

People and Practices: Fostering transitions toward sustainability through transdisciplinary inquiry and individual, social and organisational learning

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree and nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and in the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student:

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To my utter astonishment...

To the supporters, mentors, supervisors, advocates and friends that have buffered me from my own insecurities, sat silently listening to the confused, messy process of clarifying my thoughts, picked me off the ground, dusted me off and gently shoved me back into the doctoral abyss ... you believed in me until I finally grew enough, both professionally and personally, to believe in myself.

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RELEVANT PUBLICATIONS

Journal papers

1. Fam D., Mitchell C.A., & Abeysuriya K. (2013) 'Facilitating organisational learning to support decision making and planning for sustainability in the water sector', *Water Policy*, vol. 15, pp. 1094-1108
2. Fam D. & Mitchell C.A., (2013), 'Sustainable innovation in wastewater management: lessons for nutrient recovery and reuse', *Local Environment*, vol. 18, no. 7, pp. 769-780
3. Lopes, A., Fam, D., Williams, J. (2012) 'Designing sustainable sanitation: involving design in innovative, transdisciplinary research', *Design Studies*, Elsevier, UK, pp. 1-22.
4. Abeysuriya, K.R., Fam, D. & Mitchell, C.A. (2012), 'Reinventing the toilet - Urine diversion where it's needed most', *The Conversation*, vol. 24 October.
5. Fam, D.M., Mellick-Lopes, A., Willetts, J.R. & Mitchell, C.A. (2009), 'The challenge of system change: an historical analysis of Sydney's sewer systems', *Design Philosophy Papers*, vol. 3/2009, pp. 1-14.
6. Fam, D.M., Mitchell, C.A., Abeysuriya, K.R. & Lopes, A. (in-press) 'Emergence of decentralised water and sanitation systems in Melbourne, Australia', *International Journal of Water*, Inderscience Publishers, United Kingdom
7. Fam D., Abeysuriya K., Mitchell C., Lopes A. & Smith T (submitted) 'Facilitating sustainable innovation by designing socio-technical experiments as social learning systems', *Journal of Cleaner Production*
8. Fam, D.M. & Lopes, A., (submitted), 'Toilets practices and system change: lessons from a transdisciplinary research project', *Journal of Design Research*

Conference papers

9. Fam D.M., Abeysuriya, K., Meek, T., Sharples J., Mitchell C.A.,(2012), Social learning is essential in transitioning to sustainable water services, *OzWater12*, 8-10th May, Darling Harbour, Sydney

10. Fam, D.M., Mitchell, C.A., Abeysuriya, K.R. & Lopes, A. (2011), 'Facilitating social learning in transdisciplinary collaboration: a socio-technical experiment in implementing sustainable sanitation', All together now - working across disciplines: People, principles and practice, Hull, UK, July 2011 in *55th Meeting of the International Society for the Systems Sciences*, (eds) Wilby, J. and Klein, L., International Society of Systems Scientists, Conference proceedings.
11. Fam, D.M., Mitchell, C.A. & Abeysuriya, K.R. (2011), 'Learning to facilitate learning', 2nd International Conference on Sustainability Transitions - Diversity, plurality and change: breaking new grounds in sustainability transition research, Lund University, Lund, Sweden, June 2011 in *2nd International Conference on Sustainability Transitions*, (ed) Smith, A. and Grin, J., Lund University, Lund University.
12. Abeysuriya, K.R., Fam, D.M., Hagare, P. & Williams, J. (2010), 'Transitioning to sustainable sanitation through cross disciplinary, practice-based research: an on-campus pilot of urine diversion at UTS', International conference of Australasian campuses towards sustainability (ACTS Inc): connecting curriculum and campus, Melbourne, Australia, September 2010 in *The 10th international conference of Australasian campuses towards sustainability (ACTS Inc): connecting curriculum and campus*, (eds) Royal Melbourne Institute for Technology (RMIT), Melbourne, Australia, pp. 1-8.
13. Fam, D., Mitchell, C.A. & Abeysuriya, K.R. (2010), 'Institutional challenges to system innovation in wastewater management - the case of urine diversion in Sweden', Cities of The Future 2010, Marriott hotel, Boston, USA, March 2010 in *Cities of The Future 2010*, (ed) IWA, IWA, Boston, USA.
14. Lopes, A., Fam, D. & Williams, J. (2010), 'Designing sustainable sanitation through transdisciplinary research: A pilot project of nutrient recovery and reuse', Young Creators for Better City and Better Life - Cumulus Shanghai Conference 2010, Shanghai, September 2010 in *Cumulus Working Papers, Shanghai*, (eds), College of Design and Innovation, Tongji University, Shanghai, pp. 339-346.
15. Mitchell, C.A., Abeysuriya, K.R., Willetts, J.R. & Fam, D.M. (2010), 'Enabling decentralised urban sewage infrastructure by facilitating successful

organisations to provide long-term management', Cities of the Future 2010, Marriott Hotel, Boston, USA, March 2010 in *Cities of The Future 2010*, (eds) IWA, IWA, Boston, USA.

16. Fam, D.M., Mitchell, C.A. & Abeysuriya, K.R. (2009), 'Critical stakeholder engagement in shifting paradigms from removal to recovery in wastewater management - a case study of implementing urine diversion in Sweden', Brisbane, November 2009 in *Asia-Pacific Science, Technology and Society Network Conference 2009*, Griffith University, Queensland.
17. Fam, D., Mitchell, C.A., Abeysuriya, K.R. & Lopes, A. (2009), 'Distributed wastewater management in Melbourne, Australia: A case study of transition in practice', Dynamics and governance of transitions to sustainability, Amsterdam, June 2009 in *1st European Conference on Sustainability Transitions*.
18. Mitchell, C.A., Abeysuriya, K.R. & Fam, D.M. (2009), 'Sanitary systems: lifecycle thinking leads to consideration of distributed infrastructure', The Global Challenge of Managing Life Cycles, Cape Town, South Africa, September 2009 in *4th International Conference on Life Cycle Management*, (eds) von Blottnitz, H. and Winter, M., Department of Chemical Engineering, University of Cape Town, South Africa, Cape Town, South Africa, pp. 1-7.
19. Fam, D., Mitchell, C.A. & Lopes, A. (2008), 'Is design the answer to cultural acceptability of waterless toilets? a collaborative approach to design research', Torino, Italy, July 2008 in *Changing the Change - Design Visions, Proposals and Tools*, (eds) Cipolla C. & Peruccio P., Umberto Allemandi & Co., Torino.

Reports

20. Mitchell, C.A., Fam, D.M. & Abeysuriya, K.R. (2013), 'Transitioning to sustainable sanitation: a transdisciplinary pilot project of urine diversion', Institute for Sustainable Futures, UTS, Sydney, pp. 1-137
21. Mitchell, C., Fam, D. & Abeysuriya, K. (2011), Mutual Learning for Social Change: Using social research to facilitate the introduction of urine diverting toilets in the Kinglake West Sewerage Project. Prepared for Yarra Valley Water by the Institute for Sustainable Futures, University of Technology, Sydney.
22. Fam, D.M., Mitchell, C.A. & Abeysuriya, K.R. (2010), 'Kinglake mutual learning for social change project - international and local review of user manuals for

urine diverting toilets', Prepared for Yarra Valley water by the Institute of Sustainable Futures, University of Technology, Sydney.

23. Mitchell, C.A., Fam, D. & Cordell, D.J. (2010), 'Effectively managing the transition towards restorative futures in the sewage industry: a phosphorus case study p.84-97 in 'Water Sustainability and International Innovation: The Baltimore Charter - A Transformation in Managing Water"', (eds) Nelson, V., Moddemeyer, S. and Stonebridge, J., Published by Coalition for Alternative Wastewater, Manchester, UK, pp. 83-96.
24. Mitchell, C.A., Abey Suriya, K.R. & Fam, D. (2008), 'Development of qualitative decentralized system concepts for the 2009 Metropolitan Sewerage Strategy. vol 1: synthesis report', Institute for Sustainable Futures, UTS, Sydney, Australia.
25. Mitchell, C.A., Abey Suriya, K.R. & Fam, D.M. (2008), 'Development of qualitative decentralized system concepts for the 2009 Metropolitan Sewerage Strategy. vol 2: concepts and case studies', Institute for Sustainable Futures, UTS, Sydney, Australia.

Industry Publications

26. Fam, D.M. & Abey Suriya, K.R. (2011), 'Toilet talk', *WME Magazine*, vol. 22, no. 4, pp. 32-32.

Book Chapters

27. Mitchell, C.A., Fam, D.M. & Cordell, D.J. (2011), 'Effectively managing the transition towards restorative futures in the sewage industry: a phosphorus case study' in Howe, C. and Mitchell, C. (eds), *Water Sensitive Cities*, IWA Publishing, UK, pp. 1-23.
28. Willetts J., Mitchell C.A., Abey Suriya K. & Fam D. (2012) Creative tensions: negotiating the multiple dimensions of a transdisciplinary doctorate, in Lee A. & Danby S. (eds) *Reshaping Doctoral Pedagogies*, Routledge

PAPERS THAT CONSTITUTE THIS THESIS BY PUBLICATION

This thesis is based on the following six papers which will be referred to in the text by Roman numerals:

Paper I:

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Paper II:

Fam, D.M., Mitchell, C.A., Abeysuriya, K.R. & Mellick-Lopes, A. (in-press) 'Emergence of decentralised water and sanitation systems in Melbourne, Australia', *International Journal of Water*

Paper III:

Fam D. & Mitchell C.A., (2013), 'Sustainable innovation in wastewater management: lessons for nutrient recovery and reuse', *Local Environment*, vol. 18, no. 7, pp. 769-780

Paper IV:

Fam D., Mitchell C.A., & Abeysuriya K. (2013) 'Social learning in planning for sustainability - an Australian perspective on trialling sustainable water services', *Water Policy*, vol. 15, pp. 1094-1108

Paper V:

Fam D., Lopes A. & Abeysuriya K. (submitted) 'Facilitating sustainable innovation by designing socio-technical experiments as social learning systems', *Journal of Cleaner Production*

Paper VI

Fam, D.M. & Lopes, A. (submitted), 'Toilets practices and system change: lessons from a transdisciplinary research project', *Journal of Design Research*

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ABSTRACT

The goal of this thesis is to take people and practices as the primary focus in analysing past and emerging case studies of transitions in sanitation. ‘Transitions’, as structural changes in the way societal systems operate, are increasingly acknowledged as necessary for meeting sustainability goals. Uncertainties such as rapid population growth, the emergence of new pollutants, changing hydrological conditions, climate change impacts, global economic instability and declining phosphorus reserves are driving innovation and transitions in sanitation.

Integral to the process of transitioning toward sustainability are ‘people and practices’ and yet the tendency of innovation scholars is to focus on technological factors and systems of supply. This ignores the importance of the human dimensions of technological change. In light of this knowledge gap, the objective of this thesis is to investigate how ‘people and practices’ are involved in technological change and in the emergence of sustainable systems of sanitation.

Practices in this thesis are discussed at the level of *using* novel technologies (implicating end-users) and the level of *planning, designing and managing* the installation of novel technologies (implicating project teams). Complementary to the overarching framework of transition management, this transdisciplinary perspective of ‘practices’ draws on literature from practice theory, social and organisational learning and communities of practice.

Six case studies of transitions in sanitation, over three cycles of research, provide insight into how transitions have *historically occurred, are occurring at present and might be more readily facilitated in the future*. The diverse range of cases span temporal (historical and real-time cases), geographic (local and international cases) and spatial (community and city scale cases) scales with a primary focus on the emergence of urine diversion (UD) in Sweden and Australia.

The sociological perspective adopted to study transitions in sanitation revealed the complex relationship between sanitation technologies, and the users/consumers and managers/providers of these systems. Contributions to new knowledge resulting from this research span praxis and methodology. This has included identification of principles for designing experiments to support social learning in transdisciplinary projects inclusive of end-users, processes for engaging end-users in adopting new

practices through social learning, and methods for translating individual learning into organisational learning and change by organisations trialling sustainable innovation. Methodological contributions include the identification and application of a cumulative staged approach to case study research on transitions and demonstration of the value and validity of qualitative social research in facilitating and supporting the emergence of new and fragile practices.