

Impact case study (REF3b)

<p>Institution: University of Portsmouth</p>
<p>Unit of Assessment: 7 Earth Systems and Environmental Sciences</p>
<p>Title of case study: Enhancing public understanding of nuclear safety issues following the Fukushima nuclear accident</p>
<p>1. Summary of the impact</p> <p>This impact case study describes major public communication activities by Professor Jim Smith on the immediate and long-term consequences of the Fukushima accident through radio, television, print and internet media. During the weeks after Fukushima, Smith made a key contribution to the developing scientific understanding of the likely consequences of the accident and to the worldwide dissemination of that understanding. This made a documented improvement to international news agencies' coverage of the event (Evidence 2, 4, 5) and "helped elevate and inform the debate" on the risks and consequences of nuclear power (Evidence 2).</p>
<p>2. Underpinning research</p> <p>This case study is based on research into the mobility of radioactivity, its biological uptake and predictions of radiation doses and effects following nuclear accidents. The research has been conducted at the University of Portsmouth since 1999. It was led from 1999-07 by Dr David Timms (Reader in Radiation Physics: deceased, 2007), in collaboration with Prof. Jim Smith (Professor of Environmental Science from 2011), who joined Portsmouth in 2007 (as Reader) from the Centre for Ecology and Hydrology and has led the research since then.</p> <p>The body of research carried out by Timms and Smith has made a significant contribution to understanding the long-term mobility of radioactivity in the environment, external radiation dose and ecosystem impacts. This provided key underpinning to Smith's public communication work following the Fukushima accident, in particular allowing evidence-based responses to issues concerning contamination of drinking water sources, the extent and likely duration of evacuation of the contaminated areas, and radiation impacts on wildlife.</p> <p>The research has primarily focussed on radiocaesium (Cs-134 and Cs-137), and radiostrontium (Sr-90), the most important long-term contaminants in most major nuclear power plant accident scenarios. The long-term consequences of radionuclide contamination depend on their rate of transfer from contaminated land to surface waters, and the extent to which they transfer into soils. These determine levels of contamination of rivers, lakes and reservoirs, as well as redistribution and the radiation dose from radioactivity absorbed to soil. Smith and Timms' research into transfers of radiocaesium and radiostrontium from a wide range of river catchments¹ has allowed quantification of radionuclide transfers to surface waters and their relation to soil characteristics. Their model which for the first time incorporated a solution of the advection-dispersion equation into an external dose model² improves assessment of dose rate changes over time by accounting for differing, and time-changing, radionuclide depth distributions in the formation of external dose.</p> <p>Research by the submitting unit into the long term impacts of radiation on organisms has helped us to understand the ecological consequences of both routine and accidental releases of radioactivity. The simplified model ("D-Max") was developed to evaluate radiation doses to organisms in both aquatic and terrestrial environments. Smith participated in the International Atomic Energy Agency (IAEA) Environmental Modelling for Radiation Safety (EMRAS) aquatic³ and terrestrial⁴ model testing and inter-comparison exercises, providing international validation of models and highlighting key areas of uncertainty. The first population-level study of radiation effects on aquatic insects at Chernobyl⁵ observed, perhaps surprisingly, no negative impacts, even in the most contaminated lakes. A modelling study⁶ to test, for the first time, the hypothesis that oxidative stress is a mechanism for radiation damage in contaminated environments found that production of reactive oxygen species by radiolysis was far too low to cause direct radiation impacts.</p>

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This body of research has resulted in significant contributions by Smith to two key IAEA technical reports on radionuclide transfer (TRS 472: Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Terrestrial and Freshwater Environments, 2010) and post-accident emergency response (TRS 475: Guidelines for remediation strategies to reduce the radiological consequences of environmental contamination, 2012).

3. References to the research

1. Smith J.T., Wright S.M., Cross M.A., Monte L., Kudelsky A.V., Saxén R., Vakulovsky S.M., Timms D.N. (2004) Global analysis of the riverine transport of ⁹⁰Sr and ¹³⁷Cs. *Environmental Science and Technology*, 38, 850-857. DOI: [10.1021/es0300463](https://doi.org/10.1021/es0300463). 21 citations by Oct 2013.
2. Timms D N, J T Smith, M A Cross, A V Kudelsky, G Horton, R Mortlock. (2004) A new method to account for the depth distribution of radiocaesium in soils in the calculation of external radiation dose rate. *Journal of Environmental Radioactivity*, 72, 323-334. DOI: [10.1016/s02650931x\(03\)00219](https://doi.org/10.1016/s02650931x(03)00219). 6 citations by Oct 2013. *PDF available on request*.
3. Yankovich, T L, Vives i Batlle J, Vives-Lynch, S, Beresford, N A, Barnett, C L, Beaugelin-Seiller, K., Brown, J E , Cheng, J-J, Copplestone, D, Heling, R., Hosseini, A, Howard, B J, Kamboj, S., Kryshev, A.I., Nedveckaite, T, Smith, J T, and Wood, M D (2010) An international model validation exercise on radionuclide transfer and doses to freshwater biota. *Journal of Radiological Protection* 30, 1-42. DOI: [10.1088/0952-4746/30/2/S06](https://doi.org/10.1088/0952-4746/30/2/S06). 11 citations by Oct 2013.
4. Beresford, N A, Barnett, C L, Brown, J E , Cheng, J-J, Copplestone, D, Gaschak, S, Hosseini, A, Howard, B J, Kamboj, S, Nedveckaite, T, Olyslaegers, G, Smith, J T, Vives i Batlle J, Vives-Lynch, S and Yu, C (2010) Predicting the radiation exposure of terrestrial wildlife in the Chernobyl exclusion zone: an international comparison of approaches. *Journal of Radiological Protection*, 30, 341-373. DOI: [10.1088/0952-4746/30/2/S07](https://doi.org/10.1088/0952-4746/30/2/S07). 12 citations by Oct 2013.
5. Murphy, J.F., Nagorskaya, L.L., Smith, J.T. (2011) Aquatic macroinvertebrate communities in lakes exposed to Chernobyl-derived ionising radiation. *Journal of Environmental Radioactivity* 102, 688-69. DOI: [10.1016/j.jenvrad.2011.04.007](https://doi.org/10.1016/j.jenvrad.2011.04.007). 1 citation by Oct 2013.
6. Smith, J.T., Willey, N.J., Hancock, J.T. (2012) Low dose ionizing radiation produces too few reactive oxygen species to directly affect antioxidant concentrations in cells. *Biology Letters* 8, 594-597. DOI: [10.1098/rsbl.2012.0150](https://doi.org/10.1098/rsbl.2012.0150). 2 citations by Oct 2013. Ref2 output: 7-JS-002

References 1, 5, 6 should be used to assess the quality of the research. Reference 1 represents the first global analysis of long term ¹³⁷Cs and ⁹⁰Sr transport from contaminated catchments to rivers and was published in a highly-ranked journal (“#1 in Environmental Engineering and Environmental Sciences”, IF 5.26). Reference 5 for the first time studied the diversity and abundance of aquatic insect populations living in highly radioactively contaminated lakes demonstrating, surprisingly, that no population-level effects could be observed in the long term after the Chernobyl accident. This research was published in the primary journal in the Environmental Radioactivity field (IF 2.12). Reference 6 took a novel approach to evaluating potential radiation damage to organisms by oxidative stress, published in a highly-regarded Royal Society journal “particularly suited to research that requires high visibility due to its novel findings” (IF 3.35). This radiation effects research is continuing through Smith’s participation in a recently-awarded consortium grant (£392k to Portsmouth) within the NERC Radioactivity and The Environment programme.

4. Details of the impact

The communication of complex scientific issues surrounding controversial technologies has long been identified as of key importance in the public debate over their acceptance and regulation. Major concerns over science communication of GM and nuclear waste disposal were the key drivers of the influential House of Lords Science and Technology Select Committee year 2000

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report on Science and Society which led to the establishment of the Science Media Centre (SMC). Smith's media work with the SMC, and direct public engagement activities on nuclear issues, have made an outstanding contribution to the scientific community's public response to the Fukushima accident and to public understanding of nuclear and radiation risk issues in general.

This case study is set within the context of Smith's long record of commitment to public engagement activities on nuclear issues. Since 2008, he has given eight talks to practising (for Institute of Physics, IoP) and trainee physics teachers (total audience ca. 300), numerous lectures to schoolchildren (total audience ca. 700) including a prestigious IoP "Physics in Perspective" lecture. Lectures to general audiences (totalling ca. 750) have included five well-attended Cafe Scientifiques. Until 2012, he was on the organizing committee of the Institute of Physics (IoP) Teachers' Update Course³.

In the immediate aftermath of the three explosions (12-15 March 2011) at Fukushima, there was an urgent need by the international news media for independent expert opinion on the accident's significance and its consequences to people and the environment. The statement by the EU Commissioner for Energy that "There is talk of apocalypse... practically everything is out of control" was widely reported. This, together with Germany and Italy's rapid renouncement of nuclear power, contributed to an atmosphere of panic surrounding nuclear issues in Europe as well as Asia.

During the weeks after Fukushima, Smith made a key contribution to the developing scientific understanding of the likely consequences of the accident and to the worldwide dissemination of that understanding. This made a real difference to news agencies' coverage of the event, as evidenced by letters from Reuters⁴ and the BBC⁵. Through dozens of media interviews reaching a global audience of many tens of millions⁷, his knowledge of the environmental mobility of radioactivity allowed accurate prediction of the likely impacts of marine and terrestrial contamination, in particular the need for an extended area of long term evacuation (e.g. Smith, J.T. Nature article⁶; online 05/04/11). Importantly, his comments placed the likely health risks from radiation in their proper context.

A partial analysis of Smith's Fukushima coverage⁷ identified 40 outlets including The Sun, Financial Times and BBC Six and Ten O'clock News. It is likely that coverage in total ran to hundreds of media outlets; for example, coverage by Radio 4's PM, USA Today and New Zealand national public radio was not picked up by the clippings analysis. A highly successful live online Q&A session on Fukushima with Smith, run by Nature (06/04/11) received more than 5000 hits⁸ and an edited version appeared in Scientific American magazine. As a key expert for the SMC¹, Smith was one of four scientists in a press briefing (29/03/11) to 11 national science journalists including Reuters, The Guardian and the Today programme. This generated considerable science-based press coverage on the environmental contamination, and, perhaps more importantly, communicated the negligible health risks of plutonium detected near the reactor, and of Fukushima radionuclides detected in the UK and Europe. Averting unfounded scare stories on radiation is as important an impact as the generation of science-based coverage, as emphasised by Fox^{1,9}:

"The main event for the SMC in 2011 was the nuclear crisis at Fukushima [it] was the only story in town and headlines about "another Chernobyl" and "nuclear apocalypse" screamed out from front pages... [our] scientists offered a considered assessment of complex and terrifying events. Because of their efforts, alarmist headlines were at least partially balanced by the kind of accurate, evidence-based science we desperately need in times of media frenzy."

The research by the submitting unit clearly helped underpin the many interviews given by Smith. The need for permanent evacuation and assessment of health consequences needs an understanding of the environmental mobility of radiocaesium and the evaluation of dose. Prognosis of direct impacts on ecosystems is dependent on work on radiation effects on organisms to which Smith has made an important contribution. These research papers (5,6 above) themselves have generated media coverage (despite being good news stories), including New Scientist, BBC Radio Scotland and EURONEWS (broadcast worldwide).

Public engagement activities are “of vital importance to an informed public and political debate on the costs and benefits of nuclear power and radioactive waste disposal”¹. Smith’s contribution in this area has “helped elevate and inform the debate”² on the risks and consequences of nuclear power.

5. Sources to corroborate the impact

1. Letter from Chief Executive, Science Media Centre. *Supports importance of Smith’s contribution to SMC Fukushima response and the “outstanding” significance of his public engagement work.*
2. Letter from Chief News Editor, *Nature*. *Supports importance of Smith’s “outstanding” contribution to media coverage of Fukushima and helping to “elevate and inform the [public] debate” on the risks and consequences of nuclear power.*
3. Letter from Director of Education, Institute of Physics. *Supports claim on impact of direct public engagement activities.*
4. Letter from Health and Science Correspondent, *Reuters*. *Provides evidence that Smith’s contribution “made a real difference to Reuters’ worldwide coverage of this major event”.*
5. Letter from Editor, UK Specialists, BBC. *Provides evidence that “Using experts [such as Smith] greatly enhanced our analysis and led to much praise for [the BBC’s] measured approach during the unfolding disaster”*
6. Smith, J.T. (2011) A long shadow over Fukushima. *Nature* 472, p. 7. *Exemplifies the commentary on the situation at Fukushima provided by Smith.*
<http://www.nature.com/news/2011/110405/full/472007a.html>
7. Analysis of media coverage March 11 – April 30 2012; mediacoverage.co.uk. *Corroborates claim on media coverage.*
8. Letter from Chief Editor, *Nature*. *Supports claim on impact of online Q&A session on Fukushima.*
9. Fox, F. *The year in review – 2011*
http://www.researchresearch.com/index.php?option=com_news&template=rr_2col&view=article&articleid=1150883.
Emphasises the importance of the scientific community’s response to Fukushima and of the contribution of experts such as Smith.
10. “Media Meltdown” Article by Kate Kelland, *Reuters*, in SMC 10th Anniversary brochure. *Supports claim on importance of SMC to the media coverage of Fukushima and names Smith as one of three key scientists in Reuters’ coverage of the event.*
<http://www.sciencemediacentre.org/wp-content/uploads/2012/10/SMC-Anniversary-Brochure.pdf>