2019 Doctoral Research Opportunities

Six PhD projects are available at the New Zealand – China Water Research Centre, funded by the China Scholarships Council. Students will be enrolled at Lincoln University, New Zealand. The scholarship covers four years stipend and travel, and applications are made through the China Research Council. See descriptions below for more information on the projects. Enquiries in the first instance should be made to Professor Hong Di, Director of the New Zealand China Water Research Centre. Email: hong.di@lincoln.ac.nz

New Zealand – China Water Research Centre
新西兰－中国水研究中心

2019 PhD Proposal – China Scholarships Council and New Zealand – China Water Research Centre Joint PhD Programme Application

Information to be published on NZ – China Water Centre website if proposal is selected	
Project title	Greenhouse gas emissions from treated farm dairy effluent
Supervisors titles and names	Professor Hong J Di, ONZM, FRSNZ and Professor Keith Cameron, ONZM, FRSNZ
Department	Soil and Physical Sciences
School / Centre	Centre for Soil and Environmental Research
University	Lincoln University
Email contact address	Hong.di@lincoln.ac.nz
Link to Supervisor's research page	Hong Di: http://www.lincoln.ac.nz/About-Lincoln/Staff-Profiles/?sti=1&StaffID=Di+Hong Keith Cameron: http://www.lincoln.ac.nz/About-Lincoln/Staff-Profiles/?sti=1&StaffID=Cameron+Keith
Project outline Please outline the PhD project in 300 words (approx)	Farm dairy effluent (FDE) is a mixture of dung, urine and wash water from the dairy milking shed. It is common practice in New Zealand to irrigate FDE to dairy pastoral land to recycle the nutrients and dispose of the large volume of liquid effluent. However, there is risk of nutrient losses and water contamination if applied at the wrong time or in excessive amounts. Farm dairy effluent is a source of greenhouse gases and application of FDE onto land also produces greenhouse gases. Recently new FDE treatment technologies have been developed to recycle the water in FDE and to reduce the risks of water contamination. However, the effect of treated FDE on greenhouse gas emissions are unknown at this time. The objectives of this PhD project is therefore to determine the greenhouse gas emissions from the treated FDE as compared with the untreated FDE during storage and when applied to land, and develop management practices to reduce the greenhouse gas emissions. In

	addition, the effect of the land application of the treated and untreated FDE on soil microbial populations will also be studied to understand the microbial processes that drive the greenhouse gas emissions when effluent is applied to land.
References for further reading (optional)	
Please indicate if research operational funding is available to support the project, and if so, the sources of funding.	The operational costs of this project are funded by industry.

2019 PhD Proposal – China Scholarships Council and New Zealand – China Water Research Centre Joint PhD Programme Application

Information to be published on NZ – China Water Centre website if proposal is selected	
Project title	Environmental impacts of animal excrement application and mitigation options
Supervisors titles and names	Prof. Hong J Di; Dr Jiafa Luo; Professor Keith Cameron; Dr Stewart Ledgard; Dr Lin Ma
Department	
School / Centre	Faculty of Agriculture and Life Sciences, Lincoln University Ruakura Research Centre, New Zealand Center for Agricultural Resources Research, CAS, China
University	Lincoln University AgResearch Chinese Academy of Sciences
Email contact address	Hong.di@lincoln.ac.nz Jiafa.luo@agresearch.co.nz;
Link to Supervisor's research page	https://www.lincoln.ac.nz https://www.agresearch.co.nz http://sourcedb.sjziam.cas.cn/zw/zjrck/yjy/201407/t20140717_4160140.html
Project outline Please outline the PhD project in 300 words (approx)	**Hypothesis:** Application of animal excrement can improve soil quality and enhance forage yield; however, it can also impact detrimentally on the environment. These environmental impacts can be abated by appropriate mitigation options. – Animal excrement input is regarded as an effective way to improve soil quality and forage yield(Ould Ahmed et al., 2010; Domingo-Olivé et al., 2016; Bai et al., 2018; Drake et al., 2018). But its detrimental environmental impacts, such as greenhouse gas emissions and nutrient losses, could outweigh these merits(Häni et al., 2016; Luo et al., 2017). Nitrification inhibitors have been used to mitigate nitrate leaching and nitrous oxide emission(Di et al., 2009; Luo et al., 2013; Di et al., 2014) and slurry injection has been used to reduce ammonia volatilization(Velthof and Mosquera, 2011). Different mitigation options can result in trade-offs among different greenhouse gases and nutrient losses. It may be possible that some mitigation strategies are able to reduce the overall detrimental impacts of animal excrement application without compromising the positive effects on soil quality and forage yield. **Research questions:**

	- What are the environmental impacts of animal excrement application? - Can such environmental impacts be abated by appropriate mitigation options? - What are the trade-offs among environmental impacts caused by different mitigation options? **Objectives:** - To quantify the greenhouse gas emissions and nutrient losses from animal excrement application - To explore appropriate mitigation options to abate the environmental impacts - To ascertain the trade-offs among these environmental impacts **Materials and methods:** - Field experiments and glasshouse work will be undertaken, combined with laboratory analysis, to answer the research questions. - The environmental impacts of animal excrement application - Animal manure and urine will be applied to soil, each at four different application rates. Ammonia (NH_3) and greenhouse gas (GHG, i.e. CO_2, N_2O, CH_4) emissions and nitrate leaching will be measured. Dynamic and static chamber methods will be used to measure NH_3 and GHG emissions, separately. Nitrate sensors will be installed in the soil to monitor nitrate leaching. Soil pH value, temperature, bulk density and water content will be measured to explain the underlying causes of the environmental effects. - Mitigation options to abate GHG emissions and trade-offs among different gases - Mitigation options such as broadcasting, manure incorporation, slurry and urine injection will be compared. Methods for measuring NH_3 and GHG emissions will be the same as above. The actual global warming potential under the different options will be calculated from the measured data. Potential trade-offs among emissions of NH_3, N_2O, CH_4 and CO_2 will be clarified. Soil variables, such as soil temperature and water content will be used to explain results. - Mitigation options to abate nitrate leaching and trade-offs with different greenhouse gases - Nitrification inhibitors (NI), like dicyandiamide (DCD), will be used to reduce nitrate leaching. Nitrate content in different soil layers will be measured to quantify the leaching potential of each inhibitor treatment. For field work, nitrate sensors will be installed at a depth of 150 cm to monitor the nitrate content of the ground water in real time. For glasshouse experiments, leachate will be collected directly for laboratory analysis. NH_3 and GHG emissions will be measured. The trade-offs between nitrate leaching and various GHG emissions will ultimately be quantified. **Novelty aspect:** - By clarifying the potential trade-offs among different options when attempting to reduce the environmental impacts caused by animal excrement application to soil, this study would enable identification of optimal mitigation solutions.

References for further reading (optional)	References Bai, Z., Caspari, T., Gonzalez, M.R. et al., 2018. Effects of agricultural management practices on soil quality: A review of long-term experiments for Europe and China. Agriculture, Ecosystems & Environment, 265: (10.1016/j.agee.2018.05.028) 1-7. Catt, J.A., 2001. The agricultural importance of loess. Earth-Science Reviews, 54(1): (https://doi.org/10.1016/S0012-8252(01)00049-6) 213-229. Di, H.J., Cameron, K.C., Podolyan, A. and Robinson, A., 2014. Effect of soil moisture status and a nitrification inhibitor, dicyandiamide, on ammonia oxidizer and denitrifier growth and nitrous oxide emissions in a grassland soil. Soil Biology and Biochemistry, 73: (10.1016/j.soilbio.2014.02.011) 59-68. Di, H.J., Cameron, K.C., Shen, J.P., Winefield, C.S., O'Callaghan, M., Bowatte, S. and He, J.Z., 2009. Nitrification driven by bacteria and not archaea in nitrogen-rich grassland soils. Nature Geoscience, 2(9): (10.1038/ngeo613) 621-624. Domingo-Olivé, F., Bosch-Serra, À.D., Yagüe, M.R., Poch, R.M. and Boixadera, J., 2016. Long term application of dairy cattle manure and pig slurry to winter cereals improves soil quality. Nutrient Cycling in Agroecosystems, 104(1): (10.1007/s10705-015-9757-7) 39-51. Drake, J.A., Patti, A.F., Whan, K., Jackson, W.R. and Cavagnaro, T.R., 2018. Can we maintain productivity on broad acre dairy farms during early transition from mineral to compost fertilization? Agriculture, Ecosystems & Environment, 257: (10.1016/j.agee.2017.12.022) 12-19. Häni, C., Sintermann, J., Kupper, T., Jocher, M. and Neftel, A., 2016. Ammonia emission after slurry application to grassland in Switzerland. Atmospheric Environment, 125: (10.1016/j.atmosenv.2015.10.069) 92-99. Kang, S., Zhang, L., Liang, Y., Hu, X., Cai, H. and Gu, B., 2002. Effects of limited irrigation on yield and water use efficiency of winter wheat in the Loess Plateau of China. Agricultural water management, 55(3): 203-216. Laurenson, S., Cichota, R., Reese, P. and Breneger, S., 2018. Irrigation runoff from a rolling landscape with slowly permeable subsoils in New Zealand. Irrigation Science, 36(2): 121-131. Luo, J., Ledgard, S.F. and Lindsey, S.B., 2013. Nitrous oxide and greenhouse gas emissions from grazed pastures as affected by use of nitrification inhibitor and restricted grazing regime. Sci Total Environ, 465: (10.1016/j.scitotenv.2012.12.075) 107-14. Luo, J.F., Wyatt, J., van der Weerden, T.J. et al., 2017. Potential Hotspot Areas of Nitrous Oxide Emissions From Grazed Pastoral Dairy Farm Systems. Advances in Agronomy, Vol 145, 145: (10.1016/bs.agron.2017.05.006) 205-268. Ould Ahmed, B.A., Inoue, M. and Moritani, S., 2010. Effect of saline water irrigation and manure application on the available water content, soil salinity, and growth of wheat. Agricultural Water Management, 97(1): (10.1016/j.agwat.2009.09.001) 165-170. Poulsen, D., 2013. http://www.lincoln.ac.nz/Lincoln-Home/About-Lincoln/Staff-Profiles/?StaffID=Almond+Peter Technical Report R13/60 Velthof, G.L. and Mosquera, J., 2011. The impact of slurry application technique on nitrous oxide emission from agricultural soils. Agriculture, Ecosystems & Environment, 140(1-2): (10.1016/j.agee.2010.12.017) 298-308.
Please indicate if research operational funding is available to support the project, and if so, the sources of funding.	China Scholarships Council is the potential supporter for this project.

New Zealand – China Water Research Centre
新西兰 – 中国水研究中心

2019 PhD Proposal – China Scholarships Council and New Zealand – China Water Research Centre Joint PhD Programme Application

Information to be published on NZ – China Water Centre website if proposal is selected	
Project title	Incorporate hydrologic connectivity into land use suitability assessment for improved water utilisation and water quality outcomes
Supervisors titles and names	Dr. Henry Chau (Lecturer); Dr. Wei Hu (Senior Scientist); Dr. Hong Di (Professor); Dr. Mike Beare (Science Group Leader, Senior Scientist, Adjunct Professor); Dr. Rogerio Cichota (Senior Scientist); Dr. Bing Si (Professor of Northwest Agriculture and Forestry University) Dr. Paul Johnstone (Science Group Leader, Senior Scientist)
Department	Department of Soil and Physical Sciences (Lincoln University); Sustainable Production Portfolio (Plant & Food Research, New Zealand)
School / Centre	
University	Lincoln University; Plant & Food Research, New Zealand Northwest Agriculture and Forestry University (China)
Email contact address	Wei.Hu@plantandfood.co.nz; Henry.Chau@lincoln.ac.nz
Link to Supervisor's research page	https://scholar.google.co.nz/citations?user=bGdRRLMAAAAJ&hl=en (Wei Hu) https://scholar.google.co.nz/citations?user=Of55BZoAAAAJ&hl=en (Mike Beare) https://scholar.google.co.nz/citations?user=KmHTHKIAAAAJ&hl=en (Henry Chau) http://www.lincoln.ac.nz/Lincoln-Home/About-Lincoln/Staff-Profiles/?sti=1&StaffID=Di%20Hong (Hong Di) https://www.researchgate.net/scientific-contributions/81267796_Rogerio_Cichota (Rogerio Cichota) https://scholar.google.co.nz/citations?user=N3uQ6LQAAAAJ&hl=en (Bing Si) https://scholar.google.co.nz/citations?user=tAPkGFEAAAAJ&hl=en (Paul Johnstone)
Project outline Please outline the PhD project in 300 words (approx)	Land use change and intensification is imposing a pressing and worldwide common challenge-how to intensify agricultural production to meet increasing demand for safe and sustainable food supply, while maintaining or enhancing environmental outcomes. To this end, there is an increasing need to incorporate water quantity and quality outcomes into land use suitability decision making. Hydrologic connectivity (e.g., drainage and runoff) among soil, ground, and surface water at the watershed scale affects not only water utilisation but also agricultural

	contaminant losses (e.g., nitrate, P, agrichemicals) as water is a carrier of chemical elements. Therefore, improved water utilization and water quality outcomes are expected by reducing hydrologic connectivity between the source area of land use pressures and aquatic receiving environments. Meanwhile, hydrologic connectivity can be influenced by a range of biophysical attributes (e.g., soil water regulating function, constraints of land parcels, landform, and climate) and plant water demand. This PhD project proposal is based on the hypothesis: significant improvements in agricultural water utilisation and reductions in contaminant losses can be achieved by matching land use and management practices with those biophysical attributes that reduce the hydrologic connectivity between the source area of land use pressures and aquatic receiving environments. The main objectives include: (1) identifying critical factors that affect soil water regulating functions (e.g., water storage and release) and their interactions with biophysical attributes that influence hydrologic connectivity (e.g., drainage and run-off); (2) developing a conceptual model of incorporating hydrologic connectivity into land use suitability assessment; and (3) assessing the influence of land use on water use efficiency and water quality outcomes under different biophysical environments (soil, topography and climate) using the developed conceptual model and a suitable existing model (e.g., SWAT, HYDRUS, APSIM). We welcome applicants who have experience and knowledge in soil functions, water and solute transfer, nutrient and contaminant losses, land use management, biophysical modelling and production systems.
References for further reading (optional)	Covino T, 2017. **Hydrologic connectivity** as a framework for understanding biogeochemical flux through watersheds and along fluvial networks. Geomorphology 277, 133-144. McDowell RW et al., 2018. The **land use suitability** concept: Introduction and an application of the concept to inform sustainable productivity within environmental constraints. Ecological Indicators 91, 212-219. Hatfield JL., 2001. Managing soils to achieve greater **water use efficiency**: A review. Agronomy Journal 2, 271-280. Vereecken, H et al., 2010. Using **Pedotransfer Functions** to Estimate the van Genuchten-Mualem Soil Hydraulic Properties: A Review. Vadose Zone Journal 9, 795-820. Borah DK and Bera M., 2004. Watershed−scale **hydrologic and nonpoint−source pollution models**: review of applications. Transactions of the ASAE 47, 789-803.
Please indicate if research operational funding is available to support the project, and if so, the sources of funding.	2018 Catalyst: Strategic Investment Round – April (Preferred if successful) SSIF funding from the Land Use Suitability project in Plant & Food Research's Sustainable Agro-ecosystems programme (Alternative)

2019 PhD Proposal – China Scholarships Council and New Zealand – China Water Research Centre Joint PhD Programme Application

Information to be published on NZ – China Water Centre website if proposal is selected	
Project title	Functional and compositional responses of soil microbial communities to the long-term application of biosolids to a coastal pine forest
Supervisors titles and names	Professor Hong J. Di, Dr Jianming Xue, Professor Keith Cameron, Dr Wenhua Wei and Dr Jiafa Luo
Department	Soil and Physical Sciences, Lincoln University in collaboration with SCION, AgResearch, and The University of Otago
School / Centre	Faculty of Agriculture and Life Sciences
University	Lincoln University
Email contact address	Hong.Di@lincoln.ac.nz or Jianming.xue@scionresearch.com
Link to Supervisor's research page	http://www.lincoln.ac.nz/Lincoln-Home/About-Lincoln/Staff-Profiles/?sti=1&StaffID=Di%20Hong http://www.cibr.org.nz/the-cibr-team/soil-science/
Project outline Please outline the PhD project in 300 words (approx)	Biosolids, rich in organic carbon (C) and nutrients, are commonly used as soil amendments on cropland, and preferably on forestland in New Zealand. Biosolids from the Nelson regional wastewater treatment plant have been applied to a 1000-ha radiata pine plantation at Rabbit Island since 1996. Applications of biosolids have been proved to be very beneficial to trees growing on this site. However, the underlying mechanisms of how this management practice improved the functions and services of the soil ecosystem remain unknown. Additionally, how will anthropogenic nutrient addition alter ecosystem processes, leading to declining groundwater quality? The aims of this PhD project are: (1) to determine the microbial feedbacks to environment changes that are involved in C and nitrogen (N) cycling in the plant-soil coupling ecosystem subjected to biosolids amendment, (2) to investigate the impacts of biosolids application on the stability of soil organic matter in sandy soil. This project will test the following hypotheses: 1. The biosolids application would change the quantity and quality of soil organic matter and other edaphic properties. These changes are expected to significantly affect soil microbial community and functional activities, resulting in different soil C and N transformation processes and availability between biosolids application and control soils.

	2. As the soil microbial feedbacks and soil C and N transformation processes change, biosolids application may sequentially alter the allocation strategies into aboveground and belowground compartments of forest. 3. Soil microbial feedbacks to the C and N transformation processes would induce differences in extracellular enzymes among plots. Microbial community and extracellular enzyme activities are directly mediated or influenced by the soil labile C pools and the N retention mechanisms. Biosolids application should therefore influence the total and specific enzyme activities, and changes in activities may be correlated with increases or decreases in quantity or quality of C and N fractions.
References for further reading (optional)	
Please indicate if research operational funding is available to support the project, and if so, the sources of funding.	The research operational funding from a MBIE-funded project is available to support this PhD project

2019 PhD Proposal – China Scholarships Council and New Zealand – China Water Research Centre Joint PhD Programme Application

Information to be published on NZ – China Water Centre website if proposal is selected	
Project title	Hydrological behavior of irrigated loess landscapes
Supervisors titles and names	Associate Professor Peter Almond, Dr Seth Laurenson, Dr Steve Thomas, Dr Sam Carrick
Department	Soil and Physical Sciences, Lincoln University in collaboration with Agresearch, Plant and Food Research, Landcare- Manaaki Whenua Research.
School / Centre	Faculty of Agriculture and Life Sciences
University	Lincoln University
Email contact address	Peter.Almond@lincoln.ac.nz
Link to Supervisor's research page	http://www.lincoln.ac.nz/Lincoln-Home/About-Lincoln/Staff-Profiles/?StaffID=Almond+Peterhttp://www.cibr.org.nz/the-cibr-team/soil-science/
Project outline Please outline the PhD project in 300 words (approx)	Loess-derived soils are wide spread globally and are inherently fertile (Catt, 2001) making them some of the most important soils on the planet for sustaining food supply. The Chinese Loess Plateau and the eastern sides of both islands of New Zealand include areas of intensive agriculture based on loess soils. Agriculture in both areas occurs within subhumid to semi-arid climates and water availability limits agricultural production (Kang et al., 2002; Poulsen, 2013). In New Zealand loess landscapes are often rolling in nature and only recently has spray irrigation technology advanced to allow them to be irrigated practically. Recent studies suggest problems of slow infiltration and overland flow lead to some inefficiencies of water use with the potential for contaminant transport into receiving waters (Laurenson et al., 2018). In Canterbury on the eastern side of South Island where there is expansion of irrigation onto rolling loess downlands the local territorial authority (Environment Canterbury) has commissioned a multi-agency (NIWA National Institute of Water and Atmospheric Science), Agresearch, Plant and Food, Manaaki Whenua – Landcare Research) study of the hydrology of these landscapes with focus on groundwater recharge. The study is sited in a small zero-order drainage basin where loess (multiple loess sheets) overlies alluvial gravel. Soils formed in the loess (and paleosols in buried loess sheets) are Pallic soils, characterised by dense subsurface pans (fragipans). The aim of the PhD is to characterise and quantify the flowpaths of rain and irrigation water in the drainage basin. The hypotheses are: • Overland flow is modulated by lateral throughflow above fragipans in the surface soil and in paleosols in buried loess sheets • Groundwater recharge is facilitated by transmission of water to the axis of the drainage basin where water percolates through a valley fill into underlying alluvial gravels.

	The PhD candidate would be operating within a multidisciplinary research project, and would have high levels of support for hydrological modelling, soil characterisation, meteorological measurement, and soil-geomorphology expertise from participating research organisations. Skills and knowledge would have good transferability to Chinese loess landscapes.
References for further reading (optional)	Catt, J.A., 2001. The agricultural importance of loess. Earth-Science Reviews, 54(1): (https://doi.org/10.1016/S0012-8252(01)00049-6) 213-229. Kang, S., Zhang, L., Liang, Y., Hu, X., Cai, H. and Gu, B., 2002. Effects of limited irrigation on yield and water use efficiency of winter wheat in the Loess Plateau of China. Agricultural water management, 55(3): 203-216. Laurenson, S., Cichota, R., Reese, P. and Breneger, S., 2018. Irrigation runoff from a rolling landscape with slowly permeable subsoils in New Zealand. Irrigation Science, 36(2): (10.1007/s00271-018-0570-3) 121-131. Poulsen, D., 2013. http://www.lincoln.ac.nz/Lincoln-Home/About-Lincoln/Staff-Profiles/?StaffID=Almond+Peter Technical Report R13/60
Please indicate if research operational funding is available to support the project, and if so, the sources of funding.	The research operational funding is available from Manaaki Whenua Landcare Research, Environment Canterbury and Lincoln University.