

<b>Institution:</b> University of Leeds		
<b>Unit of Assessment:</b> UoA 12		
<b>Title of case study:</b> Mapping hazardous infectious faecal wastes		
<b>Period when the underpinning research was undertaken:</b> 2011–2020		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Barbara Evans	Senior Lecturer, Professor	01/01/09 – date
Andrew Sleight	Lecturer, Senior Lecturer	01/08/1998 – date
Louise Fletcher	Research Fellow, Lecturer	01/05/2001 – date
Miller Camargo-Valero	Research Fellow, Lecturer, Associate Professor	01/03/2009 – date
Sangaralingam Ahilan	Research Fellow	29/05/2013 – 31/12/2016
Oscar Veses	Research Assistant	03/11/2015 – 30/06/2018
<b>Period when the claimed impact occurred:</b> 2014–2020		
<b>Is this case study continued from a case study submitted in 2014?</b> No		
<b>1. Summary of the impact [100 words]</b>		
<p>Lack of access to safe sanitation affects 2.6 billion people, particularly in low/middle income countries. Political and engineering bias towards 'global north'-style centralised sewerage, despite most people depending on distributed on-site sanitation, results in large investments actually benefitting very few people. University of Leeds research develops tools that generate accessible whole-city visualisations of safe and unsafe (i.e. hazardous and infectious) human excreta flows and identify policy and institutional gaps requiring investment. Our research has influenced investments in over 100 global cities, maximising public health benefits for over one million people, and are embedded in institutional planning covering a population of 2.4 billion.</p>		
<b>2. Underpinning research [500 words]</b>		
<p>In 2011 the University of Leeds was commissioned by the World Bank to start collaborative research to inform their \$10 billion investment in Urban Sanitation. We identified that many of these investments failed to improve the faecal sludge management (FSM) systems that accounted for 80–100% of services in most low- and middle-income (LMIC) cities. The portfolio was instead dominated by investments in centralised sewerage that benefitted very few people. We also found that institutional analyses failed to address the full range of sanitation services, hiding critical problems, and highlighted the need for practical tools to analyse the status of sanitation in a city and better target investment.</p> <p>Two tools were developed [1]: the 'Service Delivery Assessment' (SDA) Scorecard showing the underlying drivers of the sanitation performance, and the 'Shit-Flow Diagram' (SFD), which visually represents the resulting excreta flows. Together, they enable a comparative assessment of policy environments, budgeting and financial performance, human resources, and regulation. Uniquely, they bridge the disciplinary gap between engineers (who understand the processes) and planning/finance professionals (who wish to place sanitation investments into a wider systems framework). The SFD works well for technical and non-technical audiences, and the SDA helps those wanting to identify key policy and investment bottlenecks</p>		

(Figure 1). In tandem, they promote investment in infrastructure integrated with necessary institutional frameworks, avoiding the wasted funds and poor public health outcomes that characterise many planning interventions.



**Figure 1** Bill Gates showing a SFD at the *Reinvented Toilet Expo*, Beijing, 2018 [L].

In 2014 the SDA and SFD were honed through twelve city case studies, co-produced with local stakeholders [2], identifying typical modes of failure and associated interventions. The cities were characterised into a three-tier typology based on their SDA score and the proportion of human excreta that is safely managed. The work demonstrates: how city planners can overcome their specific challenges; that investments in infrastructure without

adequate policies and operational funds for services will be unsuccessful; and, that comprehensive FSM systems will be needed in most LMIC cities. This (and **Evans'** wider portfolio e.g. Refs. [3] and [4]) led to **Evans** participating in the development of the United Nations methodology for estimating access to safely managed sanitation in the Sustainable Development Goal (SDG) framework, refining the SFD approach for use in global monitoring (see e.g. Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO and UNICEF, 2018), <https://washdata.org/report/jmp-methodology-2017-update>; a SFD features on page 11).

The newest SFD paper looked at progress with the roll out of the SFD, its accompanying graphics generator and manual, and the 100+ SFD reports published since 2014 [5]. Analysis of 39 cities identified five critical technical failure modes associated with the degrees to which containment, emptying, discharge, delivery and treatment of faecal sludge are achieved. Identifying these gives clear direction as to which processes and infrastructures are causing a city to miss the SDG goals for safely managed sanitation for all (see also Ref. [2]). The paper develops a set of standard intervention packages to effectively improve sanitation services in low-resource settings. A further phase of the SFD project, funded by the Bill and Melinda Gates Foundation (PI **Evans**, OPP1210665, US\$790k) currently underway at the University of Leeds will strengthen the tools and ensure that their use is institutionalised.

### 3. References to the research (indicative maximum of six references)

- [1] Peal A, Evans BE, Blackett I, Hawkins P, and Heymans C. Fecal Sludge Management: analytical tools for assessing FSM in cities. *Journal of Water, Sanitation and Hygiene for Development* 4(3), 371–383 (2014). <https://doi.org/10.2166/washdev.2014.139>
- [2] Peal A, Evans BE, Blackett I, Hawkins P, and Heymans C. Fecal Sludge Management: a comparative assessment of 12 cities. *Journal of Water, Sanitation and Hygiene for Development* 4(4), 563–575 (2014). <https://doi.org/10.2166/washdev.2014.026>
- [3] Balasubramanya S, Evans B, Hardy R, Ahmed R, Habib A, Asad N S M, Rahman M, Hasan M, Dey D, Fletcher L, Camargo-Valero M A, Rao K C, and Fernando S. Towards sustainable sanitation management: Establishing the costs and willingness to pay for emptying and transporting sludge in rural districts with high rates of access to latrines.

*PLoS ONE* 12(3) e0171735 (2017).

<https://doi.org/10.1371/journal.pone.0171735>

- [4] Bartram J, Brocklehurst C, Bradley D, Muller M, and Evans B. Policy review of the means of implementation targets and indicators for the sustainable development goal for water and sanitation. *npj Clean Water* 1(1), 3 (2018).

<https://doi.org/10.1038/s41545-018-0003-0>

- [5] Peal A, Evans B, Ahilan, S, Ban R, Blackett I, Hawkins P, Schoebitz L, Scott R, Sleigh A, Strande L, and Veses O. Estimating Safely Managed Sanitation in Urban Areas; Lessons Learned from a Global Implementation of Excreta-Flow Diagrams. *Frontiers in Environmental Science* 8, Article 1 (2020).

<https://doi.org/10.3389/fenvs.2020.00001>

All of the above journals are internationally recognised with rigorous review processes and international editorial boards. The quality of the underpinning research being at least 2\* is demonstrated by all five references.

Prior to leaving the University, **Ahilan** and **Veses** contributed to the original research in Ref. 5 as members of **Evans**' research group in the School of Civil Engineering.

#### 4. Details of the impact (indicative maximum 750 words)

Impacts on practitioners and delivery of professional services: The SFD and SDA have brought rigour to investment decisions around urban sanitation, raising its profile and steering funds towards technical interventions that actually improve outcomes, replacing interventions based on standard budget allocations and outdated master plans [A, B, C]. They had an immediate impact on policy discussions at the World Bank, being formalised in their toolkit for urban sanitation planning [A]. After the work was presented at the 2013 Stockholm World Water Week, meetings between the University of Leeds, the World Bank, the Federal Government of Germany (Deutsche Gesellschaft für Internationale Zusammenarbeit) [A, B, C] led to a partnership that formed the Bill and Melinda Gates Foundation (BMGF) funded 'SFD Promotion Initiative' (SFD-PI) (<https://sfd.susana.org/about/the-sfd-promotion-initiative>).

In 2015, the world committed to the Sustainable Development Goals (SDGs). SFDs are incorporated in the design of data collection and reporting protocols for the WHO/UNICEF Joint Monitoring Programme for Water, Sanitation and Hygiene (JMP) [D, 5], mandated by the UN to report on SDG6.1 and 6.2 including urban sanitation. Evans participated in the development of a methodology for estimated access to safely managed on site sanitation as Chair of the Advisory Group [D]. SFD/SDA concepts are integrated into the World Health Organisation normative 'Guidelines on Sanitation and Health' [E] and listed as key components in the urban sanitation guidelines of e.g. the NGOs Water and Sanitation for the Urban Poor (WSUP) [C] and WaterAid [F], and the Asian Development Bank [C, G].

Impacts on understanding and learning: The SuSanA website (<https://tinyurl.com/yxvkyx6a>) develops and transparently archives city-level SFDs. Over 120 reports, currently covering a population of 140 million people, are freely available allowing planners, academics and funding agencies to target sanitation-related decisions and investments using a globally-recognised standard [A, C]. The SFD-PI training events have reached an estimated 8,000 professional and government staff [B], improving analysis of existing sanitation constraints at the local level using the publicly available graphic generator tool with accompanying materials. Work by practitioners who have benefitted from the training has been presented at e.g. Stockholm World Water Week and the World Bank Spring Meetings.

Impacts on public policy and services: From its inception, the impact of the SFD graphic on non-technical stakeholders has been to cause shock and dismay at the unaccounted faecal waste within their cities, leading national governments to institutionalise the SFDs into their sanitation planning programmes. In India, SFDs have been imbedded in the government's scaling up of urban sanitation as part of the Swachh Bharat Nirmal programme, and more than 700 cities have developed City Sanitation Plans based on the SFD approach [H]. In South Africa more than eight cities have used SFDs as part of their planning process, and the government is now working in partnership with their Water Research Commission, and the Indian Centre for Science and the Environment, requiring all municipal governments to prepare SFDs as the basis for funding decisions from the central government [H]. Indonesia has institutionalised the SFD, with every municipality required to produce one as part of their city sanitation plans [I].

Impacts on the health and wellbeing of people: There is an extremely low level of access to safely managed sanitation services in cities and towns in the global south. The SFD tool can unlock enormous public health benefits through improved targeting of sanitation investments. SFDs are now widely used in World Bank Project Appraisal Documents; for example, to target an investment of US\$115M in Mozambique, and US\$65M in Zambia [A]. The Asian Development Bank has also extensively used the SFD tool to optimise sanitation investments in Indonesia, Nepal, the Philippines, Papua New Guinea and Vietnam [G]. The SFD/SDA report for Nairobi was produced by a coalition of stakeholders supported by Evans over the course of nine months. It re-evaluated the status of sanitation in the city, potentially improving the lives of nine million people. Newspaper headlines [J] prompted by the report catalysed a clear policy shift [K].

In 2018 Bill Gates announced that the World Bank Group and the BMGF had “committed to work together to unlock at least \$1billion in investments in innovative sanitation solutions to help address the urgent challenge of 2.6 billion people around the world living without access to sanitation services” [B]. In his speech at the Beijing Toilet Expo attended by hundreds of Chinese and international sanitation experts, he used the image of an SFD to visualise his point regarding the problems of unsafe urban sanitation (Figure 1) [B, L].

##### **5. Sources to corroborate the impact** (indicative maximum of 10 references)

- [A] Letter from the Lead Water and Sanitation Specialist, Water Global Practice, The World Bank, Washington, DC 20433 USA, 20 January 2021.
- [B] Letter from the Sr. Program Officer, WSH Program, Bill & Melinda Gates Foundation, Seattle, WA 23350 USA, 26 January 2021.
- [C] Letter from the Head of Project – Sustainable Sanitation, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), 53113 Bonn, Germany, 26 January 2021.
- [D] Letter from the Unit Head, WASH, Dept. of Environment, Climate Change and Health, World Health Organisation, 28 October 2020.
- [E] ‘Guidelines on Sanitation and Health’, World Health Organisation (2018), p29 et seq, p68 et seq.  
<https://apps.who.int/iris/bitstream/handle/10665/274939/9789241514705-eng.pdf?ua=1>
- [F] ‘Comparison of tools & approaches for urban sanitation September 2016’, Water Aid (2016).  
<https://washmatters.wateraid.org/publications/urban-sanitation-tools-and-approaches>

- [G] Letter from the Chief Sector Officer, Sustainable Development and Climate Change Department, Asian Development Bank, Manila, Philippines, 1 February 2021.
- [H] Letter from the Senior Director & Academic Director, School of Water & Waste Centre for Science and Environment, New Delhi-110 062, India, 21 October 2020.
- [I] Letter from the Director of Housing and Settlements, Directorate Housing and Settlements, National Development Planning Agency (BAPPENAS), Jakarta 10310, Republic of Indonesia, 21 January 2021.
- [J] 'Where does your 'shit' go? 66% of Nairobi human waste unaccounted for', Nairobi Star, 5 July 2018.  
<https://www.the-star.co.ke/news/2018-07-05-where-does-your-shit-go-66-of-nairobi-human-waste-unaccounted-for/>
- [K] Letter from the Co-Founder, Sanergy Inc, Brookline, MA 02446, USA, 26 October, 2020.
- [L] Bill Gates, Speech at Reinvented Toilet Expo, Beijing, China, 6 November 2018, Paragraph 20.  
<https://www.gatesfoundation.org/Media-Center/Speeches/2018/11/Reinvented-Toilet-Expo>