

<b>Institution:</b> The Open University		
<b>Unit of Assessment:</b> B7 Earth Systems and Environmental Sciences		
<b>Title of case study:</b> Reducing the health risks associated with waste management and farming through pioneering bioaerosol research and industry engagement		
<b>Period when the underpinning research was undertaken:</b> 2003-2020		
<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>
Dr Toni Gladding	Senior Lecturer in Environmental Engineering	2001-present
Dr Catherine Rolph	Lecturer in Environmental Sciences	2015-present
<b>Period when the claimed impact occurred:</b> 2013-2020		
<b>Is this case study continued from a case study submitted in 2014?</b> N		
<b>1. Summary of the impact</b>		
<p>Waste and environmental pollution research at the OU has driven policy and practice changes in waste and farming through research funded by Government, regulatory agencies, research councils and industry. In particular <b>Gladding</b> and <b>Rolph's</b> research on the bioaerosols generated by industrial waste management sites and intensive farming has had a demonstrable impact by:</p> <ul style="list-style-type: none"> <li>• Improving health and safety in the UK waste management industry;</li> <li>• Shaping the waste industry's response to the coronavirus pandemic;</li> <li>• Setting the standard for measuring emissions from waste sites and farms in the UK;</li> <li>• Providing evidence to support more sustainable household waste collection and management.</li> </ul>		
<b>2. Underpinning research</b>		
<b>Health and Safety in the Waste Industry</b>		
Based on a comprehensive study of industrial waste management facilities in the UK and drawing on European data, <b>Gladding's</b> 2003 article was the first to evidence the respiratory health risks posed by hand sorting mixed waste [O1]. This work established the importance of health and safety considerations within materials recycling and the occupational risks.		
<b>Household Waste Collection Frequency (and health and safety)</b>		
In later laboratory studies between 2013 and 2014 [G1], funded by Zero Waste Scotland, OU work challenged suggestions that reducing the frequency of mixed household waste collection from weekly to every three or four weeks would pose an increased risk to public health [O2]. The research demonstrated no increased bioaerosol exposure risk to the general public at a 3-to-4-week collection frequency. However, a prolonged delay in collection (over 7 weeks) could be of concern to waste collection and processing staff hence missed collections should be avoided.		
<b>Emissions from Industrial Sites</b>		
Realising that standard sampling approaches and equipment for measuring the environmental spread of bioaerosols from industrial sites did not exist, <b>Gladding</b> systematically established these baselines utilising several funding sources. This included the UK Government's Department for Environment, Food & Rural Affairs (DEFRA) in 2014/15 [G2] that established sampling methods to measure environmental spread of site emissions [O3, O4]. This work established the sampling approaches and equipment to measure bioaerosols downwind of sites that returned scientifically rigorous results and underpinned regulatory approaches to sampling. Through an Environment Agency-funded study in 2015/16 [G3], <b>Gladding</b> applied the same approaches to assess the bioaerosol emissions emitted by intensive farming [O6]. This research demonstrated much higher concentrations of <i>Staphylococcus</i> species downwind of farms. This pathogen is also a potential source of antibiotic resistance in the environment. From 2016-2019 funded by the Natural Environment Research Council (NERC) [G4], <b>Gladding</b> and <b>Rolph</b> conducted one of the first assessments of the impact of industrial operations on the downwind concentration of endotoxin, a bioaerosol component known as a respiratory sensitiser [O5]. This		

work established that endotoxin is primarily an occupational concern and did not travel beyond the site boundary.

In 2019/20 a parallel research project funded by Innovate UK **[G5]** (and co-funded by NERC) allowed OU expertise in bioaerosols to be put to practical use and to provide the waste and farming industries with much needed risk information via training materials, webinars and information.

### **COVID and Waste Management.**

The body of bioaerosols research work carried out by **Gladding** since 2000 contributed to lending her expertise in the recent pandemic on organism transmission and survival.

Additionally, in 2020, **Gladding** as part of a team secured a grant from the Economic and Social Research Council (ESRC) to analyse the impact of the spread of COVID-19 through the waste management industry. The team has yet to publish the findings of this study, but thus far the work has found the industry to be fragmented but successfully supported by the Waste Industry Safety and Health forum and targeted COVID guidance.

### **3. References to the research**

- O1. Gladding, T.L.,** Thorn, J., & Stott, D. (2003) Organic Dust Exposure and Work-Related Effects Among Recycling Workers. *American Journal of Industrial Medicine* 43, 6: 584-591. <https://doi.org/10.1002/ajim.10220>
- O2. Gladding, T.L.,** & Gwyther, C.L. (2017) A Study of the Potential Release of Bioaerosols from Containers as a Result of Reduced Frequency Residual Waste Collection. *Science of the Total Environment*. 576: 481-489. <https://doi.org/10.1016/j.scitotenv.2016.10.060>
- O3. Nasir, Z.A.,** Hayes, E., Williams, B., **Gladding, T.L., Rolph, C.,** Khera, S., Jackson, S., Bennett, A., Collins, S., Parks, S., Attwood, A., Kinnersley, R.P., Walsh, K., Garcia Alcega, S., Pollard, S.J.T., Drew, G., Coulon, F., & Tyrrel, S. (2019) Scoping studies to establish the capability and utility of a real-time bioaerosol sensor to characterise emissions from environmental sources. *Science of the Total Environment*. 648:25-32. <https://doi.org/10.1016/j.scitotenv.2018.08.120>
- O4. Nasir, Z.A., Rolph, C.,** Collins, S., Stevenson, D., **Gladding, T.L.,** Hayes, E., Williams, B., Khera, S., Jackson, S., Bennett, A., Parks, S., Kinnersley, R.P., Walsh, K., Pollard, S.J.T., Drew, G., Alcega, S.G., Coulon, F., & Tyrrel, S. (2019) A controlled study on the characterisation of bioaerosols emissions from compost. *Atmosphere* 9(10), 379: <https://doi.org/10.3390/atmos9100379>
- O5. Rolph, C.A.,** Gwyther, C.A., Tyrrel, S., Ahmad Nasir, Z.A., Drew, G.H., Jackson, S., Khera, S., Hayes, E., Williams, B., Bennett, A., Collins, S., Walsh, K., Kinnersley, R., & Gladding T.L. (2018) Sources of Airborne Endotoxins in Ambient Air and Exposure of Nearby Communities—A Review. *Atmosphere*. 9(10): 375. <https://doi.org/10.3390/atmos9100375>
- O6. Gladding, T.L., Rolph, C.A.,** Gwyther, C.L., Kinnersley, R., Walsh, K., & Tyrrel S. (2020) Concentration and composition of bioaerosol emissions from intensive farms: Pig and poultry livestock. *Journal of Environmental Management*. Vol 272, 15th October 2020, 111052. <https://doi.org/10.1016/j.jenvman.2020.111052>

### **Relevant Grants:**

- G1. T. Gladding** (PI), Zero Waste Scotland funded OU laboratory studies LAS005-011 and LAS005-002 during 2013/14 on behalf of the Scottish Government GBP115,000.
- G2. T. Gladding** (PI), Validation of Bioaerosol Sampling Approaches and Devices Defra funding (WR0615) 2014 GBP38,000.
- G3. T. Gladding** (PI), Environment Agency (EA) (SC130025/1 and SC130025/2) 2014/15 GBP28,000 (Whole grant GBP57,000).

- G4.** T. **Gladding** (PI). Detection and Characterisation of Inflammatory Agents Associated with Bioaerosol Emitted from Biowaste and Intensive Agriculture, NERC funded research project (NE/M011763/1) 2016-19 GBP324,115 (Whole grant GBP1.5m).
- G5.** T. **Gladding**, Innovate UK 511541 GBP97,572 +company contribution GBP145,639 total
- G6.** T. **Gladding** (PI), ESRC Waste management during the COVID-19 outbreak GBP22,850 (Whole grant GBP280,000).

#### 4. Details of the impact

##### Improving health and safety in the UK waste management industry

The UK's waste management industry is worth GBP11bn and employs approximately 80,000 people. However, the industry's fatality rate is 16 times greater than the all-sector average; its 3.9% accident rate and 4.5% illness rate are both significantly higher than all industry averages of 1.9% and 3.1% respectively [C1, pp.18-33]. In 2003, the Chartered Institution of Wastes Management (CIWM) invited **Gladding** to share her expertise as part of the Waste Industry Safety and Health (WISH) Forum, a unique and independent partnership between the Health and Safety Executive (HSE), waste industry, local authorities, trade/professional associations and trade unions. In 2012, **Gladding** became secretary of WISH, and steers the forum in collaboration with an industry Chair, and leads the website (funding and operation) which publishes guidance and information [C2]. Within the impact period, **Gladding** was a significant author on WISH guidance based on her research [O1-O6, G1-G6] on health surveillance, bioaerosols and people sleeping in bins [C4].

Between 2017 and 2018 the HSE used WISH guidance to underpin the successful prosecution of 27 waste firms, with fines totalling GBP2.8m [C3]. In a 2018 report, the Environmental Services Association credited WISH with improving health and safety performance in the industry [C1, p.12]. In a 2020 survey 94% of 70 waste management and local authority respondents reported they actively used WISH guidance and 69% said that they regularly used the forum's information sheets [C5, p.2, graph 4]. Moreover, 66% cited the guidance's benefits in improving their organisation's health and safety climate, while 61% said it enhanced employee involvement [C5, p.3, graph 6]. Writing in January 2021, the Chair of WISH explained how **Gladding's** research-based expertise had directed WISH to publish guidance and how her expertise was used during the COVID response [C6].

##### Shaping the UK waste industry's response to the coronavirus pandemic

In March 2020, DEFRA approached WISH to avoid the cessation of waste collection in the UK as a result of the COVID-19 pandemic. In April 2020, **Gladding** used her research in bioaerosols [O1-O4, G1-G3, G6], to write the first draft of a new information note (INFO13) on how to manage waste safely during the pandemic as part of a special task group [C7, pp.2-35]. INFO13 recommended that, while obeying two-metre social distancing may not be practicable for waste personnel, waste collection operations could, and should continue with reasonable safety measures in place. An INFO13 consultation received approximately 50+ responses from Government and industry [C7, pp.36-63]. In April 2020, a House of Commons Library insight cited INFO13 in guidance for Members of Parliament [C7, p.64-66] and it was later referenced by the UK Government in official guidance on prioritising waste collection during the pandemic [C7, p.70]. During 2020 **Gladding** and WISH held several webinars in conjunction with industry publisher, LetsRecycle, with 433-851 participants a time [C7, p.82]. The International Solid Waste Association published INFO13 and **Gladding** presented the UK response at an international webinar attended by 405 people in 64 countries [C7, p.88]. INFO13 ensured household waste collection continued during the pandemic in 2020 in the UK and significantly influenced waste organisations overseas.

##### Setting the standard for measuring emissions from waste sites and farms in the UK

**Gladding** and **Rolph's** work on the sampling and quantification of airborne microorganisms at waste facilities [O3-O6, G2-G5] provided underpinning evidence for the Environment Agency's technical guidance note, M9, which sets out a standardised method for measuring bioaerosols at all UK waste sites [C8, p.2]. Writing in January 2021, the Environment Agency's M9 lead

explained how the research is an instrumental part of M9 and that the national regulatory approach is substantially based on a protocol **Gladding** authored [C8, p.3; C9]. Subsequent work applying the same sampling methods to intensive farming practices [O5, G4] and on endotoxin [O6, G5] informed the decision to extend these monitoring provisions to over 12,000 farms in the UK [C9] and fed into the decision to exclude endotoxin from M9.

### **Providing evidence to support more sustainable waste management via reduced waste collection frequency (in Scotland)**

**Gladding's** 2017 research found that reducing the frequency of mixed household waste collection did not pose a risk to public health [O2, G1], prompting 10 of Scotland's 32 local authorities to reduce waste collection frequency [C10a]. In a December 2020 letter, Zero Waste Scotland's Policy Manager described how this change played a "significant role in supporting waste reduction and increased recycling" and explained that **Gladding's** research had been a "significant enabling research publication that allowed people to make operational changes with a greater degree of confidence in the health consequence to their residents" [C10b].

## **5. Sources to corroborate the impact**

### **C1. Waste industry statistics:**

- Environmental Services Association: Spotlight on health and safety: Contrasting performance in the waste and recycling industry (pp. 2-17).
- Health and safety UK waste industry statistics (pp. 18-33).

### **C2. [WISH website and guidance](#)**

### **C3. Evidence of HSE engagement:**

- HSE directly quoting WISH Guidance after a prosecution (p.2).
- Evidence of HSE using WISH Guidance in inspection campaign (pp. 3-47).

### **C4. WISH research on people sleeping in bins extensively reported nationally (Guardian article).**

### **C5. WISH user survey [September-December 2020] 70 responses (pdf).**

### **C6. Testimonial letter Industry Chair of WISH.**

### **C7. Evidence of the impact of WISH guidance on managing waste during the coronavirus pandemic, based on **Gladding's** research:**

- a. [WISH Information Document: Covid-19 and Waste Management Activities](#), the draft Info13 was produced in late March 2020 (pp. 2-16) and the first official release of Info13 was on 2 April 2020 (pp. 17-35).
- b. Collected responses to consultation on WISH information note (pp. 36-63).
- c. House of Commons Library insight, citing WISH information note. 6th April 2020 (pp. 64-66).
- d. UK Government Guidance for England, Guidance on prioritising waste collection services during coronavirus (COVID-19) pandemic, last updated 14th December 2020 (pp. 67-81).
- e. Covid 19 Waste Project and associated webinars (pp. 82-84).
- f. International Solid Waste Association pdf and webinar details (pp. 85-92).

### **C8. Evidence of impact for setting the standard for measuring emissions from waste sites and farms in the UK:**

- M9 environmental monitoring of bioaerosols at regulated facilities: Guidance on the monitoring of bioaerosols from stacks, open biofilters and in ambient air (p.2).
- Standardised Protocol for Monitoring Bioaerosols (p. 3-51).

### **C9. Testimonial letter from the Environment Agency.**

### **C10. Evidence of reduced waste collection frequency and increased recycling:**

- Email confirming number of Scottish Authorities who switched collection (p.2).
- A testimonial from Policy Manager Zero Waste Scotland (p.3- 4).