Institution: University of Northampton		
Unit of Assessment: 14: Geography and Environmental Studies		
Title of case study: Hazardous Waste and the Circular Economy		
Period when the underpinning research was undertaken: 2009 - 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Margaret **Bates** Terry **Tudor**	Professor Senior Lecturer	2006 - 2020 2005 - 2019
Period when the claimed impact occurred: 2013 - 2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact

The effective management of solid waste, including waste electrical and electronic equipment (WEEE) in developing countries poses significant challenges. **Professor Bates** and **Dr Tudor's** research has led to changes and developments in these areas both within the United Kingdom (UK) and internationally. There has been a specific focus, and significant international impact, from research looking at potentially hazardous waste electrical and electronic equipment (WEEE or e-waste), and waste from healthcare facilities.

The research has informed UK national policy development and waste management practices for WEEE and healthcare waste, and has had impact in countries such as Brazil, Ghana, Italy, Kenya, Nicaragua, Nigeria and South Africa. This work has had far-reaching consequences both for international strategies to deal with the huge volumes of waste that modern societies generate annually, and for the health and livelihoods of local communities.

2. Underpinning research

Bates and **Tudor's** research focuses on the environmental, social and governance (ESG) risks associated with the management of selected waste streams, particularly WEEE and waste from healthcare facilities. These waste streams generate human health risks from bacterial and viral contamination (in the case of healthcare waste) and from inhaling toxic fumes when burning WEEE to salvage valuable scrap metals. This research has been undertaken in conjunction with a range of public and private sector organisations, and individuals, in the UK and internationally, to address the continuing environmental and health challenges in waste management.

Tudor has examined links between waste management and potential public health risks within the National Health Service (NHS), identifying the negative impacts on the environment and communities' and their environment when healthcare waste disposal is poorly managed. **[3.1, 3.2] Tudor's** research was cited in the European Commission JRC Science for Policy Report on *Best Environmental Management Practice for the Waste Management Sector* (2018) **[5.1]**, a document 'intended to support the environmental improvement efforts of all organisations dealing with waste management by providing guidance on best practices' (p. 15). The report is designed as a 'working tool', drawing on **Tudor's** research into the incineration of health-care waste. The report was used as the basis for an interactive website for Green Best Practice in Europe. **[5.1]**. The research has also focussed on the implementation of support for local authorities to embed zero waste initiatives in England, and the utilisation of behaviour change principles to facilitate improved practice **[3.3,3.4]**.

Bates led research that identified, assessed, and tested circular models of production and consumption for high resource efficiency in relation to the risks associated with the management of WEEE, particularly plastics waste **[3.4]**. In partnership with the Technical University Berlin and Fraunhofer IZM, the researchers determined reverse logistics methods in which materials are removed at the end of their life cycle (e.g., from households in the case of consumer electronics) and used to capture some additional value and ensure their proper disposal. Metrics were developed to assess the impact of the reverse logistics approach based on a review of circular design strategies and business models and their categorisation. The research developed systemic tools for the realisation of a circular business in order to assist companies to create their own customised circular business models **[3.5].**

Bates and **Tudor** developed and delivered training for the management of WEEE by third sector organisations, in Brazil and Nicaragua, as part of the LAWEEDA (2016 – 2019) Erasmus+; Management of WEEE by third sector organisations. While previous research focused on the work of the 'formal' sector, this research explored the 'informal' sector and developed an education concept and training packages for e-waste management. By establishing regional Business and Training Centres (one in Brazil and one in Nicaragua) that serve as a knowledge hub and interface, the project supported HEIs in these countries to modernise and internationalise the academic and non-academic training of engineers and technicians. **[5.2**]

Bates's research in Africa focused on the illegal importation of high volumes of e-waste in countries such as Nigeria. Emphasising the societal challenges faced by the proliferation of e-waste on the second-hand market, as marginal communities earned a living from processing the waste under often dangerous conditions. The research presented well-received recommendations for the adoption of environmentally sound management of e-waste across Africa **[3.6]**, with examples of best practice from case studies in Kenya, Nigeria and South Africa.

3. References to the research

[3.1] Tudor, T. L., Townend, W. K., Cheeseman, C. R., & Edgar, J. E. (2009). An overview of arisings and large-scale treatment technologies for healthcare waste in the United Kingdom. *Waste Management & Research*, *27*(4), 374 - 383. https://doi.org/10.1177/0734242X09336244

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[3.3] Tudor, T. L., Woolridge, A. C., Phillips, C. A., Holliday, M., Laird, K., Bannister, S., Edgar, J. E., Rushbrook, P. (2010). Evaluating the link between the management of clinical waste in the National Health Service (NHS) and the risk of the spread of infections: a case study of three hospitals in England. International Journal of Hygiene and Environmental Health. 213, 6, p. 432-436 5 p.

[3.4] Vaccari, M., Zambetti, F., **Bates**, M., **Tudor**, T., & Ambaye, T. (2020). Application of an Integrated Assessment Scheme for Sustainable Waste Management of Electrical and Electronic Equipment: The Case of Ghana. *Sustainability*. https://doi.org/10.3390/su12083191

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[3.6] Bates, M., & Osibanjo, O. (2019). Management of Electronic Waste in Africa. In G. H. Eduljee, & R. M. Harrison (Eds.), *Electronic Waste Management* (2 ed., pp. 137-165). Royal Society of Chemistry. https://doi.org/10.1039/9781788018784-00137

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4. Details of the impact

Research from the University of Northampton (UoN) informed policy development and best-practice for waste management, with an international focus on waste electrical and electronic equipment (WEEE) and waste from healthcare facilities in nationally and internationally. Due to its largely applied nature, this research has informed both policy and practice:

Advising UK government bodies

Bates and **Tudor** have both contributed to policy development in the UK through advisory positions with governmental and non-governmental organisations. **Bates** was a member of the advisory board for the All Party Sustainable Resource Group (Jan 2001 – Jan 2020). and has contributed advice to a number of government reports. This includes contributing to policy options regarding compostable food packaging (2019) In 2016, **Bates** advised the Government Office for Science in the development of their report From Waste to Resource Productivity, which formed the evidence base for the Government Chief Scientific Adviser's Report created for policymakers, regulators, local authorities and industry stakeholders **[5.3, 5.4]**.

The report set out 13 specific areas to facilitate strategic direction, enhance understanding of the issues, risks and opportunities, and to encourage action on the ground to make the UK a more resource productive society. It has informed the development of the Resources and Waste Strategy for England that was published in December 2018. The Resources and Waste Strategy sets out a plan for how resources such as plastic, paper and metals will be conserved by reducing the amount of waste generated and promoting efficient use of existing resources, with the aim of promoting the values of a circular economy **[5.5]**

In May 2018 **Bates** joined the Scottish Government's expert panel on Environmental Charging and Other Measures to provide advice to Scottish Ministers 'with the goal of encouraging the long-term and sustainable changes in consumer and producer behaviour required to move towards a circular economy.' The resulting report was received by the government, who was 'broadly content to accept the package of recommendations set out by the Panel.' **[5.4]**
Bates and **Tudor** have both worked extensively with the Chartered Institution of Wastes Management (2017-2020). **Bates** was the organisation's president (2016-2017) and served as the chair of the Executive Committee through 2020.

Tudor contributed to the sections on waste handling and storage for the Chartered Institution of Wastes Management's official guidance document for healthcare waste management in England & Wales **[5.6]**. Although some local NHS hospitals have produced their own guides, to date this is the only nationally recognised guide in the UK for managing waste produced in a healthcare setting. Building on this work, Health Protection Scotland and the Scottish National Health Services applied Tudor's research on the management of clinical waste in the NHS **[3.1]** to their review of the safe disposal of healthcare waste. The resulting document informed the Standard Infection Control Precaution (SICPs) section in the Safe Disposal of Waste in the National Infection Prevention and Control Manual **[5.7]**.

REBus; Enabling Industry to change (2013- 2017)

UoN partnered with REBus, an EU Life+ funded partnership project, pioneering and testing a methodology that enables companies to transform their strategies to profitable, resilient and more resource efficient business models (REBMs). In the UK, the project worked with

companies directly, in particular on schemes that incentivise the return of products for recycling or reuse, in order to divert them from waste streams, for example, REBus helped Argos, a retailer with 740 high-street outlets, implement a "gadget trade-in" service. The work done by REBus involved preparation of the business case, assistance in promoting the scheme and in staff training. The "gadget trade-in" service rolled out to all UK Argos stores in May 2015 **[5.8]**.

Creating guidance for waste management in Europe:
The research has impacted policy in Europe more widely, and contributed to the European Union's ambitious plan for a circular economy. **Tudor** was a member of the European Union's Wastes Management Technical Working Group and contributed to the European Commission's JRC Science for Policy Report 'Best Environmental Management Practice for the Waste Management Sector' (2018) in relation to effective management of healthcare waste across Europe. The report articulates a necessity to develop alternative modes of waste disposal and cites Tudor's research extensively in relation to the requirements to effectively segregate and thermally treat healthcare waste **[3.4, 5.1].** The report serves as one of the key guidance documents of Interreg Europe, which is the main pan-European non-governmental agency that supports regional and local governments across Europe in the development and implementation of waste management policy **[5.9]**.

As part of the PolyCE project researchers at the university contributed to the design of videos as part of an EU-wide consumer-awareness raising campaign on the benefits of recycled plastics in WEEE, and were featured in parts of the video as experts. The campaign was promoted via social media and through a Colombian TV programme organized by Click-Verde (November 2019).

Improving waste management in developing countries

In 2018, **Bates** appointed as an expert for the EU project 'Promotion of sustainable growth in Palestine through an environmentally safe, innovative and economically valuable treatment of WEEE'. As the advisor for The E-waste Solutions Alliance for Africa project Bates worked with companies such as Dell, HP, Nokia, Phillips and Reclaimed Appliances to develop regulations, guidelines and infrastructure, to increase recycling in Lagos and Nigeria, particularly in second-hand markets.

Bates contributed learning materials to the development of innovative tools for LaWEEda, which raised knowledge and understanding of WEEE for a variety of third-sector stakeholders in Brazil and Nicaragua, including non-governmental workers, charity workers, waste management practitioners, training organisations, in addition to policy makers and higher education institutions. This research has led to more circular and financially viable organisations and the development of new entities, including spin-offs from participating universities such as Universidade Federal do Rio de Janeiro. The project improved the quality of higher education and enhanced its relevance for the labour market and society by creating new connections between higher education institutes and industry partners in the area of e-waste management between Brazil and Nicaragua as well as the EU. LaWEEEda led to an upskilling of participants, who were drawn from informal social sectors, and the development of new ways of working. It resulted in the creation of new support networks, and the cascading of the training, through a train-the-trainer approach **[5.2]**.

5. Sources to corroborate the impact

[5.1] Dri M., Canfora, P., Antonopoulos, I.S., Gaudillat, P. (2018**)** 'Best Environmental Management Practice for the waste management sector', *JRC Science for Policy Report*. Publications Office of the European Union. https://doi.org/10.2760/50247

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[5.3] Government Office for Science (2017). *Report of the Government Chief Scientific Adviser: From waste to resource productivity: evidence and case studies*

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[5.5] GOV.UK. "Resources and Waste Strategy for England." Accessed November 19, 2020. https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england.

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Partners: The Waste and Resources Action Programme (WRAP) (UK), Aldersgate Limited (UK), KTN Ltd (UK), Rijkswaterstaat (The Netherlands), The University of Northampton (UK).
Budget: €3,104,725 (EU contribution from LIFE programme €1,552,361) http://www.rebus.eu.com

[5.9] Integra Europe https://www.interregeurope.eu/policylearning/news/3657/best-environmental-management-practices-for-the-waste-management-sector/ Accessed on 20 May 2019