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Wildeboer, V.; Savini, F.

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– THE STATE OF THE CIRCULAR ECONOMY: Waste Valorization in Hong Kong and Rotterdam

VIKTOR WILDEBOER AND FEDERICO SAVINI

Abstract

The concept of the circular economy has gained significant political momentum because it offers policymakers a viable approach to tackling resource depletion, reducing waste and promoting economic development all at the same time. Current research, however, only focuses on the technological feasibility of this model, overlooking circularity's inherent contradiction: namely, that it valorizes waste rather than reducing it. This article tackles this limit by questioning the role of the state in what we describe as 'waste valorization'. It interrogates the urban political ecology of construction and demolition waste, the largest stream of inert materials in the world. It analyses CDW's geographies and economic position in urban development and the shifting rationales by which it is governed. To do this, it compares historical shifts in how CDW has been regulated in Hong Kong and Rotterdam. The article shows that waste is no longer an abject residual of urbanization, but a driver of urban development and a burgeoning sphere of accumulation in ecological capitalism.

Introduction

Urbanization leaves in its wake the largest solid waste stream in the world: construction and demolition waste (henceforth CDW) (Chen *et al.*, 2018). Demanding 28.7 billion tons of construction materials worldwide, urbanization is today the prime driver of resource depletion. Our economy demands 18 kilograms of sand per person per day, while the consumption of minerals is expected to double by 2050 (Circle Economy, 2020). As a residual of urbanization, cities produce three billion tons of CDW each year, and half of this waste is reused or recycled as backfilling material in the (re) production of all that makes up the urban fabric: from materials under bridges, to roads and buildings.

Under these conditions, the recovery of materials from waste has become a prime goal of governments, which, at all scales, are searching for viable ways of combining resource efficiency with economic outputs (European Commission, 2015). Labelled the circular economy, most recent approaches to resource productivity rest on a view of sustainability that is concerned to valorize all the residues and surpluses of urban production and consumption (Reike *et al.*, 2017). Circularity models advocate a form of economic development that prospers by perpetually valorizing residual streams. Waste becomes 'wealth', the source of economic and social value (Lacy and Rutqvist, 2016). This article dissects the institutional factors that drive this new paradigm of sustainable growth and interrogates cities' role in this process. It does this to explain a transition in capitalist accumulation from a paradigm of economic development involving the management of waste to one that prospers from waste valorization.

Current research on the circular economy privileges techno-managerial approaches, which focus primarily on waste recovery's technological and infrastructural requirements (Lu and Yuan, 2011). These studies overlook the political and institutional drivers behind infrastructural adaptations and therefore reach contradictory

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conclusions: on the one hand, the (circular) valorization of waste is understood as a shift away from processes of environmental and labour exploitation that produce valueless materials, such as garbage. On the other, this valorization reveals a new paradigm of eco-modernization, which reproduces capitalist accumulation through resource exploitation and wasteful consumption (Reike *et al.*, 2017). In other words, it reframes waste as a source of value for urban development that might exacerbate the conflict between urban economies' dependency on the constant supply and waste reduction imperatives (Savini, 2019; Corvellec *et al.*, 2020).

This article questions the changing urban political ecology of CDW by disentangling the contradiction of circular economy discourses, that is, valorizing waste to reduce it. As we show in the next section, the urban political ecology literature has only begun to question the centrality of waste in ecological capitalism and still neglects the historical trajectories leading capitalism to develop a seemingly new contradiction: valuing waste to reduce it. We problematize the state's role as the regulatory infrastructure that revalues waste materials, which change from being an unwanted externality to an economic resource (O'Brien, 1999). As Loftus (2018) argues, the socio-political drivers behind emerging sustainability fixes can be found in the (ecological) state's problematization of the regulatory nexuses (see also While *et al.*, 2004).

The article compares historical trajectories of CDW valorization in the Hong Kong and Rotterdam regions. We analyse CDW—a large-scale non-household waste stream—to grasp how shifts in regulations rearticulate city-regional metabolisms (Kaika and Swyngedouw, 2000; Gille, 2010). We dissect three historical periods, focusing on three shifting dimensions of the state: the governance rationale enacted to process CDW, the changing geographies of waste streams and the articulation of economic and environmental concerns in development policies—what we call the economic-environmental nexus. The valorization of waste, we contend, reveals how the ecological state is geared toward marketizing, privatizing, and commodifying waste streams in urban development. Our comparative case study shows that, through this regulatory infrastructure, waste now drives urban transformations via land reclamation and infrastructural development.

Building on insights from the regulation theory of the state, the following section conceptualizes these dimensions and applies them to waste ecologies. We then explain the research methodology used in this study, which was conducted between January 2019 and June 2020. The two case studies are presented separately. The article concludes by reflecting on the institutional processes that drive waste valorization, advancing a critique of the emerging models of waste valorization entailed in circular economy discourses.

From abjection to valorization: the state and the new urban political ecology of waste

Over the years, urban political ecology has conceptualized waste as resulting from the urbanization of capital through socio-environmental exploitation. Garbage was urbanization's residue and had no place in cities (Kaika *et al.*, 2006). The rift between cities and rural areas, urban and natural, marked the foundations of the materialist critique of waste production (Foster, 2000). Modern urbanization has produced today's wastelands, sites where the exploitation of nature and labour materializes as unwanted garbage. Historically, waste has been understood as abject material in capitalist accumulation, the unavoidable 'negative' value-form or 'anti-value' of capital (Harvey, 1997; Gidwani and Reddy, 2011). Waste was devalorized because it could not be circulated in the urban economy of industrial production, real-estate, knowledge and finance.

The value of waste emerges from conflicts over capturing the socio-economic utility of residuals (Gidwani, 2013). These conflicts revolve around the institutional infrastructures that determine the owning, processing, appropriating and (re)

distribution of residuals (see, for example, Gille, 2010; Lepawsky and Billah, 2011; Schindler and Demaria, 2019). The devalorization of urban waste, typical of modern urbanization, reflects dominant recovery modalities that privilege economies of scale, cheap labour costs, global value chains and large-scale recovery facilities over community-based and short-chain value creation (Melosi, 2005). Devalorization also produces a culture of disposal that thrives on wasteful consumption (see Hawkins and Muecke, 2003).

Waste's geographies, in turn, mirror the asymmetrical socio-spatial relations produced by global economic accumulation (Gandy, 2013). Exposure to bacteria, rubbish and excrement signals marginality, exclusion and exploitation. In urban political ecology, waste's abjection is understood as key to the urban 'hygiene' paradigm that sees residuals as incompatible with cities' accumulation strategies (Gandy, 2004). The abjection of waste characterizes a mode of urbanization that thrives on the separation of the 'urban'—the places of socio-economic development—and the marginal. Such marginal sites of waste processing and socio-environmental damage, the wastelands of urban agglomerations, are needed for urban economic growth (Lepawsky *et al.*, 2015).

Increasing concerns about resource efficiency and the rise of circular economy narratives mark a shift in waste's position in contemporary urbanization. Waste is now centred in economic approaches to sustainable development (Blomsma and Brennan, 2017). This renewed centrality reveals an emerging urban political ecology of waste: it is no longer a pollutant of urbanization, but is now commodified through a process of valorization (see also Schindler and Demaria, 2019). As Gidwani (2013: 781) puts it, historically 'waste begins as capital's external frontier but has now come to mark both its external and internal frontiers: an enemy to be engaged and beaten'. In our view, the concept of circularity embodies a paradigm of green growth that imagines the 'end of waste' but not wasteful consumption. It refuses waste's negativity in economic processes, instead turning it into a business opportunity. As we later show, large waste streams like CDW are valorized to sustain urban development and land reclamation projects.

To capture this renewed political ecology of urban space, we must grasp how this valorization changes the existing regulatory infrastructure of material flows (Aglietta and Breton, 2001; Castree, 2008). An accumulation regime can be defined as a 'pattern of production and consumption that is reproducible over a long period' (Jessop, 2013: 8). Regimes become institutionally embedded through modes of regulation, the regulatory principles organizing the state apparatus. A mode of regulation is defined as an 'ensemble of norms, institutions, organisational forms, social networks, and patterns of conduct that can temporarily stabilize an accumulation regime ... despite the conflictual and antagonistic nature of capitalist social relations' (*ibid.*). Capitalism's long-term cycles can be understood through the historical succession of accumulation regimes—alternating periods of stable accumulation and regime change (Boyer, 2018). Studies using this approach have dissected the regulatory mutations that adapted capitalism to economies of knowledge and finance through precarization, specialization of labour and uneven globalization of investment circuits (Jessop and Sum, 2000).

In urban political ecology, this approach has explained the relationship between economic accumulation and environmental transformations. For example, Meadowcroft's (2005: 3) 'eco-state' is 'concerned explicitly with keeping patterns of consumption and production within ecological limits'. While and colleagues further problematized the role of environmental regulations in fostering an urban economy of sustainable development (While *et al.*, 2004; 2010). They argue that, from the late 1990s, sustainability targets have become central to all governments' approaches to economic development. This generates an altered mode of regulation that rescales governmental powers, produces new ecologies through the adaptation of infrastructures and consumption patterns, and rearticulates environmental goals within regional economic development.

However, urban political ecology research on the eco-state has not yet considered waste's central position in urban development, nor developed a critique of circular economy programmes within capitalist accumulation (see, for example, Savini, forthcoming). Waste valorization, we argue, signals the formation of an eco-state to address a contradiction of contemporary capitalism: the simultaneous worsening of resource depletion and accumulation of valueless waste materials. This valorization shifts governing arrangements and waste policy discourses: waste is transformed from a hazard into a socio-economic resource (Bulkeley *et al.*, 2007; Gille, 2010). Yet, the specific socio-spatial and ecological effects of this valorization depend on the policy regimes that regulate the modalities, institutions and geographies of waste circulation (Pollans, 2017; Savini, 2019; Schindler and Demaria, 2019). The state's regulatory infrastructure defines how waste's value is created and appropriated. We identify three dimensions of this regulatory infrastructure: (1) the rationales organizing waste governance, (2) the changing geographies of waste circuits, and (3) the discursive coupling of economy and environment.

First, the rationales for waste governance rearticulate institutional responsibilities for the management of waste streams. Since the 1990s, the privatization and marketization of environmental services has motivated a transition from command-and-control measures to market-based solutions such as eco-taxes (Turner, 2003). While disposal regulations remain strong in the waste sector, they now sustain a market of different waste (sub)streams. Policy instruments increasingly promote public-private partnerships and privatization (Prendeville *et al.*, 2018). This is accompanied by ongoing privatization of waste management facilities and the formation of large-scale industrial global conglomerates in utility services. Yet, because of waste disposal's high costs and low yields (due to the availability of cheap primary resources), public authorities retain an important role (e.g. in providing public incinerators and collection) and the market remains highly regulated (e.g. through incentives and concessions) (Massarutto, 2007). Waste valorization mutates the industrial composition of the waste sector: it pushes the marketization of waste (sub)streams and increases the legal responsibilities of waste producers and consumers, including urban households, in the recovery process (Pollans, 2019; Savini and Giezen, 2020).

Second, these shifts in governance rationales redefine waste's urban geographies. Waste management requires significant space, but residuals' market value tends to remain relatively low. In valorizing waste, market actors deal with these logistic complexities by deploying infrastructural adaptation and relocation strategies. Governments guide these geographical shifts through regulatory requirements for land use, industrial development, infrastructural zoning and waste processing fees (Davoudi, 2009). In this light, the emergence of multinational giants providing waste and integrated utility services (e.g. Remondis, Suez, Renewi etc.) responds to a new scalarity of waste value chains. While these chains operate transnationally, they rely on regional networks of waste processing sites. Waste value chains are, therefore, glocal. Waste valorization affects cities' spatial configurations by producing urban sites of value extraction from residual streams. Because longer value chains increase logistical and labour costs, waste companies have in the past either exported to countries where labour was cheaper or sought economies of scale by combining waste recovery with other utility services. To minimize processing costs, they today locate industrial sites close to cities, the sources of waste.

Third, alongside changes in governance rationality and spatial reorganization, the rise of waste valorization reflects waste's new position within economic development strategies. The economic-environmental nexus is a discursive articulation of economic and environmental policies. Valorization centres waste—conventionally an environmental concern—within economic development programmes. In doing so, it resolves the state's paradoxical position as both protector of the environment and enabler

of economic development (Pollans, 2019). As Gille (2010) argues, the shifting definitions of waste in policy arenas are both the product of, and essential drivers for, the creation of new state-driven waste-governing practices. Circular economy discourses (part of green growth) purport to regulate waste for a new kind of sustainable development, but do not question wasteful consumption, the source of waste itself. Circularity becomes a moral discourse justifying waste valorization as an environmental strategy while bypassing the major challenge of waste reduction (see also Gregson *et al.*, 2015).

Together, governance rationales, waste geographies and the discursive articulation of environmental and economic policies shape the profile of the ecological state. Changes in waste governance produce new geographies of material streams that promote, even demand, a shift in the public discourse on the economic utility of waste. In what follows, we offer a historical analysis of the political ecology of CDW in two urban agglomerations to trace the interrelations of these three processes.

Methodological note

This research compares two city regions: Hong Kong and Rotterdam (the latter also known as the Rijnmond Region, but henceforth Rotterdam). These cases were selected because of the major differences in how their overall CDW sectors are organized. Whereas in Rotterdam CDW is collected and processed by private companies, in Hong Kong CDW processing is under government control. Given these differences, it was possible to trace the historical trajectory by which, in both locations, CDW went from being primarily a matter of public regulation to a diversified sector of public-private governance.

The two city regions also bear similarities. CDW recovery is challenging in both contexts, for urban redevelopment is intertwined with the history and organization of their large ports and logistical industries. In Rotterdam for every 100 houses that were built in 2015, 115 were demolished, while demolition rates were about 10 times lower in other Dutch cities (Gladek *et al.*, 2018). In Hong Kong, rapidly rising land values made urban redevelopment—and with it CDW—a crucial driver of economic wealth for both private development companies and governmental authorities (Lee and Tang, 2017: 3404). Both city regions are very dense and under intense developmental pressure. As such, they face the challenges posed by both the scarcity of material resources (mostly imported) and the spatial burden of waste itself. Both regions have a very high CDW reuse ratio (94% in Hong Kong, EPD, 2017; 96% in Rotterdam, CBS, 2018). This article focuses on the inert fraction of CDW (about 90% of the total volume), which consists of materials such as concrete, bricks and stones.

The research team collected three types of data between May 2019 and May 2020. First, we carried out desk research on waste policy, regulation and statistics (at both national and regional levels) to identify relevant actors and key political and economic challenges facing CDW processing. Second, we interviewed 25 experts in construction, waste, and government (13 in Rotterdam, 12 in Hong Kong). Questions addressed the history of waste management regulations, geographies of construction materials and CDW streams, and attempts to valorize waste historically and today. These interviews benefited from visits to waste processing sites and construction material suppliers, during which we discussed the infrastructural adaptations required to valorize waste. Third, we retrieved background information through archival research on CDW management in the two regions and analysis of trends and developments in the construction and waste management sectors.

CDW in Hong Kong: a material initially wanted, now wasted

In the centuries before the British arrived in Hong Kong, the islands' economy was built on the production of seashell-cement and excavation of 'excellent local granite' (Walker and Rowlinson, 1990: 13). With British settlement in 1841, the demand for

land began to grow. The city's steep hills relegated development to the scarce land on the shoreline. This problem was overcome by reclaiming land from the sea by filling shallow waters and rice paddies (Ho, 2018). These waters were packed with CDW, which was abundant in Hong Kong and thus presented a cheap alternative to more expensive materials such as sand and rocks. In the following century, accumulation by land reclamation became the territory's primary land development strategy and the dominant mode of CDW disposal, a strategy mirrored by Singapore (Grydehøj, 2015). Accordingly, public authorities and developers in Hong Kong did not see high volumes of CDW as a problem, for they sustained an urbanization pattern in which the 'rate of reclamation is governed by the availability of landfill [CDW]' (Newcombe *et al.*, 1978: 14).

As a key driver of Hong Kong's urbanization, land reclamation became the pillar of the city's land economy. Low tax rates increased public authorities' reliance on property-related income, predominantly secured by selling land-reclamation projects (Chiu, 1973). Land reclamation allowed the government to control land supply while also providing an outlet for CDW. Large property developers benefited from land's scarcity and high value since newly reclaimed land was awarded to the highest bidder (Interview with an expert in the supply of construction materials, September 2019), and they were the only actors of sufficient size competing in the open tenders (see also Ng, 1999: 13). This structured the city's political economy, making Hong Kong's government and a few big property developers influential players in land development. It formed what Lee and Tang (2017: 3403) call the 'hegemony of the real estate sector', which penetrates all facets of daily life in Hong Kong.

– Contested construction and the limits of reclamation

In the late 1970s and early 1980s, the economic transition from a manufacturing to a finance-led economy started to exacerbate the environmental burden of CDW on the city's development regime. Despite this, the government did not impose stricter regulations on account of the lobbying power of the construction industry, which feared that waste disposal costs would be internalized (Chung and Poon, 1994). From the late 1970s to the 1990s, Hong Kong was a 'waste management' state. Public waste-management schemes released the construction industry from the burden of CDW management. Waste became external to the urban economy.

Like many countries across Asia, Hong Kong increased its capacity to incinerate solid waste even though incineration could not deal with the largest fraction of CDW. The Hong Kong government also tried to impose a disposal tax on CDW, but met with fierce resistance from the industry (*ibid.*). The absence of a disposal fee ensured that no private recycling firms could be established, for land prices remained high and CDW could be disposed of for free (Planning Bureau, 1998). Disposal mainly took place in public reclamation projects, which turned urban development into a way of managing waste (Environmental Protection Department, 1993).

When a temporary drop in reclamation projects in the late 1980s limited the space available for CDW processing, contractor firms started to dispose of their CDW in landfills. The government found this undesirable: landfill space was scarce, expensive, and landfills were intended almost exclusively for municipal solid waste. Indeed, whereas few alternative processing methods were available to process municipal waste, CDW could be used for land reclamation (Works Branch, 1993). However, lacking any regulatory instruments to direct CDW flows, the government's only option was to divert CDW from landfills by ensuring that 'there are sufficient strategically located [reclamation] sites available at all times to accommodate all suitable surplus excavated material and other suitable construction waste' (Works Branch, 1993: 1).

The rising volumes of CDW were deemed so problematic that they motivated new reclamation projects. Yet, the government's response ignored the growing social discontent over the land development system, where (in 2004) about 20% of Hong

Kong's built area was on reclaimed land (Ng, 2011). Like Xiamen in mainland China or nearby Macau, land development through reclamation created spaces of little public value (Grydehøj, 2015). Hong Kong citizens' protests against reclamation culminated in a ban on further reclamation in Victoria Harbour (see Figure 1) through the implementation of the Harbour Ordinance (1997). Several planned reclamation projects were cancelled while intensified real estate development continued to generate CDW. Again, the government feared that CDW would be landfilled but could no longer turn to reclamation as a viable outlet.

– The difficult transition to waste valorization

Rising resistance to land reclamation made CDW valorization central to the government's strategy to ensure that construction could continue. The city found itself entangled in a set of challenges: maintaining a steady supply of construction materials, managing the stream of CDW in a densifying region, and dealing with the increasing economic burden of urban development waste for both public and private actors. Waste processing's changing role in the city region's overall economic output may mark the beginning of a new waste valorization regime. However, as we shall show, such a transition did not fully unfold in Hong Kong, despite the numerous efforts made in that direction and policies implemented from the 2000s. In 1998 the government implemented the Waste Reduction Framework Plan, a 10-year strategy to alleviate the pressure of CDW on the landfill capacity and conserve natural resources by boosting the recycling industry (Planning Bureau, 1998). This was to be achieved by involving the private sector in CDW management; the right to process CDW was put out to tender.

This started in 2002. Hong Kong's government set up two sites, both of which had the capacity for both the temporary storage of CDW and the production of recycled aggregates from it (Lu and Tam, 2013). The government tendered the recycling of CDW to private companies, but no successful candidate was selected, partly because construction companies affiliated with primary material suppliers had little incentive to reuse CDW and partly because the government was seen as being overly controlling in recycling (interview with an expert in the supply of construction materials, September 2019). Given the lack of private interest, the government took matters into its own hands, operating the sorting and crushing plant itself. Although the resulting recycled aggregates were mainly used in government works, the correctional service department also used them to produce pavement bricks. This gave rise to multiple projects for reusing CDW, the Hong Kong Wetland Park (completed in 2006) being the best-known. Nevertheless, overall recycling remained limited (interview with a former government official [Architectural Services Department], October 2019).

With the introduction of a CDW disposal charging scheme in 2006, the government gradually and effectively started to open the sector to private companies (Lu and Tam, 2013). This scheme aimed to 'promote the reduction of construction waste at source, encourage selective demolition and on-site sorting and recycling by financial incentive' (Education Bureau, 2011: 15), by levying a fee for each ton of CDW disposed of. The increased cost of disposal boosted the waste recovery market. Two CDW recycling companies undercut the government's disposal charge by allowing construction companies to dispose of their CDW at the company site instead of a government processing facility. The companies make pavement bricks out of CDW released from tunnelling works and demolition projects. One company is located in the government's EcoPark. Opened by the Environmental Protection Department in 2006, it aimed to boost the domestic recycling industry, which suffered under the high land prices. Indeed, land scarcity had a 'chokehold on recycling' (interview with an employee of a CDW recycling company, October 2019). The EcoPark 'endeavors to promote the turning of waste into resources by returning recyclable materials to the production line and the consumption loop, promoting the development of the local environmental and recycling industry' (EcoPark, 2020: para. 3).

Despite this, CDW valorization still remained limited, leading the government to start exporting CDW to relieve pressure on domestic disposal sites. From 2007 onwards, the Hong Kong government paid to export the majority of its CDW to the nearby region of Taishan in mainland China. Yet disposal charges were not sufficient to cover the costs of exports and governments had to invest considerable resources in waste processing (Audit Commission, 2016: vi). In 2016, in response to this shortage, the government increased the fees to HK \$200 (€21.31) per ton, an increase of about 80%. However, this was contested—the initially proposed fee of HK \$500 (€57.12) per ton was defeated after opposition from real estate developers. A professor in construction engineering at the University of Hong Kong noted:

a lot of people said it was too expensive. But it was mainly the businessmen and the developers who objected. Eventually we raised it to 200 dollars. We are not moving forward, our rate of recycling is very low, that is a problem. This is a policy issue. There are also technical issues, but they are not difficult to solve (interview, September 2019).

Negotiations around the establishment of disposal fees and obligations show the rationale of waste valorization: to balance the public drivers behind waste recovery, the real estate industry's requirements and waste disposal companies' financial yields. The rejuvenation of urban development through further land reclamation served to combine these ambitions, particularly with reclamation projects on the city's peripheries (Disneyland in 2005, the Hong Kong-Zhuhai-Macao bridge in 2009). Currently, two new reclamation projects are underway—the Third Runway (begun 2016) and the residential new town Tung Chung (begun 2017). There are ambitious future reclamation plans for 'Lantau Tomorrow', an artificial residential island between the city centre and airport (see Figure 1).

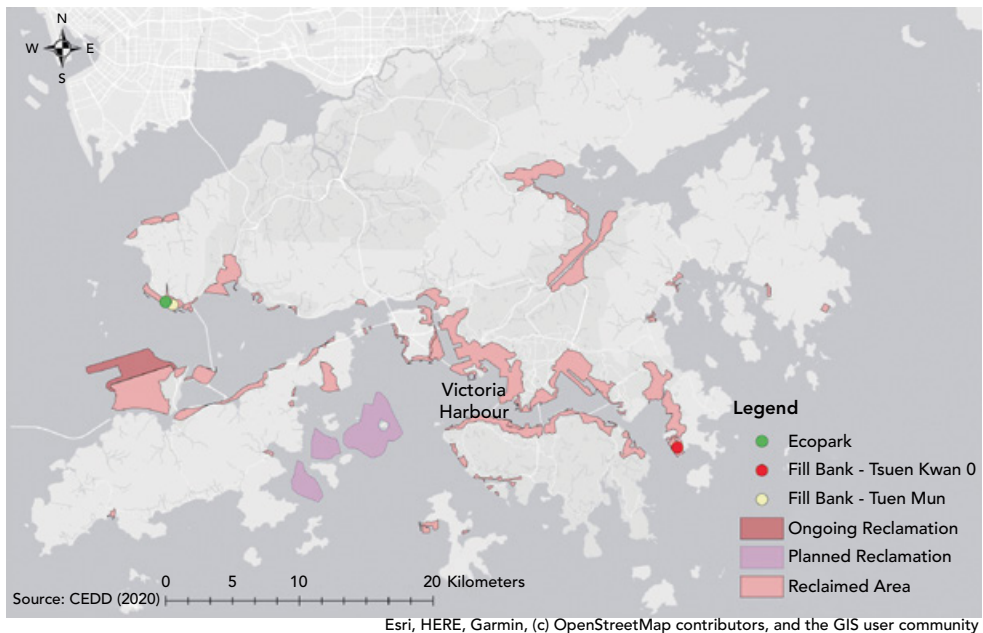


FIGURE 1 Map of reclamation and CDW processing sites in Hong Kong (source: map produced by the authors, based on CEDD, 2006)

Waste valorization in Hong Kong has not fully taken hold. Land reclamation remains the preferred way of disposing of CDW given high management costs (because of density) and a relatively undeveloped CDW recovery industry. The result is a high rate of CDW reuse in land development, similarly to countries like Singapore (Fujii and Rohan, 2019), and a limited reuse of CDW in construction projects themselves. The sudden cessation of reclamations in the late 1990s and resulting emphasis on alternative CDW processing methods testify to the link between waste management and land reclamation. Hence, while recycling developed as a public service in the early 2000s, the city's historical reliance on reclamation resulted in CDW disposal by way of exports and new reclamation projects more recently.

Rotterdam: From reconstruction to circularity

Rotterdam's image as the city that is 'continually rebuilt' (van den Berg, 2012: 157) took off in May 1941, when the city centre was bombed to destruction in the second world war. With almost all its buildings destroyed, the inner city could now make room for automobiles and commercial spaces. Several large housing projects were realized during the reconstruction in the 1950s. Demand for primary materials such as sand and gravel increased (Veraart, 2019) and the frequent renovations in the following decades generated a steady supply of CDW (Ramakers, 1990).

At that time regulations organizing waste largely related to public health and hygiene (Hendriks, 1999). As a relatively 'cleaner' waste stream, CDW fell largely outside these frameworks. It was disposed of in municipally managed former sand excavation pits or privately owned farmland at a price set by the owner (interview with a director of a waste management company, September 2019). CDW was transported far beyond the Rotterdam regional area (Kreijger, 1983). This put pressure on the environments of smaller municipalities that bordered larger cities, where undifferentiated, untreated and contaminated waste was disposed of without proper treatment (Eikelboom *et al.*, 2000). As in Hong Kong, this period was characterized by markedly site- and material-specific regulations allowing for quick CDW disposal or no regulation at all. As we show below, this disposal system became problematic when the growing strength of public opinion on sustainability pushed governments to regulate waste not as public health but as an environmental issue (van der Heijden, 1998; see also Gille, 2010). Throughout the 1970s and 1980s, waste disposal regulations diversified as responsibility for waste processing continued to fall upon municipalities and provinces. Waste disposal varied among city regions and the lack of common environmental regulations led to highly diversified, often opaque waste disposal markets, with different quality standards (de Jong and Wolsink, 1997).

– Upscaling governmental waste management

In the 1970s and 1980s, the rise in housing and infrastructure development began to burden the existing logistical infrastructure, the supply of raw materials and, consequently, increased development costs (e.g. Veraart, 2019). In response to these challenges, the national government approached resource management more carefully, following a hierarchical waste management strategy known as 'de Ladder van Lansink', which aimed to prevent, reuse, recycle, recover or dispose of waste (Kemp, 2007). Waste management responsibilities were taken up by provincial and national authorities, and overall waste processing costs increased.

In 1977 the national government implemented the first national Waste Law (*Afvalstoffenwet*), which shifted responsibilities for waste management from local to provincial governments (van der Heijden, 1998). This law, which marked a centralization of waste regulations that would continue for three decades, was a milestone in the creation of a waste market. It promoted the progressive merging of local waste corporations and the internationalization of waste management corporations.

Moreover, waste processing sites were rationalized in this period, with CDW moving further toward cities' fringes, becoming part of industrial hubs around port areas. Through the Waste Law, the national government closed provincial borders to waste exports, implying that provinces should become self-sufficient in terms of waste disposal capacity and inducing them to set up a Provincial Waste Plan (*Provinciaal Afvalstoffen Plan*). Although many small landfills were closed, a few remaining sites were expanded to serve regions, with stricter environmental regulations and higher disposal fees (Kreijger, 1983). In the province of Zuid-Holland, the number of landfills was reduced from 54 to 10 and the total landfill area decreased from 239 hectares to 132 hectares between 1977 and 1996 (van der Heijden, 1998) (see Figure 2). Stricter control and higher dumping fees led to increased CDW disposal costs, creating new business opportunities.

One such opportunity lies in the development of new CDW-crushing technologies that were already available in the early 1980s (Nolthuis and Hartevelde, 1984). Crushing made it easier for demolition companies to store, transport and recover CDW, dovetailing with an increase in demand for road base materials due to expanding road networks. Crushed CDW was an effective (and cheap) substitute for the sand and cement that had previously been used in road construction. The government welcomed these alternative materials, for the projected growth in demand for construction materials in the 1980s and 90s had led to concerns about the availability of sand (Veraart, 2019). A senior government advisor in circular construction from the Rijkswaterstaat explained that the volume of CDW was: 'about three times as much as the municipal waste [and] you can build all sorts of things on broken rock. It was a very welcome material' (interview, April 2019).

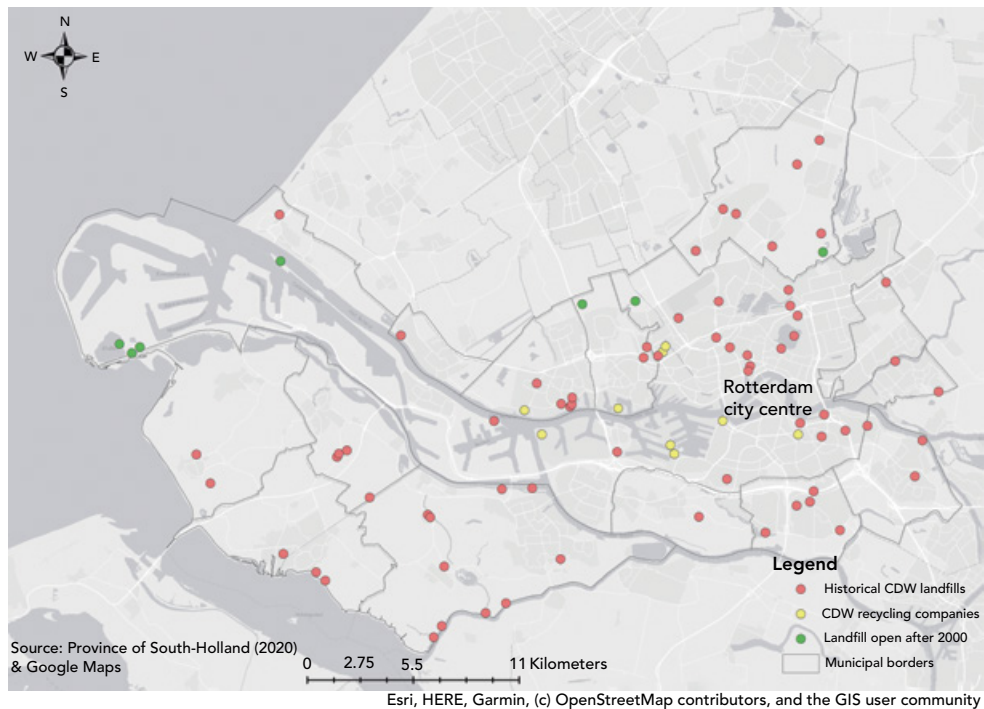


FIGURE 2 Waste disposal in the Rotterdam region (source: map produced by the authors, municipal borders from © Kadaster, CBS, 2018 and Province of South Holland, 2020)

The high volume of CDW, its versatility, and the increasing scarcity of materials led the Dutch government to promote recycled aggregates by investing in research and setting up quality standards (interview with a senior government advisor in circular construction [Rijkswaterstaat], April 2019).

This was the beginning of a series of regulatory reforms that would restructure the political ecology of waste in the Netherlands and set up the pillars of what we understand as a waste valorization regime. Demolition companies were eager to produce recycled aggregate, for this allowed them to sell their CDW instead of paying disposal fees. The push for privatization in the waste sector allowed commodifying waste substreams, whose circulation generated economic added value rather than management costs. Although volumes of CDW increased from the early 1990s, they were largely absorbed by the emerging recycling industry, which turned demolition companies into construction material suppliers. The fact that CDW no longer had to be transported to landfills ensured that CDW material flows could remain close to urban areas, where both demand for and production of CDW was greatest (Nolthuis and Hartevelt, 1984). In 1985, half of the 12 million tons of generated CDW ended up in landfills, while the other half was recycled or reused. Ten years later, in 1995, 13 million of the total 14 million tons of generated CDW was reused and only one million landfilled (Environmental Data Compendium, 2020).

In the mid-1980s, the Dutch government started to enforce stricter environmental regulations for the landfilling and recycling of CDW, also as a response by the Brundtlandt commission's concerns over waste accumulation and resource scarcity (Brundtland, 1987). The National Environmental Plan (*Nationaal Milieubeleidsplan*) of 1989 reshaped the CDW landscape by urging the optimal use of resources through recycling (van der Heijden, 1998). For CDW, this meant increasing the recycling rate from 50% to 90% between 1990 and 2000 (Hendriks, 1999). This was pursued through a ban on landfilling reusable waste (including CDW) in 1995. The ban ensured that the 90% recycling target was easily achieved. These new regulations signalled the increasing impact of the state's emerging environmental concerns in the 1990s, not least in restructuring the land development market and economic performance at large.

The increased regulations made CDW processing more complex, benefiting larger businesses who could reach economies of scale and industrial synergies. An expert on waste markets stated that these developments allowed large US waste management firms to enter the Dutch waste market: 'Many of these family-owned businesses were bought up. The Americans came to Europe with loads of money. They bought companies to get national coverage ... this was the aim' (interview with a spokesperson for the recycling trade association, May 2020).

Although these investments had various levels of success, the current Dutch waste recovery market keeps a strong multinational orientation, dominated by conglomerates of multi-utility firms operating across the whole of Western and Central Europe (Savini, 2021).

– The circular economy as a strategy of value-chain governance

The waste reforms of the 1980s and 1990s significantly altered the Dutch CDW landscape. Stricter environmental regulations began forcing companies and municipalities to comply with higher standards of waste disposal; governments and businesses started framing waste management in terms of sustainable development in line with other policies such as renewable energy and industrial efficiency; waste became an integrated service combined with water and logistics management; and a nexus of specialized firms developed to deal with different waste substreams (*ibid.*). These three developments affected the construction industry's accumulation regime, which was highly resource intensive. In 2005, sand and gravel (mainly used for concrete) accounted for about 40% of the total materials used in the Netherlands (Lambert *et al.*, 2013). This

led to increasing environmental criticism of sand extraction and inefficiencies in waste transportation (interview with a spokesperson for the recycling trade association, May 2020). Accordingly, concrete's dominance as a construction material was increasingly problematized.

To introduce market mechanisms and respond to the conglomeration of waste companies, the Dutch government harmonized splintered provincial waste management strategies under one National Waste Plan in 2003 (Ministry of Housing, Spatial Planning, and the Environment, 2003). Through this national plan, the government reopened provincial borders for waste trading and promoted waste valorization by stimulating reuse and recycling. The second National Waste Plan (2009) signalled a new approach to waste valorization (Bergsma *et al.*, 2014). It introduced a private model of industrial treatment (the Cradle2Cradle concept) in a public policy for the first time and developed a material management strategy for integrating waste management into production processes.

This reorientation was also triggered by changes in international regulatory frameworks. Given that the Netherlands already had comparatively high CDW recycling rates, the EU had a limited influence on the Dutch CDW sector. In 2008 the EU Waste Framework Directive set a target of 70% CDW recycling in 2020, which the Netherlands had already achieved in the mid-1990s. In 2012 the EU started promoting the circular economy as a resource management strategy able to boost EU competitiveness (European Commission, 2012).

This new discourse stimulated different rationales and geographies of waste regulation in the Netherlands and Rotterdam city region. A circular construction sector was one of the five pillars of the Dutch government's 2016 plan 'The Netherlands Circular in 2050', for this industry consumed about 50% of all the Netherlands' resources (Ministry of Infrastructure and the Environment; Ministry of Economics, 2016). Given the trends toward marketization and privatization, the government looked to public-private partnerships for means of achieving its ambitions for circularity and opening a new material recovery market. The so-called Concrete Covenant (*Betonakkoord*) marked a new agreement between actors in the whole construction value chain (from sand to building and waste) and municipal, provincial and national governments. It aimed to recycle 100% of waste concrete into new concrete, thus ensuring that CDW would be valorized in new buildings, not 'downcycled' into road base material.

In 2009 Rotterdam's city government had already commissioned a similar project to recycle concrete waste containers into new containers. This project began Circle City (*Cirkelstad*), a national network of city governments and construction sector actors cooperating to increase construction waste valorization by sharing knowledge and best practices. In 2014, Rotterdam's government started adopting circular economy practices to increase waste reuse. This was expanded in 2019, when the municipality released a circularity plan for the next four years. CDW valorization is central to this plan, for CDW constitutes about 60% of the city's waste. In the plan, the municipality states that it will 'incorporate circularity in our tendering policy to give an extra boost to circular economy business' (Municipality of Rotterdam, 2019: 3).

Besides tendering for circularity, the municipality stimulates and facilitates circular construction 'hubs' and a digital marketplace for secondary building materials (interview with a municipal employee in urban development, Municipality of Rotterdam, April 2020). Thus, the circular economy discourse justifies increasing local production and consumption, stimulating the domestic manufacturing economy.

Comparing the states of waste valorization

Although the patterns of waste valorization in Hong Kong and Rotterdam diverge, in both regions, CDW has become a significant input for urban and land development. The regulatory infrastructure within the 'waste disposal' period (see Table 1) was

TABLE 1 The periods of CDW processing

	Waste Disposal	Waste Management	Waste Valorization
Governance rationale	No restrictions or regulations on CDW	Prohibitions, public regulations and (mostly) public disposal; Reclamation or landfilling	Privatization, marketization, partnership; Increased landfilling charges
Geography	Scattered and local	Regionalization and displacement of unsorted components	Concentration of CDW processing capacity; Multi-utility industrial sites near agglomerations
Economic-environmental nexus	CDW secondary to (re) construction; Resource dependency	Increasing concerns about waste's environmental burden on economy	Waste as opportunity for regional economic development

SOURCE: Authors' research

characterized by a separation between the economic and ecological concerns of waste disposal. Environmental exploitation and pollution were unavoidable effects of urban (re)development in both cities. Public authorities largely shouldered waste's economic and environmental costs. Mineral extraction has turned Hong Kong's steep hills into quarries and Dutch grasslands into lakes. Relatively underdeveloped environmental regulations meant that CDW was dumped close to where it was produced, either in landfills on urban outskirts or land reclamation sites. As in many large cities across the world, this disposal method relied on a devalorization of waste in which garbage unproblematically filled scattered sites, and mineral excavations were repurposed (see Melosi, 2005).

In both regions, increasing environmental concerns have led to stricter governmental control over CDW flows since the 1970s, giving rise to what is known as a waste management state. In the Netherlands provincial waste export routes were closed and landfill taxes were raised stimulating the development of a private CDW recycling sector and CDW reuse in infrastructural projects. This consolidated a regional network of waste facilities, in line with the strengthening of Rotterdam's port economy. Hong Kong's government, by contrast, pushed for reclamation sites sufficient to steer CDW away from landfills. In both cases, regulatory frameworks set the boundaries of a state-led CDW business that profited from the increasing demand for building materials. Hong Kong's case reveals a state-led approach that coupled waste management with land development. Urban development was a cheaper outlet for CDW reuse—the stream retained a low value despite its diverse composition—without increasing disposal costs for the land development industry. In Rotterdam, CDW was displaced from provincial areas to feed a burgeoning waste-recovery industry. Neither of these strategies successfully tackled the ever-increasing need for construction materials and culminated in a ban on land reclamation in Hong Kong and gradually increasing dissatisfaction with mineral extraction in the Netherlands. Hong Kong's sudden halting of reclamation left the territory with little space to dispose of CDW, leading the government to support the limited domestic recycling industry through disposal charges, the EcoPark and adapting building regulations.

Since the mid-1990s, rising concerns about resource scarcity have combined with increasing CDW streams and technological advancements in CDW crushing, leading both Rotterdam and Hong Kong to approach CDW management through what we understand as a valorization approach, one that seeks to maximize waste's economic value through regional circulation and substream management. However, this transition has been neither smooth nor parallel in the two contexts given the waste sector's strong path dependencies.

In both countries, landfilling charges were increased to stimulate a waste recovery sector. As a result, the CDW sector opened for partnerships between regional

and national governments and market players, setting the foundations for the sector of integrated multi-utility services. This transition was slower in Hong Kong than Rotterdam, however. In the former, waste valorization efforts have remained relatively stagnant in recent decades, with few companies venturing into the sector. CDW remained publicly regulated, with large real estate developers and the Hong Kong Housing Authority assuming a central position in urban development. This is because, in Hong Kong, land reclamation always provided a large-scale outlet for CDW reuse and the role of public authorities remained generally strong both in the management of CDW and in land reclamation projects. Waste already had a valuable role in urban development.

In the Netherlands, instead, the industry of minerals and concrete is beginning to consider circular economy investments, for reusing materials effectively means reducing demand for primary materials. The reforms of the mid-1980s sustained both the centralization of waste regulation and the privatization of waste management. These reforms laid the foundations for the coalition of waste and utility services that today is driving circular economy strategies in the building sector. In the Netherlands, ambitions for a circular economy have developed in the context of a progressive centralization of CDW since the mid-1990s and internationalization of the waste market, which has integrated with logistics and other utilities over the last decade. Hong Kong, instead, displays a strong path dependency in favour of public CDW disposal, conditioned by the historically significant role of public land development agencies and the necessity of publicly sponsored land reclamation projects for much CDW reuse. The sector's liberalization began only in the mid-2000s.

Concluding remarks

Historically, waste was to be disposed of, recycled, or expelled from dense urban areas. It was invisible to the real estate economy, which saw waste materials as a cost to absorb in land development business cases. This understanding of waste as abject material, still central to urban political ecology research, risks overlooking an emerging political ecology of residuals. This article has dissected the regulations that underpin waste valorization processes to show that CDW can be an input of urban development, not simply an externality. It has analysed the largest inert stream of urban waste through the lens of metabolism. It has also highlighted CDW's role in (re)producing urbanization and redevelopment processes and advanced a critique of emerging circular economy programs within urban political ecology.

The explosion of circular economy and eco-modernization discourse indicates a shift away from a politics of waste management (primarily concerned with disposal) to one of valorization (in which waste becomes an input for accumulation). Urban development drives this valorization process, as large amounts of CDW are reused in renewal and land reclamation. We understand the circular economy as an emergent discourse that legitimates and fuels the renewed centrality of CDW in urbanization processes and reshapes the regulatory infrastructure of waste streams.

The comparison of Rotterdam and Hong-Kong's regional CDW-recovery strategies shows how waste valorization embodies a rationale of waste governance that marketizes waste's sub-stream (e.g. concrete, sand, gravel, wood, steel) and sustainable urban development. Valorization also affects the geography of waste, as waste is now recovered by industrial conglomerates located near urban agglomerations. Finally, this process demands that the role of CDW in sustainable economic development should be reframed. Our analysis shows that repositioning CDW for development fails to question the production of waste.

Our historical perspective has dissected the political ecology of urban waste that took hold through the state's shifting regulatory infrastructure. Beginning at the turn of the century, urban waste management evolved from a single (mostly publicly regulated)

sector to a value chain for partnership-building and liberalization. This shift reshaped the geography of waste streams, with waste circuits becoming more regional and less dispersed. It promoted economies of scale that could capture and reuse materials in the urban development process itself. The increasing worldwide investments in waste disposal facilities are certainly necessary to reach global environmental targets. Early industrialized countries often frame these investments as interventions towards a circular economy that can reduce waste exports. Yet, our perspective on waste valorization reveals the inherent contradiction of such programs. The circular economy, at least in its initial stages, relies on the valorization of waste. Garbage becomes a valuable commodified resource that is circulated via urban development. Circular economy programs may, therefore, increase urban economies' dependency on wasteful consumption.

Viktor Wildeboer, Independent researcher, viktor.wildeboer@outlook.com

Federico Savini, Department of Human Geography, Planning and International Development, University of Amsterdam, Nieuwe Achtergracht 166, 1018 WV Amsterdam, The Netherlands, f.savini@uva.nl

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