Waste Management 79 (2018) 689–699

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Urban mining demonstration bases in China: A new approach to the reclamation of resources

Yuan Hu [a,*], Mark Poustie [a,b]

[a] School of Law, Shanghai University of Finance and Economics, 777 Guoding Road, Shanghai 200433, China
[b] Honorary Scholar at University of Strathclyde Law School, Lord Hope Building, 141 St James Road, Glasgow G4 0RQ, Scotland, UK

ARTICLE INFO

Article history:
Received 13 April 2018
Revised 25 July 2018
Accepted 14 August 2018

Keywords:
Urban mining
Waste collection and recycling
Industrial park
Circular economy
China

ABSTRACT

This paper aims to examine a key Chinese circular economy program, the Urban Mining Demonstration Base Construction (UMDBC) Program, for its successes, experiences and existing problems. Using publicly available data and detailed investigation and analysis, we discuss the details of the UMDBC Program. Although the whole program has been implemented and has made significant progress, some problems exist. Our findings suggest that it is more important for the Chinese government to provide an effective legal framework than merely provide financial support. The experiences and lessons from research into the UMDBC Program could serve as an example to other developing countries facing environmental and resource pressures.

1. Introduction

As concentrated areas of population and economic activities, cities and their hinterlands aggregate a large number of physical resources in different forms from raw material to products. With a growing pressure on both resources and the environment, it is increasingly clear that the flow of material should not be stopped with discarded products. Instead, the loop should be closed by turning the discarded material into new resources. Against this background, the concept of urban mining has developed. Urban mining[1] indicates those activities of recovery of materials and energy from products, buildings and waste generated from urban catabolism (Baccini and Brunner, 2012). The materials stocked in city areas can be perceived as a vital source of resources, with concentrations of elements which are comparable to or even surpassing raw materials stocked in nature (Cossu and Williams, 2015). "Urban mining provides a systematic management of anthropogenic resources stocks and waste (products and buildings), in the view of long term environmental protection, resource conservation, and economic benefits" (Cossu, 2013).

Specifically, urban mining can be understood from two perspectives, one is that "urban" means the area inside city boundaries, the other is that "mining" is understood as the extraction of secondary resources from obsolete materials (Krook and Baas, 2013). Sometimes, the term "urban" also has a wider connotation of wastes generated from urban-style living such as e-waste. Therefore, urban mining is akin to waste recycling but more linked to the urban materials which are usually composed of most of the waste in the world and could be recycled efficiently. Since human resource input for secondary materials extraction from anthropogenic stocks is indispensable and thereby the concerns of costs and benefits are essential, urban mining originally focused on e-wastes which "contain relatively high value concentrations of expensive metals and rare earth elements" (Cossu and Williams, 2015). The concept has developed as a reflection of the shift away from conventional mining of raw materials to a recognition of the significance of extracting value from waste as societies shift towards the circular economy. Theoretical studies and practices have been carried out all around the world (Brunner, 2011; Di Maria et al., 2013; Gottberg et al., 2006; Lederer et al., 2014; Mueller et al., 2017; Sun et al., 2015; Tunsu et al., 2015; Van Beers et al., 2007; Van Eygen et al., 2016). Other studies have shown that states have taken a different approach to urban mining with some setting mandatory recycling targets and leaving it to the market as to how to meet the target sometimes with the incentives

* Corresponding author.
E-mail addresses: hu.yuan@mail.shufe.edu.cn (Y. Hu), mark.poustie@strath.ac.uk (M. Poustie).

[1] Urban mining is different form landfill mining. The latter involves excavating wastes already buried in landfills to obtain value through recycling or recovery, to create space in landfills and aerate them. The former is a broader term and potentially incorporates landfill mining as it can be defined as reclamation of raw materials from waste. However, we are using it in a distinct sense of a system of centralized sites to facilitate reclamation of raw materials from wastes which have usually been discarded but not landfilled yet. Though landfill mining is potentially included within the scope of this article, it is not specifically addressed.

https://doi.org/10.1016/j.wasman.2018.08.032
0956-053X/

of taxes on disposal and/or waste separation requirements (Ogus, 1999; Snape and de Souza, 2006; Van Calster, 2015).

Urban mining plays a more and more important role in many countries since most of the world economies are increasingly facing scarcity of raw materials, less space for garbage dumping and serious pollution caused by waste landfills and incineration. The European Commission identifies waste as the key resource to reduce its dependence on imported raw materials (European Commission, 2011). The focus of these policies is to reduce waste first, then followed by product reuse and material recycling to avoid landfills (Davoudi, 2000; European Commission, 2003). Van Beers et al. (2007) estimated that the recovery rate of waste copper in Australia had reached 70%. In Japan, a study showed that the inputs of energy and resources from recovery of gold, silver, copper, iron, aluminum, etc. could take 60% of the inputs of energy and resources from the exploitation of raw ores (Yamasue and Minamino, 2009).

The concept of urban mining was introduced to China in the early twenty first century, and was soon promoted by researchers and adopted by Government. The Chinese Government adopted this idea and initiated a program called Urban Mining Demonstration Base Construction (UMDBC) in 2010. The National Development and Reform Commission (NDRC) and the Ministry of Finance (MOF) gave a definition of urban mining in the Notice of the Initiation of UMDBC Program (NDRC and MOF, 2010). According to the Notice, urban mining in China refers to recycling resources from materials such as waste iron and steel, waste non-ferrous metals, waste rare metals, waste plastic and waste rubber. These materials are generated in industrialization and urbanization processes, and are contained in waste electro-mechanical equipment, wires and cables, communication instruments, vehicles, electric and electronic equipment, and metal and plastic packaging.

The named demonstration base is a kind of special industrial park where waste reuse and recycling activities are carried out in a cluster. In the past seven years, significant progress has been made with the UMDBC Program. This study introduces the initiation of the program in China, and its achievements as well as problems. Reasons behind the performances of the UMDBC Program are discussed, and considerations for improvement are made for its potential to address environmental issues and resource constraints.

2. UMDBC program: Initiation and policy design

2.1. Why China needs the UMDBC program

China is the largest producer and consumer of resources and energy in the world. Its production of primary energy, crude steel, ten kinds of nonferrous metals and cement ranked first in the world (MLR, 2016). However, the domestic resource per capita of China is far lower than the world average. It is difficult for China to meet its economic and social development needs with the current supply of resources, and sustainable development is faced with the challenge of a resources bottleneck (SC, 2013). Therefore, new thinking for China is emerging in the resource management domain: that is, we should rely not only on traditional natural resources, but also on recycled resources. Urban mining could not only alleviate the resources pressure, but also reduce pollution and land shortage problem caused by waste landfills. The Chinese Government hopes the implementation of the UMDBC Program could help it reach its resource and environmental management targets[2]. From our observations, this prospect presents the following important opportunities:

First of all, the UMDBC Program could help establish a new approach to the use of resources and materials, and could be an important way of mitigating the crippling effects of resource depletion and energy shortages. China's economic growth relies heavily on natural resources. For example, petroleum consumption increased from 224.95 million tons in 2000 to 551.6 million tons in 2015, and steel consumption[3] increased from 141.21 million tons in 2000 to 1023.89 million tons in 2015 (National Bureau of Statistics, 2001–2016). Among the huge amount of raw materials consumed by China, a large part, often more than a half, were imported from abroad. In 2010, external dependence on foreign iron, copper, aluminum, and lead were up to 51.2%, 72.0%, 47.9% and 25.5%, respectively (Wen et al., 2015). Every year, China produces a large amount of waste. If this waste is used efficiently, it could replace part of the demand for raw materials, reduce pollution, and create a circular development mode of "resource-product-waste-recycled resource". Table 1 presents the recycling of some waste materials in China from 2009 to 2013. From the table, we can see that the recycling rate of major renewable resource is very low in recent years. The ratio actually decreased from 23.47% in 2009 to 19.31% in 2013, which is far behind the European Union's 42.2% in 2013 and 45.6% in 2016 (Eurostat, 2016). It also indicates the big potential for China to improve its materials recovery performance.

The UMDBC Program could also help to reduce the environmental pollution and achieve carbon emission reductions and hence help China to meet its commitments under the Paris Agreement.[4] The exploitation of raw ores, as well as the subsequent production and utilization processes, results in serious environmental pollution. Waste recycling could achieve significant environmental benefits if it is carried out in an environmentally friendly way, such as in an urban mining base. Compared with using raw natural resources, the UMDBC Program can reduce energy consumption by 35 million tons of standard coal, the discharge of wastewater by 2.2 billion tons, Sulphur Dioxide emissions of 0.78 million tons, Carbon Dioxide emissions of 80 million tons (Ma, 2014). A study by Wen et al. (2015) also showed that urban mining could bring significant environmental benefits. In 2020, recycled iron and aluminum could save 96.3 and 32.0 million tons of standard coal, respectively, and recycled copper could save 1305.5 million tons of water and reduce 1255.9 million tons of solid wastes. The use of four urban mines, covering recycled iron, aluminum, copper and lead, will reduce the emissions of Sulphur Dioxide by 1.8 million tons in 2020 (Wen et al., 2015).

Furthermore, the UMDBC Program is believed to have other functions such as creating employment in China. By the end of 2013, there were more than 100 thousand renewable resources recycling enterprises, with more than 18 million employees (MOC et al., 2015). Trade, logistics, equipment manufacturing and other sectors all benefit from waste reuse and recycling.

It is generally perceived that the waste recycling capacity in China is not adequate, and the existing recycling system is not well established, with the characteristics of "disordered, nonstandard and high-pollution" (Wen et al., 2015). To address all these problems and in consideration of all the resources, environmental and social benefits of urban mining, the Chinese government has significant incentives to sponsor the construction of urban mining bases.

[2] The UMDBC Program will also assist China in complying with its obligations under the Sustainable Development Goals, notably Goal 12: Ensure Sustainable Production and Consumption Patterns (http://www.un.org/sustainabledevelopment/sustainable-consumption-production/ - last visited 9 March 2018).

[3] There is no direct steel consumption data. We use the data from the China Statistical Yearbooks to calculate the apparent consumption amount, which is the sum of outputs and imports minus exports.

[4] See NRDC, Department of Climate Change, Enhanced Actions on Climate Change, China's Intended Nationally Determined Contributions, 2015 http://www4.unfccc.int/ndcregistry/PublishedDocuments/China%20First/China%27s%20First%20NDC%20Submission.pdf (last accessed 2 March 2018).