Institution: Cranfield University

Unit of Assessment: 12

Title of case study: Embedding formalised risk management in the international water sector

Period when the underpinning research was undertaken: 2003-2018

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:**
Prof Simon **Pollard** (OBE DSc FREng)	PVC, Water, Energy and Environment	2002-present
Dr Simon **Jude**	Research Fellow then Lecturer, now Senior Lecturer	2010-present
Dr Heather **Smith**	RF then Lecturer, now Senior Lecturer	2011-present

Period when the claimed impact occurred: 2014 – 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

From 2003-2020, **Pollard** (OBE DSc FREng), **Jude** and, latterly, **Smith** have been funded by the US Water Research Foundation, five water utility consortia, EPSRC, NERC and ESRC to address the growing need for formalised risk management in the international water sector. Since 2014 Cranfield's work has fundamentally changed the way risk is viewed and managed within the sector. With a new network of risk managers, utilities in the UK (e.g., Yorkshire Water), the US (e.g., Philadelphia Water), Portugal (EPAL) and Canada (e.g., Calgary Water), have transformed their fragmented risk capabilities into cogent corporate entities:

- allowing them to create new business value from good risk governance through enhanced regulatory relationships and reduced business losses; and
- making them more resilient as utilities.

2. Underpinning research (indicative maximum 500 words)

Water utilities must supply safe, wholesome, and affordable drinking water that consumers can trust. In doing so, they manage a myriad of risks *preventatively*, because contaminated drinking water cannot be 'recalled' once supplied. In 2003, the international water sector accepted an over-reliance on compliance monitoring, in isolation, as an inadequate defence against waterborne disease. The International Water Association issued the "*Bonn Charter for Safe Drinking Water*", a commitment to preventative risk management. In parallel, the complexity of business risks being faced by utility managers became more widely recognised. The sector needed to refresh its capabilities in risk management, with a more proactive approach to safer drinking water to inform asset management, corporate decisions on risk and long-term capital plans. In short, the water safety agenda and the need to manage business risks better, converged; with the ensuing requirement to adopt risk management as a formalised business process.

Drawing on Cranfield's expertise in engineering and environmental risk analysis, Pollard, Jude, and Smith researched operational (day-to-day), tactical (risks across business functions) and strategic (corporate) risks with a new network of water utility partners. Their research

established the trajectory for change, using evidence-informed industry guidance and case studies of value to public and private utilities of various populations served. In contrast to other high reliability sectors (e.g., aviation, defence), the water sector was dominantly asset-centric and analytic in its approach to risk, with a poor understanding of root-cause failure, human factors, the essential characteristics of high reliability organisations and the temporal dynamics of risk. Using critical reviews, in-company studies and semi-structured interviews, the research sought to remedy these deficiencies and:

(i) for the first time, benchmarked a suite of utilities' risk management capabilities [R1], using a maturity tool developed by Cranfield (2007) to propose improvements to risk management in the sector;
(ii) it produced an authoritative critique of risk tools, their application and the engineering and business decisions they were being used to inform (2006-7)
(iii) it highlighted the understated influence of human reliability and inter-agency relationships as key contributors to water safety and risk management cultures in the sector (2009) [R2] & [R3];
(iv) it developed a novel fusion of risk 'heat maps' with horizon-scanning methods [R4], & [R5], projecting temporal changes to a set of strategic risks to inform long term 'master plans' and discussions on utility resilience (2014-2015) in the face of increased extrinsic risk [R6].

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

[R1] MacGillivray, B.H., Sharp, J.V., Strutt, J.E., Hamilton P.D., & Pollard S.J.T., (2007) Benchmarking risk management within the international water utility sector. Part II: a survey of eight water utilities, *Journal of Risk Research* 10(1), 105- 123. https://doi.org/10.1080/13669870601011191

[R2] Wu, S., Hrudey, S., French, S.E., Bedford, T., Soane, E., & Pollard, S., (2009) A role for human reliability analysis in preventing drinking water incidents and securing safe drinking water, *Water Research* 43, 3227-3238. https://doi.org/10.1016/j.watres.2009.04.040

[R3] Jalba, D., Cromar, N.J., Pollard, S.J.T., Charrois, J.W., Bradshaw, R. & Hrudey, S.E., (2014) Effective drinking water collaborations are not accidental: interagency relationships in the international water utility sector, *Science of the Total Environment* 470, 934-944. https://doi.org/10.1016/j.scitotenv.2013.10.046

[R4] Luís, A., Lickorish, F., & Pollard, S., (2015) Assessing interdependent operational, tactical and strategic risks for improved utility master plans, *Water Research* 74, 213-226. https://doi.org/10.1016/j.watres.2015.02.021

[R5] Luís, A., Pollard, S., & Lickorish, F., (2016) Evolution of strategic risks under future scenarios for improved utility master plans, *Water Research* 88, 719-727. https://doi.org/10.1016/j.watres.2015.10.057

[R6] Chalker, R.T.C., Pollard, S.J.T., Leinster, P.L., & Jude, S., (2018) Appraising longitudinal trends in the strategic risks cited by risk managers in the international water utility sector, 2005-2015, *Science of the Total Environment* 618, 1486-1496. https://doi.org/10.1016/j.scitotenv.2017.09.294.

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

The key impacts emerged within the census period from 2014 onwards, as risk managers in the sector began deploying the guidance from this research with their Executive bodies and Boards.

Background

The risk manager network created by the Cranfield team early on (2003 to 2006), and the practical guidance on the machinery of risk management (2006 to 2013) led to higher quality engagements; it cemented collaboration on risk between utility executives, Boards and regulators; and it improved their associated corporate planning processes. Impacts below emerged within the census period from a rich system of knowledge exchange between the Cranfield team and 25 international risk managers that would not have otherwise exchanged their expertise.

Creating business value from good risk governance, 2014 to 2016. (**Political impact**)

The long-term research aim has been to underpin the successful deployment of risk management within the sector, create business value and shape thinking on utility resilience; critical because extrinsic threats (cyber-attack, climate change, access to external investment; pandemics) have become more prominent [R6]. Over 150 individuals from over 60 utilities and their stakeholders from 10 countries (UK, USA, Canada, Australia, Portugal and others) have participated in the network, indicating the global reach achieved (network attendance and funding stated in US Water Research Foundation report frontispieces [S10]. By 2014 onwards, the combined findings [S1] were sufficiently impactful for Pollard to chair sector-facing dissemination workshops in Calgary and Philadelphia [S2] and to address [S3] the opening session of the 2015 International Water and Climate Forum, the biennial meeting of utility managers in North America.

The risk and futures methodology [R4] & [R5] is embedded within EPAL's (Empresa Portuguesa das Aguas Livres) terms of reference for its revised Master Plan, which will include investments to EPAL's water supply system. A number of significant capital investments were informed by the methodology for EPAL, most notably, duplication of the 18km 'Castelo do Bode' trunk main for Lisbon, an investment of *ca.* EUR 30M, included in the current capital investment plan. An options appraisal evaluated four alternatives and risk/opportunity/performance comparisons were made. The option selected was the most expensive, but considered of greatest long-term value, given the higher levels of resilience and long-run benefits for this option under projected climate change conditions *(Administrador Executivo do Conselho de Administração, Águas do Tejo Atlântico)* [S8a&b].

Following this, Pollard and Jude led a risk governance pilot study for Philadelphia Water, seconding Chalker (Cranfield research assistant) to support the utility's in-house team [R7] & [S9]. Visibility of the research led to Pollard supporting Canada's first standard (CAN/UL2984) on managing public risk [S4a&b] and a request to produce a 2nd edition of his primer on risk for water professionals [S5]. Pollard has since communicated the programme's findings to the National Infrastructure Commission at Royal Academy of Engineering and through the Academy's Engineering Policy Centre.

It is challenging to quantify the *avoidance* of harm and loss from risks managed well. However, testimonials from the UK, US and Portugal underline the reach and contribution of this research towards formalising risk management within the sector [S6]-[S9]. Yorkshire Water commented on the transformation of their risk management capability as a result of their engagement with the research:

> *"We had a very dispersed, disconnected enterprise risk management system in Yorkshire Water back in 2009 to 2010 that was assessed at a basic level of maturity on all the Cranfield maturity models. Since that point, I have implemented a wide-ranging transformation of the company-wide risk*

> *management system of internal control, and taken the maturity up to a mature and, in some areas, advanced state. This has been based upon the fundamental maturity models provided out of the Water Research Foundation research, the basics of risk management and implementing concepts such as Bow Tie Analysis, PESTLE and source pathway receptor tools and techniques for risk identification and management."*
>
> *"Yorkshire Water has also benefited through being able to reference with our regulators OFWAT and the EA that we have been researching. Why does this benefit? Well, the team at Cranfield are recognised internationally and nationally in the UK as a centre of expertise in risk and resilience, so this connection provides assurance to our regulators that we take our licence obligations and the need to follow leading practise seriously."* (Risk and Compliance Manager, Yorkshire Water) [S7].

In Portugal, EPAL, with their newly-formed team built a risk-informed approach [R4] & [R5] to capital planning. A former Cranfield PhD recipient, promoted to Director given her leadership on risk, commented that through association with this research:

> *"EPAL assumed the leadership in risk management in the water sector in Portugal, having been disseminating this knowledge not only within the sector but also across sectors. Internationally, and apart from sharing our experience and knowledge in congresses and seminars, EPAL is now working with the World Bank helping other utilities to become "utilities of the future", where risk management plays an important role"* (Administrador Executivo do Conselho de Administração, Águas do Tejo Atlântico) [S8a&b].

Towards organisational resilience, 2016-2020. (**Political impact**)

Cranfield and its sustained network of risk managers continues to secure funding on the practical actions that utilities can take to govern risk better and secure resilience in the face of increased extrinsic threat. In 2017, Smith and Jude were funded by the US Water Research Foundation to develop a prioritised research agenda on resilience to guide future funding priorities. The most pressing need remains in organisational resilience [S6]. Several workshop attendees were members of the US Water Utility Climate Alliance (WUCA) and Smith has supplied further case studies on resilience in strategic infrastructure planning for WUCA guidance and training materials.

In a follow-on 2018 workshop, hosted by EPAL and chaired by Jude, 15 members of the network began drafting their own resilience case studies for forthcoming Foundation guidance by Cranfield in response to calls for better resilience from regulators and the US Effective Utility Management Review Steering Group (2016). Philadelphia Water Department (PWD) have found this engagement especially rewarding:

> *"The work with Cranfield University has been, absolutely, instrumental to PWD's internal thinking on risk management and documentation. As the water and wastewater industries in the USA move forward, there will no doubt arise an increased interest in risk governance concepts and tools. This is already evident in the American Water Works Association's Standard G410-18, Business Practices for Operations and Management (2018) wherein aspects of risk governance are provided. Also, this year (2020) large water utilities in the USA must complete Risk and Resilience Assessments to comply with America's Water Infrastructure Act. The background education provided by Cranfield University in risk governance helped PWD's engineers understand the risk concepts applied by the assessment"* (Director, Bureau of Laboratory Services, Philadelphia Water Department) [S9].

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

[S1] Mauelshagen, C., Jude, S., Pollard, S., Hrudey, S.E., Owen, D., Fesko, P., & Pritchard, R., (2016) Risk governance: achieving value by aligning risk governance with other business functions in water utilities (TC #4573), *Water Research Foundation*, Denver, Co., USA, ISBN 978-1-60573-252-7, 117 https://www.waterrf.org/research/projects/securing-value-integrating-risk-governance-other-business-functions-international

[S2] Pollard, S.J.T., & Owen, D., (2014) Risk management for water utility organizations. Presented at the US Water Research Foundation risk governance workshop, *Chemical Heritage Foundation*, Philadelphia Water Department, Philadelphia, US, March 3rd, 2014. https://www.waterrf.org/event/risk-management-water-utility-organizations-2014

[S3] Pollard, S., Jude, S., Holman, I., & Weatherhead, E.K., (2015) Risk, resilience, and foresight: improved strategic planning for utilities. *International Water and Climate Forum*, San Diego, CA, December 7-9, 2015 https://www.amwa.net/article/international-forum-celebrates-waterclimate-progress-envisions-future

[S4a&b] [a] Invitation to participate in the development of a guideline for managing risks to the public interest
[b] Underwriters Laboratories of Canada (2019) CAN/UL 2984 Management of Public Risks – Principles and Guidance, UL Standards, Mississauga, ON, Canada https://ulstandards.ul.com/downloads/ul-publishes-first-ever-guideline-on-public-risk-management/

[S5] Pollard, S.J.T., (2016) *Risk management for water and wastewater utilities, 2nd Edition*, IWA Publishing, London, ISBN 9781780407470, 180pp. https://www.iwapublishing.com/books/9781780407470/risk-management-water-and-wastewater-utilities-%E2%80%93-second-edition

[S6] Fulmer, A., & Burlingame, G., (2018) *Adv. Water Res.* Oct-Dec 2018, 20-22. http://www.advancesinwaterresearch.org/awr/20181012/MobilePagedReplica.action?pm=2&folio=20#pg22

[S7] Group Risk and Compliance Manager, Yorkshire Water and Kelda Water

[S8a&b] [a] Testimonial - Director of Asset Management Division, EPAL, Portugal
[b] Email - Director of Asset Management Division, EPAL, Portugal

[S9] Director of Bureau of Laboratory Services, Philadelphia Water Department

[S10] https://www.waterrf.org/search?keyword=Simon%20Pollard&topic=Risk%20Assessment
(See Corroborating Evidence Zip File for copies a,b,c &d)