COST-BENEFIT ASSESSMENT OF COMMUNITY-BASED RECYCLING AND WASTE MANAGEMENT IN PAKISTAN

A JOINT PAPER BY IDS AND TEARFUND

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Particular thanks to Stephen Spratt and David Wilson for their insightful comments and suggestions at the peer review stage; to Solomon Khurrum, Gerald Angelo and Ashraf Mall for providing field data, and to Paul Cook, Tineke Harris and Joanne Green for comments on the paper.

Design: Wingfinger Graphics

Cover photos: Andrew Philip/Tearfund *(left and top right)*; Tearfund Pakistan *(bottom right)*

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ABSTRACT

Open burning of waste is estimated to cause 14,000 premature deaths a year in Pakistan and could account for a quarter of the nation's reported carbon emissions, according to recent estimates. Dumped waste is also a major cause of diarrhoeal diseases. A community-based approach to waste management addresses these problems while also creating jobs. A centre piloting this approach offers ten dollars in benefits for every dollar invested in establishing it, and the centre became self-financing in its third year. This approach reduces the need for more expensive, centralised waste management facilities by up to 90 per cent. These figures are consistent with the wider success of this model across Asia.

1 INTRODUCTION: THE PROBLEM

Following their 2016 *Virtuous Circle*[1] paper on the circular economy in developing countries, Tearfund and the Institute of Development Studies are examining existing approaches to waste management in developing countries, with a view to replicating best practice. This cost-benefit assessment evaluates the pilot of a community-based approach in Pakistan and assesses the feasibility of implementing the same approach in other (poorer) areas.

In 2015, United Nations Environment Programme's (UNEP) first Global Waste Management Outlook[2] (GWMO) estimated that more than 2 billion people currently lack access to any form of waste collection. A further 1 billion have their waste collected but disposed of in an unsafe manner (for example, via centralised dumpsites). Against this backdrop, it is alarming to note that waste generation in the cities of low-income nations is expected to double in the next 15 to 20 years.[3]

In Pakistan, at the time of writing, there was just one sanitary landfill consistent with international standards (opened in 2016).[4] Although illegal, open dumping and open burning are the most common methods of waste disposal, causing severe environmental degradation, particularly air pollution, and risks to public health.[5]

1 Gower R and Schröder P (2016) *Virtuous circle: how the circular economy can create jobs and save lives in low- and middle-income countries*, Tearfund and the Institute of Development Studies

2 Wilson D et al (2015) *Global waste management outlook*, UNEP

3 Wilson D et al (2015) *Global waste management outlook*, UNEP

4 Even here, a recent investigation by *Pakistan Today* uncovered evidence of illegal dumping: www.pakistantoday.com.pk/2017/04/06/lwmc-fails-to-dump-waste-in-scientific-manners

5 Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institution of Wastes Management and Waste Aid; Zuberi M and Ali S (2015) 'Greenhouse effect reduction by recovering energy from waste landfills in Pakistan', *Renewable and Sustainable Energy Reviews*, vol 44, April 2015, pp 117–131

Islamabad has 34 informal settlements, which are home to about a third of the city's population. Many residents are among the most marginalised in the city, including religious and ethnic minorities and those living in extreme poverty. These settlements lack municipal services such as waste collection and are often located close to water courses that contain untreated waste.

THE INCIDENCE OF DIARRHOEA IN UNDER-FIVES CAN BE TWO-THIRDS LOWER IN HOUSEHOLDS WITH ACCESS TO APPROPRIATE WASTE MANAGEMENT

Waste is dumped in open spaces throughout these areas and creates an inhospitable and dangerous environment, contaminating soil and groundwater and increasing the spread of infectious diseases.[6] For example, a recent multivariate study in Ethiopia found that the incidence of diarrhoea in under-fives is two-thirds lower in households with access to appropriate waste management.[7]

Open burning is also a major public health concern. Research suggests that as much as 40 per cent of the world's waste could be subject to open burning, producing up to 29 per cent of anthropogenic emissions of particulate matter and a tenth of mercury emissions.[8] The emissions of small particulate matter alone are estimated to cause 270,000 premature deaths globally each year, and 14,000 in Pakistan.[9] Other emissions include dioxins, a group of '30 highly toxic chlorinated organic chemicals'[10] that can be breathed in or ingested following settlement on crops or consumption by domestic livestock.[11] While these figures are subject to a high degree of uncertainty (because some progress has been made since the data was collected, particularly in upper-middle-income countries[12]), they offer a good guide to the scale of the problem, especially in low- and lower-middle-income countries such as Pakistan, where there are still few or no landfills that meet international standards. The health impacts may even be an under-estimate in these contexts, given that available statistics focus on small particulate matter alone.

These health impacts also exacerbate the fragility of existing livelihoods in informal settlements by causing respiratory conditions and other health problems for residents that make work challenging or sometimes impossible.

Finally, open burning of waste is one of the developing world's largest sources of carbon emissions. The same landmark research cited above[13] suggests that in many developing countries open burning of waste accounts for a significantly higher share of total anthropogenic emissions than previously thought. In the case of Pakistan, the new estimates suggest that open burning of waste produces about 46 million tonnes CO_2, or more than a quarter of the country's carbon emissions.[14] This compares to the 12.29 million tonnes CO_2-equivalent (about three per cent of total CO_2-equivalent emissions in 2015) stated in Pakistan's national greenhouse gas inventory submitted to the UNFCCC.[15]

A holistic approach to waste management thus promises a triple win: creating jobs while preventing damage to health and the climate from open burning and dumping.

6 Wilson D et al (2015) *Global waste management outlook*, UNEP; for a specific example, see *Journal of Environmental Protection*, no 4; and Makoni FS, Ndamba J, Mbati PA and Manase G (2004) 'Impact of waste disposal on the health of a poor urban community in Zimbabwe', *East African Medical Journal*, no 81

7 Gebru T, Taha M and Kassahun W (2014) 'Risk factors of diarrhoeal disease in under-five children among health extension model and non-model families in Sheko district rural community, Southwest Ethiopia: comparative cross-sectional study', *BMC Public Health*, *14*, 395. Available at: http://doi.org/10.1186/1471-2458-14-395

8 Thompson A (2014) 'Burning trash bad for humans and global warming', *Scientific American*, September 2014; based on research in Wiedinmyer C, Yokelson R and Gullett B (2014) 'Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste', *Environmental Science & Technology*, vol 48, no 16, pp 9523–9530

9 John K Kodros et al (2016) 'Global burden of mortalities due to chronic exposure to ambient PM2.5 from open combustion of domestic waste', *Environmental Research Letters,* vol 11, 124022 [see supplementary material], scaled to Pakistan's 2015 population

10 United States Environmental Protection Agency, *Backyard Burning – Human Health*. Available at https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/health.html [accessed on 9 August 2017]

11 Ibid

12 Wilson D et al (2015) *Global Waste Management Outlook*, UNEP

13 Wiedinmyer C, Yokelson R and Gullett B (2014) 'Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste', *Environmental Science & Technology*, vol 48, no 16, pp 9523–9530 (see supplementary tables)

14 Ibid

15 Pakistan's Intended Nationally Determined Contributions (PAK-INDC) (2016). Available at: www4.unfccc.int/Submissions/INDC/Published%20Documents/Pakistan/1/Pak-INDC.pdf

2 COMMUNITY-BASED WASTE MANAGEMENT AS A SOLUTION

Traditionally, waste is seen as a problem for municipal governments, and indeed in many countries local governments have a legal responsibility to provide waste management services. However, as the GWMO makes clear, the financial resources available to municipal governments in low-income countries at best barely pay for waste collection under a centralised management system, let alone treatment or safe disposal. This is why so much waste is burned at dumpsites or left uncollected. For example, before a recent DFID-funded project in Bo, Sierra Leone, the local municipality was spending more than 30 per cent of its budget on waste management, but there was no household collection, and only 30 per cent of the population had access to communal collection points.[16]

As a result, the lead author of the GWMO (and chair of the UK's Chartered Institution of Wastes Management, CIWM), David Wilson argues:

'Community-based waste management initiatives… are often the only hope for many smaller cities, towns and villages, as well as informal settlements around larger cities, where local authorities simply do not have the resources to provide any level of waste management service.'[17]

Moreover, even where local governments are able to finance waste management services, the GWMO advises that 'decentralised and community-based small-scale facilities can provide a viable and affordable alternative [to centralised facilities],'[18] especially in locations where economies of scale cannot be realised, such as smaller second- and third-tier cities.

Community-based approaches typically address 80 to 90 per cent of the waste generated by a community, with a residual amount transported to the local dump (or sanitary landfill, if available). These approaches can thus dramatically reduce the need for expensive, centralised facilities, but not eliminate this need entirely. In Section 8, we compare the cost of community-based approaches with available information regarding the cost of centralised collection and disposal.

COMMUNITY-BASED APPROACHES TYPICALLY ADDRESS 80 TO 90 PER CENT OF THE WASTE GENERATED BY A COMMUNITY

Interest in these approaches is growing, with the UK's CIWM recently publishing a series of toolkits to support the development of community-based approaches in developing countries.[19]

3 INTEGRATED RESOURCE AND RECOVERY CENTRES (IRRCs)

In most developing countries, recycling is mainly carried out by the informal sector (who make up about one per cent of the urban population).[20] Successful municipal schemes typically involve these existing actors. For example, in Maputo, Mozambique, a highly successful scheme sees micro-enterprises collecting waste in city suburbs, before it is processed at centralised facilities.[21]

16 www.dandc.eu/en/article/bos-city-council-setting-new-standards-waste-disposal

17 Foreword to Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institution of Wastes Management and Waste Aid

18 Wilson D et al (2015) *Global waste management outlook*, UNEP, p 133

19 Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institution of Wastes Management and Waste Aid

20 Medina M (2008) *The informal recycling sector in developing countries: organizing waste pickers to enhance their impact*, World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/10586

21 Wilson D et al (2015) *Global waste management outlook*, UNEP, p 228

Community-based recycling schemes take this approach a step further, by both collecting *and* processing waste at community level. They are thus also suitable for contexts where local government does not have the capacity to deliver any form of centralised facilities.[22]

Integrated Resource and Recovery Centres (IRRCs) are one example of a community-based recycling scheme. They are locally based, closed-loop systems operated by (former) informal sector workers in close cooperation with municipal government sanitation workers. The model originated in Bangladesh in 2007, and was pioneered by the NGO Waste Concern. It has since been effectively replicated in a number of East Asian countries, with the support of (UNESCAP).[23]

IRRCs provide an inclusive, market-based approach to waste management, offering safer and more lucrative employment for waste pickers (and others), as well as significant health and environmental benefits for the community. The approach is ideal for informal settlements in fast-growing cities, as well as secondary cities and towns.

The IRRC intervenes along three axes:

- with households in the community to introduce regular (almost daily) waste collection and encourage waste separation at source
- with waste pickers to manage door-to-door collection and operate a community-based processing plant
- with consumers and downstream businesses to sell organic compost and recyclables

A partnership with local government cuts across these three axes. This often means establishing the IRRC on publicly owned land, and ensures that the IRRC is aligned with regional or national waste management policy. In addition, local government can encourage (or even legislate for) source separation by local businesses and households, working closely with the IRRC.[24]

4 THE IRRC IN ISLAMABAD

The first pilot IRRC in Pakistan was established in Sector G-15, Islamabad, in 2014 by the Dr Akhtar Hameed Khan Memorial Trust (AHKMT), with the support of UNESCAP, Waste Concern (Bangladesh) and UN-Habitat, following the model's success elsewhere in Asia.

Sector G-15 is a relatively wealthy area, with larger detached houses. Before the IRRC was set up, there was no waste collection, and household waste was dumped outside houses and periodically burned.

The IRRC has the capacity to process waste from 3,000 households and is currently operating at half-capacity. Some households separate the waste at source, and this has been actively encouraged (although efforts have not been as successful as hoped). The waste also undergoes further sorting post-collection, at the centre.

The IRRC team collect waste almost daily (as is necessary throughout the tropical world). This averts insanitary conditions and also makes sorting easier. Waste is sorted by IRRC staff alongside two employees from a contractor who pays a fee to the IRRC and in return receives all the plastic, metal and other dry recyclables collected. The IRRC keeps the organic material and uses this as chicken feed and to produce compost. The IRRC then sells a mixture of chicken manure and compost as a high-quality soil conditioner (or fertiliser).

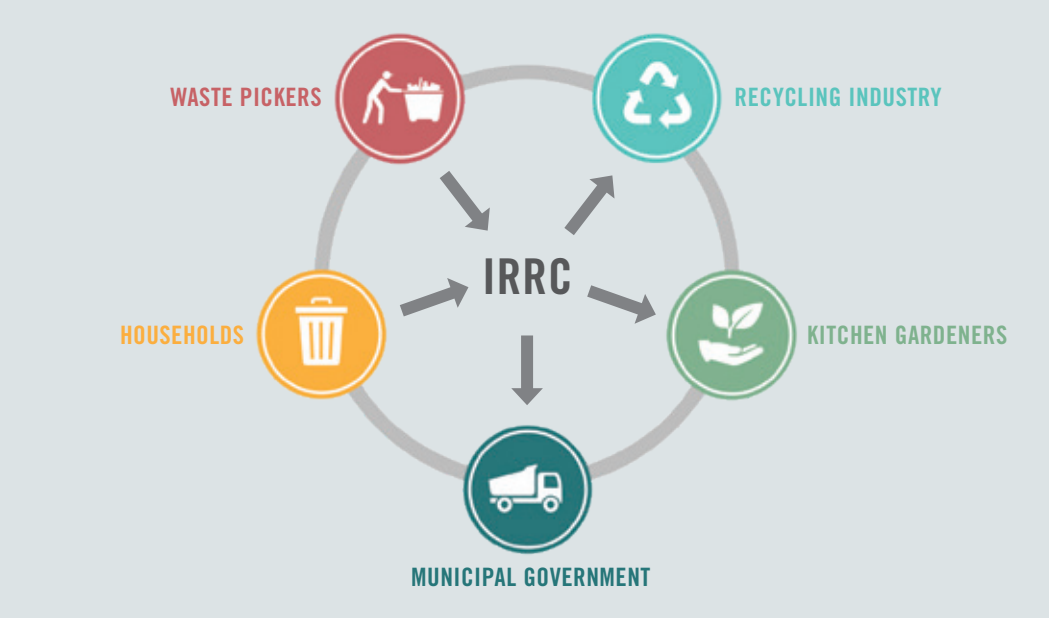
Approximately ten per cent of the waste collected cannot be recycled or composted, and this is disposed of at a municipal landfill.

22 Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institution of Wastes Management and Waste Aid

23 United Nations Economic and Social Commission for Asia and the Pacific (2015) *Valuing waste, transforming cities*, UNESCAP and Waste Concern

24 Storey D, Santucci L, Aleluia J and Varghese T (2013) 'Decentralised and integrated resource recovery centres in developing countries: lessons learnt from Asia-Pacific'. Paper presented by UNESCAP at the 2013 ISWA Congress; see also UNESCAP (2015) *Valuing waste, transforming cities*, UNESCAP and Waste Concern

Figure 1 Stakeholders connected to the IRRC



5 COST-BENEFIT ASSESSMENT

The purpose of this paper is to make a quantitative assessment of the costs and benefits of the IRRC, and to explore the viability of implementing the same approach in a poorer district (ie an informal settlement). This assessment is intended to provide a good indication of the relative scale of costs and benefits, but it is not comprehensive or definitive, given weaknesses in both the data available from the field and the limited range of proxies available to quantify health impacts. Our calculations are based on data from autumn 2017, when the IRRC was operating at half-capacity.

First, we describe the initial set-up costs associated with the IRRC. Then, we consider the social costs and benefits for the main stakeholders (community residents, employees and wider society), and thirdly, we consider the financial sustainability of the IRRC itself.

Table 1 Basic information for the IRRC

Location: Sector G-15, Islamabad			
Households served currently: 1,500	**Jobs created:** 13	**Total waste processed:** 1,000 tonnes per year	**Capacity:** 2,000 tonnes per year

5.1 Set-up costs

LAND

The Azad Jammu Kashmir Housing Society provided the land for the IRRC for free, after buying neighbouring land for housing development from the Capital Development Authority. So, the cost of the land is not included in our assessment. The Pakistani government has already committed to provide land for further centres at no cost.

CONSTRUCTION, STAFF TIME, SUPPORT

Field work estimated the total cost of the project as USD 71,500 split over two years, after which AKHMT's support was no longer required. This is worth emphasising: donor finance was only required for the initial two-year set-up phase.

5.2 Social costs and benefits

These figures are described below and summarised in Table 2 (see page 9).

COMMUNITY RESIDENTS' COSTS

The only cost to community residents is the nominal fee charged for waste collection. The IRRC charges PKR 200 per month per household (approximately USD 2) and was serving 1,500 households at the time of writing.

EMPLOYEES' LIVELIHOODS

The IRRC has created 13 jobs so far (11 directly and two via the recycling contractor). Field work conducted by Tearfund partner Pak Mission Society (PMS) indicates that the directly employed workers have typically improved their earnings by 60 per cent in taking the role (with a salary of PKR 14,000 per month or USD 133). To be conservative, for the analysis we assume a 27 per cent increase from PKR 11,000 to 14,000 for these 11 workers.

These workers also typically reduced their working hours by 25 per cent in taking the IRRC role. We have included this as a benefit (increased leisure time), which we have valued at their previous hourly rate. Workers gain social security registration and a pension,[25] but lack of data on these benefits has prevented us from quantifying them.

Finally, others beyond the IRRC also benefit: besides the two individuals employed by the contractor, other consumers and businesses gain access to recycled materials and cheap, high-quality compost produced by the IRRC. However, we have not included these secondary benefits due to lack of reliable data regarding the prior earnings of the contractor's employees or the difference in access to recycled resources resulting from the IRRC.

COMMUNITY RESIDENTS' HEALTH

The IRRC improves health and well-being in three main ways:

- reduced air pollution from open burning
- reduced soil and groundwater contamination from leachate[26]
- improved sanitation, safety and general aesthetics (with associated reductions in diarrhoeal disease and benefits for general well-being)

These benefits are partially 'private', in that they accrue directly to the beneficiaries of waste collection, and partially social, in that they affect the wider community. For example, if my waste is collected rather than burned, I will breathe in less polluted air, but so will those living nearby (and similarly for groundwater contamination and safety).

Identifying suitable proxies for these health impacts is difficult. We combine two approaches but even these in combination represent only a partial estimate of the health benefits.

Firstly, we use the nominal fees paid by households for IRRC waste collection as a revealed preference lower-bound estimate for the benefits that these households receive. These fees represent a lower-bound estimate because: (i) households would potentially pay more and we do not know how much;

25 www.pessi.gop.pk/overview.php

26 For example, in Jamaica, 25 per cent of groundwater sources have been closed because of contamination with waste; Wilson D et al (2015) *global waste management outlook*, UNEP

(ii) households are almost certainly unaware of the full extent of the health costs associated with open burning and dumping, since many of these health effects are not immediate or obvious (such as the long-term impact on life expectancy); and (iii) we would expect households to value only their private benefit, rather than benefits to other households.

We therefore assume that household fees provide a value for relatively immediate (and private) improvements in health, such as reduced diarrhoeal disease, plus the value of general improvements in sanitation, safety and aesthetics.

We supplement this revealed preference lower-bound with an assessment of one aspect of a more distant and social (external) health impact: premature mortality associated with fumes from open burning. We take existing estimates of premature death caused by small particulate matter emissions in Pakistan[27] and associated welfare losses,[28] and scale these to the reduction in particulate matter from open burning achieved by the IRRC.[29] These estimates are focused solely on mortality arising from a subcategory of particulate matter emissions (PM2.5) and thus exclude morbidity and impacts from other forms of air pollution arising from open burning.

We combine these estimates to give an overall indication of the health benefits of the IRRC. Our judgment is that this still represents an underestimate, because the benefits of reduced soil and groundwater contamination are not quantified. (It seems unlikely that such benefits will feature in households' willingness to pay, because they are not obvious or private, but lack of data from the field prevents us from making our own objective valuation.)

We note also that the methods for converting mortality into numerical values are also partial, and do *not* reflect 'the value of any single person's life or death, nor… a society's judgment as to what that value should be'.[30]

Finally, survey work in the community conducted by AHKMT provides confirmation of the health benefits: respondents report lower instances of dengue fever and other waste-related diseases, and are also spending less on ad hoc healthcare, following the introduction of waste collection.

RESPONDENTS REPORT LOWER INSTANCES OF DENGUE FEVER AND OTHER WASTE-RELATED DISEASES … FOLLOWING INTRODUCTION OF WASTE COLLECTION

WIDER SOCIETY – CLIMATE CHANGE MITIGATION BENEFITS

We quantify two routes through which the IRRC mitigates climate change:

- reducing emissions from open burning
- displacing virgin materials with recyclate in local manufacturing industries, in particular high-frequency materials such as paper and cardboards, glass, PET, steel and aluminium cans and scrap metals

In the case of the first, we use the estimates for emissions from open burning of waste calculated by Wiedinmyer et al,[31] and scale these to the reduction in open burning achieved by the IRRC. For the latter, we use emissions factors for recycling of plastics, metals and paper from Turner et al,[32] and, in the

27 Kodros JK et al (2016) 'Global burden of mortalities due to chronic exposure to ambient PM2.5 from open combustion of domestic waste', *Environmental Research Letters,* vol 11, 124022 (see supplementary material)

28 World Bank and Institute for Health Metrics and Evaluation (2016) *The cost of air pollution: strengthening the economic case for action*, Washington DC, World Bank

29 This assumes that the reduction in open burning moves through a linear or convex part of the curve in the relationship between particulate matter pollution and mortality. This is likely because open burning is often the primary (or at least a major) driver of air pollution within informal settlements. Furthermore, simulations have shown that the low resolution used for air pollution modelling dramatically reduces the mortality estimates provided, because pollution is highly localised and in the case of waste burning, coincident with high population densities. Higher resolution models produce higher mortality figures than those suggested here. See Kodros JK et al (2016).

30 World Bank and Institute for Health Metrics and Evaluation (2016) *The cost of air pollution: strengthening the economic case for action*, Washington DC, World Bank

31 Wiedinmyer C, Yokelson R and Gullett B (2014) 'Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste', *Environmental Science & Technology*, vol 48, no 16, pp 9523–9530 (see supplementary tables)

32 Turner D, Williams I, Kemp S (2015) 'Greenhouse gas emission factors for recycling of source-segregated waste materials', *Resources, Conservation and Recycling,* vol 105, part A, pp 186–197, ISSN 0921-3449

absence of published estimates of the rebound effect in this context, we assume a conservative rebound effect of 50 per cent.

There are two other plausible routes through which the IRRC mitigates climate change (reducing breakdown of organic waste in the community and displacing chemical fertiliser with locally produced compost), but we do not have the field data to assess either of these.

DISCOUNT RATES

We monetise the climate impacts using the US EPA's central scenario for the social cost of carbon, which is based on a three per cent discount rate.[33] These figures are close to the lower end of the range for appropriate carbon values as described by the High-Level Commission on Carbon Prices, cited by the World Bank and others.[34] The climate change benefits increase in value as carbon prices rise throughout the assessment period.

For non-carbon impacts, we use a discount rate of ten per cent, based on the judgment in DFID's *Guide to Investment Appraisal* that 'experience suggests that a discount rate in the range of 8 per cent to 12 per cent… is a useful operational guide over a wide range of countries'.[35]

SUMMARY OF SOCIAL COSTS AND BENEFITS

Once the IRRC is operating, the social costs and benefits are as described in Table 2.

Our calculations indicate that the IRRC offers major benefits to society in the form of improved public health and reduced carbon emissions. The health effects are attributable to the reduction in open burning and open dumping achieved by the IRRC, although we could not quantify these impacts in their entirety (with the effect on soil and groundwater a notable omission). The bulk of the carbon savings arise from reductions in open burning, rather than the recycling of metal, plastic or paper. This is partly because waste in slum areas contains relatively small percentages of these items, as it is mostly comprised of organic material. The economic benefits are real (13 safe, secure jobs) but contribute less overall than improvements in health or mitigation of climate change.

These figures should be interpreted as indicative rather than conclusive. The financial flows associated with the IRRC were sourced through conversations between Tearfund partner PMS and AHKMT, rather than on published accounts, and there is also some uncertainty surrounding the quantification of health benefits.

BENEFIT-COST RATIO

We evaluate the project from the perspective of a donor assessing whether to provide the initial set-up costs for the IRRC (after which the IRRC becomes self-financing). We thus focus on the net benefit/investment ratio, which takes the net benefits for society in each year of the IRRC's operation and compares this with the initial set-up cost.

Using a 15-year time horizon (on the basis that the IRRC should last for this long), the project exhibits a net benefit/investment ratio of 10:1, such that every dollar invested by a donor yields USD 10 in benefits for society.

We also evaluate the net benefit/investment ratio using a higher discount rate for non-climate change benefits (of 12 per cent) and a ten-year time horizon. Even on this basis, every dollar invested yields USD 6.5 in benefits for society.

It is worth emphasising that these figures are intended to provide a guide to the scale of the benefits on offer, given the caveats noted above. However, it is also worth noting that the IRRC is currently operating at 50 per cent capacity and could feasibly increase its processing and collection (with associated increases in benefits for society).

33 US Government (2016) *Technical update of the social cost of carbon for regulatory impact analysis*

34 www.worldbank.org/en/results/2017/12/01/carbon-pricing

35 DFID (2005) *Guide to investment appraisal for DFID economists*

Table 2 Discounted social costs and benefits in third year (2015 USD)

Project costs	Value (2015 USD)
Household fees (approx USD 2 per household per month)	27,702
Total costs	27,702

Project benefits	Value (2015 USD)
Livelihoods for employees	
Improved earnings for workers	3,047
Access to social security	Not quantified
Increased leisure time for workers	2,793
Health and well-being for community residents	
Time saved for households (no burning/dumping)	27,702
Improved sanitation (and resultant reduction in child mortality from diarrhoeal diseases)	
Improved aesthetics (reduced odour, improved appearance)	
Reduced premature adult mortality from PM2.5 emissions	14,218
Reduced soil and groundwater contamination	Not quantified
Climate change mitigation (wider society) [36]	
Reduced GHG emissions from open burning	34,055
Reduced GHG emissions from recycling plastic, metal and paper	1,576
Reduced GHG emissions from dumping of organic waste	Not quantified
Reduced GHG emissions from displacement of chemical fertiliser	Not quantified
Total benefits	83,391

5.3 Financial sustainability of the IRRC

FINANCIAL COSTS

In addition to staff costs (which were described earlier), running costs amount to between PKR 60,000 and PKR 75,000 each month (an average of about USD 650). This includes utilities, repair and fuel costs.

FINANCIAL EARNINGS

The IRRC charges PKR 200 per month per household (approximately USD 2) and served 1,500 households at the time of writing. In addition, a fee of PKR 50,000 per month (USD 475) is received from the dry recycling contractor. Sales of compost amount to PKR 17,500 per month (USD 165).

ASSESSMENT OF SUSTAINABILITY

The IRRC became self-sustaining in its third year. According to the figures above, it turns a profit each month of about USD 1,400, which is being reinvested in additional equipment for the IRRC.

36 Based on a total saving of 809 tonnes CO_2-equivalent per year, compared with the status quo

Table 3 Financial costs and earnings

	Monthly (PKR)	Monthly (2015 USD)	Annual (2015 USD)
Income			
Household fees	300,000	2,850	34,200
Sale of recyclable material	50,000	475	5,700
Sales of compost	17,500	166	1,995
	367,500	3,491	41,895
Cost			
Staff wages	154,000	1,463	17,556
All other costs	68,000	646	7,752
	222,000	2,109	25,308

Income is dominated by household fees, which provide 80 per cent of revenue. As such, the IRRC is heavily dependent on maintaining user satisfaction (as the wider literature on user fees demonstrates).[37]

However, the IRRC currently turns a small profit, and as such, even if income from fees fell by about 50 per cent, or alternatively if all sales of recyclables and compost ceased, the IRRC would remain viable.

Furthermore, there are good reasons to suggest that more money could be earned from sales of compost and recyclable material. Discussions with experts suggest that existing arrangements for the sale of plastics, metals and glass (via a contractor) and compost (which is not well marketed) may not deliver maximum value for money. Selling the recycled waste streams separately might yield more income.

Given the profitability of the IRRC model, it might prove attractive to impact investors as well as donors, although the payback period is long (two-year set-up, plus four to five years' repayment, even on the basis of a zero-interest rate). The project would also appear risky, with little bankable collateral available in the case of default (since the land provided for these projects often belongs to local government) and is small-scale compared with other impact investment projects. There is also a danger that pressure to increase profitability in order to repay loan finance would push up user fees, which could mean additional costs to poor households.

6 COMPARISON WITH OTHER IRRC PROJECTS

UNESCAP has been promoting IRRCs in the Asia-Pacific region since 2007, concluding that 'IRRCs create jobs for the urban poor and save costs for local government…, mitigate environmental degradation… and contribute to better hygiene and an improved urban environment by reducing vectors and diseases'.[38] The experience of its IRRC pilot in Vietnam, which processes one tonne of waste per day, is typical:

'This IRRC, which is managed and operated by a workers' cooperative, has been able to cover all operational costs and generates surplus revenues which are shared by the workers. The source of revenues for the IRRC is derived from the sale of compost, recyclables and a collection fee for door-to-door waste collection from 700 households and two small markets. The compost produced is mostly absorbed locally through sales

37 See Wilson D et al *(2015)* 'Global waste management outlook', UNEP

38 Storey D, Santucci L, Aleluia J and Varghese T (2013) 'Decentralised and integrated resource recovery centres in developing countries: lessons learnt from Asia-Pacific', paper presented by UNESCAP at the 2013 ISWA Congress

within the neighbourhood. In addition to providing 6 jobs through the cooperative, the IRRC project has also created a strong sense of ownership as the workers are trained to manage and operate the IRRC and their performance is inextricably linked to the long term sustainability and profitability of the IRRC.'

UNESCAP's assessment[39] of its existing IRRCs does not include a cost-benefit analysis, but the number of jobs created, compost produced and emissions mitigated are consistent with those for the pilot IRRC in Pakistan.

7 FEASIBILITY OF REPLICATION IN A POORER COMMUNITY

Tearfund is planning to replicate the IRRC model in two of Islamabad's informal communities in 2018.

Preliminary research conducted to inform this replication suggests that the benefits of the IRRC are likely to be higher if located in an informal settlement, since these arise in large part from reducing fumes from waste burning and insanitary conditions caused by dumped waste. Both effects will be amplified in slum areas because of the density of housing.

The financial sustainability of the project is likely to be more challenging, but should be manageable. The existing IRRC is heavily dependent on user fees – which will be less affordable in an informal settlement. However, the existing IRRC also turns a profit each month, and could thus break even with a much lower level of fees. Furthermore, preliminary research suggests that the cost of collection per household will be lower, because of the density of the housing, so the same number of staff could serve a larger number of households.

A conservative, preliminary budget for the IRRC is described in Table 4, where user fees are charged at 50 per cent of the rate in the current pilot, but 25 per cent more households are served with the same number of staff. On this basis, the IRRC continues to turn a small profit.

Table 4 Illustrative financial scenario for IRRC in informal settlement

	Notes	Monthly cost (PKR)	Monthly cost (USD)
Income			
Household fees	*100 PKR from 2000 households*	200,000	1,900
Sale of recyclable material	*As currently*	50,000	475
Sales of compost	*As currently*	17,500	166
		267,500	2,541
Cost			
Staff wages	*As currently*	154,000	1,463
All other costs	*As currently*	68,000	646
		222,000	2,109
	Profit	45,500	432

39 UNESCAP (2015) *Valuing waste, transforming cities*, UNESCAP and Waste Concern

CASE STUDY IRRC worker Hameed Gul

Hameed Gul is 45 years old and sorts waste at the IRRC in Sector G-15, Islamabad. He receives a salary of PKR 14,000 per month and also receives health benefits for himself and his family through social security. Before joining the IRRC, Hameed was a domestic worker, putting in longer hours (12 hours a day) for less money (just PKR 8,000).

He says: 'After joining the IRRC, my life has changed completely. My financial situation has improved, and I have learnt health and hygiene practices from IRRC, which has improved my health and the health of my family. I have gained knowledge of solid waste management, composting and recycling, which is very useful for me and my community. I am happy and satisfied as I am playing a productive role in society.'

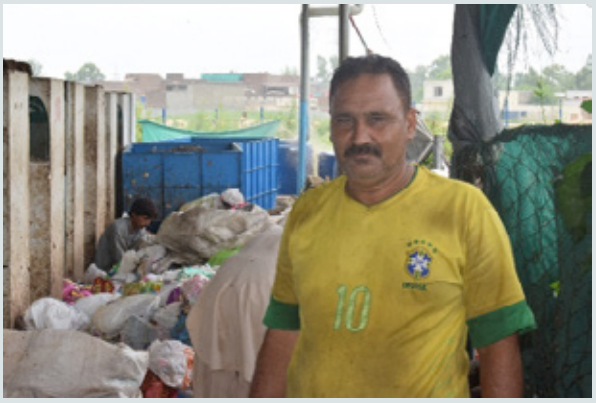


Photo: Solomon Khurrum

8 COMPARISON WITH CENTRALISED WASTE MANAGEMENT APPROACHES

According to the GWMO, community-based approaches such as the IRRC are thought to offer 'a viable and affordable alternative to [centralised approaches]',[40] and, in the words of the GWMO's lead author, 'may offer the only hope for many small cities, towns and villages, as well as informal settlements around larger cities'.[41]

This paper has demonstrated that community-based approaches can be provided on a break-even basis (in that they break even or turn a profit, excluding set-up costs), and leave just ten per cent of waste requiring centralised disposal. As such, they do not completely replace centralised approaches, but can dramatically reduce the need for them in the long term, as well as mitigating major health and climate change impacts.[42]

The purpose of this section is to compare the cost of community-based options with centralised approaches. The GWMO contains an assessment of the net costs (after revenue generation) for a variety of centralised approaches. Table 5 reproduces some of this information.

As is clear, each of these approaches involves significant costs each year. As a comparison, the IRRC breaks even after the initial set-up. If the cost of setting up the IRRC is spread over a 15-year lifespan, then the cost per tonne would be USD 5/tonne at current capacity, or USD 2/tonne at full capacity. As such, the net cost of the IRRC is a factor of ten lower than these centralised alternatives (in large part because it can generate its own income via user fees).

40 Wilson D et al (2015) *Global Waste Management Outlook*, UNEP

41 Foreword to Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institute of Waste Management and Waste Aid

42 This is borne out by other research too; for example, see: www.unescap.org/sites/default/files/8.%20Quy%20Nhon.pdf

Table 5 Costs for centralised waste collection and disposal

TECHNOLOGY	Net cost in low-income country (USD / tonne)	Net cost in lower-middle- income country (USD / tonne)	Source
Available resources, upper limit	*<40*	*40 – 120*	*GWMO, based on 1% of GNI*
Collection	20 – 50	30 – 75	World Bank
Sanitary landfill	10 – 30	15 – 40	World Bank
Composting (excluding sales revenue)	5 – 30	10 – 40	World Bank
Incineration	N/A	40 – 100	World Bank

NOTE: These costs are cumulative, so to collect and dispose of waste in a sanitary landfill, the cost is collection + sanitary landfill.

Finally, it is worth drawing attention to the fact that not all of the centralised approaches available offer the same health, climate and livelihood benefits as community-based recycling. One option is particularly unattractive in a developing country context: waste-to-energy (incineration) plants. These sit at the bottom of the waste hierarchy and depend on international technology suppliers and contractors for construction and operation. However, as 'bankable projects', they can appear attractive to donors. In a European context, emissions arising from incineration have fallen sharply as a result of new technology introduced to meet the EU Waste Incineration Directive (approximately 50 per cent of both investment and operating costs relate to emissions controls).[43] However, in developing countries that lack stringent environmental legislation or the means to enforce it, this technology can be omitted, with serious implications for public health and climate change.[44]

9 CONCLUSION

The IRRC pilot in Islamabad demonstrates the potential for community-based waste management to improve public health, mitigate climate change and create safe jobs. Despite quantifying only some benefits, our analysis suggests that for every dollar invested by a donor, the IRRC model offers USD 10 in benefits (over 15 years at a ten per cent discount rate[45]). The benefits are particularly significant in relation to improved public health and climate change mitigation, although employment creation also plays a part. The IRRC diverts 90 per cent of waste from centralised disposal and is a factor of ten cheaper than providing centralised disposal facilities.

THE PILOT DEMONSTRATES THE POTENTIAL FOR COMMUNITY-BASED WASTE MANAGEMENT TO IMPROVE PUBLIC HEALTH, MITIGATE CLIMATE CHANGE AND CREATE SAFE JOBS

Replication in an informal settlement appears feasible. (The current IRRC is in a relatively wealthy area.) The benefits accrued are likely to be larger in this informal settlement context, because of the higher costs associated with waste burning and dumping (due to population density). Financial sustainability in the long term would be more challenging, because user fees would be less affordable for an IRRC in an informal settlement. However, our research suggests that the IRRC would break even if it charged user fees at less than 50 per cent of the rate in the current pilot. It is also possible that more could be earned

43 Defra and others (2004) *Review of environmental and health effects of waste management*

44 www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf

45 With the exception of climate change where we use a three per cent discount rate, consistent with expert advice, as outlined earlier.

from sales of compost and recycled materials. Tearfund's initial feasibility research (to support replication into two informal settlements in 2018) suggests that this level of user fees is affordable for residents.

However, even if an IRRC approach in informal settlements required some small level of ongoing support, it would still be much cheaper than any of the alternative waste management approaches available. The cost would be more than justified by the significant health, climate and livelihood benefits created.

The analysis presented suggests that community-based waste management approaches offer a 'best value for money' solution for donors and governments. They would help address multiple targets under the Sustainable Development Goals, including SDG 3 (Good Health and Well-being), SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), SDG 12 (Sustainable Consumption and Production), SDG 13 (Climate Action), SDG 14 (Marine Life, in the case of settlements on the coast or major rivers) and SDG 15 (Life on Land). In the specific case of Islamabad, there is an urgent need for replication and up-scaling of this successful model to other areas. The IRRC appears to offer a highly cost-effective way of improving waste management in the fast-growing cities of Pakistan – and beyond.

FURTHER READING

Lenkiewicz Z and Webster M (2017) 'Making waste work: a toolkit', Chartered Institution of Wastes Management and Waste Aid

UNESCAP (2015) *Valuing waste, transforming cities*, UNESCAP and Waste Concern

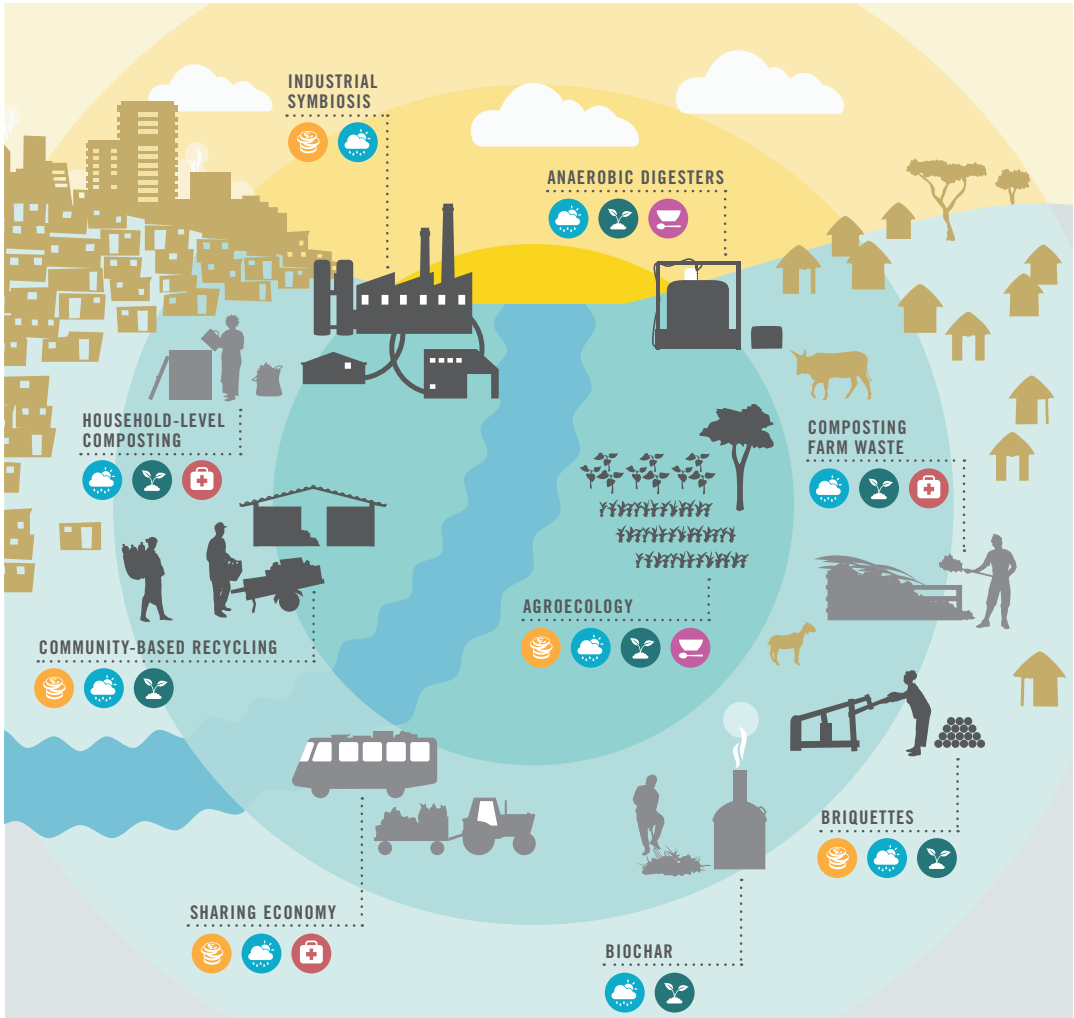
Wiedinmyer C, Yokelson R and Gullett B (2014) 'Global emissions of trace gases, particulate matter, and hazardous air pollutants from open burning of domestic waste', *Environmental Science & Technology*, vol 48, no 16, pp 9523–9530

Williams M et al (2018) *Bending the curve: best practice interventions for the circular economy in developing countries*, Tearfund

Wilson D et al (2015) *Global waste management outlook*, UNEP

ANNEX COMMUNITY-BASED WASTE MANAGEMENT IN A CIRCULAR ECONOMY CONTEXT

The graphic below is reproduced from *Bending the Curve* (2018), and describes a range of promising circular economy interventions for developing countries, alongside an indication of the benefits that they offer.



INTERVENTIONS:

PROVEN	**COMMUNITY-BASED RECYCLING** and waste collection **ANAEROBIC DIGESTERS** – biogas production using agricultural waste **INDUSTRIAL SYMBIOSIS** – waste from one industrial process becomes raw material for another **AGROECOLOGY** – a 'whole system' approach to food production that uses waste as an input **BRIQUETTES** – turning agricultural waste into solid fuel
EVOLVING	**SHARING ECONOMY** – ride sharing, tractor sharing etc **HOUSEHOLD-LEVEL COMPOSTING** **COMPOSTING FARM WASTE** **BIOCHAR** – fertiliser and fuel derived from agricultural waste

BENEFITS:

Health · Jobs · Reducing carbon emissions · Reducing pollution · Food

COST-BENEFIT ASSESSMENT OF COMMUNITY-BASED RECYCLING AND WASTE MANAGEMENT IN PAKISTAN

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