planning, including employment planning, proved to be the weak link in Mumbai's transformation, both as a modernist inclusive city, and as a global world class city (Sharma, 2000, Banerjee-Guha, 2002). In the nationalist era, institutional weakness had proved unable to enforce regulations and accommodate existing migration. Similarly, in the global era, despite celebrated plans, implementation remained chaotic and dysfunctional, and lacked a long-term vision that would reach all citizens (Grant and Nijman, 2002). Local authorities remained weak and subjugated to state entities. Significant lack of co-ordination, unclear distribution of roles between agencies, insufficient financial resources and technical capacity, inadequate consideration of cost-recovery, and unclear regulation of private sector participation created an environment for corruption and incoherent results (Banerjee-Guha, 2002). For example, FWM resulted "unscientific and chaotic", and unable to efficiently handle the city's waste (Gupta et al. 1998:137). Consequently, Mumbai grew in a sporadic manner, with high levels of congestion, strain on infrastructure and natural resources, affecting waste flows around the city.

In this respect, IWM has in fact responded to the challenges set forth by ineffective and exclusionary urban planning and market forces. As space for the urban poor was reduced, slums sprung across the city and combined living and working spaces, responding to the necessity for housing and income generation opportunities. Since there was limited capacity for enforcing zoning restrictions and labour for manufacturing was readily available, industries emerged where space was found, and provided work for many unskilled and semi-skilled workers (Sharma, 2000). The uncollected and unsorted waste resulting from municipal insufficiency proved itself to be a supply of valuables in the waste economy. Scavenging became a source of livelihood for the large population of rural migrants arriving with few urban skills and limited education.

Hence, we understand that IWM can provide solutions to issues of migration, lack of alternative employment and waste accumulation, offering a livelihood strategy to the urban poor that planning did not reached. In fact, if Mumbai is to become the 'slum free' city it aspires to be, it will have to respond to major urban trends effectively by learning and negotiating with actors that can provide effective solutions. In the following section, we analyse current governing forces of urban reproduction, in the attempt to find space for sustainable and inclusive negotiation of urban flows.

5.3 Governing urban flows

Principal forces driving the distribution of governance over urban flows

The process of "first worlding" (Katz, 2001 in Banerjee-Guha, 2002) did not encompass all citizens equally. In fact, IWM is a clear example of the unequal distributions of costs and benefits: while the wealthy benefit from the production of goods through resources depletion (negative externality), the poor handle the discarded rests and face important health risks to create new goods they cannot consume. In parallel, they produce an environmental service benefitting the entire population (positive externality) (Moreno-Sanchez and Maldonado, 2006). These processes tend to be self-reinforcing, and can be viewed in the light of a core/periphery analysis, which highlights the actors driving the governance of urban flows (Biel, 2006). In term of the WM industry, the core can be understood as the waste producing wealthy citizens, and the periphery as the waste reducing urban poor in IWM[9]. Let us look at the role of these actors in this model.

a. Middle and Upper Classes: Since the weakening of the state, the elite have largely contributed to stirring urban transformation, materialising their demands through private sector provision[10] and civil society mobilisation (Anjaria, 2009). To sustain order-building in the form of development and consumption, and local entropy reduction at the core, resources are drawn from two environments: the physical sphere – both nationally and internationally - and the social sphere, the urban poor in IWM, resulting in the exploitation of both man and nature. This can be discourse or market driven, and occurs through two mechanisms leaving the periphery in a lower-order state: (i) appropriation of peripheral exergy (resources), and (ii) the export of disorder.

With respect to (i) exergy from physical environment is dissipated in the form of the material and energy required in the process of extraction, production, recycling and transportation of goods. This allows the core to enjoy the goods used, discarded and re-circulated. In terms of dissipation of human exergy, elites depend on labour resources of large segments of the population to fulfil their ever-increasing demands, symbolised by the description of a corporate office in Boo's work (2012) simply called "More".

In terms of (ii), for comfort to be increased at the core, disorder has to be exported elsewhere. The core strongly relies on privatisation to create their orderly reality. Market demands for sanitary enclaves, reminders of the *islands of purity* in the colonial "contaminated city" (McFarlane, 2008a), are met by real estate developers and private WM contractors, as this is believed to be the only effective way to manage waste (Samsons, 2009). This is accompanied by the elimination of "polluting" industries, decadent housing and members of society that do not fit images of modernity, moving them out of sight (Banerjee-Guha, 2002), utterly reconfiguring urban flows through the eradication of workplaces and livelihoods. Wealth and influence confers the ability to attract more wealth and influence, as illustrated by Vision Mumbai's suggestion to allocate more land to the core. Ultimately, peripheral out-groups experience entropy acceleration through "decentralisation", as the poor are confined to insecure spaces, facing ever-increasing precariousness in occupation, health and education prospects. In addition, disorder displacement is accelerated through a civil society movement described as "bourgeois environmentalism". The movement is founded on the discrimination between "good" and "bad" natures, producing new imaginaries concerning what the city should resemble (McFarlane, 2008a, Anjaria, 2009). These "citizen groups" envision their role as a manifestation of citizenship, which reinforces and legitimises their position, proclaiming themselves "stewards of the city's streets and sidewalks" in the name of all Mumbaikars. This rhetoric omits the inaccessibility of certain platforms of participation to the urban poor, by-passing their views, in particular the most invisible amongst them – the waste-pickers. Urban elites effectively "shape the landscapes and lives of millions of Indians" (Baviskar, 2002) becoming creators of the urban fabric, reinforcing their position as directors of urban flows.

b. Waste Collectors: Inequalities in IWM are reproduced through subsystems of domination in the "social metabolism" (Martínez Alier, 2009), as waste-picking is often taken up by the most vulnerable members of society - women, children, and the elderly (Wilson et al, 2006). Scavengers are typically Dalits[11] and Muslims (Wilson et al. 2006, Boo, 2012). While the caste boundaries are blurred in the cosmopolitan city, the system still "legitimises" social differences, relegating certain groups to "unclean professions" (Moreno-Sanchez and Maldonado, 2006) and creating feedback mechanisms resulting in poverty traps. Biel (2006) claims that the core re-asserts its supremacy by negating the value of the out-groups, justifying control by the elite as a way to ensure a healthy environment. Creative and positive views of the poor are generally blocked out (McFarlane, 2008b). On the contrary, the urban poor are stigmatised and blamed for the city's chaos and dirt, echoing colonial geographies of contamination underwritten by association of disgust at "under-civilised, racialised polluting bodies" (McFarlane, 2008a), where local knowledge of sanitation is amply considered inadequate. In fact, the perception of authorities and other citizens are often denigrating, whereby scavengers are seen as "part of the rubbish they work in" (ASMARE, 1998 in Nas and Jaffe, 2004). Negative public perception has significant impacts on self-confidence (UNESCO, 2001 in Nas and Jaffe, 2004). Boo's fictional character Mirchi, a child from a waste-trading family living close to luxury hotels, proclaims: "Everything around is roses. […] And we're the [rubbish] in between." (2012:xii). In addition, while the core benefits from a clean environment, waste collectors and recyclers are exposed to squalid environments and multiple health hazards - respiratory diseases; illnesses transmitted through pollutants, toxic waste, faeces, animals; risks of fire; cuts; damage from curbed positions and heavy loads, etc. (Chikarmane and Narayan, 2009). Since slums emerge in relation to sources of precious waste, many are near hazardous places such as landfills (Moreno-Sanchez and Maldonado, 2006). Hence, waste collectors are increasingly pushed to the margins of society, both in terms of status, living space, and possibility to pursue activities, while other milieus grow in proportion.

c. Other actors: Biel (2006) explains the core/periphery model can be envisioned as enclosing different scales, revealing intermediary actors. These include organised criminal groups (OCGs), whom have a stake in profits from redevelopment project through corruption and violence (Weinstein, 2008), reinforcing processes of decentralisation and chaos displacement. 'Waste mafias' also divert resources from waste-pickers (Chikarmane and Narayan, 2008). In addition, OCG, goondas [slumlords], authorities and the police, see waste-pickers and recycling plant owners as resources from which haftas [bribes] are extracted through threats (Samsons, 2009, Boo, 2012). Nonetheless, these relations can create a situation whereby powerful actors have an interest in postponing redevelopment plans through connections with authorities in order to maintain their position.

Waste collectors also suffer exploitation by recycling plant owners and middlemen (Medina, 2000), who move entropy downwards to more deprived spheres. Labour relations have been describes in Marxian terms by Birkbeck (1979 in Nas and Jaffe, 2004:340) whereby surplus benefits middlemen while scavengers are charged low rates (Wilson et al, 2006). Exploitation also occurs at the factory levels, where exergy is extracted in the form of underpaid, precarious, hazardous and unprotected work (Sharma, 2000). Nonetheless, waste pickers do need a market to sell to. In some instances, exchanges were identified as patron-client relations, based on mutual trust and guaranteed exchanges, ensuring stability for both parties (Nas and Jaffe, 2004). Whichever the interpretation, IWM actors remain at the bottom of socio-economic ladder through reinforcing processes of power accumulation[12].

We have observed that IWM can be understood and exploited as a fuel to for order-building. One crucial question is: what happens when all room for extraction is eroded?

What will then maintain order and prevent entropy? The DRP is at the heart of discussion on resource appropriation and chaos displacement. As the site sits on prime land, core/periphery dynamics reclaim more for the core, annihilating the work of several generations of actors who developed businesses and livelihoods. Will projects such as the DRP lead to unsustainable dissipation?

Nonetheless, whether the project will go through as it is, in a modified form, or not at all, will depend on whether actors affected by the core's influence will succeed in cutting out space for negotiated governance.

Negotiated spaces: society-centred governance

Despite repression, the urban poor significantly contribute to the daily functioning of the urban metabolism, as "society-centred" governance (Pierre, 2000 in Allen et al. 2008) is achieved through collective provision and regulation of IWM. While many work individually, others have joined forces to develop possible systems of emergence. Hence, we shall analyse different models employed by waste-pickers to regain control over urban resources.

a.Hybrid systems of governance: Community Based Organisations (CBOs) have an increasing role in catalysing demands of the urban poor involved in IWM. Throughout India, many strategies for improving welfare have been elaborated, mostly involving organising waste-pickers in co-operatives, unions or companies (Samsons, 2009). These organisations established creative relations with the municipality, private actors, and residents, and participate in data collection and production of knowledge concerning IWM issues and effective solutions for IWM. International networks such as the Global Alliance of Informal Waste-Pickers, and Workers in Informal Employment: Globalising and Organising (WIEGO) increase knowledge sharing, visibility and capacity to negotiate the governance of urban flows (Samsons, 2009).

In Mumbai, the following CBOs are documented: Aakar, the Forum of Recyclers Communities and Environment (FORCE), Stree Mukti Sanghatna (SMS) and the Dharavi Project (Chikarmane and Narayan, 2009, ACORN, 2012). Objectives include organising waste-pickers to secure access to stable and remunerative sources of waste, better working conditions, and by-pass middlemen. Many initiatives have sought collaboration with the municipality, obtaining contracts for door-to-door collection in schemes such as the Advanced Locality Management[13], the Slum Adoption Scheme[14], or Chakachak Mumbai[15]. This reduces expenditures for the MCGM, as it was found that the cost of per ton of MSWM is US$35 with community participation, US$41 with public-private partnership and US$44 when managed municipally (Sharholy et al., 2008). Some contracts included insurance, sick leave and paid holidays (Chikarmane and Narayan, 2009). In addition, organisations have occasionally obtained vehicles, scrap stores, PET bottle shredding units, composting and bio-methanation plants run by waste-pickers (Chikarmane and Narayan, 2009). Other initiatives involve setting up self-help groups for savings, facilitating access to government loans, data collection and surveying, identity cards allocation (Chikarmane and Narayan, 2009), training and value-addition. Collaborations to obtain waste are also set up directly with private businesses. Beyond contracts, waste-picker organisations create recognition of the environmental services provided. The Dharavi Project boasts the motto "Reduce, Recycle, Reuse and Respect" (ACORN, 2012).

CBOs are faced with significant difficulties, including delayed payments by the MCGM, unprofitability of plants provided and high maintenance costs, corruption in the tender system and in agreements between municipal workers, vehicle drivers, contractors which depress the capacities of waste-pickers (Chikarmane and Narayan, 2009, Samsons, 2009). Hence, integration remains difficult and sometimes ineffective. Chikarmane and Narayan (2009) claim these systems can only become sustainable if voice, visibility, validity (legal recognition) and viability are progressively built up. Nonetheless, through negotiations, many have achieved a degree of success, allowing waste pickers to have a stake in the governing of material, economic and social flows. This has signified a shift for scavengers from victims to as actors of urban development, increasingly empowered to make claims in the negotiation of urban flows, described by Appadurai (2001) of "deep democracy" or "governmentality from below".

b.Contested urbanisation – negotiating redevelopment. We highlighted that scavengers and the recycling industry are vulnerable to urban planning outcomes, and were rarely involved in decision-making over their living and working spaces, as considered unable to self-govern (McFarlane, 2008a). In the case of the DRP, the MCGM does not envision collaborations with waste-picker organisation (Vinod, 2012), highlighting insufficient voice, visibility, validity and viability on behalf of the waste pickers to be considered in collaborative models of service provision. The future of their industry will depend on how much bargaining power they will manage to secure, but also by that of other gross-root groups engaged in contesting the DRP. Residents and businesses (including the 13th Compound Industrial Association) have mobilised for the right to be part of the planning process, headed by the *Dharavi Bachao Andolan* [Save Dharavi Movement] - a coalition of resident associations, cooperatives and political parties, and the *Dharavi Vikas Samiti* [Dharavi Development Committee] - made up of local leaders (Arputham and Patel, 2010). Additionally, numerous activists, scholars, journalists around the world have shed light on Dharavi's value and fight against its eradication. Grass-root organisations have the support of the Alli-

ance - a tripartite organisation including: the Society for the Promotion of Area Resources (SPARC) - an NGO of social work professional; the National Slum Dwellers Federation (NSDF); and Mahila Milan - a network of poor women's saving groups. Over the last decades, the Alliance has set precedents demonstrating the capacity of the urban poor to manage and improve their own communities by applying local knowledge, succeeding not only in service provision, but in "serv[ing] as a form of government and produc[ing] governable spaces and governable subjects" (Roy, 2009:163), becoming engines of urban governmentality. The Alliance believes in pushing their objectives, including negotiated resettlement, through collaboration rather conflict with authorities, working with government, private companies, and financial institutions (Burra, 2005)[16]. Although most examples relate to housing, water and sanitation, these models of negotiation can be extended to solid WM.

Hence, if included in effective mobilisation, the role of IWM can also be that of engaging in urban planning in order to move towards urban inclusion and sustainability.

NOTES TO CHAPTER 5

1. Generally cart-pullers.
2. Except for energy dispersion in transportation and the recycling process.
3. Identified as major shock (Mahadevia et al., 2005).
4. In fact, the Malad dumping ground was saturated and shut 2002, and Gorai in 2009, the closure of Deonar was planned for 2012 but remains opened and overused amidst waves of protests by the neighbouring residents due to the inability of the municipality to manage the volume of waste without using this dumping ground. In addition, the opening of the Kanjurmarg landfill in 2012 provoked opposition by neighbouring communities, and difficulties in setting up a new dumping cell due to lack of funds have been reported, with waste destined to Kanjurmarg being diverted to Deonar (Hindustan Times, 2012a, 2012b, Indian Express 2013).
5. `E.g. airport expansion, Bandra-Worli Sealink, etc.
6. E.g. public buses, water and sanitation, etc.
7. Traditionally foreigners and Guajarati.
8. From Maharashtra, Kerala, Karnataka, Tamil Nadu, Bihar, Nepal, Bangladesh, etc.
9. The poor also produce waste, but wealthy citizens produce significantly more (KRIVA and SPARC, 2010).
10. Hence we shall not embark on a detailed analysis of the role of the state or international donors whom support them to simplify the discussion.
11. Including casts traditionally in charge of WM such as the Matang.
12. Nonetheless, Sharma (2000) narrates of "rags-to-riches" stories, whereby recycling workers have a hope of becoming plant owners.
13. ALM: set up by the MCGM to mobilize citizens in participating in SWM through waste minimisation, segregation at source, and waste awareness, particularly successful with the "bourgeois environmentalism" movement. In addition to FWM, collaborations were established with SMS to ensure door-to-door collection (Mahadevia et al.2005).
14. SAS: movement for health and sanitation where slum communities are remunerated by the MCGM for waste collection through CBOs. The pilot project took place in Dharavi and expanded to other slums.
15. "Sparkling Mumbai": Initiative to improve cleanliness as part of the Mumbai Transformation Project.
16. There is an extensive literature on the Alliance, which we cannot explore due to the limited scope of this work c.f. Patel and Mitlin (2001), Appadurai (2001), McFarlane (2004), Burra (2005), SPARC (2011).

6. Conclusion: urban planning through the understanding of metabolic flows

6.1 Scenarios for redevelopment:

In the light of our analysis of urban flows, we developed an in-depth understanding of the role of IWM in the city's metabolism. With respect to redevelopment projects, we established these can be problematic for IWM in terms of displacement from working and living spaces, and formalisation of WM services. Problems arise at city level, as unemployment sores and services are disrupted. Nonetheless, current working and housing spaces are clearly in need of improvement if they are to guarantee a better quality of life for actors in IWM. Concerning the DRP, there are three possible scenarios:

Scenario 1: A myopic plan: A DRP is carried out with none or few modifications. The recycling industry is moved out, and waste handling is formalised, ignoring the importance of the '13th Compound' as a core nexus of the urban metabolism in terms of economic turnover, poverty alleviation and environmental service. The idealisation of Mumbai as a world class city remains short-sighted, and does not account for long-term rebound effects of disrupting existing livelihoods.

Scenarios 2: Status quo: Individual vested interests from the current situation and incapacity to negotiate maintain a situation of stall. This would allow recycling plants to remain, although it would also entail the perpetuation of unhygienic, hazardous, and inadequate working conditions with low profitability for waste-pickers.

Scenario 3: Negotiating urban flows: National and international discontent attract attention and put Mumbai in the spotlight, creating pressure for negotiation. Positive outcomes build up from current successes, namely: the setting up of an expert committee with representatives from civil society; acknowledgement of the need for comprehensive data; the consideration of more decentralised community-driven upgrading and community involvement. This could include IWM organisations: recycling plant owners could negotiate the terms of their upgrading, displacement or regularisations, while waste-pickers organisations negotiate for service provision. This might include contracts for WM services, a guaranteed supply of waste from current and/or new businesses, training and equipment, etc.

6.2 Lessons learned

I would argue that a better incorporation of the lessons learned from Chapter 5 with respect to the consideration of the characteristics of IWM in future planning would increase the likelihood of strategies, plans and policies to respond adequately to the city's challenges, while remaining adaptive to future changes. This will not only ensure greater sustainability, but if all actors of urban life are included appropriately, it can set the basis for a just, inclusive and resilient city.

The main lessons for urban planning of IWM are the following:

a) IWM acts as an efficient and self-organising system that reduces waste volume and costs for municipal authorities. Acknowledging and including IWM in planning can result in beneficial outcomes for the urban ecosystem, increasing resilience to natural disasters and disease spread.

b) IWM subsists by providing responses to challenges such as unemployment and FWM insufficiencies linked to population pressure and overconsumption. If current dissipative modes of urbanisation remain in place, the problem of urban poverty and waste accumulation will amplify. These forces cannot be ignored when planning for cities: if Mumbai aims to 'modernise', urban poverty, housing, employment and industrial planning have to be tackled constructively and inclusively. In fact, the management of urban flows can only be effective if everyday practices are considered. If ignored, policies will result in incongruities, corruption, and inefficiency when implemented. This can be facilitated by building onto existing practices by the urban poor that have proved to be effective.

c) The urban poor can self-govern and create innovative forms of governance in all fields including WM. If CBOs are acknowledged and included in planning, they can have a role negotiating mutually beneficial and coherent outcomes for the city.

6.3 Concluding thoughts

In conclusion, lessons learned seem to point in the direction of greater involvement of IWM actors in the planning process to create a more sustainable and just city,

which in the case of Dharavi corresponds to Scenario 3. Nonetheless, this option leaves unanswered questions concerning the general sustainability of Mumbai's urban metabolism. Roy (2009) criticises the Alliance's model of governmentality as not questioning overall structures, but negotiating with existing powers to stabilise the lives of the urban poor, hence achieving change through co-opted emergence. There is no reassessment of forces of accumulation drawing on global resources to produce goods, while one can consider self-sufficiency or limited use of resources to be at the heart of the idea of sustainability (Niza et al. 2009). Nonetheless, within the current system, the recognition of IWM's contribution to the urban metabolism and its integration in planning remains of great value, as it would ensure the improvement of conditions for the urban poor, while contributing to urban resilience and environmental soundness, marking the first steps towards sustainable development.

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Annexes

Annex 1: Glossary

Decoupling: The OECD defines decoupling the breaking of the link between 'environmental bads' and 'economic goods'. This is achieved though increasing resource productivity and 'eco-efficiency', which is the delivery of "competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life cycle" (Schmidheiny, 1992)

Source: UNEP, 2011, URL: http://www.environment.gov.za/sites/default/files/docs/decoupling_natural_resourceuse.pdf

Dematerialisation: Refers to the absolute or relative reduction in the quantity of materials required to serve economic functions

Source: Wenick et al. 1996, URL: http://phe.rockefeller.edu/Daedalus/Demat/

Ecological economics: The study of the efficient allocation of resources within the boundaries of the earth's estimated carrying capacity. The principal goal is that of resource efficiency. To not be confused with environmental economics, which is a subset of neoclassical economics, which recognises the importance of the ecosystem for human welfare and use a variety of techniques to assign market values to the environment to incorporated it into market models, but remains devoted to economic maximisation as the ultimate goal.

Source: Daly and Farley, 2004, URL: http://indomarine.webs.com/documents/Ecological_Economics_Principles_And_Applications.pdf

Entropy: The law of entropy states that energy and matter in a closed system move inexorably toward a less ordered (less useful) state , according to the Second Law of Thermodynamics. Therefore, entropy is the resulting low-order, chaotic state

Source: Daly and Farley, 2004, URL: http://indomarine.webs.com/documents/Ecological_Economics_Principles_And_Applications.pdf

Exergy: The maximum work that can be done by a composite of a system and a reference environment. It is also defined as available energy or utilisable energy

Source: Dincer and Rosen, 2007, URL: http://books.google.co.uk/books?id=ruR7U3IjrR0C&printsec=frontcover&source=gbs_atb#v=onepage&q&f=false

Externality: An externality occurs when an activity or transaction by some parties causes an unintended loss or gain in welfare to another party, and no compensation for the change in welfare occurs. If the externality results in a loss of welfare, it is a negative externality, and if it results in a gain, it is positive.

Source: Daly and Farley, 2004, URL: http://indomarine.webs.com/documents/Ecological_Economics_Principles_And_Applications.pdf

Feedback Mechanisms: a circuit that feeds back some of the output to the input of a system. A positive feedback loop amplifies the original output, while a negative feedback loop has a corrective function.

Industrial ecology: the study of the physical, chemical, and biological interactions and interrelationships both within and between industrial and ecological systems, and to identify and implement strategies for industrial systems to more closely emulate harmonious, sustainable, ecological ecosystems. The goal of industrial ecology is to change the linear nature of the industrial system, where raw materials are used and products, by-products, and wastes are produced, to a cyclical system where the wastes are reused as energy or raw materials for another product or process.

Source: Garner and Keoleian, 1995, URL: http://www.umich.edu/~nppcpub/resources/compendia/INDEpdfs/INDEintro.pdf

Informal sector: Characterised by small-scale, labour-intensive, largely unregulated and unregistered, low-technology manufacturing or provision of services

Source: Wilson, et al. 2001 in Wilson et al., 2003, URL: http://previous.wiego.org/occupational_groups/waste_collectors/Wilson_Velis_Cheeseman_Informal_Sector_Waste.pdf

Kuznets Curve: The theory by which income inequality first rises and then falls as economic development proceeds. This implies that the inequality indicator is an inverted U-shaped function of income per capita. This has been expanded to

the theorising of environmental degradation, whereby in the early stages of economic growth degradation and pollution increase, but beyond some level of income per capita the trend reverses, so that at high-income levels economic growth leads to environmental improvement.

Source: Stern, 2003, URL: http://www.ecoeco.org/pdf/stern.pdf

Political Ecology: The basic notion of political ecology is the coming together of political economy and cultural ecology, focusing on factors that shape relations of power among human groups, and that influence relations between these and diverse aspects of their environments. "Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself" Blaikie and Brookfield (1987: 17)

Source: Paulson et al. 2003, URL: http://search.proquest.com.libproxy.ucl.ac.uk/docview/201030623/138ED04FE877C439B93/3?accountid=14511

Urban Ecology: is an understanding of the city as natural ecosystems which interacts with its environment

Source: Marcotullio and Boyle, 2003, URL: http://www.ias.unu.edu/binaries/UNUIAS_UrbanReport1.pdf

Urban Political Ecology: Marxist current concerned with the social and material production of urban nature. It focuses on how urban environments are controlled and manipulated to serve the interests of the elites at the expense of marginalised populations

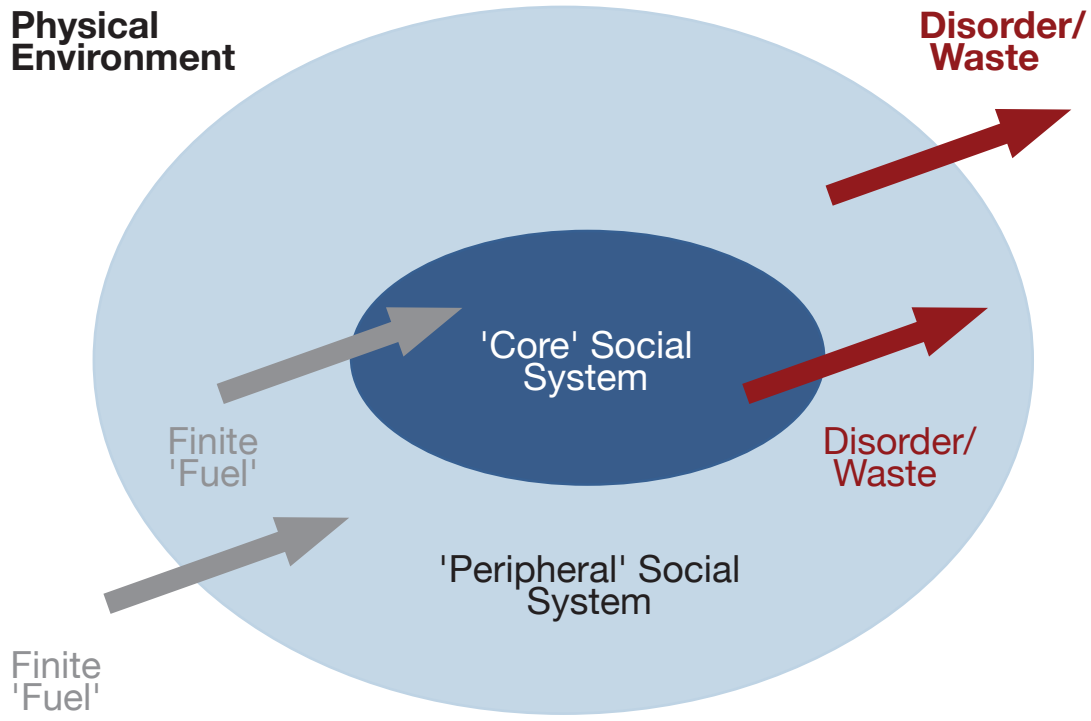
Source: Swyngedouw and Heynen, 2003, URL: http://nheynen.myweb.uga.edu/pdf/antipode1

World System Theory: world-systems perspective is a strategy for explaining social change by focusing on whole intersocietal systems rather than single societies, stressing the importance of networks (trade, information flows, alliances, and fighting) linking polities and cultures together. Hence, the world-system, and not national entities, becomes the primary unit of social analysis. Structurally, this entails a stratification system between core, peripheral and semi-peripheral regions, mainly dictated international division of labour.

Source: Chase-Dunn, nd, URL: http://www.sociologyencyclopedia.com/fragr_image/media/dependency

Annex 2: Two levels of dissipation in core/periphery analysis

Figure 1: Two levels of dissipation in core/periphery analysis. Source: Biel, 2006



Annex 3: Overview of Mumbai – the megacity

Greater Mumbai, which includes the Island City and the Suburbs, is an18km peninsula that runs North to South, and is home to 12.5 million people, while 20 million people reside in the wider Mumbai Metropolitan Region (Census of India, 2011). It is the fourth most populous city in the world, and is projected to grow to a population of 26 million by 2025 (UN, 2010). It is also among the most densely populated, with an average of around 21,000 inhabitants per square km (Census of India, 2011).

Despite numerous constraints, Mumbai has a booming economy, generating 5% of India's GDP and a third of tax revenue (Cities Alliance, 2010). By 2025 Mumbai's GDP is estimated to grow by 6.3% annually, making the city jump from the 29th wealthiest worldwide, with a GDP of $209 billion in 2008, to the 11th with a GDP of $594 billion (Pwc, 2009). Mumbai is the financial and commercial heart of the country, and houses institutions such as the Mumbai Stock Exchange, the National Stock Exchange, and the headquarters of many national and multinational banks and corporations. These are mainly located in the Central Business District (CDB) in the southern part of Mumbai.

Mumbai is a very active, industrious city – characterised by a varied economy both within the formal and informal sector. While Delhi considered the political and intellectual capital, Mumbai is the place where 'things happen', attracting people from around and outside India. In fact, cosmopolitanism is a long-standing tradition, and Mumbai is the Indian city with the largest variety of ethnic, linguistic and religious groups. The most common languages are Marathi, Hindi, Gujarati and English, and the ethnic majorities are composed of Maharastrians (42%) and Gujarati (19%) (Census of India, 2001 in Watson et al, 2011). In terms of religion, Hindus represent 67.39% of the population, Muslims 18.56%, Buddhists 5.22%, Jains 3.99% and Christians 4.2% (Census of India, 2001 in Watson et al, 2011).

The process of urban growth has been closely paralleled by rapid urbanisation, for which Mumbai earned the title of 'megacity'[1]. The vision of cities as centres of economic growth has influenced India's population distribution. In fact, 32% of the Indian population currently live in cities currently live in cities (World Bank, 2014), with urban centres significantly contributing to India's GDP[2]. Nonetheless, although this process increased overall prosperity, it also deepened regional disparities, creating incentives for migration and shifting the problem of poverty from rural to urban areas, with 76.4 million Indian urban citizens living below the poverty line (Government of India, 2012).

Annex 4: Summary of the Dharavi Redevelopment Plan (DPR)

Background:

The Dharavi Redevelopment Plan (DRP) DRP was elaborated in 2004 through a public-private partnership between architect Mukesh Metha and the Maharashtra Housing and Area Development (MHADA), which consist in a tabula rasa redevelopment strategy for the whole area.

Main characteristics:

- The division of Dharavi into five sectors to be redeveloped by five different private developers
- The increase in density by setting a higher FSI (Floor Space Index) at four as opposed to two and a half in the rest of Mumbai
- Applying a single typology to the whole territory, consisting in a three-story podium and a high-rise
- Financing through cross-subsidisation and Transferable Development Rights (TDR)
- The cost-free allocation of a 300 sq foot flat to all residents that can prove to have settled in Dharavi before 2000

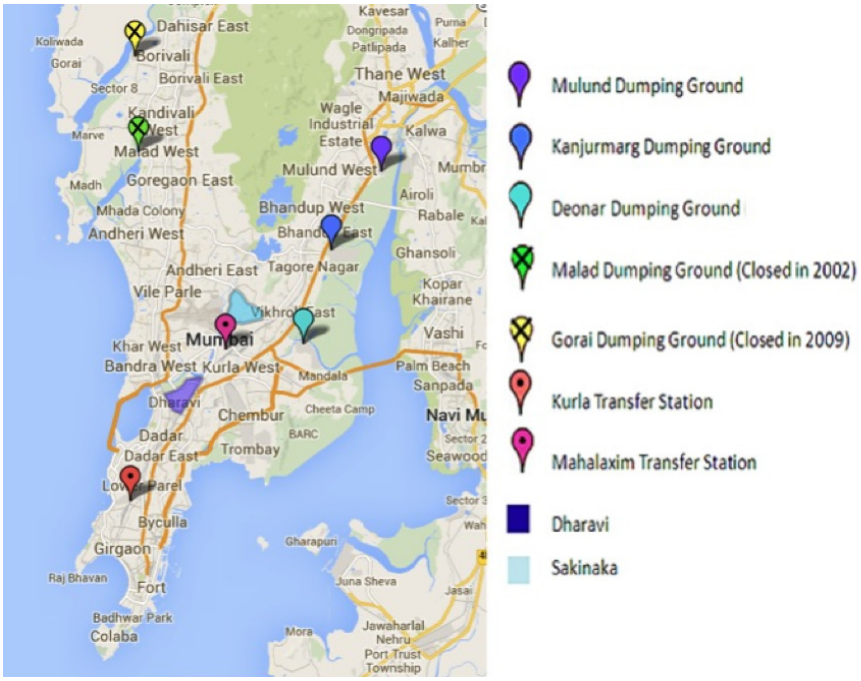
Contested issues:

- The division into five sectors does not respect current socio-spatial boundaries established by the community
- The 'one typology fits all' model ignores the diversity and multiplicity of current economic activities in Dharavi. The high-rise structure removes the possibility to use public space to socialise and to carry out income generating activities e.g. drying pottery, sorting waste, or selling street food
- Households are allocated mono-functional flats, while livelihood opportunities often depend on combining working and living spaces
- Eligibility criteria excludes many of Dharavi's residents, as not all can prove how long they have lived there, and renters and transient tenants are not included in the flat allocation scheme. Nonetheless, Dharavi houses many migrants which rely on these type of arrangements
- Despite claims to include Dharavi's residents in planning, there is little evidence of an effective method to carry this out. In addition, residents are poorly informed about decisions taken concerning the area
- There are fears that investment incentives embedded in the TDRs will direct priorities towards profit maximisation over social provision

Source: Adapted from: BUDD, 2009

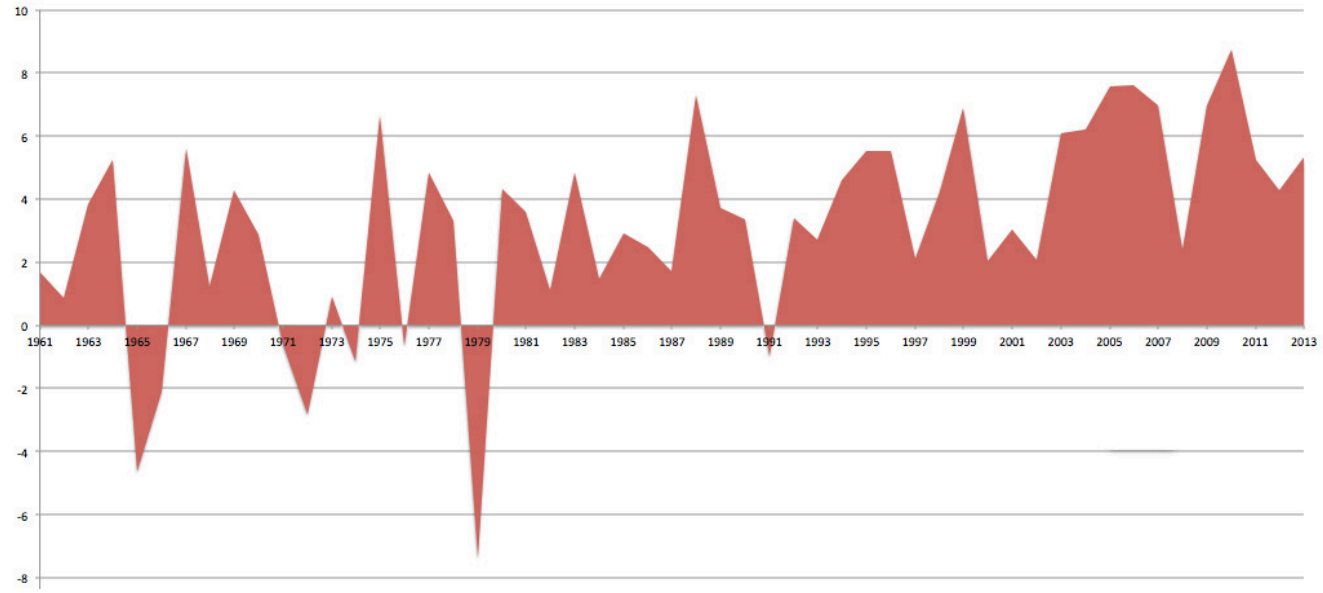
Annex 5: Location of dumping grounds and relevant areas

Figure 1: Location of dumping grounds and relevant areas. Source: Map Data © 2014 Google – Edited in Google Maps Maker by author based on information from Mahadevia et al, 2005



Annex 6: Indian GDP per capita growth between 1961 and 2013

Figure 1: Illustration of fluctuations during 'national phase' and mostly positive growth in 'global phase'. Source: World Bank Development Indicators, 2014



NOTES TO ANNEXES

1. Exceeding 10 million inhabitants
2. 60% in 2000 according to the World Bank (2002), but likely to have increased since

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